Third Five-Year Review Report for Silver Bow Creek/Butte Area Site

Volume 2: Stream Side Tailings Operable Unit

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Acronyms and Abbreviations

AMC	Anaconda Mining Company
AOC	administrative order on consent
ARAR	applicable or relevant and appropriate requirements
ARCO	Atlantic Richfield Company
BA&P	Butte, Anaconda, and Pacific Railway
BPSOU	Butte Priority Soils Operable Unit
BSB	Butte-Silver Bow
CD	Consent Decree
CDM	CDM Federal Programs Corporation
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Act Information System
CFR	Code of Federal Regulations
CFRTAC	Clark Fork River Technical Assistance Committee
cfs	cubic feet per second
COC	contaminant of concern
CQAP	Construction Quality Assurance Plan
CTEC	Citizen's Technical Environmental Committee
cy	cubic yard
ds/m	deciSiemens per meter
EC	electrical conductivity
ELG	effluent limitations guidelines
EPA	U. S. Environmental Protection Agency
ESD	explanation of significant differences
ESG	Ecological Solutions Group
HBI	Hilsenhoff biotic index
HHRBC	Human health risk based
HI	Hazard Index
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MDEQ	Montana Department of Environmental Quality
MDFWP	Montana Department of Fish, Wildlife, and Parks
MDHES	Montana Department of Health and Environmental Science

mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MR	Montana Resources
MWRR	Mine Waste Relocation Repository
NCP	National Contingency Plan
NPL	National Priority List
NSPS	new source performance standards
O&M	operation and maintenance
OU	operable unit
PEC	Probable Effects Concentrations
PRP	potentially responsible party
RAO	remedial action objective
RI/FS	remedial investigation/feasibility study
Rocker	Rocker Timber Framing and Treatment Plant
ROD	record of decision
RPM	Remedial Program Manager
RRU	Reclamation Research Unit
SAR	sodium absorption ratio
SBC	Silver Bow Creek
SBCRG	Silver Bow Creek remediation goals
SST	Streamside Tailings
TBC	to be considered
TEC	Threshold Effects Concentrations
TSS	total suspended solids
ug/L	micrograms per liter
USGS	U.S. Geological Survey
WSP	Warm Springs Ponds

SECTION 1

Introduction

The U.S. Environmental Protection Agency (EPA) Region 8 and the Montana State Department of Environmental Quality (MDEQ) have completed a Five-Year Review of the remedial actions implemented at the Silver Bow Creek/Butte Area Superfund Site, Comprehensive Environmental Response, Compensation, and Liability Act Information System (CERCLIS) ID: MTD980502777 in Silver Bow and Deer Lodge Counties, Montana. The review was conducted from September 2009 through May 2011. This report documents the results of the review for the Stream Side Tailings Site (SST or SST Site), one of the Operable Units (OU) within the Silver Bow Creek/Butte Area Superfund Site. CH2M HILL Inc., an EPA contractor, supported the Agencies in preparing this Five-Year Review.

The purpose of the Five-Year Review is to determine whether the remedy or other response action in place or under construction within the SSTOU is protective of human health and the environment and otherwise in compliance with the SST Site Record of Decision (ROD). The methods, findings, and conclusions of such reviews are documented in five-year review reports. In addition, Five-Year Review Reports identify deficiencies found during the review, if any, and identifies recommendations to address them.

The SSTOU is one of seven active, separate remedial operable units comprising the Silver Bow Creek/Butte Area Superfund Site. Table 1-1 summarizes the SSTOU review dates after completion of the ROD.

The comprehensive five-year review guidance states that reviews should be conducted either to meet a statutory mandate or as a matter of EPA policy. EPA must implement a statutory five-year review to be consistent with Comprehensive Environmental Response, Compensation, and Liability Act as amended (CERCLA) Section 121(c), which states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to assure that human health and the environment are being protected by the remedial action being implemented.*

EPA interprets this requirement further in the National Contingency Plan regulations (NCP) Section 300.430(f)(4)(ii) of the Code of Federal Regulations (CFR), which states:

> *If a remedial action is selected that results in hazardous substances, pollutants or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.*

Based on both CERCLA and NCP requirements, statutory Five-Year Reviews are required in 2010 for the started remedial actions at the entire Silver Bow Creek/Butte Area NPL Site. This report will be the third, Five-Year Review of the SSTOU. The remedial action initiation date of 1995 triggered the first and second Five-Year Reviews in 2000 and 2005, respectively. As of this writing, remedial action construction continues within the 26-mile OU on Subareas 3 and 4, both of which are scheduled to be substantially complete in 2013. Because the ROD is designed to leave waste in place, long term monitoring, institutional controls and continued Five-Year Reviews will be required to achieve and maintain long-term protectiveness.

TABLE 1-1
Stream Side Tailings Operable Unit—Summary of Five-Year Review Dates

ROD Date	Remedial Action Status	Date of Previous Five-Year Reviews	2005 Five-Year Review Requirement
11/29/1995	Subareas 1 & 2: RA complete, reveg in place, M & M ongoing	3/23/2000	Statutory
	Subareas 3 & 4: RA in progress	9/30/2005	

SECTION 2

Site Chronology

Table 2-1 presents important site events and relevant dates for the SSTOU. The identified events are illustrative, not comprehensive.

TABLE 2-1
Chronology of Site Events

Event	Operable Unit	Date
Placer gold discovered in Silver Bow Creek	00	1864
Large scale underground mining in Butte	03/08	1875 – 1955
Open pit mining at Berkeley Pit	03	1955 – 1982
Major smelting period in Butte	03/08	1879 – 1900
Discovery of mining-related contamination along Silver Bow Creek between Butte and Warm Springs, Montana	01	9/01/1979
Hazard Ranking System package completed	00	12/01/1982
Silver Bow Creek Site proposed to the NPL	00	12/30/1982
Silver Bow Creek Site (Original Portion) listed as Final on the NPL	00	09/08/1983
Silver Bow Creek (Original Portion) Phase I Remedial Investigation Final Report	00	01/1987
ROD for SSTOU	01	11/29/1995
Unilateral Administrative Order for SSTOU (Remedial Design/Remedial Action)	01	3/29/1996
Explanation of Significant Differences (ESD) for SSTOU	01	08/31/1998
Consent Decree for SSTOU, which provided for implementation of the 1996 SSTOU ROD as modified by the 1998 ESD	01	11/13/1998
Initial Five-Year Review Silver Bow Creek/Butte Area Site With Emphasis on WSP OUs	04/12	03/23/2000
Second Five-Year Review Silver Bow Creek/Butte Area Site With Emphasis on WSP OUs	00	09/2005

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SECTION 3

Background

3.1 Location and Setting

Throughout much of the 20th century, the Butte Mining District produced globally significant quantities of copper, lead, zinc, molybdenum, gold, and silver. Large-scale mining in Butte, as well as the operation of silver mills and copper and zinc concentrators/smelters, has resulted in the generation of tremendous volumes of mining-related waste including waste rock, mill tailings, slag, and aerial smelter emissions. Historically, Silver Bow Creek (SBC) and its floodplain were used to impound smelter tailings and to convey wastes out of Butte. Mining wastes carried from Butte and deposited in extensive overbank and in channel deposits, have impacted water quality throughout the entire length of SBC and the upper Clark Fork River between Butte and Missoula, Montana.

SBC originates in Butte at the confluence of the Metro Storm Drain and Blacktail Creek—forming the head waters of the Clark Fork River—and is the primary drainage feature through the Stream Side Tailings OU (see Figure 3-1). Downstream of Butte, SBC flows west about 10 miles, into Durant Canyon. Within the canyon, the creek is directed northward and enters the Southern Deer Lodge Valley and continues to flow for another 6.5 miles before entering the Warm Springs Ponds (WSP).

The SSTOU bounds the floodplain of SBC and is described in the SSTOU Administrative Order on Consent (AOC) as follows:

- The extent of fluvially deposited tailings along SBC, from the northern boundary of the Lower Area One portion of Priority Soils OU to the southern edge of the Warm Springs Ponds (WSP) OU. The width of the OU includes the adjacent railroad beds. For the purposes of remedial action, the OU boundary also includes any additional areas in close proximity to the contamination (MDHES, 1995).
- The Rocker Timber Framing and Treating Plant in Rocker, Montana is located within the floodplain of Silver Bow Creek, but is not classified as part of SSTOU. The Rocker facility retains its own OU designation.

3.2 Physical Characteristics

The SSTOU ranges in elevation from about 5,480 feet above mean sea level at the northern end of Lower area One (LOA), to about 4,920 feet above mean sea level at the Interstate 90 Bridge south of the Warm Springs Ponds inlet. The SSTOU encompasses the northern boundary of Butte as well as the entire length of SBC from its origin in the Summit Valley, through Durant Canyon, to its end at the confluence with Warm Springs Creek in the Southern Deer Lodge Valley. The SSTOU includes approximately 26 miles of stream and stream-side habitat, up to the treatment/settling lagoons of the Warm Springs Ponds.

The SSTOU lies within the Northern Rocky Mountain Physiographic Province and is characterized by a cool, semi-arid climate. Winters are long, cold, and dry, and summers are short, warm, and dry. Average maximum daily temperatures range from 14°F in January to 79°F in July. Annual precipitation in Butte averages 11.72 inches per year and generally varies from 6 to 20 inches (BPSOU PRP Group, 2002). The wettest months are May and June when the area typically receives approximately one-third of the annual precipitation. The landscape surrounding the SSTOU is characterized by high mountain peaks reaching elevations above 10000 feet. Typically, higher elevations are snow covered from October until May. Surface water and groundwater resources receive the most recharge in the spring and early summer because of melting mountain snow pack and spring rains.

The geology of the SSTOU is diverse and varies significantly from east to west. In the east, rocks in the Butte Area are largely Cretaceous intrusive rocks of the Boulder Batholith. The Boulder Batholith is comprised predominantly of quartz monzonite and is host to the ore deposit that has been extensively mined in the Butte area. Batholithic rocks extend north and west from Butte and comprise the mountains on the southern and eastern margins of the Southern Deer Lodge Valley. The Boulder Batholith is locally overlain by the Eocene Lowland Creek Volcanics, a suite of extrusive igneous rocks of quartz-latite composition (ARCO, 1995a). Silver Bow Creek flows onto the Lowland Creek Volcanics as it passes through Durant Canyon between Miles Crossing and Gregson. The Lowland Creek Volcanics are generally more resistant to weathering than the Boulder Batholith. This results in the steep-sided valley walls of Durant Canyon. The Anaconda Pintlar and Flint Creek Mountains west of the Southern Deer Lodge Valley consist of folded and faulted complexes of Precambrian metasedimentary rocks (Belt Series) and Paleozoic and Mesozoic sedimentary rocks that are intruded by granitic plutons. The SBC floodplain is dominated by Tertiary and Quaternary alluvium overlying bedrock. The thickness of alluvium ranges from less than 10 feet west of Butte (above the SSTOU) to several hundred feet in the Southern Deer Lodge Valley at the end of the SSTOU.

Silver Bow Creek is the primary drainage feature in the study area. Stream flow is measured continuously at three monitoring stations within the SSTOU by the United States Geological Survey (USGS). Monthly mean flow in SBC below Butte (period of record October 1983 to September 2004) ranges from 17.9 cubic feet per second (cfs) to 29.6 cfs, with highest average flows measured in May and lowest average flows measured in January. Similarly, monthly mean flow measured in SBC below the WSP (period of record March 1972 to September 2003) ranges from 61.6 cfs (September) to 273 cfs (June). Over the respective periods of record for the Butte and Warm Springs stations, peak stream flow was measured at 447 cfs (June 30, 1998) and 1,320 cfs (June 20, 1975), respectively. From a total maximum daily load (TMDL) perspective, the 7-day consecutive low flow with a 10-year return frequency (7Q10) for the Silver Bow Creek Stations, below Blacktail Creek, at Opportunity, and at Warm Springs were respectively, 12 cfs, 12 cfs, and 17 cfs.

Groundwater occurs in both bedrock and alluvial aquifers within the Silver Bow Creek/Butte Area site. Movement of groundwater within bedrock aquifers is controlled by open fractures and joints in the rock. Groundwater flow in alluvial aquifers is controlled by the primary porosity of the unconsolidated alluvial sediments and these aquifers generally report to SBC. Alluvial aquifers in the SSTOU are typically impacted by mining-related contaminants. Bedrock aquifers show less impact.

3.3 Land and Resource Use

The SSTOU covers an area of approximately 26 linear miles of stream and floodplain. It is a large SSTOU with diverse land uses and resources. The SSTOU lies within both Silver Bow and Deer Lodge Counties and encompasses the small urban areas of Rocker, and Ramsay, Montana. These areas are out of the active floodplain area and include urban residential, commercial, and industrial land use. Significantly, the SSTOU includes stream and stream-side habitat over the length of SBC from the northern boundary of Butte to its confluence with Warm Springs Creek. Aquatic life in SBC is severely impaired as a result of water quality and habitat degradation from mining-related contamination. Land within the SBC corridor is predominantly in public ownership (NRIS, 2005) and consists of sparsely populated open land used primarily for ranching and recreational purposes. The Warm Springs Ponds are located at the downstream end of the SSTOU and cover an area of approximately 2,500 acres. These ponds offer habitat for migrating waterfowl and breeding areas for dozens of songbird and osprey. The area is designated a wildlife refuge that is administered by the Montana Department of Fish Wildlife and Parks (MDFWP).

The active SBC floodplain does not support a residential population. Underlying alluvial aquifers are used as a source of drinking water beyond the floodplain areas.

3.4 History of Contamination

The following history of SSTOU contamination was obtained from the ROD for the SST OU (MDHES, 1995).

The first recorded disturbance of the SBC channel occurred in 1864 when placer mining techniques were used to extract gold along the stream and its tributaries (Freeman, 1900; Smith, 1952). The gold recovered by placer mining was relatively pure, in the form of dust, flakes, or nuggets. Mercury was sometimes used to “attract” small pieces of gold. This phase of mining activity was short-lived; most placer operations in the area had ceased by 1869, although minor activity continued on a few local streams (Reclamation Research Unit and Schafer and Associates, 1993).

Some evidence of early placer mining along upper portions of SBC is still evident in the form of waterways required to convey water for hydraulic mining and spoils piles (Historical Research Associates, 1983). The waterways are in disrepair and no longer convey water. As Butte’s placer deposits played out during the 1870s, miners turned their attention to the area of hard rock mining. No clear record of the amount of mining wastes produced and disposed of by placer miner operations exists.

In addition to placer mining along SBC, hard rock mining started on mineralized vein outcroppings on Butte Hill, north of SBC (Smith, 1952). Some mining claims on the Butte Hill were re-staked in the 1870s because of favorable assays of silver ore found in the area (Smith, 1952). Silver mill construction during the mid-1870s ushered in the era of industrial mining in Butte. This rejuvenated mining activity in Butte and, by the year 1878, several small mills were operating in the area. A combination of factors contributed to a boom in Butte's silver production during the early 1880s. Completion of railroads to Butte in 1881 along with favorable silver prices led to a drastic increase in mine production. Most existing mills increased their production.

Between 1879 and 1885, at least six major mills were built along SBC from Meaderville to Williamsburg. These mills were operated more or less continuously until 1910 (Freeman, 1900; Smith, 1952; Historical Research Associates, 1983). The early mills were steam-powered stamp mills (50-10 stamps) designed to crush, concentrate, and amalgamate silver ore. Mills constructed during this time were the: Centennial, Dexter, Davis, Young and Roudebush, Walker Brothers, Clipper, Silver Bow, Grove Gulch, and Thornton (Historical Research Associates, 1983). By 1886, five new mills appeared in the vicinity of Butte's Missoula Gulch and along SBC: the Alice, the Moulton, the Lexington, the Margret Ann, and the Blue Bird (Historical Research Associates, 1983). The Blue Bird Mill was located on SBC east of the town of Rocker and contained 90 stamps which was unusually large at the time. Production capacities from these new mills were many orders of magnitude greater than previous mills. Butte's silver era ended with the repeal of the Sherman Silver Act in 1893. These mills produced tailings and other mining wastes, which were disposed of near the mills. Some of that waste material was disposed directly into or washed into SBC.

By the late 1880s copper mining had become more important, and Butte became one of the nation's prominent copper mining centers. Many of the previously described mills and smelters were used for copper production, and more mills and smelters were added. Five such facilities located along SBC were especially significant. They are the Colorado Smelter, the Butte Reduction Works Facility, the Parrott Smelter, the Montana Ore and Purchasing Company Smelter, and the Butte and Boston Smelter. All of the described facilities along SBC discharged wastes alongside or directly into SBC. These facilities operated large concentrators and smelters and disposed of volumes of waste directly into, or near, SBC.

In 1884, a copper smelter (Old Works) was constructed at the lower end of Warm Springs Creek at the new town of Anaconda, 27 miles west of Butte (Smith, 1952; Reclamation Research Unit and Schafer and Associates, 1993). The newer Washoe Smelter was constructed in 1903 and began operations on Smelter Hill, directly east of Anaconda. The major smelters erected along SBC in the Butte vicinity continued to operate until approximately 1910 (Reclamation Research Unit and Schafer and Associates, 1983). The Amalgamated Copper Company and the Anaconda Copper Mining Company took possession and control of almost all other companies and facilities in the Butte area. These companies ultimately combined into the Anaconda Copper Mining Company. After 1910, most of the ore mined in Butte was then shipped via the Butte, Anaconda and Pacific Railway (BA&P) to the Anaconda Copper Mining Company's (AMC) Washoe Smelter for processing (Reclamation Research Unit and Schafer and Associates, 1993).

By 1917, approximately 150 mines were located in and near Butte and the population of Butte grew to over 100,000. The mines, which were controlled by AMC or its predecessors, produced a total of approximately 934 million pounds of copper (Techlaw, 1985). This corresponds to a maximum of approximately 4.2 million cubic yards (cy) of ore assuming a 5 percent copper content and an ore density of 163 pounds per cubic foot (Techlaw, 1985). Water pumped from these mines contributed to the contamination of SBC.

About 1908, AMC began constructing dikes near the mouth of SBC. These several, often meager construction efforts were intended to trap sediments and prevent further downstream movement of mining, milling, and smelter wastes.

By about 1917, and after several washouts of the original series of dikes, a larger dike was constructed above, thus creating Pond 2. During the mid 1950s, AMC constructed still larger dikes to contain the increasing volume of waste that continued to move down SBC. Thus, Pond 3 was created, and altogether, 19 million cy of tailings were contained within three Warm Springs settling ponds.

AMC commenced surface mining of low-grade copper ore with the opening of the Berkeley Pit in 1955 and built the Weed Concentrator in 1963 to process this ore. These operations also contributed contamination to SBC.

In 1977, AMC merged with the Atlantic Richfield Company (ARCO) which expressly assumed liability for AMC. ARCO closed all underground mines in 1980 and continued active mining only in the Berkeley Pit. ARCO closed the Berkeley Pit in 1982 and the East Berkeley Pit in 1983. There was a hiatus of mining in Butte until 1986, when Montana Resources (MR) initiated open-pit mining operations in the Continental Pit. Aside from a 3-year break in operations between July 2000 and November 2003 (because of economic considerations), MR continues today to mine copper and molybdenum in the Continental Pit.

Although floods and storm events contributed to the transport of waste in SBC, and then as far downstream on the Clark Fork River as Lake Pend Oreille in Idaho, they were not the exclusive cause of contamination downstream. Upstream facilities in Butte discharged waste directly into or along SBC, and did not exercise due care in anticipating flood events or storm events and taking precautions to avoid waste movement.

Waste was transported from the various mining and smelting operations downstream via overland flow and surface water transport.

In June 1908, the largest flood in recorded history in the SBC basin occurred, contributing to the extent of fluvially deposited tailings found today. Heavy rains fell in late May and early June, melting the snow pack and causing extensive flooding (CH2M HILL, 1989). Flood waters transported tailings from smelting facilities in Butte and along SBC and deposited them downstream as flood waters waned. Flood flows and fluvial deposits were physically constrained by railroad grades constructed parallel to SBC, limiting the areal extent of flood deposited tailings.

Other recorded significant storm events occurred in 1892, 1894, 1938, 1948, 1964, 1975, and 1980 (CH2M HILL, 1989). All of these events occurred during the spring and early summer when precipitation and melting snow combined to produce large runoffs. These events also contributed to the movement of mine wastes from their sources into the SBC floodplain.

The Utah and Northern, a subsidiary of Union Pacific Railroad and the first railroad in Montana, reached Butte in December 1881. The towns of Anaconda and Butte were linked to the Union Pacific Railroad line from Utah in 1884. A narrow-gage rail line was used to transport ore and mining-related materials between the mines in Butte and the smelter in Anaconda. This was the first railroad constructed in the SSTOU. A second rail line, owned and operated by Marcus Daly and a group of investors (BA&P) to serve the Butte-Anaconda mining industry, was also constructed along the SBC floodplain in the 1890s. A third line was added to this corridor in 1905 by Chicago, Milwaukee, St. Paul and Pacific Railroad; it ran from Butte to Finlen. This line was eventually abandoned in 1980 and the tracks removed. Currently, three rail lines run adjacent to the SSTOU corridor; Rarus (BA&P) from Butte to Anaconda, Montana Western Railroad (leased from Union Pacific Railroad), and the Union Pacific Railroad. Parts of all three rail lines were constructed with mining waste materials. In addition, the lines that transported ore concentrate to the Anaconda smelter became contaminated by numerous uncontrolled spills occurring during the transport of this material (MDHES, 1995).

3.5 Regulatory History Summary

The SBC/Butte Area National Priority List (NPL) Site is located in Silver Bow and Deer Lodge counties of Montana at the easternmost extent and headwaters of the upper Clark Fork River drainage. EPA designated the original SBC Site as a Superfund site in September 1983, under the authority of CERCLA. Work began on a Phase I remedial investigation and feasibility study (RI/FS) in 1984. During the course of this RI/FS, the importance of Butte as a source of contamination to SBC was formally recognized. Preliminary results from the RI/FS indicated that upstream sources were at least partly responsible for the contamination observed in the creek. After a thorough analysis of the relationship between the two sites (Butte and SBC), EPA concluded that they should be treated as one site under CERCLA. EPA subsequently modified the existing SBC Site to include the Butte Area and the formal name was changed to the "Silver Bow Creek/Butte Area NPL Site" in 1987.

Early on, Montana Department of Health and Environmental Sciences (MDHES) (now Montana Department of Environmental Quality [MDEQ]) was the lead agency for the Butte Metro Storm Drain; Butte Reduction Works and Colorado Tailings; all of SBC including the WSP; and the Clark Fork River to Milltown. EPA was lead agency for the Berkeley Pit and remaining OUs of the Butte Area portion of the site. In 1989, EPA became the lead agency for all OUs except for SBC proper, which by then had become known as the Streamside Tailings Operable Unit (SSTOU). Within 18 months, EPA shifted the Clark Fork River OU from the Silver Bow Creek/Butte Area Superfund Site to the Milltown Reservoir Sediments Superfund Site. That situation remains true today. In 2008, MDEQ became the lead agency for remedy and restoration implementation for the Clark Fork River OU.

A summary of the contamination and basis for taking action is presented in the following section.

3.6 Basis for Taking Action

As previously stated, the SSTOU is located between the city of Butte and the community of Warm Springs, Montana. MDEQ is the lead agency for the OU, which includes SBC, its floodplain, adjacent railroad beds, and associated mining wastes, from Butte, 26 miles downstream to the inlet of the WSP. Hazardous materials released into site media throughout the OU are described in the following text.

3.6.1 Soil

Wastes from mining, milling and smelting facilities once located in Butte and along SBC, as well as contributions from smelting and refining activities in Anaconda, Montana, were washed by annual high flows and flood events down the drainage for more than 100 years. These wastes, primarily tailings, are characterized as acidic with median pH values ranging from 3.5 to 5.1 standard units; contain high levels of arsenic (median concentrations of 145 to 649 milligrams per kilogram [mg/kg]); and metals such as cadmium (median concentrations of 0.1 to 17 mg/kg), copper (median concentrations of 760 to 4,395 mg/kg), lead (median concentrations of 218 to 2,265 mg/kg), mercury (median concentrations of 0.4 to 37.5 mg/kg), and zinc (median concentrations of 1,032 to 7,210 mg/kg) (Titan Environmental Corp., 1995). When the SSTOU ROD was signed in 1995, it was estimated that 2,500,000 to 2,800,000 cy of tailings and contaminated soils covered about 1,300 acres. In some areas, the tailings were several feet thick. The largest single tailings deposit, 160 acres, was located near the town of Ramsay and is known as Ramsay Flats. The tailings were largely unvegetated (see Appendix A).

3.6.2 Surface Water

Discharge in SBC varies from the beginning of the OU to its northern boundary. During low flow, SBC flow averages about 21 cfs at its upper end to 40 cfs at its lower end. The highest recordable flows were approximately 450 cfs (July 30, 1998) and 1300 cfs (February 11, 1996), respectively. The project reach of Silver Bow is intercepted by three tributary sources: Silver Lake Pipeline discharge, Browns Gulch, and German Gulch. Water quality includes elevated concentrations of dissolved and total arsenic, cadmium, copper, lead, mercury, and zinc that are often above State and Federal water quality criteria. SBC also contains tailings and is devoid of most aquatic life (MDEQ, 1995).

3.6.3 Groundwater

The alluvium underlying SBC varies in thickness throughout the OU and supports an alluvial aquifer. Water levels fluctuate 1 to 2 feet annually in response to seasonal influences. Scattered areas of the shallow alluvium contain detectable concentrations of arsenic and copper, cadmium, and zinc throughout the operable unit. Concentrations of arsenic, copper and cadmium were elevated above State and Federal drinking water maximum contaminant levels (MCLs) (Titan Environmental Corp., 1995).

3.6.4 Sediments

Streambed sediments are transient throughout the OU and consist primarily of sand and silt, with a very small percentage of clay. The highest arsenic and metals concentrations were associated with the silt and clay fractions, which were enriched between 10- and

65-fold over background for arsenic, cadmium, lead, and zinc. Copper is enriched 40- to 70-fold over background. Total metals and arsenic concentrations were approximately one-half to one-third of the concentrations found in tailings/impacted soils.

3.6.5 Railroad Bed and Ballast Materials

Railroad line embankments aligned along SBC were constructed with a variety of materials including mine waste rock, slag (smelter waste), and a sporadic veneer of ore concentrate from uncontrolled spills. The volume of this material was estimated to be approximately 600,000 cy in the RI. Concentrations of metals and arsenic in waste rock materials are similar to that in tailings/impacted soils. Slag actually contains higher concentrations of arsenic and metals (especially zinc) but is considered less mobile because of its vitrified structure.

3.6.6 Human Health Risk

The Baseline Risk Assessment for the SSTOU was issued by MDEQ in 1995. The U.S. EPA and MDEQ have defined carcinogenic potential risk in excess of 1 in 10,000, and hazard indices in excess of 1.0 as unacceptable.

The Streamside Tailings Baseline Human Health Risk Assessment evaluated three exposure scenarios to determine the health risks related to OU use by residents, workers (occupational), and recreationists. The primary carcinogenic risk (primary health threat) to people living in or near the OU comes entirely from potential exposure to arsenic in soil and groundwater. Calculated Reasonable Maximum Exposure values were 2.5×10^{-4} for ingesting soil or sediment and 3.11×10^{-4} for ingestion of near-stream groundwater.

Noncarcinogenic risks exceeded acceptable levels for arsenic in soils under the residential scenario (hazard index [HI] = 1.1 for ingestion of soil/sediment and HI = 1.2 for near-stream ground water). As with the carcinogenic risks, the noncarcinogenic risks vary depending on the amount of contamination a person contacts. Noncarcinogenic risks related to arsenic, cadmium, copper, and zinc in groundwater were found only in upper alluvial, near-stream groundwater within and directly adjacent to the floodplain. The risks posed by lead contamination in soils are generally within the acceptable range based on the risk model used in Butte.

Human health risk based concentrations (HHRBC) in soil were not explicitly defined in the baseline risk assessment for SST. The baseline risk assessment (CDM, 1994) for an OU adjacent to SST—the Butte Priority Soils OU—did define HHRBCs, and they provide a basis for comparison to the SSTOU. The Butte Priority Soils OU HHRBCs are as follows:

- Arsenic
  - 250 mg/kg arsenic in residential areas and railroad beds that transect residential areas
  - 500 mg/kg arsenic for commercial/industrial areas
  - 1,000 mg/kg for open space used for recreational purposes

- Lead
  - 1,200 mg/kg for residential yards and play areas
  - 2,300 mg/kg at waste dump/source areas outside residential areas

3.6.7 Environmental Risk

In the Environmental Risk Assessment (CDM, 1994) for the SSTOU, potential risks to ecological receptors were evaluated by comparing current or predicted conditions and chemical concentration in exposed media, with similar data correlated with potential to cause adverse effects. The risk characterization integrates exposure assessments and effects assessments to estimate potential for ecological receptors, and then considers the ecological significance of the predicted effects. A weight-of-evidence approach, using measures of potential adverse effects, was then used to define risk potentials to receptors in/on a media and chemical basis. Risk potential (defined as low, medium, and high) was estimated by evaluating the difference between average and upper 95 percent confidence limit concentrations to relevant effects concentrations. These relevant effects concentration values were taken from the scientific literature. Risk potentials were rated as high when average or upper 95 percent values greatly exceeded the relevant effects concentration. Table 3-1 summarizes information presented (Table 5-20) in the Baseline Risk Assessment (CDM, 1994) document.

Other chemical stressors identified for surface water included ammonia (moderate to high), dissolved oxygen (low to high—depending on location and time), and nitrogen (moderate to high).

TABLE 3-1
Original Baseline Risk Assessment Information

Media (units)	Contaminant of Concern (COC)	Arithmetic Mean/ U95 Concentrations	Effects Concentration [a]	Risk Potential
Surface Water (µg/L) dissolved	Arsenic	15.6/24.1	48 – 850	Low
	Cadmium	1.66/2.26	0.47 – 5.0	Moderate
	Copper	50.7/59.6	3.9 – 54	High
	Lead	3.0/6.57	0.8 – 500	Moderate
	Mercury	0.16/0.16	0.012 – 4.0	Low to Moderate
	Zinc	336/586	40 – 277	High
Sediment (mg/kg)	Arsenic	75.2/113	23.8 – 24.8	High
	Cadmium	4.7/7.0	3.9	High
	Copper	828/1,580	325 – 354	High
	Lead	250/319	62.4	High
	Mercury	3.5/6.7	0.2 – 2.0	High
	Zinc	1,380/2,120	1,064	High

TABLE 3-1
Original Baseline Risk Assessment Information

Media (units)	Contaminant of Concern (COC)	Arithmetic Mean/ U95 Concentrations	Effects Concentration [a]	Risk Potential
Surface Soil (mg/kg)	Arsenic	303/515	25 – 100	High
	Cadmium	6.5/12	4 – 50	Moderate
	Copper	1,470/2,485	60 – 100	High
	Lead	723/1,241	250 – 1,000	High
	Mercury	1.82/5.7	2 – 10	Low to Moderate
	Zinc	1,837/2,920	200 – 500	High

[a] See Table 5-17 in Baseline Risk Assessment (CDM, 1994)

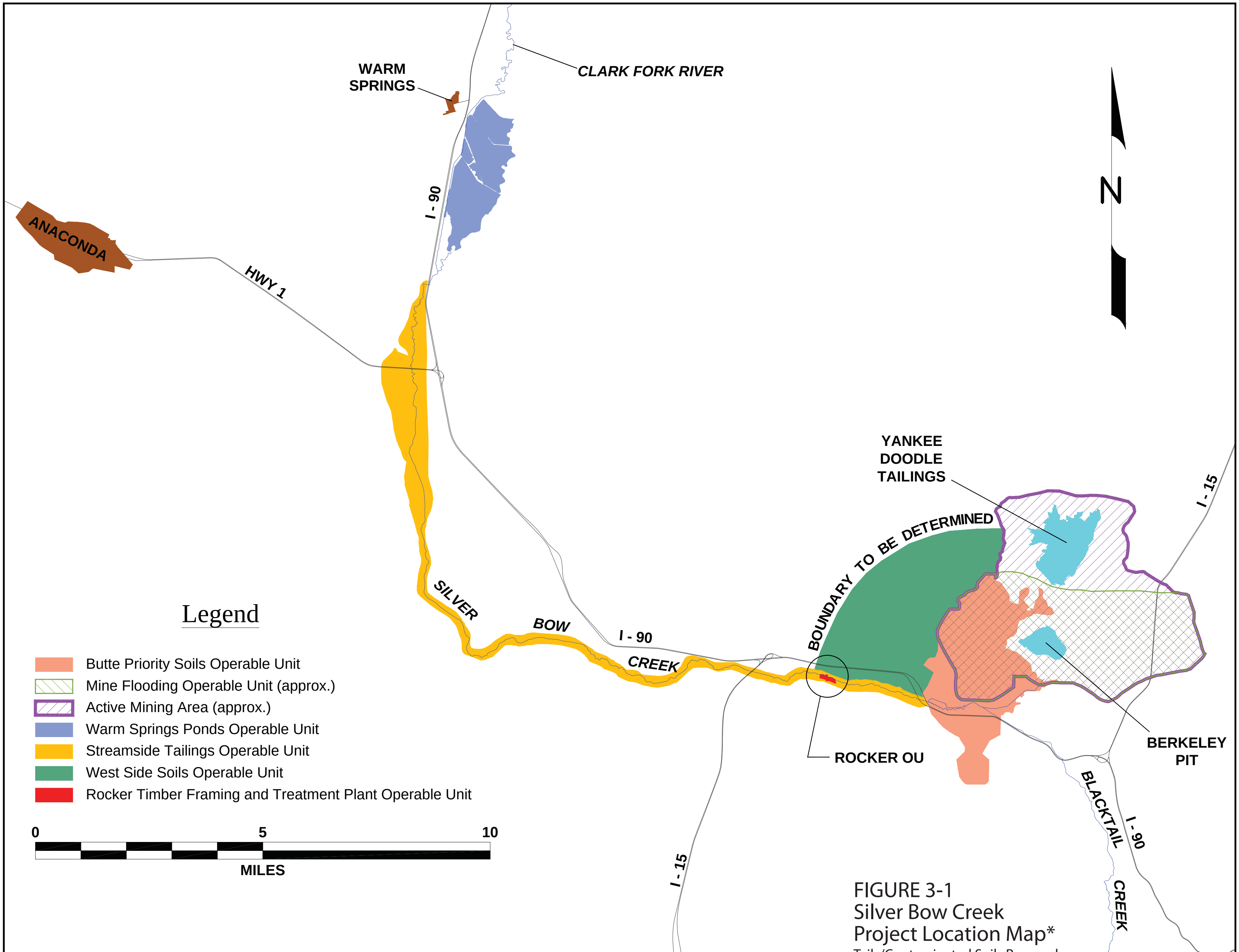

FIGURE 3-1
Silver Bow Creek
Project Location Map*
Tails/Contaminated Soils Removal
Silverbow Creek OU 5 Year Review

* Amended from Silver Bow Creek/Butte Soils 5 yr Review. CDM 2005

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SECTION 4

Remedial Actions

4.1 Remedy Selection

The final remedial action, remedial action objectives (RAOs), and final remediation standards for surface water, tailings and impacted soils, railroad materials, groundwater, and air resources in the SSTOU as defined by the ROD (MDHES, 1995) are listed below.

4.1.1 Remedial Action Objectives

RAOs are as follows:

1. Meet the more restrictive of the aquatic life or human health standards for surface water identified in MDEQ-7 Circular (formerly MDEQ Circular WQB-7) through application of I-classification requirements.
2. Prevent exposure of humans and aquatic species to instream sediments having concentrations of inorganic contamination in excess of risk-based standards. A physical criterion is used to define those sediments posing the greatest risk to receptor species. A contingency is established to develop metal-specific concentrations that would be risk-based, and allow sediment cleanup standards if the physical criterion standard cannot be employed appropriately.
3. Attain the remedial action objective to improve the quality of SBC's surface water and instream sediments to the point that SBC could support the growth and propagation of fishes and associated aquatic life, one of the designated goals for an I-class stream, including a self sustaining population of trout species (provided that upstream sources of SBC contaminants are eliminated, meeting the two remediation standards identified above).

4.1.2 Remediation Standards

Remediation Standards for surface water, groundwater, soils and air are as follows:

- In addition to surface water standards described above, attain compliance with applicable MDEQ-7 Circular, Federal MCLs and Federal non-zero maximum contaminant level goals for all OU groundwater.
- Prevent discharge of groundwater that would prevent attainment of SBC ambient MDEQ-7 Circular standards or instream sediment remediation goals.
- Compliance with air ARARs within or adjacent to the SSTOU during implementation of the remedial action.

4.1.3 The Major Components of the Remedy Selected for the SSTOU

The major components of the remedy selected for the SSTOU are as follows (EPA, 2000):

1. Removal of tailings/impacted soils from the floodplain from most areas within the 100-year floodplain. Excavated tailings/impacted soils will be placed in mine waste relocation repositories at locations to be determined during remedial design/remedial action. To meet RAOs, removal will include tailings/impacted soils where (a) they are saturated by groundwater; (b) in-place treatment would not be effective because of

thickness of tailings or lack of buffer material between the tailings and groundwater; or (c) treated tailings/impacted soils could be eroded into SBC.

2. All waste left in place within the OU will be treated in-situ and protected from washout or erosion from lateral stream migration and flood flows.
3. Fine-grained instream sediments located in depositional areas are to be removed and placed in repositories with the excavated tailings/impacted soils. After removal of contaminated instream sediments, the channel bed and streambank will be reconstructed.
4. All contaminated railroad materials that pose a risk to human health or the environment will be excavated, treated, and/or capped. Excavated railroad materials will be placed in repositories.
5. No separate remedial action is planned for groundwater or surface water. Remedial activities for SSTOU tailings/impacted soils and for sources of contaminants upstream or offsite under other cleanup actions are expected to reduce contaminant releases to groundwater and surface water with the goal of ultimately attaining State water quality standards.
6. The ROD called for an institutional controls program which will be coordinated through a joint effort of the Butte-Silver Bow (BSB) and Anaconda-Deer Lodge local governments.

4.1.4 Explanation of Significant Differences

An ESD was proposed by MDEQ and approved by EPA in 1998. The ESD proposed the following nine changes from the remedy described in the ROD (MDEQ, 1998):

- The volume of tailings/impacted soil in the SSTOU was increased based on additional information.
- Modifications to the alignment of SBC and the channel profile were selected (elevation profile).
- Use of a temporary stream diversion during and after construction to facilitate dewatering and excavation of near-stream tailings, and to enhance floodplain and streambank revegetation efforts, was approved.
- Changes in the criteria for instream sediment removal were selected as a result of other remedial design changes.
- Modifications to the mine waste relocation repository design were selected.
- Inclusion of sediment basins was selected, to capture contaminated overland flows from offsite mine waste sources.
- Treatment wetlands were eliminated as the final land use in Subarea 1.
- The proposed schedule for SSTOU remedy implementation was revised.
- The estimated cost of the SSTOU remedy was re-evaluated and increased.

4.2 Remedy Implementation

The State of Montana, with approval from EPA, assumed the lead for implementation of remedial design and remedial action. The remedial design and construction was initiated using the four physiographic Subareas described in the RI (see Figure 4-1). In general, remedial construction has proceeded from upstream to downstream (Subarea 1 through Subarea 4) through the 26-mile operable unit. To facilitate construction schedules, each Subarea was further subdivided into reaches to accommodate site specific characteristics and limitations imposed by topography and climate.

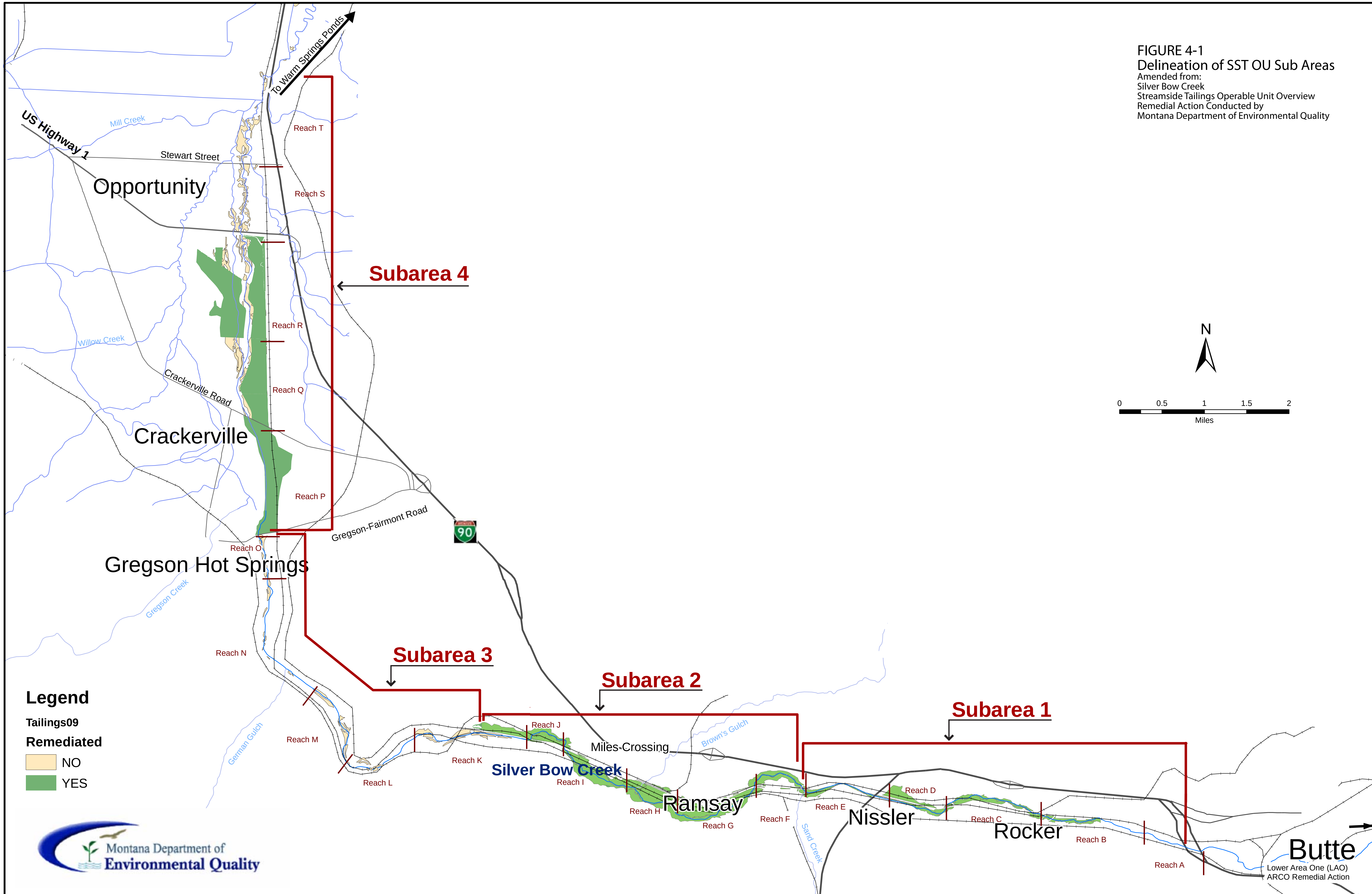

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Table 4-1 summarizes remedial design completion dates, initiation of construction, status of remedial construction (complete or ongoing), and if not complete, proposed completion dates. A description of the remedial performance of each Subarea after construction is presented in subsequent subsections.

TABLE 4-1
Summary of Significant SSTOU Remedial Design and Remedial Action

	Subarea 1	**Subarea 2**	**Subarea 3**	**Subarea 4**
Initiate Remedial Construction	**Reaches:** A (7/1999)	**Reaches:** F, G, and H (4/2004) I and J (10/2006)	**Reaches:** K & L (7/2009) Other Construction Pending for M, N, and O	**Reaches:** R 152 (6/2003) R Phase 1 (7/2004) R Phase 2 (7/2005) Q Phase 3 and 4 (4/2006) Q Phase 5 (9/2007) P Phase 6 and 7 (7/2008) Other Construction Pending for S and T
Status of Remedial Construction	Completed **Reaches:** A (04/2001) B and C (2003) D and E (12-2003)	Completed **Reaches:** F, G, and H (11/2006) I and J (3/2009)	Ongoing	Ongoing **Reaches:** R 152 (12/2003) R Phase 1 (7/2005) R Phase 2 (12/2005) Q Phase 3 and 4 (12/2006) Q Phase 5 (5/2008) P Phase 6 and 7 (ongoing)
Proposed Construction Completion Date	Completed	Completed	2013	2012

In general, implementation of the remedy, which is currently ongoing, consists of the methodical excavation of floodplain tailings and impacted soils to a predetermined depth established during design, through test pitting and sampling. To date, excavated soils were disposed of at a local repository (Mine Waste Relocation Repository [MWRR]) or the Opportunity Ponds tailings disposal facility (Anaconda). Verification sampling, to confirm an acceptable removal of contaminated material, was performed within each reach before replacement soil, top soil, and revegetation were applied. The remedial action goal guiding the excavations was to remove 90 percent of the floodplain tailings/impacted soils with 95 percent confidence. Verification sampling was performed on a reach by reach basis utilizing a 150 foot grid across the removal area to determine whether the remedial goal was achieved (Maxim, 1998). Remedial excavation, as measured by verification sampling, was considered a success if four of the six constituents of concern were less than the following concentrations:

- Arsenic—200 mg/kg
- Cadmium—20 mg/kg
- Copper—1,000 mg/kg
- Mercury—10 mg/kg
- Lead—1,000 mg/kg
- Zinc—1,000 mg/kg

The verification sampling was not intended to demonstrate complete removal (100 percent) and therefore, individual "hot spots" could remain in place and still be compliant with the remedial action goal (CQAPP, 1998) (see Figure 4-2 Concept Diagram). However, the removal process was periodically adjusted based on previous reach verification sampling data to help reduce the frequency of residual hot spots. Removal process adjustments consisted of over-excavation in 6- to 9-inch increments as the remedy moved down stream (Maxim, 2001 Final Design Report). The success of this method is reflected in a reduction of the sample percent failure rate as construction progressed downstream.

During remedial excavation, SBC was often diverted into a temporary ditch or away from a targeted bank by use of a coffer dam, to facilitate the following:

- Removal of contaminated sediments within the natural channel.
- Reconstruction of a new channel through the remediated floodplain.
- Construction of new culverts, bridges, and other related structures, where appropriate.

As previously mentioned, several active rail lines are located adjacent to SBC and its floodplain through the operable unit. Contaminated rail bed material was identified by sampling and either removed, treated in place, or capped in accordance with the ROD (MDHES, 1995). Excavated material was transported to MWRR or the Opportunity ponds.

No remedy was applied to surface water or groundwater; their cleanup is directly dependent on the successful remediation of the floodplain soils.

The status of remedial action by subareas is presented in Table 4-2 and described in the following sections.

4.2.1 Subarea 1 (Rocker) Remedial Performance

Subarea 1 is approximately 5.2 miles long. Remedial construction in this area was initiated in July 1999 and completed with final EPA sign-off in December 2003. Remedial construction accomplished the following:

- A mine waste relocation repository (MWRR) was constructed.
- A haul route was constructed.
- Approximately 766,754 cy of tailing and impacted soils was removed from the floodplain.
- Approximately 171,900 cy of contaminated soil was removed from Reach A, including the base of active rail lines, and was deposited in the MWRR. The rest of the material was deposited in the Opportunity Ponds.
- A new channel and floodplain for SBC was realigned and constructed.
- Creek banks and floodplain were planted with vegetation.
- In accordance with the SSTOU ROD (MDHES, 1995) and an Interim Long-Term Monitoring Plan (MDEQ and MDOJ Natural Resource Damage Program, 2009), post construction monitoring was initiated for surface water, groundwater, instream sediments, vegetation, soil as a measurement of revegetation success or failure, aquatic biological resources, and local birds.
- Institutional controls have not yet been applied to this Subarea, although a paved path and some signage, gates, and fencing have been constructed as part of a planned Greenway project.

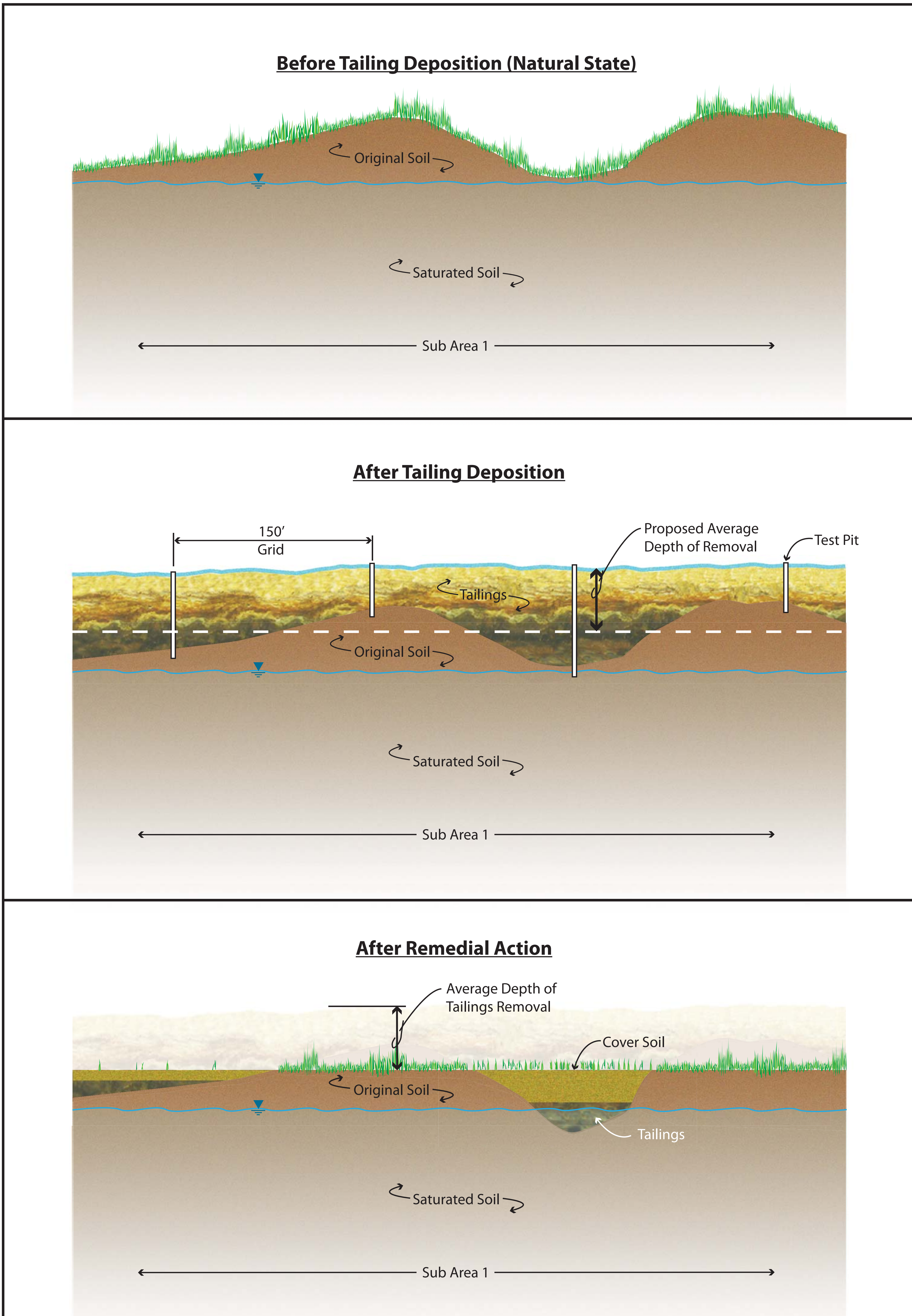

FIGURE 4-2
Sub Area 1 - Remedial Excavation
Concept Diagram
Tails/Contaminated Soils Removal
Silverbow Creek OU 5 Year Review

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TABLE 4-2
Stream Side Tailings Five-Year Review
Subarea Tailings/Impacted Soils and Railroad Bed Material Removal Summary, January 6, 2010

	Remedial Investigation – Tailings and Impacted Soils Estimated (cy)	RI – Railroad Bed Contaminated Material Estimated (cy)	Design – Tailings and Impacted Soils Estimated (cy)	Actual Removal Volume – Tailings and Impacted Soils (cy)	Designed Railroad Cap (sq. yd. x 0.5 foot)	Railroad Material Cap (sq. yd. x 0.5 foot)	Railroad Material Removed	Remedial Construction Status (Date)
Subarea 1	426,000 – 285,000	277,200						Complete (12/2003)
Reaches A			166,800	166,562	14,100	14,100	-	
B and C			351,000	347,253	15,000	15,000	14,100	
D and E			302,500	252,939	27,996	27,966	4,471	
Subtotal				766,754			18,571	
Subarea 2	866,000 – 808,000	235,954						Complete (3/2009)
Reaches F, G, and H			1,234,000	1,258,013	16,440	16,440	17,523	
I and J			482,100	519,398	40,740	40,740	1,500	
Subtotal				1,777,411			19,023	
Subarea 3	248,000 – 160,000	95,000						Incomplete
Reaches K and L*			245,000	50,952				
M,N, and O			464,925					
Subtotal				50,952				

TABLE 4-2
Stream Side Tailings Five-Year Review
Subarea Tailings/Impacted Soils and Railroad Bed Material Removal Summary, January 6, 2010

	Remedial Investigation – Tailings and Impacted Soils Estimated (cy)	RI – Railroad Bed Contaminated Material Estimated (cy)	Design – Tailings and Impacted Soils Estimated (cy)	Actual Removal Volume – Tailings and Impacted Soils (cy)	Designed Railroad Cap (sq. yd. x 0.5 foot)	Railroad Material Cap (sq. yd. x 0.5 foot)	Railroad Material Removed	Remedial Construction Status (Date)
Subarea 4	1,300,000	31,300						Incomplete
Reach R Parcel 152			104,800	103,064				
Phase 1			289,400	252,270				
Phase 2			288,200	359,782				
Phase 3 and 4			234,000	333,088			27,710	
Phase 5 (Sed Pond)								
Phase 6 and 7*			482,000	458,000				
Subtotal				1,506,204			27,710	
Total All Areas				**4,050,369**			**65,304**	

Notes:
Actual = Final or most recent Construction Completion Report
Contaminated RR bed material = waste rock, slag, concentrate, impacted soils
Design = Design reports for each subarea
RI = SST Remedial Investigation (1995)
* Currently under construction, not complete

4.2.2 Subarea 2 (Ramsey Flats) Remedial Performance

Subarea 2 is approximately 5.6 miles long. Remedial construction in this area was initiated in April 2004 and completed in March 2009. EPA has not yet signed off on remedial construction within this Subarea. Remedial construction accomplished the following:

- Approximately 1,777,411 cy of tailing and impacted soils from the floodplain were removed, transported, and deposited in the Opportunity Ponds.
- Approximately 19,023 cy of contaminated soil from the base of active rail lines was removed and deposited in the Opportunity Ponds.
- A new channel and floodplain for SBC was realigned and constructed.
- Creek banks and floodplain were stabilized with vegetation.
- In compliance with the SSTOU ROD (MDHES, 1995) and an Interim Long-Term Monitoring Plan (MDEQ and MDOJ, 2009), post construction monitoring has been initiated for surface water, groundwater, instream sediments, vegetation, soil as a measurement of revegetation success or failure, aquatic biological resources, and local birds.
- Some institutional controls have been applied to this Subarea in the form of a locked gate along an access road. Additional signage, gates, and fencing are proposed.

4.2.3 Subarea 3 (Canyon) Remedial Performance

This Subarea is currently under remedial construction. Subarea 3 is approximately 5 miles long. It lies in a narrow canyon, and contains discontinuous bands of floodplain tailings/impacted soils that cover about 160 acres. This area is not yet remediated and therefore, EPA has not yet signed off on remedial construction. The completion of remedial construction is scheduled for 2011. Remedial construction to date has accomplished the following:

- Approximately 50,952 cy of tailing and impacted soils from the floodplain have been removed, transported, and deposited in designated cells within the Opportunity Ponds.
- No contaminated soil from the base of active rail lines has been removed from this Subarea.
- Because of topographic constraints and proximity to an active rail line, realignment and construction of a new channel and floodplain for SBC is limited.
- Stabilization of creek banks and floodplain with vegetation is proposed.
- A temporary instream sediment basin was constructed at the downstream end of this Subarea to trap contaminated sediments liberated by remedial construction in Subareas 2 and 3, reduce peak flows entering Subarea 4, and reduce recurrent ice jam problems in Subarea 4. This sediment basin will be removed and the stream channel restored upon completion of Subarea 3.
- In compliance with the SSTOU ROD (MDHES, 1995) and an Interim Long-Term Monitoring Plan (MDEQ and MDOJ, 2009), post construction monitoring has been

initiated for surface water, groundwater, instream sediments, vegetation, soil as a measurement of revegetation success or failure, aquatic biological resources, and local birds.

- Institutional controls have not been applied to this Subarea.

4.2.4 Subarea 4 (Upper Deer Lodge Valley) Remedial Performance

Subarea 4 is approximately 6.8 miles in length, and consists of 700 acres of floodplain tailings and impacted soils. Remedial action in this area is not complete; therefore, EPA has not yet signed off on remedial construction for this subarea. The completion of remedial construction is scheduled for 2012.

To date, remedial construction accomplished the following:

- Approximately 1,505,807 cy of tailing and impacted soils from the floodplain have been removed, transported, and deposited in the Opportunity Ponds.
- Approximately 27,710 cy of contaminated material associated with an inactive rail line was removed, transported, and deposited in a designated cell of the Opportunity Ponds.
- Realignment and construction of a new channel and floodplain for SBC.
- Revegetation of creek banks and floodplain.
- In compliance with the SSTOU ROD (MDHES, 1995) and an Interim Long-Term Monitoring Plan (MDEQ and MDOJ, 2009), post construction monitoring has been initiated for surface water and instream sediments. Monitoring is proposed for groundwater, vegetation, soil (as measured by revegetation success or failure), aquatic biological resources, and local birds, upon formal completion of remedial construction.
- Some institutional controls have been applied to this Subarea in the form of locked gates along access roads. Additional signage, gates, and fencing are proposed.

4.3 Remedy O&M

Prescribed operation and maintenance (O&M) activities are described by the ROD for the SSTOU, and include a long-term plan to monitor, manage, and maintain reclaimed areas and onsite repositories. The monitoring, management and maintenance program is intended to address vegetative performance on treatment areas, onsite repositories, remediated streambanks, streambank stability, and channel meander. It will also address instream sediment sampling for both contaminant concentrations and macroinvertebrate abundance and diversity. Repairs to areas damaged or eroded over time will be completed as needed. Vadose zone, saturated zone, and overland flow monitoring will promote documentation of metals immobilization in all remediated areas of the SSTOU.

Since completion of the 2005 Five-Year Review, MDEQ has focused maintenance on the following:

- Visual inspection for accelerated erosion of remediated floodplain and streambanks within Subareas 1 and 2. Repair of damage and cleanup from intermittent floods (such as occurred in 2002).

- Quarterly monitoring is performed for surface water and sediments only. Other monitoring (for example, groundwater, vadose zone, vegetation, and soils) is performed on a less frequent basis and the schedule varies by the type of monitoring. Geomorphic monitoring occurs on restored reaches of SBC on 5 year intervals.
- Annual and semi-annual sampling/monitoring of macroinvertebrates, periphyton, and fish.
- Additional soils removal triggered by verification sampling in active construction areas (2007 and 2008—Subareas 3 and 4 - ongoing) and additional soils removal to address metal salt contaminated spots in previously remediated areas.

Table 4-3 presents the approximate annual O and M costs preceding the current Five-Year Review.

TABLE 4-3
Annual System Operations/O&M Costs

Dates	Total Cost
2002	$21,165 (Remove Soil with Salt Formation)
2003	$16,347 (flood cleanup)
2007	$231,731 (remove additional hot spots)
2008	$96,978 (remove additional hot spots)

Maintenance and operational costs are addressed on an as needed basis until remedial construction for the entire SSTOU is complete. As indicated in Table 4-3, O&M costs have been variable on a year to year basis. This should stabilize when the construction is complete, and a formal, structured monitoring process is applied to the entire OU. The costs in Table 4-3 do not reflect the cost of monitoring surface water, groundwater, sediment, vadose zone, vegetation, fisheries, or benthic macroinvertebrates over the last 5 years.

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SECTION 5

Progress Since Last Five-Year Review

Remedial construction to implement the remedy was initiated in 1995, and involved removal of streamside tailings and stream channel reconstruction in Subarea 1. Because of the interim construction status of SSTOU during the first and second Five-Year Reviews, no definitive protectiveness statements, recommendations, or follow-up activities for the SSTOU were offered.

The second Five-Year Review was completed in September 2005. At that time, the status of remedial construction was as follows:

- Construction and revegetation had been completed for Subarea 1 (Reaches A-E) and Subarea 4 (Reach R, parcel 152).
- Construction was complete for Reach F of Subarea 2 and beginning for Reach G.
- Of the 1,400 acres of contaminated tailings and soils alongside SBC, approximately 200 acres of floodplain impacted with tailings had been remediated. More than 874,000 cy of tailings had been removed from the floodplain.
- Cleanup was scheduled to be completed sometime between 2011 and 2013.

In contrast, through 2009 and the preparation of the current (3^{rd}) Five-Year Review, remedial construction has accomplished the following:

- Construction and revegetation has been completed for Subarea 2 (Reaches F, G, H, I, and J) (removed approximately 1.8 million cubic yards)
- Construction completed for Subarea 3 consists of portions of Reaches K and L (removed approximately 50,952 cy).
- Construction completed for Subarea 4 consists of portions of Reach R (Phase 1, Phase 2, Phases 3 and 4, Phases 6 and 7) (Removed approximately 1.5 million cy).

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SECTION 6

Five-Year Review Process

The SSTOU Five-Year Review team was lead by Kristine Edwards, the EPA remedial project manager for the SSTOU, with technical assistance provided by EPA contractor CH2M HILL, Inc. The SSTOU is one of several OUs comprising the Silver Bow Creek/Butte Area Superfund site contributing to a comprehensive Five-Year Review coordinated by Roger Hoogerheide/EPA, and State of Montana project manager, Daryl Reed/MDEQ.

The review was initiated in September 2009 and includes the following components:

- Community involvement
- Local interviews
- Document review
- Data review
- Site Inspection
- Five-year review report development and review

The schedule for the review extended through June 2011.

6.1 Community Notification and Involvement

Activities to involve the community in the Five-Year Review process were initiated by Roger Hoogerheide with the other EPA Remedial Project Managers (RPMs) on behalf of the entire Silver Bow Creek/Butte Soils NPL site. The project team discussed the best ways to notify the affected communities and to obtain input from members of the public, regulatory agencies, and other entities.

6.2 Notification

Two sets of display ads announcing the commencement of the Silver Bow Creek/Butte Area five-year review were placed in the local papers: the *Montana Standard* and the *Butte Weekly*. The first ad announced the start of the Five-Year Review process and ran in both papers on September 30, 2009. The second ad announced the completion of the Five-Year Review process and ran in both papers in July 2010.

In addition to the display ads, EPA staff attended the Citizen's Technical Environmental Committee (CTEC-the Site's Technical Assistance Grant Group) meetings on September 14, 2009, and November 17, 2009, to discuss the Five-Year Review Process. A separate meeting was also conducted on September 24, 2009, with CTEC's technical advisor to discuss options for community involvement in the Five-Year Review. EPA staff also attended the Butte Restoration Alliance Meetings on September 22 and October 27, 2009, to announce that the Five-Year Review would be starting, to answer questions, and to invite the members to observe site inspection activities.

6.3 Interviews

Brief interviews were conducted with several groups of people including members of the general public with direct knowledge of the SSTOU project (landowners, residents); environmental interest group members (CFRTAC); and local municipal government representatives (communities of Rocker and Ramsey, Anaconda – Deer Lodge Counties and a representative of Silver Bow County). The interviewee list originated from nominations made by the EPA and State Community Involvement Representatives.

The SSTOU encompasses some small communities spread out over a very large area (26 miles). The intent of the interviews was to gain additional perspective on the remedies being implemented.

Individuals listed in Appendix B were called and invited to participate in the interviews. These interviewees were asked to respond to ten questions similar to questions provided in EPA Five-Year Review Guidance (June 2001). The questions were modified slightly to relate to the specific OU being discussed. Interview notes are provided in Appendix B.

6.4 Responses

Kris Edwards interviewed nine people about SSTOU progress. A series of questions guided the interview and those interviewed were free to discuss any additional topic. Annotated responses to the most frequently answered questions are presented below:

- Most of those interviewed view the progress as positive and believe that they have been included in the process.
- The Greenway trail and stream and vegetative recovery are regarded as indicators that good progress has been made.
- Many stated that they understand this is an ongoing project and the final results are years away.
- Some concern exists among those interviewed about stormwater runoff from upstream sources, groundwater purity, and whether maintenance of the facilities that have been constructed will become an issue because multiple agencies are involved.
- Suggestions for ongoing communication with area residents included moveable displays, large newspaper spreads, participating in local group meetings (for example, Rotary Club, garden clubs), email, and more individual contact with landowners.

6.5 Document Review

A summary list of decision and data documents reviewed in preparation for this Five-Year review is presented in Appendix C. The primary decision documents include:

- December 1994. *Draft Baseline Risk Assessment, Streamside Tailings Operable Unit, Silver Bow Creek NPL Site*.
- January 1995. *Draft Remedial Investigation Report, Streamside Tailings Operable Unit, Silver Bow Creek NPL Site*.
- June 1995. Draft Feasibility Study Report, *Streamside Tailings Operable Unit, Silver Bow Creek NPL Site*.
- November 1995. *Record of Decision, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area*.
- August 1998. *Explanation of Significant Differences, Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area*.
- September 2005. *Second Five-Year Review Report for Silver Bow Creek/Butte Area Superfund Site*.

The primary data documents include the 2007 and 2008 annual monitoring reports. The 2009 annual monitoring report was not available at the time of this review.

- *Monitoring Report for 2007. Silver Bow Creek Stream Side Tailings Operable Unit, Silver Bow Creek/Butte Area NPL Site.*
- *Monitoring Report for 2008. Silver Bow Creek Stream Side Tailings Operable Unit, Silver Bow Creek/Butte Area NPL Site.*

6.6 Data Review

6.6.1 Surface Water Monitoring

Eleven water quality stations are currently being monitored quarterly throughout the four Subareas of the SSTOU. Comprehensive monitoring results for SST were obtained from the RI, MDEQ, and USGS reports. Primary contaminants of interest are arsenic, cadmium, copper, lead, mercury, and zinc. The locations of the current monitoring stations are presented in Figure 6-1 and in Appendix A, and appear to be somewhat consistent with original baseline monitoring sites. Surface water monitoring is being performed within the operable unit to "ascertain possible surface water contaminant loading from onsite/near-site contaminant sources"(MDHES, 1995) and to gauge the progress toward "meeting the more restrictive of aquatic life or human health standards for surface water identified in MDEQ Circular WQB-7, through application of I-classification requirements" (MDHES, 1995). The comprehensive sampling record is greater in upstream stations associated with Subareas 1 and 2, although the entire SSTOU reach received some attention during the RI phase of the program to help formulate the conceptual model (baseline conditions) for the site. All existing stations were sampled during 2007 and 2008. Comprehensive monitoring results at all stations for primary contaminants are presented in Appendix D. Surface water monitoring summary data, by station (collected by MDEQ), is presented in Table 6-1. It consists of number of samples, maximum, minimum, and average values.

Surface water quality monitoring (MDEQ) results show a significant post-remedy improvement in primary contaminant concentrations in Subareas 1 and 2 when compared to pre-remedial action baseline concentrations for all primary contaminants (see Figures 6-2 through 6-13). Contaminant concentrations from Subareas 1 and 2 also show significant reductions when compared to sampling results of partially remediated Subareas 3 and 4 downstream.

Surface water quality data were assessed with respect to meeting human health, and aquatic acute and chronic standards for the primary contaminants (dissolved and total recoverable) since the last Five-Year Review (2005). Total recoverable results were compared to the human health standards for arsenic, cadmium, copper, lead, mercury, and zinc for the available water quality monitoring record. Summary data, illustrating mean annual concentrations by station over time, are presented for monitoring years 2004 and 2008 in the following graphs. The graphs indicate improving trends particularly in the upstream subareas that have undergone remediation (see Figures 6-2 through 6-7). Arsenic, lead, and mercury are consistently below Human Health standards until station SS-11D, at which point concentrations begin to rise and exceed the standards. Downstream of station SS-11D coincides with the unremediated portion of the OU. Cadmium, copper, and zinc are well below the Human Health standard for the entire operable unit. All COCs are also significantly below historic high and low flow values for the operable unit (see Appendix D).

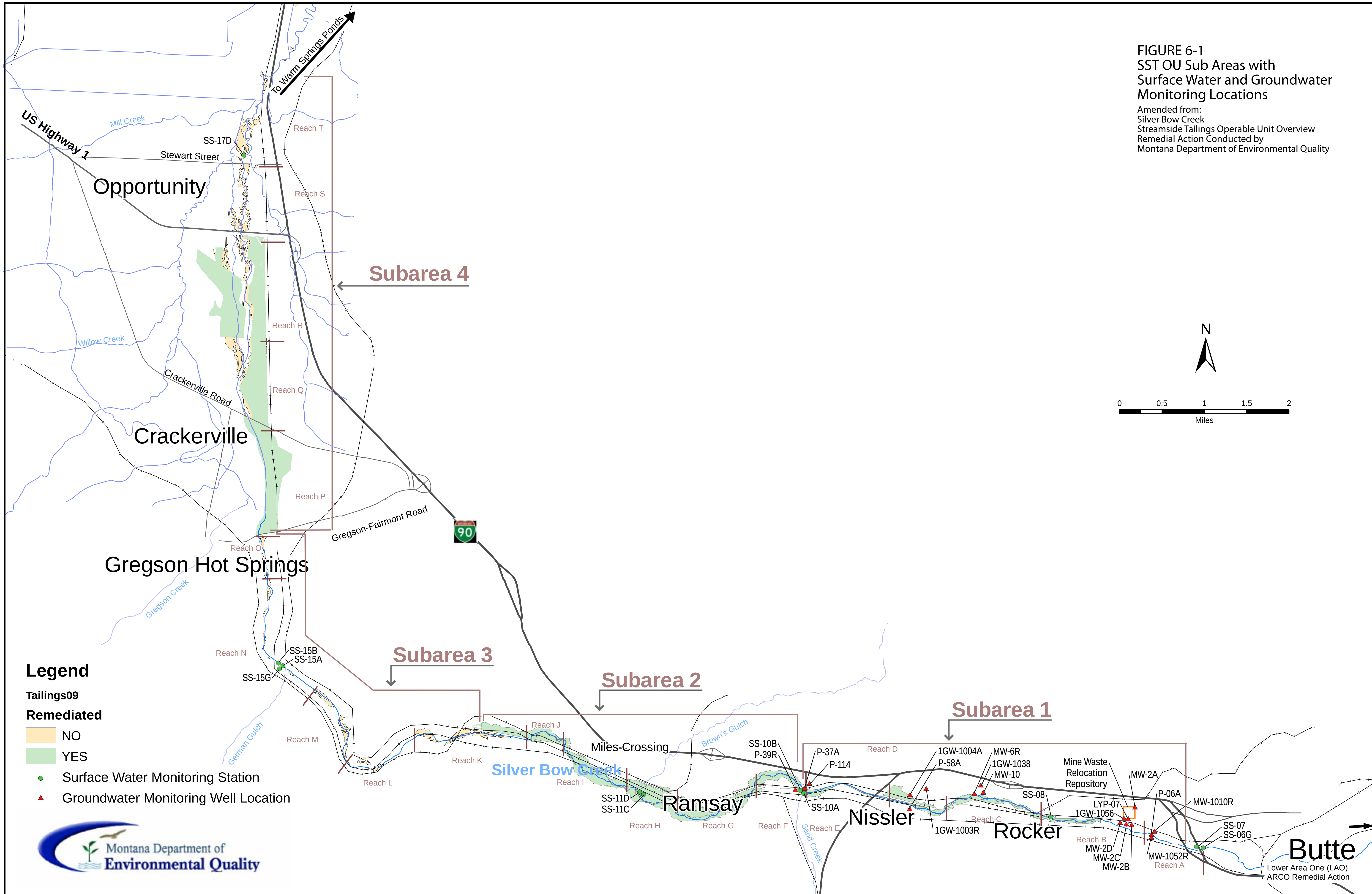

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TABLE 6-1
Summary of MDEQ SST OU Surface Water Monitoring Data (2000-2008)

		SS-06G				SS-07				SS-08A				SS-10A				SS-10B			
Constituent	Year	N	Min	Max	Avg	N	Min	Max	Avg	N	Min	Max	Avg	N	Min	Max	Avg	N	Min	Max	Avg
	2000					2	6.1	8.1	7.1												
	2002					1	7.9	7.9	7.9	1	8.1	8.1	8.1								
	2003					3	3.9	12.2	9.2	3	4.7	19.0	9.6								
	2004					4	1.5	5.0	4.1	4	4.0	5.0	4.8	2	5.0	6.0	5.5	2	4.0	5.0	4.5
	2005					2	5.0	7.0	6.0	2	4.0	7.0	5.5	2	5.0	6.0	5.5	2	5.0	7.0	6.0
	2006					4	1.5	6.0	3.9	4	3.0	7.0	5.0	4	1.5	6.0	4.4	4	4.0	6.0	5.0
	2007	4	3.0	6.0	4.8	4	1.5	5.0	3.9	4	4.0	6.0	5.0	4	4.0	6.0	5.0	4	4.0	6.0	5.3
Arsenic, dissolved (ug/L)	2008	4	3.0	4.0	3.3	4	1.5	3.0	2.2	4	3.0	4.0	3.4	4	3.9	4.0	4.0	4	3.9	4.0	4.0
	2000					1	6.2	6.2	6.2												
	2002					1	9.4	9.4	9.4	1	8.8	8.8	8.8								
	2003					3	3.5	18.9	11.3	3	5.0	64.3	25.2								
	2004					4	4.0	6.0	5.0	4	5.0	7.0	6.0	2	6.0	7.0	6.5	2	5.0	5.0	5.0
	2005					2	6.0	8.0	7.0	2	5.0	8.0	6.5	2	6.0	7.0	6.5	2	7.0	8.0	7.5
	2006					4	4.0	10.0	5.8	4	4.0	10.0	7.3	4	5.0	9.0	7.3	4	5.0	8.0	6.8
	2007	4	5.0	9.0	7.0	4	4.0	7.0	5.5	4	5.0	8.0	6.5	4	5.0	8.0	6.5	4	5.0	8.0	6.5
Arsenic, total (ug/L)	2008	4	4.5	11.0	6.6	4	3.3	6.0	4.6	4	4.1	9.0	6.0	4	4.4	9.0	5.9	4	4.2	9.0	6.1
	2000					2	1.0	1.0	1.0												
	2002					1	1.0	1.0	1.0	1	1.0	1.0	1.0								
	2003					3	0.5	0.5	0.5	3	0.5	2.1	1.0								
	2004					4	0.4	1.1	0.8	4	0.5	0.9	0.7	2	0.6	0.6	0.6	2	0.5	1.1	0.8
	2005					2	0.1	2.2	1.2	2	0.3	1.1	0.7	2	0.3	0.5	0.4	2	0.3	0.5	0.4
	2006					4	0.1	0.8	0.3	4	0.2	0.2	0.2	4	0.1	0.7	0.4	4	0.2	0.6	0.4
Cadmium, dissolved	2007	4	0.1	0.1	0.1	4	0.1	0.2	0.1	4	0.1	0.2	0.1	4	0.1	0.2	0.2	4	0.1	0.3	0.2
(ug/L)	2008	4	0.1	0.1	0.1	4	0.1	0.1	0.1	4	0.1	0.2	0.1	4	0.1	0.2	0.2	4	0.1	0.2	0.1
	2000					2	1.0	1.0	1.0												
	2002					1	1.0	1.0	1.0	1	1.0	1.0	1.0								
	2003					3	0.5	1.0	0.7	3	0.5	6.9	2.6								
	2004					4	0.5	1.1	0.9	4	0.7	1.2	1.0	2	0.6	0.9	0.8	2	1.0	1.3	1.2
	2005					2	0.2	2.3	1.3	2	0.3	1.5	0.9	2	0.5	1.1	0.8	2	0.4	1.2	0.8
	2006					4	0.2	3.2	1.0	4	0.4	1.0	0.6	4	0.5	1.3	0.8	4	0.5	1.2	0.8
	2007	4	0.2	0.3	0.2	4	0.1	0.2	0.2	4	0.2	0.3	0.3	4	0.3	0.4	0.3	4	0.1	0.4	0.2
Cadmium, total (ug/L)	2008	4	0.1	0.2	0.2	4	0.1	0.2	0.2	4	0.2	0.3	0.3	4	0.2	0.3	0.3	4	0.2	0.3	0.3
	2000					2	7.1	10.9	9.0												
	2002					1	11.1	11.1	11.1	1	14.1	14.1	14.1								
	2003					3	2.5	29.2	13.3	3	7.2	23.3	12.7								
	2004					4	7.0	16.0	11.5	4	10.0	15.0	12.3	2	11.0	13.0	12.0	2	13.0	18.0	15.5
	2005					2	12.0	24.0	18.0	2	15.0	21.0	18.0	2	12.0	13.0	12.5	2	13.0	15.0	14.0
	2006					4	9.0	14.0	12.5	4	7.0	14.0	10.3	4	0.1	11.0	6.8	4	10.0	11.0	10.3
	2007	4	4.0	11.0	7.3	4	11.0	18.0	13.3	4	9.0	12.0	10.5	4	8.0	12.0	10.3	4	8.0	12.0	10.5
Copper, dissolved (ug/L)	2008	4	4.6	6.0	5.2	4	7.0	15.5	12.4	4	7.0	11.0	9.0	4	7.0	11.1	9.3	4	7.0	11.0	9.2
	2000					1	9.6	9.6	9.6												
	2002					1	21.0	21.0	21.0	1	25.3	25.3	25.3								
	2003					3	15.9	67.3	37.2	3	31.5	105.0	56.8								
	2004					4	17.0	37.0	25.3	4	15.0	36.0	28.0	2	20.0	28.0	24.0	2	36.0	37.0	36.5
	2005					2	16.0	59.0	37.5	2	19.0	53.0	36.0	2	20.0	46.0	33.0	2	21.0	50.0	35.5
	2006					4	16.0	58.0	30.5	4	22.0	43.0	32.5	4	21.0	41.0	29.3	4	20.0	39.0	27.8
	2007	4	12.0	28.0	17.5	4	16.0	26.0	21.0	4	14.0	24.0	19.0	4	15.0	26.0	19.8	4	14.0	23.0	18.0
Copper, total (ug/L)	2008	4	7.0	21.0	15.0	4	8.0	39.0	21.7	4	14.0	26.0	20.8	4	12.0	21.0	18.5	4	11.0	21.0	17.6
	2000					2	1.0	1.0	1.0												
	2002					1	1.0	1.0	1.0	1	1.0	1.0	1.0								
	2003					3	1.0	5.0	2.3	3	1.0	5.0	3.6								
	2004					4	1.5	1.5	1.5	4	1.5	4.0	2.1	2	1.5	4.0	2.8	2	1.5	3.0	2.3
	2005					2	1.5	1.5	1.5	2	1.5	1.5	1.5	2	1.5	1.5	1.5	2	1.5	1.5	1.5
	2006					4	0.3	1.5	0.6	4	0.3	1.5	0.6	4	0.3	1.5	0.6	4	0.3	1.5	0.6
	2007	4	0.3	2.4	0.8	4	0.3	0.3	0.3	4	0.3	0.3	0.3	4	0.3	0.3	0.3	4	0.3	0.7	0.4
Lead, dissolved (ug/L)	2008	4	0.3	0.3	0.3	4	0.3	0.4	0.3	4	0.2	0.3	0.2	4	0.2	0.3	0.2	4	0.2	0.3	0.2
	2000					2	1.0	1.0	1.0												
	2002					1	4.0	4.0	4.0	1	5.0	5.0	5.0								
	2003					3	1.0	22.8	9.6	3	5.0	263	92.9								
	2004					4	1.5	1.5	1.5	4	1.5	8.0	4.6	2	3.0	7.0	5.0	2	5.0	6.0	5.5
	2005					2	1.5	1.5	1.5	2	1.5	3.0	2.3	2	1.5	4.0	2.8	2	1.5	4.0	2.8
	2006					4	1.2	15.0	5.0	4	1.6	11.0	6.2	4	1.2	10.0	5.1	4	1.2	9.0	4.8
	2007	4	1.7	5.9	3.2	4	2.0	16.0	5.9	4	1.8	3.5	2.5	4	2.0	3.7	2.5	4	1.8	2.9	2.2
Lead, total (ug/L)	2008	4	3.7	25.0	13.9	4	0.1	2.1	1.5	4	1.6	3.5	2.7	4	1.0	2.7	1.8	4	1.0	2.5	1.8
	2006					4	0.01	0.02	0.01	4	0.01	0.10	0.03	4	0.01	0.10	0.03	4	0.01	0.10	0.03
Mercury, dissolved	2007	4	0.01	0.10	0.05	4	0.01	0.10	0.05	4	0.01	0.10	0.05	4	0.01	0.10	0.05	4	0.01	0.10	0.05
(ug/L)	2008	4	0.01	0.03	0.01	4	0.01	0.03	0.01	4	0.01	0.10	0.03	4	0.01	0.03	0.01	4	0.01	0.03	0.01
	2006					4	0.10	0.10	0.10	4	0.10	0.10	0.10	4	0.10	0.1	0.10	4	0.10	0.70	0.25
	2007	4	0.02	0.10	0.06	4	0.03	0.10	0.07	4	0.03	0.10	0.07	4	0.04	0.1	0.07	4	0.03	0.10	0.07
Mercury, total (ug/L)	2008	2	0.01	0.01	0.01	4	0.01	0.03	0.01	4	0.01	0.03	0.03	4	0.01	4.8	1.21	4	0.01	0.03	0.01
	2000					2	63.5	170	117												
	2002					1	71.5	71.5	71.5	1	101	101	101								
	2003					3	78.5	196	129	3	90.0	209	137								
	2004					4	170	330	263	4	180	300	253	2	230	290	260	2	280	490	385
	2005					2	40.0	600	320	2	60.0	300	180	2	90.0	140	115	2	100	140	120
	2006					4	70.0	410	155	4	60.0	100	75.0	4	60.0	160	95.0	4	70.0	110	85
	2007	4	20.0	50.0	30.0	4	30.0	80.0	57.5	4	40.0	80.0	55.0	4	20.0	80.0	45.0	4	30.0	90.0	50.0
Zinc, dissolved (ug/L)	2008	4	10.0	28.9	19.7	4	40.0	90.0	57.3	4	40.0	70.0	54.1	4	20.0	60.0	45.3	4	20.0	60.0	45.9
	2000					2	67.7	170	119												
	2002					1	108	108	108	1	134	134	134								
	2003					3	88.0	374	216	3	186	646	403								
	2004					4	200	320	268	4	220	340	278	2	220	340	280	2	340	500	420
	2005					2	60.0	620	340	2	130	400	265	2	100	280	190	2	120	280	200
	2006					4	70.0	910	290	4	11.0	270	138	4	110	280	175	4	90.0	270	163
	2007	4	30.0	70.0	45.0	4	40.0	70.0	57.5	4	50.0	90.0	70.0	4	50.0	110	72.5	4	50.0	100	67.5
Zinc, total (ug/L)	2008	4	40.0		47.1	4	40.0	90.0	59.0	4	70.0	81.5	75.4	4	50	90.0	70.3	4	50.0	90.0	70.1

		SS-11C				SS-11D				SS-15A				SS-15B				SS-17			
Constituent	Year	N	Min	Max	Avg	N	Min	Max	Avg	N	Min	Max	Avg	N	Min	Max	Avg	N	Min	Max	Avg
	2000																				
	2002																				
	2003																				
	2004					2	8.0	9.0	8.5									2	12.0	12.0	12.0
	2005					2	9.0	14.0	11.5									2	11.0	12.1	11.6
	2006					4	6.0	12.0	9.3									4	7.0	13.0	10.8
	2007	4	6.0	7.0	6.8	4	6.0	10.0	8.0	4	8.0	12.0	10.3	4	8.0	11.0	9.5	4	8.0	11.0	10.0
Arsenic, dissolved (ug/L)	2008	4	6.0	6.1	6.0	4	6.0	6.1	6.0	4	6.6	11.0	8.2	8	4.0	6.6	11.0	4	6.6	11.0	8.2
	2000																				
	2002																				
	2003																				
	2004					2	10.0	14.0	12.0									2	15.0	18.0	16.5
	2005					2	14.0	18.0	16.0									2	17.0	20.8	18.9
	2006					4	7.0	34.0	17.5									4	16.0	22.0	18.0
	2007	4	7.0	8.0	7.5	4	6.0	12.0	9.3	4	10.0	17.0	13.8	4	9.0	17.0	12.8	4	11.0	17.0	13.5
Arsenic, total (ug/L)	2008	4	6.5	14.0	8.9	4	6.5	14.0	8.9	4	6.8	16.0	12.2	4	6.8	16.0	12.2	4	6.8	16.0	12.2
	2000																				
	2002																				
	2003																				
	2004					2	0.8	0.8	0.8									2	0.2	0.7	0.5
	2005					2	0.5	0.5	0.5									2	0.3	0.5	0.4
	2006					4	0.4	0.7	0.5									4	0.2	0.8	0.5
Cadmium, dissolved	2007	4	0.2	0.5	0.3	4	0.1	0.5	0.3	4	0.3	1.2	0.6	4	0.2	0.7	0.5	4	0.2	0.8	0.4
(ug/L)	2008	4	0.1	0.5	0.3	4	0.1	0.4	0.2	4	0.1	0.7	0.4	4	0.2	0.7	0.4	4	0.1	0.5	0.4
	2000																				
	2002																				
	2003																				
	2004					2	0.9	1.4	1.2									2	0.7	1.1	0.9
	2005					2	0.8	1.3	1.1									2	0.5	0.7	0.6
	2006					4	0.7	1.7	1.1									4	0.6	1.5	1.1
	2007	4	0.4	0.8	0.6	4	0.4	0.7	0.5	4	0.7	1.1	0.9	4	0.7	1.0	0.8	4	0.5	1.1	0.8
Cadmium, total (ug/L)	2008	4	0.3	0.6	0.4	4	0.2	0.5	0.4	4	0.5	1.1	0.7	4	0.5	1.0	0.7	4	0.4	0.8	0.6
	2000																				
	2002																				
	2003																				
	2004					2	17.0	24.0	20.5									2	21.0	24.0	22.5
	2005					2	15.0	18.0	16.5									2	27.0	29.1	28.1
	2006					4	20.0	23.0	21.3									4	20.0	32.0	23.8
	2007	4	12.0	23.0	16.8	4	12.0	16.0	13.8	4	27.0	1.1	0.9	4	23.0	30.0	26.0	4	23.0	30.0	27.3
Copper, dissolved (ug/L)	2008	4	7.0	15.0	11.9	4	6.0	16.0	10.6	4	12.0	1.1	0.7	4	17.4	29.0	22.6	4	10.0	29.0	20.1
	2000																				
	2002																				
	2003																				
	2004					2	45.0	78.0	61.5									2	71.0	72.0	71.5
	2005					2	40.0	86.0	63.0									2	83.0	120	102
	2006					4	41.0	130.0	69.0									4	59.0	150	108
	2007	4	21.0	39.0	27.5	4	19.0	35.0	24.0	4	63.0	89.0	31.0	4	55.0	75.0	67.8	4	57.0	79.0	66.3
Copper, total (ug/L)	2008	4	17.0	24.0	45.0	4	14.4	23.0	18.1	4	39.0	85.0	59.0	4	33.0	75.0	54.8	4	23.6	56.0	42.7
	2000																				
	2002																				
	2003																				
	2004					2	1.5	4.0	2.8									2	1.5	4.0	2.8
	2005					2	1.5	1.5	1.5									2	1.0	1.5	1.3
	2006					4	0.3	1.5	0.6									4	0.3	1.5	0.9
	2007	4	0.3	1.6	0.9	4	0.3	0.7	0.4	4	0.3	1.2	0.7	4	0.7	1.2	1.0	4	0.3	1.2	0.7
Lead, dissolved (ug/L)	2008	4	0.2	0.3	0.2	4	0.1	0.3	0.2	4	0.3	1.2	0.5	4	0.3	1.3	0.6	4	0.3	0.6	0.4
	2000																				
	2002																				
	2003																				
	2004					2	9.0	16.0	12.5									2	10.0	19.0	14.5
	2005					2	7.0	18.0	12.5									2	1.0	18.0	9.5
	2006					4	2.8	69.0	23.1									4	11.0	39.0	26.0
	2007	4	1.8	3.5	2.3	4	1.6	2.8	2.3	4	8.7	30.0	16.4	4	6.4	28.0	15.4	4	7.3	18.0	12.9
Lead, total (ug/L)	2008	4	1.2	1.6	1.4	4	1.2	1.7	1.4	4	5.1	24.0	12.5	4	4.5	22.0	12.2	4	2.0	8.9	6.5
	2006					4	0.01	0.10	0.03									4	0.01	0.10	0.03
Mercury, dissolved	2007	4	0.01	0.10	0.05	4	0.04	0.10	0.07	4	0.01	0.10	0.05	4	0.01	0.10	0.05	4	0.01	0.10	0.05
(ug/L)	2008	4	0.01	0.03	0.01	4	0.01	0.03	0.01	4	0.01	0.03	0.01	4	0.01	0.03	0.01	4	0.01	0.03	0.01
	2006					4	0.10	0.10	0.10									4	0.10	0.40	0.23
	2007	4	0.03	0.10	0.07	4	0.04	0.10	0.07	4	0.05	0.30	0.15	4	0.04	0.12	0.09	4	0.06	0.11	0.09
Mercury, total (ug/L)	2008	4	0.01	0.03	0.02	4	0.01	0.03	0.02	4	0.01	0.19	0.07	4	0.01	0.16	0.07	4	0.01	0.08	0.04
	2000																				
	2002																				
	2003																				
	2004					2	350	410	380									2	80.0	530	305
	2005					2	140	150	145									2	80.0	140	110
	2006					4	70.0	210	128									4	20.0	120	70.0
	2007	4	40.0	210	95.0	4	40.0	200	85.0	4	60.0	300	140	4	50.0	240	120	4	5.0	270	104
Zinc, dissolved (ug/L)	2008	4	20.0	142	80.5	4	10.0	140	71.4	4	20.0	200	119	4	100	190	142	4	10.0	172	68.0
	2000																				
	2002																				
	2003																				
	2004					2	360	510	435									2	180	620	400
	2005					2	170	340	255									2	170	350	260
	2006					4	200	430	280									4	110	440	283
	2007	4	90.0	240	140	4	70.0	240	130	4	190	330	230	4	150	260	200	4	110	300	178
Zinc, total (ug/L)	2008	4	70.0	180	121	4	60.0	190	109	4	120	320	213	4	120	300	202	4	80.0	182	143

Note: N = No. of Samples

Back

FIGURE 6-2
Annual Mean Concentration of Total Recoverable Arsenic

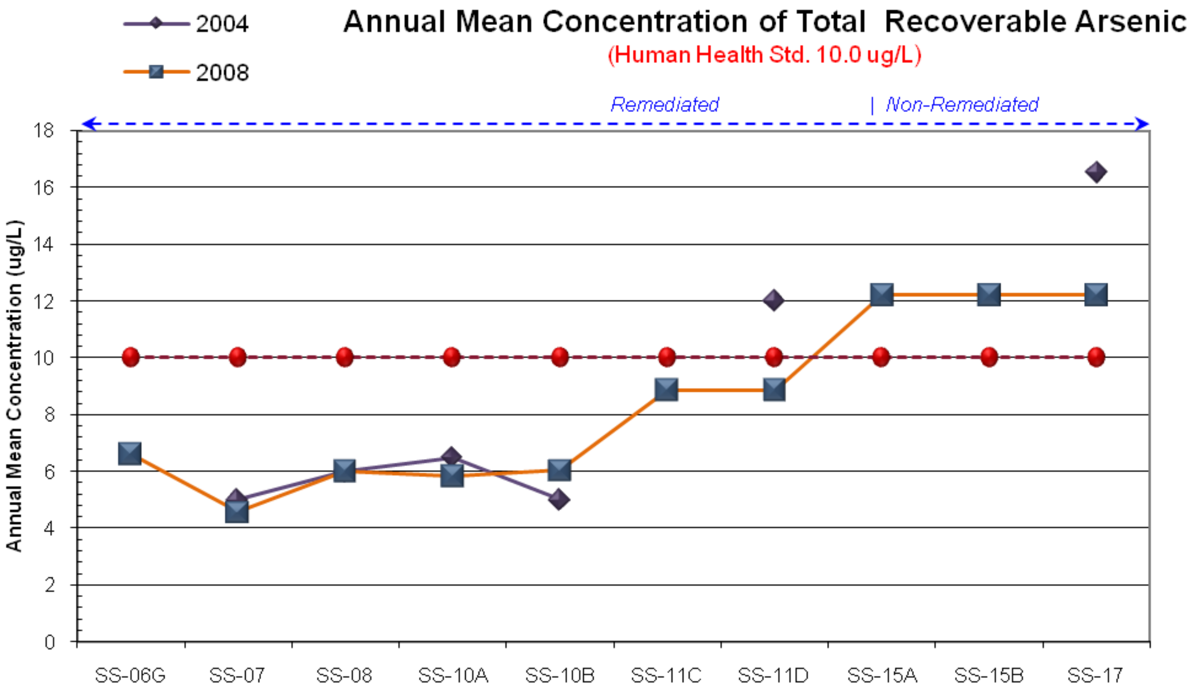


FIGURE 6-3
Annual Mean Concentration of Total Recoverable Cadmium

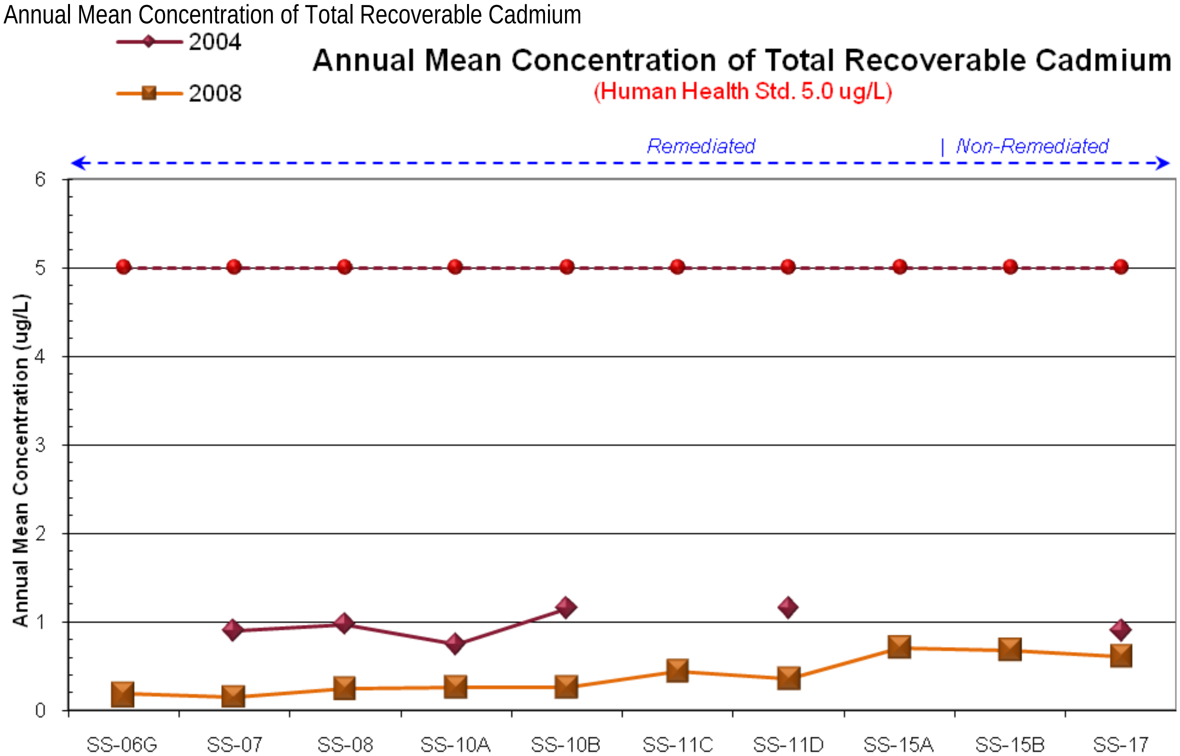


FIGURE 6-4
Annual Mean Concentration of Total Recoverable Copper

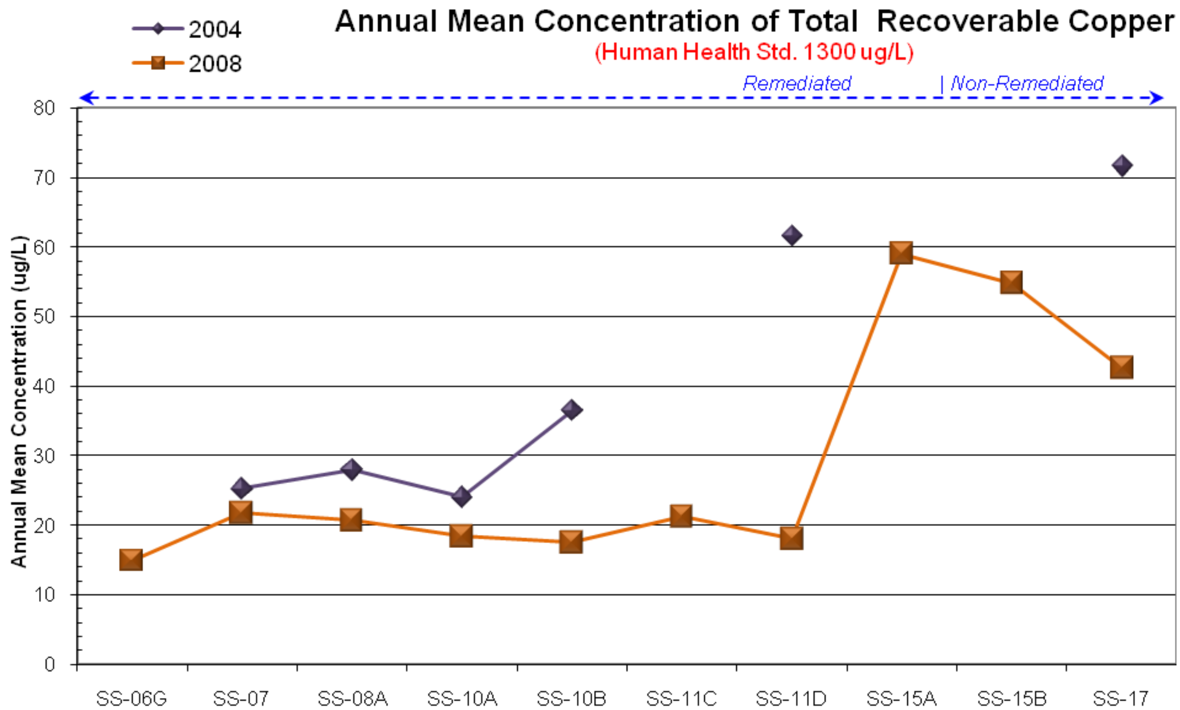


FIGURE 6-5
Annual Mean Concentration of Total Recoverable Lead

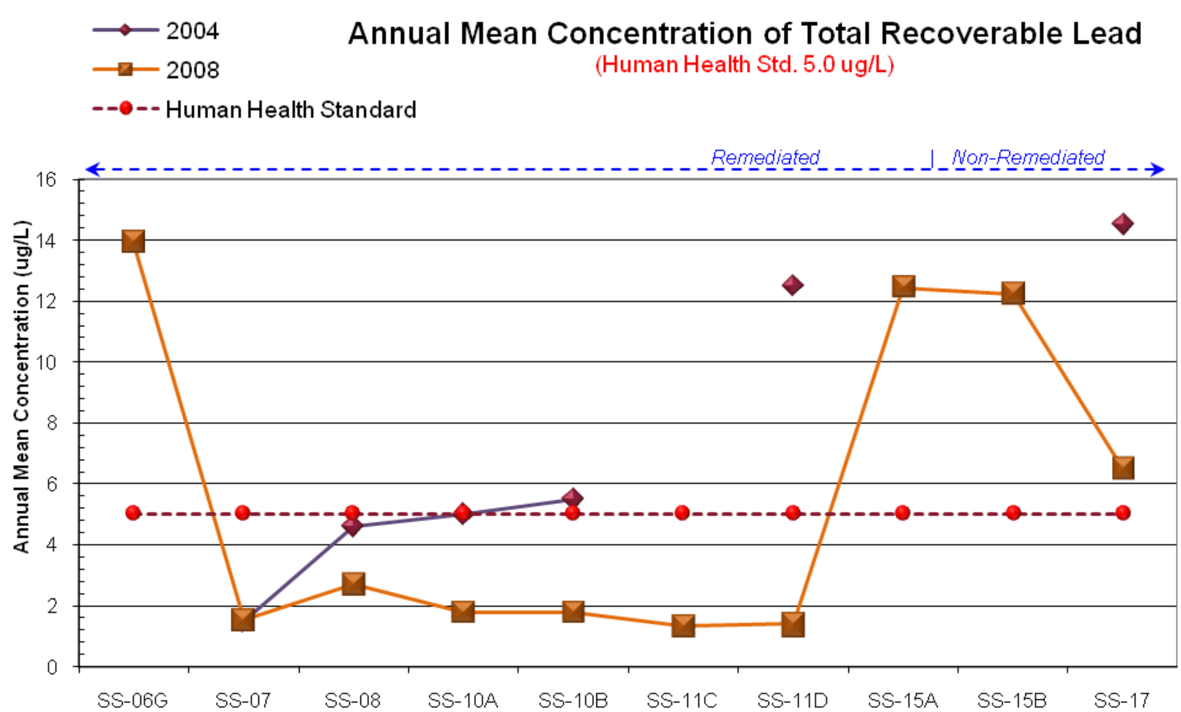


FIGURE 6-6
Annual Mean Concentration of Total Recoverable Mercury

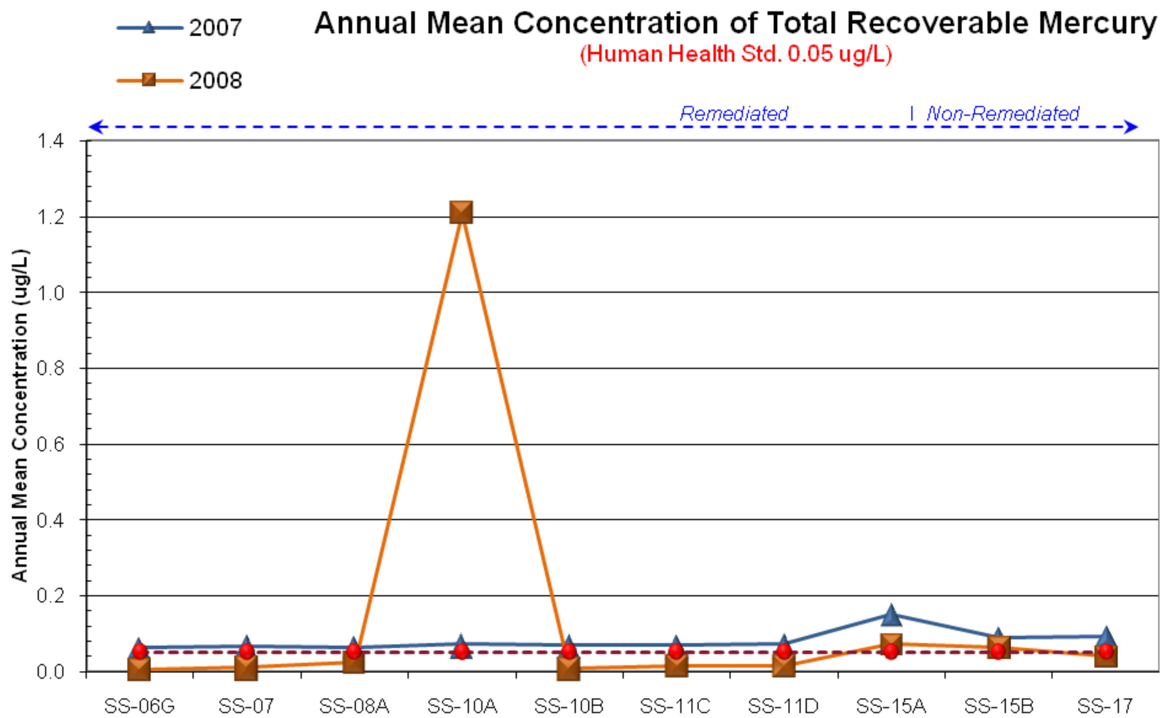
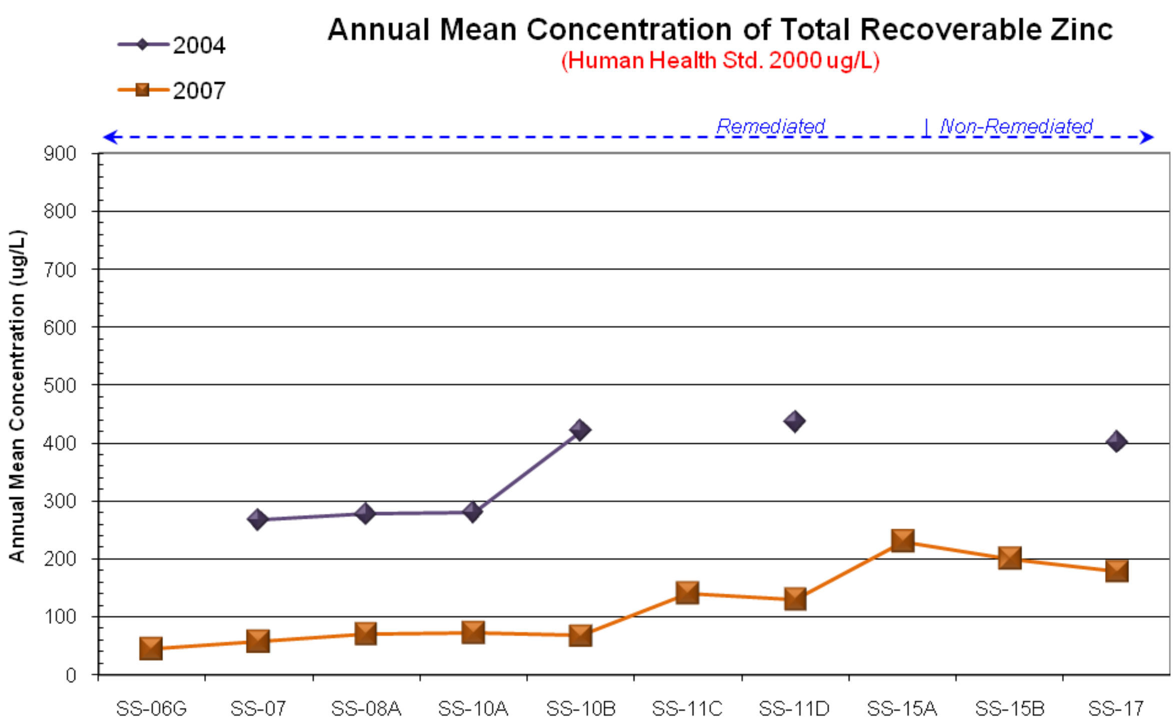


FIGURE 6-7
Annual Mean Concentration of Total Recoverable Zinc



Surface water quality dissolved data were compared to aquatic acute and chronic standards for arsenic, cadmium, copper, lead, mercury, and zinc for the available water quality monitoring record. For the purposes of this five-year review, EPA feels that use of the annual mean concentration of each constituent of concern, by station, is an appropriate relative gauge of the status of water quality in Silver Bow Creek with respect to designated cleanup goals. Given the early status of the remedy, this comparison is general in nature and will be refined as the remedy matures and variability of water quality constituent concentrations diminishes.

Summary data, illustrating mean annual concentrations by station over time, are presented in the following graphs and indicate improving trends particularly in the upstream subareas that have undergone remediation (see Figures 6-8 through 6-13). Dissolved arsenic, lead, and mercury concentrations are below both chronic and acute aquatic standards throughout the operable unit for all recorded values. Dissolved cadmium concentrations exceed aquatic chronic standards in the unremediated portion of the SSTOU. Both aquatic chronic and acute dissolved zinc standards are exceeded in the unremediated portion of the operable unit. Dissolved copper exceeds both chronic and acute standards for the entire operable unit. In general, dissolved values increase from remediated areas (upstream) to unremediated areas (downstream).

FIGURE 6-8
Annual Mean Concentration of Dissolved Arsenic

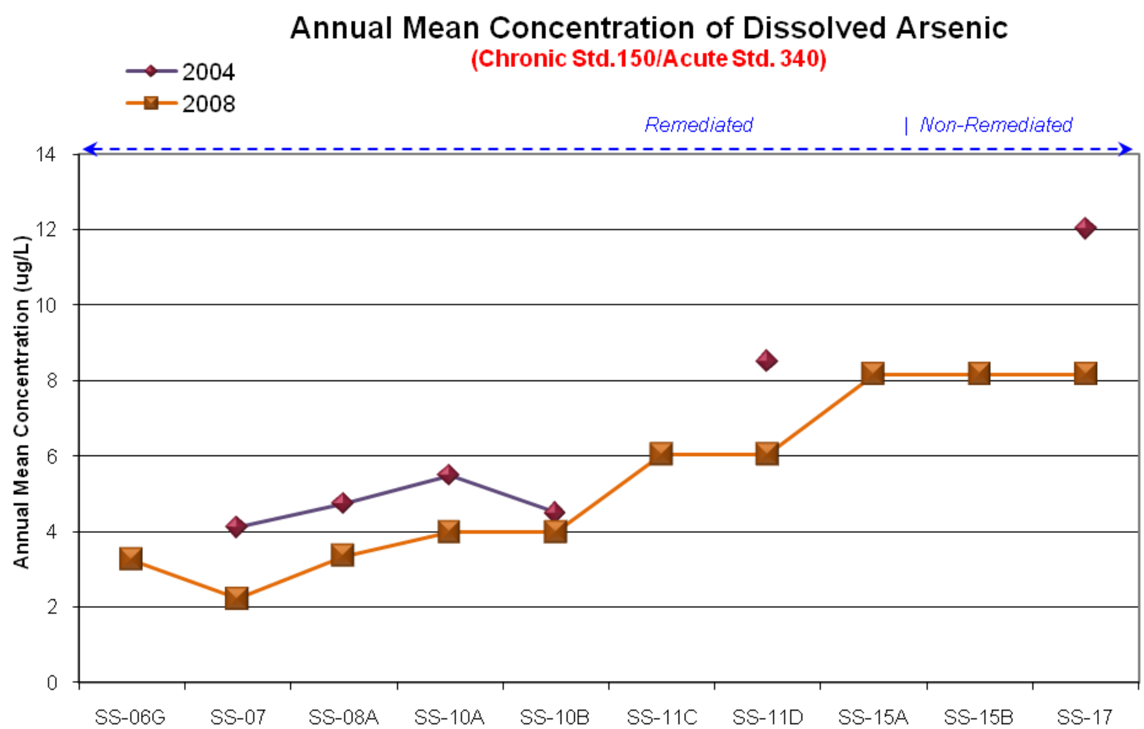
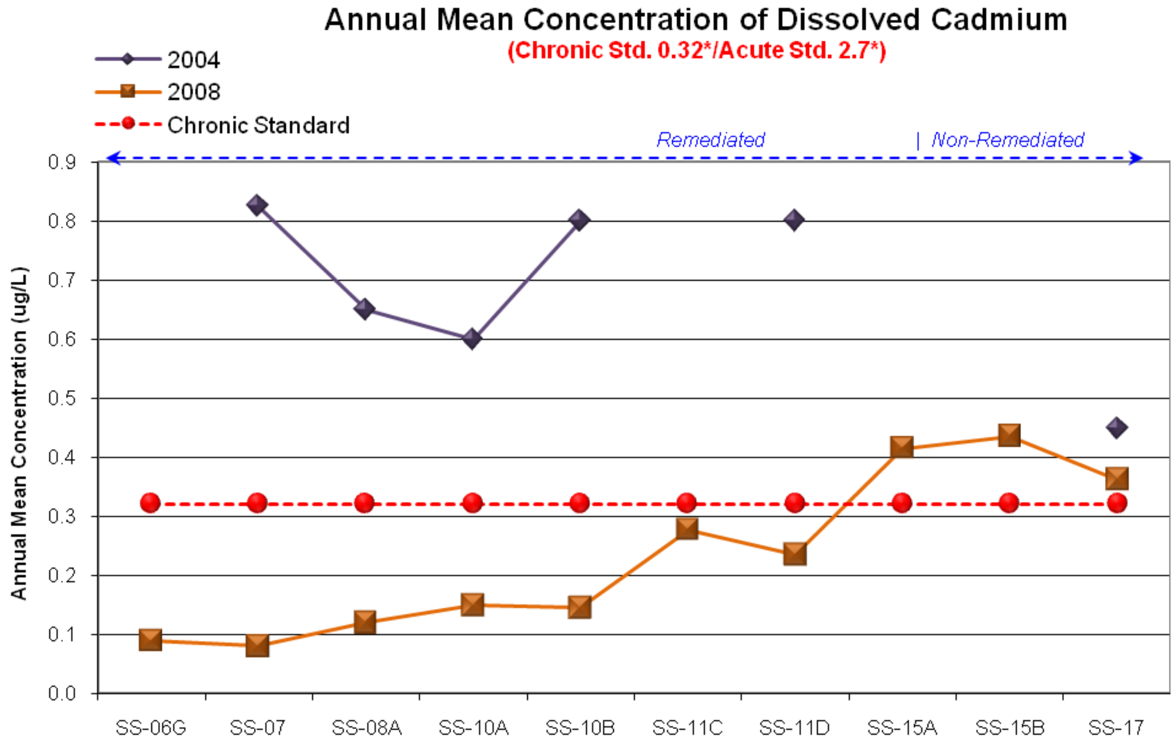
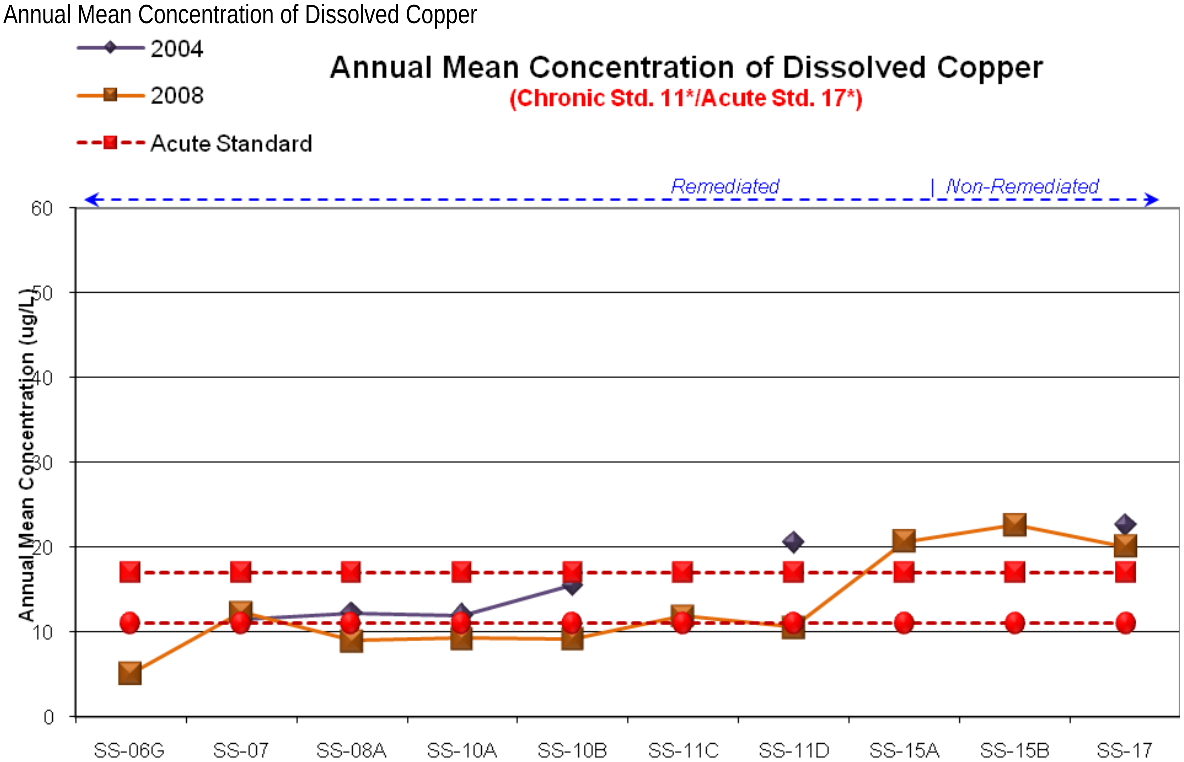


FIGURE 6-9
Annual Mean Concentration of Dissolved Cadmium



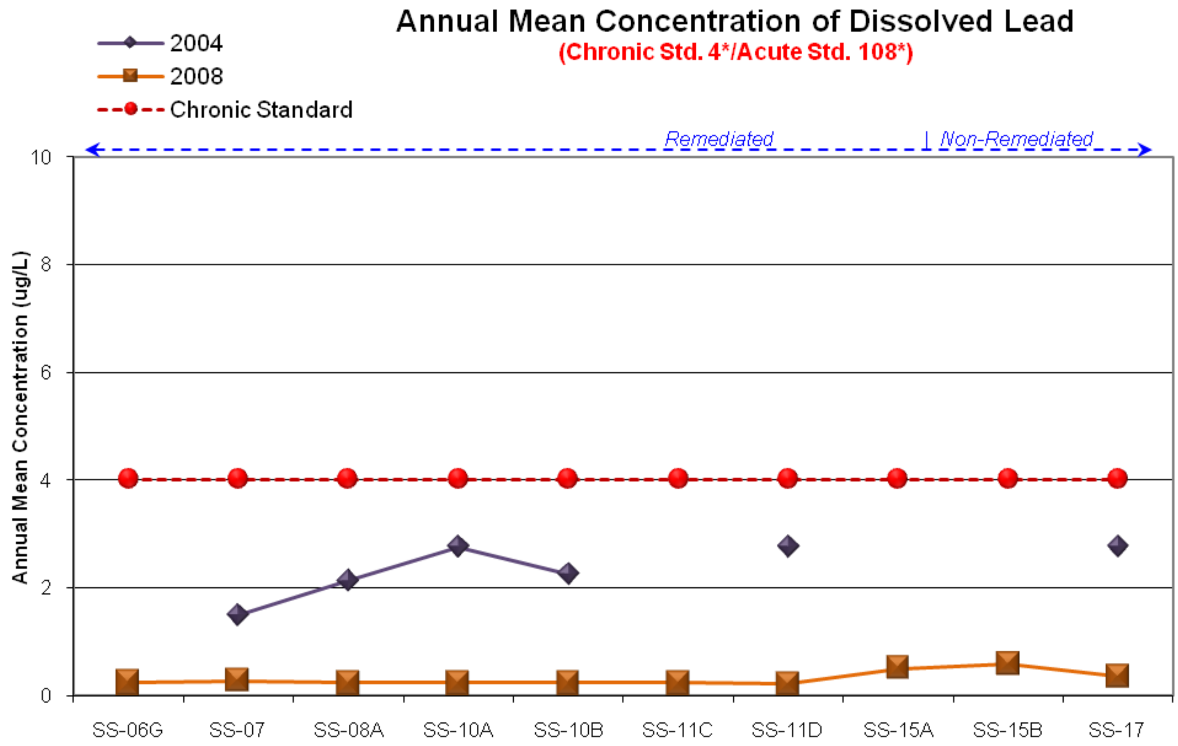
*Based on 125 mg/L hardness (typical Value for Silver Bow Creek in SSTOU)

FIGURE 6-10
Annual Mean Concentration of Dissolved Copper



*Based on 125 mg/L hardness (typical Value for Silver Bow Creek in SSTOU)

FIGURE 6-11
Annual Mean Concentration of Dissolved Lead



*Based on 125 mg/L hardness (typical Value for Silver Bow Creek in SSTOU)

FIGURE 6-12
Annual Mean Concentration of Dissolved Mercury

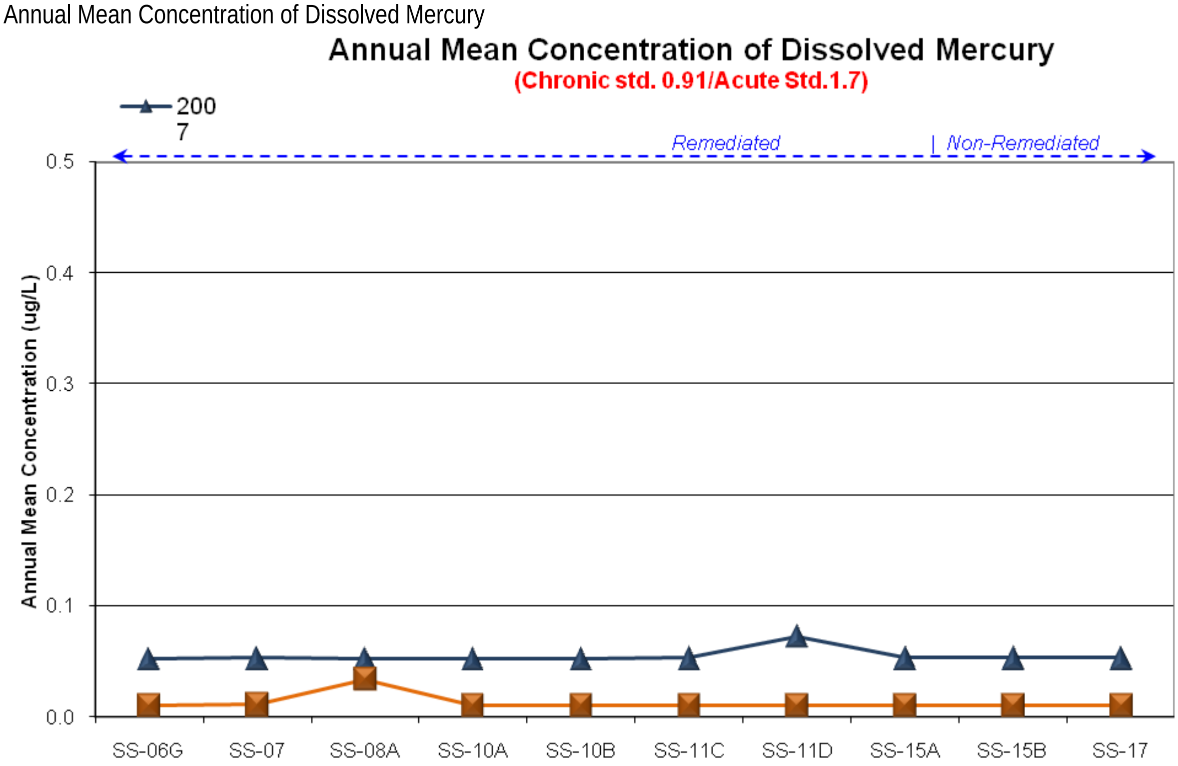
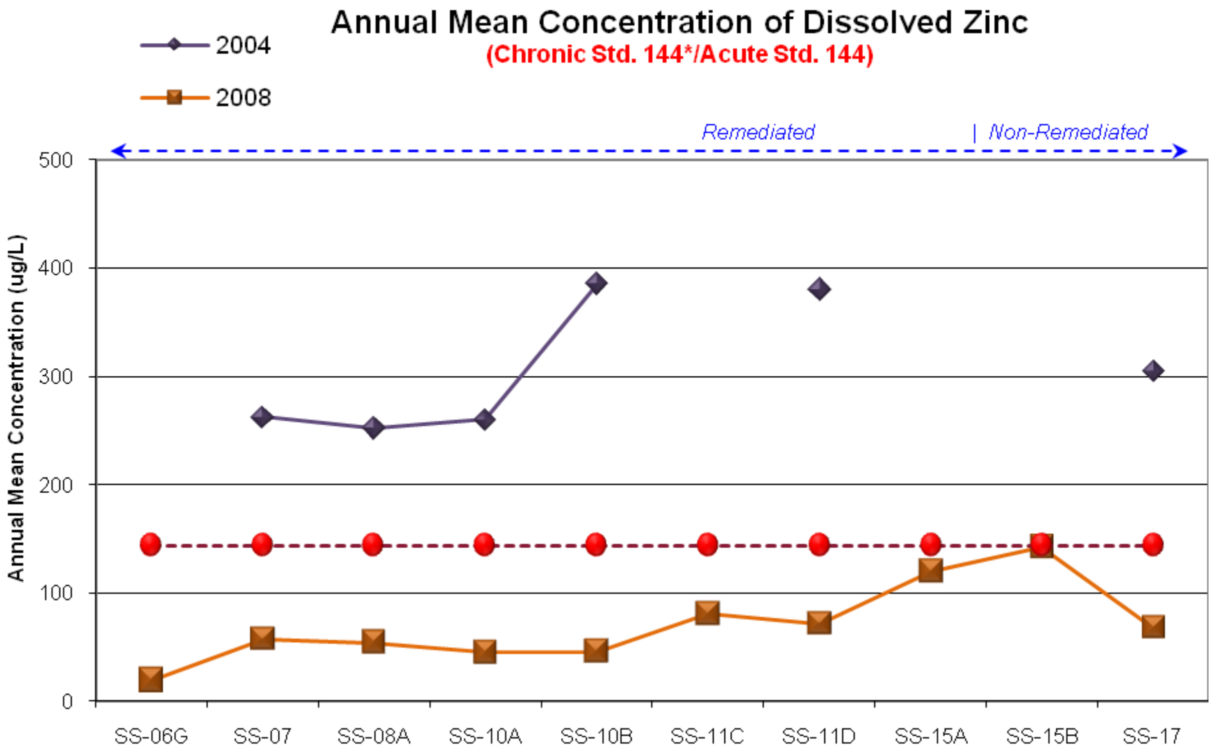


FIGURE 6-13
Annual Mean Concentration of Dissolved Zinc



*Based on 125 mg/L hardness (typical Value for Silver Bow Creek in SSTOU)

Significant reduction in metals loading from upstream sources, and reductions from the ongoing remedial actions within the SSTOU itself, are also evident in long-term USGS sampling data that bracket the project area with Stations 12323250 (SBC below Blacktail Creek in Butte) and 12323600 (SBC at Opportunity) (see Table 6-2). Approximately 39 percent of flows in SBC within the SSTOU project area enter from the upstream Butte area. During the baseline sampling period (1993 to 1998), average annual discharge in SBC was approximately 25 percent higher than the subsequent remedial action period (1999 to 2009). A reduction in arsenic, total suspended solids (TSS), and metals loads between the two periods is, in part, due to drought conditions and less flow. The average concentrations (incoming and outgoing) for arsenic, metals, and TSS were consistently higher during the baseline period than during the remedial cleanup period. Potential reasons for upstream metals concentrations to have decreased before entering the SSTOU during the cleanup period include the following:

- Reduced flows. As noted above, baseline flows were approximately 25 percent higher than flows during the remedial action period.
- Removal of the Colorado Tailings and surrounding area. This was the major source of contamination to SBC, and its removal by EPA is likely a large contributor to stream water quality improvement. The majority of removed tailings were taken to the Clark Tailings area, and a smaller portion went to Opportunity Ponds.

- Reconstruction of SBC in Lower Area One. The creek was reconfigured to alter groundwater inflow to the stream and to reduce metals loading. This action is also a major contributor to stream water quality improvement.
- Remediation of Missoula Gulch in Butte. Mine wastes were recontoured, covered with limestone where needed to adjust pH, top dressed with 18 inches of cover soil, and revegetated. Catchment basins were constructed. The catch basins significantly reduce the amount of surface water from this area that reaches SBC through catchment basins design as part of the BPSOU remedy.
- Groundwater Capture. Groundwater in the Butte area is captured by the MSD groundwater collection system and a hydraulic control channel in Lower Area One. The groundwater is then pumped to the Butte Treatment Lagoons.
- The final condition contributing to the reduction in metal loads from the SBC/Butte area is the ongoing cleanup and revegetation of contaminated areas.

6.6.2 Groundwater Monitoring

6.6.2.1 Monitoring Goal

The goal of groundwater monitoring is to demonstrate that, "Removing the source of groundwater contamination by addressing tailing/impacted soils and railroad materials, will allow contaminants in groundwater to attenuate over time through dilution, adsorption, precipitation and dispersion, and should allow eventual attainment of groundwater standards" (MDHES, 1995). "Remediation and restoration goals for groundwater call for concentrations of contaminants of concern to meet State water quality standards, Federal Maximum Contaminant Levels (MCLs), and Federal non-zero maximum contaminant level goals (MCLGs) through natural attenuation" (MDEQ and MDOJ Natural Resource Damage Program, 2009). In addition, all groundwater discharges that would prevent attainment of Circular MDEQ-7 surface water standards are to be prevented. Standards must be met at each monitoring location for the remedy to be considered successful.

Post-remedial groundwater monitoring began in 2006 and includes 18 wells, all of which are located in Subarea 1. Wells are monitored on an annual basis with the exception of wells associated with the mine waste repository, which are monitored semi-annually. The wells are distributed throughout Subarea 1 as follows:

- Colorado Tailings—three wells. The physical location of these wells is downstream of the actual Colorado Tailings area. The "Colorado Tailings" name for this well cluster is a historic vestige retained by MDEQ as part of their groundwater monitoring network. Hence, it is retained in this report.
- Mine Waste Relocation Repository (MWRR)—six wells
- Rocker Area—three wells
- Nissler—three wells
- Silver Bow—three wells

TABLE 6-2
SSTOU Water Quality Data Summary—Mean Annual Metals Loading

Station Time Frame	Average Annual Q (cfs)	Surface Water Sampling—Average Total Recoverable Metals—Concentration/Loading											
		Arsenic Concentration (µg/L)	Arsenic Load (tons/yr)	Cadmium Concentration (µg/L)	Cadmium Load (tons/yr)	Copper Concentration (µg/L)	Copper Load (tons/yr)	Lead Concentration (µg/L)	Lead Load (tons/yr)	Zinc Concentration (µg/L)	Zinc Load (tons/yr)	TSS Concentration (mg/L)	TSS Load (tons/yr)
Station 12323250 (upstream start of SST) 1993 to 1998 (Pre-remedy baseline)	33.9	15.5	0.6	2.4	0.1	160.4	6.6	32.3	1.17	724.9	30.63	39.3	1,884
Station 12323600 (downstream end of SST) 1993 1998 (Pre-remedy baseline)	89	39.5	4.3	3.3	0.3	336.7	35.2	73.6	8.8	815.6	73.4	59.1	11,483
Difference between upstream and downstream Baseline loads			**3.7**		**0.2**		**28.6**		**7.63**		**42.8**		**9,599**
Station 12323250 (upstream start of SST) 1999 – 2009 (Subareas under construction)	25.9	8.3	0.22	0.6	0.01	31.2	0.81	4.6	0.13	154.1	3.85	11.3	363
Station 12323600 (downstream end of SST) 1999 – 2009 (Subareas under construction)	65.8	25.7	1.7	1.56	0.1	188.9	12.7	43.39	3.01	374.04	23.29	33.8	3,894
Difference between upstream and downstream loads during Remedial Action			**1.48**		**0.09**		**11.89**		**2.88**		**19.44**		**3,531**

Notes:
mg/L = milligrams per liter
Q= Discharges
Original data from published USGS reports (1993 -2009)

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With the exception of the MWRR, the wells are oriented in rough transects of three. Analytes consist of dissolved metals and a suite of common ions (MDEQ and MDOJ, 2008). COCs include metals associated with tailings and other mining waste (arsenic, cadmium, copper, lead, mercury, and zinc). Analytical results are interpreted by comparisons to a background well to define local water quality, and groundwater and surface water quality standards to assess any threat to Human Health.

To assure remedy protectiveness in Subarea 2, additional groundwater monitoring wells should be installed and monitored.

6.6.2.2 Results

The short period of record and small dataset make trend assessment at each well location meaningless. As the dataset for these wells increase with time, meaningful trend analysis will improve.

Arsenic. Over the 3-year monitoring period, mean annual arsenic concentrations have remained stable and below the drinking water standard of 10 µg/L, with the exception of well 1GW-1038 located in Rocker. Concentrations in this well were as high as 100 µg/L in 2007, but dropped to 36 µg/L in 2008. Existing data appear stable for the majority of these wells.

Cadmium. Cadmium mean annual concentrations exceed the drinking water standards in one well in the Colorado tailings area (MW-1052R), and downstream in a well in the Nissler area (P-58A) and Silver Bow Area (P-37A). Annually, the data appear stable over the 3 years of record. From an upstream to downstream profile, the wells at the downstream end of Subarea 1 (P-58, P-37A) consistently exceed the drinking water standard. No other consistent condition is evident.

Copper. Mean annual copper concentrations in all the wells did not exceed the 1,300 µg/L MDEQ drinking water standard with the exception of 1 well in the Rocker area (MW-10). Concentrations consistently exceed the aquatic acute and chronic standards, 17 µg/L and 11 µg/L respectively, in eight of the wells (P-06A, MW-1052R, MW-10, GW-1038, MW-6R, GW-1004A, P-37A). No other discernable trends appear to exist in the copper data.

Lead. Mean annual Lead concentrations in all wells remain consistently below the MDEQ drinking water standard of 5 µg/L, with the exception of well MW-10 in Rocker and well 1GW-1004A in Nissler. Annual concentrations are stable to slightly downward. No linear trend exists from upstream to downstream.

Mercury. Mean annual concentrations for mercury were at or above drinking water standards (0.05 µg/L) for six of the wells during 2007. Concentrations fell during 2008 and only 2 wells remained above the standards (both Rocker wells). No consistent annual or linear trend exists from upstream to downstream.

Zinc. Mean annual concentrations of zinc exceeded drinking water standards (2,000 µg/L) in 4 wells (MW-1052R in Colorado tailings, MW-10 in Rocker, 1GW-1004A and P-58A in Nissler). The short period of record and small dataset make trend assessment at each well location meaningless. Zinc concentrations were variable in wells from 2006 through 2008.

6.6.2.3 Summary

In summary, groundwater data are very limited; therefore, few if any conclusions can be drawn from the data. It does appear, however, that for all COCs with the exception of mercury, monitoring wells in the vicinity of the repository had lower concentrations than wells located in the floodplain. Installation of future monitoring wells in other areas of the OU should be completed in a strategic manner that will allow a comprehensive assessment of shallow groundwater. Monitoring wells should be installed at the beginning of each subarea to provide data needed to evaluate each subarea's performance.

6.6.3 Sediment Monitoring

Concentrations of arsenic, cadmium, copper, lead, and zinc instream sediments have been determined at specific SBC locations from 2002 through 2008. Determinations of the COC levels are made on four different sediment size fractions: less than 0.063 millimeter (mm); 0.063 to 1 mm; 1 mm to 2 mm; and greater than 2 mm. Samples were collected and analyses were conducted quarterly. Data for 2008 are displayed in the 2008 Silver Bow Creek Monitoring Report (Confluence Consulting, Inc. et al., 2008). Sediment concentration data for all monitoring years are summarized in a technical report submitted to MDEQ by Confluence Consulting, Inc., in January 2009. In this 2009 report, the collection locations are delineated by those in remediated or non-remediated areas. Stream sediment concentrations are displayed on a series of bar graphs by location, by sampling year, and by size fraction. Concentrations defining the SBC remediation goals (SBCRGs), Threshold Effects Concentrations (TECs) and Probable Effects Concentrations (PECs) are also displayed on the graphs in these reports.

According to the 2008 Monitoring report, current SBCRGs for stream sediments are equivalent to the cleanup standards for tailings and impacted soils throughout the floodplain. Subsequent to the cleanup standards being set for SBC, consensus based sediment quality guidelines were developed by freshwater ecologists (MacDonald et al., 2000). These authors defined TEC as concentrations below which no effect on sediment dwelling organisms are expected, and PEC as concentrations at which negative effects on sediment dwelling organisms are judged more likely than not. Numerical values for SBCRG, TEC, and PEC concentrations are exhibited in Table 6-3. EPA recommends the State consider these sediment quality guidelines as restoration goals.

TABLE 6-3
Contaminants of Concern and Potential/Applicable Sediment Concentration (mg/kg) Quality Standards

Contaminants of Concern	Silver Bow Creek Remedial Goal	Threshold Effects Concentration (TEC)	Probable Effects Concentration (PEC)
Arsenic	200	9.79	33.0
Cadmium	20	0.99	4.98
Copper	1,000	31.6	149
Lead	1,000	35.8	128
Mercury	10	0.18	1.06
Zinc	1,000	121	459

The annual mean stream sediment concentration data from these reports and databases were visually and graphically (trend line) assessed in four categories as follows:

- Concentrations in stream sediments collected from remediated vs. non remediated locations
- Concentrations in different size fractions (less than 0.063 mm and 0.063 to 1 mm)
- Yearly trend in concentrations within each size fraction
- Comparisons of annual mean concentrations to numerical values of SBCRGs, and TECs and PECs

Results are displayed in Table 6-4.

6.6.4 Vadose Zone Monitoring

6.6.4.1 Monitoring Goal

The goal of vadose zone monitoring is twofold: (1) determine background soil water pore concentrations for the COCs of interest; and (2) determine if any COCs are migrating from the mine waste repository toward the SBC alluvial aquifer (MDEQ and MDOJ, 2009). Because soil pore water is not regulated by surface or groundwater quality standards, sample concentrations must be measured against established background concentrations to assess and evaluate observed changes.

Seven lysimeters were installed proximal to the mine waste repository (see Appendix A for locations). The lysimeters are monitored semi-annually with one sampling occurring during the high water period associated with spring run-off. The samples are analyzed for the dissolved metals/metalloids (arsenic, cadmium, copper, manganese, lead, mercury, and zinc), common ions (calcium, magnesium, sodium, potassium, chloride, sulfates, and bicarbonate), and field constituents (temperature, pH, redox potential (Eh), and conductance). Monitoring of lysimeters around the MWRR will continue for 10 years beyond its date of construction as an institutional control. However, if COC concentrations show no change or a declining trend for 3 years, prior to the 10 years of institutional monitoring, the number of monitoring sites will be re-evaluated and possibly reduced.

6.6.4.2 Monitoring Results

2008 was another year of low soil moisture resulting in only one lysimeter (LYS-01) producing adequate pore water in the June sampling to run analyses. No lysimeter yielded adequate water for sample analysis in September. Analytical results from LYS-01 for June 2008 yielded no detectable, arsenic, cadmium or lead. Copper was detected at a concentration of 5 µg/L which was above the 2006 background concentration of 2 µg/L for the background Lysimeter, LYS-01. Mercury was detected at 0.01 µg/L which is below the baseline value of 0.4 µg/L established by background lysimeter LYS -06 in 2006. Zinc was detected at 70 µg/L in LYS-01. This concentration was higher than the background concentration of 10 µg/L established in 2006. However, this low concentration does not indicate a concern for zinc migration out of the repository.

TABLE 6-4
Interpretation of Annual Mean Stream Sediment COC Concentrations

Category	Arsenic	Cadmium	Copper	Lead	Mercury	Zinc
Remediated vs. non-remediated locations	Concentration are less in remediated locations, with exception of 2006 data when all levels were elevated	Concentrations are similar or slightly less in remediated areas compared to non-remediated locations	Concentration are less in remediated locations, with exception of 2006 data when all levels were elevated	Concentration are less in remediated locations, with exception of 2006 data when all levels were elevated	Concentration are less in remediated locations, with exception of 2006 data when all levels were elevated	Concentration are less in remediated locations, with exception of 2004 and 2006 data when all levels were elevated
Size fraction	Concentration in the <0.063 mm fraction are generally greater than the >0.063 – 1 mm fraction	Concentration in the <0.063 mm fraction are generally greater than the >0.063 – 1 mm fraction	Concentration in the <0.063 mm fraction are generally greater than the >0.063 – 1 mm fraction	Concentration in the <0.063 mm fraction are generally greater than the >0.063 – 1 mm fraction	Concentration in the <0.063 mm fraction are generally greater than the >0.063 – 1 mm fraction	Concentration in the <0.063 mm fraction are generally greater than the >0.063 – 1 mm fraction
Yearly trend (<0.063 mm fraction)	There is a general trend of decreasing concentration with time	General constant or slightly increasing concentration trend with time	There is a general trend of decreasing concentration with time	At most locations there is a slight decreasing concentration trend with time	General constant or slightly decreasing concentration trend with time	There is a general trend of decreasing concentration with time
Yearly trend (>0.063 mm to 1 mm fraction)	General constant trend with time	There is a general trend of decreasing concentration with time	There is a general trend of decreasing concentration with time	At most locations there is a slight decreasing concentration trend with time	There is a general trend of decreasing concentration with time	There is a general trend of decreasing concentration with time
Annual mean data meet SBCRG?	Most values meet SBCRG (200 mg/kg) in remediated areas	Most values met SBCRG (20 mg/kg) in remediated areas, except at SS-07	By 2008 most values met 1,000 mg/kg in remediated areas, except at SS-07	All values met the SBCRG (1,000 mg/kg)	All but 2 values met the SBCRG (10 mg/kg)	The majority of values exceed the SBCRG of 1,000 mg/kg

TABLE 6-4
Interpretation of Annual Mean Stream Sediment COC Concentrations

Category	Arsenic	Cadmium	Copper	Lead	Mercury	Zinc
Annual mean data meet TEC?	All values from <0.063 size fraction exceeded TEC (9.79 mg/kg) in 2008. Some values from larger size fraction did meet TEC in 2008	All values in both size fractions exceeded TEC (0.99 mg/kg) in all years from 2002 to 2008	All values in both size fractions exceeded TEC (31.6 mg/kg) in all years from 2002 to 2008	All values exceed the TEC (35.8 mg/kg), except for one in the larger size fraction	All values in the <0.063 mm fraction and most values in the larger size fraction exceeded the TEC (0.18 mg/kg)	All values exceeded the TEC value of 121 mg/kg
Annual mean data meet PEC?	Some values met PEC (33.0 mg/kg) in 2008	All values from <0.063 size fraction exceeded PEC (4.98 mg/kg) in 2008. Some values from larger size fraction did meet TEC in 2008	All values from <0.063 size fraction exceeded PEC (149 mg/kg) in 2008. Some values from larger size fraction did meet PEC in 2008	Some values from >0.063 mm fraction met the PEC (128 mg/kg), while many values in the larger size fraction met the PEC	Most values in the <0.063 mm fraction exceeded the PEC (1.06 mg/kg). Some of the values in the larger size fraction also exceeded the PEC	Almost all values exceeded the PEC of 459 mg/kg

TEC = Threshold Effects Concentration – the concentration below which toxicity to aquatic organisms is unlikely.
PEC = Probably Effects Concentration – the concentration at which toxicity to aquatic organisms is probable.

In summary, the lysimeter data for 2008 are inconclusive with respect to its ability to detect the migration of COCs from the MWRR. The consistent lack of soil moisture to provide adequate sample volume at each lysimeter location prohibits a determination of any kind. If the lack of detectable moisture in the lysimeters is truly the result of low soil moisture and not a malfunction of the sampling device, then it might be concluded that any migration of COCs from the repository is unlikely because of the general lack of soil moisture. It is recommended that each lysimeter be checked to determine its ability to properly function in-situ. It is also recommended that additional lysimeter installations be considered for strategic locations in the floodplain to assist with the determination of vadose zone contamination from residual waste left in place and its potential contribution to the quality of the shallow groundwater.

6.6.5 Soils Monitoring

In 1998, soil contamination was extensive and fairly homogenous throughout the OU, justifying a remedial action involving removal of tailings and mixed soils. The following paragraphs summarize post-remedial action verification results and how they compare to remedial action performance standards.

6.6.5.1 Soil Performance Standards

The target remedial action goal is to remove 90 percent of tailings/impacted soils with 95 percent confidence. Verification sampling is used as a quality assurance measure to demonstrate that the removal goal is being achieved. Removal goals are considered achieved if at least four out of six of the constituents of concern are less than the concentrations shown in Table 6-5.

TABLE 6-5
Contaminated Material Constituents of Concern, SSTOU

Constituent	Concentration[a] (mg/kg)
Arsenic	200
Cadmium	20
Copper	1,000
Mercury	10
Lead	1,000
Zinc	1,000

[a] Concentration levels were set by MDEQ and EPA, 1998

6.6.5.2 Post-Remedy Soil Sampling

For areas that have undergone remedy, a QA/QC sampling program was instituted to verify that 90 percent of the tailings were removed with 95 percent confidence. Surface (0- to 4-inch depth) soil samples were collected from the newly exposed surface after excavation, and prior to placement of cover soils. The purpose of the sampling was to provide a statistical measure of whether the removal goal had been met. Sampling was not used to search for limited “hot-spots” of contamination that may remain in the floodplain. A significant number of samples were collected before any determination of the efficacy of the removal could be made. The sampling program was not used to redirect excavation to previously excavated areas. If verification sampling indicated that the removal goal was not being met over substantial areas, the over-excavation depth was increased in as-yet unexcavated areas to achieve the removal goal. This approach to verification of removal of tailings/impacted soils allowed the contractor to excavate to the elevations shown on the plans and conduct his operation without delays and interruptions of the construction sequence.

Raw concentration data for the six elements in the 0- to 4-inch depth increment after excavation, but prior to placement of cover soil, are found in the appendices of the Final Construction Report for each Reach. An example of verification results for SubArea 1 Reach A are shown in Appendix G.

An expected failure rate of 37.1 percent was derived from the statistical properties of 350 test pits excavated and sampled in Subarea 1 by ARCO (ARCO, 1997). Methods used to arrive at the expected failure rate are described in Appendix D of the Final Design Report (Maxim, 1999).

Measured failure rates were calculated and exhibited in the Construction Completion Reports for the different Reaches where remedy was performed. These failure rates, from upstream to downstream, are shown in Table 6-6.

TABLE 6-6
Documented Failure Rates

Subarea	Reach	Failure Rate
1	A	34.8%
1	B and C	24.3%
1	D and E	13.9%
2	F, G, and H	17.2%
2	I & J	23.8%
4	Phase 1	12.5%
4	Phase 2	8.6%
4	Parcel 152	25.0%

These failure rates were less than the expected failure rate of 37.1 percent; therefore, the removal goal for these reaches has been accomplished. However, monitoring of the waste left in place is needed to assure the long term protectiveness of the remedy.

Although the remedial action goal was met, high concentrations of the contaminants remain in materials that were not excavated. In Reach A, Subarea 1, on an element basis, 68 percent of samples had zinc concentration greater than 1,000 mg/kg, 44.6 percent of the verification samples had copper levels above 1000 mg/kg, and 33.7 percent of the verification samples had arsenic concentrations greater than 200 mg/kg. Acidity (as measured by pH) measurements of these samples indicated that 37 percent had pH values ≤6.5.

Verification data for other Reaches or Subareas were not available for review. It is likely, in these Reaches, that unexcavated materials also exhibit acid conditions and elevated metal and arsenic concentrations.

6.6.5.3 Other Post-Remedy Soil Investigations

In 2005, an investigation was initiated to gather soils and measure plant cover from certain locations in Subareas 1 and 2 which had undergone remediation. This study was titled, "Explaining Impaired Revegetation as a Function of Cover Soil Properties "Prodgers, 2005; Prodgers, 2007a; Prodgers, 2007b. The main study objective was to identify post-remediation edaphic limitations and their relation to revegetation success. Independent variables included several cover soil properties, and plant cover was the response variable. Forty sites, most with impaired vegetation and often with salt on the surface soil, were sampled. Determinations of the concentrations of several elements, as well as electrical conductivity (EC) and sodium absorption ratio (SAR) were conducted. The following text is a summary of this report and a display of the data found in the report:

- Within large areas receiving uniform treatments, spots of poor revegetation or, in extreme cases, barren patches occur.
- At several sites, soils have been recontaminated with metals. Following remedy, the metals were not in the cover soil at the concentrations now observed. Upward movement of metals and arsenic has apparently recontaminated the soils at these sites.
- Four sites with the least amount of vegetation cover have pH levels less than 5.2, and sum of metals/arsenic greater than 1,700 mg/kg. These soils are also saline. These soils have the highest metal/pH index.
- Most soils from the sites are saline with EC levels greater than 4 dS/m, although the cover soil specification for EC was 4 dS/m. Many of the soils are also sodic with SAR values greater than 12.
- The soils from all the sites evaluated because of "impaired vegetation" were either saline, sodic, low pH, and had elevated metals or various combinations of these factors. The five soils from the sites with the greatest vegetation cover (greater than 100 percent) were not saline, had metal and arsenic concentration meeting the cover soil specifications, and were of neutral pH. See Appendix H for data from this report.

Other than this 2005 cover soil study, there has been no evaluation of soils in remediated areas. The 2009 Interim Long Term Monitoring Plan (ILTMP), Section 8.3, suggests that successful revegetation indicates design criteria are met and no further soil monitoring is considered necessary. However, the 2005 cover soil study suggests that processes such as capillary rise of groundwater or downward percolation of run-on from outside the SSTOU may have degraded the cover soil. Post remedy soil sampling, as described in Section 8.0 of the 2009 ILTMP, is therefore necessary to assure that the remedy will be protective long term.

6.6.6 Revegetation Monitoring

The remedial success of the SSTOU cleanup (Subareas 1 and 2) is most visually apparent in its dramatic transformation of barren fluvial terraces of tailings, to a robustly vegetated riparian habitat in most areas.

Results of vegetation monitoring of remediated areas in the SSTOU are found in the following three documents:

- Monitoring Report for 2004. Streamside Tailings Operable Unit, Silver Bow Creek/Butte Area NPL Site (MDEQ and MDOJ, 2004).
- Explaining Impaired Revegetation as a Function of Cover Soil Properties (Prodgers, 2005; Prodgers, 2007a; Prodgers, 2007b)
- Monitoring Report for 2008. Streamside Tailings Operable Unit, Sliver Bow Creek/Butte Area NPL Site (MDEQ and MDOJ, 2008).

6.6.6.1 2004 Vegetation Monitoring

Vegetation was monitored throughout Subarea 1 of the SSTOU in 2004. The 2004 report indicated a net improvement, with half of the transects in Reach A passing the revegetation standards. Success has been limited in different areas by coarse in-situ soils, near-surface salinity, and residual contamination. Vegetation performance standards exhibited in the 2004 Report are restated in Table 6-7.

TABLE 6-7*
Minimum Desired Canopy Coverage Approximately Ten Years after Seeding in Years of Near-normal Seasonal Precipitation

Hydrologic Zone	Average Canopy Coverage
Uplands, subirrigated	60%
Streambanks, transition zone	80%
Wetlands (not open water)	100%

* From 2004 Monitoring Report

No formal performance standards for seedling density have been set. However, the 2004 report displayed desired densities as shown in Table 6-8 as a way of evaluating initial establishment relative to the need for supplemental seeding. The desired seedling densities indicate whether satisfactory revegetation is likely to develop from past seedings. Of course, seedling density is a continuous variable, and dividing it into just two classes (satisfactory and unsatisfactory) oversimplifies interpretations, especially for borderline cases.

TABLE 6-8
Minimum Desired Seedling Densities and Frequencies for Satisfactory One- or Two-Year-Old Fields

Hydrologic Zone	Average Density	Frequency
Uplands, subirrigated	1.2/square foot	70%
Streambanks, transition zone	2.5/square foot	80%
Wetlands	3/square foot	80%

Vegetation cover measured in 19 transects within Reach A showed relatively no change from 2002 to 2004, with the average canopy cover at 69 percent for each of those years. Seedling density measurements in Subarea 1, Reaches B and C were judged overall to be sufficient, but density values from several transects were deemed as insufficient. Additional measures of vegetation in Subarea 1 found in the 2004 Report included woody plant density and survival, and survival of streambank willows.

6.6.6.2 2008 Vegetation Monitoring

Revegetation in each reach or phase of the SSTOU is monitored in temporal rotation until it passes performance standards (Table 6-7). This report contains the results of 2008 revegetation monitoring in Reaches F, G, and H within Subarea 2, and most permanently seeded portions of Subarea 4. The revegetation sampling methods combine canopy coverage from plots along transects, and shrub density from 1-meter-wide belts along the same transects in established revegetation with seedling density in young revegetation.

Perennial cover in Reach F varied from 50.8 to 114.4 percent, while in Reach G, perennial cover ranged from 48.0 to 95.3 percent. The lower cover values were thought to be due to saline soils, less alfalfa, and younger plants in Reach G. Seedling densities measured in Reach H were described as good to very good.

Both cover and density measurements were made in Subarea 4. Within the areas sampled, seedling densities in 2008 were considered generally adequate.

6.6.7 Macroinvertebrates and Periphyton Monitoring

6.6.7.1 Goals for Macroinvertebrate and Periphyton Communities

Macroinvertebrates within SBC have been sampled and monitored since 1972, although no macroinvertebrates were detected there until 1975 (Canton, 1985). Since then, steady increases in density and number of species have been recorded throughout the SBC sampling stations. The restoration and remediation goals for SBC include defined objectives for macroinvertebrate and periphyton communities (MDEQ and MDOJ Natural Resource Damage Program, 2007). For both assemblages, the goal is for community composition to reflect a balanced, integrated, and adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region (Karr and Dudley, 1981). Targets reflecting these goals include progressive increase of biological integrity substantiated by indices developed to rate the health of Montana streams (Bahls, 1993; Bollman, 1998; Bukantis, 1998).

Specific goals for the macroinvertebrate community include the attainment of a total metric score of 75 percent of the total possible score in the Good category for 2 consecutive years.

Specific goals for the periphyton community include the attainment of a score within Excellent to Good biological integrity for all metrics for 2 consecutive years.

6.6.7.2 Monitoring Results in 2008

Analysis of macroinvertebrate metrics for samples collected from SBC in September 2008 indicated continued impairment overall of SBC through the reach sampled. Impairment ranged from moderate to severe, and depended on both the bioassessment method employed and station location within the study area.

- Using biocriteria developed by Bollman (1998), four of the ten sampling sites on SBC were classified as severely impaired.

- Bioassessment ratings developed by Bukantis (1998), indicated severe impairment at four sampling stations. All other sites were ranked as moderate.
- All SBC stations (with the exception of SS-15A) displayed an improvement (decrease) in the Hilsenhoff biotic index (HBI) in 2008. The HBI demonstrated an increase in the abundance of less tolerant species and a marked decrease in percent tolerant taxa throughout the study reach of SBC, when compared to the 2007 data, suggesting improved health and rehabilitation of the aquatic habitat.
- EPT richness values showed a general increase in the number of mayflies and caddisflies in SBC, further indicating improvement of stream health.

Macroinvertebrate metrics indicate the continued impairment of SBC by nutrient loading as the impacts from metals are decreased. Improvements in water quality have been documented as both mining discharge and urban effluent have been held to improved standards.

Removal of tailings and associated metals from the floodplain, and reconstruction of the stream channel has had an apparent positive influence on biological integrity at these sites. A sustained reduction in metals-tolerant taxa coincided with the removal of metals sources; however, the biotic index, a measure of nutrient-tolerant invertebrates, has risen. These results suggest that, following the reduction of metals levels, elevated nutrients have emerged as a primary constraint on aquatic life. Thus, despite extensive tailings removal efforts, only modest increases in overall biological integrity have been realized. Overall, these results suggest improvement in the remediated reaches of SBC through removal of metal contaminants. However, poor water quality entering the SSTOU, particularly in the form of elevated nutrients from the Butte WWTP discharge, remains as the factor strongly limiting full recovery of the biological community. It appears unlikely that restoration and remediation goals for the SSTOU can be met without reductions in all pollutant loading, including nutrients, throughout the SBC watershed. The Butte WWTP is under a cleanup order which requires full compliance in ten years.

The macroinvertebrate assessment methodologies presently used by the State are quite different from those used in the remainder of the Clark Fork Basin sites. The SSTOU methods for measuring macroinvertebrate community health may have been sufficient methods to use during construction. However, now that many of the stream reaches in the OU have been cleaned up, a more rigorous monitoring approach should be employed that will tease out impacts from mining contaminants as opposed to impacts from the Butte WWTP. Some suggestions for improvement are listed below:

- Sampling presently consists of a single traveling kick-sample at each site. Quantitative (Hess) sampling is performed at all other sites in the Clark Fork Basin and is replicated four times. Replicated quantitative sampling would improve the power and reliability of the macroinvertebrate assessments in the SSTOU. Data reduction efforts should be used to standardize both the historic and future data with the current data collection effort.
- The biointegrity assessment MDEQ uses for the SSTOU relies on generalized models for Montana's foothill and valley streams. Each of these models (RMVP Bolman 1998, MFVI Bukantis 1998, MMI MDEQ 2006) was developed to provide broad stroke assessments of biological integrity for most streams. Each of the models fulfills this objective (they

show Silver Bow Creek is impaired). However, they do not provide the most accurate, rigorous (no density measurement), or insightful assessment of environmental conditions since Silver Bow Creek is not a typical Montana stream, and these assessments are not sensitive enough to measure small but real changes that are useful for trend analyses. For example, they do not provide enough information to determine whether impacts are induced from metals associated with mining wastes, or from other critical stressors such as ammonia. EPA would prefer the State incorporate the multimetric analysis specifically developed for the Clark Fork River and Silver Bow Creek (McGuire 1993) or develop a comparable assessment scale using more reliable and accurate project specific metrics.

- Sampling and analyses should be standardized with existing MDEQ and EPA monitoring programs for downstream reaches of the Clark Fork River Basin.
- Longitudinal and trend assessments should fully utilize over 20 years of pre-remediation data (Canton et al 1986 and McGuire 2001) as a baseline for assessing restoration success.
- The Mill-Willow Bypass could be used as a control (reference) for Silver Bow Creek monitoring.

6.6.8 Fish Population Monitoring

6.6.8.1 Fish Population Monitoring

Prior to 2002, SBC was generally considered to be void of fish except for occasional observations of suckers during the late 1990's when remediation of the stream channel began. The 2008 Monitoring Report represents the first formal sampling of fish presence and abundance in SBC. Results from 2002 through 2008 have primarily consisted of determining the presence or absence of a fish species, an estimate of number of fish per 100 seconds of electrofishing effort (also known as Catch-Per-Unit-Effort (CPUE)) and basic size structure of fish captured.

Fish species composition and abundance in SBC varies throughout the sections sampled.

Species found during the monitoring years 2002-2008 in various portions of the watershed include westslope cutthroat trout (*Oncorhynchus clarki lewisi*), brook trout (*Salvelinus fontinalis*), rainbow trout (*Oncorhynchus mykiss*), longnose sucker (*Catostomus catostomus*), slimy sculpin (*Cottus cognatus*), and central mudminnow (*Umbra limi*). These represent all of the species presently known to occur in SBC. Westslope cutthroat trout, longnose sucker and slimy sculpin are native to the watershed while brook trout, rainbow trout, and central mud minnow are present because of introductions. Brown trout (*Salmo trutta*) (introduced species) occur downstream of SBC at the Warm Springs Ponds. However, to date, this species has not been captured during routine sampling efforts in the survey reaches of SBC. The *2008 SST Monitoring Report* exhibits species presence or absence (Table 6-1 of the report) at several locations along SBC. This information is presented in Table 6-9 and on Figure 6-14.

TABLE 6-9
Fish Species Presence/Absence, General Rating of Abundance, and Numbers (2008 Survey Data) in the Upper Silver Bow Creek Watershed as of 2008*

	Fish Species					
Sample Location	**Westslope Cutthroat Trout**	**Brook Trout**	**Rainbow Trout**	**Longnose Sucker**	**Slimy Sculpin**	**Central Mudminnow**
Headwater tributaries	Common	Common	Absent	Rare	Rare	Rare
Butte Area (Father Sheehan Park)	Rare	Common (84 and 26)	Absent	Common (12 and 4)	Common (84 and 69)	Common (16 and 9)
Remediated area above sewage outfall (Lower Area One)	Absent	Rare	Absent	Common (41)	Abundant (114)	Present (6)
Remediated area below sewage outfall (Rocker)	Absent	Absent	Absent	Abundant (188)	Rare	Rare
Remediated area near Ramsay/ Miles Crossing	Rare (2)	Rare (1)	Absent	Common (32)	Rare (5)	Rare
Nonremediated area downstream of German Gulch (Spring Sampling)	Rare (na)	Present (na)	Absent (na)	Present (na)	Rare (na)	Absent (na)
Nonremediated area downstream of German Gulch (Fall Sampling)	Rare (1)	Present (2)	Rare (1)	Common (35)	Present (4)	Absent
Nonremediated area above Highway 1 near Opportunity	Absent	Absent	Rare (4)	Present (23)	Present (29)	Absent

*From Table 6.1 of *2008 Monitoring Report for SSTOU of Silver Bow Creek* (MDEQ and DMOJ, 2008). Values in brackets are numbers of fish found in 2008. Butte area was sampled twice.

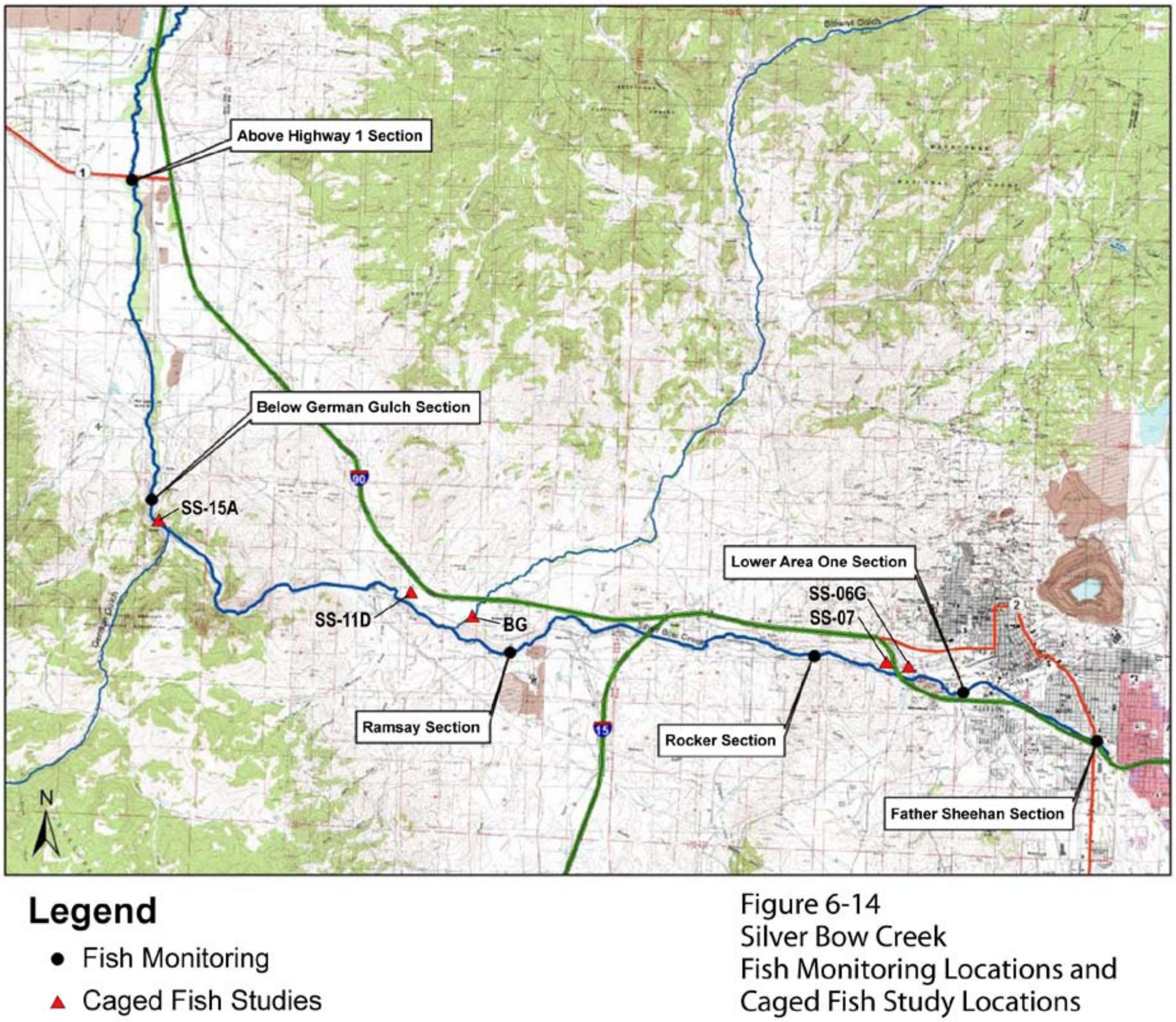

Figure 6-14
Silver Bow Creek
Fish Monitoring Locations and
Caged Fish Study Locations

Fish sampling of SBC from 2002 to 2008 provided a general perspective of fish response to ongoing remediation activities in SBC. Because numerous sections were sampled, interpretation of results should be limited to observations of major trends in fish species composition. Sampling was sufficient to determine if a sampling reach was fishless for one or more years, followed by colonization by tolerant species such as suckers and sculpin, and then followed by colonization by sensitive species such as trout. Relatively small fluctuations in fish abundance or species composition at specific sampling locations should not be considered significant unless a multi-year trend is observed.

6.6.8.2 Caged Fish Study

Cages containing 12 small (approximately 1.5 inches long) westslope cutthroat trout (obtained from the fish hatchery at Anaconda) were placed at four locations in SBC and one location in Brown's Gulch. The SBC sites were above (SS-06G) and below (SS-07) the Butte sewage treatment outfall, as well as locations near Ramsey (SS-11D) and above the confluence with German Gulch (SS-15A) (See Figure 6-14). Sites SS-06A, SS-07, and SS-11D are located in remediated areas. Site 15A is located in a non-remediated area, while Brown's Gulch served as a background or reference site. There were two cages at each site. The experiment began on August 1, 2008. Hourly measurements of water temperature, conductivity, pH, dissolved oxygen, oxygen reduction potential, and turbidity were collected (note, these data are not in the report). Water samples were collected each day and determinations of ammonia, copper, cadmium, arsenic, lead, and zinc concentrations were made. Spikes in copper and zinc concentrations were recorded on August 7 and 8 in response to a rain event in the watershed. These increased concentrations were observed at SS-07 (below sewage treatment plant), and at SS-15 (non-remediated area above German Gulch). Concentrations on these days exceed both chronic and acute standards for copper and zinc. Ammonia level in water at SS-07 also was recorded at a concentration above the acute water quality standard after the rain event. No ammonia data were collected at SS-15.

Concurrently with the rain event and spikes in copper, zinc, and ammonia, fish mortality was measured on August 8 as follows:

- SS-06G—no mortality (0 percent)
- SS-07—92 percent and 83 percent in Cages 1 and 2
- SS-11D—0 percent
- SS-15A—92 percent and 83 percent in Cages 1 and 2
- Brown's Gulch—0 percent

On August 11, all fish were dead in cages at SS-07, and on August 10, mortality rates were 92 and 100 percent at SS-15A.

Final mortality rates for fish in cages at the other sites were as follows:

- SS-06G—no mortality (0 percent). Note, this site located on SBC, is upstream of the Streamside Tailings OU. This area has been remediated and is part of Lower Area One.
- SS-11D—8 percent for each cage.
- Brown's Gulch—8 percent and 17 percent for Cages 1 and 2.

The 2008 Monitoring Report concludes the following:

> *"Clearly, ammonia concentrations measured at site SS-07 are a concern for water quality and the survival of fish. This result however was not unexpected, because of previous studies that have been conducted on Silver Bow Creek. The site above the sewage treatment outfall (SS-06G) is only 1,400 ft upstream from the site below the outfall (SS-07). The metal concentrations (Cu and Zn) observed at SS-07 were extremely high, yet remained low and stable at SS-06A, suggesting that metals inputs are rapidly entering the creek between SS-06A and SS-07. It appears as though the remediated areas of Silver Bow Creek are being recontaminated with metals from somewhere close to the sewage treatment outfall. This is clearly a concern and needs further investigation."*

6.7 Site Inspection

A field inspection of the remediation within the SSTOU was conducted on September 29 and 30, and on October 1, 2009. The EPA technical team led by the RPM was joined on the first day by the personnel from the lead remedial implementation agency, MDEQ, and their design contractors, as well as members of the Butte Technical Assistance Group. On the second and third days, the RPM and EPA's technical team conducted the inspections. The goals of this three day inspection were to assess the protectiveness of the remedy, including conditions and stability of the streambanks, the condition of the plant communities established as part of the remedy, and the integrity of the cap placed over the repository. The inspections focused on Subareas 1, 2, 3, and 4, and the repository.

6.7.1 Vegetation and Surface Soils

6.7.1.1 Subarea 1, Reach A

This is the ninth growing season for the vegetation, which is dominated by metals tolerant species like rubber rabbit brush, tufted hair grass, redtop, alfalfa, western wheatgrass, and basin wild rye. Colonization by other species is not occurring. Several areas were observed where surface soil salts are present, ranging in size from a few square feet up to 400 square feet (see Appendix E for photos). These areas often appeared wet as well. The surface soil salts result from the upward movement of water which carries dissolved cations and anions such as calcium, magnesium, and sulfate, and COCs such as copper and zinc. The salty areas are devoid of vegetation or have metals tolerant tufted hair grass present. It is possible that some water carrying the COCs to the surface is of low pH. The origin is likely the mining waste left in place. The imported cover soil in many places has been contaminated by this upward movement of salts and COCs. One area observed was adjacent to the trail, but not remediated as it was perceived to be outside the floodplain. This area, easily accessed from the trail, contained mine wastes and tufted hair grass. Surface soil salts are also common in other Reaches in Subarea 1.

6.7.1.2 Subarea 2

This area encompasses Reaches F, G, H, I, and J including Ramsay Flats. Prior to removal and replacement of cover soils, Ramsay Flats was a large expanse of land (hundreds of acres) and was essentially devoid of any vegetation. The remediation appears to be very successful with robust vegetation, and reconstructed streambanks. A series of ponds provide wildlife habitat. Vegetation in this area is more rich and diverse than Subarea 1. Trees have been planted here using restoration funds. However, surface soil salts were also common in the Subarea.

6.7.1.3 Subarea 3

Large-scale remediation of this area has yet to begin. Some limited work has been completed in the upper area of Subarea 3. In addition, MDEQ has constructed a sediment basin as SBC exits the canyon area.

6.7.1.4 Subarea 4

Remediation in the area is underway. Wastes have been removed from an area below the highway bridge near the Fairmont Resort. The streambank has been reconstructed using willow and fabric wraps. Riffles and pools have been constructed. A drop structure has been constructed to allow a pool to form so that an irrigation pump can access water. The areas have not yet been seeded. We were shown a borrow soil area with residual soil acidity and were told by MDEQ personnel that 80 acres was treated in-place by addition of lime and organic matter, and then seeded with a temporary crop of barley.

6.7.1.4.1 Issues and Concerns

Based on field observations of vegetation and soils and discussions with MDEQ, identified issues are as follows:

- Upward movement of salts from underlying materials is impacting vegetation. This phenomenon was evident in many areas of Subarea 1 and 2. Salts are coming from: (1) saline and perhaps sodic imported cover soils; and/or (2) metals and low pH water from wastes left in-place below the cover soil. Lysimeters could be placed in the riparian area to assess water quality. The State has indicated that vadose zone water is a Water of the State and therefore is assessed using State guidelines. Lysimeters could be used to ascertain whether salty areas are due to COCs and low pH waters moving up the soil profile thus affecting the permanence of the vegetation community.
- Metals tolerant tufted hair grass is present in some areas. This species is often associated with the salty areas and in these locations is indicative of elevated COC concentrations.
- Remediation in Subareas 1 and 2 is complete. The species composition seems variable as seed mixes and rates have been changing throughout the history of the remediation. These changes are not documented in monitoring reports. The vegetation is rich (total numbers of species), and structural diversity is good. Some non-native species have apparently been seeded. The long-term persistence of the vegetation is probably good, although at this time successional changes are not apparent. The salty areas need repair so that vegetation can be established.

6.7.1.5 Repository

A small waste repository was developed adjacent to the site in Subarea 1. However, most of the tailings and impacted soils excavated from the SBC floodplain were transported via rail to a Waste Management Area on the Opportunity Ponds. These ponds are part of the adjacent NPL site, known as the Anaconda Smelter Site. The bottom of the small repository is not lined. The top has a constructed soil cap approximately 24 inches thick. Waste materials were placed in the small repository in multiple lifts and each was treated with lime. The top of the repository is well vegetated with cover estimated at 80 to 100 percent. Species include basin wild rye, rubber rabbit brush, aspen, big sagebrush, and a fescue species. Weeds were not observed. Monitoring wells and lysimeters associated with the small repository were located.

No seeps, exposed wastes, or acid drainage were observed. The soil cap was stable with no signs of active erosion, and there was no evidence of adverse impact on adjacent land. On the north side of the repository, a rock lined ditch was constructed. This feature moves water around the repository to rock channels on the east and west sides of the repository. The rock channel on west side of repository feeds a sediment basin, which drains into a culvert. No sediment at the outfall or sediment in the basin was observed. The sediment basin on the east was full. A standing drain pipe was allowing a small volume of water to go through a culvert at the end of the basin. The repository fence at the NW corner need repair. The signs are in place. No public safety issues for the repository were observed.

6.7.2 Streambanks

6.7.2.1 Subarea 1, Reach A

Many of the streambanks in Reach A are devoid of woody vegetation. The coir fabric will only last 5 to 10 years, and, without woody vegetation, the stability of the bank may be comprised. Some streambanks, especially near the Greenway Trail have robust stands of *Salix exigua* (sandbar willow), an excellent streambank stabilizing pioneer woody species. In those portions of the streambanks with woody vegetation, the bands of woody vegetation are very narrow (1 to 2 meters wide). This narrow corridor may not provide enough deep, binding rootmass to hold the streambanks together during high flow. The vegetation currently growing in Reach A may not be a sustainable vegetation community because some of the species are not native to similar floodplains of western Montana. This is an issue that should be evaluated in the next five-year review in more detail, after more time allows greater vegetation development and succession.

6.7.2.2 Subarea 2 (Ramsay)

Prior to remediation, Ramsay Flats was a large expanse (several hundred acres) of barren tailings. The transformation to a well vegetated landscape is impressive. Almost all of the streambanks in this Subarea are devoid of woody vegetation. The coir will only last 5 to 10 years and without woody vegetation, streambanks may be at risk of failure during high flows. The immediate streambanks were planted with an introduced mixture of clovers. These will eventually be replaced by other species that may provide deep, binding rootmass. Many of the plants seeded/planted in this section are of an interesting mix. They include native and introduced plants along with riparian/wetland plants and upland plants, all part of the newly constructed floodplain. These combinations of plants do not naturally grow together in a relatively undisturbed floodplain. Subarea 2 seems to have a good plant cover, even though much of the cover is by either introduced plants or plants typical of the Great Plains. Again, streambank vegetation and woody vegetation, and streambank stability, is an issue that should be evaluated in the next five-year review in more detail, after more time allows more vegetation development and succession.

6.7.2.3 Subarea 3

Some limited work has been completed in the upper area of this Subarea 3. Many of the comments above for Subarea 2 also apply to this area.

6.7.2.4 Subarea 4

The newly constructed stream seems to be narrower than the stream in Subareas 1 and 2, which may result in more frequent out of bank flows if the channel is not deep enough to offset the reduction in width. Some erosion on newly constructed streambanks was observed, and an active head cut moving upstream toward the instream rock gabions just downstream of the irrigation pump station was observed.

SECTION 7

Technical Assessment

7.1 Question A—Are the remedies functioning as intended by the Record of Decision?

Yes. Review of decision and data documents, ARARs, risk assumptions, and the results of the site inspection (performed September 2009) by USEPA, MDEQ, contractor CH2M HILL, and associated subcontractors Reclamation Research Group (RRG) and Ecological Solutions Group (ESG) indicate that the remedy, as currently constructed, appears to be functioning as designed.

The remedial action, as implemented to date, is performing as expected in remediated subareas. Review of remedial actions revealed the following:

- Former waste source deposits of tailings and impacted soils, previously covering significant portions of the floodplain in Subareas 1, 2, and portions of 3 and 4, have been removed to repository locations (MWRR, and Opportunity Ponds). Remedial action (removal), although significant and consistent with the intent of the ROD as modified by the ESD, did leave residual contamination in the floodplain throughout the operable unit.
- Surface water quality has improved significantly when compared to baseline conditions. Water quality trends show consistent improvement with respect to meeting human health and aquatic chronic and acute standards in direct response to remedial actions within the OU.
- The floodplain and streambanks involved in the remedy (Subareas 1 and 2) are in various stages of revegetation and showed few signs of localized erosion. Ongoing monitoring and assessment of streambank vegetation is warranted.
- Former waste source rock, tailings, and spilled ore concentrates associated with local rail line foundations in Subareas 1 and 2 have been removed (if directly adjacent to SBC) or capped to prevent erosion (in areas not adjacent to the creek). An inactive rail line foundation located in Subarea 4 has been completely removed.

Removal of floodplain contaminated tailings/impacted soils and replacement with clean cover soils and vegetation have achieved remedial objectives by:

- Reducing direct exposure (ingestion and inhalation) of local residents and recreationists to contaminant sources, and controlling localized runoff and wind erosion of the remediated areas.
- Reducing the potential for SBC to be directly contaminated by accelerated streambank erosion of contaminated tailings and soils directly into the creek.

- Reducing the potential for SBC to be directly contaminated by over land flow from snowmelt and stormwater runoff (ancillary offsite sources in major ephemeral tributary gulches still need to be evaluated).
- Reducing the infiltration of contaminated surface water into the shallow groundwater by the removal of contaminated source material overburden.
- Reducing the potential for floods to re-mobilize contaminated source material back into the creek and floodplain.

Optimization of the remedy can be accomplished as the remedy works its way toward completion in 2012.

A more complete and thorough strategic post-construction remedial monitoring plan would provide the data to more clearly demonstrate the performance of the remedy in each subarea, and is recommended in this report. The plan should allow for careful assessment of soil, streambanks, surface water, groundwater, sediment, benthic macroinvertebrates, fish, and vegetation in each of the subareas. One method to achieve this is by careful bracketing of the subareas with monitoring transects to allow individual assessment of the remedial progress in each of these areas, while still allowing for the collective assessment of the entire operable unit. It appears that the existing monitoring stations for surface water, groundwater, and stream sediments are vestiges of baseline data collection stations. Implementation of the remedy has drastically changed the fluvial features in the floodplain. It is recommended that the monitoring station locations be reconfigured to effectively bracket the remediated subareas.

From a surface water and sediment standpoint, this would allow an assessment of discharge and water quality entering and leaving the subarea. The location of shallow groundwater monitoring wells should be co-located with water quality monitoring stations to gain efficiency in access and field monitoring time. Each groundwater monitoring transect should consist of at least three wells, one in proximity to the creek and the remaining two on opposite sides of the channel at some distance, and located to assess groundwater quality in the floodplain and allow for preparation of potentiometric maps, if needed. Opportunistic wells could also be added in strategic locations within the floodplain, to supplement the monitoring network, if warranted.

From a vegetation and soils monitoring standpoint, it is suggested that permanent transects across the flood plain and perpendicular to SBC be established and co-located to gain field efficiencies. These transects could also be aligned with the surface and groundwater stations to facilitate common access. The vegetation and soils transects can be supplemented by additional opportunistic sampling through maintenance intensive areas, when warranted.

Emerging issues with the remedy include the following:

- Sporadic areas of salt formation and revegetation failure in Subareas 1 and 2 are potentially linked to residual waste left in place within these subareas, or the capillary transport of contaminated groundwater to the surface by evaporative demand during the summer. Both conditions can create “hot spots” of contamination in surface soil which are phytotoxic and may represent a threat to human health as exposure increases through greater use of the area. Salt formation also creates a risk of recontaminating surface water through snow melt and stormwater runoff. These areas should be thoroughly investigated to determine why the salts are forming, and a method for mitigating the condition should developed and implemented. Vegetation performance standards should be met in all barren areas.

- During the community interviews, a potential source of recontamination from offsite source material transported by stormwater run-off from a gulch was raised by a resident of Rocker. The SSTOU floodplain corridor is intercepted by a number of tributary gulches that carry water only during high intensity storm events or during high snow years. A number of these gulches have remnants of historic mining activities (waste rock, mill tailings etc.) which can contribute contaminated material to the floodplain and creek during high flow runoff events. The potential impact of these areas on the creek is not known.

- The SSTOU is located downstream of the BPSOU. The remedy along SBC will be complete before the Butte remedial actions are completed. Substantial control of inputs from the BPSOU has already occurred, and ongoing stormwater control is currently undergoing extensive evaluation and control efforts. These efforts are important to the success of the SST OU cleanup.

- The proposed institutional controls for the remediated floodplain areas are assigned to the Greenway Service District (GSD) of the Butte Silver Bow Planning Department, but are not clearly documented or understood. With MDEQ concurrence, the GSD is responsible for the design, construction, and long term maintenance of the paved path that runs parallel to SBC through Subarea 1 to the town of Rocker, Montana, as currently constructed.

  Although formal institutional controls are not yet incorporated into the County records, it is anticipated that they will be completed by cessation of construction work in 2013. Institutional controls are particularly important in Subareas 1 and 2 in light of waste left in place and sporadic residual surface soil salt formation in areas barren of vegetation or supporting only sparse vegetation.

7.2 Question B—Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of remedy selection still valid?

Yes. The exposure assumptions, toxicity data, cleanup levels and remedial action objectives used at the time of the remedy are still valid. The narrative below describes changes that have occurred since the remedy was selected, and why those changes have not affected the validity of the remedy.

7.2.1 Changes to Standards, Criteria, ARARs, and to be Considered (TBCs) Since the Second Five-Year Review (2005)

The Second Five-Year Review (CDM, 2005) indicated that the Federal Safe Drinking Water Act MCLs and the State of Montana human health standards for groundwater for arsenic, cadmium, chromium, and lead had been lowered since the ROD and 1998 ESD. Effective

January 2006, EPA further lowered the arsenic MCL from 0.050 to 0.010 mg/L. Arsenic concentrations measured in groundwater samples collected since 2005 exceed the Maximum Contaminant Level (MCL) at some sample locations. However, groundwater is not used for potable consumption within the SSTOU.

TABLE 7-1
Changes in Chemical-Specific Standards

Contaminant	Media	Cleanup Level	Standard		Citation/Year
Arsenic	Groundwater and surface water	NA	Previous 0.05 mg/L	New 0.010 mg/L	SDWA 1988 and 2006

SDWA = Safe Drinking Water Act

Since the second five-year review (CDM, 2005), EPA has published the following ecological effects documents relevant to the SSTOU:

- U.S. Environmental Protection Agency. 2007. *Aquatic Life Ambient Freshwater Quality Criteria – Copper 2007 Revision.*
- U.S. Environmental Protection Agency. 2005-2007. *Ecological Soil Screening Levels (EcoSSLs).*

The changes to the copper freshwater criterion do not affect the protectiveness of the remedy selected. The EcoSSLs should be considered TBCs (see discussion on exposure pathways in the following section) that may be used to evaluate the risk to wildlife posed by residual contaminant concentrations.

None of the changes in standards or criteria are expected to affect the protectiveness of the remedy.

7.2.2 Changes to Land and Water Use, and Exposure Pathways

Current and anticipated future land and water uses at, or near, the SSTOU have not changed since the ROD and subsequent five-year reviews. However, remedial actions have enhanced instream conditions and upland/riparian habitat at areas previously devoid of vegetation. As a result, several exposure pathways that were qualitatively evaluated at the time of the risk assessments are now considered complete exposure pathways. For example, quantitative risk characterization for terrestrial wildlife was not included in the ecological risk assessment because physical disturbances from mining and contamination had resulted in very low quality habitat. Therefore, it was assumed that wildlife exposures would be limited as they were not expected to frequent the SSTOU. Cleanup and restoration activities have increased the likelihood that wildlife and recreationists will use the SSTOU area. Exposure pathways that were not considered significant in the risk assessment, but are expected to be complete now, or in the future, are as follows:

- Potential current and future exposure of terrestrial/riparian wildlife to residual contaminants in soil and food items (vegetation and prey).
- Potential future exposure of recreational users, and ingestion of contaminants accumulating in fish (for example, trout) at SBC.

7.2.3 Changes to Toxicity Factors

Several cancer slope factors and reference doses used for contaminants during the human health risk assessment have changed since the ROD. These are discussed as follows:

- **Arsenic.** The oral slope factor has been lowered from 1.75 to 1.5 mg/kg-day^{-1}, which is slightly less conservative now. An inhalation reference concentration was not used for the risk assessment and now exists at $1.5x10^{-5}$ mg/m^3. However, inhalation of dust from the SSTOU is not expected to pose a significant risk.
- **Benzo(a)pyrene.** The inhalation slope factor has been lowered from 6.1 to 3.85 mg/kg-day^{-1}, which is slightly less conservative now.
- **Cadmium.** An inhalation reference concentration was not used for the risk assessment and now exists at $1x10^{-5}$ mg/m$^{3.}$ However inhalation of dust from the SSTOU is not expected to pose a significant risk.
- **Copper.** The oral reference dose has been increased from 0.0356 to 0.04 mg/kg-day, which is slightly less conservative now.
- **Methyl mercury.** The oral reference dose has been lowered from 0.0003 to 0.0001 mg/kg-day, which is slightly more conservative now.

These human health toxicity factor changes are not significant and are not expected to affect the overall baseline risk assessment or the protectiveness of the remedy.

Although some minor changes to ecological effects criteria have occurred since the ROD, the changes are not expected to affect the overall baseline risk assessment or the protectiveness of the remedy.

7.2.4 Changes to Contaminant Characteristics

During the Fall 2009 site visit, numerous salt areas and metal salt areas were observed and documented with photographs throughout the upper section (upstream of the community of Rocker) of the OU. Many of these salt areas are located either near the stream or adjacent to the Greenway Trail. These are likely a result of residual contamination that is moving to the surface with upward movement of water. The salt areas are mostly devoid of vegetation.

7.2.5 Changes in Risk Assessment Methodology

EPA has published several new risk assessment guidance documents since the previous Five-Year Reviews. The following new guidance documents were reviewed to verify that the remedy at the SSTOU is valid:

- U.S. Environmental Protection Agency. 2005. *Guidelines for Carcinogen Risk Assessment.*
- U.S. Environmental Protection Agency. 2005. *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens.*
- U.S. Environmental Protection Agency. 2007. *Framework for Metals Risk Assessment.*

- U.S. Environmental Protection Agency. 2009. *Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual - Part F, Supplemental Guidance for Inhalation Risk Assessment.*

Considering the potential receptors, routes of exposure, and contaminants of concern at the SSTOU, the remedy is still considered valid because it sufficiently addresses the new guidance.

7.3 Question C—Has any other information come to light that could call into question the protectiveness of the remedy?

Yes. The following new information has come to light that could call into question the protectiveness of the remedy if not addressed as follow-up to this Five-Year Review process:

Exposure Pathways. Remedial actions have enhanced instream conditions and riparian habitat previously devoid of vegetation. Several exposure pathways that were qualitatively evaluated at the time of the original risk assessments are now considered complete exposure pathways. For example, quantitative risk characterization for terrestrial wildlife was not included in the ecological risk assessment because of very low quality habitat. Therefore, it was assumed that wildlife exposures would be limited as they were not expected to frequent the SSTOU. Cleanup and restoration activities have increased the likelihood that wildlife and recreationists will use the SSTOU area. Exposure pathways not considered significant in the original risk assessment, but expected to be complete now, or in the future, are as follows:

- Potential current and future exposure of terrestrial/riparian wildlife to residual contaminants in soil and food items (vegetation and prey).
- Potential future exposure of recreational users, and ingestion of contaminants accumulating in fish (for example, trout) at SBC.

These exposure pathways need to be defined and evaluated.

Surface Soil Salts. The sporadic appearance of surface soil salts in Subareas 1 and 2 was unexpected, indicates the potential for contamination hot spots, and creates the possibility of a new human health exposure pathway as remediated floodplain areas attract greater use by the public. Reformation of metals salts has the potential to contaminate SBC through stormwater overland flow and groundwater through infiltration and percolation.

Outside Source Recontamination. The U.S. Forest Service has determined that there is a potential threat to human health and the environment that stems from a potential release of cyanide and metal contamination associated with past cyanide heap leach operations. The operations occurred at the Beal Mountain Mining complex located on lands administered by the Beaverhead/Deerlodge National Forest. Beal Mountain Mine Leach Pad is located in the headwaters of German Gulch, a tributary to Silver Bow Creek (Subarea 3). The site is located approximately 6 miles from the confluence of German Gulch and Silver Bow Creek. The U.S. Forest Service is presently addressing the site as a Non-Time Critical Action under its authority stated by CERCLA. Prior to successful remedial action, any form of catastrophic release from this site could potentially introduce arsenic and metals laden sediment and water into Silver Bow Creek.

Interim Stormwater Runoff. Remedial construction in Subareas 3 and 4 were underway during preparation of this 5-year review. In the fall of 2009, significant portions of the floodplain in these areas were graded after removal of targeted contaminant soil layers, and streambanks were reconstructed according to remedial designs. In late May to early June 2010, portions of these areas were flooded by Silver Bow Creek as a result of spring storms and snowmelt runoff exceeding channel capacity (see photos at the end of Appendix E). At the time of the flooding, few best management practices (BMPs) were observed to prevent stormwater from eroding the exposed flood plan soils and transporting sediment (possibly laden with residual metals) back into Silver Bow Creek.

On December 1, 2009, EPA published revised effluent limitations guidelines (ELGs) and new source performance standards (NSPS) to control the discharge of pollutants from construction sites (74 FR 62996). The regulation is effective on February 1, 2010. These new guidelines and standards are considered stormwater ARARs and provide a reminder that stormwater BMPs should be implemented on construction sites to prevent stormwater runoff from creating accelerated erosion and transporting sediment off site. Given the status of remedial construction in these Subareas, these areas are especially sensitive to flooding and stormwater impacts until fully revegetated.

7.4 Technical Assessment Summary

According to the data reviewed, the site inspection, and the interviews, the remedy is mostly functioning as intended by the ROD. There has been one significant change in the toxicity factors (arsenic) for the contaminants of concern that were used in the risk assessments. The drinking water standard for Arsenic was reduced from 50 µg/L to 10 µg/L. There have been no changes to the standardized risk assessment methodology that could affect the protectiveness of the remedy. There have been changes to the physical conditions of the site that may warrant additional evaluation to ensure the protectiveness of the remedy. These physical changes are as follows:

- Salt areas devoid of vegetative growth in the upper sections of the SSTOU may be indicative of elevated residual contaminant concentrations remaining in place. The formation of salts on surface soils in areas barren of, or supporting sparse vegetation, was observed in Subareas 1 and 2.
- As planned, cleanup and restoration activities have significantly enhanced habitat at the SSTOU. As a result, wildlife and recreational use is expected to increase. To date, some complete exposure pathways have not been quantitatively evaluated. The following exposure pathways may require additional evaluation:
  - Potential current and future exposure of terrestrial/riparian wildlife to residual contaminants in soil and food items (vegetation and prey).
  - Potential future exposure of recreational users, and ingestion of contaminants accumulating in fish (for example, trout) at SBC.

With the exception of the information discussed above, no other information calls the protectiveness of the remedy into question.

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SECTION 8

Issues

Table 8-1 presents the issues identified during this Five-Year Review of the SSTOU.

TABLE 8-1
Issues

Issues	Affects Current Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
1. Bare surface soils with salt formation and evidence of recontamination from waste left in place was observed within remediated areas.	Y	Y
2. Potential exists for recontamination of SSTOU by sources on tributaries.	Y	Y
3. ICs are not fully and formally implemented.	N	Y
4. Potential exists for recontamination by stormwater from upstream Butte Priority Soils OU until BPSOU remediation is fully in place.	Y	Y
5. The remedial monitoring network for surface water, instream sediments, groundwater, vadose zone water, soils, and vegetation should be revised to allow a systematic assessment of the performance of the remedy throughout the SSTOU.	N	Y
6. Disturbed areas along streambanks during and after construction are not adequately treated with BMPs to prevent erosion and transport of sediment (possibly with residual metals) into Silver Bow Creek.	Y	N

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SECTION 9

Recommendations and Follow-up Actions

Table 9-1 presents the recommendations and follow-up actions resulting from the identification of issues in Section 8.

TABLE 9-1
Recommendations and Follow-up Actions

Issue	Recommendations and Follow-up Actions	Party Responsible	Oversight Agency	Milestone Date
1	All areas within the remediated reaches with little or no vegetation should be inventoried and remediated.	State	EPA	12/31/13
2	An inventory and evaluation of major tributary gulches with historic mining activity should be performed. Inventory should be field verified and noted for regulatory action, restoration work, or West Side Soils OU evaluation and remediation. Remedial progress by the U.S. Forest Service on the Beal Mountain Heap Leach Pad project should be monitored until complete.	State	EPA	12/31/12
3	A formal IC plan needs to be prepared and approved.	State	EPA	12/31/12
4	Ongoing evaluation and implementation efforts to control upstream stormwater should continue, as is currently required.	State & EPA	EPA	12/31/13
5	Align existing, and design new monitoring station locations to comprehensively monitor remediated media within each subarea. The monitoring network should be designed to accurately assess the performance of the remedy in surface and ground water, as well as vegetation, macroinvertebrates, and fish, and help identify areas not responding as intended so they can be quickly addressed.	State	EPA	12/31/13
6	Stormwater BMPs should be applied to disturbed areas along reconstructed streambanks during and after final construction activities to prevent erosion and transport of sediment (possibly with residual metals) into Silver Bow Creek. Effective BMPs should be maintained and monitored until streambanks are stabilized by deep rooted vegetation, and robust vegetative cover can be established in the reconstructed floodplain.	State	EPA	12/31/13

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SECTION 10

Protectiveness Statement(s)

The remedy at OU 01 is not protective. Source areas within the OU that can recontaminate the remedy must be identified, evaluated, and mitigated if appropriate. These include salt patches appearing on remediated areas that impede vegetation, and inadequately vegetated stream banks, as well as tributary sources. An IC plan must be developed and approved. Enforceable elements should be added to the IC program to ensure interim protectiveness, and the formal IC program should be approved by DEQ and EPA in coordination with appropriate County and local agencies and organizations. The existing monitoring plan also needs to be revised into a comprehensive groundwater, surface water, sediment, vadose zone, revegetation, macroinvertebrates, and fish monitoring plan to adequately demonstrate protectiveness. The plan also does not provide for maintenance of the remedy.

In-stream cleanup standards have not been met, although substantial progress towards these standards has been made and will likely continue. Environmental exposures continue. To be protective, the remedy must be more completely implemented, data gaps must be filled, enforceable ICs put in place, and the monitoring and maintenance plan updated and implemented.

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SECTION 11

Next Review

The next Five-Year Review for the Stream Side Tailings Operable Unit is required by September 2015, 5 years from the date of this review.

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APPENDIX A

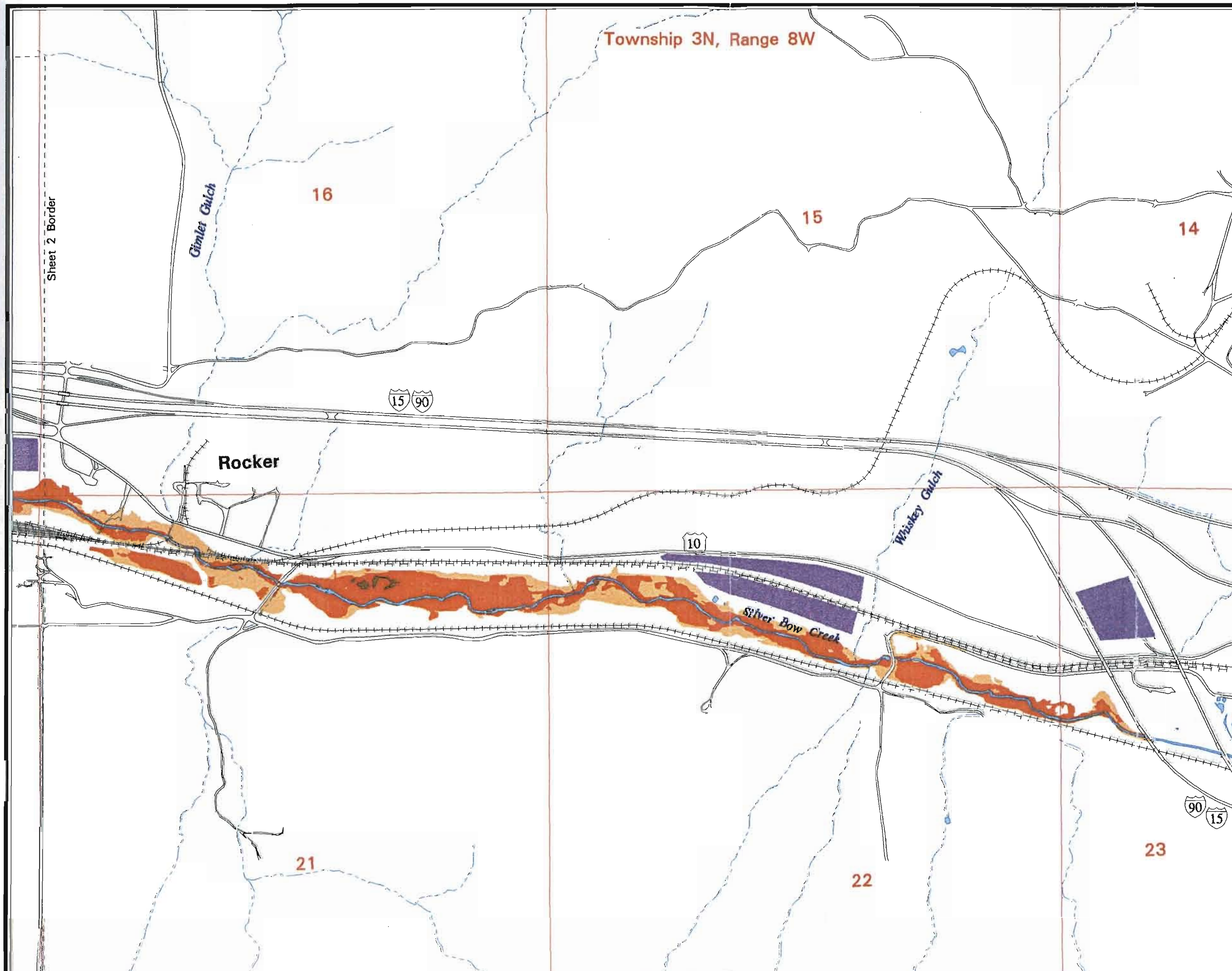
Site Maps—Pre-Remedy Tailings Maps; Current Monitoring Network

APPENDIX A-1

Maps Illustrating the Extent of Tailings Deposits Documented in the ROD (1995)

Streamside Tailings Operable Unit

Extent of Saturated and Unsaturated Tailings/Impacted Soils and Conceptual Repository Locations



Road
Railroad
Abandoned Railroad
Stream
Intermittent Stream
Section Line
Match Line
Surface Water
Extent of Tailings/ Impacted Soil
Tailings/Impacted Soil saturated by ground water
Conceptual Repository location

Tailings locations and repository areas provided by Titan Environmental of Bozeman, MT. Saturated tailings extent estimated at the State Library based on tailings and groundwater information provided by Titan. Base map is from aerial photos of 1984 and 1991 digitized by Horizons, Inc., of Rapid City, SD, and from U.S. Geological Survey 1:24,000 scale Digital Line Graphs.

North

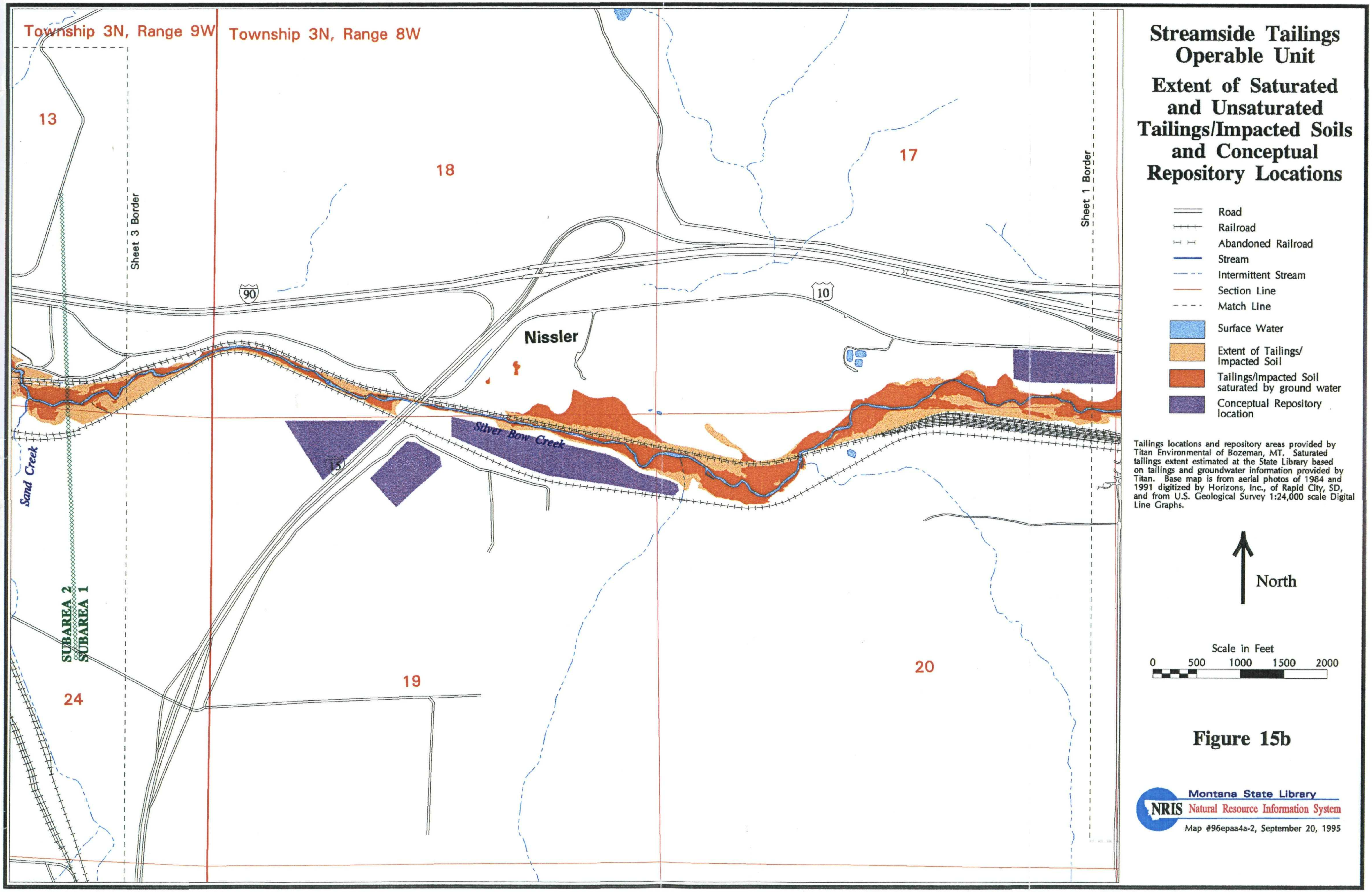
Scale in Feet
0 500 1000 1500 2000

Figure 15a

Montana State Library
NRIS Natural Resource Information System
Map #96epaa4a-1, September 20, 1995

Streamside Tailings Operable Unit

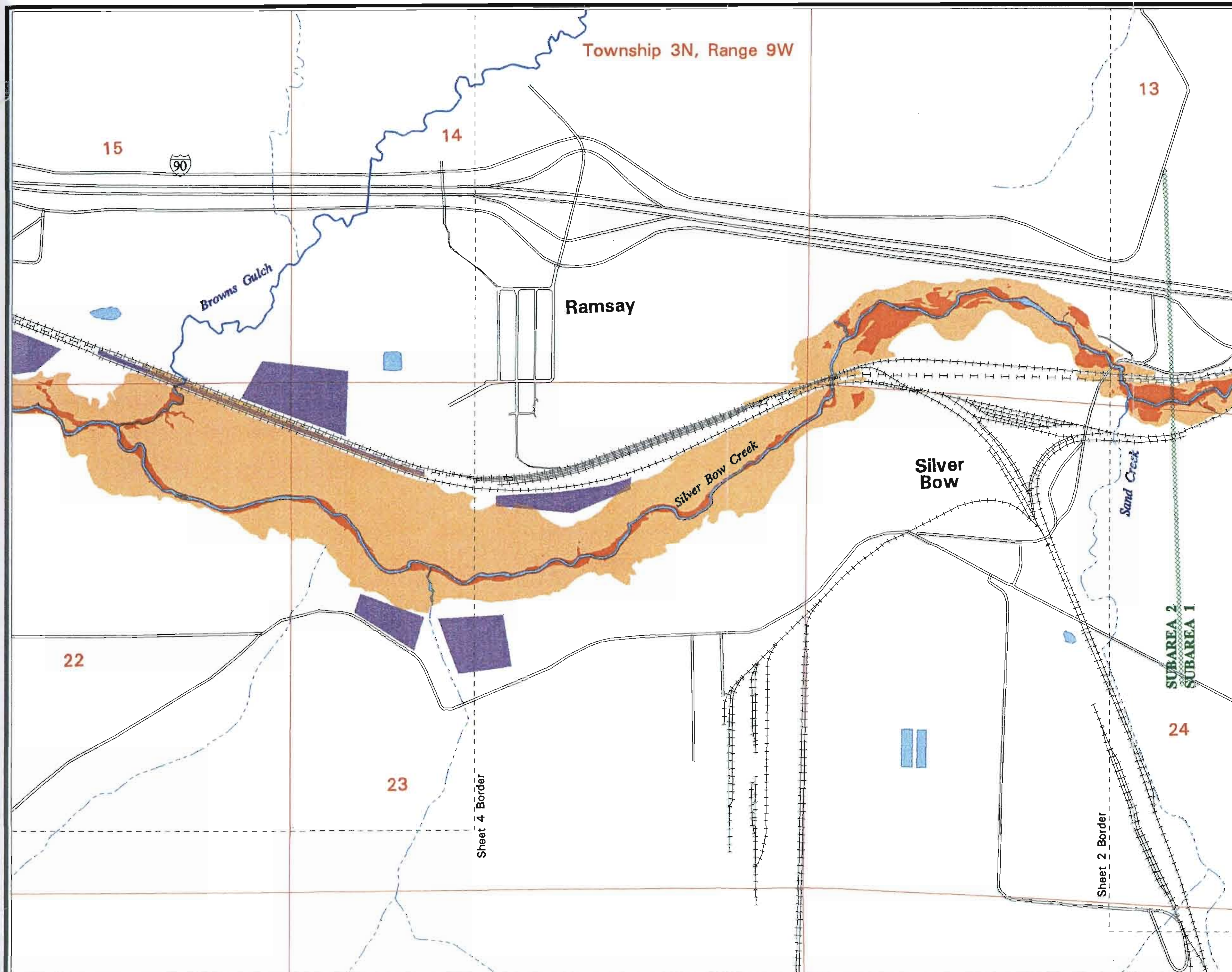
Extent of Saturated and Unsaturated Tailings/Impacted Soils and Conceptual Repository Locations



Tailings locations and repository areas provided by Titan Environmental of Bozeman, MT. Saturated tailings extent estimated at the State Library based on tailings and groundwater information provided by Titan. Base map is from aerial photos of 1984 and 1991 digitized by Horizons, Inc., of Rapid City, SD, and from U.S. Geological Survey 1:24,000 scale Digital Line Graphs.

Figure 15b

Montana State Library
NRIS Natural Resource Information System
Map #96epaa4a-2, September 20, 1995



Streamside Tailings Operable Unit

Extent of Saturated and Unsaturated Tailings/Impacted Soils and Conceptual Repository Locations

- Road
- Railroad
- Abandoned Railroad
- Stream
- Intermittent Stream
- Section Line
- Match Line
- Surface Water
- Extent of Tailings/ Impacted Soil
- Tailings/Impacted Soil saturated by ground water
- Conceptual Repository location

Tailings locations and repository areas provided by Titan Environmental of Bozeman, MT. Saturated tailings extent estimated at the State Library based on tailings and groundwater information provided by Titan. Base map is from aerial photos of 1984 and 1991 digitized by Horizons, Inc., of Rapid City, SD, and from U.S. Geological Survey 1:24,000 scale Digital Line Graphs.

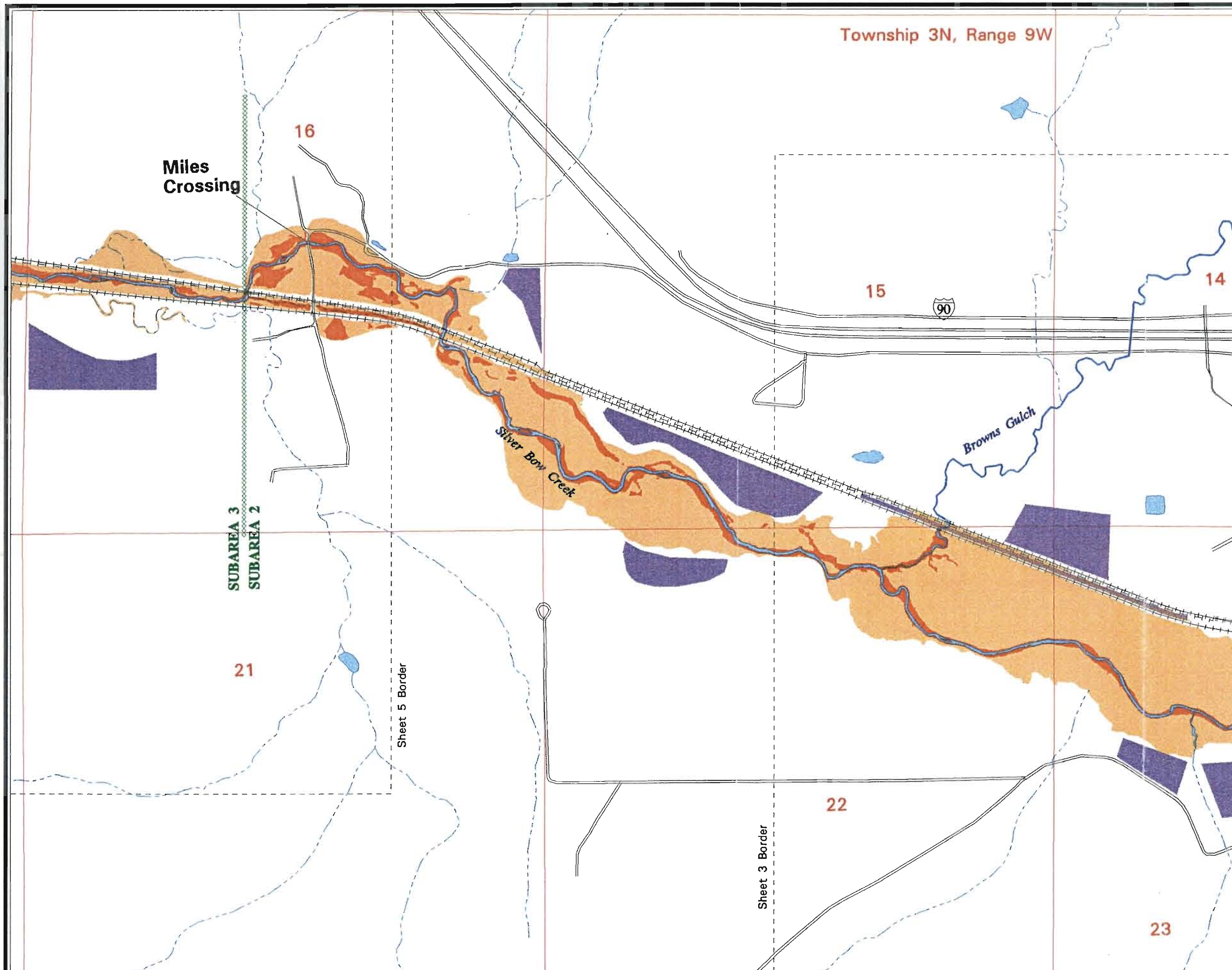
North

Scale in Feet

0 500 1000 1500 2000

Figure 15c

Montana State Library
NRIS Natural Resource Information System
Map #96epaa4a-3, September 20, 1995



Streamside Tailings Operable Unit

Extent of Saturated and Unsaturated Tailings/Impacted Soils and Conceptual Repository Locations

- Road
- Railroad
- Abandoned Railroad
- Stream
- Intermittent Stream
- Section Line
- Match Line
- Surface Water
- Extent of Tailings/ Impacted Soil
- Tailings/Impacted Soil saturated by ground water
- Conceptual Repository location

Tailings locations and repository areas provided by Titan Environmental of Bozeman, MT. Saturated tailings extent estimated at the State Library based on tailings and groundwater information provided by Titan. Base map is from aerial photos of 1984 and 1991 digitized by Horizons, Inc., of Rapid City, SD, and from U.S. Geological Survey 1:24,000 scale Digital Line Graphs.

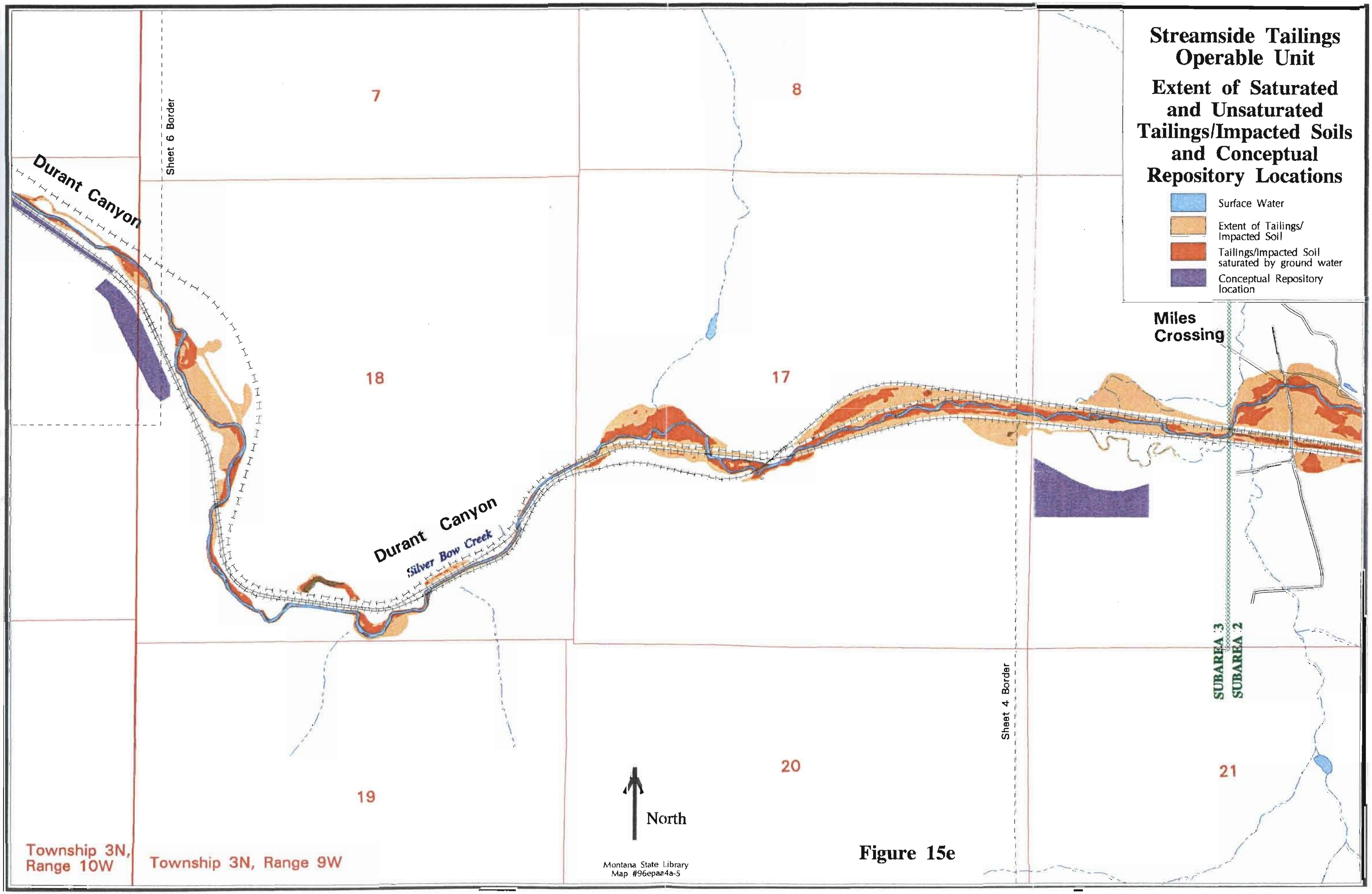
North

Scale in Feet

0 500 1000 1500 2000

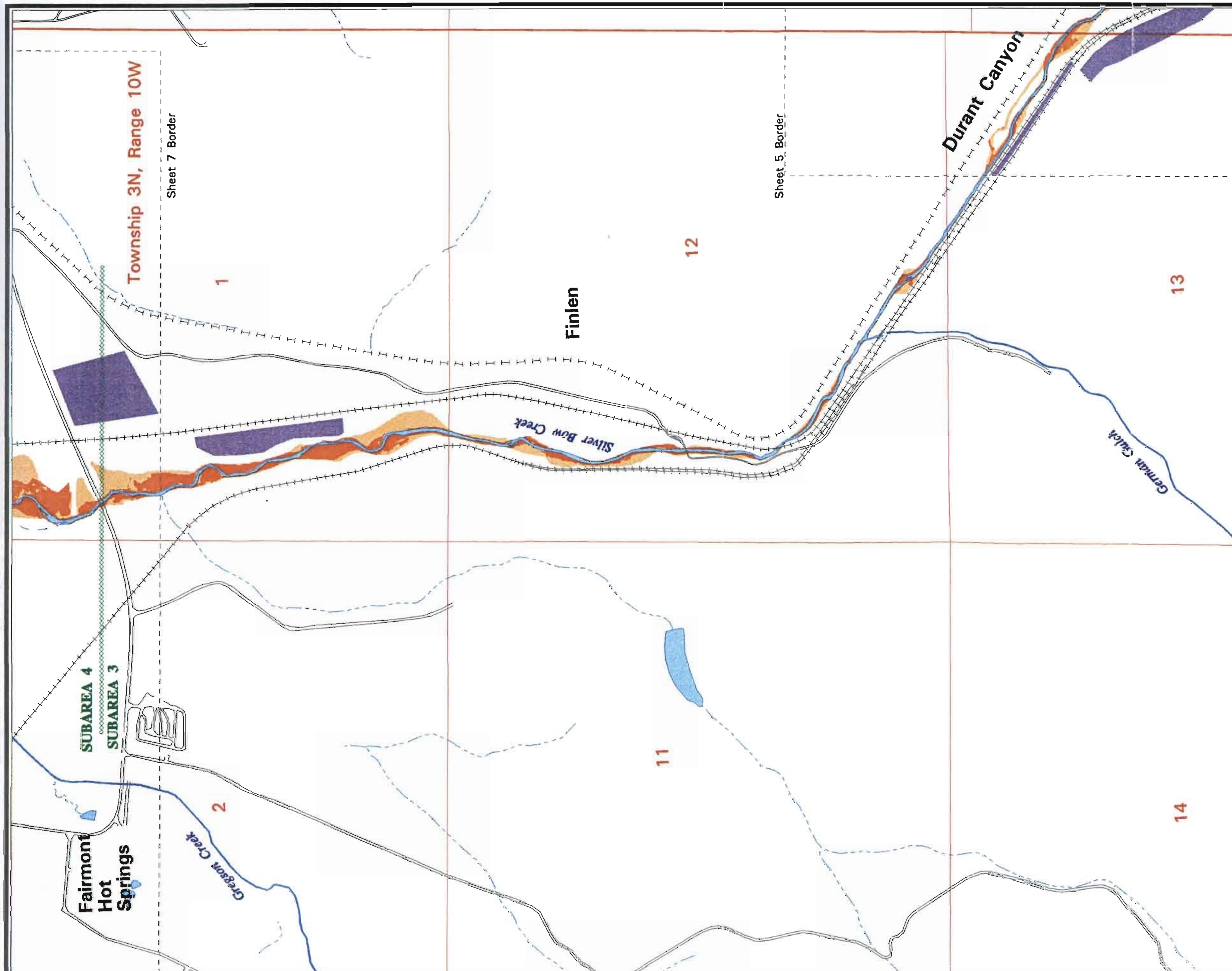
Figure 15d

Montana State Library
NRIS Natural Resource Information System
Map #96epaa4a-4, September 20, 1995



Streamside Tailings Operable Unit
Extent of Saturated and Unsaturated Tailings/Impacted Soils and Conceptual Repository Locations
Surface Water
Extent of Tailings/ Impacted Soil
Tailings/Impacted Soil saturated by ground water
Conceptual Repository location
7
8
18
17
19
20
21
Sheet 6 Border
Sheet 4 Border
Durant Canyon
Durant Canyon
Silver Bow Creek
Miles Crossing
SUBAREA 3
SUBAREA 2
North
Township 3N, Range 10W
Township 3N, Range 9W
Montana State Library
Map #96epa24a-5

Figure 15e



Streamside Tailings Operable Unit

Extent of Saturated and Unsaturated Tailings/Impacted Soils and Conceptual Repository Locations

- Road
- Railroad
- Abandoned Railroad
- Stream
- Intermittent Stream
- Section Line
- Match Line
- Surface Water
- Extent of Tailings/ Impacted Soil
- Tailings/Impacted Soil saturated by ground water
- Conceptual Repository location

Tailings locations and repository areas provided by Titan Environmental of Bozeman, MT. Saturated tailings extent estimated at the State Library based on tailings and groundwater information provided by Titan. Base map is from aerial photos of 1984 and 1991 digitized by Horizons, Inc., of Rapid City, SD, and from U.S. Geological Survey 1:24,000 scale Digital Line Graphs.

North

Scale In Feet

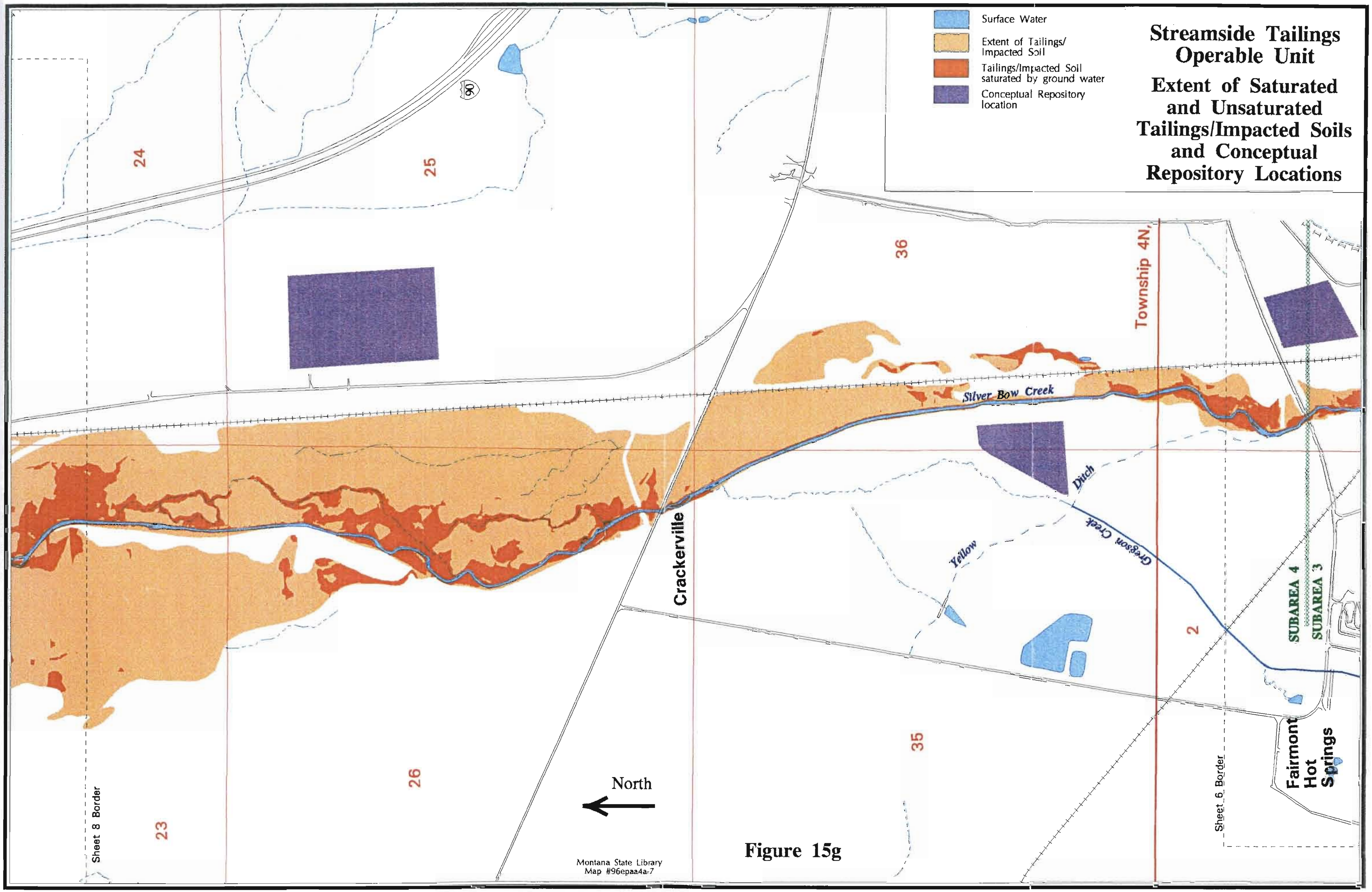
0 500 1000 1500 2000

Figure 15f

Montana State Library

NRIS Natural Resource Information System

Map #96epaa4a-6, September 20, 1995



Surface Water
Extent of Tailings/ Impacted Soil
Tailings/Impacted Soil saturated by ground water
Conceptual Repository location
Streamside Tailings Operable Unit
Extent of Saturated and Unsaturated Tailings/Impacted Soils and Conceptual Repository Locations
90
24
25
36
Township 4N,
Silver Bow Creek
Ditch
Gregson Creek
Yellow
Crackerville
SUBAREA 4
SUBAREA 3
2
35
26
23
Fairmont Hot Springs
Sheet 6 Border
Sheet 8 Border
North
Montana State Library Map #96epaa4a-7

Figure 15g

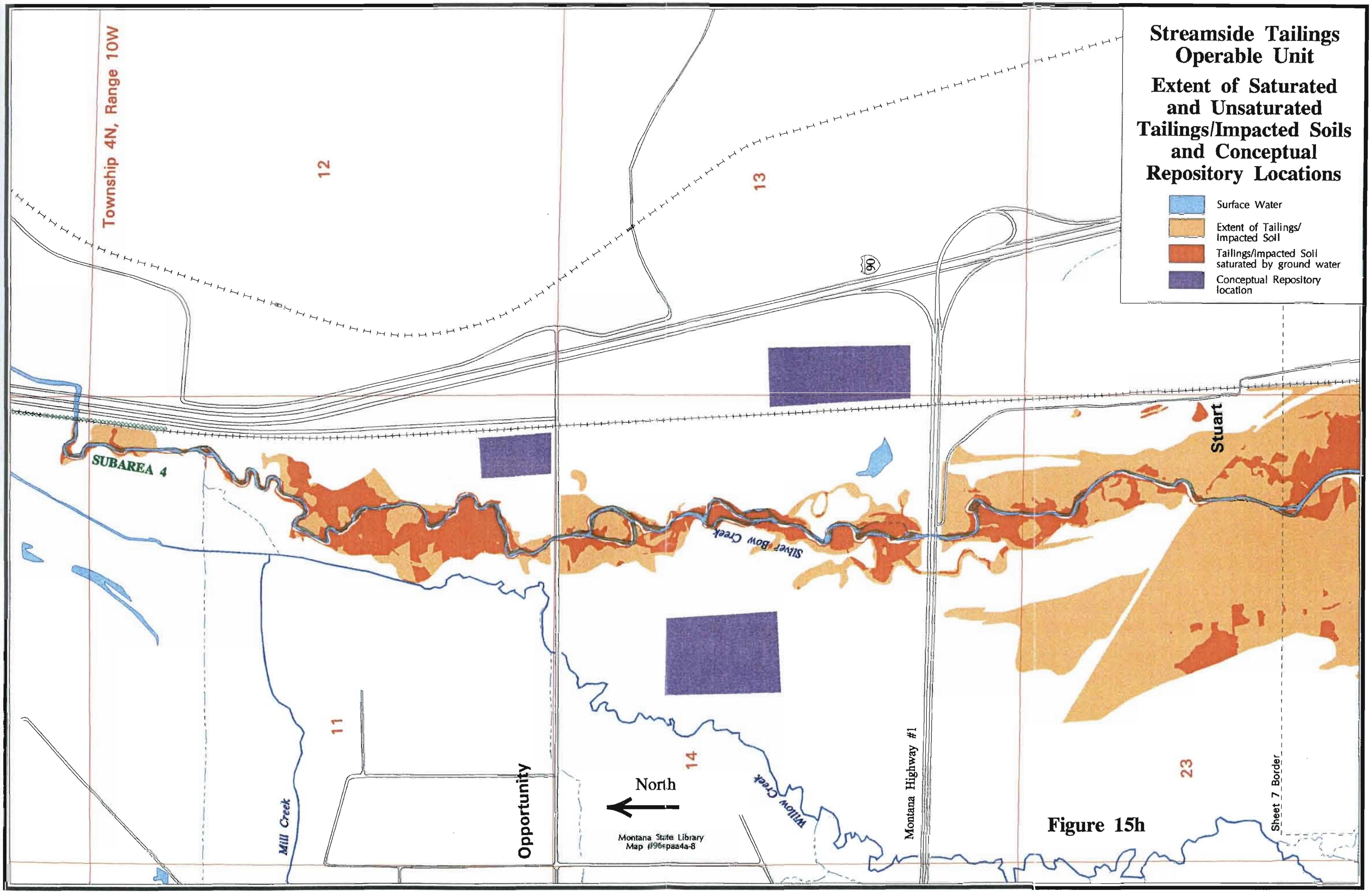

Streamside Tailings Operable Unit
Extent of Saturated and Unsaturated Tailings/Impacted Soils and Conceptual Repository Locations
Surface Water
Extent of Tailings/ Impacted Soil
Tailings/Impacted Soil saturated by ground water
Conceptual Repository location
Township 4N, Range 10W
12
13
11
14
23
90
SUBAREA 4
Silver Bow Creek
Stuart
Mill Creek
Willow Creek
Opportunity
North
Montana Highway #1
Sheet 7 Border
Montana State Library Map #96-paa4a-8

Figure 15h

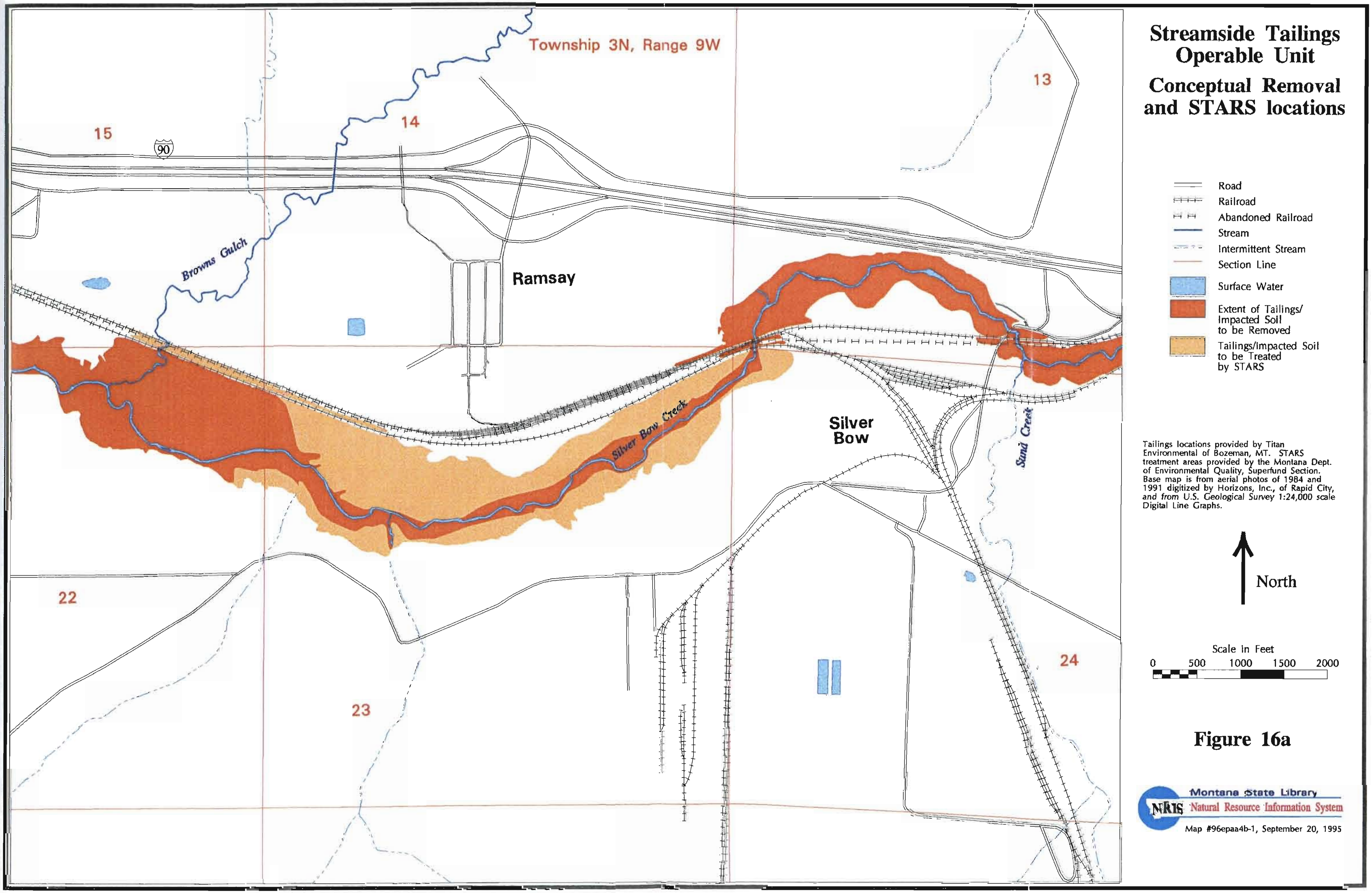
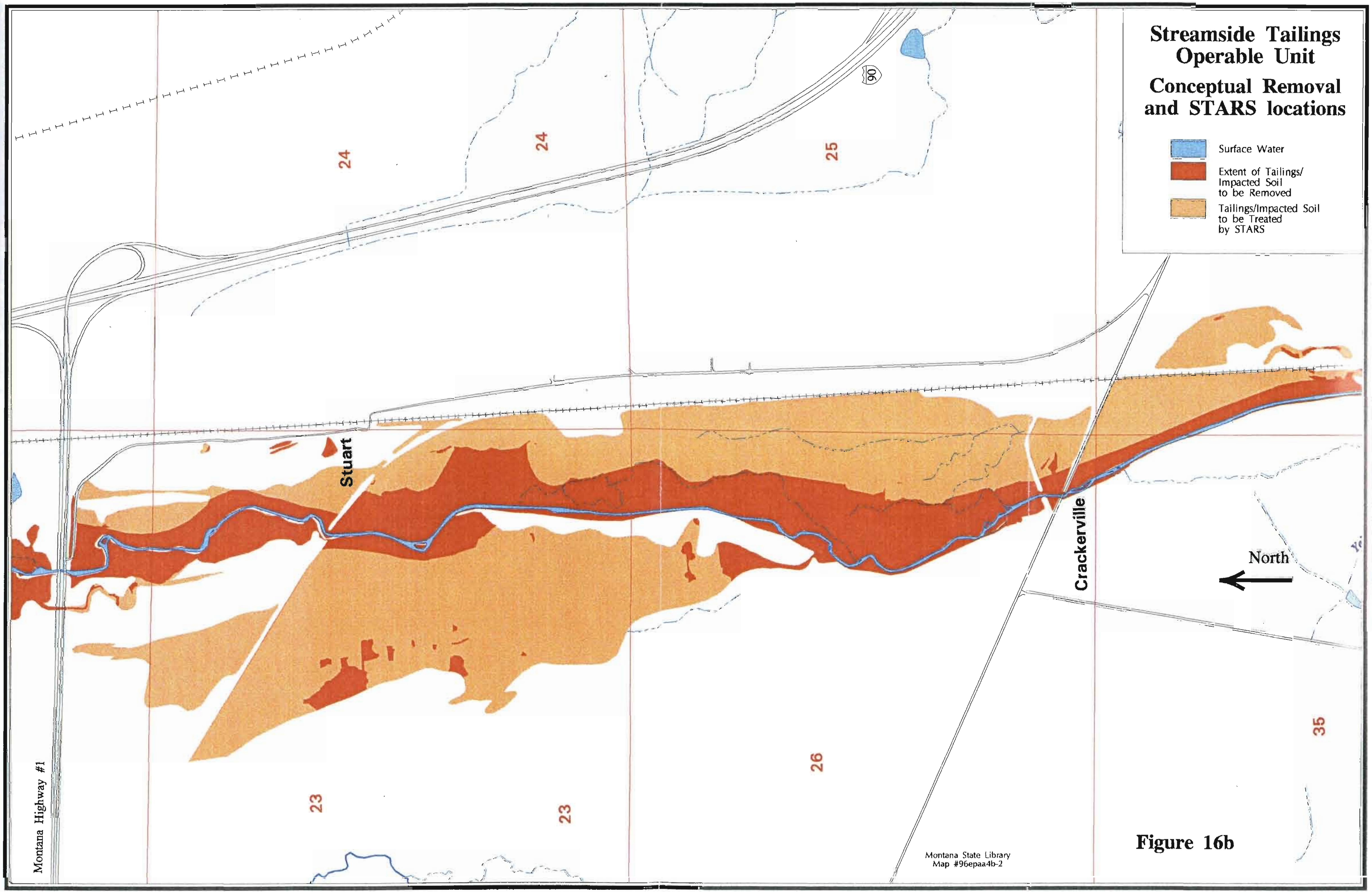
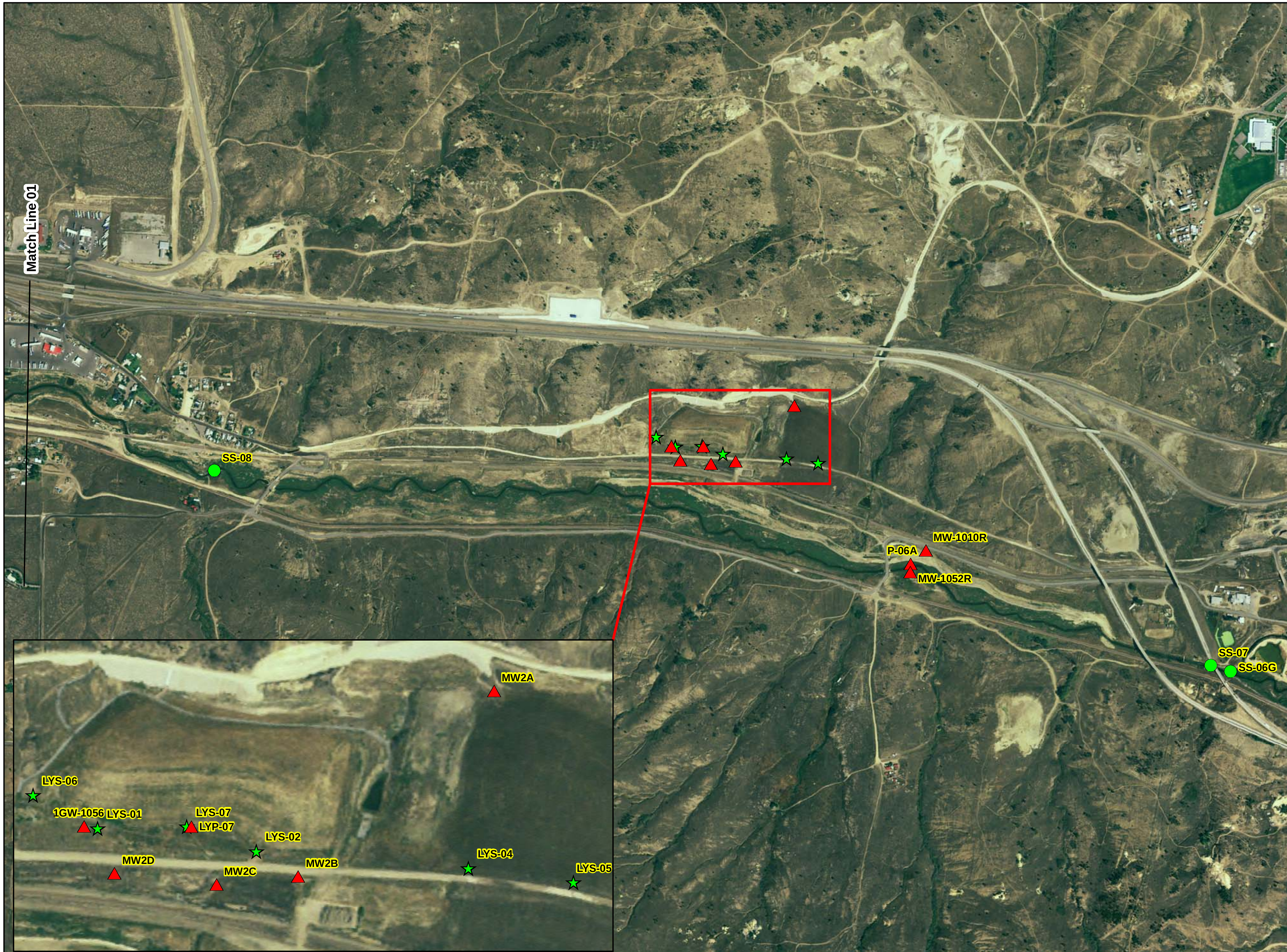

Streamside Tailings Operable Unit
Conceptual Removal and STARS locations
Road
Railroad
Abandoned Railroad
Stream
Intermittent Stream
Section Line
Surface Water
Extent of Tailings/ Impacted Soil to be Removed
Tailings/Impacted Soil to be Treated by STARS
Tailings locations provided by Titan Environmental of Bozeman, MT. STARS treatment areas provided by the Montana Dept. of Environmental Quality, Superfund Section. Base map is from aerial photos of 1984 and 1991 digitized by Horizons, Inc., of Rapid City, and from U.S. Geological Survey 1:24,000 scale Digital Line Graphs.
North
Scale in Feet
0 500 1000 1500 2000
Montana State Library
NRIS Natural Resource Information System
Map #96epaa4b-1, September 20, 1995
Township 3N, Range 9W
13
14
15
22
23
24
90
Browns Gulch
Ramsay
Silver Bow Creek
Silver Bow
Sand Creek

Figure 16a


Streamside Tailings Operable Unit
Conceptual Removal and STARS locations
Surface Water
Extent of Tailings/ Impacted Soil to be Removed
Tailings/Impacted Soil to be Treated by STARS
90
24
24
25
Stuart
Crackerville
North
35
26
23
23
Montana Highway #1
Montana State Library Map #96epaa4b-2
Figure 16b

APPENDIX A-2

Aerial Photo Map Tiles Showing Subareas, Surface Water, Groundwater, and Instream Sediment Sampling Stations



Streamside Tailings Operable Unit

Legend

- SurfaceMonitoring
- GroundMonitoring
- VadoseZone

N

Feet
0 1,000 2,000

Tile 1

Surface Water, Groundwater, and Vadose Zone Monitoring Locations

Amended from:
Interior Comprehensive Long-Term Monitoring Plan for Silver Bow Creek Stream Streamside Tailings Operable Unit, June 2009

Imagery: USDA 2005 NAIP
1 meter Color photography

Streamside Tailings Operable Unit

Legend

- SurfaceMonitoringTable5
- GroundMonitoringTable10
- VadoseZoneTable12

Feet
0 1,000 2,000

Tile 2

Surface Water, Groundwater, and Vadose Zone Monitoring Locations

Amended from:
Interior Comprehensive Long-Term Monitoring Plan for Silver Bow Creek Stream Streamside Tailings Operable Unit, June 2009

Imagery: USDA 2005 NAIP
1 meter Color photography

Streamside Tailings Operable Unit

Legend

- SurfaceMonitoring
- GroundMonitoring
- VadoseZone

0 1,000 2,000 Feet

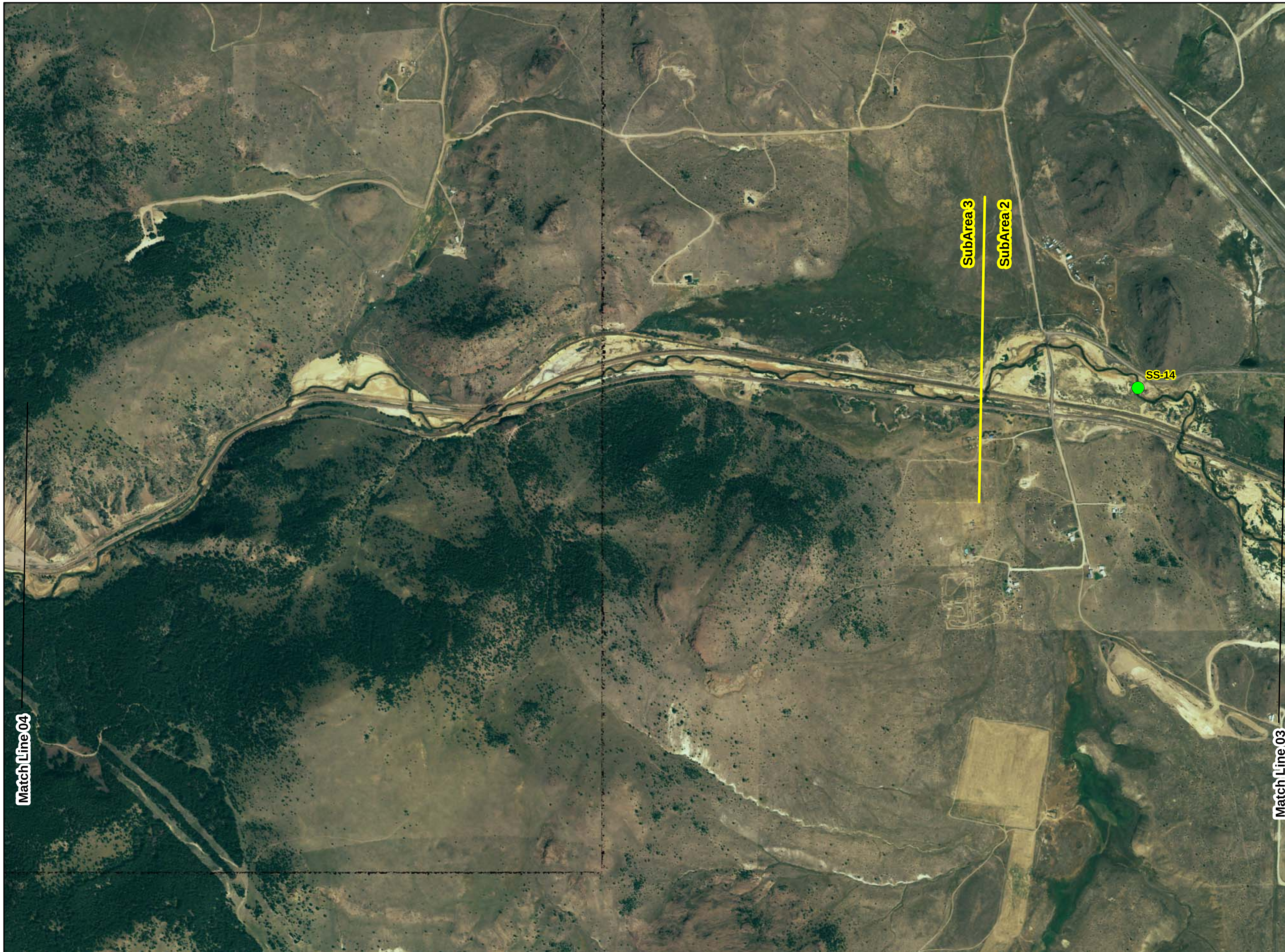
Tile 3

Surface Water, Groundwater, and Vadose Zone Monitoring Locations

Amended from: Interior Comprehensive Long-Term Monitoring Plan for Silver Bow Creek Stream Streamside Tailings Operable Unit, June 2009

Imagery: USDA 2005 NAIP
1 meter Color photography

\\OWL\PROJ\EPA\345142CLARKFORK\379980 CFR RD-RA OVERSIGHT\GIS\MAPFILES\STREAMSIDETAILINGS.MXD JCARR3 1/6/2010 11:23:24, \\Owl\Proj\EPA\345142ClarkFork\379980 CFR RD-RA Oversight\SST\Silverbow Creek Documents\2010 5 YR Draft\Appendices\App A - Maps



Streamside Tailings Operable Unit

Legend

- SurfaceMonitoring
- GroundMonitoring
- VadoseZone

Feet
0 1,000 2,000

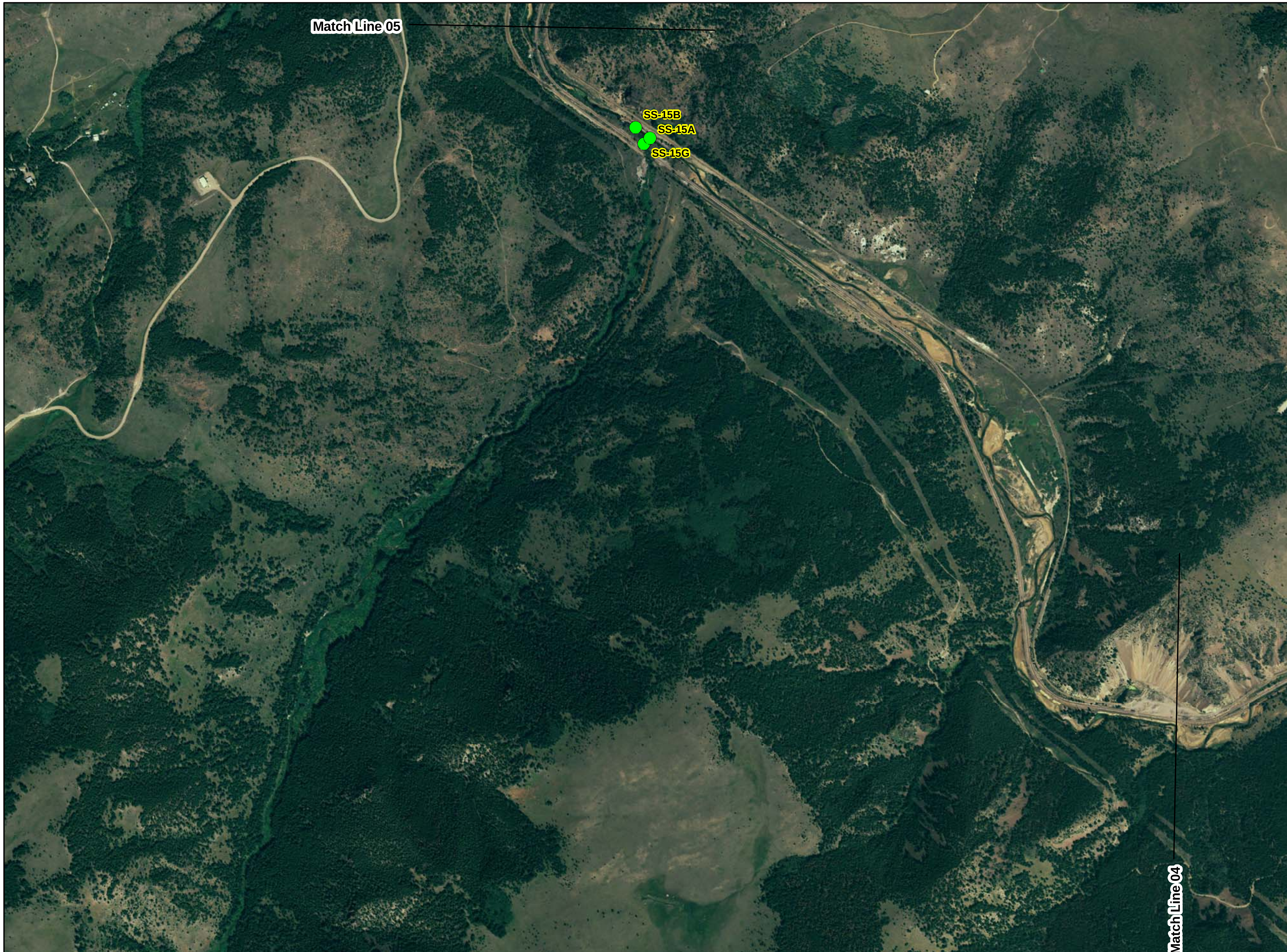
Tile 4

Surface Water, Groundwater, and Vadose Zone Monitoring Locations

Amended from:
Interior Comprehensive Long-Term Monitoring Plan for Silver Bow Creek Stream Streamside Tailings Operable Unit, June 2009

Imagery: USDA 2005 NAIP
1 meter Color photography

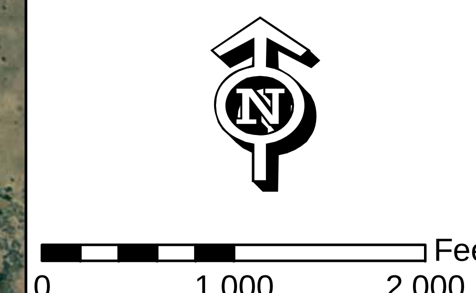
\\OWL\PROJ\EPA\345142CLARKFORK\379980 CFR RD-RA OVERSIGHT\GIS\MAPFILES\STREAMSIDETAILINGS.MXD JCARR3 1/6/2010 11:23:24, \\Owl\Proj\EPA\345142ClarkFork\379980 CFR RD-RA Oversight\SST\Silverbow Creek Documents\2010 5 YR Draft\Appendices\App A - Maps



Streamside Tailings Operable Unit

Legend

- SurfaceMonitoring
- GroundMonitoring
- VadoseZone



Tile 5

Surface Water, Groundwater, and Vadose Zone Monitoring Locations

Amended from:
Interior Comprehensive Long-Term Monitoring Plan for Silver Bow Creek Stream Streamside Tailings Operable Unit, June 2009

Imagery: USDA 2005 NAIP
1 meter Color photography

\\OWL\PROJ\EPA\345142CLARKFORK\379980 CFR RD-RA OVERSIGHT\GIS\MAPFILES\STREAMSIDETAILINGS.MXD JCARR3 1/6/2010 11:23:24, \\Owl\Proj\EPA\345142ClarkFork\379980 CFR RD-RA Oversight\SST\Silverbow Creek Documents\2010 5 YR Draft\Appendices\App A - Maps

Streamside Tailings Operable Unit

Legend

- SurfaceMonitoring
- GroundMonitoring
- VadoseZone

Feet
0 1,000 2,000

Tile 6

Surface Water, Groundwater, and Vadose Zone Monitoring Locations

Amended from:
Interior Comprehensive Long-Term Monitoring Plan for Silver Bow Creek Stream Streamside Tailings Operable Unit, June 2009

Imagery: USDA 2005 NAIP
1 meter Color photography

\\OWL\PROJ\EPA\345142CLARKFORK\379980 CFR RD-RA OVERSIGHT\GIS\MAPFILES\STREAMSIDETAILINGS.MXD JCARR3 1/6/2010 11:23:24, \\Owl\Proj\EPA\345142ClarkFork\379980 CFR RD-RA Oversight\SST\Silverbow Creek Documents\2010 5 YR Draft\Appendices\App A - Maps

Streamside Tailings Operable Unit

Legend

- SurfaceMonitoring
- GroundMonitoring
- VadoseZone

Feet
0 1,000 2,000

Tile 7

Surface Water, Groundwater, and Vadose Zone Monitoring Locations

Amended from:
Interior Comprehensive Long-Term Monitoring Plan for Silver Bow Creek Stream Streamside Tailings Operable Unit, June 2009

Imagery: USDA 2005 NAIP
1 meter Color photography

Streamside Tailings Operable Unit

Legend

- SurfaceMonitoring
- GroundMonitoring
- VadoseZone

Feet
0 1,000 2,000

Tile 8

Surface Water, Groundwater, and Vadose Zone Monitoring Locations

Amended from:
Interior Comprehensive Long-Term Monitoring Plan for Silver Bow Creek Stream Streamside Tailings Operable Unit, June 2009

Imagery: USDA 2005 NAIP
1 meter Color photography

\\OWL\PROJ\EPA\345142CLARKFORK\379980 CFR RD-RA OVERSIGHT\GIS\MAPFILES\STREAMSIDETAILINGS.MXD JCARR3 1/6/2010 11:23:24, \\Owl\Proj\EPA\345142ClarkFork\379980 CFR RD-RA Oversight\SST\Silverbow Creek Documents\2010 5 YR Draft\Appendices\App A - Maps

APPENDIX B

Community Interview Reports

SBC/SSTOU Five-Year Review Interviews

Interviews performed by: Kristine Edwards/EPA, Loren Barber/RRG

Interview Dates: February 8, 9, 17, 2010

Name	Position	Date	Interviewer	Comments
Carol Wold	Land owner	2/8/2010	Kris Edwards	Carol inherited land from her father. Father would not allow reclamation. Work dried up a wetland. State remediated by opening up 2 springs, adding ponds requested by her father and adding islands for the geese. The soil is not good and vegetation is okay, but not the best. Spoke to Tim Reilly and Joel Chavez for information. Interested in donating land to Greenway program, is disappointed that there has not been more follow up on her offer. Carol walks a lot, is amazed by the progress, and satisfied with the results. Website, public meetings, library, don't use fliers.
Jade Richter	Rocker Water and Sewer Board	2/8/2010	Kris Edwards	Most interested in work in the area behind his house. Diverted creek behind the house. Concerned about the tailings on the other side of the highway. Runoff through culvert under I15/I90 and connects with SBC. Need to trace stormwater path on a map. His information is from his own observations of work. Well water hasn't been tested since he has lived there. Kris will find out if it has been tested. She recommends testing. Has a positive opinion of the work. Information flow could have been better. Recommends a newsletter or pamphlet by mail. Something like the PitWatch explaining the work that is being done as construction proceeds. Enjoys the greenway. Suggests monitoring and remediation of metal salts areas.
Robin Anderson and Rosey Garvey	Ramsey School District	2/8/2010	Kris Edwards	Work has included removing tailings, revegetation, replacing bridges. Noted some salts at the bridge at Rocker. Takes students out on site fall and spring to do monitoring work. Meets with CFWEP. Attends seminars also. No concerns. MDEQ is proud of work, willing to go back and fix. Concerns are heard and addressed. Creek with fish, healthy, would like to see Silver Bow project be a world-wide example. Use all avenues for contact. Radio for info. Everyone is working for same goal.
Becky Gay	Anaconda-Deer Lodge County	2/9/2010	Kris Edwards	Dust control seems to be in place. Concerns: Hard to differentiate remedy from restoration. Some restoration activities are "over the top", too many access features, dirt trail adequate for most people. Concerned with maintenance of area—repairing trails, bridges, other features. Concerned with access control problems, motorized vehicles going where they shouldn't. Obtains information from Joel, newspaper, NRD, Greenway Services Board.

Name	Position	Date	Interviewer	Comments
Jim Kuipers	Kuipers and Associates, CFRTAC, Anaconda-Deer Lodge County	2/9/2010	Kris Edwards	Concerned about contamination from upstream components. Emphasized need to restore Butte area first. Wasting time not building treatment systems until Butte is reclaimed. Concerns are addressed—tours and meetings have been successful. Joel does tours, responds to dust complaints. Expectation is for a Class A fishery, model for the U.S. Provide information by meeting with people individually, best to go to other existing meetings such as Kiwanis, Rotary, Garden Club. Site was greatest public interest, most visible. Anaconda-Deer Lodge very appreciative of SST work. Need for robust biomonitoring consistency.
Tom Molloy	Butte-Silver Bow Planning Dept	2/9/2010	Kris Edwards	Followed progress of rebuilding stream channel and flood plain, greenway trail. Gets information from MDEQ, EPA, Joel and crew. Concerns-recontamination from Butte Hill. Doing creek ahead of priority soils. Big mistake not to have Cu as a COC. Lots of Cu in Butte Hill-stormwater. What will impact be when mine flooding treatment plant comes on line with 5 mil/gal/day? MT Pole site contributor to SCBC. Expectation—First class walking trail to Anaconda and Rest Area and access points Information dissemination not good. Thinks they could do a better job, no clue as to what issues they are running into or what work is being done. Use MT Standard newspaper—Sunday—half page ad 3 to 4 times per year. How they will terminate Greenway Trail on both ends? Gap in trail from Butte trails to Greenway. Concern about west side soils impacts on Butte's watershed: Browns Gulch, German Gulch. Metro sewer—protection of remedy? Will they build Greenway Trail through to Durant Canyon?

Name	Position	Date	Interviewer	Comments
Dori Skrukrud	Butte-Silver Bow Community Development	2/9/2010	Kris Edwards	Aware of work being done. Works with Greenway Fund and MDEQ. Concern is maintenance responsibility and funding. Maintenance Plan—IC Program funded on a permanent basis—corridor. MDEQ does need control, vegetative cover, bank stabilization. Greenway funds for additional organic materials, additional removals. Ramsey flats removal—restoration funded the removal of additional materials. SA4 would have allowed in place STARS treatment with lime but MDEQ decided to just remove it. Greenway is responsible for maintenance of Greenway Trail access features. Greenway represents both BSB and Anaconda Deer Lodge counties. MDEQ said they will do remedy and then they're done and will walk away. Some say any funds left over from remedy/restoration should be put into an account and used for long term O&M. Sub A3-improved but SubA4 is paved. Meet accessibility requirements. Paving urban trail, supports handicapped access. Non-motorized trail, use barriers that allow access for maintenance vehicles/ambulances. Fenced by MDEQ. Long term maintenance issued funded by remedy. Greenway SD maintains fences to keep people off. Information obtained from consultants, MDEQ, monitoring reports, get their own vegetative reports done by R. Prodgers. Yes. RA is meeting/exceeding criteria, but what about the groundwater/stormwater quality? How will upstream, stormwater runoff be contained? Treatment of Railroad beds, capped waste, feeding groundwater contamination? Waste left in place. Yes, heard, but might not be always addressed to satisfaction. Need to make sure grant money is available in advance so they can get additional work done. Expectations—corridor safe for recreation, community asset Opinion-RA is appropriate, pleased the partnership with MDEQ MDEQ NRD update fact sheets, don't use commission meetings. Portable boards that can be moved. Email for some. Libraries, Civic Center. Concerns: remedy meeting goals of ROD and institutional control of maintenance program—how will it be funded? GSD sees itself as critical component of IC's program. *MDEQ needs to move this forward. Long term protectiveness goal to buy property from recalcitrant landowners.
Jerry Earhart	Landowner (Ramsey)	2/17/2010	Kris Edwards	Information from observing cleanup project. Concerns: no description about how things would be done, not accommodating, there are loose ends. Can't cross railroad now, promised crossing but never built. Bad channel alignment-splits his property. Took out well, didn't replace it. Took dirt with no payment. Survey markers taken out and not replaced. Thinks concerns were heard, but not addressed and has a very negative opinion of work. Not satisfied with level of information provided. Personal visits are best method of information dissemination.

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APPENDIX C

References and Documents Reviewed

APPENDIX C

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APPENDIX D

Summary of Water Quality Data

State of Montana Sampling Results

TABLE 1 - Groundwater Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Cadmium, dissolved (ug/L)	Copper, dissolved (ug/L)	Lead, dissolved (ug/L)	Mercury, dissolved (ug/L)	Zinc, dissolved (ug/L)
P-06A	9/21/2006	3.0	1.7	51.0	3.5	0.030	260
P-06A	9/19/2007	5.0	1.1	47.0	10.0	0.005	210
P-06A	9/25/2008	3.0	2.0	47.0	1.6	0.025	250
MW-1052R	9/18/2007	7.0	1.1	58.0	1.1	0.005	1.6
MW-1052R	9/24/2008	1.5	120	180	0.25	0.025	2,300
MW-2A	6/22/2006	9.0	0.05	0.5	0.25	0.020	5.0
MW-2A	9/20/2006	9.0	0.04	0.5	0.25	0.005	5.0
	Annual Mean:	9.0	0.05	0.5	0.25	0.013	5.0
MW-2A	6/8/2007	11.0	1.1	3.0	0.25	0.10	5.0
MW-2A	9/18/2007	11.0	0.1	1.0	0.25	0.005	5.0
	Annual Mean:	11.0	0.6	2.0	0.25	0.053	5.0
MW-2A	6/25/2008	6.0	0.04	0.5	0.25	0.005	5.0
MW-2A	9/24/2008	10.0	0.04	0.5	0.25	0.025	5.0
	Annual Mean:	8.0	0.04	0.5	0.25	0.015	5.0
MW-2B	6/22/2006	6.0	0.04	2.0	0.25	0.02	5.0
MW-2B	9/20/2006	6.0	0.04	0.5	0.25	0.01	5.0
	Annual Mean:	6.0	0.04	1.3	0.25	0.01	5.0
MW-2B	6/8/2007	7.0	0.04	1.0	0.25	0.100	5.0
MW-2B	9/18/2007	8.0	0.04	2.0	0.80	0.005	5.0
	Annual Mean:	7.5	0.04	1.5	0.53	0.053	5.0
MW-2B	6/25/2008	4.0	0.04	0.5	0.25	0.010	5.0
MW-2B	9/24/2008	9.0	0.04	2.0	0.25	0.025	5.0
	Annual Mean:	6.5	0.04	1.3	0.25	0.018	5.0
MW-2C	6/22/2006	5.0	0.41	1.0	0.25	0.02	5.0
MW-2C	9/20/2006	5.0	0.04	0.5	0.25	0.01	5.0
	Annual Mean:	5.0	0.23	0.8	0.25	0.01	5.0
MW-2C	6/8/2007	5.0	0.04	1.0	0.25	0.10	5.0
MW-2C	9/18/2007	6.0	0.04	0.5	0.70	0.005	5.0
	Annual Mean:	5.5	0.0	0.8	0.48	0.053	5.0

TABLE 1 - Groundwater Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Cadmium, dissolved (ug/L)	Copper, dissolved (ug/L)	Lead, dissolved (ug/L)	Mercury, dissolved (ug/L)	Zinc, dissolved (ug/L)
MW-2C	6/25/2008	3.0	0.04	0.5	0.25	0.010	5.0
MW-2C	9/24/2008	7.0	0.04	0.5	0.25	0.025	5.0
	Annual Mean:	5.0	0.04	0.5	0.25	0.018	5.0
MW-2D	6/22/2006	6.0	0.09	0.5	0.25	0.02	5.0
MW-2D	9/20/2006	6.0	0.04	0.5	0.25	0.01	5.0
	Annual Mean:	6.0	0.07	0.5	0.25	0.01	5.0
MW-2D	6/8/2007	7.0	0.04	1.0	0.25	0.10	5.0
MW-2D	9/18/2007	7.0	0.04	0.5	2.10	0.005	5.0
	Annual Mean:	7.0	0.0	0.8	1.18	0.053	5.0
MW-2D	6/25/2008	3.0	0.04	0.5	0.25	0.005	5.0
MW-2D	9/24/2008	7.0	0.04	2.0	0.25	0.025	5.0
	Annual Mean:	5.0	0.04	1.3	0.25	0.015	5.0
1GW-1056	6/22/2006	6.0	0.04	1.0	0.25	0.02	5.0
1GW-1056	9/21/2006	4.0	0.04	0.5	0.25	0.18	5.0
	Annual Mean:	6.0	0.04	1.0	0.25	0.02	5.0
1GW-1056	6/8/2007	5.0	0.04	1.0	0.25	0.100	5.0
1GW-1056	9/19/2007	5.0	0.04	1.0	0.25	0.005	5.0
	Annual Mean:	5.0	0.04	1.0	0.25	0.053	5.0
1GW-1056	6/25/2008	1.5	0.04	1.0	0.25	0.005	5.0
1GW-1056	9/25/2008	5.0	0.04	0.5	0.25	0.025	5.0
	Annual Mean:	3.3	0.04	0.8	0.25	0.015	5.0
MW-6A	9/20/2006	1.5	2.9	29.0	0.80	0.005	1380
MW-6R	9/18/2007	1.5	2.7	78.0	0.90	0.005	1480
MW-6R	9/24/2008	1.5	4.5	130	0.80	0.025	810
MW-10	9/18/2007	6.0	5.8	1,110	37.0	0.005	6,270
MW-10	3/26/2008	1.5	0.0	2,100	55.0		9,310
MW-10	6/25/2008	1.5	2.7	5,100	350	0.010	7,300
MW-10	9/24/2008	6.0	4.6	290	7.7	0.110	5,760
MW-10	12/11/2008	2.6	4.8	214	0.49		4,860
	Annual Mean:	2.9	3.0	1,926	103	0.060	6,808

TABLE 1 - Groundwater Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Cadmium, dissolved (ug/L)	Copper, dissolved (ug/L)	Lead, dissolved (ug/L)	Mercury, dissolved (ug/L)	Zinc, dissolved (ug/L)
1GW-1038	9/18/2007	100	0.24	32.0	1.3	0.09	5.0
1GW-1038	3/26/2008	41.0	0.4	28.0	1.0		20.0
1GW-1038	6/25/2008	23.0	1.0	13.0	0.25	0.14	20.0
1GW-1038	9/24/2008	40.0	0.04	6.0	0.03	0.25	5.0
1GW-1038	12/11/2008	41.1	1.1	9.5	0.2		32.2
	Annual Mean:	36.3	0.6	14.1	0.4	0.20	19.3
1GW-1004A	9/21/2006	1.5	9.9	18.0	2.1	0.005	9,680
1GW-1004A	9/19/2007	1.5	9.2	160	8.3	0.005	1,080
1GW-1004A	3/26/2008	1.5	4.3	46.0	1.8		5,000
1GW-1004A	6/26/2008	1.5	5.0	40.0	0.8	0.005	7,780
1GW-1004A	9/25/2008	1.5	5.0	110	9.0	0.025	9,660
1GW-1004A	12/11/2008	0.8	1.0	13.0	0.3		6,200
	Annual Mean:	1.3	3.8	52.3	3.0	0.015	7,160
P-37A	9/21/2006	4.0	27.0	21.0	0.5	0.005	1,170
P-37A	9/19/2007	7.0	43.0	33.0	1.6	0.005	1,070
P-37A	3/26/2008	1.5	0.9	22.0	0.8		320
P-37A	6/26/2008	1.5	54.0	2.0	0.25	0.005	1,140
P-37A	9/25/2008	9.0	45.0	49.0	0.5	0.003	890
P-37A	12/11/2008	1.6	31.9	38.3	0.25		716
	Annual Mean:	3.4	33.0	27.8	0.45	0.004	767
P-58A	9/21/2006	1.5	0.6	2.0	0.3	0.005	3,400
P-58A	9/19/2007	1.5	4.3	5.0	0.3	0.005	3,300
P-58A	9/24/2008	1.5	22.0	130	0.03	0.025	3,670

State of Montana Sampling Results

TABLE 2 - Surface Water Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Arsenic, total (ug/L)	Cadmium, dissolved (ug/L)	Cadmium, total (ug/L)	Copper, dissolved (ug/L)	Copper, total (ug/L)	Lead, dissolved (ug/L)	Lead, total (ug/L)	Mercury, dissolved (ug/L)	Mercury, total (ug/L)	Zinc, dissolved (ug/L)	Zinc, total (ug/L)
SS-06G	3/20/2007	5.0	8.0	0.1	0.2	8.0	13.0	0.25	2.1	0.10	0.10	20.0	40.0
SS-06G	6/4/2007	6.0	9.0	0.1	0.2	11.0	17.0	0.25	3.0	0.10	0.10	20.0	30.0
SS-06G	9/20/2007	5.0	6.0	0.1	0.2	6.0	12.0	2.4	1.7	0.01	0.03	30.0	40.0
SS-06G	12/20/2007	3.0	5.0	0.1	0.3	4.0	28.0	0.25	5.9	0.01	0.02	50.0	70.0
	Annual Mean:	**4.8**	**7.0**	**0.1**	**0.2**	**7.3**	**17.5**	**0.8**	**3.2**	**0.05**	**0.06**	**30.0**	**45.0**
SS-06G	3/24/2008	3.0	5.0	0.1	0.2	6.0	15.0	0.25	19.0	0.01		20.0	50.0
SS-06G	6/30/2008	4.0	11.0	0.05	0.17	5.0	21.0	0.25	25.0	0.01	0.01	10.0	40.0
SS-06G	9/17/2008	3.0	6.0	0.1	0.1	5.0	7.0	0.25	8.0	0.03		20.0	40.0
SS-06G	12/9/2008	3.0	4.5	0.1	0.2	4.6	17.0	0.25	3.7	0.01	0.01	28.9	58.4
	Annual Mean:	**3.3**	**6.6**	**0.1**	**0.2**	**5.2**	**15.0**	**0.3**	**13.9**	**0.01**	**0.01**	**19.7**	**47.1**
SS-07	4/14/2000	6.1	6.2	1.0	1.0	7.1	9.6	1.0	1.0	---	---	63.5	67.7
SS-07	8/30/2000	8.1	---	1.0	1.0	10.9	---	1.0	1.0	---	---	170	170
	Annual Mean:	**7.1**	**6.2**	**1.0**	**1.0**	**9.0**	**9.6**	**1.0**	**1.0**	---	---	**116.8**	**118.9**
SS-07	6/11/2002	7.9	9.4	1.0	1.0	11.1	21	1.0	4	---	---	71.5	108
	Annual Mean:	**7.9**	**9.4**	**1.0**	**1.0**	**11.1**	**21.0**	**1.0**	**4.0**	---	---	**71.5**	**108.0**
SS-07	1/8/2003	11.6	11.6	0.5	0.5	2.5	28.3	5.0	5.0	---	---	111	187.0
SS-07	3/14/2003	12.2	18.9	0.5	1.0	29.2	67.3	1.0	22.8	---	---	196	374
SS-07	10/7/2003	3.9	3.5	0.5	0.5	8.2	15.9	1.0	1.0	---	---	78.5	88.0
	Annual Mean:	**9.2**	**11.3**	**0.5**	**0.7**	**13.3**	**37.2**	**2.3**	**9.6**	---	---	**128.5**	**216.3**
SS-07	3/24/2004	5.0	6.0	0.4	0.5	11.0	24.0	1.5	1.5	---	---	170	200
SS-07	6/10/2004	1.5	4.0	1.1	1.0	16.0	23.0	1.5	1.5	---	---	250	250
SS-07	8/26/2004	5.0	4.0	1.0	1.0	12.0	17.0	1.5	1.5	---	---	300	300
SS-07	11/18/2004	5.0	6.0	0.8	1.1	7.0	37.0	1.5	1.5	---	---	330	320

TABLE 2 - Surface Water Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Arsenic, total (ug/L)	Cadmium, dissolved (ug/L)	Cadmium, total (ug/L)	Copper, dissolved (ug/L)	Copper, total (ug/L)	Lead, dissolved (ug/L)	Lead, total (ug/L)	Mercury, dissolved (ug/L)	Mercury, total (ug/L)	Zinc, dissolved (ug/L)	Zinc, total (ug/L)
	Annual Mean:	**4.1**	**5.0**	**0.8**	**0.9**	**11.5**	**25.3**	**1.5**	**1.5**	---	---	**262.5**	**267.5**
SS-07	3/31/2005	5.0	6.0	2.2	2.3	24.0	59.0	1.5	1.5	---	---	600	620
SS-07	6/8/2005	7.0	8.0	0.1	0.2	12.0	16.0	1.5	1.5	---	---	40.0	60.0
	Annual Mean:	**6.0**	**7.0**	**1.2**	**1.3**	**18.0**	**37.5**	**1.5**	**1.5**	---	---	**320.0**	**340.0**
SS-07	3/28/2006	4.0	5.0	0.8	3.2	9.0	58.0	1.5	15.0	0.01	0.1	410	910
SS-07	6/27/2006	6.0	10.0	0.2	0.3	14.0	29.0	0.3	1.8	0.02	0.1	70.0	100
SS-07	9/19/2006	4.0	4.0	0.2	0.3	14.0	16.0	0.3	1.2	0.01	0.1	70.0	80.0
SS-07	12/14/2006	1.5	4.0	0.1	0.2	13.0	19.0	0.3	1.9	0.01	0.1	70.0	70.0
	Annual Mean:	**3.9**	**5.8**	**0.3**	**1.0**	**12.5**	**30.5**	**0.6**	**5.0**	**0.01**	**0.1**	**155.0**	**290.0**
SS-07	3/20/2007	5.0	7.0	0.2	0.2	11.0	16.0	0.3	2.1	0.10	0.10	30.0	50.0
SS-07	6/4/2007	5.0	6.0	0.1	0.2	18.0	21.0	0.3	2.0	0.10	0.10	60.0	40.0
SS-07	9/20/2007	4.0	5.0	0.1	0.1	13.0	21.0	0.3	16.0	0.01	0.03	60.0	70.0
SS-07	12/20/2007	1.5	4.0	0.1	0.2	11.0	26.0	0.3	3.4	0.01	0.04	80.0	70.0
	Annual Mean:	**3.9**	**5.5**	**0.1**	**0.2**	**13.3**	**21.0**	**0.3**	**5.9**	**0.05**	**0.07**	**57.5**	**57.5**
SS-07	3/24/2008	3.0	4.0	0.1	0.2	15.0	22.0	0.3	2.1	0.01	0.01	50.0	50.0
SS-07	6/30/2008	1.5	6.0	0.1	0.2	12.0	39.0	0.3	1.9	0.01	0.01	90.0	90.0
SS-07	9/17/2008	1.5	5.0	0.1	0.1	7.0	8.0	0.3	0.1	0.03	0.03	40.0	40.0
SS-07	12/9/2008	2.9	3.3	0.1	0.1	15.5	17.9	0.4	2.0	0.01	0.01	49.3	56.1
	Annual Mean:	**2.2**	**4.6**	**0.1**	**0.2**	**12.4**	**21.7**	**0.3**	**1.5**	**0.01**	**0.01**	**57.3**	**59.0**

TABLE 2 - Surface Water Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Arsenic, total (ug/L)	Cadmium, dissolved (ug/L)	Cadmium, total (ug/L)	Copper, dissolved (ug/L)	Copper, total (ug/L)	Lead, dissolved (ug/L)	Lead, total (ug/L)	Mercury, dissolved (ug/L)	Mercury, total (ug/L)	Zinc, dissolved (ug/L)	Zinc, total (ug/L)
Geometric Mean for Dec 1984 to August 1985													
	Low Flow Events	---	8.7	---	1.6	---	178	---	5.3	---	---	---	682
	High Flow Events	---	18.0	---	1.9	---	216	---	82.0	---	---	---	588
SS-08A	6/11/2002	8.1	8.8	1.0	1.0	14.1	25.3	1.0	5.0	---	---	101	134
	Annual Mean:	**8.1**	**8.8**	**1.0**	**1.0**	**14.1**	**25.3**	**1.0**	**5.0**	---	---	**101**	**134**
SS-08A	1/8/2003	5.0	5.0	0.5	0.5	7.6	33.8	5.0	5.0	---	---	111	186
SS-08A	3/14/2003	19.0	64.3	0.5	0.5	23.3	105	4.8	263	---	---	90.0	646
SS-08A	10/8/2003	4.7	6.4	2.1	6.9	7.2	31.5	1.0	10.7	---	---	209	377
	Annual Mean:	**9.6**	**25.2**	**1.0**	**2.6**	**12.7**	**56.8**	**3.6**	**92.9**	---	---	**136.7**	**403.0**
SS-08A	3/24/2004	5.0	7.0	0.5	1.0	12.0	36.0	1.5	5.0	---	---	180	250
SS-08A	6/10/2004	4.0	5.0	0.9	1.2	15.0	27.0	4.0	8.0	---	---	300	301
SS-08A	8/26/2004	5.0	5.0	0.5	0.7	12.0	15.0	1.5	1.5	---	---	230	220
SS-08A	11/18/2004	5.0	7.0	0.7	1.0	10.0	34.0	1.5	4.0	---	---	300	340
	Annual Mean:	**4.8**	**6.0**	**0.7**	**1.0**	**12.3**	**28.0**	**2.1**	**4.6**	---	---	**252.5**	**277.8**
SS-08A	3/31/2005	4.0	5.0	1.1	1.5	21.0	53.0	1.5	3.0	---	---	300	400
SS-08A	6/8/2005	7.0	8.0	0.3	0.3	15.0	19.0	1.5	1.5	---	---	60.0	130
	Annual Mean:	**5.5**	**6.5**	**0.7**	**0.9**	**18.0**	**36.0**	**1.5**	**2.3**	---	---	**180**	**265**
SS-08	3/28/2006	5.0	8.0	0.2	1.0	7.0	43.0	1.5	11.0	0.10	0.10	100	270
SS-08	6/27/2006	7.0	10.0	0.2	0.4	14.0	25.0	0.3	1.6	0.02	0.10	60.0	90.0
SS-08	9/19/2006	5.0	7.0	0.2	0.8	9.0	40.0	0.3	8.9	0.01	0.10	70.0	180
SS-08	12/14/2006	3.0	4.0	0.2	0.4	11.0	22.0	0.3	3.3	0.01	0.10	70.0	11.0
	Annual Mean:	**5.0**	**7.3**	**0.2**	**0.6**	**10.3**	**32.5**	**0.6**	**6.2**	**0.03**	**0.1**	**75.0**	**137.8**

TABLE 2 - Surface Water Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Arsenic, total (ug/L)	Cadmium, dissolved (ug/L)	Cadmium, total (ug/L)	Copper, dissolved (ug/L)	Copper, total (ug/L)	Lead, dissolved (ug/L)	Lead, total (ug/L)	Mercury, dissolved (ug/L)	Mercury, total (ug/L)	Zinc, dissolved (ug/L)	Zinc, total (ug/L)
SS-08	3/20/2007	5.0	7.0	0.2	0.29	12.0	20.0	0.3	2.7	0.10	0.10	50.0	80.0
SS-08	6/4/2007	6.0	8.0	0.1	0.26	12.0	18.0	0.3	2.0	0.10	0.10	40.0	50.0
SS-08	9/20/2007	5.0	6.0	0.1	0.19	9.0	14.0	0.3	1.8	0.01	0.03	50.0	60.0
SS-08	12/20/2007	4.0	5.0	0.2	0.33	9.0	24.0	0.3	3.5	0.01	0.03	80.0	90.0
	Annual Mean:	**5.0**	**6.5**	**0.1**	**0.3**	**10.5**	**19.0**	**0.3**	**2.5**	**0.1**	**0.1**	**55.0**	**70.0**
SS-08	3/24/2008	3.0	5.0	0.2	0.3	11.0	21.0	0.3	3.1	0.10	0.01	50.0	80.0
SS-08	6/30/2008	4.0	9.0	0.1	0.2	8.0	26.0	0.3	1.6	0.01	0.01	40.0	70.0
SS-08	9/17/2008	3.0	6.0	0.1	0.2	7.0	14.0	0.3	2.6	0.03	0.03	70.0	70.0
SS-08	12/9/2008	3.4	4.1	0.2	0.3	9.9	22.1	0.2	3.5	0.01	0.01	56.4	81.5
	Annual Mean:	**3.4**	**6.0**	**0.1**	**0.3**	**9.0**	**20.8**	**0.2**	**2.7**	**0.03**	**0.01**	**54.1**	**75.4**
Geometric Mean for Dec 1984 to August 1985													
	Low Flow Events	---	5.3	---	1.5	---	192	---	13.5	---	---	---	771
	High Flow Events	---	12.0	---	2.1	---	241	---	10.0	---	---	---	628
SS-10A	6/10/2004	5.0	7.0	0.6	0.6	13.0	20.0	4.0	7.0	---	---	230	220
SS-10A	11/19/2004	6.0	6.0	0.6	0.9	11.0	28.0	1.5	3.0	---	---	290	340
	Annual Mean:	**5.5**	**6.5**	**0.6**	**0.8**	**12.0**	**24.0**	**2.8**	**5.0**	---	---	**260**	**280**
SS-10A	3/31/2005	5.0	6.0	0.5	1.1	13.0	46.0	1.5	4.0	---	---	140	280
SS-10A	6/9/2005	6.0	7.0	0.3	0.5	12.0	20.0	1.5	1.5	---	---	90.0	100
	Annual Mean:	**5.5**	**6.5**	**0.4**	**0.8**	**12.5**	**33.0**	**1.5**	**2.8**	---	---	**115**	**190**
SS-10A	3/28/2006	5.0	8.0	0.7	1.3	9.0	41.0	1.5	10.0	0.10	0.1	160	280
SS-10A	6/27/2006	6.0	9.0	0.6	0.6	11.0	21.0	0.3	1.2	0.02	0.1	90.0	120
SS-10A	9/19/2006	5.0	7.0	0.2	0.8	7.0	32.0	0.3	6.3	0.01	0.1	70.0	190
SS-10A	12/14/2006	1.5	5.0	0.1	0.5	0.1	23.0	0.3	3.0	0.01	0.1	60.0	110
	Annual Mean:	**4.4**	**7.3**	**0.4**	**0.8**	**6.8**	**29.3**	**0.6**	**5.1**	**0.03**	**0.1**	**95.0**	**175**

TABLE 2 - Surface Water Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Arsenic, total (ug/L)	Cadmium, dissolved (ug/L)	Cadmium, total (ug/L)	Copper, dissolved (ug/L)	Copper, total (ug/L)	Lead, dissolved (ug/L)	Lead, total (ug/L)	Mercury, dissolved (ug/L)	Mercury, total (ug/L)	Zinc, dissolved (ug/L)	Zinc, total (ug/L)
SS-10A	3/20/2007	5.0	7.0	0.2	0.3	12.0	18.0	0.3	2.0	0.10	0.10	50.0	80.0
SS-10A	6/4/2007	6.0	8.0	0.1	0.3	12.0	20.0	0.3	2.0	0.10	0.10	20.0	50.0
SS-10A	9/20/2007	5.0	6.0	0.1	0.3	8.0	15.0	0.3	2.4	0.01	0.05	30.0	50.0
SS-10A	12/20/2007	4.0	5.0	0.2	0.4	9.0	26.0	0.3	3.7	0.01	0.04	80.0	110
Annual Mean:		**5.0**	**6.5**	**0.2**	**0.3**	**10.3**	**19.8**	**0.3**	**2.5**	**0.05**	**0.07**	**45.0**	**72.5**
SS-10A	3/24/2008	4.0	5.0	0.2	0.3	11.0	20.0	0.3	2.3	0.01	0.01	50.0	90.0
SS-10A	6/30/2008	4.0	9.0	0.1	0.2	7.0	21.0	0.3	1.0	0.01	0.01	20.0	50.0
SS-10A	9/17/2008	4.0	5.0	0.2	0.2	8.0	12.0	0.3	1.2	0.03	0.03	60.0	60.0
SS-10A	12/9/2008	3.9	4.4	0.2	0.3	11.1	20.9	0.2	2.7	0.01	4.80	51.1	81.0
Annual Mean:		**4.0**	**5.9**	**0.2**	**0.3**	**9.3**	**18.5**	**0.2**	**1.8**	**0.01**	**1.21**	**45.3**	**70.3**
Geometric Mean for Dec 1984 to August 1985													
Low Flow Events		---	14.5	---	2.5	---	322	---	15.2	---	---	---	860
High Flow Events		---	19.0	---	2.1	---	321	---	9.9	---	---	---	763
SS-10B	6/11/2004	4.0	5.0	1.1	1.3	18.0	36.0	3.0	6.0	---	---	490	500
SS-10B	11/19/2004	5.0	5.0	0.5	1.0	13.0	37.0	1.5	5.0	---	---	280	340
Annual Mean:		**4.5**	**5.0**	**0.8**	**1.2**	**15.5**	**36.5**	**2.3**	**5.5**	---	---	**385**	**420**
SS-10B	3/31/2005	5.0	7.0	0.5	1.2	15.0	50.0	1.5	4.0	---	---	140	280
SS-10B	6/9/2005	7.0	8.0	0.3	0.4	13.0	21.0	1.5	1.5	---	---	100	120
Annual Mean:		**6.0**	**7.5**	**0.4**	**0.8**	**14.0**	**35.5**	**1.5**	**2.8**	---	---	**120.0**	**200.0**
SS-10B	3/28/2006	5.0	8.0	0.6	1.2	11.0	39.0	1.50	9.0	0.10	0.10	110	270
SS-10B	6/27/2006	6.0	8.0	0.4	0.6	10.0	20.0	0.25	1.2	0.02	0.10	80.0	90
SS-10B	9/19/2006	5.0	6.0	0.2	0.7	10.0	29.0	0.25	5.7	0.01	0.70	80.0	170
SS-10B	12/14/2006	4.0	5.0	0.3	0.5	10.0	23.0	0.25	3.2	0.01	0.10	70.0	120
Annual Mean:		**5.0**	**6.8**	**0.4**	**0.8**	**10.3**	**27.8**	**0.6**	**4.8**	**0.03**	**0.25**	**85.0**	**163**

TABLE 2 - Surface Water Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Arsenic, total (ug/L)	Cadmium, dissolved (ug/L)	Cadmium, total (ug/L)	Copper, dissolved (ug/L)	Copper, total (ug/L)	Lead, dissolved (ug/L)	Lead, total (ug/L)	Mercury, dissolved (ug/L)	Mercury, total (ug/L)	Zinc, dissolved (ug/L)	Zinc, total (ug/L)
SS-10B	3/20/2007	6.0	7.0	0.2	0.3	12.0	17.0	0.25	1.8	0.10	0.10	50.0	70.0
SS-10B	6/4/2007	6.0	8.0	0.05	0.1	12.0	18.0	0.25	2.0	0.10	0.10	30.0	50.0
SS-10B	9/20/2007	5.0	6.0	0.2	0.2	8.0	14.0	0.7	1.9	0.01	0.05	30.0	50.0
SS-10B	12/20/2007	4.0	5.0	0.3	0.4	10.0	23.0	0.25	2.9	0.01	0.03	90.0	100.0
	Annual Mean:	**5.3**	**6.5**	**0.2**	**0.2**	**10.5**	**18.0**	**0.4**	**2.2**	**0.05**	**0.07**	**50.0**	**67.5**
SS-10B	3/24/2008	4.0	5.0	0.2	0.3	11.0	19.0	0.25	2.5	0.01	0.01	60.0	90.0
SS-10B	6/30/2008	4.0	9.0	0.1	0.2	7.0	21.0	0.25	1.0	0.01	0.01	20.0	50.0
SS-10B	9/17/2008	4.0	6.0	0.2	0.2	8.0	11.0	0.25	1.2	0.03	0.03	50.0	60.0
SS-10B	12/09/2008	3.9	4.2	0.2	0.3	10.9	19.2	0.2	2.5	0.01	0.01	53.4	80.4
	Annual Mean:	**4.0**	**6.1**	**0.1**	**0.3**	**9.2**	**17.6**	**0.2**	**1.8**	**0.01**	**0.01**	**45.9**	**70.1**
SS11C	3/20/2007	7.0	8.0	0.5	0.6	23.0	24.0	1.6	1.9	0.10	0.10	80.0	140
SS11C	6/4/2007	7.0	8.0	0.2	0.5	17.0	26.0	0.25	2.0	0.10	0.10	40.0	90.0
SS11C	9/20/2007	7.0	7.0	0.2	0.4	12.0	21.0	0.25	1.8	0.01	0.05	50.0	90.0
SS11C	12/20/2007	6.0	7.0	0.5	0.8	15.0	39.0	1.3	3.5	0.01	0.03	210	240
	Annual Mean:	**6.8**	**7.5**	**0.3**	**0.6**	**16.8**	**27.5**	**0.9**	**2.3**	**0.05**	**0.07**	**95.0**	**140**
SS11C	3/24/2008	6.0	7.0	0.5	0.6	15.0	23.0	0.25	1.6	0.01	0.02	130	180
SS11C	6/30/2008	6.0	14.0	0.05	0.4	7.0	24.0	0.25	1.2	0.01	0.01	20.0	70
SS11C	9/17/2008	6.0	8.0	0.2	0.3	11.0	17.0	0.25	1.3	0.03	0.03	30.0	80
SS11C	12/09/2008	6.1	6.5	0.4	0.4	14.7	21.0	0.2	1.3	0.01	0.01	142	155
	Annual Mean:	**6.0**	**8.9**	**0.3**	**0.4**	**11.9**	**21.3**	**0.2**	**1.4**	**0.01**	**0.02**	**80.5**	**121**
SS-11D	6/11/2004	9.0	10.0	0.8	0.9	24.0	45.0	4.0	9.0	---	---	350	360
SS-11D	11/30/2004	8.0	14.0	0.8	1.4	17.0	78.0	1.5	16.0	---	---	410	510
	Annual Mean:	**8.5**	**12.0**	**0.8**	**1.2**	**20.5**	**61.5**	**2.8**	**12.5**	---	---	**380**	**435**
SS-11D	3/31/2005	9.0	14.0	0.5	1.3	15.0	86.0	1.5	18.0	---	---	150	340
SS-11D	6/23/2005	14.0	18.0	0.5	0.8	18.0	40.0	1.5	7.0	---	---	140	170
	Annual Mean:	**11.5**	**16.0**	**0.5**	**1.1**	**16.5**	**63.0**	**1.5**	**12.5**	---	---	**145**	**255**

TABLE 2 - Surface Water Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Arsenic, total (ug/L)	Cadmium, dissolved (ug/L)	Cadmium, total (ug/L)	Copper, dissolved (ug/L)	Copper, total (ug/L)	Lead, dissolved (ug/L)	Lead, total (ug/L)	Mercury, dissolved (ug/L)	Mercury, total (ug/L)	Zinc, dissolved (ug/L)	Zinc, total (ug/L)
SS11D	3/28/2006	11.0	34.0	0.5	1.7	23.0	130	1.50	69.0	0.10	0.10	90.0	430
SS11D	6/27/2006	12.0	20.0	0.4	0.7	22.0	60.0	0.25	17.0	0.02	0.10	70.0	200
SS11D	9/19/2006	8.0	9.0	0.4	0.8	20.0	45.0	0.25	3.7	0.01	0.10	140	230
SS11D	12/14/2006	6.0	7.0	0.7	1.0	20.0	41.0	0.25	2.8	0.01	0.10	210	260
	Annual Mean:	**9.3**	**17.5**	**0.5**	**1.1**	**21.3**	**69.0**	**0.6**	**23.1**	**0.03**	**0.10**	**127.5**	**280**
SS11D	3/20/2007	9.0	12.0	0.3	0.4	12.0	20.0	0.25	2.6	0.10	0.10	60.0	110
SS11D	6/4/2007	10.0	12.0	0.1	0.4	15.0	22.0	0.25	2.0	0.10	0.10	40.0	70
SS11D	9/20/2007	7.0	7.0	0.2	0.4	12.0	19.0	0.7	1.6	0.05	0.05	40.0	100
SS11D	12/20/2007	6.0	6.0	0.5	0.7	16.0	35.0	0.25	2.8	0.04	0.04	200	240
	Annual Mean:	**8.0**	**9.3**	**0.3**	**0.5**	**13.8**	**24.0**	**0.4**	**2.3**	**0.07**	**0.07**	**85.0**	**130**
SS11D	3/24/2008	6.0	7.0	0.4	0.5	16.0	23.0	0.25	1.7	0.01	0.03	140	190
SS11D	6/30/2008	6.0	14.0	0.05	0.2	6.0	19.0	0.25	1.3	0.01	0.01	10.0	60.0
SS11D	9/17/2008	6.0	8.0	0.2	0.4	10.0	16.0	0.25	1.2	0.03	0.03	40.0	80.0
SS11D	12/09/2008	6.1	6.5	0.3	0.3	10.4	14.4	0.1	1.4	0.01	0.01	95.5	105
	Annual Mean:	**6.0**	**8.9**	**0.2**	**0.4**	**10.6**	**18.1**	**0.2**	**1.4**	**0.01**	**0.02**	**71.4**	**109**
Geometric Mean for Dec 1984 to August 1985													
	Low Flow Events	---	11.0	---	1.3	---	153	---	7.5	---	---	---	565
	High Flow Events	---	11.0	---	4.8	---	180	---	16.0	---	---	---	461
SS-15A	3/20/2007	11.0	15.0	0.5	0.7	31.0	63.0	1.2	14.0	0.10	0.10	120	190
SS-15A	6/4/2007	12.0	17.0	0.3	0.9	27.0	77.0	0.6	30.0	0.10	0.30	60.0	210
SS-15A	9/20/2007	10.0	13.0	0.5	0.8	34.0	89.0	0.8	13.0	0.01	0.15	80.0	190
SS-15A	12/20/2007	8.0	10.0	1.2	1.1	32.0	67.0	0.3	8.7	0.01	0.05	300	330
	Annual Mean:	**10.3**	**13.8**	**0.6**	**0.9**	**31.0**	**74.0**	**0.7**	**16.4**	**0.05**	**0.15**	**140**	**230**

TABLE 2 - Surface Water Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Arsenic, total (ug/L)	Cadmium, dissolved (ug/L)	Cadmium, total (ug/L)	Copper, dissolved (ug/L)	Copper, total (ug/L)	Lead, dissolved (ug/L)	Lead, total (ug/L)	Mercury, dissolved (ug/L)	Mercury, total (ug/L)	Zinc, dissolved (ug/L)	Zinc, total (ug/L)
SS-15A	3/24/2008	8.0	11.0	0.7	1.1	32.0	85.0	1.2	24.0	0.01	0.19	200	320
SS-15A	6/30/2008	7.0	16.0	0.1	0.5	12.0	61.0	0.3	13.0	0.01	0.07	20.0	120
SS-15A	9/16/2008	11.0	15.0	0.4	0.7	21.0	51.0	0.3	7.7	0.03	0.03	100	210
SS-15A	12/09/2008	6.6	6.8	0.4	0.5	17.8	39.0	0.3	5.1	0.01	0.01	157	201
	Annual Mean:	**8.2**	**12.2**	**0.4**	**0.7**	**20.7**	**59.0**	**0.5**	**12.5**	**0.01**	**0.07**	**119**	**213**
Geometric Mean for Dec 1984 to August 1985													
	Low Flow Events	---	11.7	---	1.1	---	163	---	5.4	---	---	---	532
	High Flow Events	---	12.0	---	1.7	---	214	---	9.2	---	---	---	506
SS-15B	3/20/2007	11.0	15.0	0.5	0.8	30.0	67.0	1.2	16.0	0.10	0.10	130	210
SS-15B	6/4/2007	11.0	17.0	0.2	0.9	25.0	74.0	0.7	28.0	0.10	0.10	60.0	180
SS-15B	9/20/2007	8.0	10.0	0.4	0.7	23.0	75.0	1.2	11.0	0.01	0.12	50.0	150
SS-15B	12/20/2007	8.0	9.0	0.7	1.0	26.0	55.0	0.8	6.4	0.01	0.04	240	260
	Annual Mean:	**9.5**	**12.8**	**0.5**	**0.8**	**26.0**	**67.8**	**1.0**	**15.4**	**0.05**	**0.09**	**120**	**200**
SS-15B	3/24/2008	8.0	11.0	0.7	1.0	29.0	75.0	1.3	22.0	0.01	0.16	190	300
SS-15B	6/30/2008	7.0	16.0	0.2	0.5	23.0	58.0	0.5	14.0	0.01	0.07	120	120
SS-15B	9/16/2008	11.0	15.0	0.4	0.7	21.0	53.0	<0.5	8.4	0.03	0.03	100	200
SS-15B	12/09/2008	6.6	6.8	0.4	0.5	17.4	33.0	0.3	4.5	0.01	0.01	158	189
	Annual Mean:	**8.2**	**12.2**	**0.4**	**0.7**	**22.6**	**54.8**	**0.7**	**12.2**	**0.01**	**0.07**	**142**	**202**
SS-17	6/11/2004	12.0	15.0	0.2	0.7	24.0	72.0	4.0	19.0	---	---	80.0	180
SS-17	12/1/2004	12.0	18.0	0.7	1.1	21.0	71.0	1.5	10.0	---	---	530	620
	Annual Mean:	**12.0**	**16.5**	**0.5**	**0.9**	**22.5**	**71.5**	**2.8**	**14.5**	---	---	**305**	**400**
SS-17	3/30/2005	12.1	20.8	0.5	0.5	29.1	120.0	1.0	1.0	---	---	140	350
SS-17	6/9/2005	11.0	17.0	0.3	0.7	27.0	83.0	1.5	18.0	---	---	80.0	170
	Annual Mean:	**11.6**	**18.9**	**0.4**	**0.6**	**28.1**	**101.5**	**1.3**	**9.5**	---	---	**110**	**260**

TABLE 2 - Surface Water Sampling Results

Sampling Site	Date	Arsenic, dissolved (ug/L)	Arsenic, total (ug/L)	Cadmium, dissolved (ug/L)	Cadmium, total (ug/L)	Copper, dissolved (ug/L)	Copper, total (ug/L)	Lead, dissolved (ug/L)	Lead, total (ug/L)	Mercury, dissolved (ug/L)	Mercury, total (ug/L)	Zinc, dissolved (ug/L)	Zinc, total (ug/L)
SS-17	3/28/2006	11.0	22.0	0.8	1.3	32.0	130	1.5	39.0	0.10	0.10	120	360
SS-17	6/27/2006	13.0	18.0	0.2	0.6	21.0	59.0	0.7	11.0	0.02	0.10	20.0	110
SS-17D	9/19/2006	12.0	16.0	0.3	1.1	20.0	92.0	1.0	19.0	0.01	0.40	40.0	220
SS-17	12/14/2006	7.0	16.0	0.7	1.5	22.0	150	0.25	35.0	0.01	0.30	100	440
	Annual Mean:	**10.8**	**18.0**	**0.5**	**1.1**	**23.8**	**107.8**	**0.9**	**26.0**	**0.03**	**0.23**	**70.0**	**282.5**
SS-17D	3/20/2007	11.0	17.0	0.4	0.8	30.0	79.0	1.2	18.0	0.10	0.10	90.0	180
SS-17D	6/4/2007	10.0	13.0	0.2	0.5	23.0	57.0	0.6	17.0	0.10	0.10	5.00	110
SS-17D	9/20/2007	11.0	13.0	0.3	0.6	29.0	68.0	0.8	9.4	0.01	0.11	50.0	120
SS-17D	12/20/2007	8.0	11.0	0.8	1.1	27.0	61.0	0.25	7.3	0.01	0.06	270	300
	Annual Mean:	**10.0**	**13.5**	**0.4**	**0.8**	**27.3**	**66.3**	**0.7**	**12.9**	**0.05**	**0.09**	**104**	**178**
SS-17D	3/24/2008	8.0	11.0	0.5	0.8	29.0	56.0	0.6	8.9	0.01	0.08	70.0	180
SS-17D	6/30/2008	7.0	16.0	0.05	0.4	10.0	43.0	0.25	8.1	0.01	0.05	10.0	80.0
SS-17D	9/16/2008	11.0	15.0	0.4	0.8	24.0	48.0	0.25	7.0	0.03	0.03	20.0	130
SS-17D	12/09/2008	6.6	6.8	0.5	0.5	17.4	23.6	0.3	2.0	0.01	0.01	172	182
	Annual Mean:	**8.2**	**12.2**	**0.4**	**0.6**	**20.1**	**42.7**	**0.4**	**6.5**	**0.01**	**0.04**	**68.0**	**143**
Annual Mean from USGS data for 1993													
Station ID	12323600	---	29.8	---	2.2	---	248	---	34.3	---	---	---	569
Sampling Results for Low Flow (10-26-92) and High Flow (3-7-93) Events													
Low Flow Event		---	17.4	---	0.7	---	100	---	12.4	---	0.08	---	350
High Flow Event		---	403	---	9.3	---	1400	---	580	---	1.6	---	1640

--- Not sampled or data not available

State of Montana Sampling Results

TABLE 3 - Sediment Sampling Results

Sampling Site	Date	Arsenic, >.063 mm (mg/kg)	Arsenic, .063 mm to 1 mm (mg/kg)	Cadmium, >.063 mm (mg/kg)	Cadmium, .063 mm to 1 mm (mg/kg)	Copper, >.063 mm (mg/kg)	Copper, .063 mm to 1 mm (mg/kg)	Lead, >.063 mm (mg/kg)	Lead, .063 mm to 1 mm (mg/kg)	Mercury, >.063 mm (mg/kg)	Mercury, .063 mm to 1 mm (mg/kg)	Zinc, >.063 mm (mg/kg)	Zinc, .063 mm to 1 mm (mg/kg)
SS-07	6/11/2002	64.2	22.5	20.0	6.8	1,200	255	173	63.0	0.5	0.5	3,700	1,250
SS-07	1/8/2003	86.7	31.8	22.6	7.8	1,114	309	244	92.0	0.5	0.5	4,627	1,606
SS-07	3/14/2003	109	85.5	22.9	14.5	6,380	2,060	1,810	380	6.0	2.0	10,400	3,500
SS-07	10/7/2003	48.0	21.8	10.9	4.3	791	199	278	119	2.0	1.0	2,124	752
	Annual Mean:	**81.2**	**46.4**	**18.8**	**8.9**	**2,762**	**856**	**777**	**197**	**2.8**	**1.2**	**5,717**	**1,953**
SS-07	3/25/2004	134	50.0	36.0	10.0	2,720	1,460	437	228	2.6	0.9	6,510	2,270
SS-07	6/10/2004	84.0	50.0	27.0	10.0	1,770	1,460	358	228	2.0	0.9	4,450	2,270
SS-07	8/25/2004	119	70.0	40.0	8.0	2,660	1,940	477	304	3.1	2.3	7,200	3,590
SS-07	11/18/2004	165	74.0	0.8	1.1	7,150	2,670	519	244	4.6	1.5	7,930	2,220
	Annual Mean:	**126**	**61.0**	**26.0**	**7.3**	**3,575**	**1,883**	**448**	**251**	**3.1**	**1.4**	**6,523**	**2,588**
SS-07	11/30/2005	55.0	31.0	12.0	5.0	1,070	483	194	125	0.9	0.4	2,570	1,520
SS-07	6/27/2006	80.0	57.0	13.0	4.0	2,190	412	359	89.0	---	---	2980	845
SS-07	9/19/2006	85.0	21.0	18.0	3.0	1,330	245	247	65.0	1.0	---	3550	756
SS-07	12/14/2006	173	22.0	12.0	3.0	3,230	566	525	88.0	---	0.3	3970	727
	Annual Mean:	**113**	**33.3**	**14.3**	**3.3**	**2,250**	**408**	**377**	**80.7**	**1.0**	**0.3**	**3500**	**776**

TABLE 3 - Sediment Sampling Results

Sampling Site	Date	Arsenic, >.063 mm (mg/kg)	Arsenic, .063 mm to 1 mm (mg/kg)	Cadmium, >.063 mm (mg/kg)	Cadmium, .063 mm to 1 mm (mg/kg)	Copper, >.063 mm (mg/kg)	Copper, .063 mm to 1 mm (mg/kg)	Lead, >.063 mm (mg/kg)	Lead, .063 mm to 1 mm (mg/kg)	Mercury, >.063 mm (mg/kg)	Mercury, .063 mm to 1 mm (mg/kg)	Zinc, >.063 mm (mg/kg)	Zinc, .063 mm to 1 mm (mg/kg)
SS-07	3/20/2007	44.0	37.0	40.0	3.0	1,690	414	190	152	0.7	0.5	5730	744
SS-07	6/4/2007	52.0	14.0	35.0	5.0	1,240	348	258	78.0	0.8	0.3	2480	781
SS-07	9/20/2007	73.0	23.0	27.0	2.0	1,460	1,250	357	75.0	0.9	0.2	3020	716
SS-07	12/20/2007	108	22.0	25.0	2.0	1,620	155	598	93.0	2.1	0.1	2140	619
	Annual Mean:	**69.3**	**24.0**	**31.8**	**3.0**	**1,503**	**542**	**351**	**99.5**	**1.1**	**0.3**	**3343**	**715**
SS-07	3/24/2008	62.0	4.0	16.0	0.2	817	22.0	199	2.1	0.6	0.1	1,850	50.0
SS-07	6/30/2008	121	6.0	17.0	0.2	1,470	39.0	350	1.9	0.7	0.1	2,360	90.0
SS-07	9/17/2008	40.0	5.0	40.0	0.1	2,160	8.0	328	0.1	2.0	0.2	3,650	40.0
SS-07	12/9/2008	56.4	29.7	13.8	1.8	798	154.0	330	153.0	0.8	0.2	1,940	682.0
	Annual Mean:	**69.9**	**11.2**	**21.7**	**0.6**	**1,311**	**55.8**	**302**	**39.3**	**1.0**	**0.1**	**2,450**	**215.5**
SS-08A	6/11/2002	96.9	62.2	12.4	9.2	917	568	418	278	4.0	3.0	2,460	1,660
SS-08A	1/8/2003	65.5	57.8	16.4	16.6	1,698	1,158	327	305	2.0	2.0	2,979	2,622
SS-08A	3/18/2003	61.6	59.7	4.6	2.9	1,210	1,300	598	142	3.0	1.0	1,370	1,490
SS-08A	10/7/2003	250	74.7	54.5	8.6	7,849	1,564	784	177	12.0	1.0	7,325	1,710
	Annual Mean:	**126**	**64.1**	**25.2**	**9.4**	**3,586**	**1,341**	**570**	**208**	**5.7**	**1.3**	**3,891**	**1,941**
SS-08A	3/24/2004	51.0	35.0	15.0	7.0	1,030	455	296	151	2.8	1.1	2,390	1,130
SS-08A	6/10/2004	55.0	43.0	18.0	8.0	844	408	275	149	2.4	1.0	2,870	1,460
SS-08A	8/25/2004	49.0	25.0	16.0	11.0	742	483	279	189	3.0	2.4	2,540	1,830
SS-08A	11/18/2004	35.0	24.0	10.0	8.0	632	366	240	134	2.1	1.1	2,040	1,310
	Annual Mean:	**47.5**	**31.8**	**14.8**	**8.5**	**812**	**428**	**273**	**156**	**2.6**	**1.4**	**2,460.0**	**1,432.5**

TABLE 3 - Sediment Sampling Results

Sampling Site	Date	Arsenic, >.063 mm (mg/kg)	Arsenic, .063 mm to 1 mm (mg/kg)	Cadmium, >.063 mm (mg/kg)	Cadmium, .063 mm to 1 mm (mg/kg)	Copper, >.063 mm (mg/kg)	Copper, .063 mm to 1 mm (mg/kg)	Lead, >.063 mm (mg/kg)	Lead, .063 mm to 1 mm (mg/kg)	Mercury, >.063 mm (mg/kg)	Mercury, .063 mm to 1 mm (mg/kg)	Zinc, >.063 mm (mg/kg)	Zinc, .063 mm to 1 mm (mg/kg)
SS-08A	11/30/2005	57.0	25.0	7.0	5.0	1,310	649	291	170	2.6	2.0	1800	1340
SS-08	6/27/2006	123	161	10.0	11.0	1,960	1,700	0.3	1.6	---	---	3,170	3,570
SS-08	9/19/2006	210	281	8.0	11.0	5,510	2,070	1860	709	7.7	---	5,240	5,170
SS-08	12/14/2006	30.0	16.0	9.0	2.0	1,160	369	237	58.0	---	0.3	1,760	499
	Annual Mean:	**121**	**153**	**9.0**	**8.0**	**2,877**	**1,380**	**699**	**256**	**7.7**	**0.3**	**3,390**	**3,080**
SS-08	3/20/2007	33.0	20.0	6.0	3.0	492	230	184	107	1.5	1.3	1300	774
SS-08	6/4/2007	---	46.0	---	4.0	---	303	---	73.0	1.7	1.5	---	1100
SS-08	9/20/2007	37.0	61.0	12.0	2.0	804	399	266	61.0	3.8	1.1	2170	490
SS-08	12/20/2007	89.0	50.0	12.0	10.0	1710	297	467	109	4.5	0.7	2290	607
	Annual Mean:	**53.0**	**44.3**	**10.0**	**4.8**	**1002**	**307**	**306**	**87.5**	**2.9**	**1.2**	**1920**	**743**
SS-08	3/24/2008	68.0	31.0	9.0	1.5	1,060	208	366	68.0	2.8	0.5	1,940	472
SS-08	6/30/2008	50.0	42.0	12.0	3.0	840	419	300	97.0	1.2	1.1	2,270	996
SS-08	9/17/2008	54.0	56.0	5.0	3.0	786	383	341	96.0	3.4	0.9	1,510	766
SS-08	12/9/2008	52.1	31.1	9.8	4.7	704	421	293	136	1.2	0.7	1,640	955
	Annual Mean:	**56.0**	**40.0**	**9.0**	**3.1**	**848**	**358**	**325**	**99.3**	**2.2**	**0.8**	**1,840**	**797**
SS-10A	6/4/2007	15.0	10.0	2.0	2.0	180	84	37.0	18.0	0.1	0.1	427	205
SS-10A	9/20/2007	20.0	19.0	8.0	8.0	608	563	136	120	0.4	0.8	3430	2470
SS-10A	12/20/2007	38.0	12.0	9.0	3.0	599	180	188	55.0	1.6	0.4	1740	458
	Annual Mean:	**24.3**	**13.7**	**6.3**	**4.3**	**462**	**276**	**120**	**64.3**	**0.7**	**0.4**	**1866**	**1044**

TABLE 3 - Sediment Sampling Results

Sampling Site	Date	Arsenic, >.063 mm (mg/kg)	Arsenic, .063 mm to 1 mm (mg/kg)	Cadmium, >.063 mm (mg/kg)	Cadmium, .063 mm to 1 mm (mg/kg)	Copper, >.063 mm (mg/kg)	Copper, .063 mm to 1 mm (mg/kg)	Lead, >.063 mm (mg/kg)	Lead, .063 mm to 1 mm (mg/kg)	Mercury, >.063 mm (mg/kg)	Mercury, .063 mm to 1 mm (mg/kg)	Zinc, >.063 mm (mg/kg)	Zinc, .063 mm to 1 mm (mg/kg)
SS-10A	3/24/2008	24.0	5.0	6.0	1.0	760	545	102	24.0	0.7	0.1	1,890	328
SS-10A	6/30/2008	40.0	21.0	9.0	3.0	580	387	152	88.0	0.4	0.5	1,860	998
SS-10A	9/17/2008	40.0	5.0	11.0	4.0	442	253	120	66.0	1.2	0.4	1,910	796
SS-10A	12/9/2008	49.1	28.5	11.2	7.1	652	469	209	131	6.5	0.4	1,770	1,220
	Annual Mean:	**38.3**	**14.9**	**9.3**	**3.8**	**609**	**414**	**146**	**77.3**	**2.2**	**0.3**	**1,858**	**836**
SS-10B	6/11/2004	49.0	16.0	16.0	4.0	838	183	218	65.0	1.5	0.4	2580	751
SS-10B	11/19/2004	17.0	5.0	8.0	1.0	443	76.0	108	26.0	0.7	0.3	1380	356
	Annual Mean:	**33.0**	**10.5**	**12.0**	**2.5**	**641**	**130**	**163**	**45.5**	**1.1**	**0.3**	**1,980**	**554**
SS-10B	11/29/2005	5.0	5.0	1.0	1.0	298	119	61.0	35.0	0.3	0.1	835	430
SS-10B	12/14/2006	33.0	10.0	12.0	10.0	838	376	209	85.0	---	---	2,090	892
SS-10B	3/20/2007	27.0	10.0	9.0	2.0	450	30.0	114	11.0	0.5	0.5	1920	144
SS-10B	6/4/2007	10.0	10.0	3.0	2.0	207	30.0	59.0	12.0	0.2	0.1	608	94
SS-10B	9/20/2007	23.0	10.0	8.0	5.0	548	267	144	70.0	0.7	0.4	2030	919
SS-10B	12/20/2007	37.0	17.0	9.0	4.0	593	234	161	66.0	1.4	0.4	1680	680
	Annual Mean:	**24.3**	**11.8**	**7.3**	**3.3**	**450**	**140**	**120**	**39.8**	**0.7**	**0.4**	**1560**	**459**
SS-10B	3/24/2008	35.0	5.0	8.0	3.0	609	154	160	41.0	1.1	0.1	1,530	404
SS-10B	6/30/2008	27.0	5.0	7.0	1.0	410	106	144	32.0	0.5	0.1	1,400	293
SS-10B	9/17/2008	30.0	5.0	8.0	1.0	602	80	198	31.0	1.3	0.1	1,640	242
SS-10B	12/09/2008	43.1	10.3	8.4	2.2	574	150	192	46.4	0.9	0.3	1,640	413
	Annual Mean:	**33.8**	**6.3**	**7.9**	**1.8**	**549**	**123**	**174**	**37.6**	**0.9**	**0.1**	**1,553**	**338**

TABLE 3 - Sediment Sampling Results

Sampling Site	Date	Arsenic, >.063 mm (mg/kg)	Arsenic, .063 mm to 1 mm (mg/kg)	Cadmium, >.063 mm (mg/kg)	Cadmium, .063 mm to 1 mm (mg/kg)	Copper, >.063 mm (mg/kg)	Copper, .063 mm to 1 mm (mg/kg)	Lead, >.063 mm (mg/kg)	Lead, .063 mm to 1 mm (mg/kg)	Mercury, >.063 mm (mg/kg)	Mercury, .063 mm to 1 mm (mg/kg)	Zinc, >.063 mm (mg/kg)	Zinc, .063 mm to 1 mm (mg/kg)
SS11C	3/20/2007	10.0	10.0	6.0	2.0	306	14.0	70.0	10.0	0.5	0.5	1280	51.0
SS11C	6/4/2007	26.0	10.0	9.0	2.0	422	63.0	85.0	16.0	0.5	0.1	1500	204
SS11C	9/20/2007	30.0	10.0	10.0	2.0	538	70.0	96.0	49.0	2.0	0.1	2160	250
SS11C	12/20/2007	17.0	50.0	9.0	10.0	361	23.0	65.0	10.0	0.5	0.1	1090	95.0
	Annual Mean:	**20.8**	**20.0**	**8.5**	**4.0**	**407**	**42.5**	**79.0**	**21.3**	**0.9**	**0.2**	**1508**	**150**
SS11C	3/24/2008	35.0	5.0	8.0	3.0	609	154	160	41.0	1.1	0.1	1,530	404
SS11C	6/30/2008	27.0	5.0	7.0	1.0	410	106	144	32.0	0.5	0.1	1,440	293
SS11C	9/17/2008	30.0	5.0	8.0	1.0	602	80.0	198	31.0	1.3	0.1	1,640	242
SS11C	12/09/2008	28.6	8.2	7.8	2.0	384	91.3	100	24.7	0.8	0.1	1,540	326
	Annual Mean:	**30.2**	**5.8**	**7.7**	**1.8**	**501**	**108**	**151**	**32.2**	**0.9**	**0.1**	**1,538**	**316**
SS11D	3/20/2007	10.0	10.0	2.0	2.0	128	25.0	49.0	10.0	0.5	0.5	243	39.0
SS11D	6/4/2007	22.0	10.0	9.0	2.0	401	90.0	80.0	14.0	0.5	0.1	1570	197
SS11D	9/20/2007	20.0	10.0	3.0	2.0	128	49.0	26.0	15.0	0.1	0.6	532	197
SS11D	12/20/2007	25.0	10.0	10.0	2.0	478	82.0	87.0	20.0	0.6	0.1	1520	247
	Annual Mean:	**19.3**	**10.0**	**6.0**	**2.0**	**284**	**61.5**	**60.5**	**14.8**	**0.4**	**0.3**	**966**	**170**
SS11D	3/24/2008	11.0	5.0	7.0	1.0	299	32.0	61.0	61.0	0.3	0.1	1,150	116
SS11D	6/30/2008	15.0	5.0	7.0	1.0	250	71.0	95.0	24.0	0.1	0.1	1,120	238
SS11D	9/17/2008	10.0	5.0	8.0	1.0	395	40.0	130	23.0	1.0	0.1	625	106
SS11D	12/09/2008	28.6	4.8	9.8	1.1	402	44.9	119	13.7	0.8	0.1	1,230	153
	Annual Mean:	**16.2**	**5.0**	**8.0**	**1.0**	**337**	**47.0**	**101**	**30.4**	**0.5**	**0.1**	**1,031**	**153**

TABLE 3 - Sediment Sampling Results

Sampling Site	Date	Arsenic, >.063 mm (mg/kg)	Arsenic, .063 mm to 1 mm (mg/kg)	Cadmium, >.063 mm (mg/kg)	Cadmium, .063 mm to 1 mm (mg/kg)	Copper, >.063 mm (mg/kg)	Copper, .063 mm to 1 mm (mg/kg)	Lead, >.063 mm (mg/kg)	Lead, .063 mm to 1 mm (mg/kg)	Mercury, >.063 mm (mg/kg)	Mercury, .063 mm to 1 mm (mg/kg)	Zinc, >.063 mm (mg/kg)	Zinc, .063 mm to 1 mm (mg/kg)
SS-15A	3/20/2007	139	90.0	10.0	2.0	2,170	364	837	138	0.5	0.7	3490	1040
SS-15A	6/4/2007	---	94.0	---	5.0	---	422	---	188	4.9	0.8	---	1240
SS-15A	9/20/2007	210	63.0	23.0	2.0	2,930	233	756	340	6.0	0.2	4860	766
	Annual Mean:	**174.5**	**82.3**	**16.5**	**3.0**	**2,550**	**340**	**797**	**222**	**3.8**	**0.6**	**4175**	**1015**
SS-15A	3/24/2008	275	80.0	18.0	3.0	2,410	353	943	171	7.3	1.0	3,980	876
SS-15A	6/30/2008	250	120	11.0	5.0	2,180	651	900	215	5.8	0.9	3,480	2,320
SS-15A	9/16/2008	110	92.0	36.0	5.0	2,590	536	600	226	5.0	1.1	5,470	1,490
SS-15A	12/09/2008	230	97.6	23.6	3.7	2,630	359	825	177	---	0.4	4,170	201
	Annual Mean:	**216**	**97.4**	**22.2**	**4.2**	**2,453**	**475**	**817**	**197**	**6.0**	**0.9**	**4,275**	**1,222**
SS-15B	3/20/2007	143.0	87.0	15.0	6.0	2140	699	698	310	4.0	2.4	3070	1810
SS-15B	6/4/2007	---	74.0	---	9.0	---	387	---	216	6.3	0.6	---	2360
SS-15B	9/20/2007	175.0	104.0	13.0	2.0	3080	406	601	141	---	0.3	4140.0	691
	Annual Mean:	**159.0**	**88.3**	**14.0**	**5.7**	**2610**	**497**	**650**	**222**	**5.2**	**1.1**	**3,605**	**1620**
SS-15B	3/24/2008	176	79.0	16.0	4.0	2,140	503	699	231	5.8	1.3	3,460	1,240
SS-15B	6/30/2008	182	61.0	12.0	1.0	1,440	249	460	144	4.2	0.4	2,430	716
SS-15B	9/16/2008	132	88.0	35.0	5.0	2,980	493	776	215	6.4	1.1	5,400	1,560
SS-15B	12/09/2008	247	79.5	13.4	3.3	2,150	501	965	244	6.1	0.8	2,870	1,220
	Annual Mean:	**184**	**76.9**	**19.1**	**3.3**	**2,178**	**437**	**725**	**209**	**5.6**	**0.9**	**3,540**	**1,184**

TABLE 3 - Sediment Sampling Results

Sampling Site	Date	Arsenic, >.063 mm (mg/kg)	Arsenic, .063 mm to 1 mm (mg/kg)	Cadmium, >.063 mm (mg/kg)	Cadmium, .063 mm to 1 mm (mg/kg)	Copper, >.063 mm (mg/kg)	Copper, .063 mm to 1 mm (mg/kg)	Lead, >.063 mm (mg/kg)	Lead, .063 mm to 1 mm (mg/kg)	Mercury, >.063 mm (mg/kg)	Mercury, .063 mm to 1 mm (mg/kg)	Zinc, >.063 mm (mg/kg)	Zinc, .063 mm to 1 mm (mg/kg)
SS-17	6/11/2004	152	101	10.0	6.0	1580	811	511	290	3.8	2.0	3530	2,000
SS-17	6/8/2005	184	98.0	7.0	4.0	1,050	439	526	202	3.8	1.1	2220	1,260
SS-17	11/29/2005	133	94.0	10.0	4.0	1,780	652	358	191	2.6	0.9	3820	1,720
	Annual Mean:	**159**	**96.0**	**8.5**	**4.0**	**1,415**	**546**	**442**	**197**	**3.2**	**1.0**	**3,020**	**1,490**
SS-17D	6/27/2006	159	102	11.0	4.0	1,820	518	533	165	---	---	3,610	1,070
SS-17D	9/19/2006	184	56.0	14.0	4.0	1,400	440	462	144	3.3	---	3,960	1,270
SS-17D	12/14/2006		55.0		4.0		293		114	---	0.3	1,210	514
	Annual Mean:	**172**	**71**	**12.5**	**4.0**	**1,610**	**417**	**498**	**141**	**3.3**	**0.3**	**2,927**	**951**
SS-17D	3/20/2007	143.0	66.0	6.0	2.0	826	318	340	125	0.7	0.5	2160	863
SS-17D	6/4/2007	138.0	67.0	12.0	3.0	1610	286	415	132	2.9	0.5	3260	921
SS-17D	9/20/2007	106.0	73.0	14.0	3.0	1720	357	414	126	2.8	0.5	3530	1180
	Annual Mean:	**129.0**	**68.7**	**10.7**	**2.7**	**1385**	**320**	**390**	**128**	**2.1**	**0.5**	**2983**	**988**
SS-17D	3/24/2008	109	64.0	10.0	2.0	1,130	256	303	102	2.4	0.3	2,360	817
SS-17D	6/30/2008	140	75.0	11.0	3.0	1,170	371	390	143	2.7	0.6	2,500	1,300
SS-17D	9/16/2008	140	67.0	20.0	3.0	1,900	313	537	134	3.6	0.6	3,720	1,050
SS-17D	12/09/2008	123	88.6	9.6	4.6	952	356	386	197	2.9	0.4	2,960	1,520
	Annual Mean:	**128**	**73.7**	**12.7**	**3.2**	**1,288**	**324**	**404**	**144**	**2.9**	**0.5**	**2,885**	**1,172**

--- Not sampled or data not available

USGS Surface Water Quality Data

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (μg/L)	As, unfiltered (μg/L)	Cd, filtered (μg/L)	Cd, unfiltered (μg/L)	Cu, filtered (μg/L)	Cu, unfiltered, recoverable (μg/L)	Pb, filtered (μg/L)	Pb, unfiltered, recoverable (μg/L)	Zn, filtered (μg/L)	Zn, unfiltered, recoverable (μg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323250	3/8/1993	21	10	17	2.4	3	80	200	1.2	18	900	1000	16	0.91
12323250	4/12/1993	30	5	21	2.4	4	85	360	0.8	84	780	1200	104	8.4
12323250	4/26/1993	37	6	39	2.1	6	65	550	2.4	250	750	1600	162	16
12323250	5/14/1993	24	7	17	2.4	4	120	300	0.9	35	930	1100	28	1.8
12323250	5/24/1993	20	8	12	1.9	2	85	130	0.25	7	710	790	7	0.38
12323250	6/6/1993	21	7	11	2.1	3	90	150	0.25	7	790	950	6	0.34
12323250	7/12/1993	22	9	14	2.3	2	110	140	0.25	3	800	850	5	0.3
12323250	8/16/1993	30	9	15	2.6	3	120	190	1.4	13	930	1000	11	0.89
12323250	10/28/1993	29	9	18	2.8	3	120	250	1.0	31	1000	1100	29	2.3
	Annual Mean:	**26.0**	**7.8**	**18.2**	**2.3**	**3.3**	**97.2**	**252.2**	**0.9**	**49.8**	**843.3**	**1065.6**	**40.9**	**3.5**
12323250	2/15/1994	15	6	22	1.5	4	47	320	0.8	42	590	940	37	1.5
12323250	3/8/1994	19	5	10	1.6	2	60	100	1.0	10	610	730	16	0.82
12323250	4/11/1994	26	8	11	1.4	2	54	100	0.25	4	490	550	6	0.42
12323250	4/25/1994	52	8	20	1.3	2	70	210	1.9	62	460	700	49	6.9
12323250	5/12/1994	28	10	14	1.3	2	53	93	0.5	6	540	650	8	0.6
12323250	5/20/1994	41	8	15	1.3	2	75	140	1.1	12	460	570	19	2.1
12323250	6/13/1994	26	8	13	1.6	2	67	130	0.6	18	550	660	17	1.2
12323250	7/11/1994	22	7	18	2.4	2	93	130	0.25	4	810	900	6	0.36
12323250	8/17/1994	17	6	10	6.2	6	47	85	0.25	7	2200	2200	3	0.14
12323250	11/28/1994	19	8	22	0.5	4	22	220	0.25	48	580	1200	64	3.3
	Annual Mean:	**26.5**	**7.4**	**15.5**	**1.9**	**2.8**	**58.8**	**152.8**	**0.7**	**21.3**	**729.0**	**910.0**	**22.5**	**1.7**
12323250	2/6/1995	21	5	18	1.3	3	45	170	2	34	670	900	31	1.8
12323250	3/9/1995	23	10	22	1.6	2	50	170	0.25	21	600	730	32	2
12323250	4/10/1995	35	8	23	2.5	4	50	290	0.9	110	850	1200	125	12
12323250	4/28/1995	26	9	12	1.9	2	71	110	0.25	9	710	770	12	0.84
12323250	5/8/1995	65	7	22	0.9	2	53	160	1.5	48	330	530	94	16
12323250	5/22/1995	54	9	18	0.9	1	50	91	1.2	16	320	380	---	---
12323250	6/5/1995	93	13	28	0.5	2	42	150	2.2	60	200	350	99	25
12323250	7/11/1995	35	11	22	2.2	3	70	150	0.8	28	710	870	25	2.4
12323250	8/7/1995	25	10	18	2.9	3	100	190	0.25	7	960	1100	11	0.74
	Annual Mean:	**41.9**	**9.1**	**20.3**	**1.6**	**2.4**	**59.0**	**164.6**	**1.0**	**37.0**	**594.4**	**758.9**	**53.6**	**7.6**
12323250	12/9/1996	23	6	13	3.4	4	120	220	0.25	4	1200	1300	9	0.56
12323250	3/3/1997	22	4	14	3.2	3	160	300	0.25	13	1000	1200	11	0.65
12323250	3/20/1997	134	9	45	1.5	3.6	115	365	1.9	127	488	980	194	70

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (µg/L)	As, unfiltered (µg/L)	Cd, filtered (µg/L)	Cd, unfiltered (µg/L)	Cu, filtered (µg/L)	Cu, unfiltered, recoverable (µg/L)	Pb, filtered (µg/L)	Pb, unfiltered, recoverable (µg/L)	Zn, filtered (µg/L)	Zn, unfiltered, recoverable (µg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323250	4/21/1997	42	5	11	5.4	5.6	246	303	0.8	6	1500	1600	12	1.4
12323250	5/5/1997	40	5	10	3.2	3.5	133	190	0.25	3.9	943	980	11	1.2
12323250	6/4/1997	41	5	12	5.4	5.4	303	430	1.6	9.8	1540	1540	11	1.2
12323250	6/25/1997	46	5	11	4.1	4.5	114	205	0.25	5	1240	1310	15	1.9
12323250	8/4/1997	31	5	11	5.8	5.9	98.1	179	0.6	7.5	1770	1800	6	0.5
12323250	11/3/1997	24	8	21	0.9	1.6	18.8	147	0.3	44.8	320	480	71	4.6
	Annual Mean:	**47.5**	**5.8**	**16.9**	**3.7**	**4.1**	**148.5**	**264.9**	**0.7**	**27.1**	**1100.1**	**1236.3**	**41.4**	**10.2**
12323250	3/11/1998	22	5	9	1.1	1.8	19.7	81.6	0.3	11.3	367	470	16	0.95
12323250	4/14/1998	40	4	8	3.5	3.6	77	89	1.0	5.8	918	960	12	1.3
12323250	5/1/1998	42	6	12	1.3	1.7	33.5	68	M	10.6	366	430	51	5.8
12323250	5/12/1998	38	6	10	1.2	1.3	28.5	55	M	12	328	380	13	1.3
12323250	5/29/1998	39	8	19	1.5	2.6	34	106	1.0	27.6	424	640	405	43
12323250	6/26/1998	73	8	13	1.4	1.8	32.1	81.5	1.0	14.9	358	460	28	5.5
12323250	8/21/1998	24	7	8	1.8	1.8	21.1	47	0.3	2.6	520	570	6	0.39
12323250	11/17/1998	28	6	10	1.5	2.1	14.3	72.8	0.25	8.8	503	540	14	1.1
	Annual Mean:	**38.3**	**6.3**	**11.1**	**1.7**	**2.1**	**32.5**	**75.1**	**0.6**	**11.7**	**473.0**	**556.3**	**68.1**	**7.4**
12323250	2/22/1999	21	6	10	0.9	1.7	12	81.9	0.25	10.4	426	500	20	1.1
12323250	4/27/1999	30	6	9	0.7	0.5	12.9	40.7	0.25	4.8	209	254	13	1.1
12323250	5/12/1999	30	7	8	0.7	0.5	14.1	40	0.25	3.7	223	265	11	0.89
12323250	5/30/1999	75	13	20	0.9	1.6	50.5	129	M	19.5	240	352	35	7.1
12323250	6/22/1999	29	9	11	1.2	1.4	19.2	41.2	0.25	3.1	372	398	6	0.47
12323250	8/12/1999	30	8	11	1.4	1.4	32.6	55.3	0.25	4.9	343	396	6	0.49
12323250	11/15/1999	21	8	13	0.2	1.3	6.9	82	0.5	35.6	118	285	19	1.1
	Annual Mean:	**33.7**	**8.1**	**11.7**	**0.9**	**1.2**	**21.2**	**67.2**	**0.3**	**11.7**	**275.9**	**350.0**	**15.7**	**1.8**

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (μg/L)	As, unfiltered (μg/L)	Cd, filtered (μg/L)	Cd, unfiltered (μg/L)	Cu, filtered (μg/L)	Cu, unfiltered, recoverable (μg/L)	Pb, filtered (μg/L)	Pb, unfiltered, recoverable (μg/L)	Zn, filtered (μg/L)	Zn, unfiltered, recoverable (μg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323250	3/6/2000	23	6.5	11	1.1	2	20	75.9	0.5	13.9	301	426	20	1.2
12323250	4/4/2000	24	6.6	10	0.7	1.6	16	53.6	0.5	15.3	237	319	18	1.2
12323250	5/9/2000	22	6.9	9	0.8	1.1	14.3	30.1	0.5	3.1	241	257	9	0.53
12323250	5/22/2000	21	7.1	8	0.7	1	39.1	25.6	0.5	1.97	248	254	6	0.34
12323250	6/4/2000	16	9.3	10	0.7	0.9	15.6	27.1	M	2.1	155	178	4	0.17
12323250	7/21/2000	14	7.1	10	1.2	1.1	13.3	30.7	0.5	1.4	266	292	4	0.16
12323250	9/1/2000	13	7.3	7	0.8	0.7	9.2	15.7	0.5	1.09	217	234	4	0.14
12323250	10/30/2000	24	5.1	12	0.8	1.6	15.3	65.5	0.5	18.3	277	419	48	3.1
	Annual Mean:	**19.6**	**7.0**	**9.6**	**0.9**	**1.3**	**17.9**	**40.5**	**0.5**	**7.1**	**242.8**	**297.4**	**14.1**	**0.9**
12323250	1/6/2001	13	5.1	10	0.7	1.3	6.3	37.4	0.5	8.76	267	334	26	0.91
12323250	3/28/2001	24	6.3	8	1	1.2	23.8	36.9	0.5	2.32	325	376	10	0.65
12323250	5/2/2001	30	5.4	8	0.5	0.7	12.3	23	0.5	2.92	181	191	13	1.1
12323250	5/22/2001	18	6.6	8	0.8	0.9	15.5	24.6	0.5	1.72	240	235	8	0.39
12323250	6/4/2001	36	7.3	10	0.9	1.2	21.4	51.2	M	7.37	313	366	24	2.3
12323250	7/23/2001	18	8.9	13	0.6	0.7	12.2	20.9	0.5	1.05	198	209	3	0.15
12323250	9/4/2001	14	8.1	9	0.6	0.7	11.3	23.2	0.5	1.65	303	334	8	0.3
12323250	11/6/2001	18	7.5	11	1.2	1.5	13.8	36	0.5	4.18	309	374	14	0.68
	Annual Mean:	**21.4**	**6.9**	**9.6**	**0.8**	**1.0**	**14.6**	**31.7**	**0.5**	**3.7**	**267.0**	**302.4**	**13.3**	**0.8**
12323250	3/14/2002	18	7.8	9	0.05	0.4	4.5	28.3	0.24	7.42	89.7	128	19	0.92
12323250	4/8/2002	21	4.3	6	0.2	0.3	10.5	23.3	0.32	3.88	94	106	12	0.68
12323250	5/6/2002	18	4.6	4	0.2	0.3	8.9	18.8	0.2	2.18	86.4	107	11	0.53
12323250	5/29/2002	18	5.5	6	0.12	0.21	5.3	16	0.15	1.46	81.5	91	7	0.34
12323250	6/3/2002	27	7.3	9	0.14	0.36	10.9	23.6	0.46	4.65	60.4	93	14	1
12323250	6/24/2002	16	7.7	8	0.2	0.24	9.2	16.6	0.12	1.54	65.6	88	11	0.48
12323250	8/20/2002	16	7.4	9	0.11	0.18	8.1	13.5	0.17	0.5	70.7	86	5	0.22
	Annual Mean:	**19.1**	**6.4**	**7.3**	**0.1**	**0.28**	**8.2**	**20.0**	**0.2**	**3.1**	**78.3**	**99.9**	**11.3**	**0.6**

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (μg/L)	As, unfiltered (μg/L)	Cd, filtered (μg/L)	Cd, unfiltered (μg/L)	Cu, filtered (μg/L)	Cu, unfiltered, recoverable (μg/L)	Pb, filtered (μg/L)	Pb, unfiltered, recoverable (μg/L)	Zn, filtered (μg/L)	Zn, unfiltered, recoverable (μg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323250	3/17/2003	29	6.4	9	0.25	0.52	10.3	32.3	0.79	7.38	110	169	24	1.9
12323250	4/2/2003	31	5.2	8	0.23	0.4	14.1	35.8	0.74	10.5	86	139	39	3.3
12323250	4/28/2003	28	5.3	6	0.24	0.28	10.9	17.2	0.3	1.6	102	111	7	0.53
12323250	5/26/2003	20	6.4	8	0.24	0.3	12.2	21.8	0.24	1.89	80	107	7	0.38
12323250	6/3/2003	18	7.5	9	0.13	0.24	12.2	21.3	0.19	1.53	47	77	6	0.29
12323250	6/16/2003	15	5.4	6	0.23	0.29	13.2	20	0.26	1.5	88.2	106	4	0.16
12323250	7/28/2003	14	6.4	6	0.09	0.11	8.4	15.6	0.2	0.65	33.9	45	4	0.15
12323250	8/25/2003	16	5.6	6	0.15	0.17	9.8	16.2	0.24	1.03	58.6	66	2	0.09
12323250	11/17/2003	18	3.8	5	0.46	1.02	3.2	25.5	0.2	4.68	182	227	15	0.73
	Annual Mean:	**21.0**	**5.8**	**7.0**	**0.22**	**0.37**	**10.5**	**22.9**	**0.4**	**3.4**	**87.5**	**116.3**	**12.0**	**0.8**
12323250	3/17/2004	18	3.7	6	1.06	1.29	8.8	29.9	0.3	2.69	268	278	8	0.39
12323250	4/20/2004	18	4.7	5	1.07	1.13	15.7	26.3	0.23	2.29	242	247	11	0.53
12323250	5/17/2004	18	3.4	4	1.02	1.19	18.3	35.3	0.22	2.01	227	245	8	0.39
12323250	6/1/2004	17	4.6	6	0.87	1.07	12.4	21.2	0.13	1.72	162	186	6	0.28
12323250	6/13/2004	15	3.3	5	1.54	1.78	15	29.1	0.12	1.33	326	346	5	0.2
12323250	7/19/2004	15	4.9	5	1.27	1.29	15.1	24.7	0.22	0.85	314	308	3	0.12
12323250	8/20/2004	15	4.6	5	2.02	1.9	23.9	27.8	0.18	0.74	478	473	3	0.12
12323250	12/15/2004	16	2.9	3	0.97	1.18	10.2	42.1	0.26	2.27	277	286	10	0.43
	Annual Mean:	**16.5**	**4.0**	**4.9**	**1.2**	**1.4**	**14.9**	**29.6**	**0.21**	**1.7**	**286.8**	**296.1**	**6.8**	**0.3**
12323250	3/9/2005	16	2.3	3	1.18	1.54	9.1	61.9	0.3	2.73	284	323	9	0.39
12323250	4/18/2005	21	3.6	4	0.16	0.26	11.3	21.8	0.33	1.68	54	68	5	0.28
12323250	5/16/2005	38	5.7	9	0.1	0.22	12.1	22.5	0.37	2.41	27.8	47	10	1
12323250	6/1/2005	67	6.9	19	0.12	1.39	14	111	0.68	31	35.3	230	97	18
12323250	6/13/2005	34	6.2	7	0.09	0.2	10.2	18.8	0.26	2.27	27.2	38	9	0.83
12323250	7/25/2005	16	5.6	6.5	0.12	0.18	11.9	18.4	0.27	1.11	26.7	38	5	0.22
12323250	8/23/2005	15	5.7	6.4	0.1	0.14	11.6	17.3	0.27	1.09	31.9	43	4	0.16
12323250	10/17/2005	17	4.2	4.9	0.13	0.16	7.7	14.1	0.19	1.27	36	46	6	0.28
	Annual Mean:	**28.0**	**5.0**	**7.5**	**0.3**	**0.5**	**11.0**	**35.7**	**0.3**	**5.4**	**65.4**	**104.1**	**18.1**	**2.6**

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (μg/L)	As, unfiltered (μg/L)	Cd, filtered (μg/L)	Cd, unfiltered (μg/L)	Cu, filtered (μg/L)	Cu, unfiltered, recoverable (μg/L)	Pb, filtered (μg/L)	Pb, unfiltered, recoverable (μg/L)	Zn, filtered (μg/L)	Zn, unfiltered, recoverable (μg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323250	3/20/2006	19	3.1	4	0.09	0.2	5.2	22.6	0.32	2.31	42.4	61	11	0.56
12323250	4/17/2006	54	6	7.9	0.11	0.23	14.4	22.5	0.46	3.19	40.2	48	12	1.7
12323250	5/8/2006	36	5	6.2	0.15	0.25	12	18.5	0.22	1.34	45.8	56	7	0.68
12323250	5/22/2006	27	7.6	9.7	0.12	0.23	13.4	20.4	0.31	2.01	33.4	45	8	0.58
12323250	6/8/2006	34	8.1	11.2	0.13	0.3	12.7	27.1	0.44	4.99	68.8	61	15	1.4
12323250	7/24/2006	15	5.2	5.7	0.17	0.21	13.9	18.7	0.23	0.77	47.8	55	2	0.08
12323250	8/23/2006	15	5.2	5.6	0.11	0.2	5.8	15.1	0.17	0.64	41.8	57	4	0.16
12323250	11/13/2006	19	3.6	4.5	0.12	0.22	8.9	18.7	0.15	1.99	46.3	58	7	0.36
	Annual Mean:	**27.4**	**5.5**	**6.9**	**0.13**	**0.230**	**10.8**	**20.5**	**0.3**	**2.2**	**45.8**	**55.1**	**8.3**	**0.7**
12323250	2/26/2007	19	3	4.1	0.16	0.26	13	24.5	0.27	2.3	60.7	75	9	0.46
12323250	3/26/2007	28	3.7	4.9	0.11	0.14	12.2	19.3	0.26	1.52	36	47	6	0.45
12323250	5/10/2007	25	5.1	6.3	0.12	0.2	12.4	22.1	0.33	3.47	41.8	59.3	10	0.68
12323250	6/5/2007	33	6.8	8.3	0.2	0.21	12.7	19.7	0.35	2.53	36	45.5	8	0.71
12323250	6/19/2007	33	6.6	8.2	0.08	0.14	11.3	16.7	0.27	1.73	30.9	41.5	7	0.62
12323250	7/24/2007	15	4.8	5.5	0.15	0.15	9.5	13.3	0.24	0.66	50.4	51.6	2	0.08
12323250	8/27/2007	15	4.8	5.4	0.07	0.12	8.5	10.5	0.18	0.71	36.4	38.3	3	0.12
12323250	11/6/2007	22	3.2	4.2	0.11	0.15	8.6	35.1	0.27	1.53	51.2	56.1	5	0.3
	Annual Mean:	**23.8**	**4.8**	**5.9**	**0.1**	**0.17**	**11.0**	**20.2**	**0.3**	**1.8**	**42.9**	**51.8**	**6.3**	**0.43**
12323250	3/3/2008	19	3	4.1	0.1	0.15	11.7	18.1	0.16	2.1	37.8	46.4	10	0.51
12323250	4/7/2008	21	3	4.3	0.1	0.14	9.8	19.8	0.16	2	37.7	49.8	12	0.68
12323250	5/5/2008	37	4.8	6.2	0.05	0.11	10.9	21.3	0.27	1.69	24	31.9	9	0.9
12323250	6/2/2008	67	7.8	9.2	0.06	0.13	9.2	16.6	0.31	2.85	16	29.1	14	2.5
12323250	6/17/2008	73	9.3	10.8	0.06	0.1	8.4	14.8	0.3	2.15	18.3	31.1	10	2
12323250	7/7/2008	35	6.8	9.2	0.1	0.13	14	22.1	0.25	2.05	29.7	42.3	8	0.76
12323250	8/18/2008	15	4.5	5.1	0.08	0.09	8.5	11.7	0.23	1.03	37.5	42.9	2	0.08
12323250	10/20/2008	29	3.6	3.9	0.1	0.14	5.9	9.5	0.17	1.61	28.5	36.8	5	0.39
	Annual Mean:	**37.0**	**5.4**	**6.6**	**0.1**	**0.1**	**9.8**	**16.7**	**0.23**	**1.9**	**28.7**	**38.8**	**8.8**	**1.0**
12323250	3/22/2009	33	5.2	7	0.1	0.2	9.1	20	0.41	4.64	31.7	50.8	18	1.6
12323250	4/27/2009	34	3.9	4.9	0.09	0.1	7.4	12.7	0.23	1.35	26.8	32.9	6	0.55
12323250	5/18/2009	40	5.2	5.9	0.06	0.13	8	13.7	0.26	1.71	24.2	28.8	9	0.97
12323250	6/1/2009	33	6.2	8.1	0.06	0.09	8	14.1	0.29	1.64	21	30.5	8	0.71
12323250	6/22/2009	55	8.6	10.5	0.19	0.25	18.3	31.4	0.34	3.32	59.4	81.4	13	1.9
12323250	7/13/2009	31	6.3	7.5	0.1	0.19	15.2	16.8	0.33	1.88	32.8	42.9	6	0.5
	Annual Mean:	**37.7**	**5.9**	**7.3**	**0.1**	**0.2**	**11.0**	**18.1**	**0.31**	**2.4**	**32.7**	**44.6**	**10.0**	**1.0**

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (μg/L)	As, unfiltered (μg/L)	Cd, filtered (μg/L)	Cd, unfiltered (μg/L)	Cu, filtered (μg/L)	Cu, unfiltered, recoverable (μg/L)	Pb, filtered (μg/L)	Pb, unfiltered, recoverable (μg/L)	Zn, filtered (μg/L)	Zn, unfiltered, recoverable (μg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323600	3/8/1993	56	34	140	2	6	180	980	2.3	200	620	1400	215	33
12323600	4/12/1993	51	6	17	1.7	2	46	150	0.25	15	370	610	10	1.4
12323600	4/26/1993	49	7	16	0.9	2	46	140	2.2	11	190	470	10	1.3
12323600	5/14/1993	108	13	26	0.7	2	49	190	0.25	26	220	400	40	12
12323600	5/24/1993	92	9	11	1	1	45	100	0.8	12	110	260	16	4
12323600	6/7/1993	104	7	16	1.4	2	70	180	0.25	15	430	600	16	4.5
12323600	7/12/1993	64	8	12	0.9	1	60	140	0.25	8	130	370	10	1.7
12323600	8/16/1993	50	9	18	1.4	2	160	210	0.6	10	180	420	6	0.81
12323600	10/28/1993	52	7	12	1.4	2	51	140	0.7	12	440	590	12	1.7
	Annual Mean:	**69.6**	**11.1**	**29.8**	**1.3**	**2.2**	**78.6**	**247.8**	**0.8**	**34.3**	**298.9**	**568.9**	**37.2**	**6.7**
12323600	2/18/1994	47	8	14	2.3	3	60	120	0.6	10	580	680	6	0.76
12323600	3/8/1994	37	10	18	1.5	2	60	140	0.7	18	380	520	12	1.2
12323600	4/11/1994	58	9	19	0.9	2	47	140	0.25	17	170	410	14	2.2
12323600	4/25/1994	133	10	24	1.1	2	70	210	1.2	36	310	480	37	13
12323600	5/12/1994	107	7	15	0.5	0.5	28	79	0.25	11	110	230	21	6.1
12323600	5/20/1994	143	11	29	1.1	2	75	220	0.7	41	320	580	51	20
12323600	6/13/1994	52	8	16	0.9	1	57	140	0.25	10	160	360	10	1.4
12323600	7/5/1994	51	1	170	41	49	450	3900	0.25	260	13000	15000	183	25
12323600	7/11/1994	56	7	15	1.1	1	48	96	0.25	13	200	370	10	1.5
12323600	8/17/1994	26	11	13	0.8	1	35	85	0.25	7	140	260	6	0.42
12323600	11/28/1994	33	8	16	0.7	1	25	92	0.25	16	390	640	24	2.1
	Annual Mean:	**67.5**	**8.2**	**31.7**	**4.7**	**5.9**	**86.8**	**475**	**0.5**	**39.9**	**1433**	**1775**	**34.0**	**6.7**
12323600	2/6/1995	62	14	34	1.4	3	63	300	2.3	62	400	740	53	8.9
12323600	3/9/1995	51	8	22	1.5	2	35	170	0.25	34	370	590	26	3.6
12323600	4/10/1995	75	7	22	1.1	2	30	160	0.7	39	250	460	28	5.7
12323600	4/28/1995	63	8	16	1.2	2	33	100	0.25	17	340	480	19	3.2
12323600	5/8/1995	189	9	44	1.2	3	66	320	2.1	87	320	630	176	90
12323600	5/22/1995	173	11	22	0.6	1	38	120	2	29	130	240	39	18
12323600	6/5/1995	315	11	100	1.2	4	100	560	2.7	190	260	700	258	219
12323600	7/11/1995	155	20	92	1.9	4	120	560	0.25	150	310	930	201	84
12323600	8/7/1995	49	9	22	1.7	3	80	260	0.25	11	260	630	10	1.3
	Annual Mean:	**125.8**	**10.8**	**41.6**	**1.3**	**2.7**	**62.8**	**283.3**	**1.2**	**68.8**	**293.3**	**600.0**	**90.0**	**48.2**

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (μg/L)	As, unfiltered (μg/L)	Cd, filtered (μg/L)	Cd, unfiltered (μg/L)	Cu, filtered (μg/L)	Cu, unfiltered, recoverable (μg/L)	Pb, filtered (μg/L)	Pb, unfiltered, recoverable (μg/L)	Zn, filtered (μg/L)	Zn, unfiltered, recoverable (μg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323600	12/9/1996	47	6	16	1.7	3	39	160	0.25	21	520	760	20	2.5
12323600	3/4/1997	44	8	19	2.4	3	46	200	0.25	23	660	910	27	3.2
12323600	3/20/1997	361	14	235	2.1	11.9	160	1930	5.1	650	581	2320	801	781
12323600	4/21/1997	103	9	27	1.7	2.6	68.3	222	0.7	42	431	720	66	18
12323600	5/6/1997	126	9	26	1.2	1.9	58.9	180	0.9	44.6	307	500	61	21
12323600	6/4/1997	296	11	22	0.8	1.7	50.8	165	1.5	31.7	183	390	109	87
12323600	6/25/1997	148	9	18	1.4	1.9	52.6	132	0.5	16.9	328	500	38	15
12323600	8/4/1997	59	8	17	2	3.3	54	185	0.25	14.4	213	780	10	1.6
12323600	11/3/1997	52	7	14	1.2	1.7	43.1	138	0.3	16.5	279	460	17	2.4
	Annual Mean:	**148.6**	**9.4**	**47.3**	**1.6**	**3.5**	**66.7**	**394.0**	**1.2**	**104.9**	**372.8**	**822.5**	**141.1**	**116.2**
12323600	3/11/1998	39	8	17	1.3	2.3	37.4	195	0.3	29.9	339	610	26	2.7
12323600	4/14/1998	65	7	16	1.8	2.6	47.3	158	M	21.8	419	660	21	3.7
12323600	5/1/1998	104	9	20	< 0.1	1.4	35.8	127	1	30.7	143	340	62	17
12323600	5/12/1998	83	9	15	0.5	1	29.6	101	0.3	16	124	270	23	5.2
12323600	5/28/1998	98	9	18	0.9	1.6	38.5	138	1	28.9	186	400	32	8.5
12323600	6/26/1998	140	10	27	1.4	2.5	84	262	2	58	324	620	76	29
12323600	8/21/1998	31	9	18	1.6	2.4	65	230	M	13.8	251	540	10	0.84
12323600	11/17/1998	45	8	14	1.5	1.9	36.7	101	0.3	12.2	431	530	9	1.1
	Annual Mean:	**75.6**	**8.6**	**18.1**	**1.3**	**2.0**	**46.8**	**164.0**	**0.8**	**26.4**	**277.1**	**496.3**	**32.4**	**8.5**
12323600	2/22/1999	36	10	19	1.6	2.4	31.8	159	0.25	21.8	425	560	21	2
12323600	4/27/1999	72	9	16	0.5	1	44	95.6	0.25	15	102	250	19	3.7
12323600	5/12/1999	67	10	12	0.6	1.1	33.6	83	0.25	10	134	260	13	2.4
12323600	5/30/1999	189	11	122	0.9	6.7	61	1150	2	307	289	1720	491	251
12323600	6/4/1999	207	10	60	1	3.8	61.6	623	3	132	293	1000	196	110
12323600	6/22/1999	88	9	13	0.7	0.5	33.6	80.1	0.25	9	158	237	13	3.1
12323600	8/12/1999	37	14	32	0.9	2.2	62.9	344	M	48.9	98	533	32	3.2
12323600	11/16/1999	35	11	17	1.1	1.4	31.3	87.2	0.5	16.7	352	469	11	1
	Annual Mean:	**91.4**	**10.5**	**36.4**	**0.9**	**2.4**	**45.0**	**327.7**	**0.9**	**70.1**	**231.4**	**628.6**	**99.5**	**47.1**

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (µg/L)	As, unfiltered (µg/L)	Cd, filtered (µg/L)	Cd, unfiltered (µg/L)	Cu, filtered (µg/L)	Cu, unfiltered, recoverable (µg/L)	Pb, filtered (µg/L)	Pb, unfiltered, recoverable (µg/L)	Zn, filtered (µg/L)	Zn, unfiltered, recoverable (µg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323600	3/6/2000	36	10.3	18	0.8	1.6	43	129	0.5	19.1	144	359	15	1.5
12323600	4/4/2000	39	12.1	18	0.6	0.65	32.4	109	0.5	19.3	95.5	301	17	1.8
12323600	5/9/2000	45	10.4	16	0.5	1.4	24.2	84.2	M	15.4	147	324	17	2.1
12323600	5/22/2000	45	8.7	13	0.3	0.7	19.4	62.2	0.5	11.7	55.5	190	14	1.7
12323600	6/4/2000	25	13.2	16	0.2	0.6	33.6	61.7	0.5	8.21	26.6	144	10	0.68
12323600	7/21/2000	15	15.6	22	0.3	0.7	25.5	65.1	0.5	7.04	70.7	169	7	0.28
12323600	9/1/2000	16	18.6	23	0.4	0.9	29.7	79.4	0.5	7.5	109	251	9	0.39
12323600	10/30/2000	31	8.4	15	0.7	1.3	39.1	122	0.5	12.8	202	403	12	1
	Annual Mean:	**31.5**	**12.2**	**17.6**	**0.5**	**1.0**	**30.9**	**89.1**	**0.5**	**12.6**	**106.3**	**267.6**	**12.6**	**1.2**
12323600	1/4/2001	36	8.9	17	1.3	1.8	36.1	145	0.5	22.5	406	538	17	1.7
12323600	3/28/2001	49	10.3	24	1.4	2.5	57.5	225	0.5	36.7	362	662	31	4.1
12323600	5/2/2001	67	9.7	18	0.4	1.3	19.8	121	0.5	23.8	178	323	28	5.1
12323600	5/22/2001	46	9.7	14	0.4	0.7	22	59.6	0.5	8.62	94.4	192	14	1.7
12323600	6/4/2001	74	9.3	47	0.7	4.6	40.2	684	3	151	397	1180	125	25
12323600	7/23/2001	23	15.4	28	0.5	1.2	42.1	156	0.5	14.9	40.6	245	8	0.5
12323600	9/4/2001	13	16.2	20	0.3	0.8	30.7	71.1	0.5	7.03	58.4	161	7	0.25
12323600	11/7/2001	27	9.1	16	1.3	2	30.1	101	0.5	11.8	487	656	13	0.95
	Annual Mean:	**41.9**	**11.1**	**23.0**	**0.8**	**1.9**	**34.8**	**195.3**	**0.8**	**34.5**	**252.9**	**494.6**	**30.4**	**4.9**
12323600	3/14/2002	29	13	16	1.4	1.6	43.7	102	0.3	14.3	343	405	14	1.1
12323600	4/8/2002	42	15.2	63	0.8	1.8	61.2	283	0.61	101	224	416	43	4.9
12323600	5/6/2002	39	11.3	16	0.4	0.8	29.3	85.8	0.33	14.6	77.5	221	14	1.5
12323600	5/29/2002	60	10.3	15	0.25	0.69	19.5	86.2	0.28	15	59.1	162	17	2.8
12323600	6/3/2002	94	11.3	21	0.38	1.34	31.5	154	0.88	32.3	95	287	35	8.9
12323600	6/24/2002	49	11.9	16	0.22	0.61	19.9	76.9	0.25	12.4	33.6	143	13	1.7
12323600	8/20/2002	14	18.7	23	0.46	0.89	40.7	98.5	0.4	7.11	29.1	151	7	0.26
	Annual Mean:	**46.7**	**13.1**	**24.3**	**0.6**	**1.1**	**35.1**	**126.6**	**0.4**	**28.1**	**123.0**	**255.0**	**20.4**	**3.0**
12323600	3/15/2003	176	14.7	91	2.08	5.22	142	860	3.17	269	491	1230	238	113
12323600	4/2/2003	61	11	27	1.45	2.23	69.7	214	1.38	52.9	336	539	56	9.2
12323600	4/28/2003	75	10.3	15	0.84	1.18	50	97	0.92	15.5	177	251	18	3.6
12323600	5/26/2003	101	11.5	14	0.37	0.78	28.5	73.9	0.39	12.4	59	163	28	7.6
12323600	6/3/2003	90	9.5	14	0.29	0.58	25.4	60.6	0.27	10.2	40	119	17	4.1
12323600	6/16/2003	39	12.5	15	0.35	0.69	30.4	61.1	0.31	7.47	38.2	139	9	0.95
12323600	7/28/2003	13	22.1	22	0.23	0.52	25.3	54.3	0.39	5.38	28.3	97	5	0.18
12323600	8/25/2003	17	19.3	28	0.78	1.31	37.8	95.2	0.26	7.43	81.9	204	6	0.28
12323600	11/17/2003	25	9.9	17	0.76	1.49	25.1	130	0.2	26.9	237	392	23	1.6
	Annual Mean:	**66.3**	**13.4**	**27.0**	**0.8**	**1.6**	**48.2**	**182.9**	**0.8**	**45.2**	**165.4**	**348.2**	**44.4**	**15.6**

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (μg/L)	As, unfiltered (μg/L)	Cd, filtered (μg/L)	Cd, unfiltered (μg/L)	Cu, filtered (μg/L)	Cu, unfiltered, recoverable (μg/L)	Pb, filtered (μg/L)	Pb, unfiltered, recoverable (μg/L)	Zn, filtered (μg/L)	Zn, unfiltered, recoverable (μg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323600	3/16/2004	35	12.1	15	0.85	1.18	46.2	107	0.33	13.1	129	228	10	0.95
12323600	4/20/2004	43	15.6	16	0.57	1.04	25.4	78	0.22	14.5	123	256	18	2.1
12323600	5/17/2004	38	10.8	17	0.42	1.08	22.1	94.5	0.3	19.4	115	283	21	2.2
12323600	6/1/2004	35	12.2	18	0.28	0.75	20	70.1	0.24	12.5	50.9	169	12	1.1
12323600	6/13/2004	30	12.1	17	0.27	0.8	18.5	68.4	0.29	12.2	81.8	203	13	1.1
12323600	7/19/2004	21	20.7	22	0.47	1.12	35.5	103	0.31	9.81	49.7	201	8	0.45
12323600	8/20/2004	16	16	24	1.57	3.04	67.2	216	0.27	14.7	204	517	12	0.52
12323600	12/15/2004	21	11	14	0.88	1.21	30	81.3	0.4	12.7	256	315	11	0.62
	Annual Mean:	**29.9**	**13.8**	**17.9**	**0.7**	**1.3**	**33.1**	**102.3**	**0.3**	**13.6**	**126.2**	**271.5**	**13.1**	**1.1**
12323600	3/8/2005	26	12.5	17	0.78	1.29	32.7	93.2	0.3	15.1	157	263	11	0.77
12323600	4/18/2005	37	12.4	17	0.39	0.94	23.1	87.8	0.23	14.5	65.1	216	13	1.3
12323600	5/17/2005	165	10.3	46	0.57	4.09	41	554	1.49	125	203	791	202	90
12323600	6/1/2005	119	9.5	80	0.49	3.87	36.2	472	0.93	149	147	1100	93	30
12323600	6/13/2005	95	10.8	16	0.24	0.79	24	93	0.96	17.6	77.2	159	18	4.6
12323600	7/26/2005	27	16.6	19.2	0.23	0.78	18.5	79.6	0.58	12.3	63.5	168	11	0.8
12323600	8/24/2005	17	13.7	18.3	2.72	3.85	60	206	0.4	13	611	856	14	0.64
12323600	10/18/2005	34	11.4	18.9	0.4	1.29	13.7	143	0.44	30	148	320	26	2.4
	Annual Mean:	**65.0**	**12.2**	**29.1**	**0.7**	**2.1**	**31.2**	**216**	**0.7**	**47.1**	**184**	**484**	**48.5**	**16.3**
12323600	3/20/2006	26	11.4	14.9	0.53	0.87	25.2	78.4	0.37	14.6	138	221	15	1.1
12323600	4/18/2006	113	11.5	20.7	0.85	1.52	57.1	141	1.69	30.6	274	329	38	12
12323600	5/9/2006	105	10.4	14.6	0.34	0.77	22.3	66	0.76	15.2	99.3	162	20	5.7
12323600	5/23/2006	101	10.3	14.7	0.24	0.72	15.7	70.8	0.54	18	62.4	142	29	7.9
12323600	6/13/2006	114	15	24.2	0.46	1.3	38.9	146	2.22	33.4	98.3	245	38	12
12323600	7/25/2006	18	18.2	20.6	0.22	0.71	20.8	69.5	0.57	12.4	42.1	139	14	0.68
12323600	8/24/2006	13	16.6	19	0.2	0.7	19.3	70.8	0.55	11.9	44.1	147	16	0.56
12323600	11/14/2006	34	8	10.6	0.55	0.96	18.9	65.4	0.25	10.7	214	274	16	1.5
	Annual Mean:	**65.5**	**12.7**	**17.4**	**0.4**	**0.9**	**27.3**	**88.5**	**0.9**	**18.4**	**122**	**207**	**23.3**	**5.2**
12323600	2/26/2007	32	8	10.1	0.77	0.94	25.5	61.4	0.27	8.6	194	251	13	1.1
12323600	3/27/2007	59	9.1	13.8	0.56	1.49	24.2	63.7	0.37	14.2	142	217	17	2.7
12323600	5/9/2007	59	9.5	12.4	0.24	0.6	18.6	59.5	0.33	13.1	49.4	136	20	3.2
12323600	6/5/2007	80	10.8	14.6	0.22	0.69	17.3	72.5	0.58	16.9	47.5	139	23	5
12323600	6/19/2007	81	11.3	15.2	0.24	0.65	21.8	68.7	0.7	14.9	67.2	142	21	4.6
12323600	7/24/2007	25	18.5	19.5	0.27	0.7	18.9	65.7	0.51	12.9	35.8	120	16	1.1
12323600	8/28/2007	15	13.1	12.2	---	0.57	---	31.1	0.36	5.66	---	110	6	0.24
12323600	11/5/2007	33	7.6	9.5	0.33	0.55	19.5	55.6	0.28	7.51	53.6	119	8	0.71
	Annual Mean:	**48.0**	**11.0**	**13.4**	**0.4**	**0.8**	**20.8**	**59.8**	**0.4**	**11.7**	**84.2**	**154**	**15.5**	**2.3**

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (µg/L)	As, unfiltered (µg/L)	Cd, filtered (µg/L)	Cd, unfiltered (µg/L)	Cu, filtered (µg/L)	Cu, unfiltered, recoverable (µg/L)	Pb, filtered (µg/L)	Pb, unfiltered, recoverable (µg/L)	Zn, filtered (µg/L)	Zn, unfiltered, recoverable (µg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323600	3/3/2008	27	8	16.8	0.75	1.36	31.6	134	0.4	30.7	198	316	---	---
12323600	3/3/2008	27	7.9	14.1	0.74	1.09	31.4	102	0.37	20.4	198	268	---	---
12323600	3/3/2008	27	7.7	13.9	0.65	1.17	29.6	104	0.31	21.7	181	267	---	---
12323600	3/3/2008	27	7.6	---	0.67	---	28.2	---	0.19	---	178	---	---	---
12323600	3/3/2008	27	7.6	14	0.64	1.21	28.6	106	0.27	24.1	173	268	36	2.6
12323600	3/3/2008	27	7.6	16.5	0.66	1.32	29.1	140	0.3	31.1	162	300	---	---
12323600	3/3/2008	27	7.5	14.6	0.62	1.13	29	118	0.31	24.6	157	261	---	---
12323600	3/3/2008	27	7.6	13.3	0.67	1.07	29.4	96.9	0.32	19.4	164	245	---	---
12323600	3/3/2008	27	7.6	---	0.66	---	28.6	---	0.15	---	162	---	---	---
12323600	3/3/2008	27	7.7	14.3	0.7	1.12	30.4	113	0.3	23.1	176	270	---	---
12323600	3/3/2008	27	7.4	13	0.75	1.07	30.1	95.7	0.26	18.6	192	264	---	---
12323600	3/3/2008	27	7.4	12.5	0.79	1.11	31.9	87.5	0.27	16.6	214	271	---	---
12323600	3/4/2008	26	7.6	11.2	0.81	1.03	32	77.4	0.27	12.6	222	262	---	---
12323600	3/4/2008	26	7.6	---	0.78	---	31.6	---	0.17	---	223	---	---	---
12323600	3/4/2008	26	7.5	11	0.81	1	31	75.6	0.28	12.4	217	257	---	---
12323600	3/4/2008	26	7.6	11.3	0.77	1.01	31	76.9	0.29	13.2	213	254	---	---
12323600	3/4/2008	26	7.6	11.1	0.72	1	29.9	74.2	0.3	12.3	200	244	---	---
12323600	3/4/2008	26	7.8	10.8	0.71	0.92	30.6	69.5	0.34	11.2	196	230	---	---
12323600	3/4/2008	26	7.8	---	0.73	---	29.9	---	0.18	---	195	---	---	---
12323600	3/4/2008	26	8	10.7	0.72	0.92	31.3	65.9	0.38	9.95	199	228	---	---
12323600	3/4/2008	26	8.1	10.8	0.72	0.93	28.7	67.7	0.37	10.4	193	233	---	---
12323600	3/4/2008	26	7.8	11.8	0.7	0.97	29.2	77.5	0.35	13.9	198	248	---	---
12323600	3/4/2008	26	7.8	12.8	0.72	1.02	28.4	90	0.33	18.3	186	254	---	---
12323600	4/8/2008	32	8.3	10.3	0.76	0.97	26	50.6	0.28	7.18	206	249	12	1
12323600	5/6/2008	82	8.3	13.1	0.3	0.68	18.8	64.9	0.51	16.3	96	168	30	6.6
12323600	6/2/2008	213	9.9	14.2	0.36	0.7	32.4	77.5	0.93	16.8	87.6	150	---	---
12323600	6/2/2008	213	9.8	14.2	0.32	0.67	31.5	74.3	0.98	15.7	79.3	138	---	---
12323600	6/2/2008	209	10.1	17.4	0.34	0.79	31.7	94.7	0.96	23.9	75.7	162	37	21
12323600	6/2/2008	209	10	15.2	0.33	0.65	31.4	82.9	0.92	18.3	76	144	---	---
12323600	6/2/2008	207	10.2	15.1	0.32	0.71	30.3	83.6	0.89	19.7	72.4	144	---	---
12323600	6/2/2008	205	10.4	15.9	0.32	0.68	30.5	108	1.12	21.5	70.6	146	---	---
12323600	6/2/2008	205	10	14.7	0.31	0.63	30.4	76.7	0.86	17.1	71.1	133	---	---
12323600	6/2/2008	205	10.3	14.6	0.34	0.61	29.1	76.4	0.98	17.1	75	136	---	---
12323600	6/2/2008	205	10.3	13.8	0.3	0.65	28.4	72.4	0.96	15.1	80.8	138	---	---
12323600	6/2/2008	205	10	14.6	0.33	0.64	29.9	76.6	0.96	17.2	87	148	---	---
12323600	6/3/2008	205	10.1	14.4	0.32	0.65	28.2	73.8	0.84	15.7	89.1	146	---	---
12323600	6/3/2008	205	9.8	13.7	0.33	0.68	29.2	73.5	0.9	16.4	90.9	148	---	---
12323600	6/3/2008	205	9.6	13.5	0.32	0.64	28.8	67.5	0.89	15.5	92.2	140	---	---
12323600	6/3/2008	205	9.5	12.9	0.33	0.64	28.2	68.4	0.87	15.1	94.5	145	---	---

TABLE 4 - USGS Surface Water Sampling Results[1]

Site ID	Sampling Date	Discharge (cfs)	As, filtered (μg/L)	As, unfiltered (μg/L)	Cd, filtered (μg/L)	Cd, unfiltered (μg/L)	Cu, filtered (μg/L)	Cu, unfiltered, recoverable (μg/L)	Pb, filtered (μg/L)	Pb, unfiltered, recoverable (μg/L)	Zn, filtered (μg/L)	Zn, unfiltered, recoverable (μg/L)	TSS (mg/L)	TSS Discharge (tons/d)
12323600	6/3/2008	204	9.5	13.1	0.32	0.68	27.5	69.8	0.87	15.2	94.3	148	---	---
12323600	6/3/2008	202	9.4	13.5	0.31	0.59	26.2	66.7	0.82	13.8	88.5	140	---	---
12323600	6/3/2008	200	9.6	12.3	0.3	0.59	26.2	61.3	0.96	12	84.5	129	---	---
12323600	6/3/2008	198	9.5	12.4	0.3	0.59	26.1	62.4	0.91	12.5	80.4	127	---	---
12323600	6/3/2008	198	9.4	12.7	0.3	0.59	25.6	63.7	0.87	13.2	73	123	---	---
12323600	6/3/2008	197	9.4	12.7	0.26	0.54	29.2	64	0.86	13.2	68.1	122	---	---
12323600	6/18/2008	211	15	18.1	0.3	0.56	30.4	65.2	1.02	12.2	80.2	126	21	12
12323600	7/7/2008	71	12.7	15.9	0.17	0.38	19.7	45.4	0.3	7.36	11.2	69.7	12	2.3
12323600	8/19/2008	16	13.1	15.2	0.44	0.65	22.3	46.3	0.33	5.69	67.3	110	7	0.3
12323600	10/20/2008	34	8	9.9	0.26	0.49	14.4	40.6	0.29	8.96	35.5	99	13	1.2
	Annual Mean:	**105**	**9.0**	**13.5**	**0.5**	**0.8**	**28.7**	**79.5**	**0.6**	**16.2**	**133.1**	**190.4**	**21.0**	**5.9**
12323600	3/23/2009	78	13.7	21.2	0.91	1.11	38.5	106	1.33	27.7	136	252	88	19
12323600	4/27/2009	88	7.8	11.3	0.29	0.55	18.3	51	0.38	10.5	64.7	128	24	5.7
12323600	5/18/2009	171	10.7	18.3	0.21	0.67	24.2	88.4	0.8	30.1	27.7	142	56	26
12323600	6/2/2009	222	8.3	12.4	0.19	0.45	22.7	46.1	0.36	11.9	49.8	101	30	18
12323600	6/22/2009	168	11	14.7	0.21	0.53	20.4	58.6	0.74	12.4	45.9	121	30	14
12323600	7/13/2009	70	11.4	15.1	0.28	0.73	30.8	87.8	0.41	14.7	31.8	147	30	5.7
	Annual Mean:	**132.8**	**10.5**	**15.5**	**0.3**	**0.7**	**25.8**	**73.0**	**0.7**	**17.9**	**59.3**	**148.5**	**43.0**	**14.7**

[1]Source: http://waterdata.usgs.gov/nwis/qw

M — Presence verified but not quanitified

--- — Not sampled or data not available

APPENDIX E

Photos Documenting Site Conditions

Subarea 1—Rocker Field Trip Photos

Photos 1 to 35 of Subarea 1 (Rocker) were taken between September 29-30, 2009. Remedy for this section has been complete.

Photo 1: Upper section of Subarea 1—looking east toward Butte and Interstate 90 from the Santa Claus Road culvert over Silver Bow Creek

Photo 2: Upper section of Subarea 1—salts and metal salts around a pole on the south side of Silver Bow Creek along Santa Claus Road

Photo 3: Upper section of Subarea 1—looking west toward Rocker from Santa Claus Road culvert showing sparsely vegetated streambanks

Photo 4: Upper section of Subarea 1—looking west toward Rocker from Santa Claus Road culvert over Silver Bow Creek

Photo 5: Upper section of Subarea 1—overview of north side of Silver Bow Creek from Santa Claus Road culvert

Photo 6: Upper section of Subarea 1—close-up of sparsely vegetated streambank

Photo 7: Upper section of Subarea 1—salts along with sparsely vegetated areas

Photo 8: Upper section of Subarea 1—sparsely vegetated areas showing patches of salt

Photo 9: Upper section of Subarea 1—close-up of wicking salt areas

Photo 10: Upper section of Subarea 1—salt areas and sparsely vegetated floodplains

Photo 11: Upper section of Subarea 1—salt area

Photo 12: Upper section of Subarea 1—members of the tour on the Greenway Trail west of Santa Claus Road

Photo 13: Upper section of Subarea 1—small *Populus tremuloides* (quaking aspen) grove just outside of the operable unit

Photo 14: Upper section of Subarea 1—salt areas along with grasses and the shrub *Ribe odoratum* (buffalo currant) (reddish colored leaves)

Photo 15: Upper section of Subarea 1—larger area of salts with grasses and the shrub *Ribe odoratum* (buffalo currant) (reddish colored leaves)

Photo 16: Upper section of Subarea 1—close-up of salt area with individuals of *Deschampsia cespitosa* (tufted hairgrass) invading the site

Photo 17: Upper section of Subarea 1—salt area with individuals of *Deschampsia cespitosa* (tufted hairgrass)

Photo 18: Upper section of Subarea 1—Silver Bow Creek at Greenway Trail bridge with robust 1-2 m wide *Salix exigua* (sandbar willow)

Photo 19: Upper section of Subarea 1—Silver Bow Creek at Greenway Trail bridge showing narrow band of *Salix exigua* (sandbar willow)

Photo 20: Upper section of Subarea 1—robust, narrow band (1-2 m wide) of *Salix exigua* (sandbar willow) at Greenway Trail bridge

Photo 21: Upper section of Subarea 1—salt area adjacent to Silver Bow Creek (upper left) at the Greenway Trail bridge (south side of trail)

Photo 22: Upper section of Subarea 1—salt area adjacent to Silver Bow Creek at the Greenway Trail bridge (south side of trail)

Photo 23: Middle section of Subarea 1—looking east from South Rocker Road culvert over Silver Bow Creek

Photo 24: Middle section of Subarea 1—looking east from South Rocker Road culvert over Silver Bow Creek (notice remnants of a beaver dam)

Photo 25: Middle section of Subarea 1—remnant portion of the beaver dam on Silver Bow Creek

Photo 26: Middle section of Subarea 1—mature native willow (*Salix lasiandra* [Pacific willow]) to Silver Bow Creek (historically)

Photo 27: Middle section of Subarea 1—looking downstream to culvert (with willow sticks) under South Rocker Road

Photo 28: Middle section of Subarea 1—remains of old beaver dam upstream of culvert on South Rocker Road


Photo 29: Middle section of Subarea 1—remains of old beaver dam upstream of culvert on South Rocker Road


Photo 30: Middle section of Subarea 1—looking west towards Rocker from the South Rocker Road culvert over Silver Bow Creek


Photo 31: Middle section of Subarea 1—sparsely vegetated area along Greenway Trail upstream of South Rocker Road


Photo 32: Middle section of Subarea 1—close-up of sparsely vegetated area along Greenway Trail upstream of South Rocker Road

Photo 33: Middle section of Subarea 1—more sparsely vegetated area along Greenway Trail upstream of South Rocker Road

Photo 34: Middle section of Subarea 1—another sparsely vegetated area along Greenway Trail upstream of South Rocker Road

Photo 35: Middle section of Subarea 1—sparsely vegetated area along Greenway Trail upstream of South Rocker Road

Subarea 2—Ramsay Photos

Photos 36 to 81 of Subarea 2 (Ramsay) were taken between September 29-October 1, 2009. Remedy for this section has been complete.

Photo 36: Upper section of Subarea 2—overview of created wetlands near the small community of Silver Bow

Photo 37: Upper section of Subarea 2—looking south towards Silver Bow Creek from the railroad tracks

Photo 38: Upper section of Subarea 2—looking west along the railroad tracks and portions of Silver Bow Creek floodplain

Photo 39: Upper section of Subarea 2—Silver Bow Creek floodplain showing narrow band (1-2 m wide) of *Salix exigua* (sandbar willow)

Photo 40: Middle section of Subarea 2—looking upstream. Floodplain dominated by herbacous vegetation.

Photo 41: Middle section of Subarea 2—looking across the stream channel. Limited cover of woody seedlings along the stream.

Photo 42: Middle section of Subarea 2—looking downstream. Roger Hoogerheide (EPA) inspecting section of Silver Bow Creek streambank.

Photo 43: Middle section of Subarea 2—close-up of some of the woody seedlings such as *Salix boothii* (Booth willow) adjacent to the stream

Photo 44: Middle section of Subarea 2—exposed soil lift adjacent on Silver Bow Creek streambank

Photo 45: Middle section of Subarea 2—tour group viewing Silver Bow Creek. Dennis Smith (CH2M HILL) on left side of photo.

Photo 46: Middle section of Subarea 2—looking downstream (west) showing the vegetation dominated by herbaceous vegetation

Photo 47: Middle section of Subarea 2—floodplain showing large coverage of the introduced forb *Kochia scoparia* (kochia; fire-weed)

Photo 48: Middle section of Subarea 2—looking to the west toward Miles Crossing. Scattered areas of bare ground with *Kochia scoparia* (kochia)

Photo 49: Middle section of Subarea 2—tour group along road in the middle section of Subarea 2

Photo 50: Lower section of Subarea 2—looking upstream showing dense cover of herbaceous vegetation

Photo 51: Lower section of Subarea 2—looking downstream showing dense cover of herbaceous vegetation

Photo 52: Lower section of Subarea 2—view of immediate streambank and large amounts of seeded clover for cover (dark green in color)

Photo 53: Lower section of Subarea 2—fenced areas to protect woody vegetation from beaver activity

Photo 54: Lower section of Subarea 2—sparsely vegetation ground and willow seedling (probably *Salix boothii* [Booth willow])

Photo 55: Lower section of Subarea 2—a young willow seedling (probably *Salix boothii* [Booth willow])

Photo 56: Lower section of Subarea 2—floodplain dominated by *Cleome serrulata* (Rocky Mountain bee plant)

Photo 57: Lower section of Subarea 2—looking towards Miles Crossing and floodplain dominated by *Cleome serrulata* (Rocky Mt. bee plant)

Photo 58: Lower section of Subarea 2—close-up of streambank showing dense seeding of introduced clover mix (dark green in color)

Photo 59: Lower section of Subarea 2—Roger Hoogerheide (EPA) and Rich Prodgers (Bighorn Environmental Sciences) looking at vegetation

Photo 60: Lower section of Subarea 2—Roger Hoogerheide (EPA) and Rich Prodgers (Bighorn Environmental Sciences) looking at vegetation

Photo 61: Lower section of Subarea 2—streambank showing wire cages to protect woody plants from beaver activity

Photo 62: Lower section of Subarea 2—looking upstream from Miles Crossing bridge

Photo 63: Lower section of Subarea 2—sapling *Fraxinus pennsylvanica* (green ash) native to the Great Plains region of eastern Montana

Photo 64: Lower section of Subarea 2—robust sapling of *Salix exigua* (sandbar willow) just upstream of Miles Crossing

Photo 65: Ramsay Flats section of Subarea 2—looking upstream at former severely contaminated floodplain from the train tracks

Photo 66: Ramsay Flats section of Subarea 2—looking west along the railroad tracks showing mature willow left during construction

Photo 67: Ramsay Flats section of Subarea 2—looking to the southwest across the floodplain from the railroad tracks

Photo 68: Ramsay Flats section of Subarea 2—sapling individuals of *Shepherdia argentea* (silver buffaloberry)

Photo 69: Ramsay Flats section of Subarea 2—overview of Ramsay Flats area from railroad tracks. View is looking upstream.

Photo 70: Ramsay Flats section of Subarea 2—overview of Ramsay Flats area from railroad tracks. View is looking across the floodplain.

Photo 71: Ramsay Flats section of Subarea 2—overview of Ramsay Flats area from railroad tracks. View is looking downstream.

Photo 72: Ramsay Flats section of Subarea 2—unlocked well (G 135) with broken base at latitude 46.00032, longitude -112.68661 (WGS 84)

Photo 73: Ramsay Flats section of Subarea 2—close-up of unlocked well (G 135) with broken base at lat. 46.00032, long. -112.68661 (WGS 84)

Photo 74: Ramsay Flats section of Subarea 2—Silver Bow Creek with a widely scattered narrow band of sapling *Salix exigua* (sandbar willow)

Photo 75: Ramsay Flats section of Subarea 2—Silver Bow Creek with a widely scattered narrow band of sapling *Salix exigua* (sandbar willow)

Photo 76: Ramsay Flats section of Subarea 2—close-up of large pieces of undecomposed organic matter (black in color) added during construction

Photo 77: Ramsay Flats section of Subarea 2—unlocked monitoring well C-14 north of tracks located at lat. 46.00212, long. -112.68635 (WGS 84)

Photo 78: Ramsay Flats section of Subarea 2—close-up of unlocked monitoring well C-14 south of Ramsay on the north side of tracks

Photo 79: Upper section of Subarea 2—created wetlands near the small community of Silver Bow

Photo 80: Upper section of Subarea 2—salts along with sparsely vegetated areas along the edge of the created wetlands

Photo 81: Upper section of Subarea 2—overview of the salt areas along with sparse vegetation along the edge of the created wetalnds

Subarea 3—Canyon Photos

Photos 82 to 100 of Subarea 3 (Canyon) were taken between September 29-October 1, 2009. Remedy construction for this section is currently underway.

Photo 82: Upper section of Subarea 3—looking west from the bridge at Miles Crossing

Photo 83: Lower section of Subarea 3—looking upstream at a slickens/ impacted site on the east side of Silver Bow Creek from Fairmont Road

Photo 84: Lower section of Subarea 3—impacted site on the east side of Silver Bow Creek upstream of Fairmont Road

Photo 85: Lower section of Subarea 3—impacted site showing robust *Deschampsia cespitosa* (tufted hairgrass)

Photo 86: Lower section of Subarea 3—slickens/impacted site showing *Deschampsia cespitosa* (tufted hairgrass) and bare ground

Photo 87: Lower section of Subarea 3—gully erosion of slickens/ impacted site. Silver Bow Creek is to the right of the photo.

Photo 88: Lower section of Subarea 3—gully erosion of slickens/ impacted site. Silver Bow Creek is to the right of the photo.

Photo 89: Lower section of Subarea 3—close-up of gully erosion of slickens/impacted site

Photo 90: Lower section of Subarea 3—close-up of gully erosion of slickens/impacted site

Photo 91: Lower section of Subarea 3—looking upstream at Silver Bow Creek from Fairmont Road bridge

Photo 92: Lower section of Subarea 3—temporary sediment retention dam across Silver Bow Creek

Photo 93: Lower section of Subarea 3—temporary sediment retention dam from the road on the west side of Silver Bow Creek

Photo 94: Lower section of Subarea 3—temporary sediment retention dam from the road on the west side of Silver Bow Creek

Photo 95: Lower section of Subarea 3—temporary sediment retention dam showing outlet culverts

Photo 96: Lower section of Subarea 3—temporary sediment retention dam showing outlet culverts

Photo 97: Lower section of Subarea 3—photo of Silver Bow Creek from temporary sediment retention dam showing outflow

Photo 98: Lower section of Subarea 3—face of temporary sediment retention dam along with outflow culverts

Photo 99: Lower section of Subarea 3—close-up of rock face of temporary sediment retention dam

Photo 100: Lower section of Subarea 3—outflow control structure on temporary sediment retention dam

Subarea 4—Upper Deer Lodge Valley Photos

Photos 101 to 135 of Subarea 4 (Upper Deer Lodge Valley) were taken between September 29-October 1, 2009. Remedy construction for this section is currently underway.

Photo 101: Upper section of Subarea 4—new irrigation pump station on Silver Bow Creek for the Peterson Ranch

Photo 102: Upper section of Subarea 4—recently excavated soil and newly reconstructed stream channel in the background

Photo 103: Upper section of Subarea 4—overview of recently excavated soil from Silver Bow Creek floodplain

Photo 104: Upper section of Subarea 4—overview of recently excavated soil from Silver Bow Creek floodplain

Photo 105: Upper section of Subarea 4—reconstructed streambanks of Silver Bow Creek

Photo 106: Upper section of Subarea 4—willow stakes installed below soil lift

Photo 107: Upper section of Subarea 4—willow stakes at water's edge on outside curve

Photo 108: Upper section of Subarea 4—overview of both sides of reconstructed streambanks

Photo 109: Upper section of Subarea 4—reconstructed Silver Bow Creek stream channel

Photo 110: Upper section of Subarea 4—photo showing some gaps below a soil lift on a newly constructed streambanks

Photo 111: Upper section of Subarea 4—engineered riffle section in reconstructed Silver Bow Creek

Photo 112: Upper section of Subarea 4—looking to the west toward the large irrigation ditch along edge of floodplain

Photo 113: Upper section of Subarea 4—wet area of former Silver Bow Creek channel

Photo 114: Upper section of Subarea 4—soil removal from the floodplain

Photo 115: Upper section of Subarea 4—photo illustrates the amount of soil removed from this location

Photo 116: Upper section of Subarea 4—tight curve of newly engineered stream channel showing slight erosion

Photo 117: Upper section of Subarea 4—tight curve of newly engineered stream channel showing slight erosion

Photo 118: Upper section of Subarea 4—willow stakes protruding from the lower portion of the soil lift

Photo 119: Upper section of Subarea 4—willow stakes protruding from the lower portion of the soil lift

Photo 120: Upper section of Subarea 4—willow stakes protruding from the lower portion of the soil lift

Photo 121: Upper section of Subarea 4—close-up of willow stakes protruding from the lower portion of the soil lift

Photo 122: Upper section of Subarea 4—long curving streambank showing willow stakes protruding from the lower portion of the soil lift

Photo 123: Upper section of Subarea 4—close-up of willow stakes protruding from the lower portion of the soil lift on the outside of a curve

Photo 124: Upper section of Subarea 4—headcut moving upstream towards the newly installed irrigation pumping station

Photo 125: Upper section of Subarea 4—looking downstream (north) from the pumping station

Photo 126: Upper section of Subarea 4—eroding streambank downstream of the pumping station

Photo 127: Upper section of Subarea 4—eroding streambank at latitude 46.04477, longitude -112.79709 (WGS 84)

Photo 128: Upper section of Subarea 4—red-colored existing irrigation ditch along the west side of Silver Bow Creek floodplain

Photo 129: Upper section of Subarea 4—looking upstream from irrigation pumping station to Fairmont Road bridge

Photo 130: Upper section of Subarea 4—erosion of streambank downstream of pumping station

Photo 131: Upper section of Subarea 4—new growth from native streambank stabilizing shrub *Salix exigua* (sandbar willow)

Photo 132: Upper section of Subarea 4—close-up of headcut downstream of pumping station (latitude 46.04443, longitude -112.79708 [WGS 84])

Photo 133: Upper section of Subarea 4—instream rock gabion (stainless steel cage) to control headcut just downstream of pumping station

Photo 134: Upper section of Subarea 4—instream rock gabion (stainless steel cage) to control headcut just downstream of pumping station

Photo 135: Upper section of Subarea 4—fly over of construction site by a bald eagle

Mine Waste Relocation Repository (MWRR) Photos

Photos 136 to 163 of the Mine Waste Relocation Repository (MWRR) Site were taken between September 29 and 30, 2009.

Photo 136: MWRR—sign in southeast corner of repository along South Excelsior Avenue road

Photo 137: MWRR—overview of repository from the south end showing dense cover of seeded *Chrysothamnus nauseosus* (rubber rabbitbrush)

Photo 138: MWRR—monitoring well MW-2C located in southwest portion of repository at lat. 46.00276, long. -112.58702 (WGS 84)

Photo 139: MWRR—overview of monitoring well MW-2C

Photo 140: MWRR—view of west pond showing rock-lined drainage ditch

Photo 141: MWRR—west pond overflow stand pipe located at latitude 46.00281, longitude -112.58700 (WGS 84)

Photo 142: MWRR—west pond outlet pipe located at latitude 46.00270, longitude -112.58703 (WGS 84)

Photo 143: MWRR—west pond rock-lined emergency spillway

Photo 144: MWRR—rock-lined drainage ditch in northwest corner of repository

Photo 145: MWRR—rock-lined drainage ditch along north end of repository

Photo 146: MWRR—sapling *Populus tremuloides* (quaking aspen) on the repository side of the drainage ditch

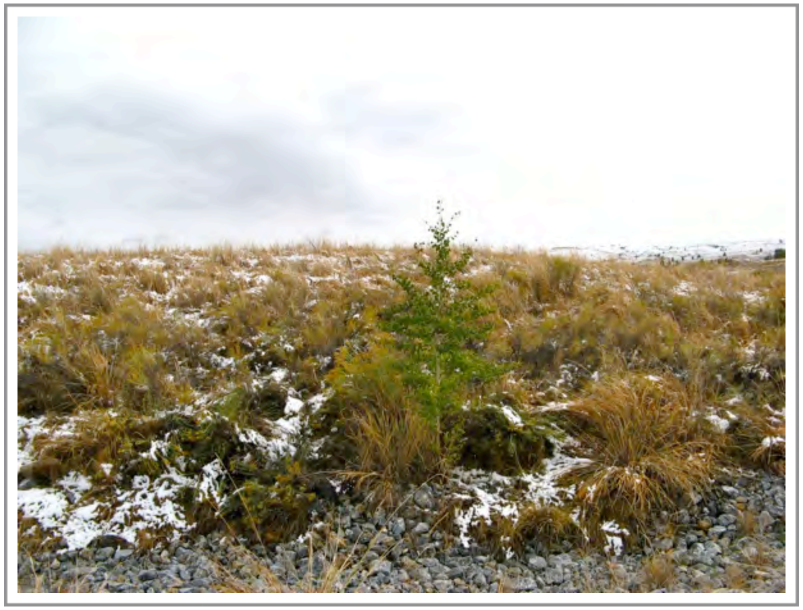

Photo 147: MWRR—another view of the sapling *Populus tremuloides* (quaking aspen) on the repository side of the drainage ditch

Photo 148: MWRR—rock-lined drainage ditch along the north end (top) of the repository

Photo 149: MWRR—rock-lined drainage ditch along the north end (top) of the repository

Photo 150: MWRR—rock-lined drainage ditch along the northeast portion (top) of the repository

Photo 151: MWRR—monitoring well MW-2A located northeast of the repository at latitude 46.00391, longitude -112.58115 (WGS 84)


Photo 152: MWRR—overview of monitoring well MW-2A


Photo 153: MWRR—fence along northeast portion of the repository. Sections of the fence are down in this area.


Photo 154: MWRR—downed fence along the northeast section of the repository


Photo 155: MWRR—downed fence along the northeast section of the repository

Photo 156: MWRR—looking south (downhill) into the east pond

Photo 157: MWRR—rock-lined ditch along the top draining into the ditch upstream of the east pond

Photo 158: MWRR—looking upstream (north) of the drainway leading into the east pond

Photo 159: MWRR—overview of the east pond

Photo 160: MWRR—looking upstream (north) from the emergency spillway of the east pond

Photo 161: MWRR—looking downstream (south) from the emergency spillway of the east pond

Photo 162: MWRR—east pond overflow stand pipe located at latitude 46.00282, longitude -112.58266 (WGS 84)

Photo 163: MWRR—looking upstream along the east edge of the repository from the South Excelsior Avenue road

Silver Bow Creek Stormwater Photos

Photos taken by Ken Brockman on June 3, 2010, near the Crackerville Road (Subarea 4) and further downstream.




APPENDIX F

Comments Received from Support Agencies and the Community

Responsiveness Summary - Streamside Tailings Operable Unit

The responsiveness summary includes comments received on the draft SST OU five year review report (Volume 2) during the December 12, 2010 through January 31, 2011 comment period. The comments are shown as received but were edited to include only those comments pertaining to the SSTOU. EPA responses are included in italicized text.

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CITIZENS TECHNICAL ENVIRONMENTAL COMMITTEE

www.buttectec.org
January 31, 2011

Roger Hoogerheide
US Environmental Protection Agency
Region VIII, Montana Office
10 West 15th Street Suite 3200
Helena, MT 59626

Text edited to show SST OU comments only

Dear Mr. Hoogerheide,

CTEC recognizes that progress has been made in Silver Bow Creek/Butte Area National Priorities List (NPL) site remedy over the last decade. Many reclaimed and rebuilt areas are so well-established that local residents have forgotten the hills of bare mining wastes that existed here only a few years ago. Aquatic and terrestrial wildlife populations in and around Silver Bow Creek continue to increase, as does recreational use of restored reaches. While strides have been made, the long-term success of the remedy depends on learning from past experience and addressing deficiencies in the remedy where they exist. This letter and attachment describe aspects of the remedy that remain a concern to CTEC members in the expectation that they be addressed by the final Five Year Review report.

The attached detailed discussion of concerns can be summarized as follows:

3) The downstream-first approach to remedy creates a risk of recontamination of restored areas. CTEC would like to see upstream areas remedied before recontamination can happen. Furthermore, lessons learned from down-stream remedy implementation should be fully considered when finalizing up-stream remediation options. Specifically, EPA's public acknowledgment during CTEC's meeting at the Butte Chamber of Commerce stating that "Stream Side Tailings Operable Unit has cleaned up quicker than anticipated" should be used as a lesson learned when considering full removal actions within the Butte Priority Soils Operable Unit (BPSOU). EPA needs to show an ability to learn from one operating unit to another.

EPA Response*: Regarding the risk of recontamination, EPA's efforts to control upstream sources are ongoing and have resulted in a substantial reduction of water column metals. EPA expects further reductions as the BPSOU ROD is fully implemented. Ongoing monitoring will help EPA ensure that Silver Bow Creek, below the BPSOU, is not recontaminated at levels that might cause environmental problems.*

Regarding lessons learned, EPA recognizes that removal actions may result in environmental improvements. EPA has ordered substantial removal actions throughout the BPSOU, and other sites. For example, at Lower Area One, we removed the bulk of contaminated soils from the old Colorado Tailings and Butte Reduction Works area. Removal actions are seldom 100% complete, however. For example, waste was left in place within the SSTOU (8.6% to 34.8% failure rate according to Construction Completion Reports). EPA's five year review report for the SSTOU recommends additional and *improved monitoring to continue to assess the effects of the residual waste, just as further efforts at monitoring and remediation are needed in BPSOU. Another public comment on the five year review describes information from a senior project conducted by a Montana Tech student, with oversight by Professor Chris Gammons. There, groundwater monitoring performed post-removal found significant concentrations of metals in ground water near Miles Crossing (C. Gammons, A. McGivern, Dec. 22, 2010). The groundwater contribution at the SSTOU to base flow and the quality of water in Silver Bow Creek is still unknown. The groundwater study illustrates that removal, although initially aesthetically pleasing and effective at removing bulk waste from sensitive locations, may require additional polishing through some form of in-place treatment to mitigate the influence of residual contamination. The exact nature of the mitigation depends on understanding the physical and chemical interactions occurring within the flood plain and shallow groundwater. This is discerned through continued investigation, monitoring, and careful treatment – the application of lessons learned.*

Recently, much attention has been given to removal of wastes or contaminated soils as the most effective cleanup method. In reality, the most effective cleanup may be the application of several tools. For instance, Montana Tech students found very low to non-detectable levels of metals in shallow ground water beneath in-place treated soils at the Governor's Demonstration Project area, located at the headwaters of the Clark Fork River (L. Gordon, A. Dutton, C. Gammons, Dec. 17, 2010). At the Governor's Demonstration Project, in-place treatment appears to have mitigated soil contaminants. While in-place treatment is not necessarily superior to other treatment options such as removal, it can be very effective at mitigating risks under site specific conditions. Thus, EPA's ROD for the Clark Fork River OU and other Clark Fork basin area OUs includes a combination of in-place treatment and removal. Removal is certainly a tool in the remediation tool bag, but it should not be the only tool, and it should be considered in context with site-specific conditions.

Significant differences exist between the operable units in the Clark Fork basin, and EPA takes these differences into account when developing the remedy for each operable unit. The different remedies reflect EPA's efforts to assimilate lessons learned from a variety of Superfund sites in the United States, and apply the best tools available for the operable units located in Montana.

7) In rebuilt reaches of Silver Bow Creek, areas with metal salts accumulating on the ground should be mapped and metal concentrations in surface and ground water and should be monitored to provide baseline data, define long-term trends, and adapt the cleanup to prevent metal salt accumulation along Silver Bow Creek in the future.

EPA Response: *EPA agrees with this comment and has noted this concern in the 5YRR.*

8) CTEC would like to be assured that a flood will not severely recontaminate the rebuilt reaches of Silver Bow Creek or overwhelm the Warm Springs Ponds and release contaminants further downstream.

EPA Response: *MDEQ has indicated the remedial design for the SSTOU actions required that non-deformable banks were constructed for the 100-year flood event. Upper bank structures were designed to handle stress from a 50-year event for the life of the fabric (2-5 years). The channel cross-sections were designed for a bank full capacity (between 150 and 200 cfs). Over topping of the bank was expected between a five and ten year event (9440-610 cfs). Successful revegetation is key to the success. Subarea 4 experienced some failures in 2010 during spring flows, and EPA is working with MDEQ to correct those areas where flooding occurred. The Warm Springs Ponds are designed to handle flood events and should not be overwhelmed by such events.*

CTEC members are looking forward to release of the final Five Year Review. And, as there is great concern that past comments and concerns by the citizens of Butte have been disregarded and that the public has not been afforded concrete answers to their concerns, CTEC requests that EPA specifically address these concerns as presented in a formal written response letter sent directly to CTEC.

Respectfully,
orginal signed by
Suzzann Nordwick
President, CTEC Board of Directors

Julie DalSaglio, EPA
Joe Vranka, EPA
Sara Sparks, EPA
Mike Bishop, EPA
Scott Brown, EPA
Wendy Thomi, EPA
Nikia Greene, EPA
Daryl Reed, DEQ
Joe Griffin, DEQ
Joel Chavez, DEQ

Paul Babb, BSB
Jon Sesso, BSB
Tom Malloy, BSB
Rick Larson, BSB
Eric Hassler, BSB
Pat Cunneen, NRD
Carol Fox, NRD
Greg Mullen, NRD
Tom Mostad, NRD
Doug Martin, NRD

U.S. Senator Jon Tester – Butte office
U.S. Senator Max Baucus – Butte office
U.S. Rep. Denny Rehberg – Missoula office
Helen Joyce, CTEC VP
Dave Williams, CTEC Secretary
Elizabeth Erickson, CTEC Treasurer
John Ray, CTEC

Silver Bow Creek/Butte Area National Priorities List (NPL) Site-Wide Comments

A. NPL Remedy Progress: While voluntary and prescribed interim actions such as storm water controls, waste capping, and groundwater capture and treatment have improved protection of human health and the environment in Butte, metals can still migrate downstream and recontaminate remediated reaches of Silver Bow Creek (SBC). The Stream Side Tailings Operable Unit (SSTOU) is being remediated ahead of Butte Priority Soils, and the Westside Soils OUs in the headwaters is at the beginning of Superfund assessment and actions. The Five Year Review is an opportunity to evaluate how individual OUs are progressing and how well NPL remedy is progressing as a whole. It is a chance to make sense of the patchwork of interim actions by targeting final remedy for the entire NPL site, ensuring that OU cleanup is properly prioritized so as to not recontaminate downstream areas.

The Final Five Year Review needs to include a discussion describing how the remedy is progressing on a site-wide basis and include what contingencies are being considered:

1. the vastly different schedules for remedy completion,
2. effects that slower cleanup upstream has on achieving remedial goals downstream,
3. potential for recontamination of remediated areas downstream.

<u>EPA Response</u>: *EPA believes the ongoing actions to control dissolved and particulate metals from upstream sources from the BPSOU have been and will be effective, and will assure that upstream contributions do not prevent the achievement of remedial action goals for the SSTOU. EPA made recommendations in the 5YRR to inventory other areas outside the SSTOU that may contribute to recontamination, and mitigate those areas as necessary to assure recontamination of the SSTOU does not occur.*

Operable Unit Comments

Butte Priority Soils Operable Unit (BPSOU)

General Comments

Surface water management program

3. EPA's 2008 Surface Water Characterization Report, Butte Priority Soils Operable Unit, section 5 shows that most of the copper input to Silver Bow Creek occurs during storm events. Remedial actions must be constructed today to reduce the storm load of metals to the creek. The Five Year Review should determine appropriate measures needed to ensure protection of the SSTOU remedy from storm water runoff as required by the SSTOU ROD. The Five Year Review needs to address the immediate implementation of final storm water actions to protect downstream water quality on SBC.

<u>EPA Response</u>: *The five year review report notes that the BPSOU ROD elements which remediate surface water are not fully implemented. The report also covers the ongoing progress in addressing surface water contamination from the BPSOU. Outside of the five year review report process, EPA recognizes the importance of addressing storm water and snow melt runoff, and is working diligently to further address these sources of surface water contamination as part* *of the remedial implementation process for the BPSOU ROD. As these efforts develop, EPA will inform the public of our progress and provide relevant data. These efforts will be evaluated in future five year review reports in accordance with EPA guidance.*

Draft Recommendations and Follow-Up Actions for the SSTOU (section 9, vol. 2) include: "Ongoing evaluation and implementation efforts to control upstream stormwater should continue. The goal should be to demonstrate no significant recontamination concern through instream water quality and sediment sampling. If significant recontamination is occurring (current data do not show this) design additional mitigation measures to control or treat." This action is given a milestone date of 2012; but what that milestone date means is not described. It is not clear how the evaluation proposed will demonstrate that no significant recontamination concern exists.

EPA Response: *EPA has revised the recommendation in the 5YRR to include a specified date. The evaluation will be performed through an inventory of tributaries and ongoing water quality monitoring within and above the SSTOU.*

Additionally, it appears that there is an incongruity between the BPSOU and SSTOU Recommendations and Follow-Up Actions wherein the STTOU recommends the follow-up action of demonstrating no significant recontamination concern and the BPSOU recommendations appear to take a "business as usual" approach to stormwater control implementation. The review should explicitly describe how the recontamination issue will be evaluated and by what date. CTEC contends that additional measures to control or treat stormwater must be expedited such that the risk of recontamination is minimized.

EPA Response: *The five year review notes the concern of recontamination; it also notes that efforts at the BPSOU to address contamination are effective to date and ongoing. See the response above for further information about surface water remediation at the BPSOU. EPA sees no incongruity between these two positions. EPA will continue to monitor for recontamination, and will continue remediation efforts at BPSOU to control the risk of recontamination.*

Stream Side Tailings

7. Areas of reclaimed soil in the SBC flood plain visited by CTEC members and technical advisors lack vegetation and seem to be experiencing wicking of salts, acids and/or toxic metals from underlying managed-in-place soils. A comprehensive map of these areas would provide a baseline for trend analysis in future Five Year Reviews. Moreover, data about potential wildlife and human toxicity risks in these areas should be collected and evaluated. Questions remain whether contaminated soil was adequately excavated and/or adequate cover soil was used in these problematic areas.

CTEC supports the proposals contained in the Five Year Review to these address issues. The occurrence of unanticipated issues with the remedy, including recontamination of imported soils, accumulation of contaminants in surface soils, and areas that don't meet vegetative objectives indicates that contingency measures will be needed to support the remedy for many years. Funds which remain once remedy construction is complete should remain in a fund specifically for SSTOU to pay for contingency measures to address issues with the remedy.

EPA Response: *EPA agrees with these comments and included recommendations in the 5YRR that addresses this concern.*

8. The quality of groundwater quality leaving the BPSOU is controlled by the ability of LAO to provide a hydraulic barrier at the down-gradient edge of the OU. CTEC recommends the Five Year Review evaluate the need for a more comprehensive groundwater monitoring program (spatial, temporal, and within the deeper weathered and bedrock aquifer systems) in the up-gradient and mid-reaches of the SSTOU to identify the quality of water entering the SSTOU. If available groundwater quality data from SSTOU monitoring includes bedrock wells, this information should be evaluated separately in the Five Year Review to describe the quality of the bedrock aquifer underlying the SSTOU. The proposed comprehensive groundwater monitoring program (issue 6, table 9-1, vol. 2) should include wells downgradient of LAO to characterize the water quality of groundwater influent to the SSTOU.

EPA Response: *EPA agrees that some additional groundwater monitoring of the SSTOU would improve our understanding of how contaminated groundwater within the SSTOU is contributing to surface water metals and arsenic concentrations. As part of this five year review, EPA has recommended that additional groundwater monitoring wells be installed and co-located with surface water monitoring locations to provide a better picture of groundwater contributions. EPA is not aware of any background wells completed in bedrock that are contributing to the current monitoring program.*

9. CTEC agrees that implementation of a formal institutional control plan (table 9-1, vol. 2) is needed and should address the following: How will current land ownership affect the imposition of land use restrictions required to ensure that the remedy will be protected and that human health exposure will be managed? A map of current land ownership and a description of current allowable land uses versus those assumed in the institutional controls and anticipated future land use in the ROD is needed. Recommendations for bringing land use, ownership and designation in line with the remedy should be part of the Five Year Review.

EPA Response: *EPA has therefore recommended that an SSTOU IC plan be completed, and believes that such a plan should be done in coordination with the Counties and local agencies.*

10. A flood on the scale of the 1908 Clark Fork River flood would cause widespread recontamination of the SSTOU. A smaller more frequent reoccurrence flood is more likely and potentially would cause severe recontamination. Quicker remedy for BPSOU source areas as part of the surface water management program would protect the cleanup investment on SBC. The Five Year Review should consider the surface water connections between BPSOU and SSTOU described in EPA's 2008 Surface Water Characterization Report, Butte Priority Soils Operable Unit; and, the report should propose a strategy for achieving a faster cleanup for storm water, runoff, and groundwater contamination sources in the BPSOU to protect the remedy at the SSTOU as required by the SSTOU ROD.

EPA Response: *See the responses above regarding BPSOU efforts at surface water remediation.*

Additionally, this comment seems to reflect a belief that the upstream sources alone contribute to recontamination of SBC. However, both upstream sources and waste left in place within the SSTOU can recontaminate SBC. Current water quality monitoring data shows relatively low *contributions of COCs from upstream sources, while the station at the end of Subarea 2 shows an increase in COC concentrations roughly equivalent to the concentrations from upstream sources. Even if it were technically possible to completely eliminate metals from upstream sources, COCs still residing within the SSTOU post-remedy can recontaminate SBC. EPA is fully aware of both sources of recontamination, and the 5YRR makes recommendations to develop a more comprehensive inventory of those sources within the SSTOU and outside of the SSTOU and BPSOU, and develop mitigation strategies if appropriate. The water quality monitoring data shows a significant overall reduction in COC concentrations since the year 2000, as a result of ongoing remedial actions both upstream of, and within, the SSTOU.*

11. The occurrence of metal salts wicking from the subsurface and/or the upwelling of metal-rich water from bedrock aquifers to surface soils in the SSTOU indicates metals are mobilizing from buried in-place wastes. The current remedy does not provide for active treatment of groundwater. Assumptions about metal mobility from waste left in-place and the influence of contaminated groundwater on Silver Bow Creek water quality need reevaluation. The Five Year review should provide a plan for monitoring groundwater and vadose zone water in areas with elevated metals in surface salts. If monitoring shows that leaching of buried waste left in-place will cause perpetual maintenance needs for soils or vegetation or would cause water quality not to meet ARARs then the remedy should be adjusted to prevent this.

<u>EPA Response</u>*: EPA agrees with CTEC's concerns. The 5YRR itself does not provide a plan for monitoring, however. Rather it provides recommendations that will be tracked by EPA to assure that the issues raised will be evaluated and mitigated if appropriate.*

12. The potential for high flows to destabilize reconstructed streambanks in the SSTOU is recognized as an issue by the review, but no recommendation or follow up action is included. The review reports that vegetation planted in subareas 1 and 2 does not include sufficient deep rooted woody vegetation to hold streambanks together in the event of a flood (section 6.7.2 and table 8-1, vol. 2). Efforts should be taken during 2012 to establish woody vegetation in these streambanks.

<u>EPA Response</u>*: EPA has revised the 5YRR to include a recommendation that this issue be addressed.*

Atlantic Richfield Company's Comments on the
Silver Bow Creek/Butte Area Superfund Site Third Five-Year Review
Prepared by EPA December 2010

Text edited to include Stream Side Tailings OU comments only.

INTRODUCTION

Atlantic Richfield (AR) appreciates all the work that went into the third five-year review for the Butte Area sites and supports the overall conclusion that the remedies completed to date have resulted in tremendous progress toward achieving protectiveness of human health and the environment. We agree with the U.S. Environmental Protection Agency (EPA) that many of the remaining challenges to the ultimate recovery of Silver Bow Creek (SBC) are outside of Superfund.

SITE WIDE ISSUES

EPA proposes an integrated approach to site-wide assessment of ecological endpoints for the Butte Operable Units (OUs). Should EPA proceed with an integrated approach to site-wide eco-screening for the Butte Site OUs, AR recommends that EPA's study plan be carefully developed with appropriate Data Quality Objectives (DQOs), and consider the individual sites' unique aspects.

Specific Comments

1. Integrated SBC water quality/bio monitoring:

   The need for additional and/or integrated site-wide monitoring is raised as an issue in the five-year review documents. More specifically, EPA identifies additional "required" sampling and biological monitoring along the entire length of SBC to "assess the impacts to human health and the environment" as a site-wide issue. The development and application of a site-wide (i.e., multiple OUs) ecological screening study to evaluate attainment of designated aquatic life uses is recommended as a follow-up action to address this issue. AR recognizes that a more integrated and/or consistent (i.e., across OUs) approach may be required by EPA to ultimately determine protectiveness and compliance with certain requirements contained in decision documents, and to thereby support final "remedy in place" determinations. AR cautions, however, that implementation of the recommended action must be pursued carefully. Future data collection activity must build upon the information collected to date, serve specific objectives and associated data needs, and support specific future decisions that are identified upfront. Until this type of process is pursued, the need for additional and/or different monitoring data can't be determined.

Quantitative biological community and water quality data have been collected for more than two decades in the Upper Clark Fork River (UCFR). These data, however, have been collected using different and evolving procedures, and area-specific concerns and questions have driven biological and water quality monitoring study designs which have not always been consistent. Although these data may not have always been collected in a consistent, coordinated, or integrated manner across the entire site, these data are still useful and provide the basis for assessment of progress achieved to date, and definition of any potential future study needs. The utility of previously collected data, the types of data to be collected in the future, (if it is determined that additional data are in fact needed), and the application of data in a decision-making context will be different for different OUs, and will differ depending on the specific questions that need to be addressed to support protectiveness and compliance assessments and future decision-making. More specifically, the determination of "remedy performance", "ecological and/or human health protection" and "attainment of designated aquatic life uses" (all stated potential objectives of potential additional monitoring in five-tear review documents) may require different types of information (decision inputs) to address goals/targets at different sites.

If additional or modified future monitoring is required, planning for future monitoring should begin with establishment of a rigorous DQO framework that: defines specific objectives and decisions that need to be supported, specifies the necessary inputs (i.e., data) to support decision-making, and identifies data gaps considering the quality and utility of existing data. EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006b), describes such a process which could be used in this context to determine "the type, quantity, and quality of data needed to reach defensible decisions or make credible estimates" (USEPA, 2006b). Only after this type of process has been completed should new studies be proposed. Thoughtful integration of different types of monitoring activities (e.g., water chemistry, sediment chemistry, benthic and fish community composition, and ecotoxicity testing) should also be considered. Reliance on, or preference for, any one type of monitoring may lead to equivocal results in some situations. Differences in habitat limitations (including topography, hydrology, and biology) might require different monitoring designs, in terms of spatial and temporal scales and what is monitored. In other words, monitoring at a given type of site should be coordinated across the basin, but not all types of sites will, or should, be monitored in the same manner. Moreover, although large-scale coordination of a basin-wide monitoring program is needed, a one-size-fits-all approach to monitoring should not be adopted; specific monitoring programs should be designed at the appropriate scale required for individual projects.

This process should recognize the significant progress achieved over the past 20 years (consistent with the Comprehensive Protectiveness Statement provided in the Site-Wide Review Five-Year Review Summary Form), and should recognize that there may be two very different types of goals for this system: 1) goals which are consistent with "comprehensive protectiveness" in a CERCLA context (i.e., whether a remedy achieves specified requirements); and 2) more general goals which reflect other stakeholder's long-term desires for system function, use, and/or resource protection. These two types of goals differ from a number of perspectives, but the most important difference (from a monitoring and a performance objectives perspective) is that the former should relate directly to the influence of constituents of concern associated with historic mining activities, whereas the latter may also consider non-mining influences (e.g., flow, physical habitat, nutrients loads, urban storm water, etc.), and system use/function tradeoffs (e.g., recreational uses vs. ecological function).

<u>STREAM SIDE TAILINGS OPERABLE UNIT</u>

As remedies have been identified and implemented through the CERCLA process in southwestern Montana over time, the environmental prism through which success is judged has led to increasingly stringent regulatory interpretations and ever-greater expectations. This *moving target* approach to compliance determination is problematic because it often dismisses significant improvements in environmental conditions and can set targets that are technically impracticable to acheive. This is time-consuming, resource intensive, and does not necessarily result in risk reduction.

Furthermore, in the CFR/SBC system, some monitoring activities (e.g., benthic macroinvertebrate community assessments) have not been consistently implemented or conducted in an integrated manner. Dan McGuire's quantitative community data have been collected for more than two decades in the CFR, lower SBC (below WSP) and Mill-Willow Bypass, but macroinvertebrate community data for SBC have been collected using different and evolving procedures upstream from the WSP. Thoughtful integration of monitoring activities should be considered, and the site-wide ecological monitoring recommendation(s) provided in the Five-Year Review report may provide an opportunity to develop an appropriate DQO-driven monitoring program(s) that may provide realistic opportunities to identify more expeditiously achievable remedial objectives.

EPA Response: EPA agrees, There are differences between the macroinvertebrate sampling and evaluations performed in the SSTOU as compared to the remainder of the Clark Fork Basin sites. These differences, and suggestions for improvement, are listed below:

- *Sampling presently consists of a single traveling kick-sample at each site. Quantitative (Hess) sampling is performed at all other sites in the Clark Fork Basin and is replicated four times. Replicated quantitative sampling would improve the power and reliability of the macroinvertebrate assessments in the SSTOU. Data reduction efforts could standardize both the historic and future data with the current data collection effort.*
- *The biointegrity assessment MDEQ uses for the SSTOU relies on generalized models for Montana's foothill and valley streams. Each of these models (RMVP Bolman 1998, MFVI Bukantis 1998, MMI MDEQ 2006) was developed to provide broad stroke assessments of biological integrity for most streams. Each of the models fulfills this objective (they show Silver Bow Creek is impaired). However, they do not provide the most accurate, rigorous (no density measurement), or insightful assessment of environmental conditions. Since Silver Bow Creek is not a typical Montana stream, and these assessments are not sensitive enough to measure small but real changes that are*

useful for trend analyses. For example, they do not provide enough information to determine whether impacts are induced from metals associated with mining wastes or other critical stressors such as ammonia. EPA would prefer the State incorporate the multimetric analysis specifically developed for the Clark Fork River and Silver Bow Creek (McGuire 1993) or develop a comparable assessment scale using more reliable and accurate project specific metrics.

- *Sampling and analyses should be standardized with existing MDEQ and EPA monitoring programs for downstream reaches of the Clark Fork River Basin.*
- *Longitudinal and trend assessments should fully utilize over 20 years of pre-remediation data (Canton et al 1986 and McGuire 2001) as a baseline for assessing restoration success.*
- *The Mill-Willow Bypass could be used as a control (reference) for Silver Bow Creek monitoring.*

EPA believes that monitoring efforts appropriately change over time at Superfund (and other sites subject to environmental improvement), as conditions change. Performance standards are established in Record of Decisions and are not changed over time unless appropriate ROD modifications are made, but monitoring and other assessment tools may change. EPA believes the five year review recommendations and discussions appropriately address this issue.

Finally, as basic scientific knowledge increases and scientists develop new and enhanced assessment procedures, environmental performance thresholds tend to become more stringent. Ecotoxicologists pursue ever more sensitive test organisms as well as more sensitive test endpoints (e.g., chronic vs. acute exposure endpoints) that may not be appropriate under CERCLA. As scientists develop such thresholds and regulators apply them under site-specific circumstances, conclusion of CERCLA site activities can become increasingly difficult. Indeed, such factors are coming into play, to one degree or another, at some of the Upper Clark Fork River Basin sites.

As an example, the Five-Year Review report contains a recommendation for "*adoption of Threshold Effects Concentrations (TEC) and Probable Effects Concentrations (PEC) guidelines should be considered for instream sediment.*" As discussed in more detail in specific comment #3 below, AR would note that more stringent performance thresholds are not necessarily more protective.

EPA Response: EPA recommended in the 5-year review report that the State consider using the TEC and PEC as restoration guidelines, not standards. EPA did not recommend that the ROD remediation performance standards for sediments be altered. To be clear, EPA continues to believe the remedy specified in the ROD, including its performance standards, for the SSTOU is protective and in accordance with Superfund law. Restoration goals or guidelines often go beyond risk reduction and that is how EPA envisioned the State would utilize the TEC and PEC guidelines. However, it appears that commentors misunderstood this recommendation. Therefore, EPA will modify the 5-year review report to clarify that the TEC/PEC *recommendation is offered as a guideline consideration for restoration purposes, not a recommendation to change the ROD performance standards for sediments.*

Specific Comments

1. New Exposure Pathways not Considered in Original Risk Assessments (sample/evaluate wildlife uptake):

   The five-year review states that because "the success of remedial activities has resulted in an enhanced riparian zone along the creek where previously none had existed", there is an increased likelihood that new/additional wildlife pathways, previously not considered significant in the original risk assessment, may be complete either now, or in the future. EPA proposes to address this issue through additional sampling and data analysis including "potential current and future exposure of terrestrial/riparian wildlife to residual contaminants in soil and food items (vegetation and prey)" is recommended. AR does not support the recommendation of conducting new risk evaluations, which are typically conducted as part of the Remedial Investigation process, as part of post-remedy monitoring to determine remedy performance. Such new risk evaluations are inappropriate where years of work have led to the design, negotiation and implementation of remedies. If new risk evaluations are to be pursued, they should begin with establishment of a rigorous DQO framework. As previously discussed, EPA's *Guidance on Systematic Planning Using the Data Quality Objectives Process* (USEPA, 2006b), could be used in this context to determine "the type, quantity, and quality of data needed to reach defensible decisions or make credible estimates" (EPA, 2006). Additionally, AR recommends that EPA consider recommendations contained within OSWER Directives 9285.7-28 (Issuance of Final Guidance: Ecological Risk Assessment and Risk Management Principals for Superfund Sites, USEPA 1999) and 9285.6-08 (Principals for Managing Contaminated Sediment Risks at Hazardous Waste Sites, USEPA 2002). These OSWER Directives contain a number of useful recommendations which may be applicable to the UCFR including:

   - Superfund remedial actions generally should not be designed to protect organisms on an individual basis, but to protect local populations and communities of biota (USEPA, 1999).
   - It is not necessary to perform multi-year field studies at Superfund sites to try to quantify or predict long-term changes in local populations for appropriate risk management decisions to be made (USEPA, 1999).
   - Considering the question "Will the cleanup cause more ecological harm than the current site contamination?" the directive notes that the NCP highlights "the importance of considering both the short-term and long-term effects of the various alternatives, including the no actions alternative, in determining which ones adequately protect human health and the environment" (USEPA, 1999).
   - Ensure that sediment cleanup levels are clearly tied to risk management goals. While it is generally more practical to use measures such as contaminant concentrations in sediments to identify areas to be remediated, other measures

should be used to ensure that human health and/or ecological risk reduction goals are being met (USEPA, 2002).

- Long-term impacts (e.g., recreational uses of the water body) of each alternative on societal and cultural practices should be identified and considered where appropriate, and a comparative analysis of impacts may be useful to fully assess and balance tradeoffs associated with each alternative (USEPA, 2002).

EPA Response: EPA does not see this recommendation as a potential reason to re-open the ROD for the SSTOU. Our intent was to assure that the contamination left in place at this OU was not causing or going to cause an unacceptable risk to human or ecological receptors who now utilize the OU more frequently than before remediation occurred, which is part of an appropriate protectiveness inquiry. Upon further reflection, however, EPA believes the potential risks to receptors will be addressed if the recommendation to identify, evaluate, and mitigate risks from areas where vegetation has not been established within the OU is implemented. Therefore, EPA will modify the 5-year report by removing this recommendation.

2. Modification of Monitoring Program:

   Potential modification of the design of the remedial monitoring network for surface water, instream sediments, groundwater, vadose zone water, soils, and vegetation to better assess performance of remedies is identified by EPA as an issue for SSTOU; and evaluation of the effectiveness of existing monitoring programs in SSTOU is recommended as a follow-up action. As discussed in AR's comment on the issue of the need for additional integrated site-wide monitoring (See Site Wide comment #1), modifications and/or additions to Montana Department of Environmental Quality's (DEQ) current monitoring programs should be considered carefully, in light of information collected to date, specific objectives and associated data needs, and specific future decisions that additional data may be needed to support. AR recommends that, if changes are necessary, this be pursued through a DQO-driven process, and that modification of monitoring programs be coordinated on a site-wide basis. Additionally, although it likely makes sense to address these issues under an integrated site-wide framework to ensure consistency, a one-size-fits-all approach to monitoring should not be adopted given that the utility of previously collected data, the types of data to be collected in the future, and the application of data in a decision-making context will be different for different OUs, and will differ depending on the specific questions that need to be addressed to support protectiveness and compliance evaluations.

   EPA Response: Comments noted.

3. TEC/PEC Sediment Guideline Recommendation:

   The recommendation to consider modification of monitoring programs in SSTOU includes a specific recommendation to adopt TEC and PEC as "instream sediment quality guidelines". As discussed in AR's comments related to Site-Wide and SSTOU issues and recommendations, AR does not support adoption of new monitoring goals or targets, or modification to existing monitoring programs for sediments. If EPA pursues this course, AR would insist on a formal planning process. This planning process should begin with establishment of a rigorous DQO framework (US EPA, 2006b). Only after this process has been completed should new studies be proposed. In anticipation of consideration of TECs and PECs as instream sediment quality guidelines, AR is providing specific comments on the utility of PECs and TECs, given the overall stated objectives of the 5 year review process (i.e., “to determine whether the remedies or other response actions in place or under construction within the Site are protective of human health and the environment and otherwise in compliance with the decision documents”).

TECs and PECs are generic (non-site-specific), screening-level guidelines (commonly used to conduct screening-level risk assessments), which were developed through a consensus-based process and published by MacDonald, Ingersoll and Berger (2000) for 28 common sediment chemicals of interest, and which incorporate the effects of a mixture of multiple contaminants in sediment. It is important to understand that although some CFR data was considered in developing the calculated TECs and PECs for metals, many of the chemical/toxicity data were developed from commercial and industrial ports, harbors and heavily contaminated waterways. Therefore, many of the paired chemistry/toxicity data from the datasets used to calculate the TECs and PECs reflect combined and potentially interactive toxicity of a variety of contaminants at elevated concentrations, many of which are not present in toxic concentrations in the UCFR. Consequently, TECs and PECs would overestimate the potential for sediment toxicity associated with metals present in SBC or CFR sediments, and are therefore not considered appropriate to determine protectiveness of remedies on a site-specific basis. Therefore, TECs and PECs might at best be used as a crude initial screening tool for sediments; a decision to require remedial action should not be based on those sediment quality guidelines. The need for and utility of chemical-specific numeric sediment benchmarks to support sediment management decision-making should be considered as part of a DQO-driven process, in the context of other requests for additional integrated site-wide monitoring (e.g., biological and surface water) and risk evaluation (i.e., for new pathways previously not considered), including requests to assess uptake and accumulation of metals in aquatic biota.

EPA Response: As stated before, EPA recommended in the 5-year review report that the State consider using the TEC and PEC as restoration guidelines. EPA did not recommend that the ROD goals, objectives, and performance standards for sediments be altered. EPA still believes the remedy specified in the ROD for the SSTOU is adequate and will ensure protectiveness. Restoration goals or guidelines often go beyond risk reduction and that is how EPA envisioned the State would utilize the TEC and PEC guidelines. However, it appears that commentors misunderstood this recommendation. Therefore, EPA will modify the 5-year review report to clarify that the TEC/PEC recommendation is offered as a restoration consideration, not a recommendation to change the ROD performance standards for sediments.

CLARK FORK COALITION P.O. Box 7539, Missoula, MT 59807 ph. 406.542.0539

January 31, 2011

Roger Hoogerheide
US Environmental Protection Agency
Region VIII, Montana Office
10 West 15th Street Suite 3200
Helena, MT 59626

RE: Silver Bow Creek /Butte Area Superfund Site Third Five Year Review Report

Dear Mr. Hoogerheide,

Text edited to show SST OU comments only

Streamside Tailings OU

6. Recontamination Issues. We agree with the actions proposed for identifying the areas with salt build-up, and identifying the mechanisms by which this is occurring. The sooner this is accomplished the better, to prevent it from occurring elsewhere on site. Elsewhere, we are concerned about the potential for recontamination from Butte Hill. Nothing demonstrates the interconnectedness of the OUs as much as this issue. Remedy on the hill needs to begin as soon as possible. Delay only increases the probability of a flood event over time that could do serious damage to the Silver Bow Creek remedy. The pathways of copper delivery from the hill to Silver Bow Creek need to be identified as soon as possible, including groundwater pathways. The poor (albeit much improved) water quality in Silver Bow Creek indicates a lack of protectiveness of the remedy.

EPA Response: Both upstream sources and waste left in place within the SSTOU can recontaminate SBC. Current water quality monitoring data shows relatively low contributions of COCs from upstream sources, while the station at the end of Subarea 2 shows an increase in COC concentrations roughly equivalent to the concentrations from upstream sources. Even if it were technically possible to completely eliminate metals from upstream sources, COCs still residing within the SSTOU post-remedy can recontaminate SBC. Because EPA is aware of both sources of recontamination, the five-year review report makes recommendations to address both issues.

The water quality monitoring data shows a significant overall reduction in COC concentrations in SBC since the year 2000, as a result of ongoing remedial actions both upstream of, and within, the SSTOU. Unfortunately, current monitoring of the floodplain and associated shallow groundwater is temporally and spatially inadequate to illustrate the influence on local groundwater quality within the SST OU from the untreated waste left in place. However, we do have a glimpse of what may be happening thanks to a *senior project conducted by Montana Tech student with oversight by Professor Chris Gammons. In fact, groundwater monitoring performed post-removal found significant concentrations of metals in ground water near Miles Crossing (C. Gammons, A. McGivern, Dec. 22, 2010). The groundwater contribution to base flow and the quality of water in Silver Bow Creek is still unknown. But this study illustrates that the benefits of removal, although initially aesthetically pleasing and effective at removing bulk waste from sensitive locations, may require additional polishing through some form of in-situ treatment or other efforts to mitigate the influence of contaminated residual soil. The final five-year review report will include a recommendation for additional monitoring of groundwater.*

Regarding concerns about the potential for recontamination from Butte Hill, the five-year review report notes that the BPSOU ROD elements which remediate surface water are not fully implemented. The report also covers the ongoing progress in addressing surface water contamination from the BPSOU. EPA recognizes the importance of addressing storm water and snow melt runoff, and is working diligently to further address these sources of surface water contamination as part of the remedial implementation process for the BPSOU ROD. As these efforts develop, EPA will inform the public of our progress and provide relevant data. These efforts will be evaluated in future five-year review reports in accordance with EPA guidance.

Thank you for considering our comments. We look forward to seeing the final draft of this Five Year Report, and we sincerely hope that EPA takes a hard look at the many difficult issues that citizens in Butte have raised.

Sincerely,

Chris Brick

Christine Brick
Science Director
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<u>Comments on Third Five-Year Review Report for Silver Bow Creek/Butte Area</u>
Volume 2: Stream Side Tailings Operable Unit

Submitted by:
Rick Appleman (member of CTEC and BRA)
Environmental Engineering
Montana Tech
Butte, MT
723-3633
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Thank you for this opportunity to comment on the third five-year review. It is always a time well spent to study and try and comprehend the progress that has been accomplished by so many on such an important site. Over the years my Land and Stream Restoration class has enjoyed the tours starting from the current bottom of the new Silver Bow Creek and progressing upstream to the remediated and restored areas; what an amazing improvement.

My comments start at the beginning of the document and they are by Page and Paragraph, Figure, Table or Section; most are comments, some are suggested changes and some are questions.

Page 3-2 Paragraph 4: I think more along the TMDL process and believe that the low water 7Q10 flowrates would be a good addition and using the USGS site numbers they are approximately 12323250 Silver Bow Cr bl Blacktail Cr at Butte MT 12 cfs, 12323600 Silver Bow Creek at Opportunity MT 12 cfs and 12323750 Silver Bow Creek at Warm Springs MT 17 cfs.

EPA Response: EPA will add this low flow parameter to the text as follows: "From a total maximum daily load (TMDL) perspective, the 7 day consecutive low flow with a 10 year return frequency (7Q10) for the Silver Bow Creek Stations below Black Tail Creek, at Opportunity, and at Warm Springs were respectively, 12 cfs, 12 cfs, and 17 cfs."

Page 4-1 Paragraph 2: The WQB-7 Circular was replaced by the DEQ-7 Circular in August 2010.

EPA Response: EPA's draft five-year review report was completed prior to this change. However, EPA will add a note in the final five-year review report to document this change.

Page 4-1 Paragraph 4: I hope that a C-1 classification is in the future for Silver Bow Creek, and is under consideration.

EPA Response: The State regularly conducts Use Attainability Analysis (UAA) of I class streams, such as Silver Bow Creek. A UAA of Silver Bow Creek is being conducted in 2011. No specific classification is contemplated until the data analysis is complete, probably during the summer of 2011. The UAA will indicate alterations in stream quality and whether additional uses, such as fishing and primary contact recreation are attainable and the state will then *determine the appropriate class. The final re-classification will reflect both the level of cleanup achieved to date and the potential to support specific uses for the water body (Joel Chavez, personal communication).*

Page 6-4 Paragraph 8: Referring to an appendix such as A with the SS monitoring stations is sometimes difficult, and a figure(s) here with all the monitoring stations labeled would be a great addition.

EPA Response: The final five-year review report will contain a figure within this section of the report that shows the monitoring stations.

Page 6-5 Table 6-3: This table is very helpful with N, Min, Max and Avg.

Page 6-7 Paragraph 8: Total Recoverable was used here, but Total was used in the following Figures. I find Total misleading and Total Recoverable should be used in place of Total at all times.

EPA Response: EPA has modified the Section 6 Figures to be consistent with analyses being reported and the text.

Page 6-8 Figure 6-1: The bar data (means) should be described prior to using them in the Figures.

EPA Response: EPA has simplified these figures in the final five-year review report in response to comments from EPA headquarters. The simplified figures no longer contain the bar data because we do not discuss that data in the five-year review report.

Page 6-9 Table 6-4: I find tons/yr difficult to grasp, but lb/day are simpler and part of the TMDL process.

EPA Response: EPA understands, however, this is a CERCLA five-year review report, not a TMDL report. From a CERCLA perspective, EPA is using this table to provide an idea of the metals loading on an annual basis. The daily load values vary considerably from day to day, and are less meaningful than annual values for showing the long-term reductions in metals loading from both upstream sources and sources within the OU.

Page 6-13 Figure 6-7: If the Montana standard is based upon Total Recoverable, then why is so much time spent on Dissolved? Is there a plan to consider Dissolved for aquatic life standards?

EPA Response: The dissolved concentrations provide information that can be useful in evaluating the success of the remedy over time. Dissolved concentrations come in direct contact with the gills of many aquatic species and have the potential for direct uptake into their bodies. This intimate connection requires the State to assess and monitor this phase of water quality as an important facet of ecological risk. The monitoring program designed and implemented by MDEQ evaluates water quality results against State-approved Human Health and Aquatic Life Standards (Circular DEQ-7). The goal of the monitoring program is assess how each *contaminant of concern meet these standards. Additional monitoring of dissolved constituents is also appropriate.*

Page 6-13 Figure 6-7: The Acute Aquatic Life Standards are based upon the one-hour average concentration not to be exceeded more than once in three years and the Chronic Aquatic Life Standards are based upon the 96 hour average concentration not to be exceeded more than once in three years, but The Annual Mean Concentration does not fit these time intervals or exceedence. Why use this measure? The N, Min, Max data of Table 6-3 is more correct.

EPA Response: EPA agrees with your comment that annual mean concentration does not meet the criteria for direct application of the aquatic standards. The monitoring program designed and implemented by MDEQ evaluates water quality results against State approved Human Health and Aquatic Life Standards (Circular DEQ-7). The goal of the monitoring program is to have each contaminant of concern meet these standards. Comparison of water quality constituents to State water quality standards allows evaluation of attainment of remediation goals/performance standards. MDEQ understands that their methods of sample collection (time-weighted composite sample collection) are not in strict compliance with the Aquatic Life Standard. However, at this stage of the remedial action, MDEQ chooses to assume that the grab sample collected is representative of the one-hour average, and the 96-hour average cited for the aquatic acute and chronic standard criteria. For the purposes of this five-year review, EPA feels that use of the annual mean concentration of each constituent of concern, by station, is an appropriate relative gauge of the status of water quality in Silver Bow Creek with respect to designated cleanup goals. The text will be footnoted to alert the reader that this comparison is general in nature and will be refined as the remedy matures and variability of water quality constituent concentrations diminishes.

Page 6-14 Figure 6-8: Using an average hardness of 125 mg/L will bias the high hardness values that now run 175 mg/L and increase the chronic copper standard from 11 to 15 μg/L or about a 25% difference. By using the actual hardness values to calculate the standards, this error can be avoided, and by using a ratio of concentration to standard, the confusion of variable standards may also be avoided; ratio ≤ 1.0 indicates compliance.

EPA Response: EPA agrees. EPA reported MDEQ analytical results. This comment will be conveyed to MDEQ to consider in future water quality data analyses.

Page 6-17 Section 6.6.2.2 Results: All of the COCs appear to still have some problems.

EPA Response: This is true. However, EPA expects that groundwater concentrations of COCs will decrease over time, and after the remedy is fully implemented.

Page 6-18 Table 6-5: Sediment standards seem like a good idea if the science concurs; is Montana considering adoption?

EPA Response: EPA believes that the remedial action goals established in the ROD for sediments are still appropriate, and we do not support a ROD change or amendment to change those goals. However, restoration goals or guidelines often go beyond the remedy goal of risk *reduction, and that was the point of EPA's discussion of guidelines in section 6.5. EPA has clarified the language in this section to reflect this position.*

Page 6-20 Table 6-6: This data appears to agree with the COCs recontamination issues, and also with the need for Sediment standards like Table 6-5.

EPA Response: EPA is no longer recommending that these goals or guidelines be adopted as a change to the remedial performance standards, as explained in other responses to comments. EPA intended this discussion to address possible guidelines for the measurement of restoration efforts, and has clarified the text to reflect this.

Page 6-22 Paragraph 1: I wonder if the infiltration events for the vadose zone are short time events and sampling would have to be automated to sample as the wetting front advances?

EPA Response: EPA agrees with your observation. EPA has recommended to MDEQ in the five year review report that the monitoring program be revised, and refined, to demonstrate an understanding of anomalous site conditions and implement mitigation measures if warranted.

Page 6-22 Paragraph 3: CQAP is not in the Acronyms and Abbreviations pages.

EPA Response: EPA will add this acronym to the final report.

Page 6-22 Paragraph 4: I would like to obtain this data in simple form for spreadsheet use, and in general it would make understanding the great amount of data more useful to the public if they were available like the USGS surface water data. If they are available, please let me know and I will use them. Perhaps they could be part of the Montana Bureau of Mines and Geology database.

EPA Response: If you are seeking the verification data associated with the remedial construction for the individual subareas, it can be found in the final construction completion reports which are maintained at MDEQ (for example Subarea 1 Reach A). Please contact Joel Chavez at 406-841-5031.

Page 6-24 Paragraph 2: In hindsight, it appears that significant resources will be required to repair high concentrations of contaminant problems and most of the left over Silver Bow Creek Remediation funds of nearly $35M should be reserved, at least in part, for future maintenance. Is this being considered?

EPA Response: EPA believes the State will need to address these areas before the cleanup can be considered complete.

Page 6-24 Section 6.6.5.4: This section clearly explained the impaired revegetation problems that we see while walking along the Greenway trail; more reasons to hold back the $35M.

EPA Response: EPA believes the State will need to address these areas before the cleanup can be considered complete.

Page 6-28 Table 6-13: The 1908 flood sure left a mess and the removing the tailings and rebuilding a functioning creek have been great improvements, but sufficient water to support vegetation will be lucky to move far from the creek until high flood events better connect the floodplains to the creek. Or, a sand and gravel layer could be added to the stream designs to help willows prosper farther from the stream banks.

EPA Response: EPA would also like to see additional willow throughout the flood plain. We address this issue in Section 6.7.2 of the five-year review report. Assuming the willows along the banks flourish, natural proliferation of willows into the flood plain is expected. This process could be enhanced by additional plantings that ensure willow roots are in the active capillary zone to sustain survival through the dry season. This also assumes that water quality in the shallow groundwater is adequate to sustain plant growth. Because the remedy is relatively young, EPA will evaluate this issue more thoroughly in the next five-year review. In five years time, we should be able to see if willows are regenerating across the floodplain. Meanwhile, several qualities of Subareas 1 and 2 add up to a fairly stable floodplain even if flood events do occur. Those include:

- *Headwaters location limits the volume of water contributing to runoff events.*
- *Relatively flat gradient of the channel allows overbank flows to spread out on the floodplain, which encourages deposition.*
- *Stream channel is wide enough and with relatively long curves, and has handled flood flows well so far.*

Page 6-30 Section 6.6.7.2: These results appear to agree with Tables 6.5 and 6.6.

EPA Response: Comment noted.

Page 6-30 Paragraph 7: The Butte WWTP upgrades to reduce effluent nutrient concentrations should improve the situation. Do you know what the upgrade effluent nutrient concentrations have been designed to be, and what the dissolved oxygen concentrations have been calculated to be?

EPA Response: MDEQ's MPDES program can provide this information. It is outside the scope of the CERCLA five-year review report.

Page 6-30 Section 6.6.8.1: change pr to (.

EPA Response: EPA adjusted the text per your suggestion.

Page 6-32 Section 6.6.8.2: Nice conclusion section, but disturbing results at SS-07 below the Butte sewage treatment outfall. It would be great to read this caged fish study report and obtain the data.

EPA Response: Please contact Joel Chavez, MDEQ's Project Manager, for this information.

Page 6-33 Section 6.7.1.1: This is one more reason to hold back some of the $35M.

EPA Response: Comment noted.

Page 6-34 Section 6.7.1.3: Will the collected sediments be sampled and analyzed and then mucked out?

EPA Response: EPA has not received a remedial design for Subarea 3 from the State, so we are not able to answer this question. Joel Chavez may be able to provide you with a more immediate answer.

High Flow: Considering the Chronic Aquatic Life Standard for copper, it appears that a loading of below 1.2 pounds per day must be achieved to meet the standard, and currently any flow above about 20 cfs is a problem. Currently, 20 cfs or higher occurs about 50% of the time.

EPA Response: EPA believes that ongoing efforts to control upstream sources of copper, combined with efforts to address sources of copper from contamination left in place within the SSTOU, will result in continued reductions of copper in the water column.

Tailings/Impacted Soils: The remedial action goal of 90 percent removal with a 95 percent confidence was, in hindsight, not restrictive enough to meet the remediation goals and extensive long-term maintenance will be required. A removal of 99 percent with opportunistic additional removal might help greatly and reduce maintenance. Other cleanups such as the abandoned mines High Ore Creek area have had the same problems. I hope that downstream removals on the Clark Fork River will learn from Silver Bow Creek.

EPA Response: EPA believes that the remedial action goal for the SSTOU was appropriate, and that ongoing monitoring of the OU is necessary to assure long-term protectiveness. That is why we conduct five-year reviews. EPA has recommended that the problem areas (areas where vegetation has not been established) be identified and evaluated, and if appropriate, mitigated. Removals are seldom 99 or 100 percent. Over time, monitoring may show the need to take additional steps to assure protectiveness, perhaps through some form of in-place treatment to mitigate the influence of residual contamination. The exact nature of the mitigation depends on understanding the physical and chemical interactions occurring within the flood plain and shallow groundwater. This is discerned through continued investigation, monitoring, and careful treatment or mitigation.

While in-place treatment is not necessarily superior to other treatment options such as removal, it can be very effective at mitigating risks under site specific conditions. Thus, EPA's ROD for the Clark Fork River OU and other Clark Fork basin area OUs includes a combination of in-place treatment and removal. Removal is certainly a tool in the remediation tool bag, but it should not be the only tool, and it should be considered in context with site-specific conditions.

Significant differences exist between the operable units in the Clark Fork Basin, and EPA takes these differences into account when developing the remedy for each operable unit. The different *remedies reflect EPA's efforts to assimilate lessons learned from a variety of Superfund sites in the United States, and apply the best tools available for the operable units located in Montana.*

Future: I agree with the improvements in Silver Bow Creek from the last five-year review to this five-year review and the problems that have been noted. I also look forward to more progress during the next five years by solving the noted problems, and into the future of learning to live with wastes left in place.

TO: US-EPA, Region 8, Butte Office
From: Chris Gammons, Professor of Geological Engineering, Montana Tech
RE: Comment on EPA 5-yr Review, Vol.2, Streamside Tailings

January 11, 2011

I have read with interest the sections in Volume 2 of the EPA's 5-year Review that deal with groundwater and surface water monitoring along the Streamside Tailings Operable Unit (SSTOU). I have a question/comment directed to the EPA regarding this issue, but first some background. My students and I have recently completed an investigation of groundwater hydrogeology and geochemistry in Subarea 2 of the SSTOU, near Miles Crossing. Through a mini-grant from the NRDP, a nest of 5 shallow monitoring wells was installed with an auger rig into the reclaimed floodplain near Miles Crossing. These wells, all of which are 2" PVC and less than 10 feet deep, were installed and developed by students in the Montana Tech Field Hydrogeology class, and a 6-h pumping test was performed. Another student (Amber McGivern) then sampled the wells quarterly for water chemistry during the period August-2009 to August-2010. A final report summarizing the results of this study was recently submitted to the NRDP and Montana DEQ (Gammons and McGivern, 2010). The upshot of this study is that the alluvial aquifer in the recently reclaimed reach of Silver Bow Creek near Miles Crossing contains groundwater that is acidic (pH < 5), with extremely high concentrations of heavy metals, including Cd (up to 0.16 mg/L), Cu (up to 34 mg/L) and Zn (up to 30 mg/L). Our study was of too short a duration to examine long-term trends in water quality.

Because all of the wells in our study were close together, it is risky to extrapolate the conditions at a single well field to the alluvial aquifer as a whole. Nonetheless, it is clear that there is some very poor-quality groundwater in the shallow alluvium in this reach. Based on hydrogeological common sense, it stands to reason that this acidic and metal-rich groundwater must discharge to Silver Bow Creek (SBC) before the stream enters the bedrock of Durant Canyon. The hydrogeological setting near Miles Crossing is similar to that near the NW end of the Butte Summit Valley in the vicinity of Lower Area One: i.e., contaminated shallow groundwater exits a thick package of alluvium that pinches out to bedrock, resulting in groundwater discharge to SBC. If the metal-rich groundwater near Miles Crossing discharges to SBC, then this would cause an increase in metal load as surface water passes through this reach. However, the spacing of the monitoring stations along the SSTOU is too wide to see whether or not this is the case. The closest monitoring station upstream of Miles Crossing for which data are reported is SS-11 (Ramsay Flats), and the closest monitoring station downstream is SS-15 (SBC near German Gulch). The graphs for total and dissolved metals show substantial gains in concentrations of several trace metals (including As, Cd, Cu, Zn) between SS-11 and SS-15. The Review concludes that these gains occur as water passes through the unreclaimed section of the creek, in the canyon downstream of Miles Crossing. However, it is also possible that the increases in metal concentrations occur <u>before</u> SBC enters Durant Canyon, e.g., from discharging groundwater in the recently reclaimed floodplain. The Appendix to the Review shows a surface-water monitoring station labeled SS-14 that is very close to Miles Crossing, and yet no data are presented in the Review from this station. Such data might show whether metal loading in SBC occurs before or after the stream enters Durant Canyon.

The existence of contaminated groundwater in the alluvial floodplain of Subarea 2 is not surprising, and does not reflect negatively on the short-term success of the SSTOU remedial actions. This alluvial aquifer, which extends all the way from Durant Canyon upstream to Butte, has been severely damaged by 120 years of mining contamination. By removing the tailings from the floodplain, it stands to reason that the metals in the floodplain aquifer will eventually be "flushed out". However, this cleansing process (often termed "natural attenuation") could take many years, or even decades, before any noticeable improvement occurs. In the meantime, significant re-contamination of SBC could be occurring. It should be a priority for the State and the EPA to determine whether or not discharge of metal-contaminated groundwater is occurring in the lower half of Subarea 2 and, if so, what are the impacts on water quality in SBC. This situation should then be monitored over time to see if natural attenuation is indeed occurring.

Gammons C.H. and McGivern A. (2010) Hydrogeology and chemistry of groundwater near Miles Crossing: Final Report. Unpub. Report to Mont. Dept. Env. Quality, Dec. 2010, 35pp.

EPA Response: Thank you for providing a copy of your groundwater study near Miles Crossing. EPA is very interested in your findings, and we agree with your general observations. Contaminants from contamination left in place within the SSTOU are likely contributing to the elevated concentrations you and your students observed in the groundwater near Miles Crossing. Our five-year review report, Section 6.6.5, provides a more thorough discussion of the SST removal actions. Our five-year review report recommends that these areas of contamination which have not revegetated be identified, evaluated, and mitigated if appropriate. Mitigation may involve additional removal or in place treatment of these areas, which would speed up the time table for cleanup progress. EPA also recommended improvements to the monitoring network to help further our understanding of how groundwater may be contributing to surface water concentrations. We agree that this is a priority concern, and EPA will be working with DEQ on these efforts and tracking the recommendations made in the five-year review report.

Greenway Service District
Anaconda-Deer Lodge and Butte-Silver Bow Counties

January 31, 2011

Sara Sparks
Remedial Project Manager
U. S. Environmental Protection Agency, Region 8
Butte Office
155 West Granite Street
Butte, MT 59701-9206

Re: Greenway Service District Comments on the *Third Five-Year Review Report for Silver Bow Creek/Butte Area Superfund Site, Public Comment Review Draft dated December 2010.*

Dear Ms Sparks:

At their January meeting, the Greenway Service District (GSD) Board endorsed the following comments in regard to the ***Third Five-Year Review Report (Review Report) for Silver Bow Creek/Butte Area Superfund Site, Public Comment review Draft dated December 2010.*** Our comments are exclusive to the *Volume 2: Streamside Tailings Operable Unit (SSTOU)*, located along Silver Bow Creek, in Anaconda-Deer Lodge and Butte-Silver Bow Counties, Montana.

The GSD would like to express it appreciation to the preparers' of this review for conducting interviews with persons familiar with the on-going remedial and restoration efforts in this corridor as well as the development of the Silver Bow Creek Greenway project along Silver Bow Creek. The GSD also recognizes that this review has revealed the **critical importance of establishing a formal Institutional Controls program** for the long-term management and maintenance of this recovering landscape.

The issue of institutional controls (ICs) was discussed throughout the Review Report as a significant component of the prescribed remedy for the SSTOU. The GSD believes the Five-Year Review should reaffirm the provisions from the SSTOU Record of Decision (ROD) in connection with its discussion of ICs. The ROD requires "*institutional controls that will require the entire OU to be developed into a recreational corridor*" and the institutional controls program must ensure there are adequate land use restrictions.

Aspects of this institutional control program have been implemented through land use policies and regulations, including the designation of the Silver Bow Creek Corridor within the City and County of Butte-Silver Bow (City-County) as “Open Space” in its Growth Policy. The City-County has also recently adopted setback requirements in its Water Channel Management Zone, Chapter 17.47 of Title 17 of the Butte-Silver Bow Municipal Code that restrict construction of any kind within one hundred-fifty feet (150’) of Silver Bow Creek’s ordinary high water mark. The ROD stipulated that the open space corridor would be fundamental to the cleanup assumptions used to choose the selected remedy, as follows:

> “*An institutional controls program, which must be funded on a permanent basis as part of the remedy, will be coordinated through a joint effort of the Butte-Silver Bow and Anaconda-Deer Lodge local governments. Institutional controls, monitoring, and maintenance will be integrated into a Silver Bow Creek corridor management program (Item 15, page 5)*”

The ROD also states that the ICs shall be managed and maintained by the counties of BSB and ADL, and that the funding for the ICs shall be a part of the remedy. To this end, the counties created the GSD, which was created expressly to design, develop, oversee, and manage the Silver Bow Creek Greenway, and as such the Silver Bow Creek Greenway is an integral part of, and central to, ICs to protect remedial actions conducted in the SSTOU.

Another aspect of ICs is related to land ownership within the corridor. The Review Report describes the lands along the corridor as primarily in private ownership (Land and Resource Use, page 3-3). This is a misstatement. Along with lands owned by Atlantic Richfield Company (ARCO) in both Anaconda-Deer Lodge and Butte-Silver Bow Counties, deeded to the State of Montana as a part of the Consent Decree completed among ARCO, the United States, and the State of Montana, the GSD has purchased land and/or easements along Silver Bow Creek, to protect the remedial and restoration activities and to provide features of the Silver Bow Creek Greenway, including trails and trailheads, access control fencing, and regulatory signs.

EPA Response: EPA will change the 5YRR to reflect the mixed ownership of land.

And from Section IX – Selected Remedy, Remedial Design Action Process on Page 113 of the ROD:

> *“Provided that the final design of the SSTOU remedy can attain the cleanup criteria and performance standards, it should to the degree possible incorporate components consistent with the following environmental and community improvement actions in the project area:*
>
> - *A Silver Bow Creek recreational corridor land use as designated and adopted by the Butte-Silver Bow and Anaconda-Deer Lodge County governments;*

- *Preservation and enhancement of significant historical and pre-historical resources in accordance with the Regional Historic Preservation Plan; and*
- *Coordination with pertinent restoration actions implemented as part of the Upper Clark Fork River Basin natural resource damage restoration plan."*

and

> *"The implementation of the remedy will also be coordinated to the maximum extent possible with the possible implementation of the State's natural resource damage restoration plan in order to avoid duplication of effort and unnecessary costs and to maximize the benefits to the area (Item 16, page 5)."*

The GSD has worked closely with DEQ and the State of Montana Natural Resource Damage Program (NRDP) to cost-effectively perform remedial and restoration work together, yet, within the Executive Summary a single sentence describes these activities – "The remedy was supplemented by restoration activities provided by the State of Montana's SST Site Restoration Plan." The GSD would request recognition of the significance of these supplemental restoration activities to the "dramatic" visual transformation of Subareas 1 and 2. Without restoration dollars secured from the NRDP by the GSD, these areas, as well as Subareas 3 and 4, would not exhibit "dramatic" improvements to the aquatic and terrestrial habitat. Restoration dollars will also support the development of the Silver Bow Creek Greenway's recreational features – trails and trailhead development, pedestrian bridges, and other outdoor recreation components, as well as access control features, including gates and fences and regulatory signage.

EPA Response: EPA acknowledges that restoration activities have contributed to the overall improvements within the SSTOU. However, because the focus of the 5YRR is to evaluate remedial actions, EPA limits its report to findings related specifically to the SST OU Remedy.

The GSD firmly believes that the ultimate end land use, the Silver Bow Creek Greenway, with its recreational and access control features, meet the provisions of the ROD and are institutional control components, and should be recognized as such. Thank you for accepting these comments.

Sincerely,

Dori Skrukrud, on behalf of the Greenway Service District Board

PROJECT GREEN OF MONTANA, INC.
65 EAST BROADWAY
BUTTE, MT 59701

January 31, 2011

Environmental Protection Agency
Butte Office
155 W. Granite
Butte, MT 59701

Re: Comments on Draft EPA Five-Year Review Report

Dear EPA:

These comments are submitted on behalf of Project Green of Montana, Inc. ("Project Green") with respect to EPA's December, 2010 Five-Year Review Report for the Silver Bow Creek/Butte Area Superfund Site ("Five-Year Review"). By way of background, Project Green began as a Butte citizens' grassroots community organization and evolved to a Montana non-profit corporation (a 501(c)(3) organization) that promotes innovative remedial and restoration projects to meet long-term community objectives for clean-up in the area, and other related community projects.

Project Green's Articles of Incorporation state its primary purposes as:

To encourage innovation in Superfund remediation so that future land use of Superfund cleanup sites becomes a vital component of community development while demanding safe long-term remediation protective of human health and the environment. To create tangible community assets for the area while encouraging sound and cost-effective reclamation. To encourage technology development and deployment in Superfund remediation projects. To encourage long-term, cost-effective remedies that meet the economic development and recreational needs of the affected communities while continuing to meet the human health and environmental protection objectives of Superfund. To promote community education to encourage affected citizens to participate in the decision-making process relating to these sites in order to create economic, social, cultural, and recreational opportunities and support open space and other beneficial uses. And to operate to the ultimate benefit of the citizens of the affected areas, the State of Montana, and the United States...

While Project Green does not profess to have the technical expertise to offer comments on the technical aspects of the Five-Year Review, it offers these general comments.

Project Green recognizes that progress has been made in the Silver Bow Creek/Butte Area Superfund Site remedy over the last decade, including many reclaimed and rebuilt areas, such as the dramatic changes to the portions of Silver Bow Creek (SBC) that have undergone remedial and restoration activities, including the areas of vastly improved aquatic and terrestrial wildlife populations in and around SBC, and recreational use of restored reaches. While much progress has been made, Project Green expects the Five-Year Review to appropriately evaluate the remedy to accomplish a clean-up that incorporates the best available remedial technology, such as state-of-the-art institutional controls (ICs) that are the most effective and innovative ICs in the entire country.

With respect to the Streamside Tailings Operable Unit (SSTOU), Project Green has a long history in supporting the end land use of SBC as a passive recreational corridor as described in the SSTOU Record of Decision (ROD); i.e., the Greenway Project which is managed by the Greenway Service District as a joint effort of Butte-Silver Bow and Anaconda Deer Lodge.

The ROD addresses - in several places – the end-land use as a recreational corridor that would also serve as ICs, which contemplated the Greenway Project. For example, page 105 of the ROD states:

> *"Prevent human exposure to the tailings/impacted soils from residential or occupational activity within the SSTOU. This will be accomplished, in part, <u>through institutional controls that will require the entire OU to be developed into a recreational corridor</u>."*
>
> (emphasis added)

Also, page 113 of the ROD states:

> *"Provided that the final design of the SSTOU remedy can attain the cleanup criteria and performance standards, it should to the degree possible incorporate components consistent with the following environmental and community improvement actions in the project area:*
>
> - *A Silver Bow Creek recreational corridor land use as designated and adopted by the Butte-Silver Bow and Anaconda-Deer Lodge County governments;*
> - *Preservation and enhancement of significant historical and pre-historical resources in accordance with the Regional Historic Preservation Plan; and;*
> - *Coordination with pertinent restoration actions implemented as part of the Upper Clark Fork River Basin natural resource damage restoration plan."*

The Five-Year Review does address the importance of ICs in connection with the remedial activity, but Project Green believes the Five-Year Review should reaffirm the above-quoted provisions from the ROD in connection with its discussion of ICs. The GSD has worked closely with DEQ and the State of Montana Natural Resource Damage Program (NRDP) to cost-effectively perform remedial and restoration work together, and

Project Green believes that collaborative effort should be noted in the Five-Year Review in connection with its discussion of the SSTOU remedial work and the ICs. For example, that collaborative effort, through a GSD grant approved by NRDP, accomplished the removal of the Ramsay Flats tailings, which in addition to providing a much enhanced clean-up, also dramatically improved the appearance of that area.

The Five-Year Review also notes the issue of metal salts accumulating on the ground in rebuilt reaches of SBC. Project Green understands that the Butte Citizens Environmental Technical Committee (CTEC) will provide comments that those areas with should be mapped and metal concentrations in surface and ground water and should be monitored to provide baseline data, define long-term trends, and adapt the cleanup to prevent metal salt accumulation in the future. This goes hand-in-hand with the end land use and ICs and preventing exposure to tailings or contaminants.

Project Green understands that the GSD has also submitted comments on the Five-Year Review, and Project Green supports the GSD's comments.

Project Green also understands that CTEC and/or the Butte Restoration Alliance will be submitting detailed comments on the Five-Year Review, and while the Project Green Board has not had time to review them, Project Green recognizes their respective roles in the community in providing technical expertise or valuable community input on the many complicated issues associated with the Silver Bow Creek/Butte Area Superfund Site, and Project Green trusts that the EPA will carefully consider their comments.

Project Green would also support an extended public comment period if possible. The Five-Year Review consists of several volumes and contains a great deal of information to read and consider. The Five-Year Review was issued shortly before the December holiday season, and between the holidays and the press of business with the start of the new year, we believe many in the community would appreciate additional time to review the Five-Year Review in more detail and provide comments.

Project Green appreciates the opportunity to provide comments on this important document.

Sincerely,

Bruce Holland, President

Project Green of Montana, Inc.

cc: Project Green Board

<u>EPA Response</u>: EPA agrees with Project Green that a dedicated recreational corridor is an appropriate land use for the SST Site, as originally indicated in the SST Site ROD. The five year review report contains a recommendation that a formal Institutional Control plan should be developed which will describe this effort in greater detail.

EPA notes that substantial restoration program efforts have been important contributors to the overall cleanup at the SST site. However, the SST five year review report is intended to review remedial efforts and is focused on those aspects of the site activities.

APPENDIX G

Soils Removal Verification Process

SSTOU - Contaminated Soil Removal and Verification Sampling

PREPARED FOR: Kristine Edwards/EPA Region 8, Helena, Montana Office

PREPARED BY: CH2M HILL INC

COPIES: File

DATE: February 16, 2011

PROJECT NUMBER: 395387

The purpose of this memorandum is to present a representative summary of results of the SSTOU post contaminated soils removal verification process. This memo describes the process employed to address the inherent vertical and lateral variability of the contamination, meet ROD cleanup requirements, verify removal effectiveness, and sustain a cost effective construction schedule.

Soils Monitoring

In 1998, soil contamination was extensive and fairly homogenous throughout the OU, justifying a remedial action involving removal of tailings and mixed soils. The following paragraphs summarize post-remedial action verification results and how they compare to remedial action performance standards.

Soil Performance Standards

The target remedial action goal is to remove 90 percent of tailings/impacted soils with 95 percent confidence. Verification sampling was used as a quality assurance measure to demonstrate that the removal goal was achieved. Verification sampling followed the procedures outlined in Section 4.3.2 of the Construction Quality Assurance Program (CQAP). As explained in the CQAP, the goal for removal of all contaminated material above the “order-of-magnitude break” will be considered a “success” if at least four out of six of the constituents of concern are less than the concentrations shown in Table A.

TABLE A
Contaminated Material Constituents of Concern, SSTOU

Constituent	Concentration[a] (mg/kg)
Arsenic	200
Cadmium	20
Copper	1,000
Mercury	10
Lead	1,000
Zinc	1,000

[a] Concentration levels were set by MDEQ and EPA, 1998

At a point location, the expected failure rate of 37.1 percent was derived from the statistical properties of 350 test pits excavated and sampled in Subarea 1 by ARCO (ARCO, 1997). Methods used to arrive at the expected failure rate are described in Appendix D of the Final Design Report (Maxim, 1999).

Measured failure rates were calculated and exhibited in the Construction Completion Reports for the different Reaches. A sample of documented failure rates, from upstream to downstream, is shown in Table B.

TABLE B
Documented Failure Rates

Subarea	Reach	Failure Rate
1	A	34.8%
1	B and C	24.3%
1	D and E	13.9%
2	F, G, and H	17.2%
2	I and J	23.8%
4	Phase 1	12.5%
4	Phase 2	8.6%
4	Parcel 152	25.0%

These failure rates were less than the expected failure rate of 37.1 percent; therefore, the removal goal for these reaches has been accomplished.

Summary of Verification Samples

Removal was considered accomplished if four of the six constituents of concern had concentrations less than the concentrations in Table A. A QA/QC sampling program was instituted to verify that 90 percent of the tailings were being removed with 95 percent confidence. Surface (0- to 4-inch depth) soil samples were collected from the newly exposed surface after excavation, and prior to placement of cover soils. The purpose of the sampling was to provide a statistical measure of whether the removal goal had been met. Sampling was not used to search for limited "hot-spots" of contamination that may remain in the floodplain. A significant number of samples were collected before any determination of the efficacy of the removal could be made. The sampling program was not used to redirect excavation to previously excavated areas. If verification sampling indicated that the removal goal was not being met over substantial areas, the over-excavation depth was increased in as-yet unexcavated areas to achieve the removal goal. This approach to verification of removal of tailings/impacted soils allowed the contractor to excavate to the elevations shown on the plans and conduct his operation without delays and interruptions of the construction sequence.

Verification Data for Reach A

Raw concentration data for the six elements in the 0- to 4-inch depth increment after excavation, but prior to placement of cover soil, are found in Appendix G of the Final Construction Report for Reach A (see Attachment to this Memo). Results are shown in Table C.

TABLE C
Concentrations (mg/kg) of COCs in Verification Sampling in Reach A, Subarea 1

Element	No Samples	Mean	Standard Deviation	Minimum	Maximum
Arsenic	92	231	326	4.1	1,850
Cadmium	92	10.2	9.7	3.2	52.5
Copper	92	1,372	1590	29.2	8,790
Lead	92	684	1,148	34	5,990
Mercury	92	4.7	14.3	0.0049	123
Zinc	92	3,139	5737	103	50,800
pH	92	6.5	–	3.5	9.9

Although a statistical analysis determined removal did meet the remedial action goal of 90 percent removal of tailings/impacted soils with 95 percent confidence, high concentrations of the contaminants remain in materials that were not excavated. On an element basis, 68 percent of samples had zinc concentration greater than 1,000 mg/kg, 44.6 percent of the verification samples had copper levels above 1000 mg/kg, and 33.7 percent of the verification samples had arsenic concentrations greater than 200 mg/kg. Acidity (as measured by pH) measurements of these samples indicated that 37 percent had pH values ≤6.5.

Verification data for other Reaches in Subarea 1 or Subarea 4 were not available for independent review. It is likely, in these Reaches, that unexcavated materials also exhibit acid conditions and elevated metal and arsenic concentrations.

Attachment

APPENDIX G

SUMMARY TABLES

Final Construction Report
Streamside tailings Operable Unit
Subarea 1, Reach A
Remedial Action

TABLE 6
Tailings/Impacted Soils Removal Verification Sampling Results
Silver Bow Creek / Butte Area NPL Site
Streamside Tailings Operable Unit, Subreach 1 Reach A
Sample Depth 0 - 4 inches

Easting	Northing	Sample Date	Sample ID	Laboratory Number (MSE / Ashe)	Pass / Fail	pH (s.u.)	Arsenic (mg/Kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Zinc (mg/kg)
1210470	745400	8/14/00	TS-5400N0475E	000815O002 / A-0867	Fail	7.5	1010.00	4.1	*3350	434	2.2	*1830
1210650	745300	8/14/00	TS-5300N0650E	000815O001 / A-0866	Pass	7.3	82.10	U3.6	522	599	7.1	*1230
1210750	745300	7/28/00	TS-5300N0750E	000731K007 / A-0809	Pass	6.7	32.10	U3.6	621	143	1.1	723
1210900	745300	7/28/00	TS-5300N0900E	000731K008 / A-0810	Fail	6.5	415.00	17.5	*2020	*2680	1.6	*7940
1211050	745150	7/28/00	TS-5150N1050E	000731K009 / A-0811	Pass	7.1	28.80	U3.6	388	75.7	0.27	336
1211050	745250	7/28/00	TS-5250N1050E	000731K010 / A-0812	Fail	7.5	598.00	*31	*3970	*1470	6.8	*10200
1211200	745150	7/28/00	TS-5150N1200E	000731K011 / A-0813	Fail	6.6	531.00	*24.2	*4370	*1470	8.3	*8080
1212850	745000	7/14/00	TS-5000N2850E	000717M012 / A-0771	Fail	7	157.00	12.4	*1080	*3120	*18.6	*5640
1213000	745000	7/14/00	TS-5000N3000E	000717M019 / A-0778	Pass	7	19.70	4.4	100	105	0.23	*3660
1213150	745000	7/14/00	TS-5000N3150E	000717M018 / A-0777	Pass	6.8	24.20	11.3	59.3	155	2	*1390
1213300	745000	7/14/00	TS-5000N3300E	000717M017 / A-0776	Fail	6.4	743.00	*47.9	*2520	*3490	*16.4	*50800
1213450	745000	7/14/00	TS-5000N3450E	000717M016 / A-0775	Pass	6.8	17.00	6.3	137	318	0.72	*7630
1213600	745000	7/14/00	TS-5000N3600E	000717M015 / A-0774	Pass	6.2	9.10	U3.6	31.1	53.1	B0.023	826
1213750	745000	7/14/00	TS-5000N3750E	000717M014 / A-0773	Pass	6.7	49.00	17.6	475	748	2.6	*3380
1213900	745000	7/14/00	TS-5000N3900E	000717M013 / A-0772	Pass	6.8	51.90	15.7	116	369	8.5	*2810
1214050	745000	7/14/00	TS-5000N4050E	000717M011 / A-0770	Pass	7.1	17.50	U3.6	73.4	61.3	0.091	802
1214070	744865	7/14/00	TS-4865N4075E	000717M006 / A-0765	Pass	7.1	4.10	U3.6	45.6	62.3	0.099	854
1214200	744865	7/14/00	TS-4865N4200E	000717M005 / A-0764	Fail	6.8	580.00	*22.9	*3170	*5990	*123	*11700
1214200	745000	7/14/00	TS-5000N4200E	000717M010 / A-0769	Fail	7.1	515.00	18.6	*2930	612	1.9	*6250
1214350	744865	7/14/00	TS-4865N4350E	000717M004 / A-0763	Fail	7.9	572.00	12.2	*1290	*5670	*55.8	*10400
1214350	745000	7/14/00	TS-5000N4350E	000717M009 / A-0768	Pass	7.6	15.70	U3.6	69.9	96.2	0.84	408
1214500	744865	7/14/00	TS-4865N4500E	000717M003 / A-0762	Fail	7.1	24.50	*42.3	*3620	363	1.6	*4410
1214500	744980	7/14/00	TS-4980N4500E	000717M008 / A-0767	Pass	7.4	122.00	5.9	533	608	7.5	*1310
1214650	744865	7/14/00	TS-4865N4650E	000717M002 / A-0761	Pass	7.7	31.70	U3.6	239	389	2.1	*1280
1214650	744965	7/14/00	TS-4965N4650E	000717M007 / A-0766	Pass	8.2	26.60	U3.6	71.2	56.7	0.15	103
1214800	744900	7/14/00	TS-4900N4800E	000717M001 / A-0760	Pass	6.9	59.80	U3.6	172	92.7	0.12	214
1215700	744850	5/19/00	TS-4850N5700E	000522K001 / A-0487	Pass	7.6	5.90	U5.3	*1410	34	U0.019	765
1215850	744700	5/11/00	TS-4700N5850E	000512K001 / A-0407	Fail	6.1	277.00	12.3	*5090	421	1.1	*2110

Notes:

(s.u.) - Standard units
(mg/kg) - Millgrams per kilogram
U - Below laboratory practical quantitation level

-- - Sample not collected/analyzed
* - Exceeds Criteria Level

TABLE 6
Tailings/Impacted Soils Removal Verification Sampling Results
Silver Bow Creek / Butte Area NPL Site
Streamside Tailings Operable Unit, Subreach 1 Reach A
Sample Depth 0 - 4 inches

Easting	Northing	Sample Date	Sample ID	Laboratory Number (MSE / Ashe)	Pass / Fail	pH (s.u.)	Arsenic (mg/Kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Zinc (mg/kg)
1215850	744850	5/30/00	TS-4850N5850E	000531P002 / A-0612	Pass	7.3	46.80	U5.3	650	211	1.1	*1080
1216000	744700	5/25/00	TS-4700N6000E-A	000526L012 / A-0607	Pass	5.8	47.90	7.7	961	113	B0.02	*5390
1216000	744800	5/30/00	TS-4800N6000E	000531P003 / A-0613	Pass	7.1	128.00	U5.3	*1000	750	2.4	*1940
1216150	744550	5/25/00	TS-4550N6150E	000526L004 / A-0599	Fail	5.8	701.00	13.8	*4350	943	0.75	*3510
1216150	744700	5/30/00	TS-4700N6150E	000531P005 / A-0615	Pass	6.7	40.40	9.9	*4680	134	0.16	*1310
1216150	744850	5/25/00	TS-4850N6150E	000526L002 / A-0597	Fail	6.2	1120.00	17.4	*3720	*1550	1.6	*5000
1216300	744400	5/25/00	TS-4400N6300E	000526L003 / A-0598	Pass	7.1	24.00	U5.3	156	140	1	399
1216300	744550	5/30/00	TS-4550N6300E	000531P004 / A-0614	Pass	7	13.90	*29	303	141	0.0049	932
1216300	744700	5/3/00	TS-4700N6300E	000509J002 / A-0406	Fail	4.3	667.00	12.1	*1320	660	1.5	*3180
1216350	744700	6/6/00	TS-4700N6350E	000612K007 / A-0640	Fail	7.1	365.00	6.9	*1360	942	4.9	*2070
1216450	744400	5/11/00	TS-4400N6450E	000512K002 / A-0408	Fail	4.9	793.00	6.2	736	*1360	5.4	*2930
1216450	744550	5/25/00	TS-4550N6450E	000526L005 / A-0600	Pass	7.4	72.90	9.5	868	385	0.54	*1920
1216450	744700	4/27/00	TS-4700N6450E	000502K001 / A-0376	Pass	7.1	88.60	U6.2	708	248	0.76	471
1216600	744400	5/11/00	TS-4400N6600E	000512K003 / A-0409	Pass	4.3	20.90	8	588	94.6	0.064	*1510
1216600	744600	5/30/00	TS-4600N6600E	000531P006 / A-0616	Pass	7.2	17.10	U5.3	43.3	67.1	0.04	203
1216700	744400	5/25/00	TS-4400N6700E-A	000526L006 / A-0601	Pass	4.5	9.60	U5.3	547	58.5	0.039	633
1216700	744550	4/27/00	TS-4550N6700E	000502K002 / A-0377	Pass	7.2	75.20	U6.2	*1370	412	4.5	*1780
1217050	744250	5/11/00	TS-4250N7050E	000512K004 / A-0410	Pass	6.2	17.70	U4.4	83.4	61.9	0.06	*2810
1217050	744400	4/27/00	TS-4400N7050E	000502K003 / A-0378	Pass	3.9	345.00	U6.2	672	331	1.5	*2700
1217200	744250	5/11/00	TS-4250N7200E	000512K005 / A-0411	Fail	3.6	544.00	7.1	*2250	*1120	3.6	*1780
1217200	744400	5/11/00	TS-4400N7200E	000512K006 / A-0412	Fail	6.2	201.00	5.4	*1070	981	2.1	*2780
1217350	744100	5/11/00	TS-4100N7350E	000512K007 / A-0413	Fail	3.5	1850.00	7.1	*1170	*2280	*14	*3120
1217350	744250	5/11/00	TS-4250N7350E	000512K008 / A-0414	Fail	6.8	202.00	*28.4	*3990	747	2.4	*5780
1217500	744100	5/19/00	TS-4100N7500E	000522K002 / A-0488	Fail	6.7	215.00	12.1	*3980	376	0.57	*3050
1217500	744250	4/27/00	TS-4250N7500E	000502K004 / A-0381	Fail	5.6	228.00	10.5	*3570	413	0.95	*3670
1217650	744100	4/27/00	TS-4100N7650E	000502K005 / A-0379	Fail	4.9	342.00	9.1	*1430	239	4.3	*2020
1217650	744250	5/3/00	TS-4250N7650E	000509J001 / A-0405	Pass	7.2	87.90	U6.2	*1110	211	0.19	*1240
1217800	744100	4/27/00	TS-4100N7800E	000502K006 / A-0380	Fail	6.2	344.00	U6.2	*1460	506	1.6	*2960

Notes:

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(mg/kg) - Millgrams per kilogram
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* - Exceeds Criteria Level

TABLE 6
Tailings/Impacted Soils Removal Verification Sampling Results
Silver Bow Creek / Butte Area NPL Site
Streamside Tailings Operable Unit, Subreach 1 Reach A
Sample Depth 0 - 4 inches

Easting	Northing	Sample Date	Sample ID	Laboratory Number (MSE / Ashe)	Pass / Fail	pH (s.u.)	Arsenic (mg/Kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Zinc (mg/kg)
1217850	744150	6/6/00	TS-4150N7850E	000612K011 / A-0643	Fail	7.3	439.00	U5.3	*2690	*1470	1.3	*2660
1218020	744030	6/6/00	TS-4030N8020E	000612K009 / A-0641	Pass	7.3	511.00	13.3	991	573	1.2	*6040
1218250	744100	11/22/99	TS-8250E4100N	S013829 / 9-2155	Fail	6.6	1440.00	*52.5	*8790	*1440	0.29	*16000
1218300	744040	6/6/00	TS-4040N8300E	000612K010 / A-0642	Pass	7.1	96.30	7.2	*1140	376	0.15	*2190
1218400	744150	10/28/99	TS-8400E4150N	S013066 / 9-1841	Pass	9.9	14.90	*20.9	266	113	4.7	*2720
1218550	743800	5/24/00	TS-3800N8550E-A	000526L009 / A-0604	Fail	6.5	306.00	15.7	*2440	867	1.4	*3540
1218550	744020	6/6/00	TS-4020N8550E	000612K008 / A-0644	Pass	6.7	50.40	8.1	678	169	0.15	*2190
1218550	744100	11/1/99	TS-8550E4100N	S013081 / 9-1842	Pass	7.7	184.00	U3.4	*1870	826	6.2	*1940
1218700	743800	4/25/00	TS-3800N8700E	000427J002 / A-0319	Pass	6.2	22.20	U6.2	140	97.4	0.063	436
1218700	743900	4/25/00	TS-3900N8700E	000427J004 / A-0321	Fail	6.1	258.00	U6.2	*1140	*1320	*21.2	*3640
1218700	744100	11/4/99	TS-8700E4100N	S013272 / 9-1911	Pass	7.11	23.10	U3.4	170	168	0.98	438
1218850	743950	4/25/00	TS-3950N8850E	000427J001 / A-0318	Fail	4.6	330.00	12.8	*1820	*1300	2.9	*4010
1219000	743800	3/31/00	TS-3800N9000E	0003311003 / A-0193	Pass	6.1	113.00	6.4	*6470	311	0.073	*1090
1219150	743650	4/7/00	TS-3650N9150E	000410O001 / A-0214	Pass	5.9	32.90	*24.2	*1440	335	2	418
1219300	743650	4/7/00	TS-3650N9300E	000410O002 / A-0215	Pass	5.9	36.10	U6.2	244	183	0.82	*1340
1219300	743800	11/4/99	TS-9300E3800N	S013273 / 9-1912	Fail	4.09	561.00	U3.4	815	*2200	*22.9	*1620
1219450	743500	4/4/00	TS-3500N9450E	000410O006 / A-0219	Pass	6.8	29.00	U6.2	*1150	157	0.73	*1290
1219450	743650	4/5/00	TS-3650N9450E	000410O005 / A-0218	Pass	6	7.90	U6.2	98.4	59.3	U0.02	516
1219600	743500	4/5/00	TS-3500N9600E	000410O003 / A-0216	Pass	7.1	248.00	U6.2	857	405	3	*1410
1219600	743650	11/4/99	TS-9600E3650N	S013274 / 9-1913	Pass	4.42	7.40	U3.4	*1200	153	0.28	313
1219750	743500	4/17/00	TS-3500N9750E	000418J001 / A-0282	Pass	6.3	88.50	U6.2	839	326	0.69	*1600
1219900	743350	4/10/00	TS-3350N9900E	000411J002 / A-0225	Pass	3.7	598.00	9.6	782	560	2.7	*3350
1219900	743500	4/12/00	TS-3500N9900E	0004131020 / A-0233	Pass	6.8	101.00	6.4	536	362	2.3	970
1220050	743350	4/5/00	TS-3350N0050E	000410O004 / A-0217	Fail	6.2	338.00	7.2	*1910	*1590	*11.1	*3070
1220150	743350	3/31/00	TS-3350N0150E	0003311004 / A-0194	Pass	6.2	80.90	6	449	310	0.19	*5270
1220350	743350	4/10/00	TS-3350N0350E	000411J001 / A-0224	Fail	3.7	389.00	6.8	*1910	657	2.1	*1700
1220500	743500	11/22/99	TS-0500E3500N	S013830 / 9-2154	Pass	7.26	15.30	*23.7	79	55.2	6.3	*1250
1220650	743200	12/10/99	TS-0650E3200N	S013884 / 9-2300	Pass	7.07	61.10	U3.4	178	261	4.8	471

Notes:

(s.u.) - Standard units
(mg/kg) - Millgrams per kilogram
U - Below laboratory practical quantitation level

-- - Sample not collected/analyzed
* - Exceeds Criteria Level

TABLE 6
Tailings/Impacted Soils Removal Verification Sampling Results

Silver Bow Creek / Butte Area NPL Site
Streamside Tailings Operable Unit, Subreach 1 Reach A
Sample Depth 0 - 4 inches

Easting	Northing	Sample Date	Sample ID	Laboratory Number (MSE / Ashe)	Pass / Fail	pH (s.u.)	Arsenic (mg/Kg)	Cadmium (mg/kg)	Copper (mg/kg)	Lead (mg/kg)	Mercury (mg/kg)	Zinc (mg/kg)
1220650	743350	11/15/99	TS-0650E3350N	S013642 / 9-2061	Pass	6.54	39.90	U3.4	279	155	1.9	321
1220950	743050	12/9/99	TS-0950E3050N	S013856 / 9-2247	Pass	7.21	22.00	U3.4	137	146	0.26	430
1221050	743100	11/5/99	TS-1050E3100N	S013275 / 9-1914	Pass	7.1	18.70	U3.4	127	75.9	4.6	298
1221050	743250	10/18/99	TS-1050E3250N	S012876 / 9-1730	Pass	7.2	16.60	U3.2	29.2	132	0.22	267
1221200	743250	10/18/99	TS-1200E3250N	S012875 / 9-1731	Pass	7.5	34.80	U3.2	189	116	0.47	586
1221250	743100	10/25/99	TS-3100N1250E	S012922 / 9-1776	Pass	7.3	97.20	U3.4	808	249	0.3	821
1221350	743100	10/26/99	TS-3100N1350E	S012975 / 9-1782	Pass	7.2	102.00	U3.4	317	217	1.7	625
1221350	743250	10/18/99	TS-1350E3250N	S012874 / 9-1732	Pass	7.7	26.00	*26.3	593	53	U0.034	684
Criteria Levels							**200**	**20**	**1000**	**1000**	**10**	**1000**

Total Pass	**60**
Total Fail	**32**
Total	**92**
Percent Pass	**65.2%**

Notes:

(s.u.) - Standard units
(mg/kg) - Millgrams per kilogram
U - Below laboratory practical quantitation level

-- - Sample not collected/analyzed
* - Exceeds Criteria Level

APPENDIX H

Soils Co-Located with Sparse Vegetation

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http://reclamationresearch.net/

MEMORANDUM

To: Dennis Smith, CH2M Hill

From: Dennis Neuman

Re: Revised section of the SST 5 year review regarding contamination of cover soils via upward movement of water carrying salts, sodium, acidity, and metals

Date: February 17, 2011

Explaining Impaired Revegetation as a Function of Cover Soil Properties (Prodgers, 2005; Prodgers, 2007a; Prodgers, 2007b)

In 2005, an investigation was initiated to gather soils and measure plant cover from certain locations in Subarea 1and 2 which had been remediated as part of the cleanup of Silver Bow Creek Streamside Tailings OU. The main study objective was to identify post-remediation edaphic limitations and their relation to revegetation success. Independent variables were several cover soil properties; plant cover was the response variable. Forty sites, most with impaired vegetation and often with salt on the surface soil, were sampled. Determinations of the concentrations several elements, as well as electrical conductivity (EC) and sodium absorption ratio (SAR) were conducted. The following text is a review of this report and a display of the data found in the report:

- Within large areas receiving uniform treatments, spots of poor revegetation or in extreme cases barren patches occur. These areas were observed on several occasions, most recently on a field tour in late September 2009.
- At least 11 site soils have been contaminated with metals. The metals were not initially in the cover soil at the concentrations now observed.
- Four sites with the least amount of vegetation cover (values are 0, 0, 4, and 8 percent) have all have pH levels less than 5.2 and sum of metals/arsenic greater than 1,700 mg/kg. These soils are also saline (EC greater than 4 dS/m). These soils have the highest metal/pH index.
- All soils, with the exception of three, from the sites are saline with EC levels greater than 4 dS/m. The cover soil specification for EC is 4 dS/m. Many of the soils are also sodic with SAR values greater than 12. Either poor quality cover soils were laid down during remediation or they became saline and sodic by upward movement of salt and sodium from materials beneath the cover soil.

- At least 11 site soils have been contaminated with metals. The metals were not initially in the cover soil at the concentrations now observed. Upward movement of metals and arsenic has contaminated the soils at these sites.
- The soils from all the sites evaluated because of "impaired vegetation", were either saline, sodic, low pH, and elevated metals or various combinations of these factors. The five soils from the sites with the greatest vegetation cover (greater than 100 percent) were not saline, had metal and arsenic concentration meeting the cover soil specifications, and were of neutral pH. Table 6-9 shows data for the sites arranged by increasing vegetation cover. The soils data are for the 0 to 2 inch depth increment.
- Specifications for cover soils for use in SST OU are found in the SST ROD and the 1999 Final Design Report (Table 3.10-1). Some of these coversoil specifications are as follows:
    - Arsenic < 30 mg/kg
    - Cadmium < 4 mg/kg
    - Copper < 100 mg/kg
    - Lead < 100 mg/kg
    - Zinc < 250 mg/kg
    - Mercury < 5 mg/kg
    - SAR (sodium adsorption ratio) < 12
    - EC (electrical conductivity) < 4 dS/m
    - pH > 5.5 < 8.5

  Highlighted data in the table below exceed cover soil specifications and most likely have been contaminated by upward movement of water conveying salts and metals. Note: see section above regarding low pH and elevated metal/arsenic concentrations in unexcavated materials which were capped with cover soils.

Soils Data Co-located with Increasing Vegetative Cover

cover	Cu	Mn	Zn	As	EC	SAR	pH
%	mg/kg	mg/kg	mg/kg	mg/kg	dS/m		
Cover soil Specifications	100		250	30	<8	<12	>5.5<8.5
0	619	957	898	10	10.1	6.9	5.2
0	2491	2386	1708	146	5.81	0.9	5
4	2599	2274	3808	17	18.1	4.5	3.4
8	511	694	545	5	9.9	3.2	3.3
10	554	1160	1291	50	14	36.7	7.1
10	29	424	61	5	17.4	43.1	7.7
13	31	414	131	6	18	36.8	8
15	56	430	136	9	10.8	29.6	7.8
16	88	686	207	8	4.04	4.7	6.6
18	31	440	95	5	13.5	35.9	8
18	47	476	144	5	7.56	9.5	6.9
18	42	530	164	8	11.7	30.2	8.3
20	21	700	81	7	3.94	6.3	7.7
20	27	585	62	6	28.4	19.7	5.8
21	37	598	142	8	15.6	35.9	8.2
21	47	938	127	6	11.2	29.2	8
23	505	1530	1029	68	5.97	3.8	5.5
24	40	419	88	6	21.5	50.3	7.7
25	2165	3922	4598	181	14.4	14.9	6.1
25	36	1136	81	11	26.1	72.1	7.6
26	23	325	53	6	16.4	13.1	7.6
26	26	647	121	2	10.2	29.5	8.2
27	113	511	243	25	0.25	0.3	6.3
29	85	561	427	8	14.8	29.2	7.6
29	53	503	206	8	11.4	25.8	8.2
30	27	320	70	4	12	24.3	7.9
32	44	549	179	5	17.4	44.5	8.1
34	188	1517	333	19	5.95	28.9	8.2
34	41	1160	202	8	6.29	9.7	7.7
35	23	331	58	7	16.3	37	7.6
54	1086	1939	2615	127	3.51	3.9	7
54	35	668	110	6	4.82	7.7	7.9
55	34	437	115	19	7.03	17.1	7.9
62	813	2194	1731	121	4.27	4.3	7.3
64	34	476	90.1	5	6.29	9.9	7.6
65	57	415	97	10	4.33	6.1	7.8
104	38	444	81	7	4.1	3.4	7.7
116	53	731	105	6	6.78	17.1	7.6
119	36	583	182	6	4.47	12.2	7.7
124	29	386	74	6	5.16	3.3	7.5
130	37	597	124	6	5.34	7.8	7.6