BIOLOGICAL ASSESSMENT

Silver Bow Creek/Butte Area Superfund Site

Prepared for

U.S. Environmental Protection Agency

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Acronyms and Abbreviations

°C	degrees Celsius
°F	degrees Fahrenheit
ac-ft	acre-feet
amsl	above mean sea level
ARAR	Applicable or Relevant and Appropriate Requirement
BA	biological assessment
BLM	Bureau of Land Management
BMFOU	Berkeley Mine Flooding Operable Unit
BMP	best management practice
BO	biological opinion
BPSOU	Butte Priority Soils Operable Unit
BTL	Butte Treatment Lagoon
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	Clark Fork River
cfs	cubic feet per second
CHRU	Columbia Headwaters Recovery Unit
COC	contaminant of concern
DEQ	Montana Department of Environmental Quality
DNRC	Montana Department of Natural Resources and Conservation
DPS	Distinct Population Segment
DO	dissolved oxygen
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act of 1973, as amended
ESD	Explanation of Significant Differences
FS	feasibility study
FWP	Montana Fish, Wildlife, and Parks
FYR	Five-Year Review
IPAC	Information for Planning and Consultation
LAU	lynx analysis unit
LCA	Lynx Conservation Agreement
LOA	Lower Area One
LWD	large woody debris

MBTSG	Montana Bull Trout Scientific Group
mg/L	milligram per Liter
MWB	Mill-Willow Bypass
NMFS	National Marine Fisheries Service
NPL	National Priorities List
NPS	National Park Service
O&M	operations and maintenance
OU	operable unit
PCE	primary constituent element
PLC	Programmable Logix Controller
PRP	Potentially Responsible Party
Reclamation	Bureau of Reclamation
RI	remedial investigation
RMAP	Residential Metals Abatement Program
ROD	Record of Decision
RP	Responsible Party
SBC	Silver Bow Creek
SBCBA	Silver Bow Creek/Butte Area
Site	Silver Bow Creek/Butte Area Superfund Site
SSTOU	Streamside Tailings Operable Unit
T&E	threatened and endangered
TSS	total suspended solids
UAO	Unilateral Administrative Order
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WQS	Water Quality Standards
WSC	Warm Springs Creek
WSPs	Warm Springs Ponds

SECTION 1

Introduction

1.1 Purpose and Need

Pursuant to section 121(d) of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), the U.S. Environmental Protection Agency (EPA) has identified the federal Endangered Species Act of 1973, as amended (ESA), as an applicable or relevant and appropriate requirement (ARAR) for the six ongoing remedial actions at the Silver Bow Creek/Butte Area (SBCBA) Superfund Site (Site) in southwestern Montana (see Figure 1-1). Consistent with recommendations in EPA's Comprehensive Five-Year Review Guidance, EPA is seeking to determine the effect of changed ARARs on the protectiveness of the remedies. Given the U.S. Fish and Wildlife Service's (USFWS) designation of bull trout *(Salvelinus confluentus)* critical habitat (75 FR 63898) in the nearby Warms Springs Creek drainage and the upper Clark Fork River (CFR), the ESA ARAR has changed. The purpose of this biological assessment (BA) is thus to help inform whether that change affects the ongoing protectiveness determinations for the remedies within the SBCBA Site and to ensure substantive compliance with the ESA as an ARAR.

CH2M has prepared this BA for EPA to evaluate the potential effects on threatened and endangered (T&E) species and their designated critical habitat, as applicable, that may occur as a result of remedial actions within the SBCBA Site, consistent with section 7(a)(2) of the ESA. ESA Section 7 requires federal agencies to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of a listed species, or result in the destruction or adverse modification of federally designated critical habitat. ESA section 9 also prohibits the take of listed species. This BA evaluates and addresses federally listed T&E species and any relevant designated critical habitat that may occur within the action area and/or may be affected by the project.

1.2 Background

Extensive mining, milling, and smelting operations in Butte from the 1880s until the 1980s produced widespread degradation of the environment while generating large volumes of mine waste and contamination (see Photo 1-1). Much of this waste was dumped in an uncontrolled manner in the vicinity of Butte or directly into Silver Bow Creek (SBC). These waste disposal practices contaminated soil, sediment, groundwater, and surface water with arsenic and heavy metals, leaving the natural landscape of the area void of vegetation and wildlife. Mining operations conducted waste disposal in this manner at the Site until the early 1970s. During the height of mining activity, the largest flood in the area's history occurred in 1908. This event contributed to the extensive distribution of contaminants throughout the fluvial corridors of SBC and CFR from Butte to Milltown, Montana.

Photo 1-1. Historical photo of Butte Hill in 1890s (note numerous waste rock dumps, lack of vegetation, proximity of houses and buildings to active mining, etc.).

In September 1983, EPA listed the SBC Site on the CERCLA National Priorities List (NPL). Work began on a site-wide remedial investigation (RI) in 1984. Preliminary results indicated that upstream sources (in and around Butte) were primarily responsible for the contamination observed in the creek. After an evaluation of the two areas (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 SBCBA Superfund Site in 1987. The Site addresses the release or threatened release of contamination associated with mining operations, which include the impacted and degraded areas that extend from the rural areas surrounding Butte, through large portions of Butte itself, into the Blacktail Creek/SBC drainage, and downstream to the Warm Springs Ponds (WSPs). Screening studies and risk assessments since the early 1990s identified contaminants of concern (COCs) and quantified human health and environmental risks from these COCs in solid media (including tailings [discarded milled ore, not worth further processing], waste, sediment, soils, and indoor dust), surface water, and groundwater. For over 30 years, EPA's remedial activities at the Site have been implemented with the objective of cleaning up the significant soil, groundwater, and surface water contamination resulting from a century of copper mining activities to protect human health and the environment.

1.3 Silver Bow Creek/Butte Area Superfund Site

The Site comprises seven contaminated areas, defined as Operable Units (OUs), delineating a contiguous corridor of contamination for approximately 26 miles, from the waste piles in and around Butte downstream to the WSPs (see Figure 1-2). Records of Decision (RODs) are approved for six of the seven OUs (described in the following subsections), including two OUs for the WSPs complex. The two WSPs OUs have interim RODs prescribing interim actions to be performed until the final remedial action is selected and documented in final RODs.[1] For the seventh OU, West Side Soils, the RI stage of the

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[1] EPA (1999) guidance suggests that the use of an interim ROD for a site or OU may be appropriate when there is a need to: (a) take quick action to protect human health and the environment from an imminent threat in the short term, while a final remedial solution is being developed; or (b) institute temporary measures to stabilize the site or operable unit and/or prevent further migration of contaminants or further environmental degradation (EPA, 1999).

CERCLA process has not yet started. Large stretches of the Site are linked by SBC. As such, in addition to affecting upland habitats in the drainage, each OU potentially influences the natural integrity of SBC through the discharge of treated water, surface water runoff, groundwater discharge, and erosion of channel material. In concert, these contributions dictate the quality of water flowing into the WSPs. The SBC water entering the Ponds is subjected to a combination of active treatment methods and naturally occurring (passive) processes that affect water quality. Consequently, the quality of water emanating from the watershed encompassing the SBCBA Site is modified and ultimately controlled by the WSPs before it is discharged to the Mill-Willow Bypass (MWB), and flows to the upper CFR, which is designated as critical habitat for the bull trout.

The following text provides a summary of each OU in the SBCBA Site, along with each OU's potential to affect terrestrial features, habitat, and water quality in SBC as it flows north through the drainage. All protective measures currently in place and described below were developed to remediate environmental and human health concerns in the watershed and in turn, minimize potential effects resulting from historic land-use activities (hard rock mining) on ESA-listed species and their habitat in the area. Much of the following text for this section was obtained from the SBCBA *Fourth Five-Year Review Report* (EPA, 2016) (FYR) and RODs for the OUs comprising the Site.

1.3.1 Mine Flooding/Berkeley Pit OU (OU3)

The Berkeley Mine Flooding OU (BMFOU) is located in the Butte mining district and includes portions of the Montana Resources' permitted active mine area (the active mine area is governed largely by a permit issued by the state of Montana, and EPA has deferred Superfund action that would be duplicative of actions required by the permit), and includes the contaminated bedrock aquifer. It is bounded by the Continental Divide to the east, SBC to the south, Missoula Gulch to the west, and the Yankee Doodle Tailings Pond and upper SBC to the north (Figure 1-3 and Photo 1-2). Mine features and the town of Butte have significantly altered the natural topography and environment of this area. The Berkeley Pit is BMFOU's major feature. It is 1,780 feet deep and encompasses 675 acres. Historically, the upper reach of SBC extended above the Yankee Doodle Tailings Pond and was the main stream drainage in the BMFOU. Mining and other activities in the area greatly changed the original channel alignment. Runoff from the localized area surrounding the Berkeley Pit does not currently reach SBC below Blacktail Creek. Surface water in the active mining area is controlled by a series of ditches and ponds that convey runoff and mine process water to various locations, including the Berkeley Pit. From the Montana Resources Concentrator to the confluence with Blacktail Creek, SBC flows west and then north en route to the southern Deer Lodge Valley.

With the cessation of area dewatering in the early 1980s, the Berkeley Pit represents the low point in the area and as such, is filling with water (groundwater and runoff). The water is contaminated by its exposure and contact with mineralized bedrock, mine wastes, and tailings. Contaminated water has flooded thousands of miles of associated underground mine workings (lying beneath the mine area, the city of Butte and town of Walkerville, and the Montana Resources permitted active mine area). The rising pool elevation in the Berkeley Pit represents a concern as it approaches a layer of alluvium that extends out into the lower Butte valley; as such, it is closely monitored. Active mining continues in the Continental Pit nearby, in Montana Resources' permitted area. The active mining operations use treated site water, which beneficially affects the water balance in the BMFOU. An active hard rock mining permit issued by Montana Department of Environmental Quality (DEQ) addresses future reclamation of the active mining operations.

Photo 1-2. Recent aerial photo of Berkeley Mine Flooding OU and active mine area (south end of SBCBA Site).

The remedy selected in the ROD (EPA, 1994), and revised by the Explanation of Significant Differences (ESD) (EPA, 2002a), addresses contaminated water in the Berkeley Pit, contaminated water in associated underground mine workings, and other contaminated inflow to Berkeley Pit and BMFOU. The focus of the BMFOU selected remedy is on containment and eventual treatment of the contaminated water; there are no water quality standards to be met in the affected BMFOU aquifer. The Berkeley Pit is filling with water from surrounding bedrock and alluvial aquifers and from surface water runoff. Water accumulating in the pit and in the bedrock aquifer is acidic (the result of acid-generating reactions, such as the oxidation of pyritic minerals) and contains high concentrations of metals. Because the water level in the Berkeley Pit is the lowest groundwater elevation in the bedrock system, all bedrock groundwater in the area flows toward the Berkeley Pit. By design, the selected remedy ensures that contaminated mine water is contained and treated. However, if water levels were to continue to rise in an uncontrolled manner, the hydraulic gradient could change and contaminated water could begin to flow out of the East and West Camps into surrounding alluvial groundwater and eventually to SBC. To prevent this, the selected remedy determined critical groundwater level elevations for the East Camp (5,410 feet above mean sea level [amsl]) and the West Camp (5,435 feet amsl) that should not be exceeded. Management of future rising groundwater includes pumping water to the Horseshoe Bend water treatment plant and use of treated water in the Montana Resources active mine operations, or discharge of treated water to SBC. Models predict that pit infilling will approach critical thresholds by 2023 if remedial action is not employed to reduce infilling rates. The potential for SBC to be influenced by groundwater entering the valley alluvium from BMFOU is low for the foreseeable future, but will likely increase if, for some reason, groundwater rises unchecked by mining use or remedial action. Additional discussion of options for water control can be found in the SBCBA FYR report (EPA, 2016).

1.3.2 Butte Priority Soils OU (OU8)

The Butte Priority Soils OU (BPSOU) is located a few miles west of the Continental Divide at an elevation range of approximately 5,400 to 6,400 feet amsl. The BPSOU is centered on Butte Hill, the location of the historic Butte Mining District. The BPSOU surface area covers a five-square-mile area that includes the predominantly urban setting of Butte and Walkerville (including their neighborhoods, schools, and parks), as well as commercial and industrial areas (see Figure 1-4). Historically, these communities were built close to the silver and copper mining and milling centers and facilities. In 1920, the population of Butte peaked at 60,313. Operations of mines, mills, concentrators, and smelters in this area generated tailings, related wastes, and a variety of other materials that were dumped onsite, including in the midst of residential areas. The BPSOU-contaminated media includes impacted soils, mine wastes and attic dust, along with mining-impacted alluvial groundwater and surface water associated with the historical and current SBC floodplain in Butte. As of the 2010 U.S. Census, 33,525 people lived in Butte, and 675 people lived in Walkerville.

Two primary streams flow within the Butte area, Blacktail Creek, and SBC. The confluence of Blacktail Creek and SBC occurs within the Butte City limits and this OU. Below this point, the main stem is considered SBC. To accommodate historic mineral extraction/processing activities, SBC was rerouted as needed and used for waste disposal. Tailings impoundments were placed in the floodplain, and wastes were discharged directly into the creek, degrading water quality and habitat conditions in the riparian corridor. With the advent of open pit mining, most of the upper reach of the SBC channel and floodplain were fundamentally altered (as described for BMFOU). Today, many of the waste deposits along historic SBC above and below its confluence with Blacktail Creek remain in place except for remediated areas such as Lower Area One (LAO).

The remedy selected for this OU in the ROD (EPA, 2006) and the ESD (EPA, 2011b) directs cleanup activities to address contaminated solid media (waste rock piles, smelter wastes, milling wastes, contaminated soil, and contaminated dust), surface water base flow, stormwater runoff, and alluvial groundwater. For more information on relevant remedial action objectives, see the 2006 ROD and 2011 ESD for BPSOU.

Substantial cleanup of solid media in residential areas occurred prior to the ROD using Superfund removal authority. After extensive remedial design efforts, EPA and DEQ approved the Butte-Silver Bow Residential Metals Abatement Program (RMAP) in 2010. The RMAP requires a multi-pathway approach to address arsenic, lead, and mercury above action levels in yard soil, indoor dust (living space and direct exposure to nonliving space dust), interior and/or exterior lead paint, and lead solder in household drinking water pipes. After many years of work under pre-ROD removal actions, and extensive post-ROD remedial action work under orders from EPA, numerous contaminated nonresidential areas in BPSOU were remediated through removal of contaminated soils/waste to approved repositories or have working caps and revegetation. The integrity of the caps is continually monitored and maintained, which includes corrective actions.

Above the confluence of SBC and Blacktail Creek, groundwater is currently being captured by a subdrain (French drain) installed under the SBC channel. The captured groundwater is transported to the Butte Treatment Lagoons (BTL) for treatment. The hydraulic control channel also captures contaminated groundwater and directs it to the BTL for treatment. The performance of the subdrain is being monitored and evaluated. Upgrades were completed in 2013. A comprehensive groundwater monitoring program for the entire alluvial aquifer is being developed as part of ongoing remedial design efforts. It is intended to ensure proper functioning of the groundwater control and capture system.

Substantial surface water cleanup work and wet weather control cleanup work was performed under Superfund removal authorities pre-ROD. This work included the removal of substantial portions of the Colorado Tailings and portions of Butte Reduction Work tailings along the base of Butte Hill in the Lower

Area One (LAO) removal action, and the construction of catch basins in the Missoula Gulch area, as well as controls on railroad facility run-off. Surface water monitoring is occurring under a draft interim surface water monitoring plan. Since 2009, three cycles of stormwater control best management practices (BMPs) to mitigate contaminated stormwater runoff have been implemented. These actions included: reclamation and revegetation of areas identified as contamination contributors to stormwater runoff; initiation of routine stormwater system sediment cleanout activities; expansion and improvement of existing catch basins; and initiation of a curb and gutter program. For more detail on BMPs completed under the third cycle, see the 2016 FYR (EPA, 2016).

The BPSOU is still in the remedy implementation phase (including remediation of parts of upper Blacktail and SBC, further capping, additional stormwater controls, and additional groundwater controls), as well as ongoing routine operations and maintenance (O&M) on certain remedial components. Although diminishing with successive remedial construction, conditions at the BPSOU still have the ability to adversely influence water quality in SBC through snow melt and stormwater runoff and other pathways.

1.3.3 West Side Soils OU (OU13)

The West Side Soils OU is located north of Butte; it is bounded to the west by SBC and to the east by the catchment holding the Yankee Doodle tailings impoundment. The exact boundaries of this OU have not been fully determined. The area consists primarily of rangeland. The purpose of this OU is to remediate and eliminate receptor exposure (human and environmental) to mine waste and associated contaminated media (soil, surface water, and groundwater). A future RI will document the extent, fate, and transport of contaminants while a future feasibility study (FS) will identify viable remedial alternatives, ultimately resulting in a Proposed Plan and ROD to guide the final remedial action (cleanup). The remedial investigation/feasibility study (RI/FS) for this OU has not begun, and no EPA removal or remedial action has been taken.

1.3.4 Streamside Tailings OU (OU1)

The focal point of the Streamside Tailings OU (SSTOU) is lower SBC. SBC integrates water quality contributions from five upstream SBCBA OUs and delivers them directly into the WSPs Active Area OU. The SSTOU ranges in elevation from approximately 5,480 feet amsl at the northern end of LAO to approximately 4,920 feet amsl at the I-90 Bridge south of the WSPs inlet. The SSTOU spans most of the entire length of SBC from its origin in the Summit Valley, through Durant Canyon, to its mouth at the inlet to the WSPs in the Southern Deer Lodge Valley. The SSTOU comprises approximately 26 miles of stream and stream-side habitat of SBC and its floodplain (see Figure 1-5). It also includes associated channel sediment, fluvially deposited tailings, and groundwater contamination. Historically, the creek was used to impound smelter tailings and convey wastes out of Butte. The SSTOU ROD (EPA, 1995a) estimated that 2.5 to 2.8 million cubic yards of tailings and contaminated soils covered about 1,300 acres of the OU (see Photos 1-3 and 1-4). In some areas, the tailings were several feet thick. In its pre-ROD conditions, mining wastes, transported downstream by storm and annual runoff events, caused acidic conditions and contaminated the stream and floodplain with arsenic and metals, including cadmium, copper, lead, mercury, and zinc. Historically, aquatic life in SBC was absent or severely impaired as a result of water quality and habitat degradation caused by mining-related contamination. The human health risk assessment conducted during the RI/FS identified the primary carcinogenic risk to people living in or near the area as potential exposure to arsenic in soil and groundwater.

The SSTOU is a large, linear OU with diverse land uses and resources. The SSTOU is located 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 residential, commercial, and industrial land uses. 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. Underlying alluvial aquifers are used as a source of drinking water beyond the floodplain areas.

To facilitate remedial construction, the OU was divided into four subareas based on geomorphic features that control soil, hydrogeology, surface water, fluvial ecology, and demographic/land use characteristics. The objective of SSTOU remedial action was to: remove tailings and impacted soils from the active channel and most areas within the 100-year floodplain, place wastes in designated mine waste repositories; treat all waste left in place; prevent its remobilization from erosion caused by lateral stream migration and flood flows; remove fine-grained in-stream sediments in depositional areas and place in repositories; reconstruct a fluvially competent channel bed and streambank; excavate, treat, and/or cap all contaminated railroad materials that pose a risk to human health or the environment and place in designated repositories; and apply institutional controls to limit use and access. Remedy implementation began in Subarea 1 in 1999 and was substantially concluded in Subarea 4 in 2014, although annual maintenance activities are ongoing to sustain the integrity of the remedy. In Subarea 3, just north of Durant Canyon, a large fish barrier was constructed across SBC at the request of the Montana Fish, Wildlife, and Parks (see Photo 1-5). The purpose of the barrier is to prevent upstream migration of introduced species from SBC, WSPs, and the Clark Fork River drainage basin below the barrier to protect native cutthroat trout above the barrier in SBC and German Gulch Creek (a tributary to SBC), while allowing downstream migration of cutthroat trout.

The removal of tailings-impacted soils from channel floodplains under the SSTOU remedial action, in conjunction with the remedial activities for sources upstream in other OUs, has significantly reduced contaminant levels in SBC. Attainment of performance standards (DEQ, 2012) for water quality throughout the SSTOU continues to be a goal. According to findings reported in the SBCBA 4th FYR (2016), water quality in SBC is significantly improved and approaching performance standards. Surface water monitoring results indicate improved water quality in the SSTOU at all sites where remediation has been completed. However, metal COC concentrations remain variable, and frequently exceed performance goals during spring runoff and storm events. Of the metal COCs, copper most commonly exceeded performance goals in 2013. Remediation work is ongoing at the SSTOU in accordance with the last two five-year review reports.

Photo 1-3. Silver Bow Creek (Ramsay Flats area); Pre-Remedy (early 1970s).

Photo 1-4. SBC Stream Bank with copper salts; Pre-Remedy.

Photo 1-5. Fish barrier constructed across SBC. Located approximately 6.5 miles upstream of the Warm Springs Ponds.

1.3.5 Rocker Timber Framing and Treatment Plant OU (OU7)

The Rocker OU is the smallest OU in the Site, encompassing approximately 16 acres. This OU is located south of U.S. Interstate 15/90 near Rocker, Montana, approximately 3 miles west of Butte, in Silver Bow County (Figure 1-6). The Rocker OU is bounded to the south and west by the SSTOU. Railroad lines and sidings owned by the Butte, Anaconda, and Pacific Railway Company also border the area to the south. The three property parcels that make up the Rocker OU are owned by Anaconda Railroad and Rarus Railroad. The Butte, Anaconda, and Pacific Railway Company has two small storage sheds in the western end of the OU. The property currently includes a repository of treated materials from previous onsite remedial action. The repository is contoured to promote proper surface drainage, vegetated, fenced to limit trespassing, and riprapped along a portion of the north side to protect against erosion during SBC flood events. The small community of Fredericksburg is located to the south. The community of Rocker is just north of SBC.

The Rocker Timber Framing and Treating Plant was built in 1909 and operated until approximately 1957. The Anaconda Company, predecessor to Atlantic Richfield Company, owned and operated the plant. Initially, the facility treated mining timbers with a creosote solution. Later, it used arsenic trioxide solutions for treatment. During operations, uncontrolled releases of process materials (arsenic trioxide powder), treated wood chip residues, and dripped or leaked process solutions (creosote and caustic heated arsenic brines) resulted in contaminated soils and significant groundwater contamination. In addition, and because of its proximity to SBC and its floodplain, wood-treating wastes intermixed with contaminated tailings when mining waste washed downstream from mining and smelting activity in Butte. Arsenic in soils and groundwater at the Rocker OU is the primary COC.

The community of Rocker is surrounded by rangeland and zoned for agricultural, residential, and commercial uses. Land in the Rocker OU is currently used by industry and the railroad, with some recreational use on the Greenway Trail along SBC. Many local wells identified in the area are no longer used because of the potential for contaminants to be drawn into the private wells through use. The Rocker OU overlies three aquifers that are hydraulically connected to each other.

Arsenic in soils and groundwater associated with shallow, intermediate, and deep alluvial groundwater systems represents the human health risk at this OU. No other contaminant (including other metals, creosote, and polycyclic aromatic hydrocarbons) was determined to pose unacceptable cancer or noncancer risk in excess of EPA's acceptable risk range.

The remedy for the Rocker OU ROD (EPA, 1995b) addresses surface soil, alluvium, and groundwater contaminated by wood-treating compounds and mining waste. The goal of the remedy is to attain groundwater quality standards (DEQ, 2012) and prevent the migration of contaminants to SBC through treatment and the removal of contaminated source materials in the soil. Remedial construction began in April 1997.

Recent monitoring information has revealed that arsenic concentrations in groundwater are increasing and that the groundwater plume appears uncontained. The remedy has not succeeded in attaining water quality standards for groundwater underlying and adjacent to the OU. The responsible party (RP) is re-evaluating the conceptual site model to help understand the change in conditions at the Site. Supplemental remedial technologies are also being evaluated to address increasing groundwater arsenic concentrations. Additional groundwater investigation is underway to determine the extent of the plume. The analysis will also determine whether the implemented remedy can meet the goals of the remedy (presented in the Rocker OU ROD [EPA, 1995b] and revised by the Rocker OU ESD [EPA, 2014]), or whether further remedial action is required so that it is protective over the long term.

With respect to SBC, water quality data summarized in the SBCBA FYR (2016) shows no appreciable contribution from the Rocker site. However, additional evaluation and characterization of the area is currently being conducted to further determine if the shallow groundwater has the potential to impact SBC. Additional remedial work will be required at this OU.

1.3.6 Warm Springs Ponds Active Area Operable Unit (OU4) and Inactive Area Operable Unit (OU12) (WSPAAOU and WSPIAAOU)

The WSPs are located in Deer Lodge County, approximately 7 miles east of Anaconda, near the historical confluence of Silver Bow, Willow, Mill, and Warm Springs creeks. These streams form the principal headwaters of the Clark Fork River, which begins approximately 0.25-mile north of the Inactive Area OU boundary.

SBC flows into the south end of the WSPs approximately 26 miles downstream of Butte. The OUs principally consist of three sediment settling ponds built in series over a period of approximately 60 years (Figure 1-7): Pond 1 was completed in approximately 1911, Pond 2 was completed in approximately 1916, and Pond 3 was completed during the late 1950s. Collectively, the WSPs complex covers approximately 2,500 acres. I-90 and the Mill-Willow Bypass (stream diversion around the WSPs) border the OUs to the west. The Clark Fork River borders the OUs to the north. Foothills and rangeland border the ponds to the east, and marsh lands and incoming SBC borders the area to the south. With the construction of the ponds, SBC has been physically separated from other headwaters of the Clark Fork River for over 100 years.

The objective of the ponds was to trap and settle contaminated mine waste (tailings) and sediments transported down SBC before they reached the upper Clark Fork River. The WSPAAOU (OU4) ROD (EPA, 1990) addresses Pond 2 and Pond 3, the Mill-Willow Bypass and berms, inlet and outlet structures, treatment improvement features, and monitoring systems.

In June 1991, EPA identified the Inactive Area of Pond 1 and the area beneath Pond 1 as a separate action to be addressed under a separate ROD (OU12) (EPA, 1991b).

The WSPs system has operated for over 100 years and stores a large volume of contaminated, fluvially deposited sediment (approximately 19 million cubic yards). The Ponds contain contaminated sediments transported by SBC as well as mine wastes removed from the Mill-Willow Bypass and other floodplain deposits. Response actions required by EPA resulted in the upgrade and sustained maintenance of pond containment berms and construction of an improved Mill-Willow Bypass. These features greatly reduce, or eliminate, the potential of a catastrophic release of contaminated material in the event of a large flood or earthquake.

SBC flows from the south and enters Pond 3 near the southern end of the WSPAAOU. Tailings, sediments, and associated contaminants from SBC physically settle to the bottom as the velocity of the incoming water decreases. Water flowing out of Pond 3 goes primarily into Pond 2, with a smaller volume used to maintain several wildlife ponds between Ponds 2 and 3. The effluent from Pond 2 flows into the Mill-Willow Bypass as a regulated point-source discharge (a more detailed explanation of pond operations is provided in Section 2, Project Description). Water from the Ponds then flows down the Bypass to its confluence with Warm Springs Creek, forming the beginning of the Clark Fork River.

No domestic wells are located within the WSPs complex. However, several wells are located within 1 mile east of the pond system. These wells are in bedrock aquifers that do not appear to be affected by the WSPs system. The town of Warm Springs (located northwest) pumps its water from supply wells in unconsolidated tertiary deposits from depths of approximately 200 feet. These wells are supplied with water from groundwater resources west of and hydraulically isolated from the WSPs OUs.

Although “Warm Springs Ponds” is a collective term referring to the entire pond system, interim records of decision have been prepared, approved, and implemented for both the Inactive and Active Area OUs. The interim remedial measures represent the unique management needs and characteristics of each OU. The following text summarizes the interim remedial actions applied to the WSPIAAOU and WSPAAOU.

1.3.6.1 Warm Springs Ponds Inactive Area OU (OU12)

The WSPIAAOU includes Pond 1, the historical SBC channel, some uncontaminated grassland and wet meadows below Pond 1, and the lower bypass channel (which contains the confluence of Mill and Willow creeks with discharge from Pond 2 [SBC]) (see Figure 1-7).

Before remedial action, the Inactive Area OU contained an estimated 3.4 million cubic yards of contaminated sediments, tailings, and soils. Approximately 2.9 million cubic yards of contaminated sediments, tailings, and soils were contained within Pond 1, while approximately 475,000 cubic yards of these materials were located within the historic floodplains downstream of Pond 1. These source materials consisted of overbank deposits that settled out along SBC before the construction of Pond 1.

The WSPIAAOU interim remedy was approved in June 1992, and the remedial action was completed in 1995. Pond 1, the original settling pond, was never involved in the active treatment of SBC water (supplemental lime), and no longer plays a role in settling sediments. OU12 is essentially isolated from the active treatment portion of the pond system. Remediation of the Inactive Area OU included an extensive list of actions that consolidated contaminated materials; raised, strengthened, and re-enforced berms; captured groundwater; created wet-closure cells; chemically fixed (immobilized) tailings and contaminated soils; and implemented ecological monitoring and institutional controls. A more detailed description of these activities can be found in the 2016 FYR and the Inactive Area OU interim ROD (EPA, 1992).

The Inactive Area at the northern boundary of the Site continues to achieve remedial action objectives. Offsite migration of groundwater exceeding performance standards is prevented by a pump back system. The wet closures remain inundated and biologically active. The wet closures are functioning as intended to prevent mobilization or direct exposure to COCs. The WSPs OU12 has no surface water connection to the Mill-Willow Bypass.

According to the 2016 FYR, the remedy at WSPIAAOU is expected to be protective of human health and the environment. In the interim, remedial activities completed to date have adequately addressed exposure pathways that could result in unacceptable risks.

1.3.6.2 Warm Springs Ponds Active Area OU (OU4)

The WSPAAOU comprises Pond 2 and Pond 3, the Mill-Willow Bypass, and berms, inlet and outlet structures, water treatment features, and monitoring systems. The remedy provides a means for controlling contamination associated with pond bottom sediments, surface water, tailings, and contaminated soils and groundwater within the boundaries of the OU. Remedial actions of the selected interim remedy for the WSPAAOU are extensive and were implemented from 1990 through 1995. Specifically, remedial actions have consisted of: sustained operations of Ponds 2 and 3; raising and upgrading berms to protect against floods and earthquakes; increasing the capacity of Pond 3 to accommodate the SBC 100-year flood; upgrading inlet and hydraulic structures to prevent clogging by debris and allow redirecting flows in excess of the 100-year event into the Bypass; upgrading treatment (lime addition) capacity of the ponds to handle flows up to 3,300 cubic feet per second (cfs); mixing water column pool water; removing and consolidating tailings and soils removed from the MWB into Pond 1 and Pond 3 berms; widening the Bypass channel to handle 70,000 cfs and armoring berms of all ponds; flooding dry portions of Pond 2; establishing surface and groundwater quality monitoring systems and performing all activities necessary to ensure compliance with all ARARs; and implementing institutional controls to prevent future residential development, swimming, and consumption of fish by humans.

The selected remedy is an interim cleanup measure that provides the highest degree of certainty that it will be successful. The interim remedy is largely functioning as intended. The final actions at this OU will be determined after remediation of all upstream OUs is completed. Arsenic and pH continue to exceed WSPs effluent discharge standards on a seasonal basis, mainly during the summer and fall months.

SBC water quality coming into the ponds continues to improve. Atlantic Richfield continues to study arsenic cycling in the WSPs and additional remedial work is likely for the WSPs as a result. The Montana Department of Natural Resources and Conservation (DNRC) established the area under WSPs as a controlled groundwater area, prohibiting its domestic use. Atlantic Richfield's private ownership of all the land associated with the WSPs OUs contributes to access control and prevents public use of contaminated groundwater, swimming in the ponds, and preserves the integrity of the pond complex. Revisions to, and attainment of, the cleanup goals will be considered in the final remedy selection. For example, if the existing standards are found to not be protective, the original water quality cleanup levels stipulated in the interim ROD for the WSPs OUs (EPA, 1991b) may need to be revised because the Montana surface water quality standards are now more stringent for certain contaminants (e.g., cadmium and copper). In addition, the additional and focused ecological risk assessment called for in the 2011 FYR has not been completed.

A final ROD is anticipated in the future for the entire WSPs complex (possibly within 15 years). The final remedial work to be described in the final ROD has not yet been determined.

1.4 Endangered Species Act Action Area

"Action area" refers to areas affected directly or indirectly by the proposed action, and not merely the immediate area involved in the action (50 *Code of Federal Regulations* [CFR] § 402.02). This may include upland, riparian, and aquatic areas affected by site preparation, construction, and site restoration design criteria at each action site (USFWS and NOAA Fisheries, 1998). The ESA action area, therefore, extends to where direct or secondary (indirect) impacts could potentially occur as a result of the remedial action activities in all six of the OUs with selected remedies in the SBCBA Site. Thus, the action area is defined as the extent of the SBCBA Superfund Site where remedial action has occurred or is occurring (see Figure 1-2), and downstream from the WSPs discharge into the Mill-Willow Bypass to its confluence with Warm Springs Creek and into the upper Clark Fork River. This represents the extent to which any anticipated effects to water quality associated with flow from the WSPs might persist.

As previously mentioned, SBC is the common link connecting the OUs and integrating surface water flow and quality within the project site north into the WSPs. SBC conveys water affected by the upstream OUs to the WSPs, which manipulate and control the water quality of effluent discharged to the MWB and to the upper CFR.

SECTION 2

Project Description

This section describes the proposed action, with a brief discussion of the active elements of the remedial actions occurring in the OUs comprising the SBCBA Site, followed by a more detailed description on the operation, maintenance, and functioning of the WSPs complex.

2.1 Proposed Action

The proposed action for this BA consists of the performance of remedial action activities at the OUs that make up the SBCBA Superfund Site. As described in Section 1.0, multiple remedial actions have been implemented in the action area over the last 30 years for the purpose of protecting human health and the environment. The results of these activities are reflected in marked improved site conditions, including water quality improvements in SBC. Additional remedial activities will continue to occur at the six OUs.

Table 2-1 lists active elements of the remedial actions at each OU (proposed action) that are ongoing or expected to be completed within the next 5 years.

Table 2-1. SBCBA Site Active Remedial Elements

Operable Unit	Active Remedial Elements
Berkeley Pit Mine Flooding OU3	• Continue to capture Horseshoe Bend discharge, treat water, and pump into Montana Resources Mining Operation. • Monitor groundwater levels in East and West Camp mine workings relative to exceeding alluvium contact threshold elevation. • Upgrade the capacity of the Horseshoe Bend water treatment plant to handle anticipated groundwater volume for treatment and discharge. Confirm discharge water quality is acceptable for discharge to SBC if such discharge occurs. • Sustain the Butte Alluvial and Bedrock Controlled Groundwater Area as the required institutional controls. • Sustain the Waterfowl Mitigation Plan for the Berkeley Pit.
Butte Priority Soils OU8	• Complete the remediation of contaminated residential properties (for example: soil removal, capping, and revegetation). • Maintain the integrity of soil caps on existing nonresidential properties and repositories to prevent uncontrolled exposure or releases to the environment. • Upgrade, expand, and maintain the groundwater subdrain and related features that captures contaminated groundwater and discharges to the Butte Treatment Lagoon System for treatment. • Sustain monitoring of groundwater levels and water quality. Implement remedial activities as necessary. • Reclaim and revegetate areas identified as contamination contributors to stormwater runoff; initiate stormwater system sediment cleanout activities on a periodic basis; expand and improve existing catch basins and continue a curb and gutter program. • Maintain and implement stormwater control BMPs to mitigate contaminated stormwater runoff into Blacktail Creek and SBC. Address floodplain contaminated waste.
Rocker OU7	• Refine groundwater monitoring network to track and remediate expanding arsenic plume and associated soil source materials. Prevent plume in alluvial aquifer from intercepting SBC or expanding.

Table 2-1. SBCBA Site Active Remedial Elements

Operable Unit	Active Remedial Elements
	• Maintain the integrity of the contaminated soils repository and site vegetation to prevent uncontrolled exposure or releases to the environment. • Maintain institutional controls on the groundwater to prevent potable use.
Stream Side Tailings OU1	• Complete removal of residual contaminated tailings in reclaimed subareas (especially subareas 1 and 2). Revegetate as needed. • Monitor and quantify surface water contaminant loads from tributaries of SBC. Remediate as necessary. • Monitor and maintain integrity of remediated floodplain areas and BMPs to prevent stormwater erosion and transport of contaminated sediment and soil into SBC.
Warm Springs Ponds OUs (Active Area OU4 and Inactive Area OU12)	Operation, maintenance, and monitoring of surface and ground water treatment and management facilities, as described in Section 2.2.

The current operations and active remedial elements of the WSPs OUs and associated distribution of water are described in the following text.

2.2 Warm Springs Ponds OUs Operations

As the farthest downstream OUs in the SBCBA Superfund Site, the WSPs directly influence the quality of water discharged into the MWB and upper CFR. Consequently, the active remedial elements at the WSPs OUs play a large role in determining the potential water quality effects on designated critical habitat for bull trout in the Clark Fork River.

The primary objective of the WSPs system is to achieve compliance with water quality standards specified in the Unilateral Administrative Order (UAO), Exhibit 5 (EPA, 1991b) for water discharging from the system. The WSPs complex includes three large ponds constructed between 1911 and the late 1950s to capture and settle mine waste transported downstream by SBC. Only two of these ponds are still actively involved in water treatment. SBC flows into the south end of Pond 3, the largest and the most upstream pond. Most of the water flows from the northern side of Pond 3 into Pond 2. Pond 2 discharges from an overflow structure in its northwest corner to the MWB; this is considered Outfall 002 in the UAO (EPA, 1991b). The WSPs outfall creates a barrier to upstream migration of bull trout and other fish into the ponds and blocks access to the upper SBC and other headwater streams. Below this discharge point, the combined flow of MWB and the WSPs discharge is once again referred to as SBC for 0.6 mile to its confluence with Warm Springs Creek, where it becomes the upper CFR.

Other than the three main ponds, features of the WSPs complex include: lime storage silo and lime/water slurry makeup and feed system facilities for treating SBC water entering Pond 3; emergency spillways for Pond 3 and Pond 2; Pond 2 East and West wet closure facilities, three wildlife ponds between Ponds 3 and 2; the Pond 1 dry- and wet-closure facilities, three wet closure cells below Pond 1; fixed monitoring stations on the MWB and WSPs; and a groundwater interception and pumpback system (see Figure 2-1).

Photo 2-1. Pond 2 outfall structure and barrier to fish passage into the Ponds from the Mill Willow Bypass.

Operation of the WSPs treatment facilities and hydraulic structures are coordinated to optimize water quality for SBC flow ranges up to the peak 100-year flood inflow. Inflows of up to 3,300 cfs (100-year inflow) are treated and routed through the WSPs system (see Figure 2-2). Flows in excess of the 100-year event are diverted around the WSPs via the MWB. The last known occurrences of diverting flood flows were March 2003 and June 2011. Flow entering Pond 2 from Pond 3 is controlled and limited to no more than 200 cfs. Flows into Pond 3 in excess of the maximum outflow to Pond 2 are accommodated by flood storage in Pond 3 and/or discharge to the MWB. Although the primary purpose of the wet-closure cells within Pond 2 is to inundate exposed tailings and thereby prevent direct contact or release, secondary benefits to water quality are anticipated (lessen their contact with oxygen and thereby limit acid generating reactions (e.g., oxidation of pyrite and other sulfide minerals)). The major hydraulic structures have been designed such that pond levels, discharge locations, and discharge flow rates can be varied as necessary to adjust treatment operation of the WSPs system.

Treatment of water entering the WSPs consists of the following processes. Hydrated lime slurry ($Ca[OH]_2$) is added to SBC water at the Pond 3 inlet during portions of the year when influent pH is below a target value (only in winter and early spring in recent years) to raise pH to levels where dissolved metals (such as cadmium, copper, lead, and zinc) precipitate as hydroxides. Precipitated metals, along with suspended solids occurring in the influent water, settle out under the relatively quiescent conditions in the large ponds. This treatment is generally effective, and WSPs effluent quality typically meets the established discharge standards except for pH and arsenic concentrations in summer and early fall. These exceedances appear to be unrelated to influent water quality and treatment activities (such as lime addition); rather, they appear to be caused by naturally occurring seasonal processes in the ponds (including algae production/photosynthesis, biomass decay in sediments resulting in reducing conditions, and dissolution of iron and arsenic). In an attempt to mitigate arsenic bleed-back from the sediments, a number of solar-powered mixers (SolarBees) are operated in the ponds during the warm months to vertically mix pond water and disrupt stratification and stagnation of bottom water. A groundwater interceptor trench is located just downgradient of the WSPs, to capture and contain leakage from the ponds; the extracted groundwater is pumped back to Pond 2 for treatment.

In summary, active elements of the remedial actions in the WSPs OUs, which comprise part of the proposed action for this BA, include:

- Lime addition to WSPs influent at the SBC inlet to Pond 3 for upward pH adjustment.
- Adjusting hydraulic structures to maintain proper water levels and flows in the various ponds and wet closure cells comprising the WSPs complex.
- Solar mixing of the water column via SolarBee units located in Ponds 2 and 3.
- Groundwater interception/extraction and pumpback to Pond 2 via a collection trench and a line of shallow and deep wells.
- Inspection and structural maintenance of all WSPs berms, water conveyance features, toe drains, and associated pumps and piping.
- Diverting excess flows around the WSPs and Pond 2 as needed during high river flow periods.

Normal operation of each component of the WSPs system is described in the following subsections, using text obtained from the *Operation and Maintenance Plan for the Warm Springs Ponds Operable Unit* (AR, 2010).

2.2.1.1 Pond 3 Inlet

Under normal conditions, all flow in SBC is diverted through the Pond 3 inlet channel to the inlet structure. The gates at the Inlet Structure remain fully open during all flow conditions unless approved maintenance on downstream structures requires diversion of the flow. Such diversion must be approved by EPA. The flow is measured at the Inlet Structure (monitoring station SS-1) using a continuous recording gauge calibrated to the inlet gates for high flows greater than 2,000 cfs, and to the downstream weir for lower flows. When needed to meet water quality objectives, lime slurry is added downstream of the inlet structure gates to adjust the pH. Riprap baffles located in the first 300 feet of the channel downstream of the inlet structure facilitate mixing of the chemicals with the channel flow.

2.2.1.2 Pond 3

The flow passes down the inlet channel to Pond 3. The normal pool elevation at Pond 3 is set by stop logs located at the east and west outlet works structures. The normal pool elevation under the revised operating mode (post-2008 revision) at this setting is 4,870 feet amsl, which provides adequate detention time at the average annual flow.

The Pond 3 discharge is controlled by the East and West Outlet Works structures. The structures are located 2,800 feet apart to provide more uniform flow through Pond 3. The discharge rate through each outlet structure may be adjusted by the addition/removal of one or more of the stop logs from each of the three openings.

2.2.1.3 Wildlife Ponds

The siphons that feed the Wildlife Ponds have relatively small conduit diameters, and thus changes in discharge rates under normal variations in Pond 3 and Wildlife Pond water surface elevations are minimal. Approximately 2.5 cfs is discharged from Pond 3 to the East Wildlife Pond and then back to the Pond 2 inlet channel upstream of the flow measurement weir. The two West Wildlife Ponds flow in series, the first receiving approximately 5 cfs from Pond 3 and the second discharging this flow back to the southwest part of Pond 2.

2.2.1.4 Pond 2 Inlet Channel

The Pond 3 outlet structures discharge into the Pond 2 inlet channel. The flow travels in the channel to the Flow Measurement Weir where it is split between the two wet-closure cells or passes directly to Pond 2. The backwater from the Flow Measurement Weir creates head to permit gravity flow to the wet-closure cells. The flow into each cell is controlled by an inlet orifice and gate at the Flow Measurement Weir. The flow rate into each cell is measured by the differential head across the orifice as indicated by staff gages and/or electronic level sensor(s). Flow entering each wet-closure cell may be regulated by partially closing the respective gate and observing the associated flow rate.

Flows in excess of the capacity of the wet-closure cells pass over the weir and into Pond 2 through the main inlet channel. The flow over the weir is measured by a staff gage/electronic level sensor located in a stilling well. Both flow signals are transmitted to the programmable logic controller (PLC) in the Pond 3 SS-3E Sample Station where flow rates are recorded. The Pond 2 inlet channel below the flow measurement weir contains riprap baffles to enhance mixing of chemical additives and flocculation (although chemical addition is not routinely implemented).

2.2.1.5 Pond 2 Wet-Closure Cells

Flow enters the Pond 2 Wet-Closure Cells through inlet channels that are 700 feet in length. The pool levels in the wet closures are controlled by the stop log settings at the outlet structures. The minimum pool elevation is set to maintain a nominal minimum water depth over the tailings and associated soils of 1 foot and will not be altered except for approved maintenance purposes.

The normal pool elevation for the East Wet-Closure Cell is approximately 4838.7 feet amsl, which allows for a detention time of about 6 days. The stop log elevation to maintain these values is 4838.3 feet amsl. For the West Wet-Closure Cell, the stop log elevation of 4837.8 feet amsl is used to maintain a normal pool elevation of about 4838.22 feet amsl with an estimated detention time of 4 days. Flow rates and water surface elevations for normal operations are listed in Table 2-2. The outlet structures are approximately equally spaced to encourage uniform flow rates through the cells. The outlet structures discharge directly to Pond 2.

2.2.1.6 Pond 2

During normal operation, Pond 2 provides final polishing of treated water before discharge to the receiving stream. The flow enters Pond 2 from the Pond 2 inlet channel, the wildlife ponds, the wet-closure cells, and the groundwater interception and pumpback system. The diversion of flow to the wet-closure cells reduces the rate of Pond 3 flow that directly enters Pond 2 from 216 cfs to 166 cfs during the mean annual peak flow. This decreases the possibility of bottom scour in Pond 2 and distributes the flow into Pond 2 more uniformly to maximize usage of available volume for detention. The normal pool elevation in Pond 2 is controlled by the stop log setting at the Pond 2 service spillway. The typical setting of the stop log crest is 4835 feet amsl, which results in a normal pool of 4835.3 feet amsl during the average annual SBC flow of 73 cfs. The volume of Pond 2 at the normal pool of 4835.3 feet amsl is 1,630 acre-feet, which provides 11 days of detention time. Pond 2 discharges through the Service Spillway to the Pond 2 outlet channel. The flow rate is measured at the culvert/drop structure located in the outlet channel and transmitted to the PLC in the Pond 2 monitoring building. The outlet channel discharges to the MWB.

Table 2-2. Normal Operation Flow Rates and Surface Elevations (2010)
WSP System Data for Normal Operation

	Flow Condition		
System Components/Data	**Low Annual Flow**	**Average Annual Flow**	**Mean Peak Flow**
Pond 3			
Inflow (cfs)	19	73	293
Max. Pool elevation (ft amsl)	4,869	4,870	4,870.8
Volume (ac-ft)	6,020	6,318	6,980
Discharge (cfs)	19	73	216
Detention (days)	160	44	16
East Wet-closure			
Inflow (cfs)	5	13	16
Max. pool elevation (ft amsl)	4,838.5	4,838.7	4,838.8
Volume (ac-ft)	135	147	153
Discharge (cfs)	5	13	16
Detention (days)	14	6	5
West Wet-closure			
Inflow (cfs)	9	23	29
Max. pool elevation (ft amsl)	4,838.0	4,838.2	4,838.3
Volume (ac-ft)	174	185	190
Discharge (cfs)	9	23	29
Detention (days)	10	4	3
Pond 2			
Inflow (cfs)	19	73	216
Max. pool elevation (ft amsl)	4,835.0	4,835.3	4,835.9
Volume (ac-ft)	1,522	1,641	1,875
Discharge (cfs)	19	73	215
Detention (days)	40	11	4.4

Notes:
ac-ft = acre-feet
cfs = cubic feet per second

2.2.1.7 Pond 2 and 3 Mixing – SolarBees

Solar warming during the spring and summer seasons promotes stratification of the WSPs, forming a layer of warm, less-dense water at the top of the pond (called the epilimnion), and cooler, more-dense water at the bottom of the pond (called the hypolimnion), separated by a layer of relatively rapidly decreasing temperature with increasing depth (called the metalimnion or thermocline).

Stratification limits vertical mixing of the water column. Without full mixing, dissolved oxygen (DO) becomes depleted below the thermocline by biological respiration and chemical reactions, resulting in anoxia and reducing conditions in hypolimnetic water and bottom sediments. To mitigate these conditions, solar-powered mixing units (SolarBees) were added to Ponds 2 and 3. These mixing units are considered an active element of the operation of the ponds. The description of the functional operation of these mixers was obtained from the report, *Evaluation of Solar Mixers at the Warm Springs Ponds* (AR, 2013).

SolarBee units provide solar-powered circulation of the water column via an impeller-driven system. They have intake hoses set below the thermocline to provide hypolimnetic oxygenation and mixing to limit the upward progression of anoxic conditions from the pond bottom, and to minimize release of reduced inorganic species (such as manganese[II], iron[II], arsenic, hydrogen sulfide, and internal loadings of phosphorus and nitrogen) to the water column.

Eight solar-powered mixing units (SolarBee SB10000 v18) were installed in the WSPs in May 2010 and two additional units were added in August 2012, to attempt to accelerate oxidative biomass degradation and mitigate elevated summer arsenic (As) concentrations in WSPs effluent. Figure 2-3 shows their respective locations.

The WSPs SolarBee system (Figure 2-4) is designed so that each unit operates during the coolest part of the day. Each unit includes a constantly rotating, solar-powered, low-velocity, high-volume impeller that establishes a convection cell in the surrounding water (Figure 2-5). Hence, the convection cells increase mixing within the water column.

Currently, the SolarBee units are deployed at the WSPs in areas with “deep holes” (Figure 2-4) relative to the pond average depth of 4 feet within Pond 2 and 6 feet within Pond 3. Anoxic water is brought up from the bottom of the ponds and mixed with oxygen-rich surface water. The mixture plummets downward a short distance, usually to the thermocline, depending on the density of the mixture. The net result is that layers of deoxygenated water are constantly being withdrawn from the anoxic zone, and replaced by oxic water moving down through the thermocline.

2.2.1.8 Pond 1

Water is transferred from Pond 2 to the Pond 1 Wet Closure through the Pond 2 outlet/Pond 1 inlet structure located near the east end of the Pond 2 Dam. Normal flow is controlled by a throttling slide gate within the multi-chamber concrete structure. The normal setting of the slide gate is to establish a flow of approximately 2.5 cfs at the average Pond 2 water surface elevation 4835.2 feet amsl. It is estimated that the gate setting at 40 percent open will provide that flow from October through June. The gate setting from July through September will be approximately 100 percent open to provide that flow. Due to the unavoidable uncertainties and seasonal variations expected for seepage gains/losses and evaporation/evapotranspiration losses, the structure is designed to facilitate flow adjustment. The typical flow is expected to be in the range of 2 to 4 cfs to provide adequate amounts of high pH water for the Pond 1 and Lower Wet-Closure Cells. The UAO mandates the introduction of a minimum of pH 8.5 water from Pond 2 to Pond 1.

Higher flows can be provided by simply adjusting the gate opening as necessary. Flow increases during normal flood events will be modest with the higher water surface elevations in Pond 2 resulting in less than a 15 percent increase in flow for essentially all gate settings and typical yearly flood conditions. Flow can be measured by observing the water surface elevation in the inlet immediately upstream of the overflow weir (and downstream of the throttling slide gate).

The flow into the Pond 1 Wet Closure enters through a riprap-protected stilling basin. The Pond 1 Wet-Closure water surface is to be maintained at elevation 4816 feet amsl or above in order to provide the required one foot of inundation for tailings areas. The water surface area at this elevation is 96.5 acres. The actual water volume contained by the Pond 1 Wet Closure, with water surface elevation of 4816 feet amsl, is unknown. However, based on an assumption of an average water depth of two feet, and a surface area of 96.5 acres, the detention time at a net of 4.1 cfs inflow rate would be approximately 24 days. This detention time assumes an estimated 1.6 cfs seepage through the Pond 2 Dam into the Pond 1 Wet Closure. The Pond 1 Wet-Closure water is discharged through the Pond 1 outlet structure to the South Wet-Closure Cell located immediately to the north of the eastern portion of the Pond 1 Dam. The outlet structure is a reinforced concrete box with an overflow sill at elevation 4815 feet amsl. Stoplogs are available to raise the discharge elevation and have been initially installed to elevation 4816 feet amsl. The annual average discharge expected through the structure was estimated during design to be approximately 4.1 cfs.

2.2.1.9 Lower Wet-Closure Cells

The series of three wet-closure cells (South, Middle, and North) located below Pond 1 receive, in series, the discharge from Pond 1. Although the net effect of seepage and evapotranspiration is uncertain, the design estimate was for a loss of approximately 0.5 cfs on average in the South Cell, 0.2 cfs further loss in the Middle Cell, and a 0.4 cfs gain in the North Cell. The gain in the North Cell would be partially due to inflow from the Pond 1 Toe Ditch. The North Cell then discharges to the Ground-Water Interception Trench. Average detention times in the various cells are approximately as follows: South – 19 days, Middle – 7 days, and North – 5 days. The outlets/inlets for conveying water from one cell to the next consist of a concrete box outlet, as described for the Pond 1 outlet, with an overflow sill adjustable by inserting/removing stoplogs. The inlets consist of a riprap-protected stilling basin with submerged discharge to the wet-closure area.

2.2.1.10 Ground-Water Interception Trench and Pumpback Facilities

The various surface and ground-water flow paths for the northern portion of the WSPs converge at the Ground-Water Interception Trench. The sources of flow that eventually discharge into the Trench are: the Soil-Cement Toe Drain Manifold, Pond 2 toe ditch, the outlet from the North Wet-Closure Cell, and groundwater seepage. Except for increases in dramatic flood events or evaporation losses, flows are expected to be relatively stable.

The Pump Station and Pumpback Pipeline have been designed to maintain an average trench water surface elevation of 4779 feet amsl (17.5 feet lower than the North Wet-Closure Cell) by withdrawing water from the Ground-Water Interception Trench and returning it to Pond 2. The design capacity is 18 cfs with three pumps running. A fourth initially installed pump provides standby backup. Piping for a fifth pump was included in case more capacity is found to be necessary. Inlet and discharge piping was sized for 27 cfs, based on the assumption that five pumps might be operating.

SECTION 3

Status of Species and Critical Habitat

3.1 Regulatory Status – Federal Endangered Species Act

ESA section 7 requires federal agencies to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of threatened or endangered species or adversely modify designated critical habitat. As a matter of policy, EPA coordinated with the USFWS prior to developing this BA and has been in direct contact throughout the process (EPA, 2017). On October 16, 2017, CH2M conducted an Information for Planning and Consultation (IPAC) search (see Appendix A) that identified threatened, endangered, proposed and candidate species, as well as final designated critical habitat under the jurisdiction of USFWS that may occur within the action area and/or may be affected by the project.

Additionally, EPA and USFWS conducted a field evaluation (December 19 and 20, 2017) of the proposed action area to evaluate habitat, identify potential species concerns, and discuss effects that may require analysis as a result of the proposed action. Table 3-1 includes federally listed species identified from the USFWS IPAC search. A total of five federally listed species were identified by the USFWS IPAC list as potentially occurring in the general vicinity of the project.

Table 3-1 describes status, habitat requirements, and the potential to occur within the proposed action area for the following species:

- Canada lynx *(Lynx canadensis)* – threatened
- Grizzly bear (*Ursus arctos horribilus*) – threatened
- North American wolverine (*Gulo luscus*) – proposed threatened
- Red knot (*Calidris canutus rufa*) – threatened
- Bull trout (*Salvelinus confluentus*) – threatened

Of the five species identified, two have been determined to have no potential or highly unlikely potential for occurring in the action area based on their habitat requirements and a lack of suitable habitat available. These species are not anticipated to be affected by the proposed project. A determination of "no effect" was made for the federally listed red knot (threatened), as well as North American wolverine, which is proposed (threatened) for listing. The rationale for each determination is based on information provided in Table 3-1 and supported by one or more of the following:

- The species does not occur in the action area.
- The action area does not provide preferred habitat for the species.
- Implementation of the proposed action will have no direct or indirect effects on the species or its habitat.

No further discussion concerning these species will occur in this document.

The three species having endangered, threatened, candidate, or proposed federal status and with the potential to occur in the action area discussed further in this BA are Canada lynx (threatened), grizzly bear (threatened), and bull trout (threatened). Although considered unlikely because of degraded habitat and no known occurrences, Canada lynx and grizzly bear are highly transient mammals and in turn have potential to migrate through the area. Bull trout have been documented as occurring in the action area (specifically, downstream of the WSPs in the Upper Clark Fork River) and are likely to be present during various life stages (Lindstrom, 2017, pers. comm.). Critical habitat rules have also been designated for bull trout, and final critical habitat is designated for bull trout within the action area. This BA evaluates the effects of the proposed action on Canada lynx, grizzly bear, and bull trout and their designated critical habitat, as applicable.

Table 3-1. Federal Listed Species with Potential to Occur in the Silver Bow Creek/Butte Area Superfund Site Action Area
Biological Assessment

Scientific Name	Common Name	Federal Status	Habitat Requirements	Potential for Species within Proposed Action Area
Mammals				
Lynx canadensis	Canada lynx	FT	Lynx habitat can generally be described as boreal forest with cold snowy winters (Quinn and Parker, 1987). The primary forest types used by lynx in the western United States are lodgepole pine (*P. contorta*), Engelmann spruce *(Picea engelmannii)*, and subalpine fir (*Abies lasiocarpa*) (Agee, 1999; McKelvey et al., 1999; Squires and Laurion, 1999). A variety of stand ages and structures of forest cover are needed to provide suitable lynx habitat for denning and foraging.	Unlikely. Suitable habitat is not present. Because of historic mining and clearing of land in the action area, continuous forested habitat is not available. No known occurrence of this species has been recorded within the action area or in Silver Bow or Deer Lodge Counties (MNHP, 2017). The extent of higher quality and more suitable habitat in the general vicinity make use of the action area unlikely. However, because of the transient nature of lynx and proximate habitat available, the potential for this species to occur in the action area does exist.
Ursus arctos horribilus	grizzly bear	FT	Grizzly bears typically choose low-elevation riparian sites, wet meadows, and alluvial plains during spring (Willard and Herman, 1977; Reichert, 1989). During summer and fall, grizzly bears more frequently use high-elevation meadows, ridges, and open, grassy timbered sites (Servheen, 1983; Reichert, 1989). Timbered plant communities most frequented by grizzly bears include subalpine fir, whitebark pine (*Pinus albicaulis*), lodgepole pine, Douglas-fir (*Pseudotsuga menziesii*), and spruce (*Picea* spp.) western red cedar (*Thuja plicata*)-hemlock (*Tsuga* spp.) forests. Sedge (*Carex* spp.)-bluegrass (*Poa* spp.) meadows are also important, as well as shrubfields and lowland high-elevation riparian communities (Willard and Herman, 1977; Blanchard, 1980; McLellan and Shackleton, 1988).	Unlikely. Suitable habitat is not present. Large connected tracts of continuous habitat do not occur and no known occurrence of this species has been recorded within the action area or in Silver Bow or Deer Lodge Counties (MNHP, 2017). The extent of higher quality and more suitable habitat in the general vicinity make use of the action area unlikely. However, because of the transient nature of grizzly bear and proximate habitat available, the potential for this species to occur in the action area does exist.
Gulo luscus	North American wolverine	PT	Wolverines are mammals that occupy dense forests, although they often range past treelines into alpine tundra and can inhabit subalpine rock piles. They prefer mature montane forests in proximity to subalpine rock and scree habitats with boulders and wood debris for denning sites (Krebs and Lewis, 1999). Maintaining wolverine populations depends on large areas free from land-use activities that permanently alter their habitat (Ruggiero et. al., 1994).	Highly Unlikely. Suitable habitat is not present. Mature montane forests do not occur in the action area and historic land use in the area has permanently altered historic habitat. The extent of higher quality and more suitable habitat in the general vicinity make use of the action area highly unlikely.

Table 3-1. Federal Listed Species with Potential to Occur in the Silver Bow Creek/Butte Area Superfund Site Action Area
Biological Assessment

Scientific Name	Common Name	Federal Status	Habitat Requirements	Potential for Species within Proposed Action Area
Birds				
Calidris canutus rufa	red knot	FT	The red knot is a medium-sized shorebird that migrates annually between its breeding grounds in the Canadian Arctic and wintering regions ranging from the Southeastern U.S. to Chile. During migrations, red knots use key staging and stopover areas to rest and feed (Niles et al., 2008; van Gils et al., 2005; Piersma et al., 1999). This species is a specialized molluscivore, eating hard-shelled mollusks, supplemented with softer invertebrate prey, such as shrimp- and crab-like organisms, marine worms, and horseshoe crab eggs (Piersma and van Gils, 2011; Harrington, 2001). Montana was identified as a “stopover site” in the rufa range as a result of its location along a presumed flight path from the Gulf coast toward breeding grounds in the north (for example, Victoria Island). However, there is no evidence that these locations are used annually or frequently as stopover sites (FWP, 2013).	Highly Unlikely. Suitable habitat is not considered present and no known occurrences of this species have been recorded within the action area or in Silver Bow or Deer Lodge Counties (Lindstrom, 2017, pers. comm.). The extent of higher quality and more suitable “stopover sites” along this species’ migratory route make use of the action area highly unlikely.
Fish				
Salvelinus confluentus	bull trout	FT	Channel stability, substrate composition, cover, water temperature, and migratory corridors are important for fluvial and adfluvial adult and young fish-rearing and movement in streams (Rieman and McIntyre, 1993). Preferred habitat includes stable channels in low gradient streams with cold water (less than 60°F), clean gravel for spawning and rearing, and ample diverse cover such as boulders and undercut banks (Rieman and McIntyre, 1993).	Likely. Suitable habitat is present downstream of the WSPs complex and the project occurs within the range of the species and its designated critical habitat. The species is known to occur in the Clark Fork River downstream of the Warm Springs Ponds and within the action area. This species, however, is considered extirpated upstream of the Warm Springs Ponds discharges (Lindstrom, 2017, pers. comm.).

Notes:
°F = degrees Fahrenheit
FE = listed as endangered under the Endangered Species Act
FT = listed as threatened under the Endangered Species Act
PT = Proposed for listing as threatened under the Endangered Species Act

3.2 Canada Lynx

The Canada lynx (*Lynx canadensis*) was listed as a Threatened species on March 24, 2000 (65 FR 16053-16086). The final rule lists the Distinct Population Segment (DPS) of the Canada lynx in the contiguous U.S. as threatened. Critical habitat has not been designated for this species in Deer Lodge or Silver Bow Counties. No critical habitat for Canada lynx exists in the action area.

3.2.1 Distribution and Conservation

Historical range of the Canada lynx in the Greater Yellowstone area includes Idaho, Montana, and Wyoming (USFS, 2007). Both Montana and Idaho classify the Canada lynx as a furbearer but no longer allow trapping. In Wyoming, the Canada lynx has been protected as a nongame species with no open season since 1973.

In response to the uncertain population status of Canada lynx populations and habitat in the contiguous U.S. and the onset of the listing process, an interagency Canada lynx coordination effort was initiated in March 1998. The USFWS, U.S. Forest Service (USFS), Bureau of Land Management (BLM), and National Park Service (NPS) participated in this effort. As a result, documents significant to the conservation of Canada lynx on federally managed lands were published (Ruggiero et al., 1999; Ruediger et al., 2000; USFS, 2007).

One of the actions put forth in the Lynx Conservation Agreement (LCA) was that forest plans should include measures necessary to conserve lynx on all administrative units identified as having lynx habitat. National forests in Montana and parts of Idaho, Wyoming, and Utah completed the final environmental impact statement (EIS) for lynx management in the Northern Rocky Mountains in March 2007. This EIS includes assessing forest plans on all northern Rocky Mountain forests and designating and incorporating conservation measures and management actions for Canada lynx and its habitat on forest units (USFS, 2007).

3.2.2 Life History and Habitat Requirements

Canada lynx are solitary carnivores generally occurring at low densities in boreal forest habitats. Individual lynx and mothers with kittens require large home ranges to incorporate both suitable foraging habitat and suitable denning habitat, which differ in the number and maturity of woody cover. Within most of their range, Canada lynx densities and population dynamics are strongly tied to the distribution and abundance of snowshoe hare *(Lepus americanus)* (Koehler, 1990). Kittens are born in May or June after a 60- to 74-day gestation period and typically remain with their mothers until about 10 months of age. Females may not reproduce during food shortages, and food availability directly correlates with the survival probability of young Canada lynx. Few kittens survive when food is scarce (Koehler, 1990).

The primary forest types used by lynx in the western United States are lodgepole pine, Engelmann spruce, and subalpine fir (Agee, 1999; McKelvey et al., 1999; Squires and Laurion, 1999). A variety of stand ages and structures of forest cover are needed to provide suitable lynx habitat for denning and foraging.

Foraging habitat for lynx has typically been described in terms of suitability for their primary prey: snowshoe hares and red squirrels (*Tamiasciurus hudsonicus*). Prime habitat for these two species differs considerably. Red squirrel habitat occurs primarily in older closed-canopied forests with substantial quantities of coarse woody debris (USFS, 2007). Hares use young conifer stands that are densely stocked with seedlings or saplings tall enough to provide browse above typical winter snow depth (Koehler and Brittel, 1990). Preferred snowshoe hare habitat would also include sapling and old, “gap phase” forests where tree mortality and snag loss create gaps in the canopy, allowing increased understory production (Buskirk et al., 1999). Foraging habitat could be defined as either sapling or old forest structures with high densities of small-diameter stems 3 to 10 feet high. Quaking aspen *(Populus tremuloides)* stands and forest edges, as well as open grass meadows and forest ecotones, may also support moderate to high numbers of snowshoe hares and Canada lynx.

Denning habitat is defined by the presence of ground-level structures that provide security and cover for kittens. Suitable structures are often found in old and mature forests with substantial amounts of coarse woody debris; however, it may also be provided in early successional forests where wind throw and snags are present (Aubry et al., 1999). Other forest structural stages, such as closed-canopy mid-age to mature forests with little understory cover, are generally not selected for either foraging or denning, but may serve as travel habitat (Koehler and Brittell, 1990). Lynx are likely to avoid new clearcuts or barren landscapes that are more than 300 feet wide because they lack sufficient cover (Koehler, 1990). Such areas also may not be re-colonized by prey species (mainly snowshoe hares) until significant regrowth has occurred, sometimes as much as 20 to 25 years after disturbance (Koehler and Brittell, 1990).

On a landscape scale, suitable Canada lynx habitat includes a mosaic of early seral stages that support snowshoe hare populations and late seral stages of dense old growth forest that provide ideal denning, security, and red squirrel habitat. Since lynx have large home ranges, connectivity between populations is critical. Dispersal corridors and linkage habitat should be several miles wide with only narrow gaps (USFS, 2008). Large tracts of continuous coniferous forest are the most desirable for Canada lynx travel and dispersal.

3.2.3 Status of Canada Lynx within the Action Area

The action area is located in an area designated as unoccupied, secondary Canada lynx habitat or a “secondary area” as defined in the Canada Lynx Recovery Outline (USFWS, 2005) and Revised Canada Lynx Conservation Assessment and Strategy (Interagency Lynx Biology Team, 2013). Secondary areas only support lynx intermittently and lynx use of the action area would be considered transient. Recent verified observations of lynx within the action area have not occurred, and lynx are not likely to be found in the action area during proposed activities. The action area has not been designated as either a lynx analysis unit (LAU) or as linkage habitat for lynx. Neither suitable foraging habitat nor suitable denning sites are found in the action area. There are no known occurrences of Canada lynx in or near the action area (MNHP, 2017).

3.3 Grizzly Bear

The grizzly bear was listed under the ESA in 1975 (40 FR 31734) by the USFWS as threatened in the conterminous United States (lower 48 states). On November 17, 2000, the USFWS published a final rule (65 FR 69644) to designate a grizzly bear “non-essential, experimental population” in the Selway–Bitterroot ecosystem. Later, the USFWS published a notice of intent (June 22, 2001, 66 FR 33623) to reevaluate its decision to establish an experimental population of grizzly bears in east-central Idaho and western Montana. Critical habitat has not been designated for this species in Deer Lodge or Silver Bow Counties. No critical habitat for grizzly bear exists in the action area.

3.3.1 Distribution and Conservation

The grizzly bear (aka the brown bear) is one of the largest North American land mammals and an iconic symbol of the American West. Historically, their range extended throughout much of North America, from the central plains west to California and from central Mexico north throughout Alaska and Canada. Today, however, grizzly bears are found in just a fraction (approximately 2 percent) of its original range in the coterminous U.S. Between 1800 and 1975, grizzly bear populations in the lower 48 states decreased from estimates of more than 50,000 to less than 1,000 (USFWS, 2007). By the late 1800s, grizzly bear had been eliminated from much of the West. As human populations encroached on their habitat, livestock depredation control, habitat deterioration, commercial trapping, unregulated hunting, and the perception that grizzlies threatened human life were leading causes of the animal’s decline (USFWS, 2007). Low reproductive rates and late maturation age further exacerbated the decline of grizzly bears.

Many of the current threats to the survival of grizzly bears in the lower 48 states are associated with degradation of habitat due to anthropogenic land use (including mining). Habitat destruction in valley bottoms and riparian areas is particularly harmful to grizzlies as they use these linkage habitats to travel from one area to another foraging for food (Jonkel, 1978; Knight, 1980; USFWS, 2007; Zager et al., 1983). Other than humans, the only predator to adult grizzlies are other grizzly bears (Jonkel, 1978). Grizzly bear cubs, however, may fall prey to mountain lions, wolves, and other bears if they stray too far from their mother (USFWS, 2007). Grizzly bears have been known to prey on livestock where their ranges overlap with areas containing livestock and to occasionally kill humans as a result of chance encounters, usually in the backcountry. Because of conflicts between grizzly bears and humans (Spowart and Samson, 1986), grizzly bear recovery areas are located away from developed areas and areas that receive only light recreational, logging, or livestock use.

Within the area covered by this ESA listing, the grizzly bear is recognized to occur in Idaho, Montana, Washington, and Wyoming. The six ecosystems in the conterminous U.S. identified by biologists as still containing suitable habitat for grizzly bears are: Yellowstone (northwestern Wyoming, southwestern Montana, and eastern Idaho), Northern Continental Divide (northwestern Montana), the Cabinet-Yaak (northwestern Montana), Selkirks (northern Idaho and eastern Washington), the North Cascades (Washington), and Bitterroot (central Idaho and western Montana) (USFWS, 2007).

Recovery efforts for grizzly bear have experienced some limited success. More than 500 grizzlies now live in the greater Yellowstone area, and in turn grizzlies in this ecosystem are now delisted. In addition, there are more than 500 grizzlies living in the Northern Continental Divide Ecosystem, about 30 to 40 in the Selkirk Mountains in northern Idaho and northeast Washington, another 30 to 40 in the Cabinet-Yaak ecosystem in northern Idaho and western Montana, and less than 20 in the North Cascades (USFWS, 2007).

Recovery success is due in large part to a cooperative effort among several organizations called the Interagency Grizzly Bear Committee. Established in 1983, the committee includes the USDA-Forest Service, National Park Service, U.S. Geological Survey, USFWS, Bureau of Land Management, State agencies in Montana, Wyoming, Idaho, and Washington, and the Provinces of British Columbia and Alberta. The committee coordinates habitat management, research, and education and outreach for the grizzly bear.

3.3.2 Life History and Habitat Requirements

Grizzly bears require extremely large home ranges (upwards of 500 square miles for males) that encompass diverse forest habitats and a mosaic of various habitat types including wet meadows, grasslands, high elevations, and riparian zones (USFWS, 2007). Although timber is an important habitat component, the grizzly bear prefers more open habitats. Timbered plant communities most frequented by grizzly bears include subalpine fir (*Abies lasiocarpa*)-whitebark pine (*Pinus albicaulis*), lodgepole pine (*P. contorta*)-Douglas-fir (*Pseudotsuga menziesii*), and spruce (*Picea* spp.)-western red cedar (*Thuja plicata*)-hemlock (*Tsuga* spp.) forests. Sedge (*Carex* spp.)-bluegrass (*Poa* spp.) meadows are also important, as well as shrubfields and lowland high-elevation riparian communities (Willard and Herman, 1977; Blanchard, 1980; McLellan and Shackleton, 1988).

During summer and fall, grizzly bears more frequently use high-elevation meadows, ridges, and open, grassy timbered sites (Servheen, 1983; Reichert, 1989). In the winter, grizzly bears move into higher elevation habitat to hibernate, entering their dens as early as October and not emerging sometimes until May. The total length of time spent in hibernation is dependent on food availability, weather conditions, and sex (Servheen, 1981). Grizzly bears dig their own den, usually excavated in hillsides, although dens are also made in rock caves, in downfall timber, and beneath trees and stumps (Willard and Herman, 1977; Servheen, 1981).

Upon emerging from their dens, grizzly bear quickly move into lower elevation riparian sites, wet meadows, and alluvial plains that are vegetated (Willard and Herman, 1977; Reichert, 1989). Grizzly bears breed between May and July, usually in 2- to 4-year intervals. Implantation and development is delayed often until the onset of hibernation, and gestation lasts about 184 days (Craighead and Mitchell, 1987). Cubs are born during the hibernation period between late November and February, and litter sizes may vary from one to four cubs. The cubs may remain with their mother for up to three years, but not reach maturity until around five years of age (USFWS, 2007; Eberhardt, 1990). The average life span of a grizzly bear is between 15 and 20 years (USFWS, 2007), but some may live upwards of 25 to 30 years, more often if raised in captivity (Jonkel, 1978; Servheen, 1981; Craighead and Mitchell, 1987).

Grizzly bears tend to be opportunistic omnivores. They primarily eat grasses, forbs, roots, tubers, and fruits, although they also feed on insects, fish, mammals, carrion, and garbage (USFWS, 2007; Zager and Jonkel, 1983). Adult males also may prey on subordinate grizzly bears and on black bears (*Ursus americanus*) (Hechtel, 1985). Some more common plant foods include: russet buffaloberry (*Shepherdia canadensis*), Saskatoon serviceberry (*Amelanchier alnifolia*), Sitka mountain ash (*Sorbus sitchensis*), snowberry (*Symphoricarpos albus*), hawthorn (*Crataegus* spp.), honeysuckle (*Lonicera* spp.), whitebark pine seeds, pine (*Pinaceae*) vascular cambium, willow (*Salix* spp.), dogwood (*Cornus* spp.), huckleberry and blueberry (*Vaccinium* spp.), dandelion (*Taraxacum* spp.), sweetvetch (*Hedysarum* spp.), clover (*Trifolium* spp.), cowparsnip (*Heracleum* spp.), glacier lily (*Erythronium grandiflorum*), horsetail (*Equisetum* spp.), lomatium (*Lomatium* spp.), kinnikinnick (*Arctostaphylos uva-ursi*), strawberry (*Fragaria* spp.), buckthorn (*Rhamnus* spp.), paintbrush (*Castilleja* spp.), thistle (*Cirsium* spp.), fritillary (*Fritillaria* spp.), boykinia (*Boykinia richardsonii*), and sheathed cottonsedge (*Eriophorum vaginatum*) (Graham, 1978; Zager, 1980; Servheen, 1983; Hechtel, 1985; Craighead and Mitchell, 1987).

3.3.3 Status of Grizzly Bear within the Action Area

The action area occurs in the upper headwaters of the Clark Fork River, which is well upstream of the Cabinet-Yaak grizzly bear recovery zone. The action area is also east of the Selway Bitteroot recovery zone, south of the Northern Continental Divide recover zone, and northwest of the greater Yellowstone recover zone. Although proximate to multiple USFWS-designated ecosystem recovery zones where grizzly are known to occur, the action area consists of degraded and disconnected habitat that is not considered suitable for grizzly bear. No occurrences of grizzly bear have been recorded within the action area and no sightings of grizzly bear have been reported for Silver Bow or Deer Lodge counties in recent times (MNHP, 2017).

3.4 Bull Trout

The Columbia River Basin bull trout (*Salvelinus confluentus*) DPS was listed as threatened under the ESA on June 10, 1998 (63 FR 31647). All populations of this char in the contiguous 48 states were designated with Threatened status on November 1, 1999 (64 FR 58910). On October 18, 2010 (75 FR 63898), the USFWS designated critical habitat for bull trout throughout their U.S. range. Critical habitat for bull trout came into effect on November 17, 2010, and is designated for the Upper Clark Fork River. Designated critical habitat for bull trout occurs within the action area, downstream of the WSPs complex.

3.4.1 Distribution and Conservation

Once widespread in the Pacific Northwest, bull trout were common to all the major river systems flowing from the western slopes of the Rocky Mountains as far inland as Alberta's prairie and parkland, including western Canada, southeastern Alaska, Washington, Oregon, Idaho, and western Montana. One isolated population exists in a Snake River tributary in northern Nevada.

Bull trout distribution, abundance, and habitat quality have declined range wide (USFWS, 2002). The headwaters of most Columbia River Basin streams still support bull trout; however, many populations are considered depressed or declining across much of their range (Ratliff and Howell, 1992; Schill, 1992; Thomas, 1992; Buchanan et al., 1997; Rieman et al., 1997; Quigley and Arbelbide, 1997 [as in USFWS, 2002]). The largest, extant contiguous populations of bull trout are associated with the mountains of north-central Idaho and northwestern Montana (Lee et al., 1997). The Oregon Department of Fish and Wildlife estimates there are now a total of 69 bull trout populations in 12 basins in the Klamath River and Columbia River systems, and 81 percent of these populations are in danger of extinction (USFWS, 2015).

Recent information indicates broad declines and widespread habitat disruption for bull trout in the Northwest. Of the populations with sufficient information to judge status, 72 percent are declining (USDA, 1996). Bull trout no longer occur in many areas of their historical range. However, extant populations of Montana bull trout continue to exist in the Clark Fork River Basin. This includes the upper Clark Fork River and some of its tributaries (including Warm Springs Creek), downstream to Lake Pend Oreille (Lee et al., 1997).

3.4.2 Bull Trout Recovery Plan

In 2015, the USFWS released a final recovery plan for the coterminous U.S. population of bull trout (USFWS, 2015). Using criteria such as habitat quality, historic documentation of presence, recent documentation of presence, land use, presence of potentially competitive species, and the best professional judgment of its members, the USFWS recovery unit team identified priority streams to focus the implementation of recovery activities to areas having the greatest potential for supporting bull trout.

The priority streams include the following:

- Known bull trout spawning streams
- Streams with evidence of bull trout recruitment and early life stage rearing
- Streams with habitat that may potentially support some level of recruitment, or local populations, because current habitat conditions have elements necessary for bull trout occupancy

Selected priority streams are considered the best of remaining habitat for bull trout and are addressed in recovery planning efforts relative to the core areas they occur in. This project occurs in what has been designated by the USFWS as the Columbia Headwaters Recovery Unit. The USFWS released the Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout in September 2015 (USFWS, 2015). Much of the following text is taken directly from this plan:

> *The Columbia Headwaters Recovery Unit (CHRU) includes western Montana, northern Idaho, and the northeastern corner of Washington. Major drainages include the Clark Fork River basin and its Flathead River contribution, the Kootenai River basin, and the Coeur d'Alene Lake basin (USFWS, 2015).*

There are 35 bull trout core areas that occur in 4 geographic regions of the CHRU. Fifteen of the 35 core areas are referred to as "complex" core areas as they represent larger interconnected habitats, each containing multiple spawning streams considered to host separate and largely genetically identifiable local populations. The other 20 are "simple" core areas represented primarily by isolated headwater lakes (most are in Glacier National Park) with single local populations. Starting at the Clark Fork River headwaters, the Upper Clark Fork Geographic Region comprises seven complex core areas, each of which occupies one or more major watersheds contributing to the Clark Fork basin (i.e., Upper Clark Fork River, Rock Creek, Blackfoot River, Clearwater River and Lakes, Bitterroot River, West Fork Bitterroot River, and Middle Clark Fork River core areas).

With the exception of much of the headwaters of the Clark Fork River drainage (upstream of Rock Creek) and portions of the Coeur d'Alene River system, both of which were severely degraded by contamination by heavy metals, bull trout continue to be present (albeit sometimes in low numbers) in most major watersheds where they likely occurred historically in the CHRU (USFWS 2002). Because bull trout exhibit a patchy distribution, even in pristine habitats (Rieman and McIntyre 1993), the fish are not expected to simultaneously occupy all available habitats (Rieman et al. 1997). This patchiness is evident throughout the CHRU and is largely tied to the presence of remaining cold water spawning and rearing habitat. In some watersheds within the CHRU, or portions of them, bull trout were probably never numerous because of natural habitat limitations (USFWS 2002, 2008a). Despite the intact broad distribution of bull trout core areas, a number of local populations of bull trout have been extirpated in recent times.

For the most recent bull trout 5-year status review, the Service concluded that bull trout core areas in the CHRU were at overall risk levels similar to those rangewide (USFWS 2008a). This conclusion was based on a systematic core area status assessment using a modification of the Natural Heritage Program's ranking model (Master et al. 2003). This analysis ranked the extirpation risk of bull trout by individual core area. Data used to rank the core areas consisted of information on population abundance, distribution, population trend, and threats to bull trout which were summarized by core area in the Core Area Templates document (USFWS 2008a).

Complete details of the assessment are described in the Bull Trout Core Area Assessment (USFWS 2008b). Categories of risk were described as follows:

High Risk	*Core area at high risk because of extremely limited and/or rapidly declining numbers, range, and/or habitat, making the bull trout in this core area highly vulnerable to extirpation.*
At Risk	*Core area at risk because of very limited and/or declining numbers, range, and/or habitat, making the bull trout in this core area vulnerable to extirpation*
Potential Risk	*Core area potentially at risk because of limited and/or declining numbers, range, and/or habitat even though bull trout may be locally abundant in some portions of the core area.*
Low Risk	*Bull trout common or uncommon, but not rare, and usually widespread through the core area. Apparently not vulnerable at this time, but may be cause for long-term concern.*

> *Conclusions from the 5-year review (USFWS 2008a, 2008b) were that 13 of the CHRU core areas were at High Risk (37.1 percent), 12 were considered At Risk (34.3 percent), 9 were considered at Potential Risk (25.7 percent), and only 1 core area (Lake Koocanusa; 2.9 percent) was considered at Low Risk. Simple core areas, due to limited demographic capacity and single local populations were generally more inherently at risk than complex core areas under the model. While this assessment was conducted nearly a decade ago, little has changed in regard to individual core area status in the interim.*

3.4.3 Life History and Habitat Requirements

Bull trout have a complex life history, heavily influenced by the habitat in which they live. Bull trout can exhibit resident, fluvial (migrate between streams and larger rivers), or adfluvial (migrate between streams and lakes) life history strategies. Channel stability, substrate composition, cover, water temperature, and migratory corridors are important for fluvial and adfluvial adult and young fish-rearing and movement in streams (Rieman and McIntyre, 1993). Deep pools with abundant cover (larger substrate, woody debris, and undercut banks) and water temperatures below 15 degrees Celsius (°C) (59°F) are important habitat components for stream resident bull trout (Goetz, 1989). Because migratory fish are not dependent upon a single type of habitat for all life stages, the species may be more resistant to catastrophic disturbance.

Bull trout appear to have more specific habitat requirements than other salmonids (Rieman and McIntyre, 1993). Habitat characteristics including water temperature, stream size, substrate composition, cover, and hydraulic complexity have been associated with distribution and abundance (Jakober and MacMahon, 1997; Rieman and McIntyre, 1993). The habitat components required by bull trout are often summed up by the four Cs - cold, clean, complex, and connected. Bull trout exhibit patchy distributions because even under pristine conditions, the required habitat components are not ubiquitous throughout river basins. Bull trout should not be expected to occupy all available habitats simultaneously (USFWS, 2000). High-quality bull trout habitat is typically characterized by abundant cover in the form of large wood, undercut banks, and boulders; clean substrate for spawning; interstitial spaces large enough to conceal juvenile bull trout; and stable channels. Juveniles prefer larger substrate and deep pools along with other forms of complex cover (MBTSG, 1998). Because habitat has been degraded in many basins and bull trout populations in these basins may be depressed, the fish may use less optimal habitat.

Stream temperature and substrate composition are important characteristics of suitable bull trout habitat. Bull trout have repeatedly been associated with the coldest stream reaches within basins. Very cold water is required for incubation (46°F), and juvenile rearing appears to be restricted to areas with cold water (59°F) (MBTSG, 1998). However, because they can display several life history types within a single geographic area, they can also be found in larger, warmer river systems that may cool seasonally or provide migratory corridors and important forage bases.

Many factors can potentially limit the distribution of spawning and rearing habitat for bull trout, including barriers, water temperature, interactions with non-native fish species, geomorphic processes, or human disturbances. Often these factors are not independent of one another. Surveys in Montana have found that most bull trout spawning occurs in third and fourth order streams and little, if any, use of first order streams has been documented (MBTSG, 1998). Limits to the distribution of larger juveniles (sub-adult) and adult bull trout are more difficult to identify because these fish may adopt migratory life histories and range far outside of spawning and rearing areas. However, juvenile rearing habitat is associated with cold water (59°F seasonal maximum), and groundwater-influenced streams tend to be preferred (Fraley and Shepard, 1989).

Adult bull trout are top predators requiring a large prey base and a large home range. Sub-adult and adult migratory bull trout move throughout and between basins in search of prey. Adult migratory bull trout are primarily piscivorous (Rieman and McIntyre, 1993). Their food preferences include whitefish, smelt, sculpins, eggs drifting following redd construction, and other salmonids. Bull trout normally reach sexual maturity in 4 to 7 years and may live longer than 12 years (Pratt, 1992). Adult bull trout migration upstream into spawning tributaries is variable, occurring from late spring through fall periods (Downs and Jakubowski, 2003). Bull trout typically spawn from August to November during periods of decreased water temperatures and may spawn every year or in alternate years (Pratt, 1985). Soon after spawning in the fall, out-migrating adults move downstream to larger waterbodies where they take advantage of higher productivity and deeper pools for overwintering (Fraley and Shepard, 1989). Adult bull trout are observed to migrate primarily from dusk until dawn (McPhail and Murray, 1979; Swanberg, 1997; Downs et al., 2006).

Spawning usually occurs during late summer and early fall, often at sites of groundwater upwelling (Ratliff, 1992), with young emerging the following spring. Initiation of spawning is likely correlated to water temperature (5°C to 9°C [41°F to 48°F]), photoperiod, and stream flow (Shepard et al., 1984). Optimal water temperatures for spawning range from approximately 2°C to 4°C (36°F to 39°F) and should not exceed 8°C (46°F) (Weaver and Fraley, 1991). Spawning areas are usually less than 2 percent gradient (Fraley and Shepard, 1989), and water depths range from 4 to 23 inches and average 12 inches. Spawning occurs in loosely compacted gravel and cobble substrate at runs or pool tails (Fraley and Shepard, 1989). Spawning gravel with reduced fines (less than 35 to 40 percent fine sediment) and organic material is more suitable for incubating embryos. Bull trout redds are vulnerable to scouring during winter and early spring flooding and low winter flows or freezing substrate (Cross and Everest, 1995).

Incubation of fertilized eggs lasts until the following spring when the fry emerge from the gravels. Depending on water temperature, egg incubation is normally 100 to 145 days and juveniles remain in the substrate after hatching (Pratt, 1992). Fry normally emerge more than 200 days later, from early April through May, depending upon water temperature and stream flow (Pratt, 1992). Juveniles may remain in their natal tributaries for several years before moving downstream to larger rivers to mature. Rearing juveniles disperse and use most of the suitable and accessible stream areas within a drainage (Leider et al., 1986). Juvenile out-migration tends to occur during periods of increased flow. Water temperature and cover formed by substrate and large woody debris (LWD) determine distribution and abundance of juveniles (Fraley and Shepard, 1989). Juveniles are rarely found in streams having water temperatures above 15°C (59°F) and excess sediment that reduces useable rearing habitat and macroinvertebrate production (Fraley and Shepard, 1989). Juvenile fish are benthic foragers and feed on drifting insects. Bull trout feed on insects and other fish species, especially mountain whitefish (*Prosopium williamson*), young salmon, and trout. Part of the impetus for out-migration as bull trout mature is because of a shift in their diet from using primarily invertebrates to piscivory. Bull trout are opportunistic feeders, with juvenile bull trout preying on terrestrial and aquatic insects, micro-zooplankton, and small fish (Donald and Alger, 1993; McPhail and Baxter, 1996).

3.4.4 Status of Bull Trout within the Action Area

The decline of this species has been attributed primarily to poor land management practices that contribute to degraded in-stream and riparian habitat conditions (Quigley and Arbelbide, 1997). The distribution of bull trout populations in the Clark Fork River is spotty and generally occurs where habitat remains in good condition. One of the remaining core areas of bull trout distribution is in the upper sections of the Clark Fork River and a few of its tributaries.

The action area falls within section one of the Clark Fork River core area, which is located in the Upper Clark Fork Geographic Region of the CHRU. Bull trout populations in this section are considered to be at high risk of extirpation (USFWS, 2008). The biggest threats to bull trout status and distribution within the upper Clark Fork River complex core areas are believed to be (1) upland/riparian land management activities, (2) water quality, (3) connectivity impairment, and (4) non-native fishes (USFWS, 2015). The extreme fragmentation in the Upper Clark Fork reduced bull trout occupancy to a few, relatively discrete, largely disconnected tributary patches occupied by resident fish.

Within the action area, bull trout upstream of the WSPs, including Silver Bow Creek and its tributaries, are considered fully extirpated as a result of poor water quality from historic mining effluents (USFWS, 2008 and 2015; Lindstrom, 2017, pers. comm.). However, bull trout are known to occur downstream of the WSPs discharges, in the upper Clark Fork River. Section one of the upper Clark Fork River core area provides migratory, foraging, rearing, and overwintering habitat for bull trout. With the removal of Milltown Dam, fluvial and adfluvial bull trout may once again use the upper Clark Fork River as a migratory corridor for access to natal spawning tributaries (such as Warm Springs Creek). Juveniles and adults may be present in the Clark Fork River (downstream of the WSPs) year-round, although it is anticipated most bull trout would seek thermal refugia from high summer temperatures in accessible tributaries, including the Warm Springs Creek.

A study of bull trout redds in proximate tributaries to the action area (Warm Springs and Boulder Creeks) has monitored two local populations since 1999. These populations represent a majority of the known spawning populations in section one of the Clark Fork River core area. Redd counts of these populations analyzed in 2004 (FWP, 2004a) indicated a total adult bull trout population in this reach of 100 to 200 fish (as cited in USFWS, 2005). Most local populations remain well below historical levels for both adults and juveniles, and within this core area populations of bull trout are heavily fragmented (USFWS, 2005).

All life history forms of bull trout, as well as resident, fluvial, and adfluvial bull trout life history strategies have the potential to occur in the action area downstream of the WSPs complex. This area provides Foraging, Overwintering, and Migratory habitat for bull trout and is designated as critical habitat. Based on existing habitat conditions in the action area, bull trout most likely use this area primarily as a migratory corridor. Adult and juvenile bull trout may also feed and, in some cases, rear in this section of the action area. However, the limited amount of woody debris and deep pools, as well as elevated temperatures, likely make it less utilized than other accessible and more suitable habitat that occurs in the watershed. Limited, if any, spawning habitat for bull trout is available in this section of the action area, and no spawning is known to occur. All habitat upstream of the WSPs discharge is considered inaccessible to bull trout populations in the Clark Fork River. Additionally, no bull trout and no suitable habitat for bull trout are known to occur upstream of the WSPs discharge (Lindstrom and Chavez, 2017, pers. comm.).

SECTION 4

Environmental Baseline Conditions

4.1 Physical Characteristics of the Area

The SBCBA lies within the Northern Rocky Mountain Physiographic Province and is characterized by a cool, semi-arid climate (see Figure 4-1). 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 area typically receives approximately one-third of the annual precipitation in the wettest months, May and June. The landscape surrounding the SBCBA is characterized by high mountain peaks reaching elevations above 8,000 feet. Higher elevations are typically 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 SBCBA 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 comprises predominantly 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 (AR, 1995). 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.

SBC is the primary drainage feature in the action area. Stream flow is measured continuously at three monitoring stations within the SSTOU by USGS. Monthly maximum, minimum, and mean flows in SBC below Blacktail Creek in Butte (period of record October 1989 to November 2017) are 26.7, 14.6 and 20 cfs, respectively, with highest average flows measured in May and lowest average flows measured in January. Similarly, monthly maximum, minimum, and mean flow measured in SBC at Warm Springs Creek below the WSPs (period of record November 1993 to November 2017) average 142, 28.1 and 63 cfs, respectively. Mill and Willow Creeks were tributaries to SBC at one time, with their confluence upstream of the WSPs. Mill and Willow Creeks have since been rerouted into the bypass (early 1960s), along the west side of the ponds to their confluence with the discharge point from the WSPs and Warm Springs Creek, forming the beginning of the Clark Fork River.

Groundwater occurs in both bedrock and alluvial aquifers within the SBCBA 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 discharge to SBC. Alluvial aquifers in the SBCBA are typically impacted by mining-related contaminants. Mining effects on bedrock aquifers are most pronounced in the vicinity of the Berkeley Pit and active mine area in the vicinity of Butte.

4.2 Terrestrial Environment

The SBCBA Superfund Site covers an area of approximately 85 square miles, and its linear footprint extends approximately 26 miles from Butte north to the WSPs. The SBCBA Site is located within the southwestern Montana forest region—a cold, dry forest region having high valley base elevations—and a continental climate (Arno, 1979). It is a very large site with diverse land uses and resources. The site spans portions of both Silver Bow and Deer Lodge Counties and includes the urban areas of uptown Butte, Walkerville, Rocker, and Ramsay, Montana.

The south part of the Site is adjacent to the continental divide, and overlaps portions of the active mining area east of the Butte Hill. The Butte city area occupies 172 square miles, is bisected by two interstate highways (I-15 and I-90), and is laced with numerous residential and county roads. Butte's urban landscape is notable for including mining operations within residential areas, making the environmental consequences of the extraction economy all the more apparent. The natural environment and topography of the upper SBCBA Site (BMFOU, BPSOU, upper SSTOU) were, and remain today, significantly altered by historic mining activities (Berkeley Pit, Yankee Doodle Tailings Impoundment, and the active East Continental Pit). Superfund remedial activities performed over the last 30 years are gradually improving environmental conditions. Aggressive removal or capping of mine waste and contaminated soils block exposure pathways to receptors, and vegetation is being restored. Mine waste material in large quantities are no longer eroding directly into local surface water. Natural cover and vegetation that at one time provided suitable habitat for large predators (such as grizzly bear, black bear, gray wolf [*Canis lupus*], and Canada lynx) has been replaced by urban and residential infrastructure with high levels of human activity. In turn, prey species for large predatory mammals (such as Elk [*Cervus canadensis*], mule deer [*Odocoileus hemionus*), moose (*Alces alces*), and pronghorn (*Antilocapra americana*) are more commonly found in surrounding areas that have not been as adversely impacted by historic mining activities. The upper SBCBA OUs provide little, if any, suitable habitat for listed species addressed in this BA.

West and north of Butte, the site transitions into the SSTOU, which includes stream and riparian habitat over the length of SBC north to its confluence with Warm Springs Creek. For much of its length, I-90 parallels the creek, restricting access for wildlife traveling east to west through the area. SBC has several tributaries contributing to flow: Sand Creek (intermittent), Browns Gulch, German Gulch, and Gregson Creek (intermittent). Water quality and habitat in and along SBC was severely impaired by historical mining-related activities. Remedial actions along SBC have removed much of the contaminated wastes from the active channel, associated floodplain, and railroad beds (Union Pacific Railroad) that parallel the creek, and further work is ongoing. The creek was remediated to a stable geomorphic configuration with revegetated stream banks and floodplain (Photo 4-1). These remedial activities have improved water quality and riparian habitat in the OU. As vegetation matures and becomes more functional, the riparian corridor is anticipated to further improve habitat for fish and wildlife that utilize the area.

Photo 4-1. Upper section of SSTOU Subarea 1—looking east toward Butte and I-90 from the Santa Claus Road culvert over Silver Bow Creek (new riparian habitat and surrounding range land).

SBC, from Butte to the Durant Canyon, flows along a high valley before dropping over Deer Lodge Pass (5,879 feet) into the south end of the Deer Lodge Valley. Like most other passes in western Montana, but inconsistent with the rest of the SBC corridor, Deer Lodge Pass is forested. The north end of the canyon terminates in a landscape dominated by rolling hills of grassland and sage brush (Photos 4-2, 4-3, and 4-4). Where present, various species of pine, fir, spruce, and juniper are the dominant tree species. Figure 4-2 presents vegetation types in the SBC watershed.

Photo 4-2. Ramsay Flats section of SSTOU Subarea 2—overview of Ramsay Flats area from railroad tracks. View is looking downstream (note range land and forested foothills in the distance).

Photo 4-3. Lower section of SSTOU Subarea 3—looking upstream at Silver Bow Creek from Fairmont Road bridge (note sparse riparian habitat and open rangelands).

Photo 4-4. SSTOU looking upstream into Durant Canyon.

Although the SSTOU is more rural and less populated than the Butte area, its habitat was significantly impacted by mining and associated mine wastes (Photo 4-5). Today habitat in the SSTOU remains marginal and provides little suitable habitat for listed species. Habitat for prey of listed species discussed in this BA is also functionally limited in the SSTOU.

Photo 4-5. Upper section of SSTOU Subarea 4, south of the Warm Springs Ponds (note SBC in background; 2011 reclamation of floodplain area; no riparian area yet established).

The WSPs Active and Inactive OUs (approximately 2,500 acres) are located at the downstream end of the Site and consist of three treatment (two active, one inactive) ponds, wildlife ponds, and wetlands. The ponds are bounded to the west by I-90, which restricts movement of wildlife through the area. Collectively, the ponds offer foraging and nesting habitat for a variety of migratory waterfowl, songbirds, wading birds, and raptors. The ponds also offer habitat that is suitable to a variety of other wildlife such as mule deer, white-tailed deer (*Odocoileus virginianus*), and occasionally moose. The area is designated a wildlife refuge that is administered by the FWP.

4.2.1 Primary Constituent Elements for Canada Lynx

Effect determinations (found in Section 6, Determination of Effects for Listed Species) for Canada lynx and grizzly bear are based largely on existing (baseline) terrestrial conditions. No critical habitat has been formally designated for grizzly bear, and no primary constituent elements have been established. Critical habitat for Canada lynx has been designated and the following primary constituent element (PCE) developed. General habitat requirements for Canada lynx and grizzly bear are described in Section 3 of this BA.

Based on current knowledge of the physical or biological features and habitat characteristics required to sustain Canada lynx life history processes, USFWS determined in the 2009 final critical habitat rule and in the 2013 proposed rule that the PCE specific to lynx in the contiguous U.S. is:

> *"Boreal forest landscapes supporting a mosaic of differing successional forest stages and containing: (a) Presence of snowshoe hares and their preferred habitat conditions, which include dense understories of young trees, shrubs or overhanging boughs that protrude above the snow, and mature multistoried stands with conifer boughs touching the snow surface; (b) Winter conditions that provide and maintain deep fluffy snow for extended periods of time; (c) Sites for denning that have abundant coarse woody debris, such as downed trees and root wads; and (d) Matrix habitat (e.g., hardwood forest, dry forest, non-forest, or other habitat types that do not support snowshoe hares) that occurs between patches of boreal forest in close juxtaposition (at the scale of a lynx home range) such that lynx are likely to travel through such habitat while accessing patches of boreal forest within a home range."*

No large contiguous boreal forests occur in the action area. Although existing climate conditions supply sufficient precipitation, primarily in the form of snow, elevations across much of the SBCBA Site are not sufficient to maintain these snow packs for extended periods of time. Furthermore, as a result of extensive mining and clearcutting of the hillslopes in the action area, sites with abundant dead wood, windfall, and/or other coarse woody debris do not exist to the extent that they would provide suitable habitat for denning.

4.3 Aquatic Environment

4.3.1 Subbasin Description

The SBCBA Superfund Site action area is located within the Upper Clark Fork River Subbasin, Hydrologic Unit Code (HUC) 17010201. The largest watershed within this action area is the Silver Bow Creek watershed, which is located at the headwaters of the Clark Fork River in southwest Montana (Figure 4-3) and occupies approximately 473 square miles. Decades of mining activities near Butte and Anaconda, Montana, resulted in extensive degradation of water quality and both in-stream and riparian habitat along large segments of streams throughout the watershed.

The USGS gaging stations on Silver Bow Creek and the Clark Fork River (the only stations within the action area) are summarized in Table 4-1 and shown on Figure 4-3.

Table 4-1. USGS Gage Stations on Silver Bow Creek
Silver Bow Creek/Butte Area Superfund Site

Station ID	Station Name	Area Drained (square miles)
12323250	Silver Bow Creek below Blacktail Creek	125
12323600	Silver Bow Creek at Opportunity	343
12323750	Silver Bow Creek at Warm Springs	473

Stream flows in the Silver Bow Creek watershed follow hydrographs typical for the region. Flows are highest during May and June, which have the greatest amount of precipitation and snowmelt runoff. Stream flows begins to decline in late June or early July with the lowest flows occurring in September when several tributaries are dry. Streamflow typically increases during October and November as a result of fall storms (DEQ, 2014a).

Stream morphology throughout the subbasin is variable. Most streams in the Upper Clark Fork River subbasin originate in high-elevation, mountainous terrain dominated by cobble substrate, and are predominantly fed by snowmelt or storm runoff. The upper reaches are characterized by cascading step/pool to riffle-dominated channels. Eventually, these streams transition into meandering, low gradient systems with well-developed floodplains. These wide valley reaches of the Upper Clark Fork River basin streams are where significant stream morphology alterations have occurred because of historical mining activities (DEQ, 2014a). Prior to recent remediation and restoration activities, these areas had unstable banks and deposition of contaminated sediment. Stream morphology has more recently been altered by remediation activities (removal of contaminated sediments).

4.3.1.1 Silver Bow Creek

Silver Bow Creek is formed by the confluence of Blacktail Creek and the area formally known as the Metro Storm Drain (this area is geographically known as upper Silver Bow Creek and because of mining disturbances no longer a natural stream reach). Extensive 1800s and 1900s mining, milling, and smelting activities obliterated the channel, and the Berkeley and Continental Pits isolate it from its original headwaters, which drain into the Yankee Doodle Tailings Impoundment (DEQ, 2014b). Silver Bow Creek flows generally north for 26.7 miles into the Warm Springs Ponds, and includes a short reach downstream of the ponds. Several tributaries contribute to the flow along its path, including both continuously flowing streams (for example, Browns Gulch and German Gulch) and ephemeral systems (for example, Sand Creek and Gregson Creek).

Tributaries to Silver Bow Creek are classified B-1 for their water use. B-1 waters are suitable for drinking, culinary, and food processing purposes after conventional treatment. These waters are also considered suitable for bathing, swimming, and recreation; the growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and as a water supply for agricultural and industrial use. Silver Bow Creek from the confluence of Blacktail Creek to its confluence with Warm Springs Creek is classified I for water use. Streams with this designation are considered impaired and are not used for drinking water, agricultural, or industrial use.

Silver Bow Creek upstream of the WSPs was severely impaired by contaminated water and sediments. Habitat degradation from historical mining-related activities and the phyto-toxic nature of contaminants (elevated copper and zinc concentrations) resulted in a sterile aquatic environment. The remediation of Silver Bow Creek has removed contaminated material from the active channel and adjacent riparian areas. The creek was remediated to a stable geomorphic configuration with improved water quality, with revegetated stream banks (Photo 4-1). Specific information on remedial design and reconstruction of the channel bed (substrate material) are available in the Silver Bow Creek Final Remedial Design report (DEQ, 1999). As vegetation continues to mature, stream bank cover will develop; however, little to no cover currently exits. Recent (within 10 years) removals of contaminated sediments scoured areas of channel substrate. Silver Bow Creek is slowly recovering from sterile conditions in the mid-1900s and now supports fish assemblages consisting of longnose sucker, slimy sculpin, rainbow trout, brook trout and westslope cutthroat trout, although trout species were rated rare in abundance in 2014 (DEQ, 2014b).

4.3.1.2 Warm Springs Ponds

Silver Bow Creek was dammed in 1911 to create Pond 1 of the Warm Springs Ponds complex. Ponds 2 and 3 were subsequently added in an upstream progression over the next 45 years. The WSPs complex currently covers an area of approximately 2,500 acres (approximately 4 square miles). Silver Bow Creek, with an average flow of 73 cfs, enters Pond 3 from the south. Water flowing out of Pond 3 goes primarily into Pond 2, with a smaller volume being used to maintain several wildlife ponds located between Ponds 2 and 3 (see Figure 2-2). The effluent from Pond 2 is a regulated point-source discharge that flows into the Mill-Willow Bypass (EPA, 1990).

The Warm Springs Ponds were constructed, and are still used, to contain suspended sediments and treat water flowing down Silver Bow Creek before it enters the Clark Fork River. The substrate within the ponds comprises mostly fine metal-laden sediments from historical mining-related activities that occurred upstream. Nevertheless, aquatic resources are known to reside within the ponds and recreational fishing for brown, rainbow, and brook trout is common.

4.3.1.3 Mill-Willow Bypass

Mill and Willow Creeks flow from the west and south, respectively, into the Mill-Willow Bypass, a diversion channel, that routes water (average flow of 27 cfs) from these two creeks around the WSPs (EPA, 1990). Surface water from these two creeks (Mill and Willow) flow through the bypass to its confluence with discharge from the ponds. The lower Mill-Willow Bypass flows for another 0.6 mile to its confluence with Warm Springs Creek, where it forms the Clark Fork River. From its origin, the Clark Fork River generally flows in a northwesterly direction for several hundred miles to Lake Pend Oreille in northern Idaho.

Removal of contaminated tailings from the Bypass area in the early 1990s and reconstruction of a meandering Mill and Willow Creek (Mill-Willow Bypass) with overflow ponds and robust riparian vegetation have improved the riparian habitat along the west side of the ponds, and the confluence with the Ponds' discharge downstream to Warm Springs Creek. This improvement should have positive influence on fish movement and migration in this area.

Fisheries information is scarce for the MWB below Pond 2's discharge. Fish population data for this reach was obtained from the Silver Bow Creek Watershed Restoration Plan (2010) that included electrofishing surveys conducted near the mouths of Mill Creek and Willow Creek in 1989, 1990, and 1991 (FWP, 2003).

Brown trout (*Salmo trutta*) was the only species reported for these sampling events. Population estimates in Mill Creek ranged from 21 to 350 brown trout per 1,000 feet. Population estimates in Willow Creek ranged from 118 to 313 brown trout per 1,000 feet. Fish biologists generally consider these population ranges as low to moderate. In the upper Mill Creek drainage, westslope cutthroat trout, Yellowstone cutthroat trout, mountain whitefish, brook trout (*Salvelinus fontinalis*), brown trout, and westslope cutthroat trout × Yellowstone cutthroat trout hybrids are likely. The presumed presence of westslope cutthroat trout, lack of human disturbance, and size of the Mill Creek watershed indicates that this drainage shows promise as a refuge for westslope cutthroat trout as well as non-native fish species. As such, the Mill Creek sub-watershed may also provide a source of recruitment for the lower Mill-Willow Bypass, although, water quality problems may limit this potential.

Species presumed to be present in the upper Willow Creek sub-drainage include westslope cutthroat trout and brook trout.

4.3.1.4 Lower Mill-Willow Bypass below the Warm Springs Ponds to the Upper Clark Fork River

In the northwest corner of Pond 2, the SBC flow discharges from the WSPs and joins the MWB in flowing to the confluence with Warm Springs Creek and the beginning of the Clark Fork River. Most of this reach was totally reconstructed from 1990 to 1995 as contaminated tailings and soils were removed and a new channel/floodplain was configured and established. This work coincided with the upgrade of the bypass corridor and pond berms to handle 70,000 cfs (half of the maximum probable flood) and potential seismic events. In 2014, the final 0.25 mile of this reach was remediated and reconstructed. From its discharge point, the lower Mill-Willow Bypass meanders in a stable, low gradient configuration for approximately 0.6 mile before intercepting Warm Springs Creek. Vegetation, primarily in the form of sandbar willows and water birch, has established itself in a thin, intermittent riparian corridor along both banks of the creek. The deep binding root mass of the willows stabilizes bank material while providing some aquatic habitat for fish. Cover extending over the creek is sparse, hence thermal exposure during the warm summer months still contributes to elevated water temperatures. Associated floodplain terraces are moderately vegetated with snowberry (*Symphoricarpos* spp.), rose (*Rosa* spp.), currants/gooseberries (*Ribes* spp.), grasses, and shrubs (EPA, 2004).

The Clark Fork River supports a diverse fishery, including bull trout and westslope cutthroat trout (a Montana Species of Concern). Bull trout are reported between river miles 61 and 71.6 and between 75.5 and 294.6, although their abundance is rated rare in both reaches. Westslope cutthroat trout are reported as common between river miles 26 and 37, and 46 and 56, and are reported as rare between river miles 61 and 71.6 and 75.5 to 339.9 (DEQ, 2016b). Brown trout are abundant below the WSPs complex and pose a threat to bull trout populations in Warm Springs Creek and the upper Clark Fork River. Physical barriers prevent fish using the Clark Fork River, Mill-Willow Bypass, and SBC below the ponds from migrating into the Warm Springs Ponds and Silver Bow Creek above the WSPs.

4.3.1.5 Pathways and Indicators for Bull Trout

Effect determinations (found in Section 6, Determination of Effects for Listed Species) for listed species and their designated critical habitat are based largely on existing (baseline) conditions. To facilitate a consistent approach to analyzing baseline conditions and project effects on bull trout and its designated critical habitat, USFWS developed a Matrix of Pathways and Indicators (USFWS, 1998). The matrix is an analytical tool that lists diagnostics/pathways by which a proposed action could have effects on bull trout or its critical habitat. The diagnostics/pathways are divided into indicators that are described by three possible categories of function: functioning appropriately, functioning at risk, and functioning at unacceptable risk. Although the Matrix defines the three categories of function differently for each indicator (see Appendix C), USFWS describes the functions generally as:

> *[I]ndicators in a watershed are "functioning appropriately" when they maintain strong and significant populations that are interconnected and promote recovery of a proposed or listed species or its critical habitat to a status that will provide self-sustaining and self-regulating populations. When the indicators are "functioning at risk", they provide for persistence of the species but in more isolated populations and may not promote recovery of a proposed or listed species or its habitat without active or passive restoration efforts. "Functioning at unacceptable risk" suggests the proposed or listed species continues to be absent from historical habitat, or is rare or being maintained at a low population level; although the habitat may maintain the species at this low persistence level, active restoration is needed to begin recovery of the species.*

Table 4-2 provides the baseline condition of population and habitat indicators at the SBCBA Site and the anticipated effects from the proposed action on those baseline conditions.

Table 4-2. Overview of the Aquatic Environmental Baseline Conditions in the Action Area for the Silver Bow Creek/Butte Area Superfund Site
Silver Bow Creek/Butte Area Superfund Site

Diagnostic/Pathway Indicators	Environmental Baseline Conditions	Effects of the Project Actions on Environmental Baseline Conditions
Subpopulation Characteristics within Subpopulation Watersheds		
Subpopulation Size	Not Functioning[a] Functioning at Unacceptable Risk[b]	Maintained
Growth and Survival	Not Functioning[a] Functioning at Unacceptable Risk[b]	Maintained
Life History Diversity and Isolation	Not Functioning[a] Functioning at Unacceptable Risk[b]	Maintained
Persistence and Genetic Integrity	Not Functioning[a] Functioning at Unacceptable Risk[b]	Maintained

Table 4-2. Overview of the Aquatic Environmental Baseline Conditions in the Action Area for the Silver Bow Creek/Butte Area Superfund Site

Silver Bow Creek/Butte Area Superfund Site

Diagnostic/Pathway Indicators	Environmental Baseline Conditions	Effects of the Project Actions on Environmental Baseline Conditions
Water Quality		
Temperature	Functioning at Unacceptable Risk[a] Functioning at Unacceptable Risk[b]	Maintained
pH	Functioning Appropriately[a] Functioning at Risk[b]	Maintained
Sediment/Turbidity	Functioning Appropriately[a] Functioning Appropriately[b]	Maintained
Chemical Contamination/Nutrients	Functioning at Unacceptable Risk[a] Functioning at Risk[b]	Maintained
Habitat Access		
Physical Barriers	Functioning at Unacceptable Risk[a] Functioning Appropriately[b]	Maintained
Habitat Elements		
Substrate Embeddedness	Functioning at Risk	Maintained
Large Woody Debris	Functioning at Risk	Maintained
Pool Frequency	Functioning at Risk	Maintained
Pool Quality	Functioning at Risk	Maintained
Off-Channel Habitat	Functioning at Risk	Maintained
Refugia	Functioning at Risk	Maintained
Channel Conditions and Dynamics		
Width/Depth Ratio	Functioning Appropriately	Maintained
Streambank Condition	Functioning at Risk	Maintained
Floodplain Connectivity	Functioning Appropriately	Maintained
Flow/Hydrology		
Change in Peak/Base Flows	Functioning Appropriately	Maintained
Increase in Drainage Network	Functioning Appropriately	Maintained
Watershed Conditions		
Road Density and Location	Functioning at Risk	Maintained
Disturbance History	Functioning at Risk	Maintained
Riparian Conservation Areas	Functioning at Risk	Maintained
Disturbance Regime	Functioning at Risk	Maintained
Integration of Species and Habitat Conditions	Functioning at Risk	Maintained

[a] Upstream from the WSPs in Silver Bow Creek

[b] Downstream from the WSPs in Mill-Willow Bypass and upper Clark Fork River

In addition to the Matrix of Pathways and Indicators (USFWS, 1998), the USFWS has identified nine PCEs for proposed bull trout critical habitat and associated habitat indicators. The following subsections describe the nine bull trout PCEs and associative pathway conditions.

4.3.1.6 Primary Constituent Elements for Bull Trout

PCE 1: *"Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia."*

Springs, seeps, groundwater sources, or subsurface water connectivity occurs throughout the project area and supply hyporheic flows to the MWB. Specific features were identified during field investigations and reconstruction of the Mill-Willow Bypass in the mid-1990s (EPA, 1992). The shallow groundwater system around WSPIAAOU is considered a groundwater discharge area. Groundwater flow direction is from south to north. The shallow aquifers extend along existing stream channels, but do not extend laterally throughout the area. The first water bearing unit is approximately 10 feet below ground surface and consists of sand and gravel with a 10- to 15-foot thickness. Estimates of groundwater discharge downgradient of Pond 1 into the final reach of SBC and the Clark Fork River indicate minimal contribution to flow as a result of relatively low permeability and low gradient in the shallow aquifer. Under average conditions, flow in the Clark Fork River was estimated to be 127 cfs, while the shallow groundwater contribution was estimated at 1 cfs (EPA, 1992). More detailed baseline information relative to this PCE can be found in Sections 4.3.1.8, Water Quality; 4.3.1.12, Flow/Hydrology, and 4.3.1.13, Watershed Conditions. Overall, this PCE appears to be **functioning appropriately** throughout the action area.

PCE 2: *"Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including, but not limited to, permanent, partial, intermittent, or seasonal barriers."*

Physical barriers inhibit the movement of fish between SBC, the WSPs, and the headwater streams of the Upper Clark Fork River. For instance, the WSPs and upper Silver Bow Creek are inaccessible to migrating fish from the Upper Clark Fork River because of the WSPs discharge structure design. Upstream of the WSPs, below Durrant Canyon, a fish barrier was constructed to prevent the migration of invasive fish, such as brown trout, from the WSPs into the upper SBC above the barrier. A newly constructed channel contributes to the lack of good aquatic habitat and to solar heating throughout SBC. In addition, water quality in SBC continues to be negatively affected by metals (for example, cadmium and copper) concentrations that are intermittently above the Montana water quality standards for protection of aquatic life. These contaminants originate from source areas being remediated in the Butte area and continue to be carried down SBC to the WSPs, primarily during high flows. The mainstem of SBC relative to this PCE appears to be **functioning at risk.** Additional information related to this PCE can be found in Sections 4.3.1.10, Habitat Elements, and 4.3.1.14, Species/Habitat Integration.

PCE 3: *"An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish."*

The robust population of brown trout in the lower reach of SBC and upper CFR below the WSPs indicates that there is an abundant food base in that area. According to a Montana DEQ fisheries biologist, bull trout sometimes move into the area just below the WSPs outfall from Pond 2, attracted by the plentiful food in and below the WSPs discharge (Lindstrom and Chavez, 2017, pers. comm.). However, it is likely that food supplies are depleted, at least temporarily, in areas of the upper CFR that have recently undergone (or are currently undergoing) remediation to remove tailings from streambanks and floodplains, (for example, from Warm Springs Road to Deer Lodge reach). For this reason, the project area is considered to be **functioning at risk** for this PCE.

PCE 4: *"Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structures."*

The riparian corridor and channel condition in the action area are degraded in part of the lower Mill-Willow Bypass as a result of the historical deposition of mine wastes into SBC. To some extent, road development in the area exacerbated this condition. The channel continues to be confined in some locations by existing roads (I-90 and Warm Springs Road), and structural features of the WSPs (WSPs Inactive Area OU berms). In other locations, the existing topography and a degraded riparian corridor likely influences bank erosion and channel migration to some extent under natural conditions. Large woody debris and robust riparian vegetation are lacking along the extent of SBC. The recently completed remediation and reconstruction of lower Mill-Willow Bypass near the confluence with Warm Springs Creek limits the presence of undercut banks, and until regrowth occurs, limited mature riparian vegetation for refugia and thermal cover exists (Photo 4-6). In turn, aquatic habitat diversity and complexity under baseline conditions in the project area no longer represent mature natural or historical (pre-mining) conditions and the entire action area is likely **functioning at risk** relative to this PCE. More information related to this PCE can be found in Sections 4.3.1.10, Habitat Elements, and 4.3.1.11, Watershed Conditions.

PCE 5: *"Water temperatures ranging from 2° to 15°C (36° to 59°F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence."*

Water temperature is a concern for bull trout throughout the action area. Limited riparian cover in the lower section of SBC contributes to elevated water temperatures downstream of the WSPs. Solar inputs on the footprint of the WSPs also increase water temperatures in the ponds. Water temperatures in SBC upstream and downstream from the WSPs, the WSPs themselves, and the Clark Fork River downstream of the ponds are typically above the temperature range favorable for bull trout during the summer months. The water temperature data for surface waters within the action area are detailed further in Section 4.3.1.8, Water Quality. The data exhibit monthly average water temperatures above the range conducive for bull trout in one or more months of the year, leading to the conclusion that baseline water temperatures are **functioning at unacceptable risk** for bull trout throughout the action area (both upstream and downstream of the WSPs).

PCE 6: *"In spawning and rearing areas, substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system."*

Sediment and substrate characteristics in the action area have been dramatically altered relative to historical conditions. Over 4 million cubic yards of tailings and mine wastes were fluvially transported and deposited along SBC from Butte to the WSPs (EPA, 2011a). Materials deposited in the MWB channel/floodplain have since been removed and the channel reconstructed. Although there are little specific data on current substrate conditions, a flatter gradient of the valley and deposition of mine waste and tailings have and likely continue to compromise clean gravels and substrate of variable sizes throughout the SBC channel. In remediated areas, such as the confluence of lower Mill-Willow Bypass and Warm Springs Creek, new channel design and reconstruction with suitable borrow materials have contributed to more natural substrate and geomorphically stable channel configuration. In turn, the action area up to the Pond 2 discharge, and into and above the MWB, may provide some migration and rearing habitat for bull trout; however, the availability of suitable spawning gravels is considered compromised as a result of transport and deposition of fines from the WSPs downstream. Reduced velocities and limited scour through the MWB has also contributed to the deposition of fines from upper SBC downstream. Limited, if any, suitable spawning gravels occur in the upper section of SBC, above the WSPs complex. Overall, the action area, including the lower section of SBC to its confluence with Warm Springs Creek and continuing into the upper Clark Fork River is considered **functioning at risk** for this PCE.

PCE 7: *"A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departures from a natural hydrograph."*

The natural hydrograph in the action area has been altered relative to historical conditions. The removal of vegetation, topsoil, and bedrock within the upper (southern) portion of the action area, as a result of mining activity, has contributed to reduced natural infiltration and an increase in surface runoff during precipitation events and spring snowmelt. This dynamic of water flows has likely resulted in a more dynamic hydrograph with more rapid peaks and troughs than what would have occurred prior to mining activities. Despite historical land use activities and recent remediation, baseline hydrologic conditions are likely representative of current natural conditions (annual flow regime). No water diversions occur in the action area, and flows are not controlled along the extent of SBC downstream into the Clark Fork River. Overall this PCE is considered to be **functioning appropriately** throughout the action area.
More detail relative to this PCE can be found in Section 4.3.1.12, Flow/Hydrology.

PCE 8: *"Sufficient water quality and quantity such that normal reproduction, growth and survival are not inhibited."*

Baseline conditions for this PCE align well with the water quality pathway, which is described in Section 4.3.1.8, Water Quality. As discussed in that section, baseline water quality conditions for bull trout are considered to be:

- For pH: **functioning appropriately** upstream from the WSPs, and **functioning at risk** downstream from the WSPs.
- For suspended sediment/turbidity: **functioning appropriately**, both upstream and downstream from the WSPs.
- For metals and arsenic: **functioning at unacceptable risk** upstream from the WSPs, and **functioning at risk** downstream from the WSPs.

Monthly average flows in upper SBC above the WSPs can be as low as approximately 25 cfs in low-flow periods of the year (Figure 4-4). Flow data for the USGS gauging stations on SBC and Warms Spring Creek (WSC) at Warm Springs, Montana, provide a good indication of streamflows below the WSPs. These streamflows can be summed to estimate flow rates in CFR below their confluence.
Average monthly flows on SBC and CFR near the town of Warm Springs vary seasonally, and are typically equal to or greater than 40 cfs and 60 cfs, respectively, in low-flow months, and are greater than 100 cfs and 200 cfs, respectively, in high-flow months (Figure 4-4). Low flows during discrete times of the year may limit the availability of certain portions of the action area streams for some bull trout life history uses.

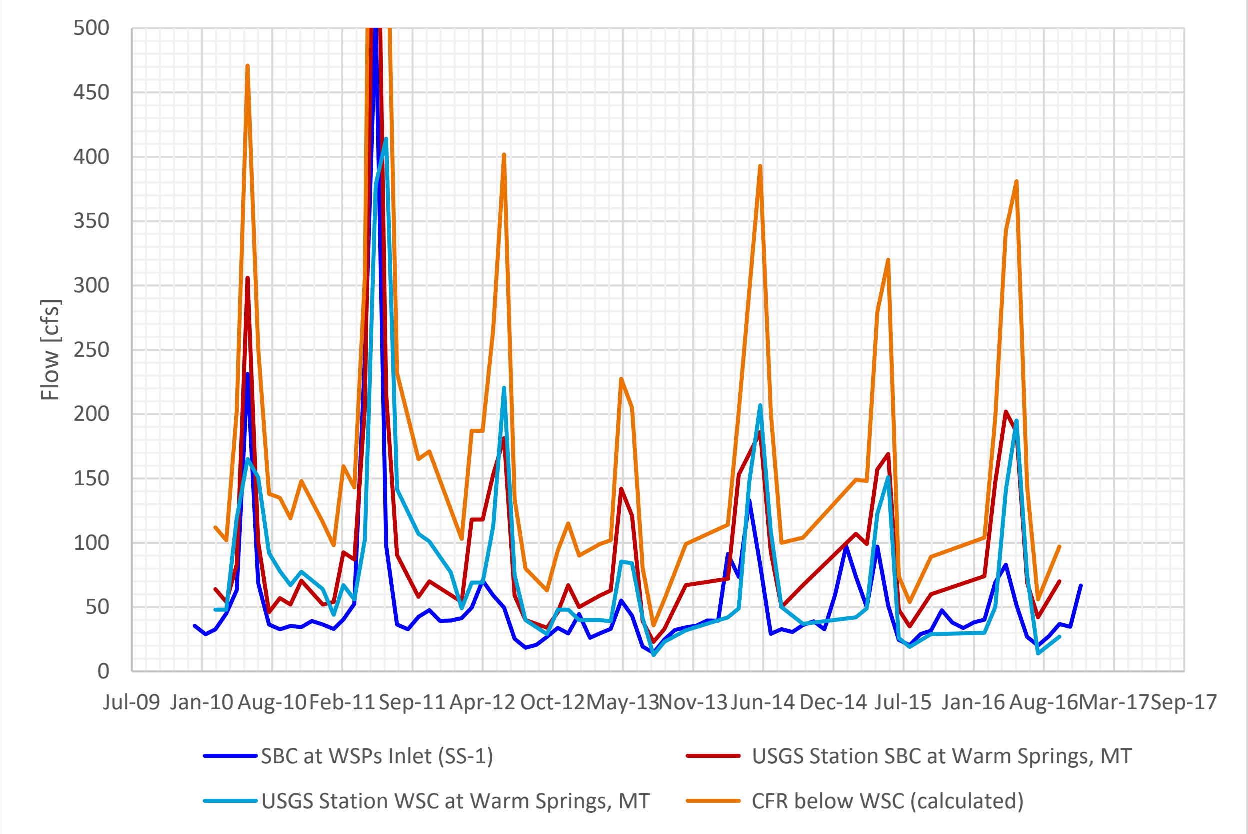

Figure 4-4. Flow Data for SBC, WSC, and CFR below WSC (monthly averages, 2010-2016)

PCE 9: *"Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competitive (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout."*

Non-native species are widely abundant in SBC, both upstream and downstream of the WSPs. In fact, the most common salmonids in the upper Clark Fork River are introduced species (EPA, 2002b). Rainbow trout (*Oncorhynchus mykiss*), brook trout, and brown trout are all known to occur in the action area (MBTSG, 1995) upstream and downstream of the WSPs complex. Introduction of brook trout poses a threat to bull trout populations in areas where populations overlap (in designated critical habitat downstream of the WSPs). Hybridization of bull trout and brook trout has been documented as a common problem in other drainages where populations coexist, and brook trout are known to out-compete bull trout in degraded habitats. Brown trout also pose a serious concern to sustaining bull trout populations as they are also known to outcompete bull trout and have been documented as representing as much as 80 percent of recorded fish assemblages just downstream of the WSPs (Lindstrom and Chavez, 2017, pers. comm.). Overall this PCE is considered to be **functioning at unacceptable risk** throughout the action area.

The nine PCEs for bull trout align well with the Matrix of Pathways and Indicators, and, in turn, many of their elements are discussed further in association with the Matrix of Pathways and Indicators throughout the remainder of this BA. A crosswalk between the Matrix of Pathways and Indicators and PCEs of proposed critical habitat for bull trout can be found in Appendix B. The nine PCEs for bull trout identified are considered within the baseline discussion and effects analysis of pathway conditions identified in Figure 4-4; Section 5.0, Effects Analysis, discusses their specific effects analyses.

4.3.1.7 Subpopulation Characteristics

Subpopulation characteristics are identified by the USFWS (1998) as the primary species diagnostic and include the following indicators: subpopulation size, growth and survival, life history diversity and isolation, and persistence and genetic integrity. Population conditions for all listed fish species covered in this BA are therefore addressed in the following text. Additional information on the status of T&E listed species populations in the action area can be found in Section 3.0, Status of Species and Critical Habitat.

The Upper Clark Fork River basin supports populations of bull trout, brook trout, rainbow trout, brown trout, and cutthroat trout. Bull trout do not occur in the upper portion of the action area (upstream of the WSPs) and are considered extirpated from this section of SBC. Resident bull trout populations do occur in the Warm Springs Creek subbasin (adjacent to the action area), and migratory forms are known to occur in the mainstem of the Upper Clark Fork River, upstream to the WSPs discharge and within the action area. Sustaining bull trout populations are known to occur in the upper reaches of the Clark Fork River basin and in tributaries to the main stem of the Clark Fork River (including Rock Creek, the West Fork of the Bitterroot River, and Blackfoot River) (USFWS, 2015). Warm Springs and Boulder Creeks (USFWS, 2005) represent a majority of the known spawning populations in section one of the Clark Fork River core area. Redd counts of these populations (FWP, 2004a) estimate a total adult bull trout population in this reach of approximately 100 to 200 fish (as cited in USFWS, 2005).

Bull trout growth and survival within the larger watershed appears to be good, and current abundance and distribution of subpopulations should support resilience in association with short-term disturbance or isolated subpopulation decline. Although migratory corridors for bull trout within the upper Clark Fork River Basin are degraded, there are no anthropogenic barriers that impede migration within the mainstem of the Clark Fork River (C. Wood, S-CNF, personal observation, 2011). Designated critical habitat downstream of the confluence of SBC and Warm Springs Creek is likely used primarily as migratory habitat and to a lesser extent for juvenile rearing and adult feeding. The action area upstream of the SBC and Warm Springs Creek confluence may also be used for adult rearing and adult feeding, but dominant brown trout populations in the area make it less suitable and recent sampling efforts have not documented occurrence of bull trout (Cook et al., 2016). In addition to brown trout populations posing a risk to bull trout populations in the upper Clark Fork River, brook trout populations in the area are considered a threat to genetic integrity.

Major concerns for listed bull trout subpopulation characteristics in the basin include the disconnection of tributary streams from mainstem rivers, degradation of riparian habitat, dewatering from irrigation withdrawals, unscreened irrigation ditches, and the introduction of non-native species (Reclamation, 2012). Based on population estimates conducted in 2004 (FWP, 2004a) subpopulations of bull trout in the upper Clark Fork Basin are generally considered Functioning at Risk. However, as noted by the status of baseline conditions below the WSPs complex, all indicators for subpopulations characteristics in the action area are considered **Functioning at Unacceptable Risk**.

4.3.1.8 Water Quality

Water quality is recognized by the USFWS (1998) as one of six habitat pathways (developed to simplify arriving at effects determinations for listed fish). Indicators to aid in assessing baseline conditions and effects from the proposed action(s) relative to water quality include temperature, pH, suspended sediment/turbidity, and chemical contamination/nutrients.

Surface water quality throughout the action area is affected by past mining practices. Historically, these effects resulted in low pH levels and elevated concentrations of metals (including cadmium, copper, iron, lead, zinc) and arsenic (a semi-metal or metalloid) in SBC from the Butte area down to the inlet to the WSPs, as well as below the ponds in SBC and the CFR. The water quality, with respect to these parameters in SBC discharging to the WSPs, has improved dramatically over the past decade as a result of remediation activities in the upstream OUs, especially the SSTOU1. In addition, SBC has historically conveyed elevated concentrations of nutrients (nitrogen and phosphorus) resulting from domestic wastewater and agricultural practices to the WSPs, but these levels have also decreased in recent years.

The WSPs modify and control the water quality of effluent discharging from Pond 2 to the MWB and downstream surface waters (SBC and CFR) through a combination of active treatment measures (for example, lime addition and operation of solar-powered aerators) and naturally occurring, passive processes (for example, solids sedimentation, photosynthesis, and solar warming). Thus, the primary effects of the proposed action are associated with the water quality of the WSPs discharge and its influence downstream in the action area.

Tables 4-1 and 4-2 summarize relevant water quality standards applicable to the action area, including WSPs discharge limits (effluent standards) established in the UAO (EPA, 1991b) and the current Montana Water Quality Standards (WQS) (DEQ, 2012). The WSPs effluent standards are generally comparable to the newer Montana WQS except for the standards for arsenic, cadmium, copper, and selenium. The WSPs limits for arsenic are lower than the WQS for aquatic life because the WSPs values are based on human health, rather than aquatic life, protection. In contrast, the WQS are more stringent than the WSPs limits for cadmium, copper, and selenium.

The standards in Tables 4-1 and 4-2 are used in this BA as the basis for evaluating: (a) the adequacy of baseline water quality for the protection of bull trout in the project area (in this section), and (b) the effects of the proposed action on water quality with respect to its suitability for bull trout (in Section 5). The standards are based on Montana water quality standards, which are more stringent than recommended federal water quality criteria in that they are based on a total recoverable methodology (including dissolved + particulate). The availability of additional or alternative toxicity data specific to the protection of bull trout was investigated. No additional criteria or standards relative to toxicity to bull trout were identified, and discussion with DEQ fisheries biologist Jason Lindstrom further validated that no chemical-specific toxicity data or standards exist for bull trout other than those specified in the Montana WQS (Lindstrom and Chavez, 2017, pers. comm.). The limited literature identified comparing the toxicity of metals (cadmium, copper, and zinc) to bull trout with toxicity to rainbow trout or national water quality criteria indicate that levels established for the protection of salmonids and other aquatic life would also be protective for bull trout (Hansen et al., 2002a, 2002b, and 2002c).

Using the Montana WQS in this BA as a metric for evaluating water quality data for the action area is based on our conclusion that the Montana WQS (as identified in the WSPs unilateral administrative order and which are based on Montana WQS in place at the time the unilateral administrative order was written) and which are more stringent than recommended federal water quality criteria, are protective of bull trout and critical habitat. The USFWS biological opinion (BO) developed for the Idaho water quality standards (USFWS, 2015) states that water quality in compliance with Idaho WQS (which are less stringent that Montana WQS) could result in adverse effects to bull trout and their critical habitat, resulting from bioaccumulation of contaminants by prey species, mortality to certain life stages, and/or creating unsuitable conditions for certain life history functions. Here, the more stringent Montana WQS are protective of bull trout. Notably, the WSPs discharge is well below the Montana WQS arsenic standard (total recoverable) for protection of aquatic life, and only rarely exceeds the Montana WQS copper standard (total recoverable). As discussed in this BA, EPA is currently working with AR to address the occasional pH standard exceedances from the WSP discharge through additional work requirements. Baseline conditions are defined as the existing conditions upon the initiation of the consultation process. To quantify baseline water quality, existing surface water data for pertinent parameters—including pH, temperature, total suspended solids (TSS), suspended sediment, turbidity, arsenic, cadmium, copper, iron, lead, and zinc—were reviewed and tabulated (Tables 4-3 through 4-7).[2] Hardness data are also

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[2] Mercury, selenium, and silver have also been regularly monitored at WSPs sampling stations, but concentrations of those elements have generally been very low and usually non-detectable.

tabulated because it affects the toxicity of, and standards for, so-called hardness-dependent metals (including cadmium, copper, lead, and zinc). These tables present monthly average data for the past 3 years (2014 through 2016) to reflect current conditions following much of the recent improvement in surface water quality within the action area. Data are presented for five locations moving downstream in the action area (Figure 4-5):

- SBC at the WSPs influent, where SBC enters the upstream end of Pond 3 (Atlantic Richfield Station SS-1, Table 4-3)
- WSPs effluent, discharged at the outfall from Pond 2 to the Mill-Willow Bypass (Atlantic Richfield Station SS-5, Table 4-4)
- MWB downstream from the WSPs outfall after mixing with the WSPs discharge (Atlantic Richfield Station MWB-3, Table 4-5)
- SBC at Warm Springs, MT (USGS Station 12323750), above Warm Springs Creek (Table 4-6)
- CFR at Warm Springs, MT, below the confluence of SBC and WSC, calculated from data for SBC and WSC at Warm Springs, MT (USGS Stations 12323750 and 12323770, respectively) (Table 4-7)

<u>Note</u>: The water quality values within the WSPs (Ponds 3 and 2) would fall within those of the WSPs influent and effluent quality, and would likely be closer to the effluent quality in Pond 2. The WSPs themselves have no state water-use classification (see Table 4-2).

Warm Springs Ponds Influent. Water quality data for SBC at the inlet to the WSPs are presented and compared to the most stringent (chronic) aquatic life WQS in Table 4-3. The data for this location provide an indication of the water quality in SBC upstream from the WSPs. While both native and introduced salmonids now occupy SBC above the ponds, there are no bull trout present, and, according to DEQ, habitat in SBC is not currently suitable to support bull trout nor is it anticipated to be suitable in the foreseeable future, primarily as a result of unsuitable water quality related to temperature (Lindstrom and Chavez, 2017, pers. comm.). Monthly average water temperatures at this location range from 0.6°F to 18.3°F, and exceed the 2°C to 15°C (36°F to 59°F) range considered favorable for bull trout (EPA, 2002b) in July and August. The monthly average pH values range from 7.93 to 8.72, and are within the WQS-implied range of 6.5 to 9.0 standard units throughout the year. Average TSS concentrations range from 5.0 to 28 milligram per Liter (mg/L) and are elevated somewhat during the spring. Monthly average metals concentrations at this location exceed the WQS for copper in all 12 months of the year, and also exceed the WQS for cadmium (February, March, and April) and iron (April only).

Warm Springs Ponds Effluent. The WSPs effluent data are presented and compared to the most stringent (monthly average) WSPs discharge limits in Table 4-4. The induced temperature change in the receiving water (ΔT, also shown in Table 4-4) regularly exceeds the allowed 1°F increase in water temperature.[3] The other parameters exceeding the WSPs discharge limits are pH and arsenic during the summer and early fall months. The monthly average pH of WSPs effluent ranged from 8.03 to 10.0, exceeding the pH 9.5 upper limit in July, August, and September. While the elevated summer pH would likely be detrimental to bull trout, the measured levels of arsenic probably are not, because the WSPs discharge limit for arsenic is based on human health rather than aquatic life protection. The arsenic concentrations in WSPs effluent are well within the WQS levels for protection of aquatic life (see Table 4-1). Monthly average concentrations of TSS in WSPs effluent were consistently low throughout the year (3.1 to 7.4 mg/L), and well below the WSPs discharge limit of 30 mg/L, indicating that the WSPs provide adequate settling of suspended solids.

The WSPs effluent exhibits marked seasonal cycling of pH and arsenic concentrations, with elevated levels occurring in summer/early fall. These fluctuations and seasonally elevated levels are apparently

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[3] The ΔT parameter is not a measure of temperature in WSPs effluent *per se*; rather, it is determined as the difference between water temperature measured downstream and upstream of the WSPs outfall (at Atlantic-Richfield Stations MWB-3 and MWB-2, respectively).

the result of naturally occurring processes (algae production/photosynthesis, and biochemical reactions resulting in iron and arsenic dissolution) that are independent of influent levels and treatment activities and are part of the baseline conditions (discussed further in Section 5.2.3).

Mill-Willow Bypass below WSPs Outfall. Water quality data for the MWB downstream from the WSPs outfall (that is, in the lower reach of SBC just below the WSPs discharge) are presented and compared to the most stringent (chronic) aquatic life WQS in Table 4-5. Monthly average water temperatures at this location range from 0.7°F to 18.6°F, and exceed the 15°C upper value considered conducive to bull trout in July and August. The monthly average pH values range from 8.16 to 8.83, and are within the WQS-implied range of 6.5 to 9.0 standard units throughout the year, indicating that the MWB discharge flow provides sufficient buffering to lower the high summer pH levels of WSPs effluent into the acceptable range. Nevertheless, the pH of MWB water below the WSPs outfall remains higher, in summer, than the pH 8.5 upper limit associated with higher-quality waters (for example, state water-use classification B-1). Turbidity levels at this MWB location are generally low (range = 1.4 to 7.7 nephelometric turbidity units), indicating modest concentrations of suspended solids (note that no TSS data are available for this location). The monthly average concentrations of all metals considered, including arsenic, were in compliance with (lower than) the chronic aquatic life WQS at this location.

Mill-Willow Bypass above Warm Springs Creek. Available water quality data for MWB upstream from WSC are presented and compared to the most stringent (chronic) aquatic life WQS in Table 4-6. It should be noted that while the data are presented as monthly averages, there were typically only one or two (and sometimes zero) measured values available for any given month, so the averages are based on limited data.

The monthly average water temperature at this MWB location ranges from 4.2°C to 15.5°C, excluding the coldest months (January, February, and December) for which no data are available, and exceeds the 15°C maximum conducive temperature for bull trout in August. Water temperatures above 15°C are believed to be especially detrimental to juvenile bull trout distribution (USFWS, 2015). The monthly average pH values in MWB range from 8.37 to 9.33, exceeding the WQS-implied range of 6.5 to 9.0 standard units in July and August, and exceeding the pH 8.5 upper limit associated with higher-quality waters in most months. Suspended sediment concentrations are generally low, ranging from 1.3 to 11 mg/L. The monthly average concentrations of all of the metals considered (including arsenic) were in compliance with (lower than) the chronic aquatic life WQS at this location.

Clark Fork River below Warm Springs Creek. Approximate water quality data for CFR downstream from the confluence of Silver Bow and Warm Springs Creeks were calculated from the available 2014 to 2016 data for the USGS gaging stations on SBC and WSC at Warm Springs, MT. These data are presented and compared to the most stringent (chronic) aquatic life WQS in Table 4-7. Again, it should be noted that the average values shown are based on limited data. Monthly average water temperatures in the CFR below WSC are slightly lower than in MWB above WSC, ranging from 3.9°C to 13.9°C (again, excluding the coldest months), with no exceedances of 15°C. The monthly average pH in CFR at this location also shows some improvement compared to MWB above WSC, with values ranging from 8.29 to 8.91 and no exceedances of the pH 9.0 implied standard. Suspended sediment concentrations were generally low, ranging from 1.3 to 15 mg/L, with the highest values corresponding with the high-flow period in May and June. Other than copper, the monthly average concentrations of metals (including arsenic) are in compliance with (lower than) the chronic aquatic life WQS at this CFR location throughout the year. Monthly average copper concentrations exceeded the chronic WQS during May and June, apparently in conjunction with the high-flow, snowmelt/runoff period.

Water Quality Conclusions. Baseline conditions for water quality vary relative to location within the action area. Bull trout occur downstream of the WSPs, but not in the WSPs themselves nor upstream from the WSPs. In addition, there is no avenue for bull trout to access the Ponds or SBC upstream from the WSPs. Consequently, baseline water quality is considered separately for surface waters upstream and downstream of the WSPs within the action area for this BA. These two general areas are assigned functional classifications for baseline water quality for bull trout in Table 4-8.

Table 4-8. Functional Classifications for Baseline Water Quality for Bull Trout
Silver Bow Creek/Butte Area Superfund Site

Water Quality Parameters	Upstream of WSPs in SBC	Downstream of WSPs in MWB, SBC, and CFR
Water temperature	Functioning at unacceptable risk	Functioning at risk
pH	Functioning appropriately	Functioning at risk
Suspended solids/sediment/turbidity	Functioning appropriately	Functioning appropriately
Metals, including arsenic	Functioning unacceptable risk	Functioning at risk

Biomonitoring in SBC and the upper Clark Fork River. Macroinvertebrate richness and diversity are widely recognized as indicators of water quality conditions. Under contract to EPA, McGuire Consulting has performed annual macroinvertebrate-based monitoring in stream reaches of the upper Clark Fork River Basin with ongoing or planned remedial actions. Monitoring was concentrated at sites from above the Warm Springs Ponds through the Deer Lodge Valley and bracketing the former Milltown Dam site (see Figure 4-6). In addition to providing current assessments of ecological conditions, these data extend a long-term database (since 1986) for evaluating water quality trends and the effectiveness of remedial activities.

This assessment, developed specifically for the Clark Fork River drainage, compares each station to a fixed reference condition (McGuire Consulting, 1993). Ten measures of macroinvertebrate community structure and composition are integrated into a single index of biological integrity. Results are presented on a scale of 0 to 100 percent, with values greater than 90 percent indicating a healthy stream environment. In addition, metric subsets estimate the relative severity of impacts from metals and nutrient pollution.

The 2016 assessments document improved conditions in the Silver Bow Creek watershed, but increased environmental stress in the upper Clark Fork River. The Mill-Willow Bypass was non-impaired, while both Silver Bow Creek stations were rated as slightly impaired. Slight biological impairment was evident at all four Clark Fork River stations in the Deer Lodge Valley.

Environmental conditions improved in Silver Bow Creek at Opportunity and below the Warm Springs Ponds, but environmental stresses increased at four Clark Fork River sites in the Deer Lodge Valley. The most recent assessments reflect a weak runoff and below-average streamflow during a hot, dry summer. Nutrient pollution was more apparent as the upper Clark Fork became more eutrophic during low-flow conditions. Significant impacts characteristic of nutrient enrichment were exhibited throughout the Deer Lodge Valley. Significant metals pollution was not indicated at any Clark Fork River site during 2016.

Long-term monitoring shows improved biological integrity throughout the Clark Fork River Basin since 1992. Most recently, floodplain restoration and contaminant removal from upper Silver Bow Creek have resulted in improved water quality and biological integrity at the Opportunity sampling site. Biological monitoring shows accelerated recovery over the past 3 years as remediation near this site was completed. Biological integrity in Silver Bow Creek improved to slightly impaired during the past 2 years.

Improved biological integrity at sites near Warm Springs Creek, and further downstream, coincided with a series of remedial actions to control metals in the upper basin and implementation of a basin-wide voluntary nutrient-reduction program during the 1990s. Impacts attributable to nutrients have declined at all stations except in Silver Bow Creek. Metals pollution has diminished throughout the basin, and significant biological impacts have been detected in the Clark Fork River on only a few dates during the past 15 years. Metals-related impacts were most evident following flood events in 1997 and 2011. However, impacts to aquatic benthic macroinvertebrates in the Mill-Willow Bypass and downstream of the Ponds from the 2011 event, as assessed through sampling by McGuire Consulting (2013), showed that the biointegrity of the benthic macroinvertebrates in the Mill-Willow Bypass and the Clark Fork River immediately below Warm Springs Creek were nonimpaired (greater than 90 percent biointegrity score). Significant metals pollution has not been indicated in the Clark Fork River since 2011. Assessment scores peaked in 2009, when all eight Clark Fork River stations were classified as non-impaired. With the exception of the Silver Bow Creek sites, biological integrity in the Clark Fork River basin has been largely unchanged, or slightly diminished, this century.

Based on 2001 through 2016 monitoring, biological integrity was usually moderately impaired in upper Silver Bow Creek, slightly to moderately impaired in lower Mill-Willow Bypass, and slightly impaired at Clark Fork River stations in the Deer Lodge Valley from Sager Lane to above Garrison. Biointegrity was typically non-impaired in the Mill-Willow Bypass and the Clark Fork River below Warm Springs Creek.

According to McGuire Consulting (2017), while the extent and severity of impacts has declined, environmental stresses continue to impact Silver Bow Creek and portions of the Clark Fork River. Upper Silver Bow Creek remains impaired by both metals and nutrients. Although the Warm Springs Ponds continue to effectively sequester metals, recent assessments of lower Mill-Willow Bypass indicate seasonal effluent toxicity consistent with episodic pulses of ammonia and/or arsenic. Lower Silver Bow Creek was classified as moderately impaired for most of the past decade, but has been slightly impaired the past 3 years. This uptick in bio-assessment scores may be in response to reduced liming and lower pH in the Warm Springs Ponds.

4.3.1.9 Habitat Access

Habitat access is recognized by the USFWS (1998) as the second of six habitat pathways. The sole indicator to aid in assessing baseline conditions and effects from the proposed action(s) relative to habitat access is *physical barriers.*

Baseline conditions associated with the WSPs and in SBC (lower and upper reaches) present several access challenges to the movement of fish from the upper Clark Fork River. First, there is no physical aquatic access into the WSPs or SBC (above the WSPs) from the upper Clark Fork River or WSC. Prior to 1960, Mill and Willow Creeks were tributaries to SBC. Their confluence with SBC was upstream of the ponds and their combined flow entered Pond 3 as SBC does today. During the early 1960s, both Mill and Willow Creeks were rerouted away from SBC, around the west side of the pond complex, east of I-90, through the channel called the Mill-Willow Bypass. This is the current condition. Secondly, approximately 6 miles upstream from the ponds, state agencies collaborated on the creation of a fish barrier downstream from the mouth of Durant Canyon. The purpose of the fish barrier was to prevent the upstream movement of brown, brook, and rainbow trout (non-native species) from the WSPs and SBC below the canyon into the upper reaches of SBC, to prevent competition and interbreeding with native westslope cutthroat trout. Several tributaries (for example, German Gulch) in the upper SBC support a native westslope cutthroat population that is beginning to migrate into the main stem of SBC with the improvement of water quality from the recent remediation (Lindstrom and Chavez, 2017, pers. comm.). No physical barriers restrict passage area from the WSPs discharge downstream into the mainstem Clark Fork River. Habitat access in Silver Bow Creek is considered **Functioning at Unacceptable Risk** for *physical barriers* as indicated by the status of baseline conditions for the project area. Habitat access downstream of the WSPs in the MWB is considered **Functioning Appropriately.**

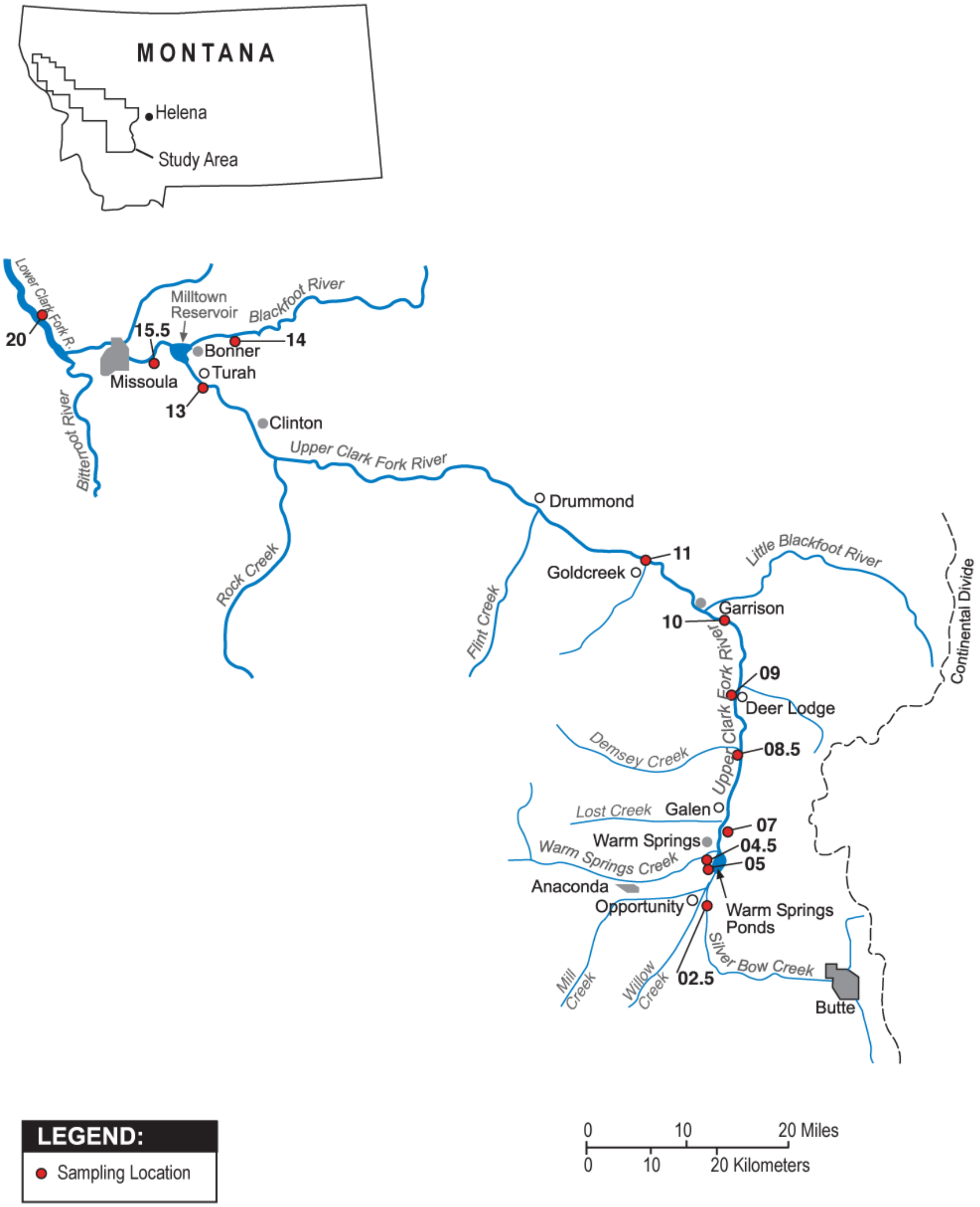

Figure 4-6. Clark Fork River Biomonitoring: 2016 Monitoring Locations

4.3.1.10 Habitat Elements

Habitat elements is recognized by the USFWS (1998) as the third of six habitat pathways. Indicators to aid in assessing baseline conditions and effects from the proposed action(s) relative to habitat elements include the following: *substrate embeddedness, LWD, pool frequency, pool quality, off-channel habitat, and refugia.*

The riparian corridor and channel condition in the action area remains degraded as a result of historical deposition of mine wastes and recent remedial activity along the lower Mill-Willow Bypass. From the confluence of MWB with the discharge from Pond 2, the lower Mill-Willow Bypass retains a meandering shape for approximately 0.6 mile to its confluence with Warm Springs Creek and the start of the Upper Clark Fork River. This reach of lower Mill-Willow Bypass flows northeast within 200 feet, and parallel to, the berms of the WSPIAAOU. The streambanks are intermittently vegetated with thin runners of sandbar willow (less than 10 feet wide), and separated by approximately 300 feet of poorly vegetated floodplain from Warm Springs Creek flowing northeast and parallel to Warm Springs Road. Less than 0.25 mile before its confluence with Warm Springs Creek, the lower Mill-Willow Bypass turns north. The final approach to Warm Springs Creek is met by a sparsely vegetated, re-aligned, remediated channel and floodplain, the construction of which was completed in 2014. As can be seen in Photo 4-6, remediation of the upper Clark Fork continues for another 0.5 mile north of Warm Springs Road. Because of the recent work, it is apparent that streambank/floodplain vegetation has not yet matured, adversely affecting aquatic habitat through lack of vegetated bank cover contributing to direct thermal exposure and absence of instream woody debris. The active channel has been broadened, eliminating undercut banks, and the height of the floodplain terrace reduced. Over time, it is anticipated this habitat will improve as vegetation matures and bank material stabilizes. Aquatic habitat diversity and complexity under baseline conditions in the mainstem of the lower Mill-Willow Bypass and the upper Clark Fork River no longer represents mature natural or historical (pre-mining) conditions and is likely **functioning at risk** for all habitat element indicators.

Photo 4-6. Mill-Willow Bypass (2014). Note sparse riparian vegetation.

4.3.1.11 Channel Condition and Dynamics

Channel condition and dynamics are recognized by the USFWS (1998) as the fourth of six habitat pathways. Indicators to aid in assessing baseline conditions and effects from the proposed action(s) relative to channel condition and dynamics include the following: *width/depth ratio, streambank condition, and floodplain connectivity.*

From 1999 to 2014, the SBC channel from Butte to Warm Springs Ponds (26 miles) was remediated in a series of four subareas from upstream to downstream, and reconstructed to remove contaminated mine waste. Reconstruction often required diverting SBC away from the portion of the channel being excavated to facilitate wholesale removal of the wastes, and repeating the process for the other side. The exception to this method of reclamation was through Durant Canyon where area was constricted by the canyon width and depth was constrained by shallow bedrock. Channel reconstruction was designed to meet geomorphic stability objectives, while promoting stream channel-floodplain connectivity. Fluvial design objectives considered appropriate width/depth channel ratios matched to anticipated flow, and local channel gradient dictated by reach topography. Average width/depth ratio for the bankfull channel was designed to range from 10 to 15 for riffles and straight reaches, and between 7 and 12 for pools (DEQ, 1999). Stream bank stability was enhanced by revegetation with willows (Sandbar [*Salix exigua*], Booth [*S. boothi*] and Geyer [*S. geyeriana*]) and other native riparian vegetation. Since the beginning of remediation in 1999, the progress of SBC reclamation has been assessed every 5 years by EPA and DEQ evaluations.

In the mid-1990s, the MWB along the west and north sides of the project area was remediated/reconstructed to remove extensive deposits of tailings and to upgrade the west-side WSPs berms to meet stipulated flood and seismic standards for the OU. The bypass corridor was reconfigured to include a stable, meandering channel with overflow ponds capable of passing half-probable maximum flood of 70,000 cfs. The channel was designed with appropriate morphology (for example, width/depth ratios, gradient, and pools and riffle sequences.) to match anticipated flow regimes while promoting stream channel to floodplain connectivity. The corridor and streambanks were successfully revegetated with willows (Sandbar, Booth, and Geyer) and function today as a stable bypass feature for Mill and Willow Creeks and the occasional flood overflow from SBC. Since the beginning of WSPs remediation (mid-1990s), the progress of SBC reclamation through the action area has been assessed every 5 years by EPA and DEQ evaluations. For instance, in an addendum to the initial Five-Year Review Report, R2 Resource Consultants concluded “that the riparian plant communities were developing well and should be allowed to continue to develop naturally, although additional willow plantings would be helpful. Limited overbank scour and bank erosion were occurring as part of the natural maturation of the channel; the overbank scour was creating habitat for willow species that were developing communities in these areas” (AR, 1998). In the second Five-Year Review (EPA, 2005), the vegetative development along the MWB was described as excellent.

The conclusion of the most recent five-year review (EPA, 2016) was that the reconstructed upper SBC channel, as well as the MWB channel was in dynamic equilibrium with annual flow regimes. Furthermore, it was determined that water quality (a result of channel condition and dynamics) in SBC had improved significantly, approaching the desired standards, and would likely meet those standards once upstream source areas were completely remediated (EPA, 2016).

SBC channel conditions and dynamics upstream of the WSPs are considered **Functioning Appropriately** for *width:depth ratio* and *floodplain connectivity* and considered **Functioning at Risk** for *streambank condition* as indicated by the status of baseline conditions for the action area. Channel conditions and dynamics in MWB are also considered **Functioning Appropriately** for *width:depth ratio* and *floodplain connectivity* and considered **Functioning at Risk** for *streambank condition* as indicated by the status of baseline conditions for the action area.

4.3.1.12 Flow/Hydrology

Flow/hydrology is recognized by the USFWS (1998) as the fifth of six habitat pathways. Indicators to aid in assessing baseline conditions and effects from the proposed action(s) relative to flow/hydrology include the following: *change in peak/base flows, and increase in drainage network.*

Silver Bow Creek is one of the major tributaries to the headwaters creating the Clark Fork River, and its drainage area covers about 473 square miles, flowing north about 26 miles from its headwaters in the continental divide near Butte, Montana. Flow regime is characterized by a robust, spring to early summer runoff (snow melt and precipitation) that commonly peaks in June. A decreasing hydrograph coincides with limited summer precipitation, which leads into the low-flow winter months.

Changes over time in the annual hydrograph for SBC appear related to changes in climatic conditions and are not unique to the system. Otherwise, there does not appear to be any significant recent change, within the last 5 years, to the drainage network within the action areas. Multiple water rights occur in the watershed.

Flow and hydrology conditions throughout the action area are considered to be **Functioning Appropriately** for all indicators.

4.3.1.13 Watershed Conditions

Watershed condition is recognized by the USFWS (1998) as the sixth habitat pathway. Indicators to aid in assessing baseline conditions and effects from the proposed action(s) relative to watershed conditions include the following: *road density and location, disturbance history, riparian conservation areas, and disturbance regime.*

The Silver Bow Creek watershed drains approximately 470 square miles and is a mix of public land managed by the USFS in the highlands and private property primarily along the SBC corridor. Vegetation in riparian areas, influenced by over a decade of remediation activities, continues to recover. The maturing vegetation consists primarily of aspen, willow, alder, sedges, rushes, grasses and mesic forbs, often mixed with sage and grassland reflecting a high elevation, cool, dry climate. Wet meadow areas occur infrequently as a result of the recent remediation of mine waste in channels and floodplains along the entire length of Silver Bow Creek (DEQ, 2014b).

Historical uses of the watershed for mining and grazing have impacted fish and wildlife habitat (see Figure 2-1 for example on mining impacts around Butte). Impacts from direct mining activities in the upper watershed include: deforestation, soil removal, large scale bedrock removal for open pit mining, creation of waste rock dumps, processing wastes and associated impacts to surface and groundwater quality and surface water runoff quantity. Loss of extensive riparian vegetation throughout the action area contributed to accelerated erosion of banks, high sediment loads, and a toxic aquatic environment. These changes resulted in habitat fragmentation and lack of connectivity, with reduced habitat quantity and quality. In spite of all the recent remedial action, these conditions still represent the primary limiting factors within the Silver Bow Creek drainage affecting the presence, productivity, spatial structure, and genetic diversity of salmonids, excluding bull trout which are considered extirpated from the upper reaches. Twenty-six miles of SBC was devastated by 100 years of mine wastes. Tailings and mine wastes in the channel and floodplain corridor varied in depth from several inches to over 7 feet thick, creating a sterile aquatic environment inhibiting lateral migration, preventing channel and floodplain interactions, and disconnecting tributaries from the mainstem (EPA, 1995a). Riparian zones along SBC, WSPs, MWB, and upper Clark Fork River, severely altered by deposition of historical mining wastes, are slowly improving as a result of aggressive remediation and revegetation of the stream channel and floodplain (occurring from early 1990s through 2017).

Road density in most of the SBC drainage is modest with some of these roads (interstate, state, and county) collocated with rail lines along the stream corridor.

Currently, environmental disturbance events within the SBC drainage consist of high snow melt runoff events, high intensity thunder storms, and occasional wildfire. The habitat appears to have moderate resiliency in recovering from these events. Watershed conditions in SBC for the most part no longer reflect natural conditions within the range of desired conditions. They are considered **Functioning at Risk** for *road density and location, riparian conservation areas, disturbance history, and disturbance regime* throughout the action area.

4.3.1.14 Species/Habitat Integration

The species/habitat integration diagnostic (which relates the existing condition of habitat and the status of the subpopulation) is recognized by the USFWS (1998) as the final step in making an appropriate effects determination that is likely to result from the proposed action.

Bull trout have likely been absent from the upper SBC since the early 1900s. There is no physical access for bull trout to move upstream from designated critical habitat of the upper Clark Fork River and Warm Springs Creek. If access were possible, habitat has been significantly impacted throughout the action area, and is still in the stages of recovery. Water quality, connectivity, habitat fragmentation, road location, and stream dewatering are all remaining threats to listed bull trout throughout the SBC drainage. Contaminant/nutrient, stream temperatures, and the availability/connectivity of suitable habitat remain in an altered state as a result of historical mining and other anthropogenic activity.

Below the WSPs complex where remaining bull trout populations are known to occur, habitat remains marginalized, although past and ongoing remedial activities appear to be promoting an improving trend in overall habitat conditions relative to baseline water quality, habitat elements, channel and watershed conditions.

The connectivity and size of subpopulations for all fish within the watershed have been reduced from historical conditions and lingering residual contaminants. This condition is anticipated to continue into the foreseeable future, however results achieved thus far are promising for improved future species/habitat integration. Overall, the integration of species and habitat pathways for the action area is considered **Functioning at Risk for bull trout** throughout the Silver Bow Creek watershed.

SECTION 5

Effects Analysis

Direct effects are defined as the direct or immediate effects of the project on the species or its habitat (USFWS, 1998). Indirect effects are those effects that are caused by the proposed action and occur later in time, but are still reasonably certain to occur (50 CFR 402.02). The proposed action is anticipated to potentially result in only insignificant and discountable adverse direct effects to listed species over the short term. Over the long term, beneficial indirect effects are anticipated. These are described in Sections 5.1 and 5.2.

5.1 Effects on Terrestrial Species and Their Habitats

Historic mining activities conducted throughout the action area rendered much of it unsuitable for a large array of flora and fauna. Remedial activities over the last few decades have been implemented with the goal of eliminating or mitigating heavy metals and arsenic in the environment for the protection of human health and the environment. Past remedial activities have worked to improve general physical characteristics of the area relative to stabilizing soils, revegetation, and capture of heavy metals; however, it is not anticipated these activities would result in habitat suitable for various life stages of Canada lynx and grizzly bear for some time. Open landscapes, sparse cover, and limited prey species throughout much of the action area still provide minimal suitable habitat. Wildlife use occurs seasonally in the few habitat patches representing upland, wetland and remaining forested areas, but most of the action area still provides marginal habitat.

No records of lynx sightings are known for either Silver Bow Creek or Deer Lodge Counties (MNHP, 2017). The action area does not provide habitat suitable for Canada lynx to use as core or denning habitat. No Canada lynx are expected to occur in the action area and, even if occasionally present, no habitat exists for its main prey species (snowshoe hare).

Although grizzly bears are known to inhabit the mountain ranges in Montana and Wyoming, no sightings near the action area are known, or documented (MNHP, 2017). The action area consists of disconnected habitat that is not considered suitable for grizzly bear other than as a migratory corridor.

Existing habitat conditions in the action area, as well as its proximity to urban settings, general human use/recreation, and roadways, would be anticipated to hinder use by both lynx and grizzly bear until well after remedial activities have ceased and conditions have matured. Despite this, more suitable habitat for both lynx and grizzly bear does occur in forests proximate to the action area, so it is possible that individuals may move through the area during the period that remedial activities are ongoing. Any use of this area by species such as lynx and/or grizzly bear would likely be limited to migration through the area to and from other proximate suitable habitat; this migration would likely occur in the forested slopes of Durant Canyon where limited cover and refugia remains and no construction of remedial elements would occur. Riparian and wetland habitat in the WSPs OUs may also provide a migratory pathway for large transient wildlife such as lynx and grizzly bear moving through the area; however, it does not maintain habitat elements considered important to make it otherwise suitable for these listed species.

Remedial activities proposed to continue require earthwork and construction but for the most part, once in place and functioning, require time to mature and begin facilitating their intended function. General earthmoving activities and use of heavy equipment in containment elements and revegetation of the action area, when implemented, do have the potential to affect lynx and/or grizzly bear that may be moving through the area in limited ways. Direct temporary effects of remedial activities that have the potential to affect lynx or grizzly bear are primarily related to noise and activity during construction or earthmoving periods. Construction noise would displace general wildlife in the area as well as lynx or grizzly bear that may be incidentally moving through the area. Any displacement of listed species or other wildlife (such as prey) would not be anticipated to perpetuate after construction elements have ceased.

Recent verified observations of lynx or grizzly bear within the action area have not occurred and neither are likely to be found in the action area during the period proposed actions would continue. Therefore, the likelihood of disturbance to transient lynx or grizzly bear is considered discountable. If transient lynx or grizzly bear were to be in a project area during implementation of remedial construction, the potential for disturbance is not expected to result in significant effects or reduce an individual's ability to move through the area. Any direct effects to listed species would be minimal, short term, and intermittent. No mortality or take would be anticipated to occur.

No long-term adverse effects to lynx or grizzly bear would occur resulting from the proposed action. It is anticipated, however, that over the long term (once construction activities have ceased), remedial activities would result in maturing forested, upland, and riparian habitats. Improving these habitats and limiting the continued release of heavy metals into the system would likely provide habitat more suitable for ESA-listed species and their prey, and establish greater connectivity with proximate habitat. Once active remedial elements are completed in the project area and after habitats have matured, indirect beneficial effects resulting from the proposed action would be anticipated to improve viability for both lynx and grizzly bear in the action area and surrounding landscape.

5.2 Effects on Aquatic Species and Their Habitats

The USFWS's nine PCEs for bull trout were evaluated independently and considered within associative pathways, and the effects determinations are described in Section 5.2.1, Primary Constituent Elements. The aquatic and riparian habitat elements in the Matrix of Pathways and Indicators (USFWS, 1998) were used to describe the environmental baseline and evaluate potential project effects on upper Clark Fork River bull trout and their designated critical habitat.

Critical pathways for bull trout recovery that potentially pertain to this project and merit discussion include subpopulation characteristics related to survival and genetic integrity risk from exotic species; water quality related to sediment/turbidity, pH, temperature, and contaminants; and habitat elements, channel condition and dynamics, and watershed conditions in upper SBC (above the WSPs complex). No other critical pathways addressed in the matrix of pathways and indicators (NMFS, 1996; USFWS, 1998) are discussed further in this BA.[4]

On the basis of residual impacts from historical land use in the basin and other factors not related to the Superfund cleanups, the key indicators of concern are currently considered "functioning at risk" or "functioning at unacceptable risk." Each indicator was evaluated for potential effects from the proposed project, and determination of the effect of the proposed action is primarily based on these indicators and pathways.

Habitat upstream of the WSPs has not been accessible to bull trout since construction of Pond 1 in 1911. No bull trout occur in SBC upstream of the WSPs, and habitat conditions are not suitable to support self-sustaining bull trout populations (Lindstrom, 2017, pers. comm.). Critical habitat for bull trout is designated for the action area downstream of the WSPs, and bull trout are known to use the upper Clark Fork River at various times seasonally.

Construction relative to remedial activities in the upper OUs have the potential to release turbidity, mobilize contaminants, and adversely affect water quality in SBC above the WSPs discharges. This would be anticipated to occur only over short-term, intermittent periods when active construction is underway. These effects, in relation to the critical habitat for bull trout, would be addressed by the WSPs.

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[4] Habitat access, flow/hydrology, and species/habitat integration pathway indicators would not be affected by the proposed action.

Water released from the WSPs downstream has the potential to affect water quality where bull trout are known to occur and in turn could affect subpopulation characteristics.

Habitat elements, channel conditions/dynamics, and watershed conditions in the upper SBC drainage (above the WSPs complex) may experience similar short-term effects related to active construction in the upper OUs, but would likely be beneficially affected over the long term, after remedial elements have matured and become functional. Yet, none of these indicators would be anticipated to be affected downstream of the WSPs complex, where bull trout may occur and critical habitat is designated.

Over the short term, minimal and discountable adverse effects to bull trout may occur, but none are anticipated, and baseline conditions for all indicators would be maintained. Over the long term, beneficial effects as a result of remedial activities in the basin would likely occur.

Anticipated effects associated with the proposed action, as they relate to USFWS diagnostics, pathways, and indicators, are described in Sections 5.2.2 through 5.2.6.

5.2.1 Primary Constituent Elements

PCE 1: *"Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia."*

Although springs, seeps, groundwater sources, or subsurface water connectivity occur in the project area, they would not be affected by the proposed action relative to current conditions. Consequently, **this PCE would not be affected.**

PCE 2: *"Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to, permanent, partial, intermittent or seasonal barriers."*

The barrier installed on the upper SBC is designed to prevent upstream fish migration while allowing downstream migration; however, bull trout do not occur in the SBC upstream of the WSPs. While the existing WSPs discharge structure prevents upstream migration of bull trout into the Ponds and upper SBC, the proposed action would not have any effect on this passage barrier relative to current conditions. Further, water quality conditions do not under current conditions, nor would they as a result of the proposed action, create any impediment to movement in the action area. **This PCE would not be affected**.

PCE 3: *"An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish."*

Remediation activities within the past decade along the SBC and upper CFR have removed riparian vegetation and disturbed the supply of terrestrial food sources in the action area. This situation should improve as riparian zones recover and mature. Since most, if not all, of the streamside remediation is now completed, and the proposed action consists of the continuation of other active remedial elements at the WSPs and other upstream SBCBA OUs, minimal effects on food sources in the action area are expected relative to current conditions. **This PCE would not be measurably affected over the short term**. Beneficial effects to this PCE upstream of the WSPs are anticipated over the long term.

PCE 4: *"Complex river, stream lake, reservoir, and marine shoreline aquatic environments and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structures."*

Recent remediation activities along SBC, lower Mill-Willow Bypass, and upper CFR have reduced aquatic habitat complexity in the action area on a short-term basis while remediation occurs. However, these remedial activities were designed to facilitate long-term improvements in water quality and in the aquatic and riparian environments in general, and habitat complexity has improved in SSTOU and should improve over time in the CFR as the channel and riparian areas progress toward more mature, natural conditions. The proposed action is not expected to measurably affect existing baseline aquatic habitat in the project area over the short term. Thus, **this PCE would not be affected over the short term**. Beneficial effects to this PCE upstream of the WSPs are anticipated over the long term.

PCE 5: *"Water temperatures ranging from 2° to 15°C (36° to 59°F), with adequate thermal refugia available for temperatures at the upper end of this range. Specific temperatures within this range will vary depending on bull trout life history stage and form, geography, elevation, diurnal and seasonal variation, shade, such as that provided by riparian habitat, and local groundwater influence."*

Prior remediation activities along the SBC, lower Mill-Willow Bypass, and upper CFR have removed riparian vegetation and contributed to solar warming of water in those areas. This situation should improve as revegetated riparian zones recover and mature. Since most, if not all, of the streamside remediation is now completed, and the proposed action consists of the continuation of other active remedial elements at the WSPs and other upstream SBCBA OUs, minimal effects on water temperatures in the action area over the short term are expected relative to current conditions. It should be noted that water temperatures in streams and rivers are also adversely affected by irrigation withdrawals, particularly during the summer and early fall, the impacts of which may be exacerbated by naturally occurring drought cycles.

The current effects of the WSPs on elevated summer water temperatures in the project area are principally the result of altered landscape conditions that have occurred since the mid-1900s and resulting function of the Ponds (solar warming), constructed separately from the Superfund cleanup many years ago, that is independent of the proposed action and represents existing baseline conditions. The proposed action includes operation of solar-powered mixers in the WSPs, which are intended to reduce elevated summer water temperatures. Therefore, the proposed action is expected to have no adverse effect on water temperatures in the action area downstream from the Ponds relative to current conditions. Minimal beneficial effects relative to reduced water temperatures during the summer months may result, although not to the extent that they would recognizably alter conditions that would occur otherwise. Water temperature effects are discussed further in Section 5.2.3, Water Quality.

In addition, the proposed action will have no effect on thermal refugia, groundwater influence on surface water, shade, or riparian vegetation in the project area over the short term, compared to current conditions. Consequently, **no adverse effect is anticipated for this PCE over the short term**. Beneficial effects to this PCE upstream of the WSPs are anticipated over the long term as vegetation matures.

PCE 6: *"In spawning and rearing areas, substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions."*

Concentrations of TSS in WSPs effluent have been relatively low. Thus, only minimal amounts of fine sediment are discharged from the WSPs to downstream surface water in the action area. This situation is expected to continue in the future, and the proposed action is not expected to negatively affect the bottom substrate in bull trout spawning and rearing areas relative to current conditions. Consequently, **this PCE would not be affected**.

PCE 7: *"A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departures from a natural hydrograph."*

The proposed action consists of a continuation of active remedial elements at the upstream OUs, and is designed to restore natural flow processes; continued operation of the WSPs is not expected to have any appreciable effect on surface water hydrology in the action area relative to existing conditions. Peak, high, low, and base flows would not be altered in SBC as a result of the proposed action, and flow departures through the Mill-Willow bypass and WSPs discharges would remain consistent with the natural hydrograph. **Thus, this PCE would not be affected.**

PCE 8: *“Sufficient water quality and quantity such that normal reproduction, growth and survival are not inhibited.”*

Baseline conditions and determination of effects for this PCE align well with the water quality pathway, which is described in Sections 4.3.1.7 and 5.2.3. As discussed in Section 5.2.3, the proposed action is not expected to negatively affect water quality in the action area relative to current conditions. Therefore, **this PCE would not be affected over the short term.** Beneficial effects to this PCE upstream of the WSPs are anticipated over the long term.

PCE 9: *“Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competitive (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.”*

Non-native species occur throughout the action area, including in critical bull trout habitat in the upper CFR downstream from the WSPs (especially brown trout). The proposed action is not expected to affect the existing baseline conditions relative to predatory, interbreeding, or competitive non-native species present in the action area. Consequently, **this PCE would not be affected.**

5.2.2 Subpopulation Characteristics

Bull trout do not occur in the action area upstream of the WSPs, nor do they have the potential to occur there under existing conditions.

Bull trout are, however, known to occur in the action area downstream of the WSPs discharge and critical habitat occurs at the confluence of Warm Springs Creek and SBC. Both adult and rearing juvenile bull trout may occur below the Ponds during various times of the year. Juvenile bull trout from populations in Warm Springs Creek likely move upstream toward the discharges of WSPs to rear, and adults ascending the mainstem Clark Fork may move into the action area to forage. However, elevated temperatures that may occur in the action area during the summer months (due to a combination of Superfund and non-Superfund causes) likely limit use of this section of the river seasonally. No spawning is currently known to occur in the action area. However, as restoration of the upper Clark Fork River continues, it is feasible that maturing channel conditions may create suitable spawning habitat that could be used by bull trout for future spawning or incubation while active remedial elements of the proposed action are still underway.

No instream work would be conducted downstream of the ponds under the proposed action. Additionally, no earthmoving or other construction is proposed that would affect any life stages of bull trout that could potentially occur in SBC below the Ponds or downstream in designated critical habitat in the upper Clark Fork River. In turn, no increase in sediment or fines transported downstream would occur, and the risk of harm to bull trout from elevated turbidity does not exist.

Although considered highly unlikely, limited activity relative to monitoring of the WSPs conditions and continued remedial elements (general human activity) have the potential to displace fish that may be foraging at the mouth of the WSPs discharges. If displacement were to occur, it would be temporary and fish would likely return once activity had ceased. Any adverse effects from general activity and noise relative to monitoring or remedial elements at the WSPs would be insignificant and not occur to the extent they would measurably affect subpopulation characteristics. No take in the form of harm or harassment is anticipated to occur, and no mortality would result as a direct or indirect effect of the proposed action.

A primary concern surrounding listed fish in the upper Clark Fork River are exotic species. Competition from brown trout and the risk of reduced genetic integrity from brook trout may threaten the persistence of self-sustaining populations. Brown trout tend to be more tolerant of higher water temperatures and reduced water quality. One concern associated with the proposed action is that continued remedial activities could contribute to elevated temperatures entering the upper Clark Fork

River from SBC and promote more suitable conditions for exotic species. Analysis of water quality data (Section 5.2.3) demonstrates that remedial elements proposed to continue in the WSPOU do not elevate water temperatures or reduce water quality relative to what would occur under existing conditions. In fact, data indicates that summer temperatures of water exiting the WSPs complex may actually be reduced by mixing of the water column (induced by SolarBees). No adverse effects to water temperature are anticipated as a result of the proposed action. Although minimal beneficial temperature effects may occur during the summer months as a result of mixing of the WSPs prior to release, any realized effects would likely be insignificant.

Any short-term effect to species/habitat integration as a result of the proposed action is considered discountable. If effects were to occur, they would likely be limited to temporary displacement and insignificant. No long-term adverse effects relative to remedial elements in the proposed action are anticipated for bull trout during any of their life stages, and no long-term deleterious impacts to the populations would be anticipated to occur because of the proposed project. No change in baseline condition is anticipated for this parameter. Overall, species/habitat integration conditions are expected to be maintained as a result of the proposed action.

5.2.3 Water Quality

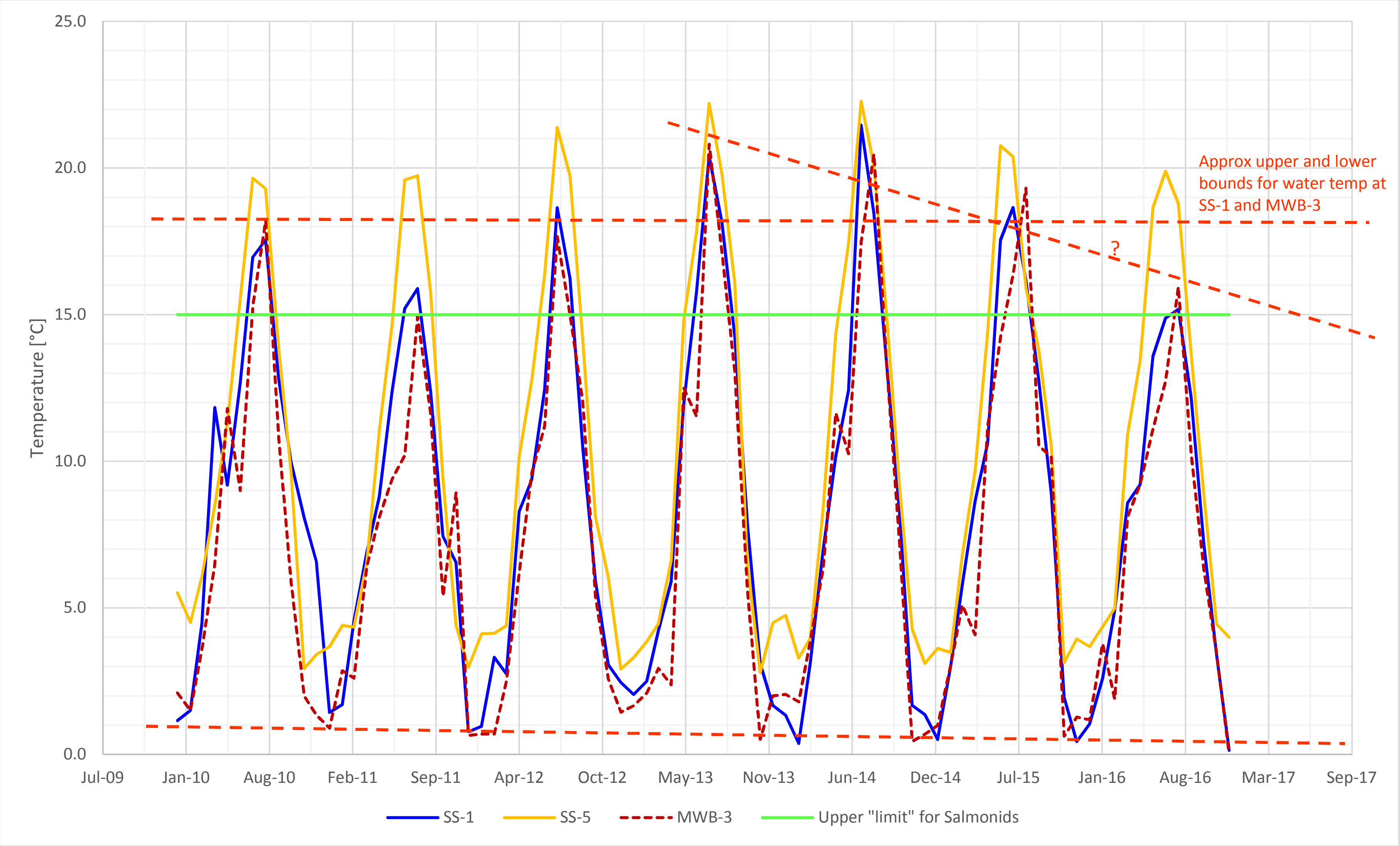
5.2.3.1 Temperature

Some solar warming of water occurs across the WSPs (Figure 5-1; compare plots for WSPs influent at SS-1 to WSPs effluent at SS-5), but solar warming is a passive function of the Ponds that will occur regardless of the proposed action. Recent water temperature data for the WSPs influent (SS-1) and for the MWB/SBC downstream from the WSPs discharge (MWB-3) demonstrate that water temperatures, on a monthly average basis, are essentially the same downstream of the WSPs discharge after mixing with the MWB flow and in the SBC entering the Ponds—indicating that the cooling effect of blending with the MWB flow essentially counteracts the solar warming in the WSPs. The data indicate that maximum summer water temperatures both above and below the WSPs are above the range conducive for bull trout and other salmonids. The maximum values may indicate a decreasing trend over the past 4 years, or possibly just a roughly constant trend with annual climatic variability over the 2010-16 period (further data are needed to verify the water temperature trend). The minimum winter water temperatures at each location appear to be essentially constant over the 7 years plotted in the figure.

One active element of the WSPAAOU that may favorably affect summer water temperatures is operation of the solar mixers. Operation of the SolarBees in the Ponds tends to reduce the water temperature of WSPs discharge in summer by inducing vertical mixing and disrupting thermal stratification. Another recent occurrence within the action area that may help decrease solar warming and elevated summer temperatures in SBC is the re-establishment of riparian vegetation and shading, over time, following remediation of floodplain areas and work already completed in the Streamside Tailings OU.

The continuation of the active remedial elements at the WSPs and other upstream OUs is not expected to adversely impact water temperatures in the action area relative to existing conditions. Summertime water temperatures below the WSPs are expected to remain unchanged or decrease slightly relative to existing conditions as a result of the proposed action.

FIGURE 5-1. Water Temperature in WSPs Influent (SS-1) and below WSPs Discharge (MWP-3)(monthly averages, 2010-2016)



pH. Active elements of the remedial actions at the upstream OUs are unlikely to appreciably affect the pH in upper SBC.

The WSPs effluent exhibits marked seasonal cycling of pH, with high pH levels in summer/early fall exceeding water quality standards (Figure 5-2). The elevated pH values are apparently the result of algae growth and photosynthesis in the Ponds, resulting in CO_2 uptake, depletion of alkalinity, and increase in pH. Algae growth in water bodies is typically limited by the availability of nutrients, particularly phosphorus and nitrogen. The WSPs have historically received relatively high nutrient loads, but nutrient loading to the upper SBC (and subsequently the WSPs) has reportedly been decreased markedly in recent years (Reed, 2017, pers. comm.). Consequently, the seasonal photosynthesis-driven increases in WSPs pH may be mitigated somewhat in the future.

Lime addition at the WSPs inlet has directly contributed to pH increases in the Ponds during certain portions of the year. Lime addition has been employed to deliberately raise pH to precipitate dissolved metals in the influent water. However, liming is implemented only when the WSPs influent pH is low (in recent years, in winter and early spring). During those periods, the WSPs effluent pH is generally at moderate levels favorable for aquatic life. Thus, it is unclear to what degree, if any, lime addition has contributed to the elevated WSPs effluent pH levels observed in summer/early fall. Furthermore, Atlantic Richfield, the responsible party for remediation of the WSPs OUs, has been conducting lime reduction trials since October 2013 (AR, 2014, 2016a, 2016b). The objective of these trials is to determine if WSPs effluent water quality could be improved, or at least maintained at current levels, when lime addition is reduced. These trials have consisted of two phases to date: the first phase used a target pH at SS-2 (the monitoring station located immediately downstream of the lime addition point) of 8.5 to 8.8 and a nominal lime addition rate reduction of 25 percent compared to the pre-study rate; the second phase is currently using a pH target of 8.0 to 8.3 at SS-2 and a nominal lime addition rate reduction of 50 percent. Thus, as lime addition is optimized by reducing the amount added to the WSPs system, it should become less likely to contribute to elevated pH in WSPs effluent.

Of the two mechanisms discussed above as potentially contributing to the seasonally elevated pH levels in WSPs effluent, the algae bloom/photosynthesis mechanism is a passive, naturally occurring process that is independent of the proposed action, whereas lime addition is an active element of the WSPs operation and a component of the proposed action for this BA. Lime addition has been reduced in recent years and will likely continue to be reduced in the future as lime addition is optimized, influent water quality improves, and influent pH increases. Consequently, the proposed action is not expected to adversely affect water pH in the action area (downstream of the WSPs) relative to existing conditions, and, if anything, may result in improved action area pH in the future.

Suspended Sediment and Turbidity. Active remedial elements in the Streamside Tailings OU likely contributed to elevated suspended solids levels in SBC and the lower Mill-Willow Bypass, the result of removal of material from the channel and riparian zone. These actions are now nearly or entirely complete, and the disturbed areas are undergoing recovery and revegetation; the contribution of suspended sediment to the waterways has and should continue to decrease. TSS data for WSPs influent and effluent over the period 2010-16 are presented in Figure 5-3. Those data show that while influent TSS has decreased markedly over that period, WSPs effluent TSS has remained relatively constant and at levels well below the WSPs discharge limits. Sedimentation of suspended solids in the Ponds is a passive function that is independent of the proposed action. Consequently, the proposed action is not expected to affect suspended sediment or turbidity levels in the action area relative to current conditions.

Contaminants. Concentrations of metals/elements of interest (arsenic, cadmium, copper, iron, lead, and zinc) in WSPs influent and effluent over the period 2010-16 are presented in Figures 5-4 through 5-9. With the exception of arsenic, all these figures depict similar trends: substantial decreases in influent concentrations over that time, and relatively constant effluent concentrations, on average, that are well below the WSPs discharge limits.

FIGURE 5-2. pH in WSPs Influent (SS-1) and Effluent (SS-5) (monthly averages, 2010-2016)

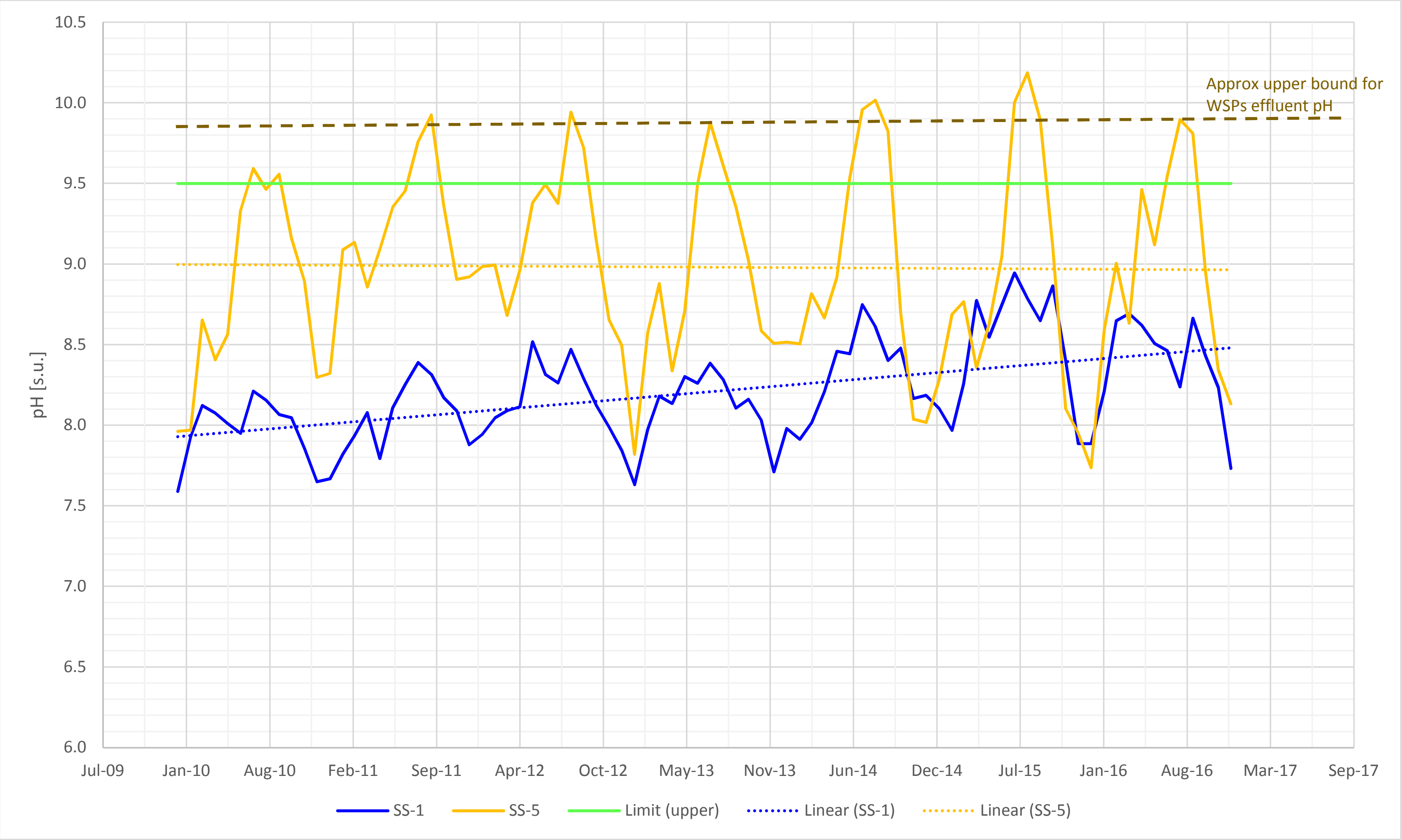


FIGURE 5-3. TSS in WSPs Influent (SS-1) and Effluent (SS-5) (monthly averages, 2010-2016)

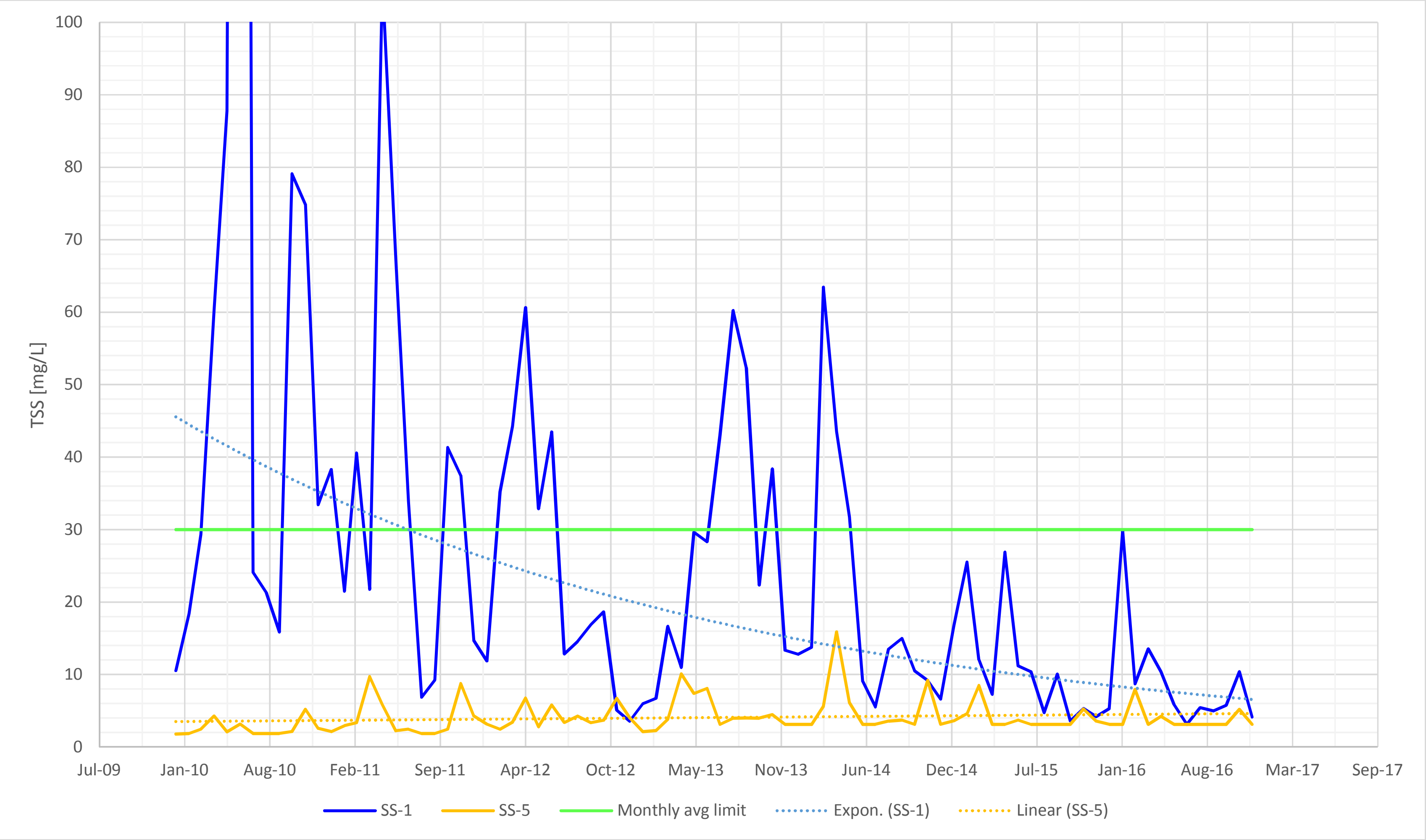


FIGURE 5-4. Total Arsenic in WSPs Influent (SS-1) and Effluent (SS-5) (monthly averages, 2010-2016)

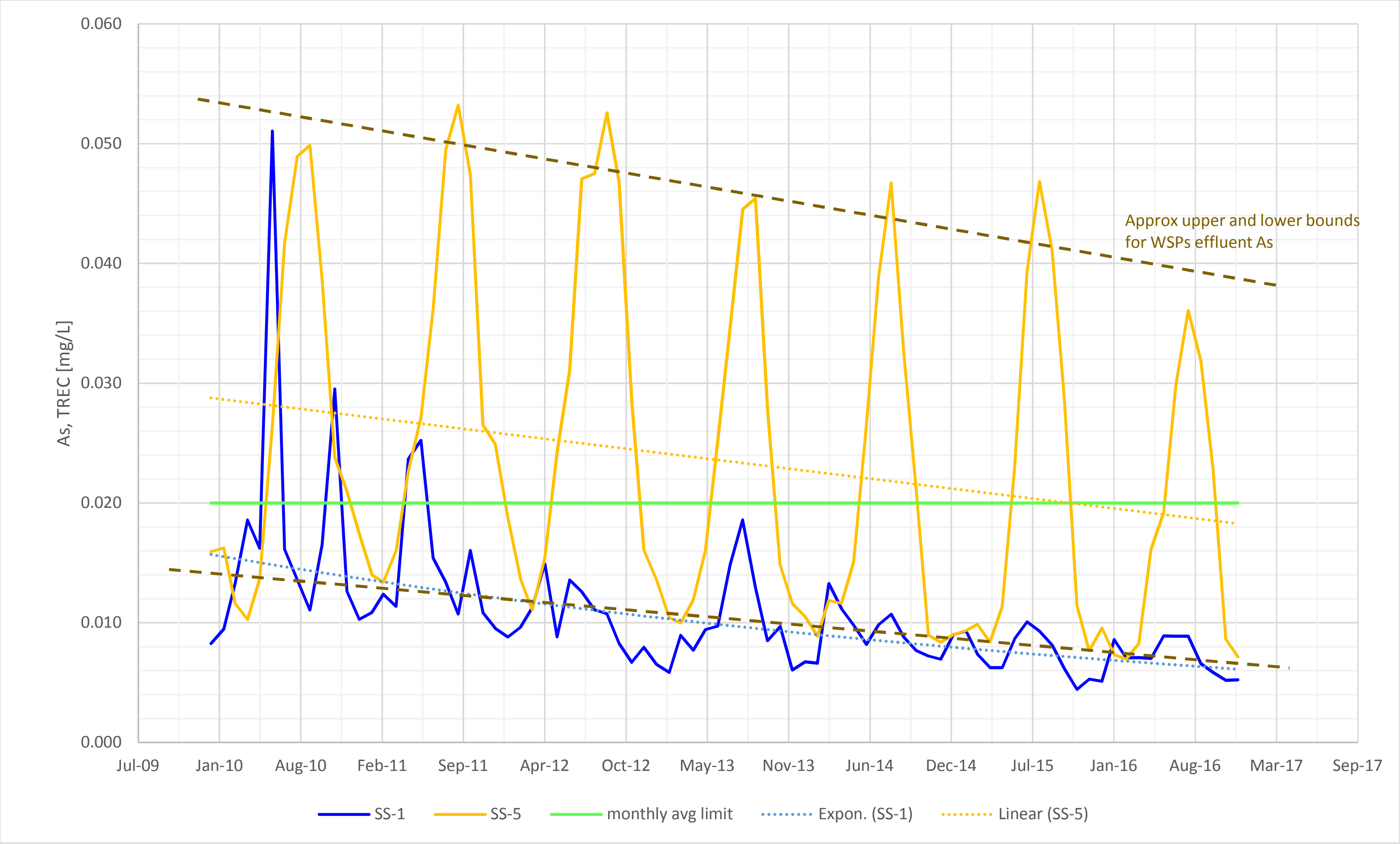


FIGURE 5-5. Total Cadmium in WSPs Influent (SS-1) and Effluent (SS-5) (monthly averages, 2010-2016)

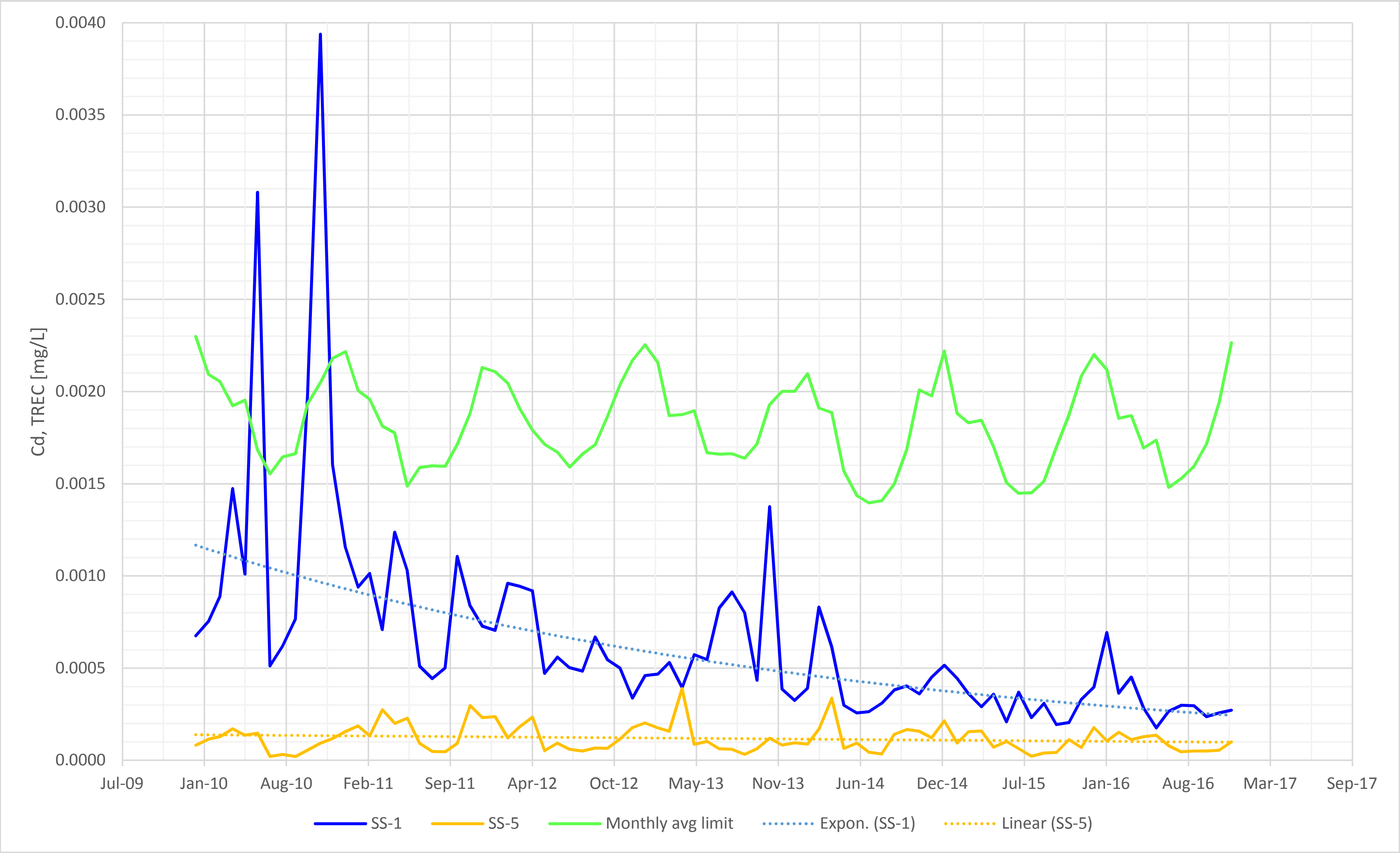


FIGURE 5-6. Total Copper in WSPs Influent (SS-1) and Effluent (SS-5) (monthly averages, 2010-2016)

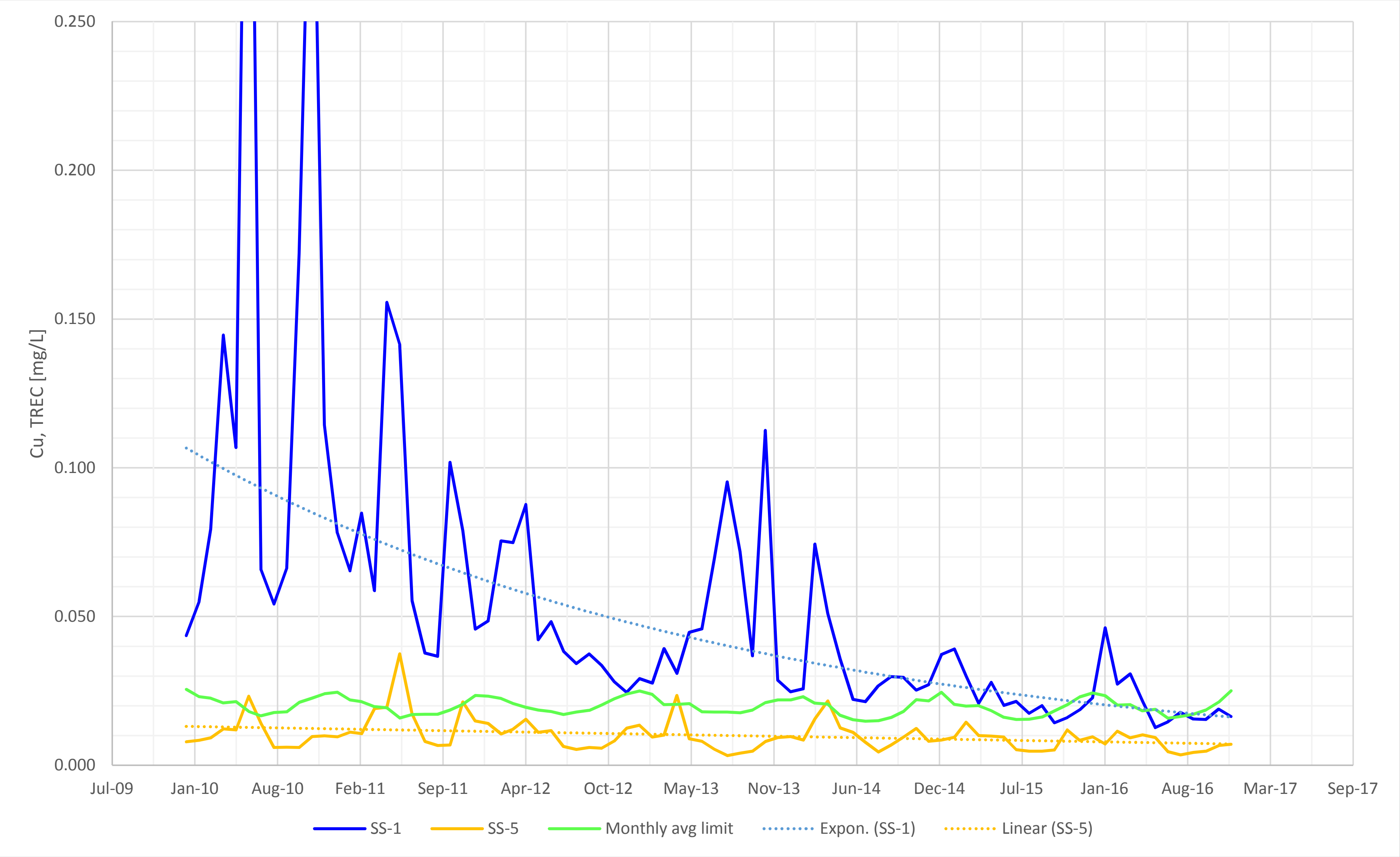


FIGURE 5-7. Total Iron in WSPs Influent (SS-1) and Effluent (SS-5) (monthly averages, 2010-2016)

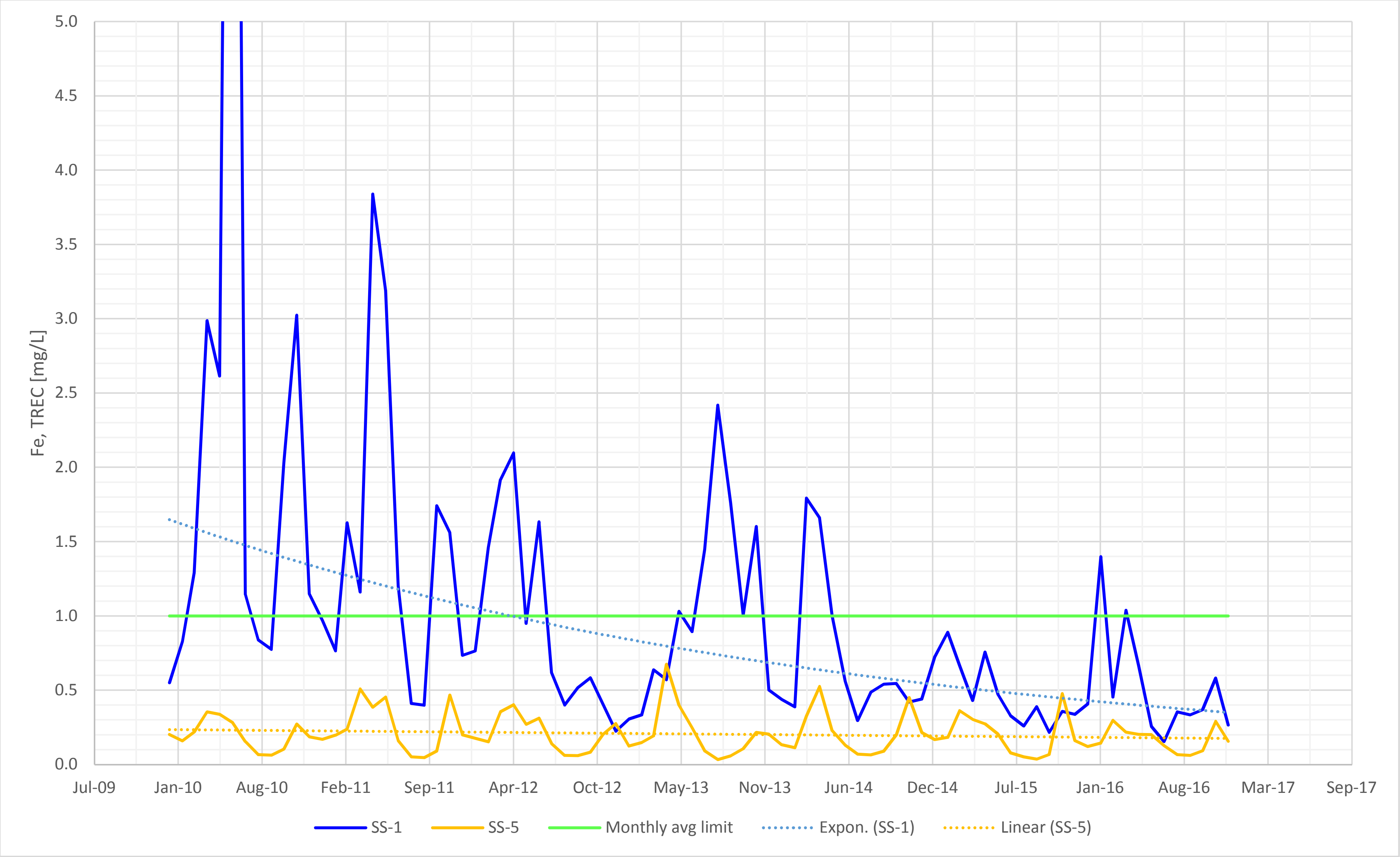


FIGURE 5-8. Total Lead in WSPs Influent (SS-1) and Effluent (SS-5) (monthly averages, 2010-2016)

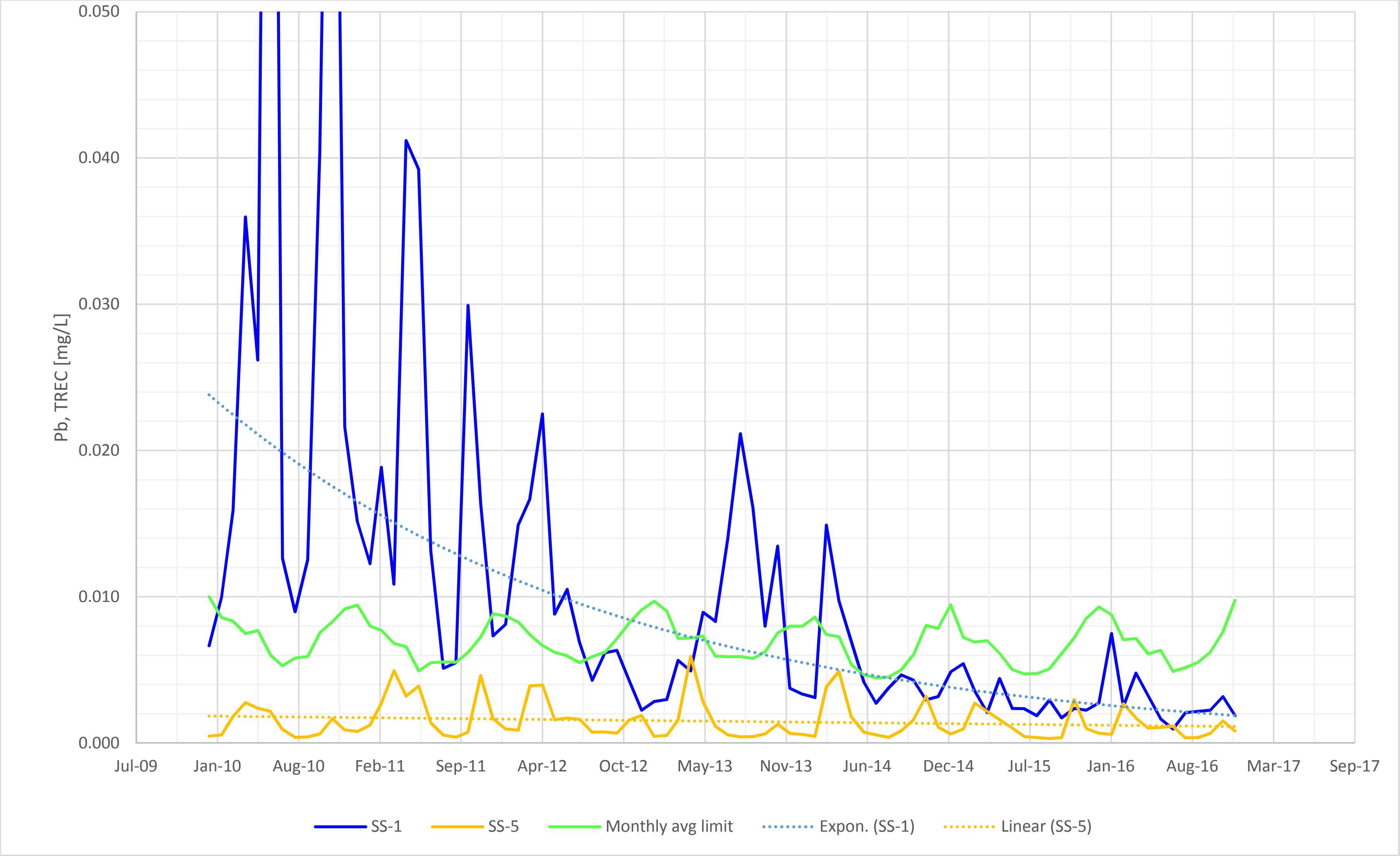
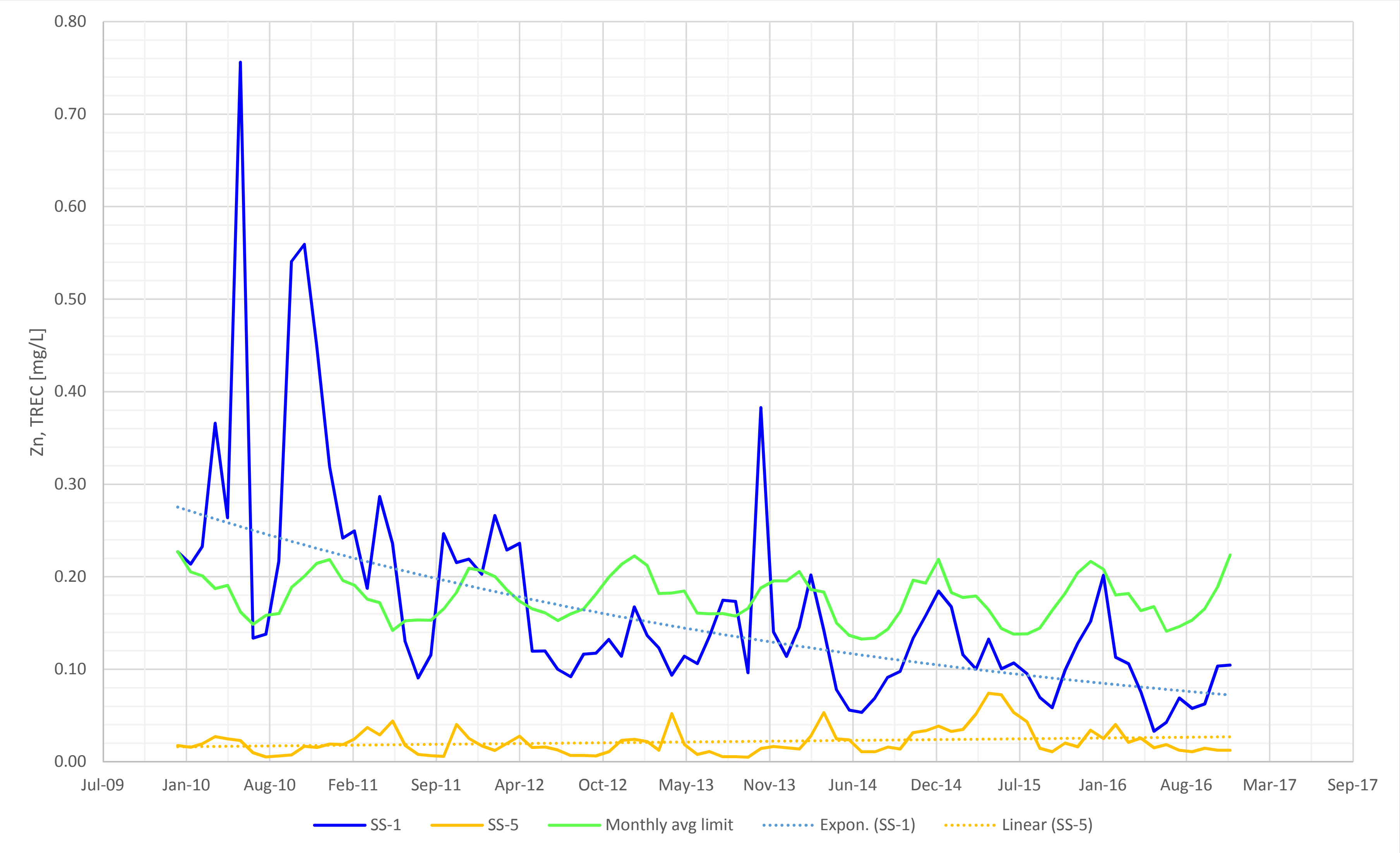


FIGURE 5-9. Total Zinc in WSPs Influent (SS-1) and Effluent (SS-5) (monthly averages, 2010-2016)



The essentially flat linear trendlines for WSPs effluent concentrations of these metals (excluding arsenic) indicate that the proposed action would have little or no effect on metals concentrations emanating from the WSPs and downstream in the action area, relative to current conditions. If anything, the future concentrations of these metals could potentially decrease slightly as water quality in the upper SBC continues to improve as a result of remediation efforts and metals concentrations in WSPs influent water decline.

Arsenic concentrations in WSPs effluent exhibit marked seasonal cycling, with maximum concentrations exceeding WSPs discharge limits in summer/early fall (Figure 5-4). This cycling appears to be the result of passive, naturally occurring processes in the Ponds that are independent of the proposed action. For example, mechanisms of arsenic release may include: (a) development of anoxic, reducing conditions in the bottom sediments, reduction of ferric iron solids to soluble ferrous iron, and release of co-precipitated arsenic; and (b) desorption of arsenic from suspended ferric oxide solids as a result of seasonally high pH levels in the water column. Some active elements of WSPs operation, such as operation of the solar-powered mixers and lime addition optimization trials, are intended to help mitigate elevated arsenic concentrations. The data in Figure 5-4 indicate that the high arsenic concentrations in WSPs effluent during the summer months exhibit a decreasing trend over time. Additionally, it should be noted that while the summertime arsenic concentrations in WSPs effluent exceed the WSPs discharge limits, those limits are based on human health rather than aquatic life considerations. Indeed, the WSPs effluent concentrations are well below Montana WQS for the protection of aquatic life (chronic value = 150 micrograms per liter). Therefore, the proposed action is expected to have little or no effect on arsenic concentrations emanating from the WSPs and in the action area. These concentrations are expected to decrease in the future, and the concentrations under current conditions are unlikely to have any adverse effect on bull trout.

5.2.4 Habitat Elements

Habitat elements downstream of the WSPs complex would not be affected by the proposed action.

Upstream of the Ponds, no adverse effects to existing habitat elements would be anticipated to occur because of remedial activities proposed. Primary remedial actions to reclaim channel and riparian areas within SBC (SSTOU) have already been implemented. No temporary or permanent impacts to existing wetlands would occur as a result of the proposed action, and no existing habitat elements in the channel would be degraded.

Effects to high-flow refugia, substrate embeddedness, LWD, and off-channel habitat that are anticipated to occur over the long term would improve habitat elements. Revegetation and riparian enhancement elements along upper SBC and hillslopes would contribute to evolution toward more diverse and functional habitat features. As remedial elements in the upper OUs evolve and mature over time, it is anticipated that long-term recruitment and storage potential for LWD in the SBC channel and broader action area would improve. Remedial elements (once functional) would be anticipated to contribute to the evolution of dynamic natural processes in the SBC channel and creation of diverse habitats (including overhanging banks, riparian vegetation, structure in the channel, riffle pool complexes, wetland fringes, and other forms of refugia).

Whether this proposed action alone would shift baseline conditions upstream of the WSPs from Functioning at Risk to Functioning Appropriately is difficult to assess, and therefore not assumed. In turn, overall habitat elements in the action area are expected to be maintained.

5.2.5 Channel Condition and Dynamics

Channel conditions and dynamics downstream of the WSPs would not be affected by the proposed action.

The SBC channel upstream of the Ponds has already had extensive remedial actions constructed and is demonstrating improved conditions for width/depth ratio, streambank condition, and floodplain connectivity. Future proposed remedial activities in the upper reaches of the action area may adversely affect channel conditions upstream of the WSPs; however, any adverse effects that were to occur would be short term and intermittent (occurring in concert with active construction). This, however, is not anticipated to occur at a level that would measurably affect width/depth ratio, streambank condition, and/or floodplain connectivity. Bull trout do not currently occur above the WSPs complex. Therefore, any potentially adverse effects to channel conditions and dynamics as a result of the proposed action would not be realized by bull trout, nor would it impact their occupied or critical habitat.

Over the long term, remedial project elements are anticipated and intended to improve channel condition and dynamics overall. Once any future construction is completed and remedial elements have had time to further mature, it is anticipated that channel conditions and dynamics in the SBC channel will continue to improve. Bull trout would not likely benefit directly from improved channel conditions as a result of remedial activities in the upper OUs; however, indirect benefits may be realized relative to improved thermal conditions (as a result of shading by growing riparian and upland vegetation) for waters flowing downstream into bull trout critical habitat.

5.2.6 Watershed Conditions

The proposed action would not change or create any new roads downstream from the WSP, and over the long term it would improve habitat conditions in the watershed with stabilized banks, reduced contaminant releases, and maturing vegetation.

Historic land use/disturbance activities in the action area have ceased and ongoing remedial activities are designed with the intent of improving watershed conditions. Active construction that would occur in the upper OUs may contribute to minimal adverse effects to watershed conditions; however, these would only be anticipated to occur until active construction is completed (over short periods and intermittently). Additionally, any short-term effects to watershed conditions as a result of the proposed action would not extend into habitat occupied by bull trout or designated as critical. After future, remedial elements are completed and as remedial elements already constructed mature, watershed conditions are anticipated to experience improving conditions that should continue over time.

Disturbance from historic land use (for example, mining) in the area is no longer anticipated and recent trends demonstrate movement toward greater restoration efforts throughout the upper Clark Fork River watershed. Overall, it is anticipated that watershed-scale conditions would be maintained over the short term as a result of the proposed action. Over the long term, beneficial effects to watershed conditions will likely occur.

5.3 Interrelated and Interdependent Effects

This BA includes all known project effects, which are limited to the direct temporary and indirect permanent effects of proposed remedial activities in the SBCBA Site. An interdependent activity is one with no independent utility apart from the proposed action (50 CFR 402.02). An interrelated activity is an action that is part of a larger action and depends on the proposed project for its justification (50 CFR 402.02). Interrelated or interdependent actions will not occur as a result of the proposed project.

5.4 Cumulative Effects

Cumulative effects are defined in 50 CFR 402.02 as “those effects of future State or private activities, not involving Federal activities that are reasonably certain to occur within the action area of the Federal action subject to consultation.” No known non-federal projects are planned in the action area in the future.

SECTION 6

Determination of Effects for Listed Species

6.1 Canada Lynx

The proposed action **May Affect, but is Not Likely to Adversely Affect** Canada lynx because of the lack of known occurrences of this species in or near the action area and the lack of potential deleterious effects the action could have on lynx and their prey species. The proposed action would occur in currently degraded lands and along a disturbed waterway (both of which are under continued remediation). In turn, the entire action area consists of degraded habitat that is highly fragmented and not suitable for lynx. No known denning or foraging habitat is within the action area, and disturbance to LAU habitat would not occur as a result of the proposed action. Multiple existing roadways occur in the general action area, and forest habitat deemed suitable for snowshoe hares and other prey species is extremely limited. Although the proposed action would not result in any habitat degradation above and beyond what already exists, current habitat conditions in the action area will likely continue to deter the use of the area by lynx until revegetation and other remedial elements implemented in the area have matured. Once remedial elements in the upper OUs are completed and plantings have had time to mature, the upland areas of the SBCBA Site are anticipated to provide improved habitat for Canada lynx and their prey species.

The current lack of potential habitat for or presence of lynx prey species in the action area does not, however, preclude the potential for lynx to forage in or move through the area. Adjacent forests do provide limited habitat; therefore, although considered highly unlikely, the area could be used as a travel corridor by lynx moving between areas of suitable habitat. In turn, noise and activity associated with remedial activities that would continue to occur throughout the SBCBA Site have the potential to temporarily impact and/or displace lynx foraging or simply traveling through the action area. Overall, the potential for direct effects to lynx are considered discountable and any effects that may occur would be minimal. Beneficial indirect effects would be anticipated to occur over the long term as habitat matures and conditions become more suitable for lynx and their prey species.

The proposed action would have **No Effect** on critical habitat as no critical habitat for Canada lynx occurs within the action area.

6.2 Grizzly Bear

Similar to Canada lynx, the proposed action **May Affect, but is Not Likely to Adversely Affect** grizzly bear because no occurrences of grizzly bear are known to have occurred in or near the action area recently (MNHP, 2017), and the extent of potential effects that could occur to this species or its habitat as a result of the proposed action is minimal. The action area, as noted previously, is highly degraded as a result of historical mining activities and no longer provides preferred habitat for grizzly bears. Use of the area by grizzly bear as a migratory corridor is considered discountable, as habitat in the action area remains highly fragmented because of deforestation and existing roadways. No denning habitat is known to occur in the area and forage habitat is considered minimal.

Regardless of the limited potential for grizzly bear to occur in the action area and the degraded habitat conditions that persist, it is possible grizzly bear may be temporarily affected by the proposed action. Grizzly bear are known to occur in recovery zones to the southeast and to the northwest of the project area. Although these recovery zones are hundreds of miles from the action area and provide more suitable habitat for grizzly bear, this species is highly transient and could potentially move through the action area while remedial activities are ongoing. Any potential use of the area by grizzly bear would likely occur in the case of individuals moving to and/or from more suitable habitat. If grizzly bear were to move through the action area they could potentially be displaced by ancillary noise and activity associated with the proposed action, but would more likely be deterred from passing through the area as a result of existing roadways, poor habitat conditions, and lack of a suitable prey base. Overall the potential for direct effects to grizzly bear are considered discountable and any effects that may occur would be minimal. Beneficial indirect effects would be anticipated to occur over the long term as habitat matures and conditions become more suitable for grizzly bear.

The proposed action would have **No Effect** on critical habitat for grizzly bear as none has been designated.

6.3 Bull Trout

No suitable habitat for or known populations of bull trout occur in the action area upstream of the WSPs discharge, and existing physical barriers preclude bull trout from accessing this area. Bull trout are known to occur downstream of the discharge, and USFWS has determined that suitable habitat exists. USFWS has identified the upper Clark Fork River extending into the Warm Springs Creek tributary (at the confluence of SBC and Warm Springs Creek) as critical habitat in its Bull Trout Recovery Plan (USFWS, 2002).

Treatment of water in the WSPs was developed with the primary purpose of improving water quality for human health and cold water biota prior to its release. Bull trout use SBC below the WSPs discharge and the upper Clark Fork for forage. They are also likely to continue to use the area below the outfall and downstream into the upper Clark Fork during the period that active remedial elements occur in the SBCBA Site. No spawning is known to occur in this area, and it is likely used solely for forage and migration as fish move out of Warm Springs Creek. Any life stages of bull trout that were to use the action area during the period of continued active remediation would not experience any deleterious changes to baseline habitat conditions because of the proposed action. Water quality conditions, in particular, would not be degraded in areas occupied by bull trout. Bull trout may, however, be infrequently displaced as a result of monitoring of the WSPs complex or operation and maintenance activities that may occur in the WSPs complex, although the potential for this is considered highly unlikely (discountable). If bull trout were to be displaced because of noise and activity from any element of the proposed action, the effect would be short term and minimal.

It is understood that brown trout deleteriously affect bull trout populations in the upper Clark Fork River. However, continuing active remedial elements in the WSPs (as well as in the upper OUs) would not be anticipated to measurably shift existing conditions toward habitat more favorable to exotic species that may prey on juvenile salmonids such as bull trout. Over time, stabilization of banks and plantings along SBC and the lower Mill-Willow Bypass would likely improve elevated water temperatures by providing shade and thermal relief, while also reducing sediment inputs during high-flow events. Although there is currently no presence of bull trout in SBC and tributary streams above the WSPs complex, habitat improvements to water quality upstream of the WSPs would also contribute to improvements downstream where bull trout are known to occur.

The potential for the proposed action to deleteriously affect bull trout is considered discountable. Once remedial activities are completed and revegetation has matured, it is anticipated that water quality conditions would trend toward improving relative to temperature and contaminants. Over time, the proposed action may result in beneficial effects for bull trout; however, it is not currently ascertainable as to whether such effects would occur to the extent that they may measurably improve baseline conditions. Overall, any effects to bull trout due to continued active remedial elements in the SBCBA Site would likely be minimal.

Bull trout are known not to occur in the action area above the WSPs discharge, and baseline habitat conditions throughout the action area where bull trout have access would continue to be maintained or improved relative to the proposed action. Therefore, it is determined that the proposed project **May Affect, but is Not Likely to Adversely Affect** Columbia River bull trout and/or their critical habitat until active remedial elements in the SBCBA Site are completed. Once remedial activities are completed and revegetated areas have had time to mature, water quality benefits, as well as improvements to other habitat indicators throughout the action area, would be anticipated.

SECTION 7

References

Agee, J.K. 1999. “Disturbance Ecology of North American Boreal Forests and Associated Northern Mixed/Subalpine Forests.” In: L.F. Ruggiero, K.B. Aubry, S.W. Buskirk, et al. (tech. eds.). *The Scientific Basis for Lynx Conservation in the Contiguous United States*. General Technical Report RMRS-GTR-30. U.S. Forest Service, Rocky Mountain Research Station, Ogden, Utah.

Atlantic Richfield (AR). 1995. Draft Remedial Investigation. Streamside Tailings Operable Unit Silver Bow Creek/Butte Area National Priorities List site. Prepared by Atlantic Richfield.

Atlantic Richfield (AR). 1998. *Initial 5-Year Review Addendum.* Warm Springs Ponds Operable Unit Silver Bow Creek/Butte Area National Priorities List Site.

Atlantic Richfield (AR). 2010. *Operation and Maintenance Plan for the Warm Springs Ponds Operable Unit*. June.

Atlantic Richfield (AR). 2013. *Evaluation of Solar Mixers at the Warm Springs Ponds*.

Atlantic Richfield (AR). 2014. *First Year Assessment of the Lime Reduction Pilot Test at Warm Springs Ponds, Technical Memorandum*. Silver Bow Creek/Butte Area NPL Site, Warm Springs Ponds Operable Unit. December 2.

Atlantic Richfield (AR). 2016a. *Second Year Assessment of the Lime Reduction Pilot Test at Warm Springs Ponds, Technical Memorandum*. Silver Bow Creek/Butte Area NPL Site, Warm Springs Ponds Operable Unit. January 11.

Atlantic Richfield (AR). 2016b. *Request for Two-Year Extension of the Lime Reduction Pilot Study at Warm Springs Ponds, Technical Memorandum*. Silver Bow Creek/Butte Area NPL Site, Warm Springs Ponds Operable Unit. December 2.

Arno, S.F. 1979. “Forest Regions of Montana.” Research Paper, Intermountain Forest and Range Experiment Station, USDA Forest Service. INT-218. Ogden, Utah. April.

Aubry, K.B., G.M. Koehler, and J.R. Squires. 1999. “Ecology of Canada Lynx in Southern Boreal Forests.” In: L.F. Ruggiero, K.B Aubry, S.W. Buskirk, et al. (tech. eds.). *The Scientific Basis for Lynx Conservation in the Contiguous United States.* General Technical Report RMRS-GTR-30. U.S. Forest Service, Rocky Mountain Research Station, Ogden, Utah.

Blanchard, B.M. 1980. Grizzly bear–habitat relationships in the Yellowstone area. International Conference on Bear Research and Management 5:118–123.

BPSOU PRP Group. 2002. Butte Priority Soils Operable Unit Silver Bow Creek/Butte Area Superfund Site. Phase II R prepared by MFG Inc. for PRP Group. April 2002.

Buchanan, D., M. Hanson, and R.M. Hooten. 1997. Status of Oregon’s bull trout, distribution, life history, limiting factors, management considerations and status. Oregon Department of Fish and Wildlife, Portland, Oregon.

Bureau of Reclamation (Reclamation). 2012. *Yankee Fork Tributary Assessment Upper Salmon Subbasin, Custer County, Idaho*. Pacific Northwest Regional Office, Boise, Idaho January. 170 p. plus appendices.

Buskirk, S.W., L.F. Ruggiero, K.B. Aubry, D.E. Pearson, J.R. Squires, and K.S. McKelvey. 1999. “Comparative Ecology of Lynx in North America.” Chapter 14. In: *The Scientific Basis for Lynx Conservation*. USDA Forest Service Technical Report RMRS-GTR-30.

Cook, N. A., T. Elam, B. Liermann, J. Lindstrom, and T. Selch. 2016. Fisheries Monitoring in the Upper Clark Fork River Basin: 2016 Report. Montana Fish Wildlife and Parks, Helena, Montana.

Craighead, J.J., and J.A. Mitchell. 1987. Grizzly bear. In: J.A. Chapman and G.A. Feldhamer, editors. Wild mammals of North America. Johns Hopkins University Press, Baltimore, MD. p. 515–556.

Cross, D. and L. Everest. 1995. Fish Habitat Attributes of Reference and Managed Watersheds with Special Reference to the Location of Bull Char (*Salvelinus confluentus*) spawning sites in the Upper Spokane River System, Northern Idaho. USDA Forest Service, Fish and Habitat Relationships Currents, Technical Bulletin 17.

Donald, D.B. and D.J. Alger. 1993. Geographic distribution, species displacement, and niche overlap for lake trout and bull trout in mountain lakes. Canadian Journal of Zoology 71: 238-247.

Downs, C. and R. Jakubowski. 2003. Lake Pend Oreille/Clark Fork River Fishery Research and Monitoring 2002 Progress Report. Project 2, 2002 bull trout redd counts; Project 3, 2002 Clark Fork river fishery assessment progress report; Project 5, 2000-2002 Trestle and Twin Creeks bull trout outmigration and Lake Pend Oreille survival study; Project 6, 2002 Johnson and Granite creeks bull trout trapping; Project 7, 2002 Twin Creek restoration monitoring progress report. Avista Corporation. Spokane, Washington.

Downs, C.C., Horan, D. and E. Morgan-Harris. 2006. Spawning Demographics and Juvenile Dispersal of an Adfluvial Bull Trout Population in Trestle Creek, Idaho. North American Journal of Fisheries Management 26:190–200.

Eberhardt, L.L. 1990. Survival rates required to sustain bear populations. Journal of Wildlife Management 54: 587-590.

Fraley, J.J. and B.B. Shepard. 1989. Life History, Ecology, and Population Status of Bull Trout (*Salvelinus confluentus*) in the Flathead Lake and River System, Montana. *Northwest Science* 63: 133-143.

Goetz, F. 1989. Biology of the Bull Trout, *Salvelinus confluentus*: A literature Review. USDA Forest Service, Willamette National Forest, Eugene, OR.

Graham, D.C. 1978. Grizzly bear distribution, use of habitats, food habits and habitat characterization in Pelican and Hayden valleys, Yellowstone National Park. Thesis. Montana State University, Bozeman, MT. 124 pp.

Hanson, J.A., Lipton, J., and Welsh, P.G. 2002a. Relative sensitivity of bull trout (*Salvelinus confluentus*) and rainbow trout (*Oncorhynchus mykiss*) to acute copper toxicity. Environmental Toxicology and Chemistry, 21:633-630.

Hanson, J.A., Lipton, J., Welsh, P.G., and Suedkamp, M.J. 2002b. The effects of long-term cadmium exposure on the growth and survival of juvenile bull trout (*Salvelinus confluentus*). Aquatic Toxicology, 58(3-4): 165-174.

Hanson, J.A., Welsh, P.G., Lipton, J., Cacaela, D., and Dailey, A. 2002c. Relative sensitivity of bull trout (*Salvelinus confluentus*) and rainbow trout (*Oncorhynchus mykiss*) to acute exposures of copper and zinc. Environmental Toxicology and Chemistry, 21:67-75.

Harrington, B.A. 2001. Red knot (*Calidris canutus*). *In* A. Poole, and F. Gill, eds. The birds of North America, No. 563, The Birds of North America, Inc., Philadelphia, PA.

Hechtel, J.L. 1985. Activity and food habits of barren-ground grizzly bears in arctic Alaska. Thesis. University of Montana, Missoula, MT. 74 pp.

Interagency Lynx Biology Team. 2013. Canada lynx conservation assessment and strategy. 3rd edition. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Forest Service Publication R1-13-19, Missoula, MT. 128 pp.

Jakober, M. 1995. Autumn and winter movement and habitat use of resident bull trout and westslope cutthroat trout in Montana. M.S. Thesis, Montana State University, Bozeman, Montana.

Jonkel, C. 1978. Black, brown (grizzly) and polar bears. In: J.L. Schmidt and D.L. Gilbert, editors. Big game of North America. Stackpole Books, Harrisburg, PA. p. 227–248.

Knight, R.R. 1980. Biological considerations in the delineation of critical habitat. In: C.J. Martinka and K.L. McArthur, editors. Bears—their biology and management. Proceedings, 4th international conference on bear research and management; February 21–24, 1977; Kalispell, MT. Conference Series No. 3. Bear Biology Association. p. 1–3.

Koehler, G.M. 1990. "Population and Habitat Characteristics of Lynx and Snowshoe Hares in North Central Washington." *Canadian Journal of Zoology* 68:845-851.

Koehler, G.M. and J.D. Brittell. 1990. "Managing Spruce-Fir Habitat for Lynx and Snowshoe Hares." *Journal of Forestry.* October.

Krebs, J.A. and D. Lewis. 1999. *Wolverine Ecology and Habitat Use in the Northern Columbia Mountains: Progress Report.* BC Environment, Columbia Basin Fish and Wildlife Compensation Program. British Columbia, Canada. 26 pp.

Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow, and J. E. Williams. 1997. Broadscale Assessment of Aquatic Species and Habitats. Volume III, Chapter 4. U.S. For. Serv., Gen. Tech. Rep. PNW-GTR-405. Portland, Oregon.

Leider, S.A., M.W. Chilcote, and J.J. Loch. 1986. Movement and Survival of Presmolt Steelhead in a Tributary and the Main-stem of a Washington River. *North American Journal of Fisheries Management* 6:526-531.

Lindstrom, Jason, Montana Department of Environmental Quality. 2017. Personal communication (call); Jeff Schut/CH2M. December 4.

Lindstrom, Jason and Joel Chavez, Montana Department of Environmental Quality. 2017. Personal communication (conference call); CH2M (Fornander, Hickman, Schut and Smith) and Region 8 EPA (Elsen, Archer). November 2.

McGuire Consulting. 1993. *Clark Fork River Macroinvertebrate Community Biointegrity, 1986 through 1992*. Technical report prepared for the Montana Department of Health and Environmental Sciences/Water Quality Bureau.

McGuire Consulting. 2013. *Clark Fork River Biomonitoring, Macroinvertebrate Community Assessments – 2011*. Prepared for CH2M and submitted to EPA, Helena office. August.

McGuire Consulting. 2017. *Clark Fork River Biomonitoring, Macroinvertebrate Community Assessments – 2016*. Prepared for CH2M and submitted to EPA, Helena office. August.

McKelvey, K.S., K.B. Aubry, and Y.K. Ortega. 1999. "History and Distribution of Lynx in the Contiguous United States." In: L.F. Ruggiero, K.B Aubry, S.W. Buskirk, et al. (tech. eds.). *The Scientific Basis for Lynx Conservation in the Contiguous United States*. General Technical Report RMRS-GTR-30. U.S. Forest Service, Rocky Mountain Research Station, Ogden, Utah.

McLellan, B.N., and D.M. Shackleton. 1988. Grizzly bears and resource-extraction industries: effects of roads on behaviour, habitat use and demography. Journal of Applied Ecology 25:451–460.

McPhail, J. D., and C. B. Murray. 1979. The early life history and ecology of Dolly Varden (*Salvelinus malma*) in the upper Arrow Lakes. University of British Columbia, Vancouver.

McPhail, J.D. and J.S. Baxter. 1996. A review of bull trout (*Salvelinus confluentus*) life-history and habitat use in relation to compensation and improvement opportunities. Department of Zoology, University of British Columbia. Fisheries Management Report No. 104. Vancouver, British Columbia, Canada.

Montana Bull Trout Scientific Group (MBTSG). 1995. Upper Clark Fork River Drainage Bull Trout Status Report. Report prepared by the Montana Bull Trout Scientific Group for the Montana Bull Trout Restoration Team. June.

Montana Bull Trout Scientific Group (MBTSG). 1998. The relationship between land management activities and habitat requirements of bull trout. Montana Bull Trout Restoration Team, Helena.

Montana Department of Environmental Quality (DEQ). 1999. SSTOU, SBC/BA NPL Site, Final design report, Remedial Action, Subarea 1, Reach A, Volume 1, Design Report.

Montana Department of Environmental Quality (DEQ). 2012. Circular DEQ-7, Montana Numeric Water Quality Standards. Helena, MT. October.

Montana Department of Environmental Quality (DEQ). 2014a. Final - Upper Clark Fork Phase 2 Sediment and Nutrients TMDLs and Framework Water Quality Improvement Plan.

Montana Department of Environmental Quality (DEQ). 2014b. Silver Bow Creek and Clark Fork River Metals TMDL Report. Doc. No. C01-TMDL-05aF.

Montana Department of Environmental Quality (DEQ). 2016b.

Montana Fish, Wildlife, and Parks (FWP). 2003. *Montana Fisheries Information System*. http://maps2.nris.mt.gov/wis/mfishapp/Intro2002.html.

Montana Fish, Wildlife, and Parks (FWP). 2004a. Bull Trout Index Redd Counts. Kalispell.

Montana Fish, Wildlife, and Parks (FWP). 2013. Public comments of November 27, 2013. MFWP. Helena, MT. as cited in Rufa Red Knot Background Information and Threats Assessment Supplement to Endangered and Threatened Wildlife and Plants; Final Threatened Status for the Rufa Red Knot (Calidris canutus rufa) (Docket No. FWS–R5–ES–2013–0097; RIN AY17). U.S. Fish and Wildlife Service, Northeast Region. New Jersey Field Office. Pleasantville, New Jersey. November 2014.

Montana Natural Heritage Program (MNHP). 2017. *Animal Species of Concern – Silver Bow and Deer Lodge Counties*. May 3.

National Marine Fisheries Service (NMFS). 1996. Making Endangered Species Act Determinations of Effect for Individual and Grouped Actions at the Watershed Scale. U.S. Department of Commerce, NOAA.

Niles, L.J., H.P. Sitters, A.D. Dey, P.W. Atkinson, A.J. Baker, K.A. Bennett, R. Carmona, K.E. Clark, N.A. Clark, and C. Espoz. 2008. Status of the red knot (Calidris canutus rufa) in the Western Hemisphere. Studies in Avian Biology 36:1-185.

NRIS. 2005. Montana Natural Resource Information System.

Piersma, T., G.A. Gudmundsson, and K. Lilliendahl. 1999. Rapid changes in the size of different functional organ and muscle groups during refueling in a long-distance migrating shorebird. Physiological and Biochemical Zoology 72(4):405-415.

Piersma, T., and J.A. van Gils. 2011. The flexible phenotype. A body-centred integration of ecology, physiology, and behavior. Oxford University Press Inc., New York.

Pratt, K. 1985. *Pend Oreille Trout and Char Life History Study*. Idaho Department of Fish and Game. Boise, ID. 105 pp.

Pratt, K. 1992. A review of bull trout life history. Pages 5-7 in: P. J. Howell and D. V. Buchanan, editors. Proceedings of the Gearhart Mountain Bul hop, Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Quigley, T.M. and S.J. Arbelbide, editors. 1997. *An assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins*. U.S. Forest Service General Technical Report PNW-405 (Volumes 1-4).

Quinn, N.W.S., and G. Parker. 1987. Pages 683-694 in M. Novak, J.A. Barber, M.E. Obbard, B. Malloch (eds.). Lynx. Wild furbearer management and conservation in North America. Ontario Ministry of Natural Resources.

Ratliff, D.E. 1992. Bull Trout Investigations in the Metolius River-Billy Chinook System. Pp. 37-44. In: P.J. Howell and D.V. Buchanan (eds.). Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, OR.

Ratliff, D.E. and P.J. Howell. 1992. The status of bull trout populations in Oregon. Pages 10-17 in P.J. Howell and D.V. Buchanan, eds. Proceedings of the Gearhart Mountain Bull Trout Workshop. Oregon Chapter of the American Fisheries Society, Corvallis, Oregon.

Reed, Daryl, Montana Department of Environmental Quality. 2017. Personal communication (in person); Gary Hickman/CH2M. February 8.

Reichert, C. 1989. Silviculture in grizzly bear habitat. *In*: Silviculture for all resources: proceedings of the national silviculture workshop; May 11–14, 1987; Sacramento, CA. U.S. Department of Agriculture, Forest Service, Washington, DC. p. 48–60.

Rieman, B.E. and J.D. McIntyre. 1993. Demographic and Habitat Requirements of Conservation of Bull Trout. USDA Forest Service, Intermountain Research Station, General Technical Report INT-302.

Rieman, B.E., D. Lee, G. Chandler, and D. Myers. 1997. Does wildfire threaten extinction for salmonids: responses of redband trout and bull trout following recent large fires on the Boise National Forest. Pages 47-57 in J. Greenlee, ed. Proceedings of the symposium on fire effects on threatened and endangered and habitats. International Association of Wildland Fire, Fairfield, Washington.

Ruediger, B., J. Claar, S. Gniadek, B. Holt, L. Lewis, S. Mighton, B. Naney, G. Patton, T. Rinaldi, J. Trick, A. Vandehey, F. Wahl, N. Warren, D. Wenger, and A. Williamson. 2000. *Canada Lynx Conservation Assessment and Strategy*. USDA Forest Service, USDI Fish and Wildlife Service, USDI Bureau of Land Management, and USDI National Park Service. Missoula, Montana.

Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, L.J. Lyon, and W.J. Zielinki. 1994. *The Scientific Basis for Conserving Forest Carnivores. American Marten, Fisher, Lynx, and Wolverine in the Western United States*. General Technical Report: RM-254. Fort Collins, Colorado. USDA, Forest Service, Rocky Mountain Forest and Range Experiment Station. 184 pp.

Ruggiero, L.F., K.B. Aubry, S.W. Buskirk, G.M. Koehler, C.J. Krebs, K.S. McKelvey, and J.R. Squires. 1999. *The Scientific Basis for Lynx Conservation: Qualified Insights*. Chapter 16. In: *The Scientific Basis for Lynx Conservation*. USDA Forest Service Technical Report RMRS-GTR-30.

Schill, D.J. 1992. River and stream investigations. Job Performance Report, Project F-73-R-13. Idaho Department of Fish and Game, Boise, Idaho.

Servheen, C. 1981. Grizzly bear ecology and management in the Mission Mountains, Montana. Dissertation. University of Montana, Missoula, MT. 138 pp.

Servheen, C. 1983. Grizzly bear food habits, movements, and habitat selection in the Mission Mountains, Montana. Journal of Wildlife Management 47(4):1026–1035.

Shepard, B., S.A. Leathe, T.M. Weaver, and M.D. Enk. 1984. Monitoring Levels of Fine Sediment within Tributaries to Flathead Lake, and Impacts of Fine Sediment on Bull Trout Recruitment. Unpublished paper presented at the Wild Trout III Symposium, Yellowstone National Park, WY. On file at: Montana Department of Fish, Wildlife and Parks, Kalispell, MT.

Spowart, R.A., and F.B. Samson. 1986. Carnivores. *In*: A.Y. Cooperrider, R.J. Boyd, and H.R. Stuart, editors. Inventory and monitoring of wildlife habitat. U.S. Department of the Interior, Bureau of Land Management, Service Center, Denver, CO. p. 475–496.

Squires, J.R. and T. Laurion. 1999. "Lynx Home Range and Movements in Montana and Wyoming: Preliminary Results." In: L.F., Ruggiero, K.B Aubry, S.W. Buskirk, et al. (tech. eds.). *The Scientific Basis for Lynx Conservation in the Contiguous United States*. General Technical Report.

Swanberg, T. 1997. Movements of and habitat use by fluvial bull trout in the Blackfoot River, Montana. Transactions of the American Fisheries Society 126:735–746.

Thomas, G. 1992. Status of bull trout in Montana. Report prepared for Montana Department of Fish, Wildlife and Parks, Helena, Montana.

U.S. Census Bureau. 2010. *Census 2010*. https://www.census.gov/2010census/.

U.S. Department of Agriculture (USDA). 1996. Policy regarding the recognition of distinct vertebrate population segments under the Endangered Species act. February 76, 1996. Federal Register 61:4722-4725

U.S. Environmental Protection Agency (EPA). 1990. Record of Decision, Warm Springs Ponds Operable Unit 04, Silver Bow Creek/Butte Area NPL Site, Upper Clark Fork River Basin, Montana. EPA ID: MTD980502777, September.

U.S. Environmental Protection Agency (EPA). 1991a. Explanation of Significant Differences: Streamside Tailings Operable Unit 01; Silver Bow Creek/Butte Area, EPA ID: MTD980502777, Butte, MT. U.S. EPA. June 24, 1991.

U.S. Environmental Protection Agency (EPA). 1991b. Unilateral Administrative Order for Remedial Design/Remedial Action, Silver Bow Creek/Butte Area Superfund Site, Warm Springs Ponds Active Area Operable Unit 4. (Referred to as the "Unilateral Administrative Order", or UAO.)

U.S. Environmental Protection Agency (EPA). 1992. Record of Decision – Warm Springs Ponds Inactive Area Operable Unit 12 (OU12); Silver Bow Creek/Butte Area NPL Site (Original Portions) Clark Fork River Basin, Montana.

U.S. Environmental Protection Agency (EPA). 1994. Record of Decision – Butte Mine Flooding Operable Unit 03 (OU03); Silver Bow Creek/Butte Area NPL Site, Butte, Montana.

U.S. Environmental Protection Agency (EPA). 1995a. Record of Decision – Streamside Tailings Operable Unit 01 (OU1), Silver Bow Creek/Butte Area National Priorities List Site; Silver Bow and Deer Lodge Counties, Montana.

U.S. Environmental Protection Agency (EPA). 1995b. Record of Decision: Rocker OU 7, Silver Bow Creek/Butte Area, EPA ID: MTD980502777, Butte, MT. U.S. EPA. December.

U.S. Environmental Protection Agency (EPA). 1999. *A guide to preparing Superfund proposed plans, records of decision, and other remedy selection documents*. EPA 540-R-98-031, OSWER 9200.1-23P. July.

U.S. Environmental Protection Agency (EPA). 2002a. Explanation of Significant Differences, Butte Mining Flooding Operable Unit Silver Bow Creek/Butte Area NPL Site, Silver Bow County, MT. March.

U.S. Environmental Protection Agency (EPA). 2002b. Biological Assessment Of Effect Of Proposed Remedial Action On Threatened Or Endangered Species Clark Fork River Operable Unit Milltown Reservoir Sediments/Clark Fork River Superfund Site Montana. Prepared by EPA Region 8.

U.S. Environmental Protection Agency (EPA). 2004. *Clark Fork River Operable Unit of the Milltown Reservoir – Clark Fork River Superfund Site, Record of Decision*. April.

U.S. Environmental Protection Agency (EPA). 2005. *Second Five Year Review Report for the Silver Bow Creek/Butte Area Superfund Site, Silver Bow and Deer Lodge Counties, Montana*. Prepared by CDM for EPA. September.

U.S. Environmental Protection Agency (EPA). 2006. *Record of Decision*. Butte Priority Soils Operable Unit. Silver Bow Creek /Butte Area NPL Site. Region 8. September.

U.S. Environmental Protection Agency (EPA). 2011a. Third Five-Year Review Report for Silver Bow Creek/Butte Area Superfund Site. Region 8. June.

U.S. Environmental Protection Agency (EPA). 2011b. Explanation of Significant Differences to the 2006 Butte Priority Soils Operable Unit Record of Decision. July.

U.S. Environmental Protection Agency (EPA). 2014. Explanation of Significant Differences Rock Timber Framing and Treating Plant Operable Unit (OU 7), Silver Bow Creek/Butte Area NPL Site (Original Portion), Silver Bow County, Montana. September.

U.S. Environmental Protection Agency (EPA). 2016. *Fourth Five-Year Review Report for Silver Bow Creek/Butte Area Superfund Site*. Final. January.

U.S. Environmental Protection Agency (EPA). 2017. “Silver Bow Creek/Butte Area National Priorities List Superfund Site.” Letter from Joseph Vranka/EPA Region 8 to Jodi Bush/USFWS, August 2, 2017.

U.S. Forest Service (USFS). 2007. *Final Environmental Impact Statement: Northern Rockies Lynx Management Direction*. USDA-Forest Service. National Forests in Montana and parts of Idaho, Wyoming, and Utah. March.

U.S. Forest Service (USFS). 2008. *Southern Rockies Lynx Management Direction*. *Volume 1-Environmental Impact Statement.* USDA. National Forests in Colorado & southern Wyoming.

U.S. Fish and Wildlife Service (USFWS). 1998. A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale. USFWS Regions 1 and 6.

U.S. Fish and Wildlife Service (USFWS). 2000. Bull trout occurrence and habitat selection. Western Washington Office, Seattle.

U.S. Fish and Wildlife Service (USFWS). 2002. Chapter 17, Salmon River Recovery Unit, Idaho. 194 p. *In*: U.S. Fish and Wildlife Service. Bull Trout (*Salvelinus confluentus*) Draft Recovery Plan. Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). 2005. Bull trout core area templates – complete core area by core area analysis. W. Freden, Fish and Wildlife Service, Portland, Oregon.

U.S. Fish and Wildlife Service (USFWS). 2007.

U.S. Fish and Wildlife Service (USFWS). 2008. *Biological Opinion and Conference Opinion for the Modified Idaho Roadless Rule USDA Forest Service Regions 1 and 4*. 14420-2008-F-0586 September 2008 - Snake River Fish and Wildlife Office - Boise, Idaho. 310 p.

U.S. Fish and Wildlife Service (USFWS). 2014. 50 CFR Part 17. (Docket No. FWS–R6–ES–2013–0101; 4500030114). RIN 1018-AZ77. Endangered and Threatened Wildlife and Plants; Revised Designation of Critical Habitat for the Contiguous United States Distinct Population Segment of the Canada Lynx and Revised Distinct Population Segment Boundary. AGENCY: Fish and Wildlife Service, Interior.
ACTION: Final rule.

U.S. Fish and Wildlife Service (USFWS). 2015. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus*). USFWS Pacific Region, Portland, OR, 2015.

U.S. Fish and Wildlife Service (USFWS) and National Oceanic and Atmospheric Administration (NOAA) Fisheries. 1998.

van Gils et al. 2005.

Weaver, T.M. and J. Fraley. 1991. Fisheries Habitat and Fish Populations, Flathead Basin Forest Practices. Flathead Basin Commission Water Quality and Fisheries Cooperative Program, Kalispell, MT.

Willard, E.E., and M. Herman. 1977. Grizzly bear and its habitat. Final Report. Cooperative Agreement between U.S. Department of Agriculture, Forest Service, Region 1 and University of Montana, Montana Forest and Conservation Experiment Station. 28 pp.

Wood, C. 2011. S-CNF, personal observation.

Zager, P.E. 1980. The influence of logging and wildfire on grizzly bear habitat in northwestern Montana. Dissertation. University of Montana, Missoula, MT. 131 pp.

Zager, P.E., C.J. Jonkel, and J. Habeck. 1983. Logging and wildfire influence on grizzly bear habitat in northwestern Montana. In: E.C. Meslow, editor. 5th international conference on bear research and management; [date of conference unknown]; Madison, WI. International Association for Bear Research and Management, [place of publication unknown]. p. 124–132.

Tables

TABLE 4-3. Baseline Water Quality Data for WSPs Influent (average of monthly avg values for 2014-2016) and MT Water Quality Standards

Date	pH [s.u.] WSPs Influent SS-1	pH [s.u.] MT WQS (chronic)	Temp [°F] WSPs Influent SS-1	TSS [mg/L] WSPs Influent SS-1	Hardness [mg/L as $CaCO_3$] Influent SS-1	Arsenic [µg/L] WSPs Influent SS-1	Arsenic [µg/L] MT WQS (chronic)	Cadmium [µg/L] WSPs Influent SS-1	Cadmium [µg/L] MT WQS (chronic)	Copper [µg/L] WSPs Influent SS-1	Copper [µg/L] MT WQS (chronic)	Iron [µg/L] WSPs Influent SS-1	Iron [µg/L] MT WQS (chronic)	Lead [µg/L] WSPs Influent SS-1	Lead [µg/L] MT WQS (chronic)	Zinc [µg/L] WSPs Influent SS-1	Zinc [µg/L] MT WQS (chronic)
Jan 2014-16	7.99	*6.5-9.0*	1.0	11.6	191	6.95	*150*	0.413	*0.437*	28.2	*16.2*	523	*1000*	3.66	*7.25*	150	*207*
Feb 2014-16	8.03	*6.5-9.0*	2.0	23.1	187	8.17	*150*	0.509	*0.430*	37.0	*15.9*	893	*1000*	5.34	*7.05*	172	*203*
Mar 2014-16	8.31	*6.5-9.0*	4.6	28.1	170	9.24	*150*	0.519	*0.402*	43.9	*14.7*	971	*1000*	6.99	*6.27*	144	*188*
Apr 2014-16	8.56	*6.5-9.0*	8.1	21.5	145	8.17	*150*	0.453	*0.356*	34.2	*12.8*	1043	*1000*	5.53	*5.10*	116	*164*
May 2014-16	8.54	*6.5-9.0*	10.0	23.0	126	7.69	*150*	0.314	*0.321*	28.4	*11.4*	808	*1000*	4.87	*4.28*	95.4	*146*
Jun 2014-16	8.57	*6.5-9.0*	14.5	8.7	141	8.58	*150*	0.214	*0.349*	18.3	*12.5*	429	*1000*	2.73	*4.92*	63.2	*160*
Jul 2014-16	8.72	*6.5-9.0*	18.3	6.3	175	9.59	*150*	0.301	*0.409*	19.2	*15.0*	259	*1000*	2.01	*6.48*	67.7	*192*
Aug 2014-16	8.55	*6.5-9.0*	16.6	7.9	191	9.62	*150*	0.280	*0.438*	20.7	*16.3*	366	*1000*	2.57	*7.27*	77.9	*208*
Sep 2014-16	8.57	*6.5-9.0*	12.7	10.0	189	7.84	*150*	0.330	*0.435*	21.8	*16.1*	421	*1000*	3.26	*7.18*	73.0	*206*
Oct 2014-16	8.59	*6.5-9.0*	8.2	6.6	178	6.57	*150*	0.278	*0.415*	19.8	*15.3*	377	*1000*	2.76	*6.64*	72.9	*196*
Nov 2014-16	8.27	*6.5-9.0*	2.3	8.3	188	5.61	*150*	0.274	*0.431*	20.1	*16.0*	453	*1000*	2.83	*7.08*	112	*204*
Dec 2014-16	7.93	*6.5-9.0*	0.6	5.0	203	5.82	*150*	0.352	*0.457*	20.7	*17.1*	348	*1000*	2.43	*7.84*	130	*218*
Median	**8.54**	***6.5-9.0***	8.1	**9.4**	**183**	**8.00**	***150***	**0.322**	***1.82***	21.3	***19.8***	**441**	***1000***	**3.05**	***6.84***	**104**	***176***
Min	**7.93**	***6.5-9.0***	0.6	**5.0**	**126**	**5.61**	***150***	**0.214**	***1.36***	18.3	***14.4***	**259**	***1000***	**2.01**	***4.28***	**63.2**	***129***
Max	**8.72**	***6.5-9.0***	18.3	**28.1**	**203**	**9.62**	***150***	**0.519**	***1.98***	43.9	***21.7***	**1043**	***1000***	**6.99**	***7.84***	**172**	***193***

All data in this table are from Atlantic-Richfield Co.

All metals/elements values are total recoverable (TREC)

The pH values shown are simple arithmetic averages. These are not quite accurate because pH is a log parameter, but they are reasonable approximations when the individual values do not diverge greatly.

The Montana water quality standards (WQS) shown are the chronic values for aquatic life, from Circular DEQ-7 (MDEQ, 2012).

Yellow shading indicates exceedance of monthly avg discharge limit

TABLE 4-4. Baseline Water Quality Data for WSPs Effluent Discharge (average of monthly avg values for 2014-2016) and WSPs Discharge Limits

	pH [s.u.]		Temperature [°F]			TSS [mg/L]		Hardness	Arsenic [µg/L]		Cadmium [µg/L]		Copper [µg/L]		Iron [µg/L]		Lead [µg/L]		Zinc [µg/L]	
Date	WSPs Effluent SS-5	WSPs Discharge Limit	WSPs Effluent SS-5	ΔT (below-above WSPs outfall)	ΔT limit, when T=32-66°F (0-19°C)	WSPs Effluent SS-5	WSPs Discharge Limit	[mg/L as $CaCO_3$] WSPs Effl SS-5	WSPs Effluent SS-5	WSPs Discharge Limit	WSPs Effluent SS-5	WSPs Discharge Limit	WSPs Effluent SS-5	WSPs Discharge Limit	WSPs Effluent SS-5	WSPs Discharge Limit	WSPs Effluent SS-5	WSPs Discharge Limit	WSPs Effluent SS-5	WSPs Discharge Limit
Jan 2014-16	8.18	*6.5-9.5*	*Data not shown because there are no reliable temperature data for Station SS-5.*	1.91	*≤ + 1*	3.3	*30*	225	9.69	*20*	0.162	*2.14*	9.24	*23.6*	140	*1000*	0.634	*8.91*	29.4	*210*
Feb 2014-16	8.59	*6.5-9.5*		1.52	*≤ +1*	3.6	*30*	210	8.51	*20*	0.096	*2.03*	8.34	*22.3*	147	*1000*	0.672	*8.20*	24.0	*199*
Mar 2014-16	8.86	*6.5-9.5*		1.34	*≤ +1*	7.4	*30*	188	9.56	*20*	0.160	*1.87*	13.9	*20.3*	329	*1000*	3.09	*7.13*	34.4	*181*
Apr 2014-16	8.55	*6.5-9.5*		1.43	*≤ +1*	7.4	*30*	189	9.42	*20*	0.204	*1.87*	13.6	*20.3*	349	*1000*	2.93	*7.14*	41.9	*181*
May 2014-16	9.00	*6.5-9.5*		1.10	*≤ +1*	4.5	*30*	162	14.2	*20*	0.089	*1.65*	10.9	*17.8*	235	*1000*	1.47	*5.87*	41.5	*159*
Jun 2014-16	9.23	*6.5-9.5*		1.18	*≤ +1*	3.3	*30*	150	22.9	*20*	0.111	*1.56*	10.0	*16.7*	178	*1000*	0.950	*5.34*	37.2	*150*
Jul 2014-16	9.84	*6.5-9.5*		1.62	*≤ +1*	3.1	*30*	136	36.0	*20*	0.063	*1.44*	5.84	*15.4*	92.0	*1000*	0.718	*4.70*	27.7	*137*
Aug 2014-16	10.0	*6.5-9.5*		3.74	*≤ +1*	3.3	*30*	138	43.2	*20*	0.035	*1.46*	4.23	*15.6*	60.8	*1000*	0.374	*4.81*	22.3	*139*
Sep 2014-16	9.84	*6.5-9.5*		1.06	*≤ +1*	3.3	*30*	147	35.2	*20*	0.078	*1.54*	5.28	*16.5*	62.2	*1000*	0.506	*5.21*	13.8	*147*
Oct 2014-16	8.92	*6.5-9.5*		1.45	*≤ +1*	3.1	*30*	167	24.3	*20*	0.087	*1.70*	6.45	*18.4*	120	*1000*	0.880	*6.13*	13.2	*164*
Nov 2014-16	8.16	*6.5-9.5*		0.37	*≤ +1*	6.5	*30*	198	9.68	*20*	0.108	*1.94*	10.3	*21.2*	406	*1000*	2.56	*7.61*	21.4	*189*
Dec 2014-16	8.03	*6.5-9.5*		1.15	*≤ +1*	3.3	*30*	220	7.73	*20*	0.098	*2.11*	7.83	*23.2*	178	*1000*	0.976	*8.70*	20.9	*207*
Median	**8.89**	***6.5-9.5***		**1.38**	***≤ +1***	**3.3**	***30***	**178**	**11.9**	***20***	**0.097**	***1.78***	**8.79**	***19.3***	**162**	***1000***	**0.915**	***6.63***	**25.8**	***173***
Min	**8.03**	***6.5-9.5***		**0.37**	***≤ +1***	**3.1**	***30***	**136**	**7.73**	***20***	**0.035**	***1.44***	**4.23**	***15.4***	**60.8**	***1000***	**0.374**	***4.70***	**13.2**	***137***
Max	**10.0**	***6.5-9.5***		**3.74**	***≤ +1***	**7.4**	***30***	**225**	**43.2**	***20***	**0.204**	***2.14***	**13.9**	***23.6***	**406**	***1000***	**3.09**	***8.91***	**41.9**	***210***

All data in this table are from Atlantic-Richfield Co.

All metals/elements values are total recoverable (TREC)

The pH values shown are simple arithmetic averages. These are not quite accurate because pH is a log parameter, but they are reasonable approximations when the individual values do not diverge greatly.

The WSPs discharge limits shown are the monthly average limits, when available, established in the UAO, Exhibit 4 (forΔT) and Exhibit 5 (EPA, 1991); the limits for hardness-dependent elements are based on the WSPs effluent hardness.

Yellow shading indicates exceedance of monthly avg discharge limit

TABLE 4-5. Baseline Water Quality Data for Mill-Willow Bypass below WSPs Outfall (average of monthly avg values for 2014-2016) and MT Water Quality Standards

	pH [s.u.]		Temp [°C]	Turbidity [NTU]	Hardness	Arsenic [µg/L]		Cadmium [µg/L]		Copper [µg/L]		Iron [µg/L]		Lead [µg/L]		Zinc [µg/L]	
	Below	MT	Below	Below	[mg/L as $CaCO_3$]	Below	MT	Below	MT	Below	MT	Below	MT	Below	MT	Below	MT
	WSPs	WQS	WSPs	WSPs	Below	WSPs	WQS	WSPs	WQS	WSPs	WQS	WSPs	WQS	WSPs	WQS	WSPs	WQS
Date	**MWB-3**	**(chronic)**	**MWB-3**	**MWB-3**	**MWB-3**	**MWB-3**	**(chronic)**	**MWB-3**	**(chronic)**	**MWB-3**	**(chronic)**	**MWB-3**	**(chronic)**	**MWB-3**	**(chronic)**	**MWB-3**	**(chronic)**
Jan 2014-16	8.26	6.5-9.0	1.4	3.0	229	12.2	150	0.160	0.499	6.20	18.9	160	1000	0.68	9.12	22.3	241
Feb 2014-16	8.58	6.5-9.0	2.9	2.4	201	12.8	150	0.115	0.454	6.40	17.0	193	1000	0.88	7.76	24.0	217
Mar 2014-16	8.70	6.5-9.0	3.6	7.7	196	15.6	150	0.115	0.443	12.4	16.5	383	1000	3.66	7.53	25.0	211
Apr 2014-16	8.38	6.5-9.0	6.2	7.4	156	18.5	150	0.147	0.376	12.2	13.6	425	1000	2.52	5.61	39.7	175
May 2014-16	8.58	6.5-9.0	10.7	5.1	116	22.2	150	0.111	0.302	9.36	10.6	329	1000	1.74	3.85	30.7	136
Jun 2014-16	8.35	6.5-9.0	11.9	4.5	119	37.5	150	0.054	0.307	7.25	10.8	262	1000	1.31	3.96	22.0	138
Jul 2014-16	8.78	6.5-9.0	15.5	3.0	156	24.2	150	0.078	0.375	3.84	13.6	127	1000	0.49	5.63	30.0	174
Aug 2014-16	8.82	6.5-9.0	18.6	3.2	213	26.9	150	0.076	0.472	3.90	17.8	241	1000	0.74	8.38	22.0	227
Sep 2014-16	8.83	6.5-9.0	11.3	1.4	212	20.2	150	0.030	0.471	2.80	17.7	81.0	1000	0.31	8.27	22.0	226
Oct 2014-16	8.54	6.5-9.0	7.9	1.8	226	17.4	150	0.067	0.494	3.13	18.7	82.3	1000	0.45	8.98	22.0	239
Nov 2014-16	8.34	6.5-9.0	1.5	4.4	217	10.7	150	0.050	0.481	6.03	18.1	279	1000	1.71	8.56	23.7	231
Dec 2014-16	8.16	6.5-9.0	0.7	3.1	235	10.3	150	0.045	0.509	5.30	19.3	181	1000	0.79	9.42	24.7	247
Median	**8.56**	**6.5-9.0**	**7.0**	**3.1**	**207**	18.0	150	0.077	0.463	6.12	17.3	217	1000	0.83	8.02	23.8	221
Min	**8.16**	**6.5-9.0**	**0.7**	**1.4**	**116**	10.3	150	0.030	0.302	2.80	10.6	81.0	1000	0.31	3.85	22.0	136
Max	**8.83**	**6.5-9.0**	**18.6**	**7.7**	**235**	37.5	150	0.160	0.509	12.4	19.3	425	1000	3.66	9.42	39.7	247

All data in this table are from Atlantic-Richfield Co.

All metals/elements values are total recoverable (TREC)

The pH values shown are simple arithmetic averages. These are not quite accurate because pH is a log parameter, but they are reasonable approximations when the individual values do not diverge greatly.

The Montana water quality standards (WQS) shown are the chronic values for aquatic life, from Circular DEQ-7 (MDEQ, 2012); the limits shown for hardness-dependent elements are based on the MWB-3 hardness.

Yellow shading indicates exceedance of monthly avg discharge limit

TABLE 4-6. Baseline Water Quality Data for USGS Station Silver Bow Creek near Warm Springs, MT (average of monthly avg values for 2014-2016) and MT Water Quality Standards

	pH, field [s.u.]		Temperature [°C]	Suspended Sediment [mg/L]	Hardness [mg/L as $CaCO_3$]	Arsenic, Unfiltered [ug/L]		Cadmium, Unfiltered [ug/L]		Copper, Unfiltered [ug/L]		Iron, Unfiltered [ug/L]		Lead, Unfiltered [ug/L]		Zinc, Unfiltered [ug/L]	
Date	**SBC 12323750**	**MT WQS**	**SBC 12323750**	**SBC 12323750**	**SBC 12323750**	**SBC 12323750**	**MT WQS (chronic)**	**SBC 12323750**	**MT WQS (chronic)**	**SBC 12323750**	**MT WQS (chronic)**	**SBC 12323750**	**MT WQS (chronic)**	**SBC 12323750**	**MT WQS (chronic)**	**SBC 12323750**	**MT WQS (chronic)**
Jan 2014-16																	
Feb 2014-16																	
Mar 2014-16	8.70	6.5-9.0	4.2	6.3	194	12.6	*150*	0.113	*0.442*	10.1	*16.4*	26.8	*1000*	2.52	*7.40*	16.6	*210*
Apr 2014-16	8.37	*6.5-9.0*	8.3	11.3	182	14.4	*150*	0.242	*0.422*	15.5	*15.6*	23.1	*1000*	3.12	*6.82*	32.9	*199*
May 2014-16	8.63	*6.5-9.0*	8.8	7.7	134	21.0	*150*	0.110	*0.337*	9.4	*12.0*	42.6	*1000*	1.59	*4.63*	13.4	*154*
Jun 2014-16	8.67	*6.5-9.0*	12.3	10.0	111	33.4	*150*	0.129	*0.292*	10.1	*10.2*	52.5	*1000*	1.79	*3.63*	10.5	*131*
Jul 2014-16	9.07	*6.5-9.0*	14.2	3.3	150	32.1	*150*	0.051	*0.366*	4.6	*13.2*	38.1	*1000*	0.67	*5.35*	4.13	*169*
Aug 2014-16	9.33	*6.5-9.0*	15.5	1.7	188	33.0	*150*	0.045	*0.432*	3.0	*16.0*	22.4	*1000*	0.37	*7.11*	2.10	*205*
Sep 2014-16																	
Oct 2014-16	8.67	*6.5-9.0*	8.2	1.3	199	20.7	*150*	0.044	*0.451*	3.4	*16.8*	19.3	*1000*	0.42	*7.64*	3.83	*215*
Nov 2014-16																	
Dec 2014-16																	
Median	**8.67**	***6.5-9.0***	**8.8**	**6.3**	**182**	**21.0**	***150***	**0.110**	***0.422***	**9.4**	***15.6***	**26.8**	***1000***	**1.59**	***6.82***	**10.5**	***199***
Min	**8.37**	***6.5-9.0***	**4.2**	**1.3**	**111**	**12.6**	***150***	**0.044**	***0.292***	**3.0**	***10.2***	**19.3**	***1000***	**0.37**	***3.63***	**2.10**	***131***
Max	**9.33**	***6.5-9.0***	**15.5**	**11.3**	**199**	**33.4**	***150***	**0.242**	***0.451***	**15.5**	***16.8***	**52.5**	***1000***	**3.12**	***7.64***	**32.9**	***215***

The measured data in this table are from the USGS

All metals/elements values are total (unfiltered)

The pH values shown are simple arithmetic averages. These are not quite accurate because pH is a log parameter, but they are reasonable approximations when the individual values do not diverge greatly.

SBC = Silver Bow Creek at Warm Springs, MT (USGS Station 12323750).

The Montana water quality standards (WQS) shown are the chronic values for aquatic life, from Circular DEQ-7 (MDEQ, 2012).

Yellow shading indicates exceedance of monthly avg discharge limit

TABLE 4-7. Baseline Water Quality Data for Clark Fork River near Warm Springs, MT (average of monthly avg values for 2014-2016) and MT Water Quality Standards

	pH, field [s.u.]		Temperature [°C]	Suspended Sediment [mg/L]	Hardness [mg/L as $CaCO_3$]	Arsenic, Unfiltered [ug/L]		Cadmium, Unfiltered [ug/L]		Copper, Unfiltered [ug/L]		Iron, Unfiltered [ug/L]		Lead, Unfiltered [ug/L]		Zinc, Unfiltered [ug/L]	
		MT					MT		MT		MT		MT		MT		MT
	CFR	WQS	CFR	CFR	CFR	CFR	WQS	CFR	WQS	CFR	WQS	CFR	WQS	CFR	WQS	CFR	WQS
Date	(calc'd)		(calc'd)	(calc'd)	(calc'd)	(calc'd)	(chronic)	(calc'd)	(chronic)	(calc'd)	(chronic)	(calc'd)	(chronic)	(calc'd)	(chronic)	(calc'd)	(chronic)
Jan 2014-16																	
Feb 2014-16																	
Mar 2014-16	8.53	6.5-9.0	3.9	5.1	191	10.0	150	0.090	0.438	8.7	16.2	20.1	1000	1.79	7.27	12.1	208
Apr 2014-16	8.32	6.5-9.0	7.6	9.6	179	12.0	150	0.193	0.417	13.6	15.4	19.5	1000	2.46	6.70	25.6	197
May 2014-16	8.36	6.5-9.0	7.5	10.3	124	14.8	150	0.096	0.317	11.8	11.2	31.2	1000	1.65	4.18	11.2	144
Jun 2014-16	8.29	6.5-9.0	10.7	15.2	96.6	20.2	150	0.111	0.264	16.4	9.1	35.6	1000	2.09	3.05	11.0	116
Jul 2014-16	8.65	6.5-9.0	12.6	4.7	142	20.2	150	0.054	0.350	7.1	12.5	27.9	1000	0.84	4.98	5.04	161
Aug 2014-16	8.91	6.5-9.0	13.9	1.8	180	23.6	150	0.044	0.418	3.9	15.4	20.5	1000	0.35	6.72	2.30	197
Sep 2014-16																	
Oct 2014-16	8.51	6.5-9.0	7.7	1.3	194	16.3	150	0.042	0.442	3.9	16.4	21.2	1000	0.37	7.40	3.30	210
Nov 2014-16																	
Dec 2014-16																	
Median	**8.51**	**6.5-9.0**	**7.7**	**5.1**	**179**	**16.3**	**150**	**0.090**	**0.417**	**8.7**	**15.4**	**21.2**	**1000**	**1.65**	**6.70**	**11.0**	**197**
Min	**8.29**	**6.5-9.0**	**3.9**	**1.3**	**96.6**	**10.0**	**150**	**0.042**	**0.264**	**3.9**	**9.1**	**19.5**	**1000**	**0.35**	**3.05**	**2.30**	**116**
Max	**8.91**	**6.5-9.0**	**13.9**	**15.2**	**194**	**23.6**	**150**	**0.193**	**0.442**	**16.4**	**16.4**	**35.6**	**1000**	**2.46**	**7.40**	**25.6**	**210**

The measured data in this table are from the USGS

All metals/elements values are total (unfiltered)

The pH values shown are simple arithmetic averages. These are not quite accurate because pH is a log parameter, but they are reasonable approximations when the individual values do not diverge greatly.

CFR = Clark Fork River below WSC - values calculated from data for SBC at Warm Springs, MT (USGS Station 12323750) and WSC at Warm Springs, MT (USGS Station 12323770).

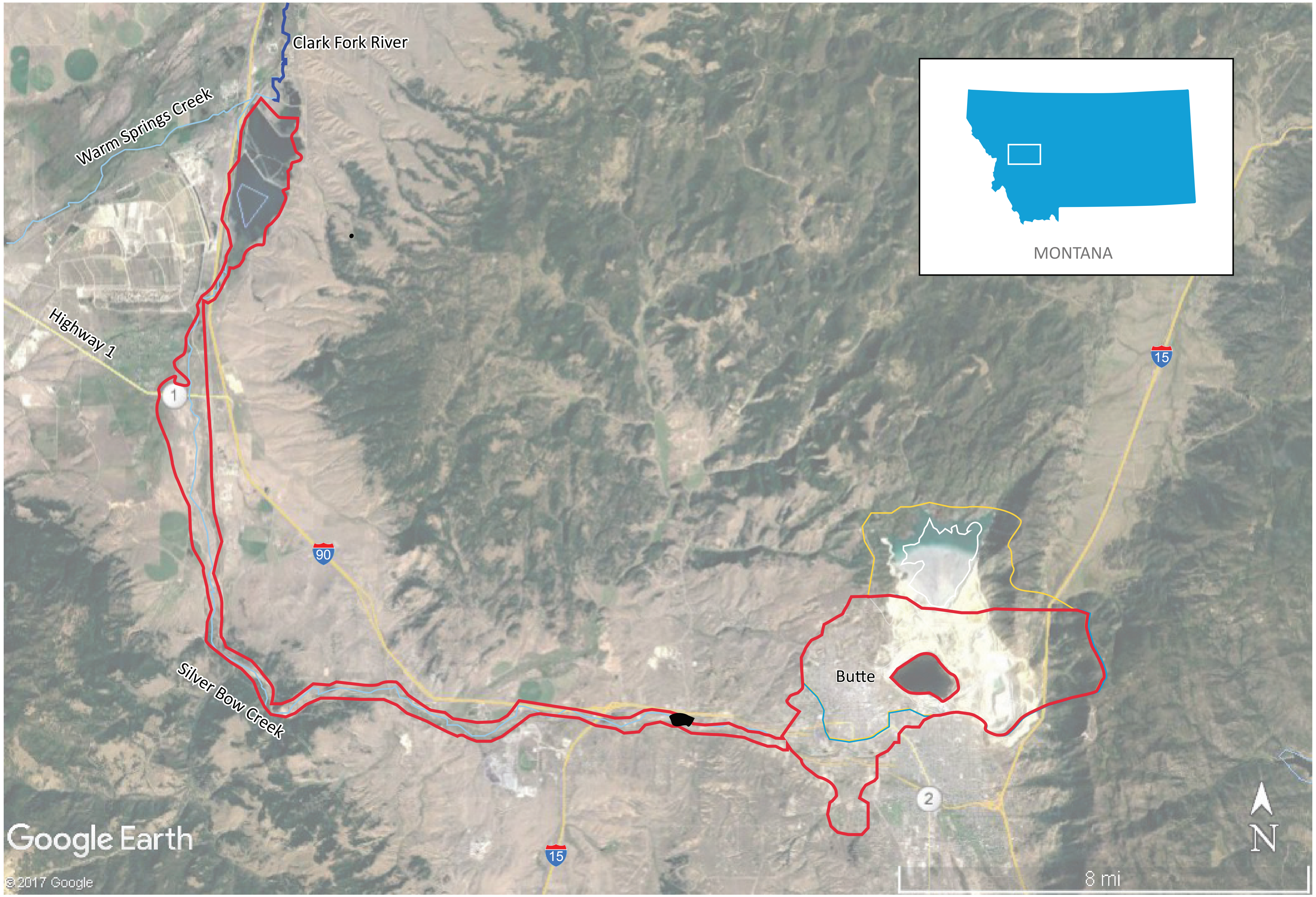
The Montana water quality standards (WQS) shown are the chronic values for aquatic life, from Circular DEQ-7 (MDEQ, 2012).

Yellow shading indicates exceedance of monthly avg discharge limit

Figures

LEGEND

— Silver Bow Creek/Butte Area Superfund Site Boundary

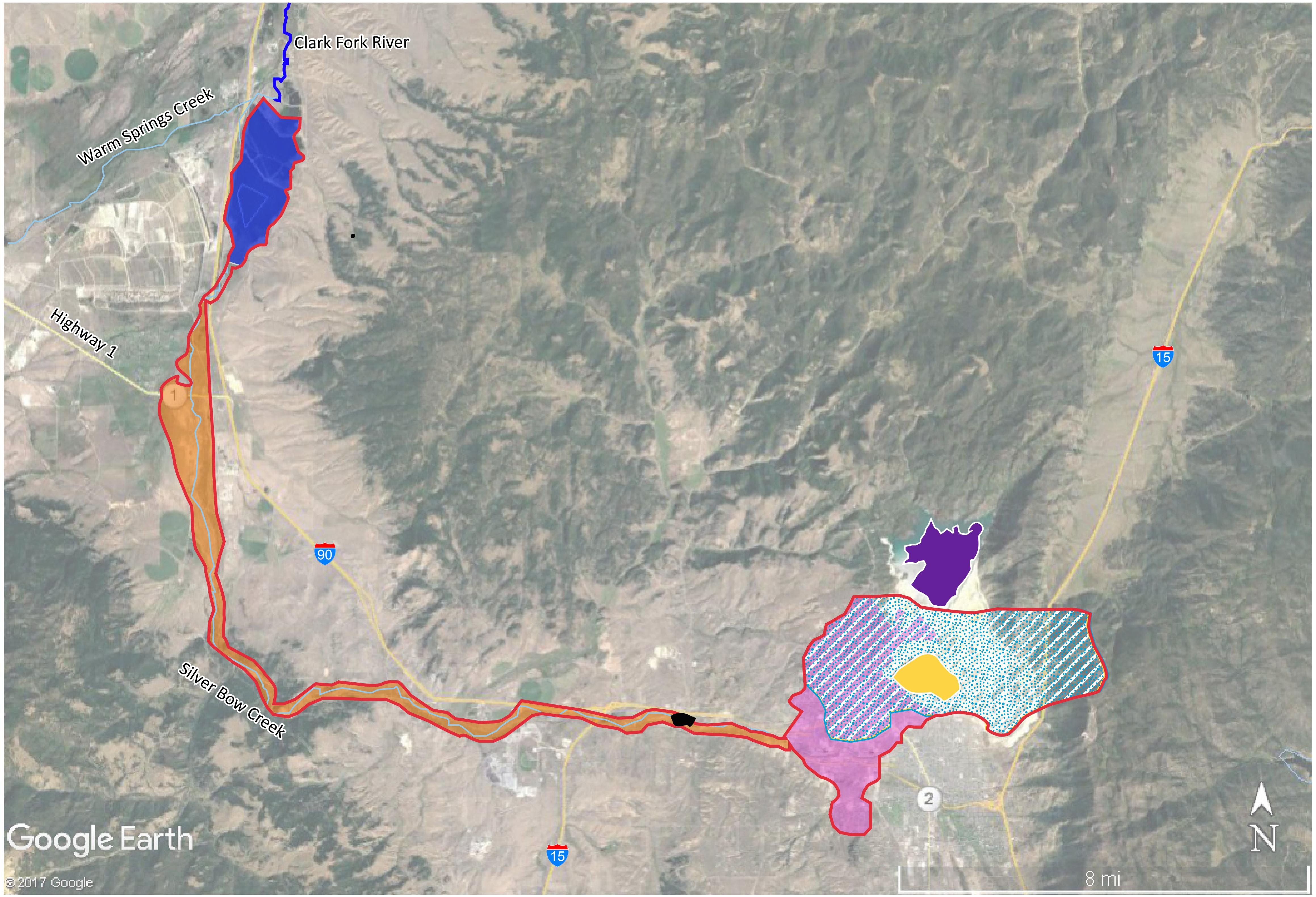


Aerial image © 2017 Google Earth. Annotation © 2017 CH2M HILL. Areas are approximate.

Figure 1-1.
Detailed Site Map
Silver Bow Creek/Butte Area Superfund Site
Butte, Silver Bow County, Montana

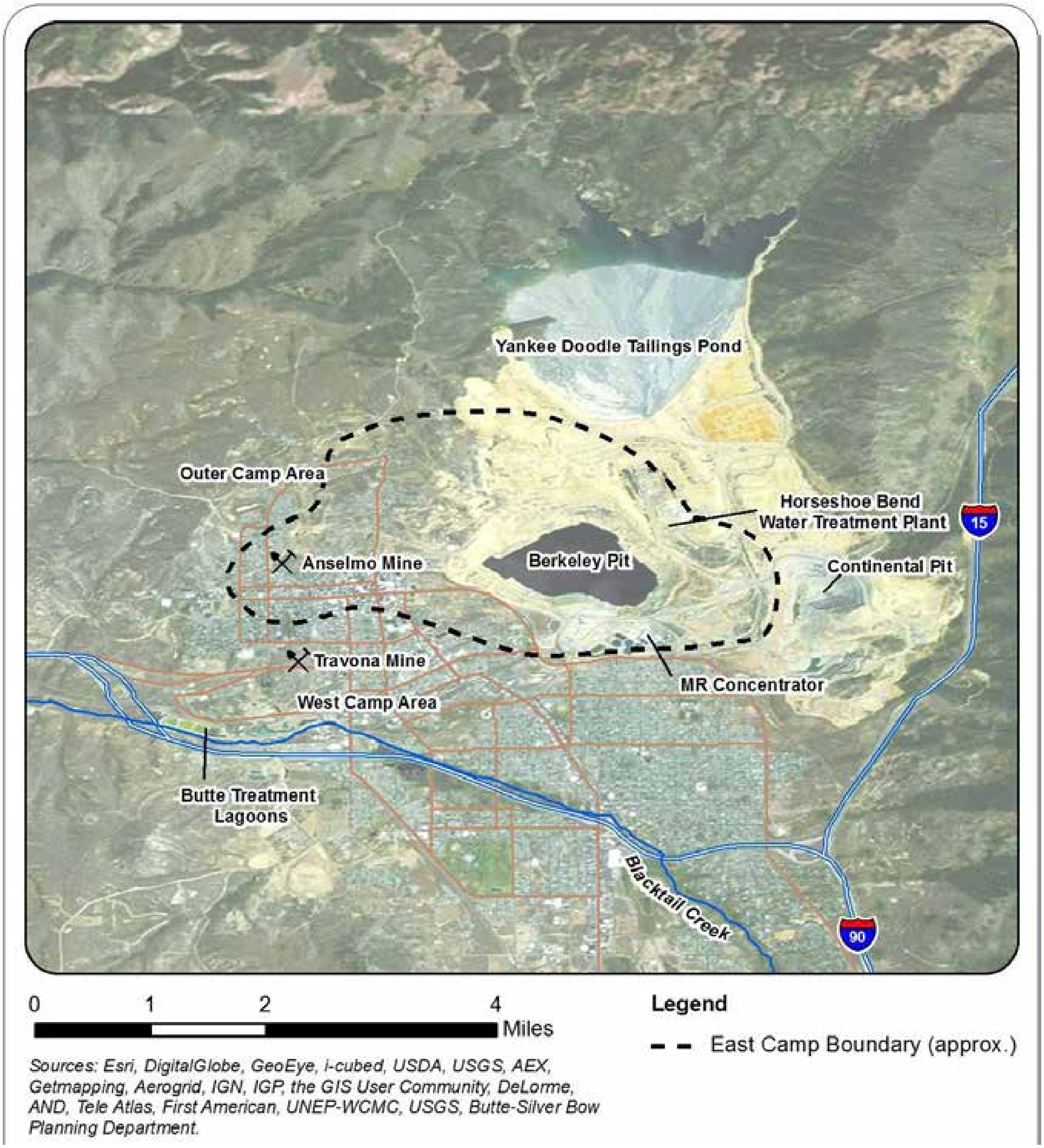
LEGEND

- 🟥 Silver Bow Creek/Butte Area Superfund Site Boundary
- 🟧 Streamside Tailings OU (OU1)
- ▨ Butte Mine Flooding OU (OU3)
- 🟦 Warm Springs Ponds Active and Inactive Areas (OU4 and OU12)
- ⬛ Rocker OU7
- 🟪 Butte Priority Soils Operable Unit (OU8)
- 🟪 Yankee Doodle Tailings
- 🟨 Berkeley Pit



Aerial image © 2017 Google Earth. Annotation © 2017 CH2M HILL. Areas are approximate.

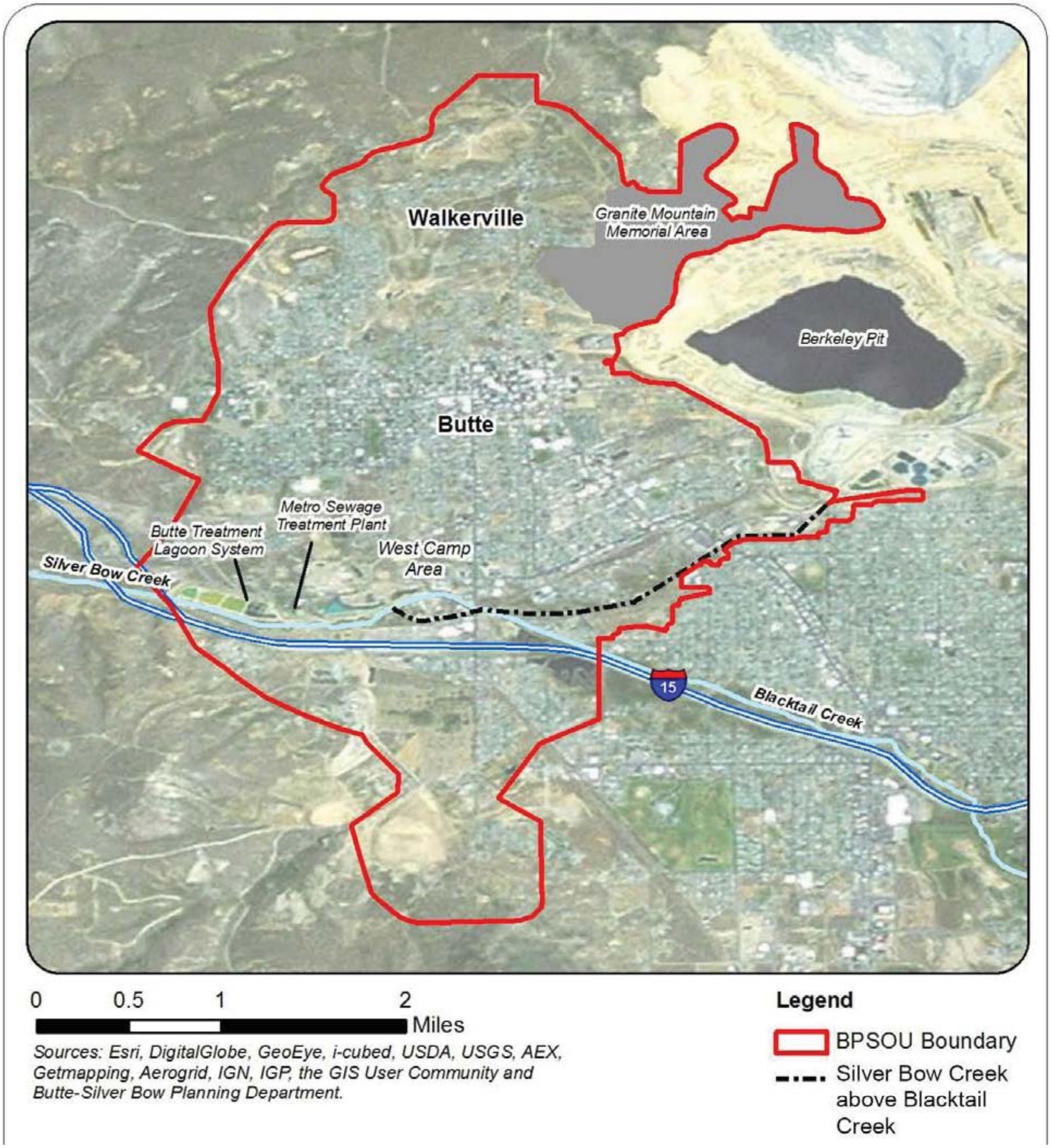
Figure 1-2.
Action Area
Silver Bow Creek/Butte Area Superfund Site
Butte, Silver Bow County, Montana



Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, the GIS User Community, DeLorme, AND, Tele Atlas, First American, UNEP-WCMC, USGS, Butte-Silver Bow Planning Department.

Amended from: SBC/BA 2016 4th Five-Year Report.

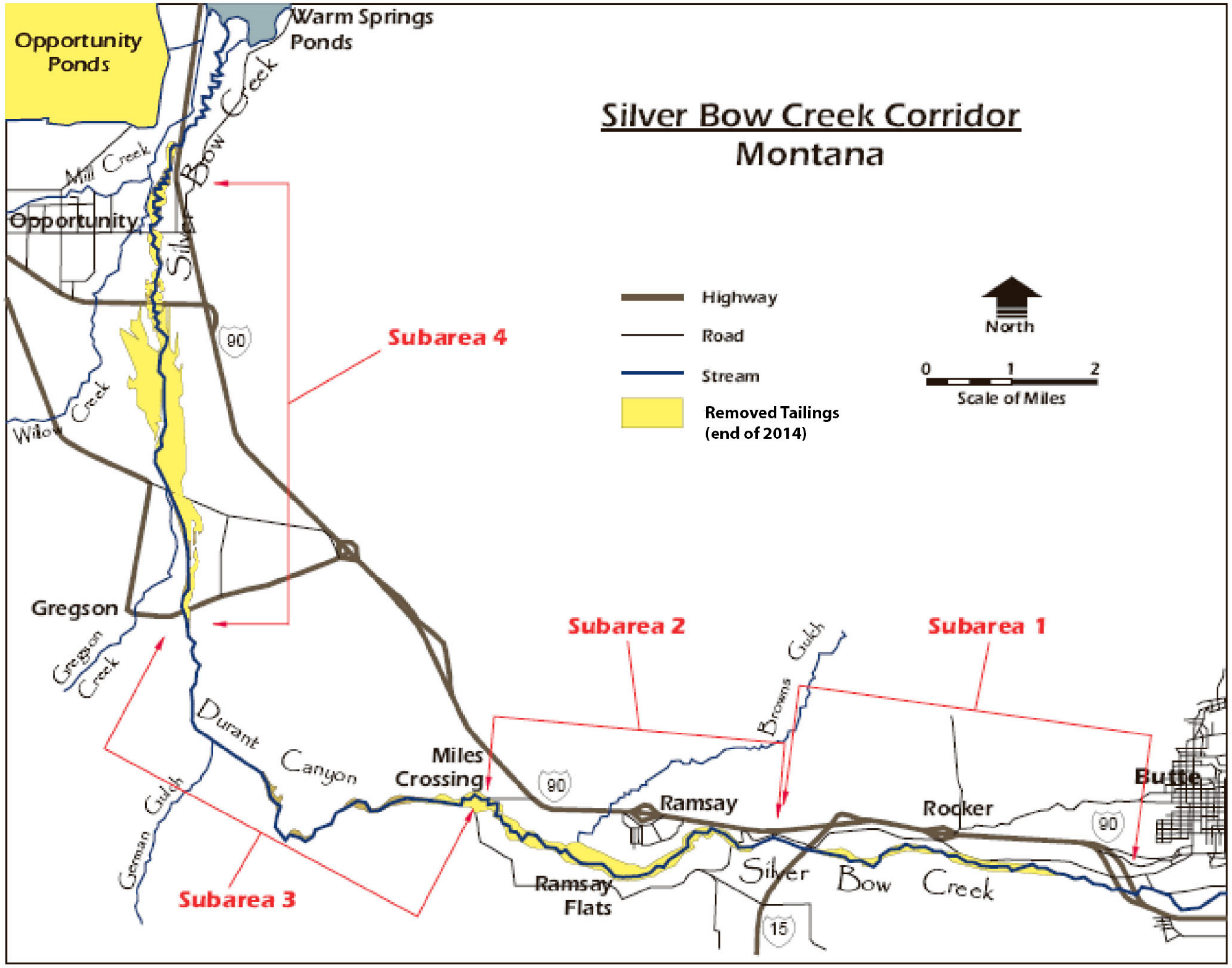
Figure 1-3.
Berkeley Pit Mine Flooding OU 3
Silver Bow Creek/Butte Area Superfund Site



Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, the GIS User Community and Butte-Silver Bow Planning Department.

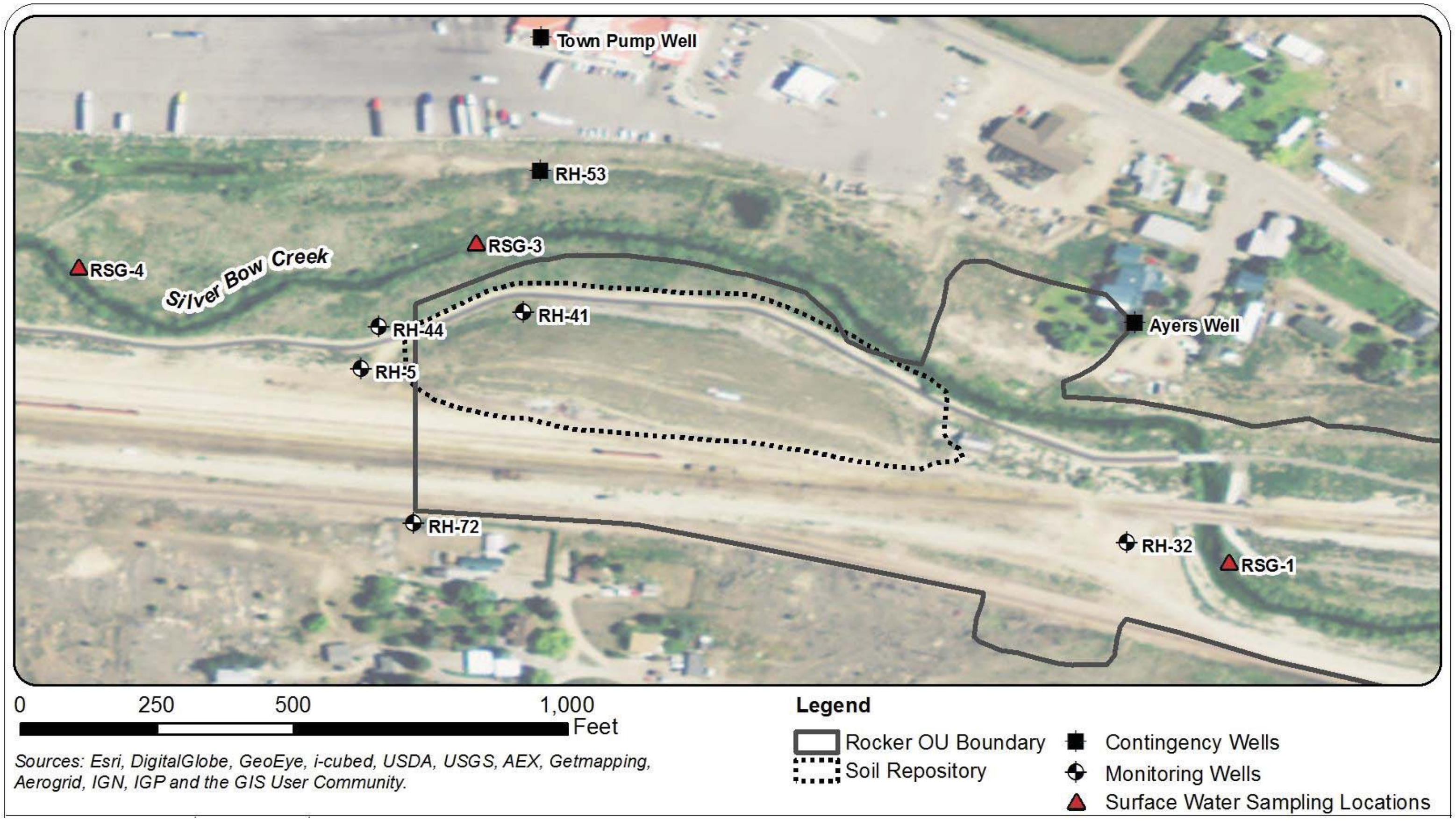
Amended from: SBC/BA 2016 4th Five-Year Report.

Figure 1-4.
Butte Priority Soils OU
Silver Bow Creek/Butte Area Superfund Site



Source: Silver Bow Creek Update Winter 2009. MDEQ and NRDP

Figure 1-5.
Streamside Tailings OU Site Features
Silver Bow Creek/Butte Area Superfund Site

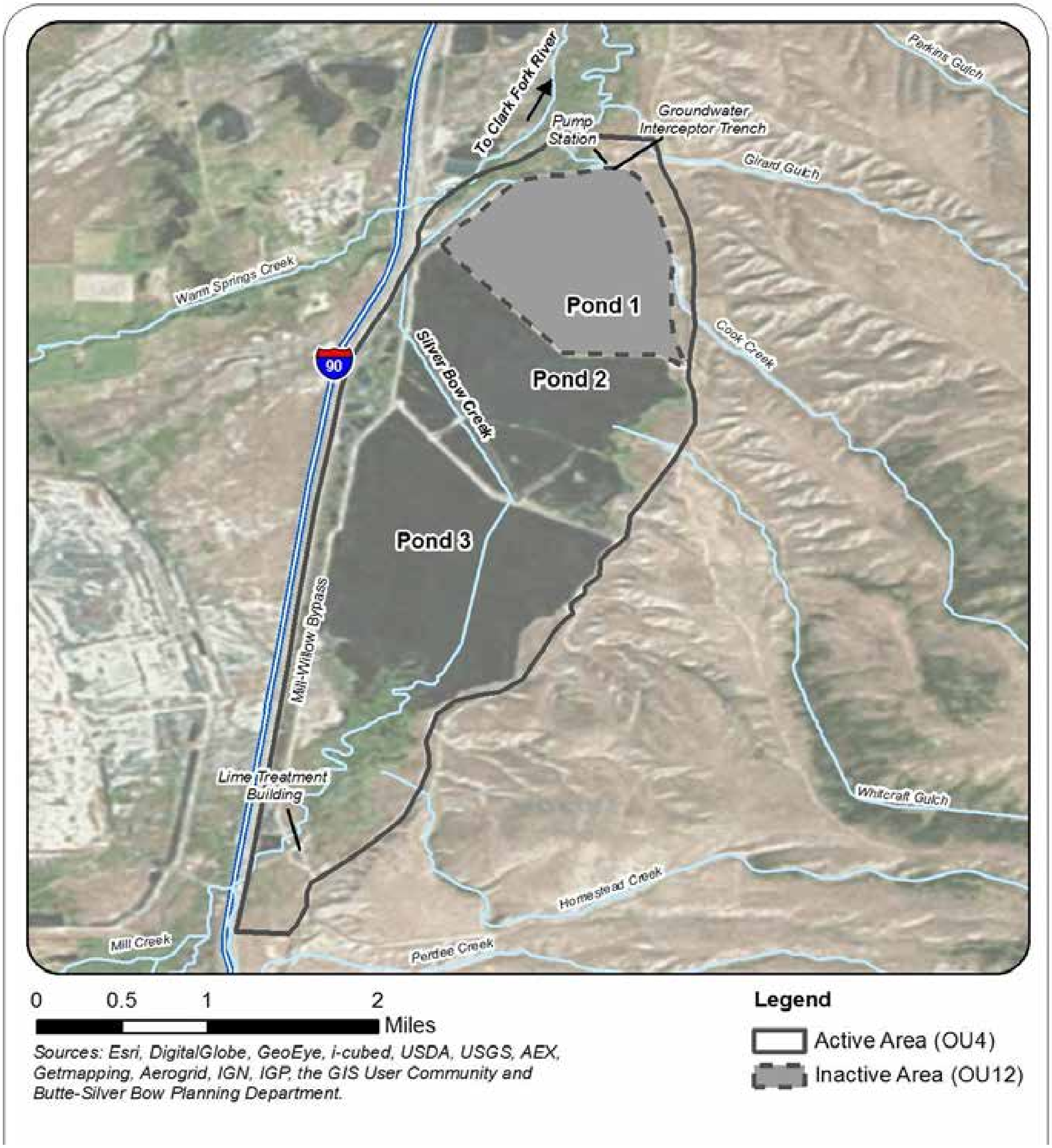


Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP and the GIS User Community.

Disclaimer: This map and any boundary lines within the map are approximate and subject to change. The map is not a survey. The map is for informational purposes only regarding EPA's response actions at the

Amended from: SBC/BA 2016 4th Five-Year Report.

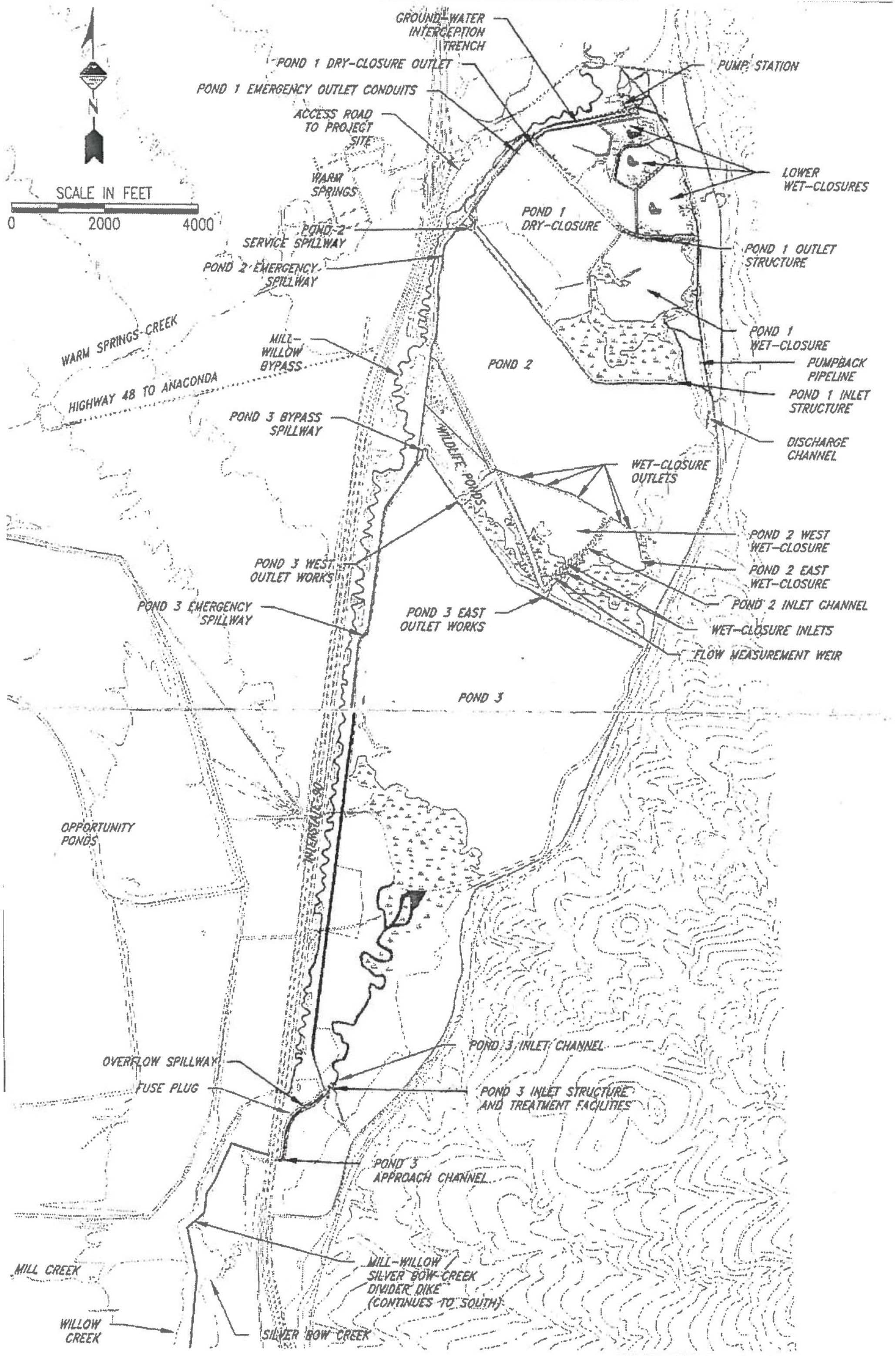
Figure 1-6.
Rocker OU
Silver Bow Creek/Butte Area Superfund Site



Sources: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, the GIS User Community and Butte-Silver Bow Planning Department.

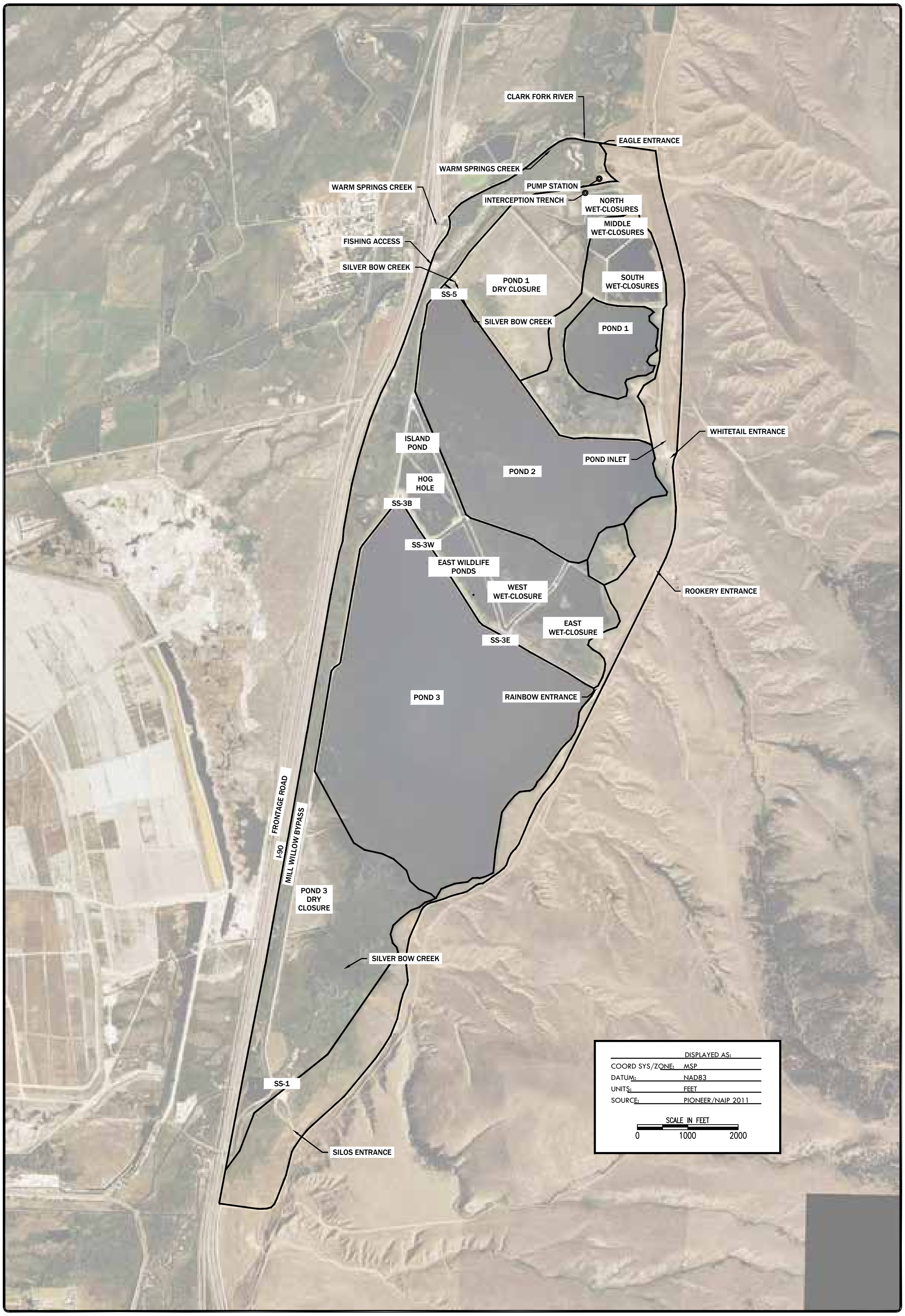
Amended from: SBC/BA 2016 4th Five-Year Report.

Figure 1-7.
Warm Springs Ponds Active and Inactive Operable Units 4 and 12
Silver Bow Creek/Butte Area Superfund Site



Amended from: Warm Springs Ponds
Operations and Maintenance Plan, ARCO, 2010

Figure 2-1.
WSP Hydraulic Facilities Plan
Silver Bow Creek/Butte Area Biological Assessment



Amended from: Pioneer Technical Services, Inc., Warm Springs Ponds Operation and Maintenance Plan, 2013.

Figure 2-2.
Warm Springs Ponds Site Map
Silver Bow Creek/Butte Area Biological Assessment

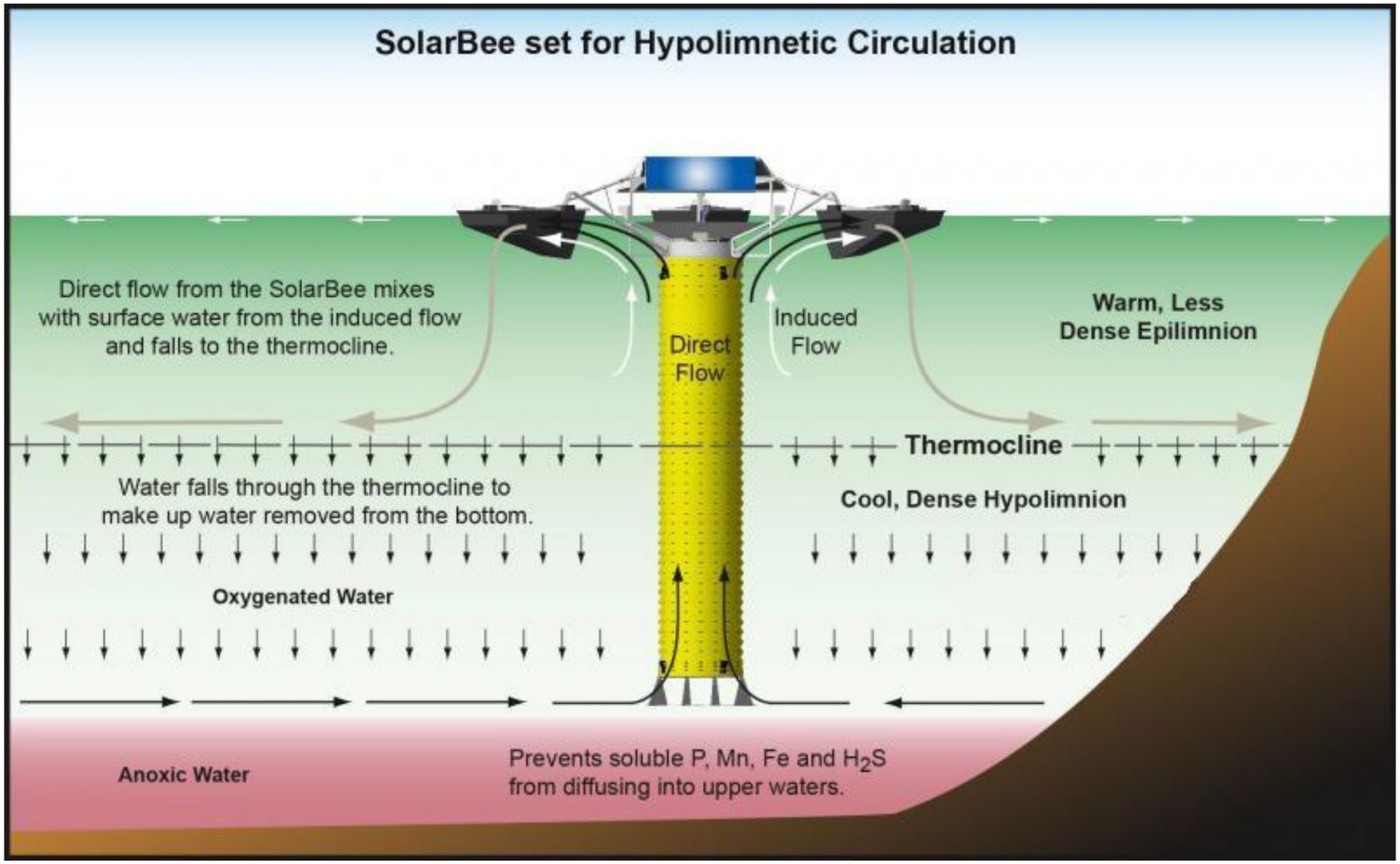
Amended from: Evaluation by Solar Mixers at Warm Springs Ponds prepared by Pioneer Technical Services, Inc., April 2013.

DISPLAYED AS:
COORD SYS/ZONE: MT ST PLANE NAD 83
DATUM: LOCAL VERTICAL
UNITS: INTERNATIONAL FEET
SOURCE: GPS

North

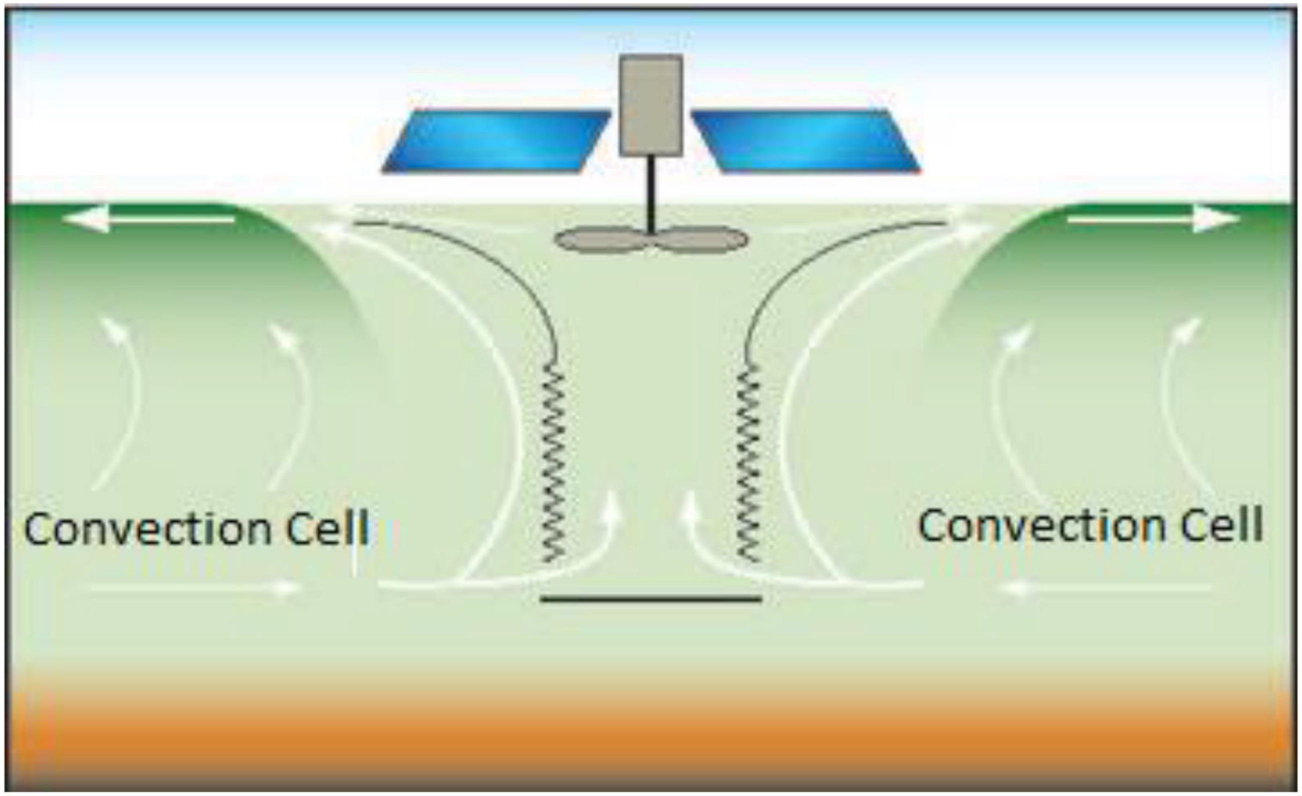
SCALE IN FEET
0 750 1500

Figure 2-3.
SolarBee Mixing Unit Locations
Silver Bow Creek/Butte Area Biological Assessment



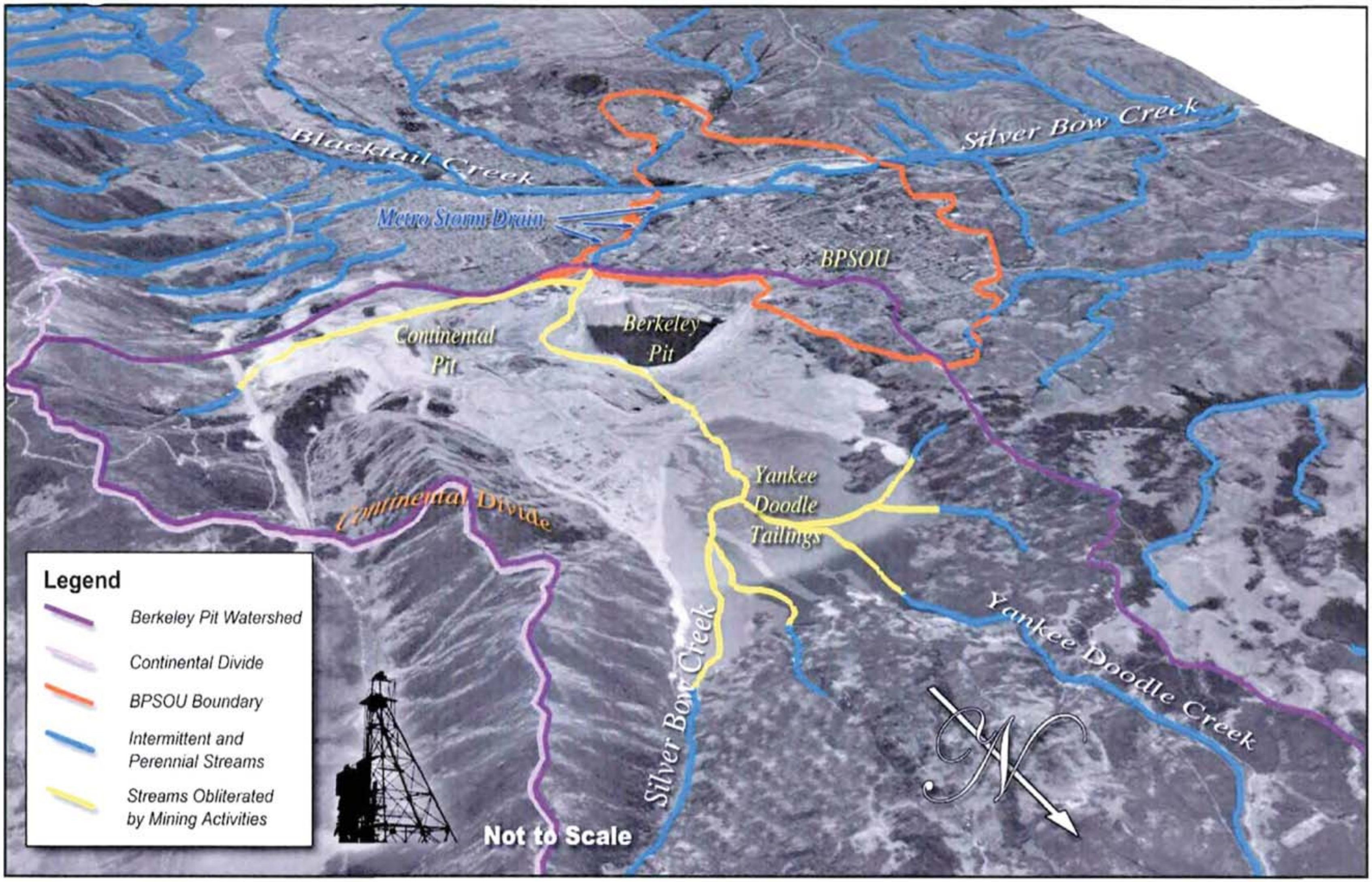
Amended from: Evaluation by Solar Mixers at Warm Springs Ponds prepared by Pioneer Technical Services, Inc., April 2013.

Figure 2-4.
SolarBee Design
Silver Bow Creek/Butte Area Biological Assessment



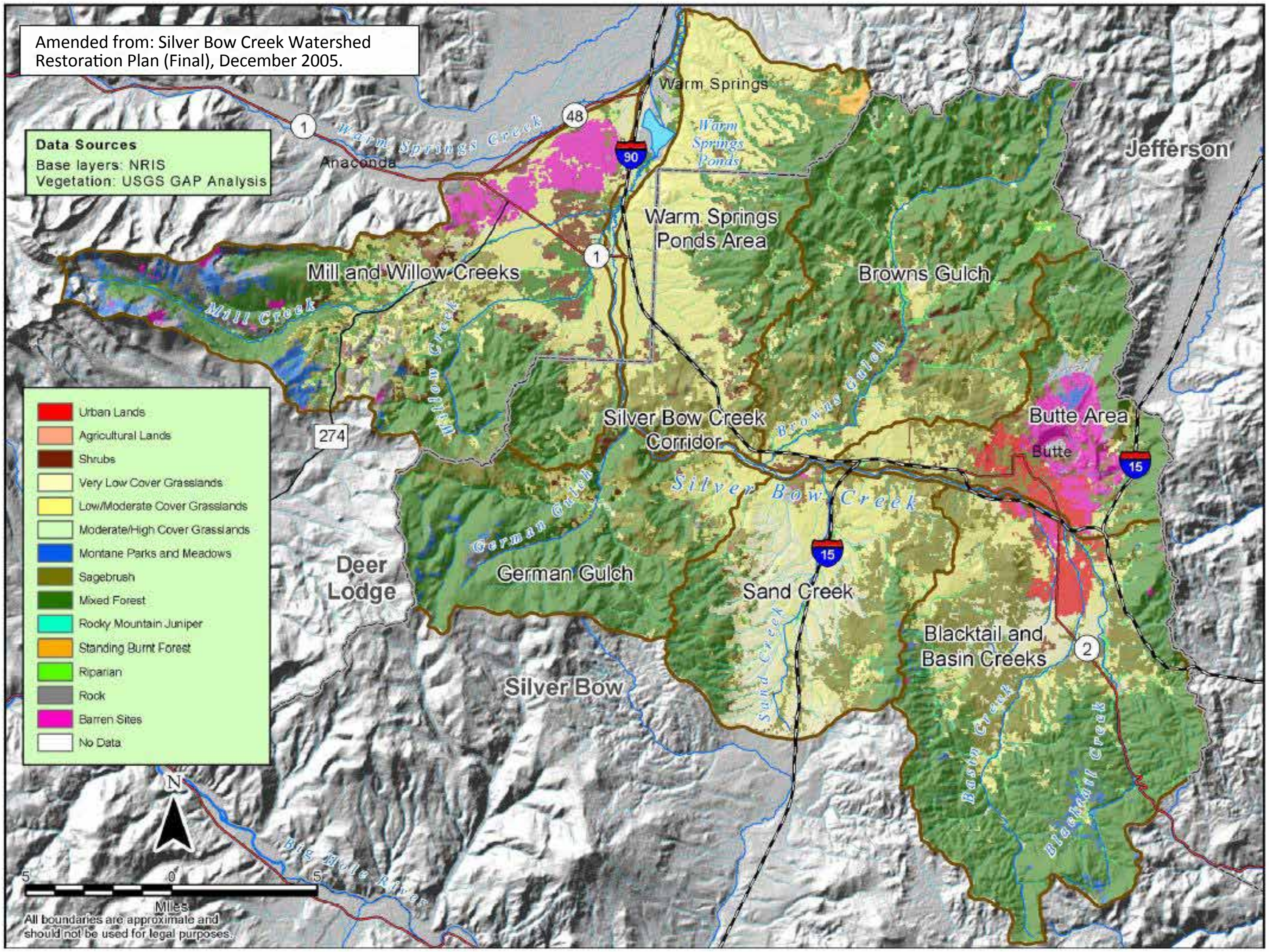
Amended from: Evaluation by Solar Mixers at Warm Springs Ponds prepared by Pioneer Technical Services, Inc., April 2013.

Figure 2-5.
SolarBee Area of Influence
Silver Bow Creek/Butte Area Biological Assessment



Amended from: BPSOU 2006 ROD

Figure 4-1.
Hydrologic Boundaries and Surface Water Features
Record of Decision, Butte Priority Soils Operable Unit
Silver Bow Creek/Butte Area NPL Site



Amended from: Silver Bow Creek Watershed Restoration Plan (Final), December 2005.

Data Sources
Base layers: NRIS
Vegetation: USGS GAP Analysis

All boundaries are approximate and should not be used for legal purposes.

Figure 4-2.
Vegetation Types in the Silver Bow Creek Watershed (USGS GAP) Data
Silver Bow Creek/Butte Area Biological Assessment

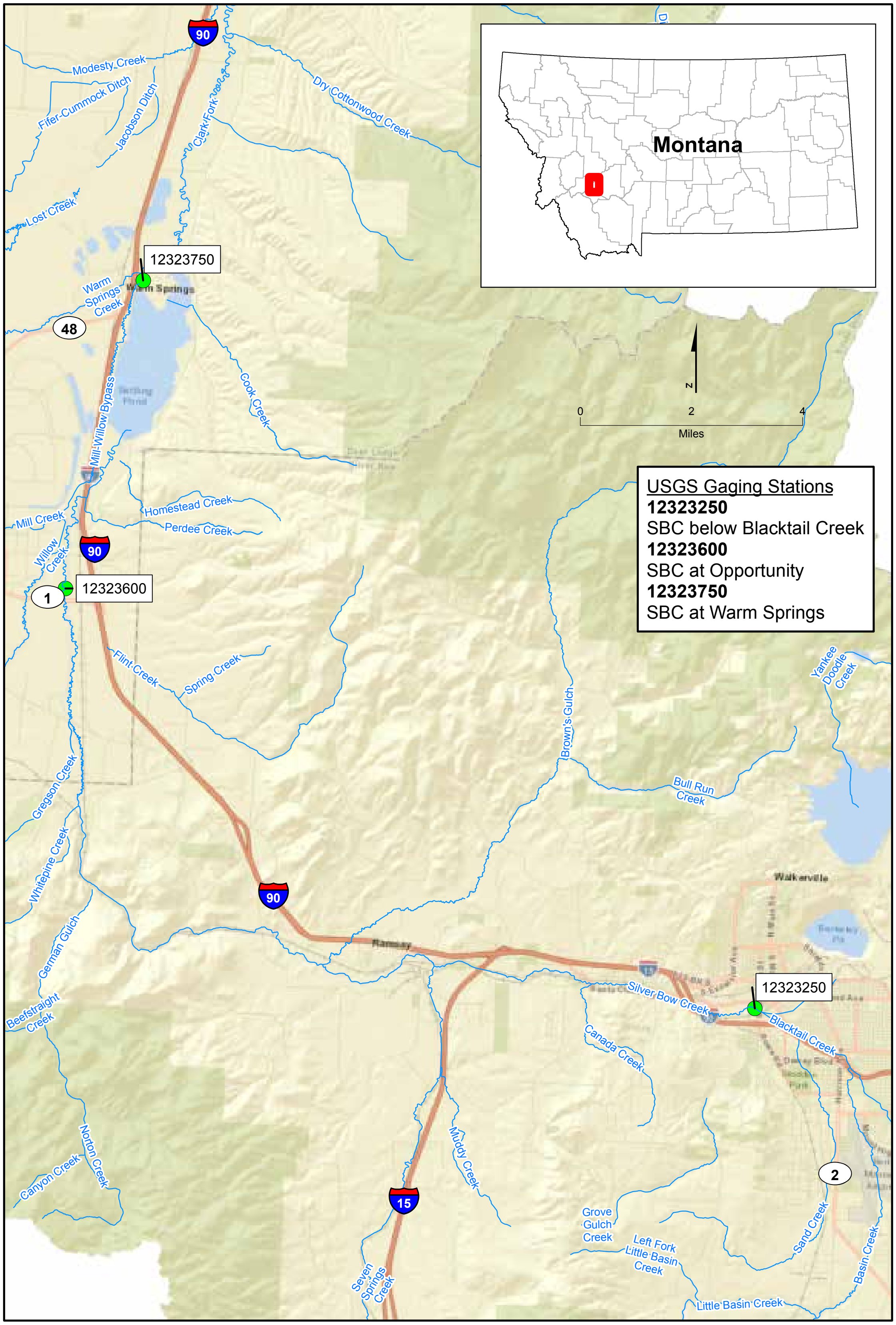
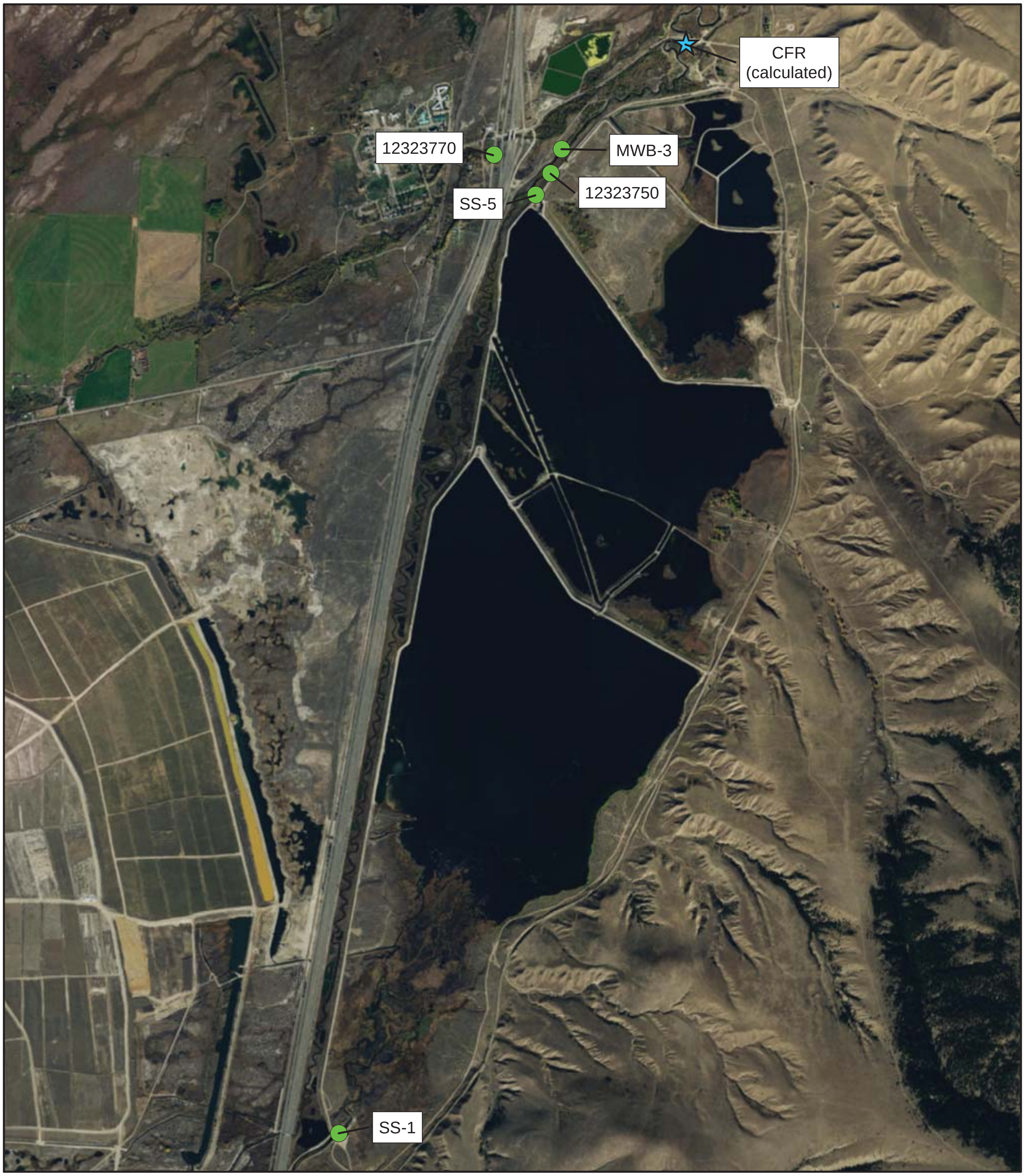


Figure 4-3.

Silver Bow Creek Watershed

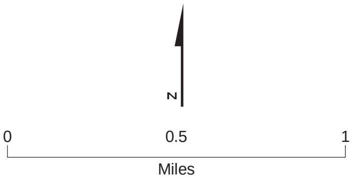
Silver Bow Creek/Butte Area Superfund Site



LEGEND

☆ Clark Fork River Water Quality Location

● Gaging Station



USGS: 12323750 - Silver Bow Creek at Warm Springs
12323770 - Warm Springs Creek at Warm Springs
ARCO: MWB-3 - Mill Willow Bypass #3
Warm Springs Ponds: SS-1 (Inlet)
SS-5 (Outlet)

FIGURE 4-5
Action Area Water Quality Stations
Silver Bow Creek/Butte Area Superfund Site
Warm Springs Ponds OUs
Deer Lodge County, Montana

ch2m

Appendix A
IPAC

IPaC Information for Planning and Consultation **U.S. Fish & Wildlife Service**

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

Montana

Local office

Montana Ecological Services Field Office

☎ (406) 449-5225
📠 (406) 449-5339

585 Shepard Way, Suite 1
Helena, MT 59601-6287

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population, even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species

[1] are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Canada Lynx Lynx canadensis There is **final** critical habitat for this species. Your location is outside the critical habitat. https://ecos.fws.gov/ecp/species/3652	Threatened

Grizzly Bear Ursus arctos horribilis There is **proposed** critical habitat for this species. The location of the critical habitat is not available. https://ecos.fws.gov/ecp/species/7642	Threatened
North American Wolverine Gulo gulo luscus No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/5123	Proposed Threatened

Birds

NAME	STATUS
Red Knot Calidris canutus rufa No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1864	Threatened

Fishes

NAME	STATUS
Bull Trout Salvelinus confluentus There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/8212	Threatened

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
Bull Trout Salvelinus confluentus https://ecos.fws.gov/ecp/species/8212#crithab	Final

Migratory birds

Certain birds are protected under the Migratory Bird Treaty Act

[1] and the Bald and Golden Eagle Protection Act[2].

Any activity that results in the take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of migratory birds or eagles is prohibited unless authorized by the U.S. Fish and Wildlife Service

[3]. There are no provisions for allowing the take of migratory birds that are unintentionally killed or injured. Any person or organization who plans or conducts activities that may result in the take of migratory birds is responsible for complying with the appropriate regulations and implementing appropriate conservation measures, as described below.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.
3. 50 C.F.R. Sec. 10.12 and 16 U.S.C. Sec. 668(a)

Additional information can be found using the following links:

- Birds of Conservation Concern http://www.fws.gov/birds/management/managed-species/birds-of-conservation-concern.php
- Measures for avoiding and minimizing impacts to birds http://www.fws.gov/birds/management/project-assessment-tools-and-guidance/conservation-measures.php
- Nationwide conservation measures for birds http://www.fws.gov/migratorybirds/pdf/management/nationwidestandardconservationmeasures.pdf

The birds listed below are USFWS Birds of Conservation Concern that might be affected by activities in this location. The list does not contain every bird you may find in this location, nor is it guaranteed that all of the birds on the list will be found on or near this location. To get a better idea of the specific locations where certain species have been reported and their level of occurrence, please refer to resources such as the E-bird data mapping tool (year-round bird sightings by birders and the general public) and Breeding Bird Survey (relative abundance maps for breeding birds). Although it is important to try to avoid and minimize impacts to all birds, special attention should be given to the birds on the list below. To get a list of all birds potentially present in your project area, visit the E-bird Explore Data Tool.

NAME	BREEDING SEASON
Cassin's Finch Carpodacus cassinii https://ecos.fws.gov/ecp/species/9462	Breeds May 15 to Jul 15
Lesser Yellowlegs Tringa flavipes https://ecos.fws.gov/ecp/species/9679	Breeds elsewhere
Long-billed Curlew Numenius americanus https://ecos.fws.gov/ecp/species/5511	Breeds Apr 1 to Jul 31
Marbled Godwit Limosa fedoa https://ecos.fws.gov/ecp/species/9481	Breeds May 1 to Jul 31
Mountain Plover Charadrius montanus https://ecos.fws.gov/ecp/species/3638	Breeds Apr 15 to Aug 15

Olive-sided Flycatcher *Contopus cooperi* https://ecos.fws.gov/ecp/species/3914	Breeds May 20 to Aug 31
Rufous Hummingbird *selasphorus rufus* https://ecos.fws.gov/ecp/species/8002	Breeds Apr 15 to Jul 15

Probability of Presence Summary

The graphs below provide our best understanding of when birds of concern are most likely to be present in your project area. This information can be used to tailor and schedule your project activities to avoid or minimize impacts to birds.

Probability of Presence (🟩)

Each green bar represents the bird's relative probability of presence in your project's counties during a particular week of the year. (A year is represented as 12 4-week months.) A taller bar indicates a higher probability of species presence. The survey effort (see below) can be used to establish a level of confidence in the presence score. One can have higher confidence in the presence score if the corresponding survey effort is also high.

How is the probability of presence score calculated? The calculation is done in three steps:

1. The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.
2. To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.
3. The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

To see a bar's probability of presence score, simply hover your mouse cursor over the bar.

Breeding Season (🟨)
Yellow bars denote when the bird breeds in the Bird Conservation Region(s) in which your project lies. If there are no yellow bars shown for a bird, it does not breed in your project area.

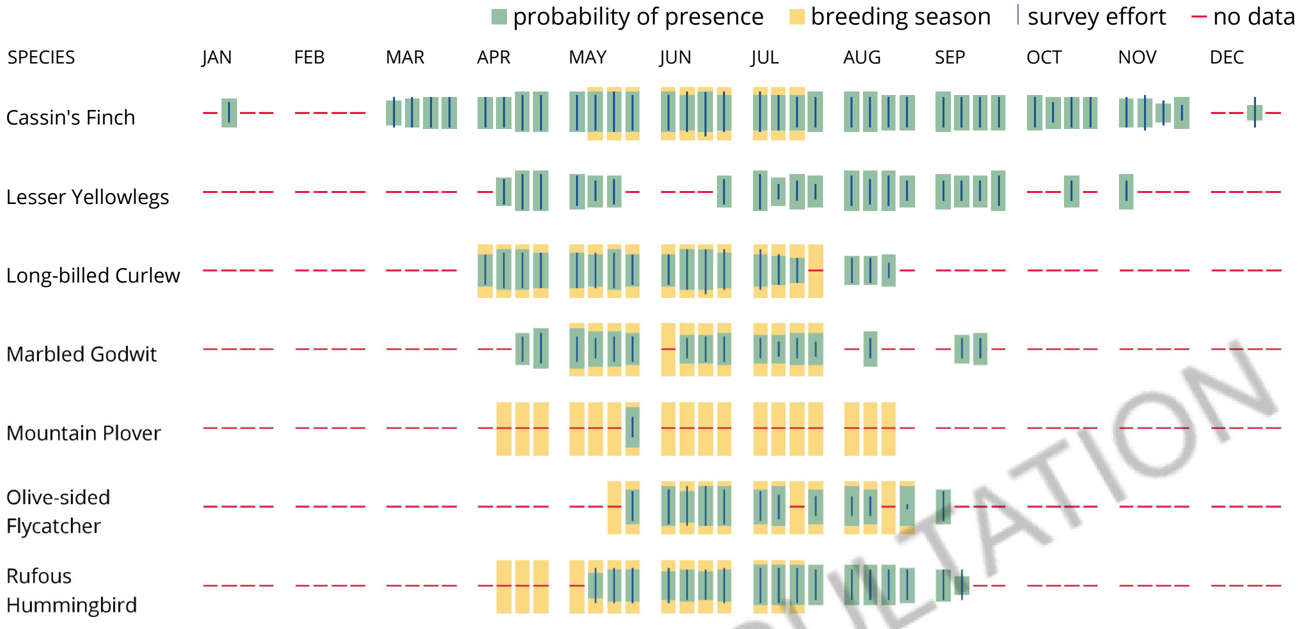
Survey Effort (|)
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the counties of your project area. The number of surveys is expressed as a range, for example, 33 to 64 surveys.

To see a bar's survey effort range, simply hover your mouse cursor over the bar.

No Data (–)
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe

Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information.



Tell me more about conservation measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Conservation Measures describes measures that can help avoid and minimize impacts to all birds at any location year round. Such measures are particularly important when birds are most likely to occur in the project area. To see when birds are most likely to occur in your project area, view the Probability of Presence Summary. Special attention should be made to look for nests and avoid nest destruction during the breeding season. The best information about when birds are breeding can be found in Birds of North America (BNA) Online under the "Breeding Phenology" section of each species profile. Note that accessing this information may require a subscription. Additional measures and/or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the migratory birds potentially occurring in my specified location?

The Migratory Bird Resource List is comprised of USFWS Birds of Conservation Concern (BCC) that might be affected by activities in your project location. These birds are of priority concern because it has been determined that without additional conservation actions, they are likely to become candidates for listing under the Endangered Species Act (ESA).

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets. The AKN list represents all birds reported to be occurring at some level throughout the year in the counties in which your project lies. That list is then narrowed to only the Birds of Conservation Concern for your project area.

Again, the Migratory Bird Resource list only includes species of particular priority concern, and is not representative of all birds that may occur in your project area. Although it is important to try to avoid and minimize impacts to all birds, special attention should be made to avoid and minimize impacts to birds of priority concern. To get a list of all birds potentially present in your project area, please visit the E-bird Explore Data Tool.

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available.

How do I know if a bird is breeding, wintering, migrating or present year-round in my project area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating or year-round), you may refer to the following resources: The The Cornell Lab of Ornithology All About Birds Bird Guide, or (if you are unsuccessful in locating the bird of interest there), the Cornell Lab of Ornithology Neotropical Birds guide. If a bird entry on your migratory bird species list indicates a breeding season, it is probable the bird breeds in your project's counties at some point within the time-frame specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

Facilities

Wildlife refuges

Any activity proposed on National Wildlife Refuge lands must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

THERE ARE NO REFUGES AT THIS LOCATION.

Fish hatcheries

THERE ARE NO FISH HATCHERIES AT THIS LOCATION.

Wetlands in the National Wetlands Inventory

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

This location overlaps the following wetlands:

The area of this project is too large for IPaC to load all NWI wetlands in the area. The list below may be incomplete. Please contact the local U.S. Fish and Wildlife Service office or visit the NWI map for a full list.

FRESHWATER EMERGENT WETLAND

- PEMA
- PEMC
- PEMAx
- PEMF
- PEMCx
- PEMAh

FRESHWATER FORESTED/SHRUB WETLAND

- PSSA
- PSSC
- PSSAx
- PSSF
- PSSAh

FRESHWATER POND

- PABFx
- PUBFx
- PABF
- PABFh
- PUSA
- PUBFh
- PABFb
- PUSCx
- PUSC
- PUBF

LAKE

- L1UBHx
- L2UBHx

RIVERINE

- R2USA
- R3USA
- R2UBH
- R4SBCx
- R4SBAx
- R3UBH
- R4SBC

A full description for each wetland code can be found at the National Wetlands Inventory website: https://ecos.fws.gov/ipac/wetlands/decoder

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Appendix B
PCE Crosswalk

Crosswalk between the Bull Trout Matrix and Bull Trout Critical Habitat Primary Constituent Elements

Prepared by:
Jeff Krupka, Karl Halupka, and Judy De La Vergne, CWFO,
March 31, 2011

The purpose of this document is to provide a consistent means for analyzing baseline conditions and project effects to both the bull trout and designated critical habitat for the bull trout using the Matrix of Pathways and Indicators.

The Matrix of Pathway Indicators (Matrix) for bull trout is used to evaluate and document baseline conditions and to aid in making effect determinations for proposed projects (USFWS 1999). The Matrix analysis incorporates 4 population indicators and 19 physical habitat indicators. Analysis of these indicators provides a systematic approach for evaluating the existing baseline condition and potential impacts in terms of metrics meaningful to bull trout.

Designated critical habitat for the bull trout (75 FR 63898) is comprised of nine primary constituent elements (PCEs). These physical, chemical, and biological features correspond to many of the Matrix habitat parameters. Table 1 shows the relationship between the PCEs for bull trout critical habitat and the Matrix habitat indicators. The *refugia* indicator is relevant to all PCEs because in order for the refugia indicator to be rated "functioning appropriately" most if not all of the PCEs must be present. Only one indicator from the population pathways, *persistence and genetic integrity*, applies to evaluation of the condition of PCEs, but this indicator is not depicted in the Crosswalk to simplify Table 1. The following information provides the rationale for how the nine PCEs for bull trout critical habitat can be addressed by using the Matrix indicators (named using italics font).

1. **Springs, seeps, groundwater sources, and subsurface water connectivity (hyporheic flows) to contribute to water quality and quantity and provide thermal refugia.**

   The analysis of *floodplain connectivity* considers the hydrologic linkage of off-channel areas with the main channel and overbank-flow maintenance of wetland function and riparian vegetation and succession. Floodplain and riparian areas provide hydrologic connectivity for springs, seeps, groundwater upwelling and wetlands and contribute to the maintenance of the water table. The *sediment* and *substrate embeddedness* indicators describe the level of fine sediment in the gravel which affects hyporheic flow. Fine sediment fills interstitial spaces making the movement of water through the substrate less efficient. The *chemical contamination/nutrients* and *temperature* indicators evaluate the water quality of groundwater. The *off-channel habitat* indicator suggests how much off-channel habitat is available, and generally off-channels are connected to adjacent channels via subsurface water. The *change in peak/base flows* indicator considers whether or not peak flow, base flow, and flow timing are comparable to an undisturbed watershed of similar size, geology, and geography. Peak flows, base flows, and flow timing are directly related to subsurface water connectivity and the degree to which soil compaction has decreased infiltration and increased surface runoff. The *drainage network increase* and *road density and location* indicators assess the influence of the road and trail networks on subsurface water connectivity. If there is an increase in drainage network and roads are located in riparian areas, it is likely that subsurface water is being intercepted before it reaches a stream. If groundwater is being intercepted then it is likely that water quality is being degraded through increased temperatures, fine sediment, and possibly chemical contamination. *Streambank condition* addresses groundwater influence through an assessment of stability. The *disturbance history* indicator evaluates disturbance across the watershed and provides a picture of how management may be affecting hydrology. The *riparian conservation areas* indicator determines whether riparian areas are intact and providing connectivity. If riparian areas are intact it is much more likely that springs, seeps, and groundwater sources are able to positively affect water quality and quantity.

2. **Migration habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats, including but not limited to permanent, partial, intermittent, or seasonal barriers.**

   The *physical barriers* indicator provides the most direct assessment of this PCE. Analysis of this indicator includes consideration of whether man-made barriers within the watershed allow upstream and downstream passage of all life stages at all flows. However, some indicators further evaluate physical impediments and others evaluate the biological or water quality impediments that may be present. The *temperature*, *sediment, substrate embeddedness*, and *chemical contamination/nutrients* indicators assess whether other barriers may be created, at least seasonally, by conditions such as high temperatures, high concentrations of sediment, or contaminants. The *average wetted width/maximum depth ratio* indicator can help identify situations in which water depth for adult passage may be a problem. A very high average wetted width/maximum depth value may indicate a situation where low flows, when adults migrate, are so spread out that water depth is insufficient to pass adults. The *change in peak/base flows* indicator can help determine if change in base flows have been sufficient to prevent adult passage during the spawning migration. The *persistence and genetic integrity* indicator addresses biological impediments by evaluating negative interactions (e.g., predation, hybridization, and competition) with other species.

3. **An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.**

   None of the indicators directly address this PCE, but a number of them address it indirectly. The *sediment* and *substrate embeddedness* indicators document the extent to which substrate interstitial spaces are filled with fine sediment. Interstitial spaces provide important habitat for aquatic macroinvertebrates, sculpin, and other substrate-oriented prey which are important food sources for bull trout. The *chemical contamination/nutrients* indicator evaluates the level to which a stream is contaminated by chemicals or has a high level of nutrients. Chemicals and nutrients greatly affect the type and diversity of aquatic invertebrate communities present in a water body. The *large woody debris* and *pool frequency and quality* indicators assess habitat complexity. High stream habitat complexity is associated with diverse and abundant macroinvertebrate and fish prey. The *off-channel habitat* and *floodplain connectivity* indicators document the presence of off-channels which are generally more productive than main channels. Off channel areas are important sources of forage, particularly for juveniles. The *streambank condition* and *riparian conservation areas* indicators both shed light on the very basis of the food base of a stream. Vegetation along streambanks and in riparian areas provide important habitat for terrestrial macroinvertebrates that can fall into the water as well as sources of nutrient inputs that support aquatic invertebrate production.

4. **Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes that establish and maintain these aquatic environments, with features such as large wood, side channels, pools, undercut banks and unembedded substrates, to provide a variety of depths, gradients, velocities, and structure.**

Several indicators address this PCE directly. The *sediment* and *substrate embeddedness* indicators provide insight into how complex substrates are within a stream by documenting percent fines and embeddedness. As percent fines and embeddedness increase, substrate complexity decreases. The *large woody debris* indicator provides an excellent picture of habitat complexity. The indicator rates the stream based on the amount of in-channel large woody debris. Habitat complexity increases as large wood increases. The *pool frequency and quality* and *large pools* indicators address habitat complexity by rating the stream based on the frequency of pools and their quality. Habitat complexity increases as the number of pools and their quality increase. The *off-channel habitat* indicator directly addresses complexity associated with side channels. The indicator is rated based on the amount of off-channel habitat, cover associated with off-channels, and flow energy levels. *Average wetted width/maximum depth ratio* is an indicator of channel shape and pool quality. Low ratios suggest deeper, higher quality pools. The *streambank condition* and *riparian conservation areas* indicators both shed light on the complexity of river and stream shorelines. Vegetation along streambanks and in riparian areas provides important habitat complexity and channel roughness. The *streambank condition* indicator also provides information about the capacity of an area to produce undercut banks, which can be a very important habitat feature for bull trout. The *floodplain connectivity* indicator addresses complexity added by side channels and the ability of floodwaters to spread across the floodplain to dissipate energy and provide access to high-flow refugia for fish. The *road density and location* indicator addresses complexity by identifying if roads are located in valley bottoms. Roads located in valley bottoms reduce complexity by eliminating vegetation and replacing complex habitats with riprap or fill, and often confine the floodplain. The *disturbance regime* indicator documents the frequency, duration, and size of environmental disturbance within the watershed. If scour events, debris torrents, or catastrophic fires are frequent, long in duration, and large, then habitat complexity will be greatly reduced.

5. **Water temperatures ranging from 2 to 15 °C (36 to 59 °F), with adequate thermal refugia available for temperatures that exceed the upper end of this range. Specific temperatures within this range will depend on bull trout life-history stage and form; geography; elevation; diurnal and seasonal variation; shading, such as that provided by riparian habitat; streamflow; and local groundwater influence.**

   The *temperature* indicator addresses this PCE directly. The indicator rates streams according to how well temperatures meet bull trout requirements. Other matrix indicators address temperature indirectly. The *off-channel habitat* and *floodplain connectivity* indicators address how well stream channels are hydrologically connected to off-channel areas. Floodplains and off-channels are important to maintaining the water table and providing connectivity to the channel for springs, seeps, and groundwater sources which contribute cool water to channels. The *average wetted width/maximum depth ratio* indicator also corresponds to temperature. Low width to depth ratios indicate that channels are narrow and deep with little surface area to absorb heat. The *streambank condition* indicator documents bank stability. If the streambanks are stabilized by vegetation rather than substrate then it is likely that the vegetation provides shade which helps prevent increases in temperature. The *change in peak/base flows* indicator evaluates flows and flow timing characteristics relative to what would be expected in an undisturbed watershed. If base flow has been reduced, it is likely that water temperature during base flow has increased since the amount of water to heat has decreased. The *road density and location* and *drainage network increase* indicators documents where roads are located. If roads are located adjacent to a stream then shade is reduced and temperature is likely increased. Roads also intercept groundwater and can reduce this cooling influence, as well as discharge typically warmer stormwater. The *disturbance history* indicator describes how much of the watershed has been altered by vegetation management and therefore indicates how much shade has been removed. The *riparian conservation areas* indicator addresses stream shade which keeps stream temperatures cool. The presence of *large pools* may provide thermal refugia when temperatures are high.

6. **In spawning and rearing areas, substrate of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. A minimal amount of fine sediment, generally ranging in size from silt to coarse sand, embedded in larger substrates, is characteristic of these conditions. The size and amounts of fine sediment suitable to bull trout will likely vary from system to system.**

   The *sediment* and *substrate embeddedness* indicators directly address this PCE. These indicators evaluate the percent fines within spawning areas and the percent embeddedness within rearing areas. The *streambank condition* and *riparian conservation areas* indicators indirectly address this PCE by documenting the presence or lack of potential fine sediment sources. If streambanks are stable and riparian conservation areas are intact then there is a low risk of introducing fine sediment from bank erosion. Also, the *floodplain connectivity* indicator indirectly addresses this PCE. If the stream channel is connected to its floodplain, then there is less risk of bank erosion during high flows because stream energy is reduced as water spreads across the floodplain. The *increase in drainage network* and *road density and location* indicators assess the effects of roads on the channel network and hydrology. If the drainage network has significantly increased as a result of human-caused disturbance or road density is high within a watershed and roads are located adjacent to streams, then it is likely that in-channel fine sediment levels will be elevated above natural levels. The *disturbance regime* indicator documents the nature of environmental disturbance within the watershed. If the disturbance regime includes frequent and unpredictable scour events, debris torrents, and catastrophic fire, then it is likely that fine sediment levels will be elevated above background levels. A consideration for all indicators directly or indirectly influencing this PCE is that it is desirable to achieve an appropriate balance of stable areas to provide undercut banks and eroding areas that are sources for recruiting new spawning gravels. Too little sediment in a stream can also be detrimental.

7. **A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal flow departure from a natural hydrograph.**

   The *change in peak/base flows* indicator addresses this PCE directly by documenting the condition of the watershed hydrograph relative to an undisturbed watershed of similar size, geology, and geography. There are several indicators that address this PCE indirectly. The *streambank condition* indicator documents bank stability. If the streambanks are stabilized by vegetation rather than substrate then it is likely that the streambank can store water during moist periods and releases that water during dry periods which contributes to water quality and quantity. The *floodplain connectivity* indicator is relevant to water storage within the floodplain which directly affects base flow. Floodplains are important to maintaining the water table and providing connectivity to the channel for springs, seeps, and groundwater sources which contribute to water quality and quantity. The *increase in drainage network* and *road density and location* indicators assess the influence of the road and trail networks on hydrology. If there is an increase in drainage network and roads are located in riparian areas, it is likely is being intercepted and quickly routed to a stream which can increase peak flow. The *disturbance history* indicator evaluates disturbance across the watershed and provides a picture of how management may be affecting hydrology; for example, it may suggest the degree to which soil compaction has decreased infiltration and increased surface runoff. The *riparian conservation areas* indicator determines whether riparian areas are intact, functioning, and providing connectivity. If riparian areas are intact it is much more likely that springs, seeps, and groundwater sources are able to positively affect water quality and quantity.

8. **Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.**

This PCE is closely related to PCE 7, with PCE 8 adding a water quality component (i.e., there is a high level of overlap in indicators that apply to both PCEs 7 and 8). The *temperature* and *chemical contamination/nutrients* indicators directly address water quality by comparing water temperatures to bull trout water temperature requirements, and documenting 303(d) designated stream reaches. Several other indicators indirectly address this PCE by evaluating the risk of fine sediment being introduced that would result in decreased water quality through increased turbidity. The *streambank condition* and *riparian conservation areas* indicators indirectly address this PCE by documenting the presence or lack of potential fine sediment sources. If streambanks are stable and riparian conservation areas are intact then there is a low risk of introducing fine sediment from bank erosion. Also, the *floodplain connectivity* indicator indirectly addresses this PCE. If the stream channel is connected to its floodplain, then there is less risk of bank erosion during high flows because stream energy is reduced as water spreads across the floodplain. *Average wetted width/maximum depth ratio* is an indication of water volume, which indirectly indicates water temperature, (i.e., low ratios indicate deeper water, which in turn indicates possible high-flow refugia). This indicator in conjunction with *change in peak/base flows* is an indicator of potential water quality and quantity deficiencies, particularly during low flow periods. The *increase in drainage network* and *road density and location* indicators assess the effects of roads on the channel network and hydrology. If the drainage network has significantly increased as a result of human-caused disturbance or road density is high within a watershed and roads are located adjacent to streams, then it is likely that suspended fine sediment levels will be elevated above natural levels. If roads are located adjacent to a stream then shade is reduced and temperature is likely increased. Roads also intercept groundwater and can reduce this cooling influence, as well as discharge typically warmer stormwater. The *disturbance regime* indicator documents the nature of environmental disturbance within the watershed. If the disturbance regime includes frequent and unpredictable scour events, debris torrents, and catastrophic fire, then it is likely that turbidity levels will be elevated above background levels.

9. **Sufficiently low levels of occurrence of nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass); interbreeding (e.g., brook trout); or competing (e.g., brown trout) species that, if present, are adequately temporally and spatially isolated from bull trout.**

The only indicator that directly addresses this PCE is the *persistence and genetic integrity* indicator. This indicator addresses the likelihood of predation, hybridization, or displacement of bull trout by competitive species. The *temperature* indicator can provide indirect insights about whether conditions are conducive to supporting “warm water” species.

Table 1. Relationship of the Matrix Indicators to the Primary Constituent Elements of Bull Trout Critical Habitat

Pathways (bold) and Indicators	**PCE 1 - Springs, Seeps, Groundwater**	**PCE 2- Migratory Corridors***	**PCE 3 - Abundant Food Base**	**PCE 4 - Complex Habitats**	**PCE 5 - Temperature**	**PCE 6 - Substrate**	**PCE - 7 Hydrograph**	**PCE 8 - Water Quality/ Quantity**	**PCE 9 - Nonnative Species***
Water Quality									
Temperature	X	X			X			X	X
Sediment	X	X	X	X		X			
Chemical Contamination/Nutrients	X	X	X					X	
Habitat Access									
Physical Barriers		X							
Habitat Elements									
Substrate Embeddedness	X	X	X	X		X			
Large Woody Debris			X	X					
Pool Frequency and Quality			X	X					
Large Pools				X	X				
Off-Channel Habitat	X		X	X	X				
Refugia	X	X	X	X	X	X	X	X	X
Channel Conditions and Dynamics									
Wetted With/Max. Depth Ratio		X		X	X			X	
Streambank Condition	X		X	X	X	X	X	X	
Floodplain Connectivity	X		X	X	X	X	X	X	
Flow/Hydrology									
Changes in Peak/Base Flows	X	X			X		X	X	
Drainage Network Increase	X				X	X	X	X	
Watershed Conditions									
Road Density and Location	X			X	X	X	X	X	
Disturbance History	X				X		X		
Riparian Conservation Areas	X		X	X	X	X	X	X	
Disturbance Regime				X		X		X	

* = PCE is also related to the population pathway, *persistence and genetic integrity* indicator

Appendix C
Matrix of Diagnostics/ Pathways and Indicators

TABLE 1. MATRIX of DIAGNOSTICS / PATHWAYS AND INDICATORS

(Remember, the values of criteria presented here are NOT absolute, they may be adjusted for local watersheds given supportive documentation. See p. 7)

DIAGNOSTIC OR PATHWAY	INDICATORS	FUNCTIONING APPROPRIATELY	FUNCTIONING AT RISK	FUNCTIONING AT UNACCEPTABLE RISK
SPECIES:				
Subpopulation Characteristics within subpopulation watersheds	Subpopulation Size	Mean total subpopulation size or local habitat capacity more than several thousand individuals. All life stages evenly represented in the subpopulation.[1]	Adults in subpopulation are less than 500 but >50.[1]	Adults in subpopulation has less than 50. [1]
	Growth and Survival	Subpopulation has the resilience to recover from short term disturbances (e.g. catastrophic events, etc) or subpopulation declines within one to two generations (5 to 10 years).[1] The subpopulation is characterized as increasing or stable. At least 10+ years of data support this estimate.[2]	When disturbed, the subpopulation will not recover to predisturbance conditions within one generation (5 years). Survival or growth rates have been reduced from those in the best habitats. The subpopulation is reduced in size, but the reduction does not represent a long-term trend. [1]. At least 10+ years of data support this characterization.[2] If less data is available and a trend can not be confirmed, a subpopulation will be considered at risk until enough data is available to accurately determine its trend.	The subpopulation is characterized as in rapid decline or is maintaining at alarmingly low numbers. Under current management, the subpopulation condition will not improve within two generations (5 to 10 years). [1] This is supported by a minimum of 5+ years of data.
	Life History Diversity and Isolation	The migratory form is present and the subpopulation exists in close proximity to other spawning and rearing groups. Migratory corridors and rearing habitat (lake or larger river) are in good to excellent condition for the species. Neighboring subpopulations are large with high likelihood of producing surplus individuals or straying adults	The migratory form is present but the subpopulation is not close to other subpopulations or habitat disruption has produced a strong correlation among subpopulations that do exist in proximity to each other. [1]	The migratory form is absent and the subpopulation is isolated to the local stream or a small watershed not likely to support more than 2,000 fish.[1]

		that will mix w[illegible]er subpopulation groups.[1]		
	Persistence and Genetic Integrity	Connectivity is high among multiple (5 or more) subpopulations with at least several thousand fish each. Each of the relevant subpopulations has a low risk of extinction.[1] The probability of hybridization or displacement by competitive species is low to nonexistent.	Connectivity among multiple subpopulations does occur, but habitats are more fragmented. Only one or two of the subpopulations represent most of the fish production.[1] The probability of hybridization or displacement by competitive species is imminent, although few documented cases have occurred.	Little or no connectivity remains for refounding subpopulations in low numbers, in decline, or nearing extinction. Only a single subpopulation or several local populations that are very small or that otherwise are at high risk remain.[1] Competitive species readily displace bull trout. The probability of hybridization is high and documented cases have occurred.
HABITAT:				
Water Quality:	Temperature	7 day average maximum temperature in a reach during the following life history stages: [1,3] incubation 2 - 5°C rearing 4 - 12 °C spawning 4 - 9°C also temperatures do not exceed 15□C in areas used by adults during migration (no thermal barriers)	7 day average maximum temperature in a reach during the following life history stages: [1,3] incubation <2°C or 6°C rearing <4°C or 13 - 15 °C spawning <4°C or 10°C also temperatures in areas used by adults during migration sometimes exceeds 15°C	7 day average maximum temperature in a reach during the following life history stages: [1,3] incubation <1°C or >6°C rearing >15 °C spawning <4 °C or > 10°C also temperatures in areas used by adults during migration regularly exceed 15°C (thermal barriers present)
	Sediment (in areas of spawning and incubation; rearing areas will be addressed under □substrate embeddedness□)	Similar to chinook salmon [1]: for example (e.g.): < 12% fines (<0.85mm) in gravel[4]; e.g. ≤20% surface fines of ≤6mm[5,6]	Similar to chinook salmon [1]: e.g. 12-17% fines (<0.85mm) in gravel[4]; e.g. 12-20% surface fines [7]	Similar to chinook salmon [1]: e.g. >17% fines (<0.85mm) in gravel[4]; e.g. >20% fines at surface or depth in spawning habitat[7]
	Chemical Contamination/ Nutrients	low levels of chemical contamination from agricultural, industrial and other sources, no excess nutrients, no CWA 303d designated reaches[8]	moderate levels of chemical contamination from agricultural, industrial and other sources, some excess nutrients, one CWA 303d designated reach[8]	high levels of chemical contamination from agricultural, industrial and other sources, high levels of excess nutrients, more than one CWA 303d designated reach[8]
Habitat Access:	Physical Barriers (address subsurface flows impeding fish passage under the pathway □flow/hydrology□)	man-made barriers present in watershed allow upstream and downstream fish passage at all flows	man-made barriers present in watershed do not allow upstream and/or downstream fish passage at base/low flows	man-made barriers present in watershed do not allow upstream and/or downstream fish passage at a range of flows

Habitat Elements:	Substrate Embeddedness in rearing areas (spawning and incubation areas were addressed under the indicator □sediment□)	reach embeddedness <20%[9, 10]	reach embeddedness 20-30% [9,10]	reach embeddedness >30%[4,10]
	Large Woody Debris	current values are being maintained at greater than 80 pieces/mile that are >24"diameter and >50 ft length on the Coast[9], or >20 pieces/ mile >12"diameter >35 ft length on the Eastside[11] ; also adequate sources of woody debris are available for both long and short-term recruitment	current levels are being maintained at minimum levels desired for □functioning appropriately□, but potential sources for long term woody debris recruitment are lacking to maintain these minimum values	current levels are not at those desired values for □functioning appropriately□, and potential sources of woody debris for short and/or long term recruitment are lacking
	Pool Frequency and Quality	pool frequency in a reach closely approximates [5]: Wetted width (ft) — #pools/mile 0-5 — 39 5-10 — 60 10-15 — 48 15-20 — 39 20-30 — 23 30-35 — 18 35-40 — 10 40-65 — 9 65-100 — 4 (can use formula: pools/mi = $\frac{5,280/\text{wetted channel width}}{\#\text{channel widths per pool}}$); also, pools have good cover and cool water[4], and only minor reduction of pool volume by fine sediment	pool frequency is similar to values in □functioning appropriately□, but pools have inadequate cover/temperature[4], and/or there has been a moderate reduction of pool volume by fine sediment	pool frequency is considerably lower than values desired for □functioning appropriately□; also cover/temperature is inadequate[4], and there has been a major reduction of pool volume by fine sediment
	Large Pools (in adult holding, juvenile rearing, and overwintering reaches where streams are >3m in wetted width at baseflow)	each reach has many large pools >1 meter deep[4]	reaches have few large pools (>1 meter) present[4]	reaches have no deep pools (>1 meter)[4]
	Off-channel Habitat (see reference 18 for identification of these characteristics)	watershed has many ponds, oxbows, backwaters, and other off-channel areas with cover; and side-channels are low energy areas[4]	watershed has some ponds, oxbows, backwaters, and other off-channel areas with cover; but side-channels are generally high energy areas[4]	watershed has few or no ponds, oxbows, backwaters, or other off-channel areas[4]

	Refugia (see Checklist footnotes for definition of this indicator)	habitats capable of supporting strong and significant populations are protected and are well distributed and connected for all life stages and forms of the species [12, 13]	habitats capable of supporting strong and significant populations are insufficient in size, number and connectivity to maintain all life stages and forms of the species[12, 13]	adequate habitat refugia do n[illegible]t[12]
Channel Condition & Dynamics:	Average Wetted Width/ Maximum Depth Ratio in scour pools in a reach	≤10[7, 5]	11 - 20[5]	>20[5]
	Streambank Condition	>80% of any stream reach has ≥90% stability[5]	50 - 80% of any stream reach has ≥90% stability[5]	<50% of any stream reach has ≥90% stability[5]
	Floodplain Connectivity	off-channel areas are frequently hydrologically linked to main channel; overbank flows occur and maintain wetland functions, riparian vegetation and succession	reduced linkage of wetland, floodplains and riparian areas to main channel; overbank flows are reduced relative to historic frequency, as evidenced by moderate degradation of wetland function, riparian vegetation/succession	severe reduction in hydrologic connectivity between off-channel, wetland, floodplain and riparian areas; wetland extent drastically reduced and riparian vegetation/succession altered significantly
Flow/Hydrology:	Change in Peak/ Base Flows	watershed hydrograph indicates peak flow, base flow and flow timing characteristics comparable to an undisturbed watershed of similar size, geology and geography	some evidence of altered peak flow, baseflow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography	pronounced changes in peak flow, baseflow and/or flow timing relative to an undisturbed watershed of similar size, geology and geography
	Increase in Drainage Network	zero or minimum increases in active channel length correlated with human caused disturbance	low to moderate increase in active channel length correlated with human caused disturbance	greater than moderate increase in active channel length correlated with human caused disturbance
Watershed Conditions:	Road Density & Location	<1mi/mi [13]; no valley bottom roads	1 - 2.4 mi/mi [13]; some valley bottom roads	>2.4 mi/mi [13]; many valley bottom roads
	Disturbance History	<15% ECA of entire watershed with no concentration of disturbance in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area there is an additional criteria of 15% LSOG in watersheds[14]	<15% ECA of entire watershed but disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; and for NWFP area there is an additional criteria of 15% LSOG in watersheds[14]	>15% ECA of entire watershed and disturbance concentrated in unstable or potentially unstable areas, and/or refugia, and/or riparian area; does not meet NWFP standard for LSOG
	Riparian Conservation Areas	the riparian conservation areas provide adequate shade, large woody debris	moderate loss of connectivity or function (shade, LWD recruitment,	riparian conservation areas are fragmented, poorly connected, or

(RHCA - PACFISH and INFISH) (Riparian Reserves - Northwest Forest Plan)	recruitment, and habitat protection and connectivity in subwatersheds, and buffers or includes known refugia for sensitive aquatic species (>80% intact), and adequately buffer impacts on rangelands: percent similarity of riparian vegetation to the potential natural community/ composition >50%[15]	etc.) of riparian conservation areas, or incomplete protection of habitats and refugia for sensitive aquatic species (70-80% intact), and adequately buffer impacts on rangelands : percent similarity of riparian vegetation to the potential natural community/composition 25-50% or better[15]	provides inadequate protection of habitats for sensitive aquatic species (<70% intact, refugia does not occur), and adequately buffer impacts on rangelands : percent similarity of riparian vegetation to the potential natural community/composition <25%[15]
Disturbance Regime	Environmental disturbance is short lived; predictable hydrograph, high quality habitat and watershed complexity providing refuge and rearing space for all life stages or multiple life-history forms. [1] Natural processes are stable.	Scour events, debris torrents, or catastrophic fire are localized events that occur in several minor parts of the watershed. Resiliency of habitat to recover from environmental disturbances is moderate.	Frequent flood or drought producing highly variable and unpredictable flows, scour events, debris torrents, or high probability of catastrophic fire exists throughout a major part of the watershed. The channel is simplified, providing little hydraulic complexity in the form of pools or side channels. [1] Natural processes are unstable.

SPECIES AND HABITAT:			
Integration of Species and Habitat Conditions	Habitat quality and connectivity among subpopulations is high. The migratory form is present. Disturbance has not altered channel equilibrium. Fine sediments and other habitat characteristics influencing survival or growth are consistent with pristine habitat. The subpopulation has the resilience to recover from short-term disturbance within one to two generations (5 to 10 years). The subpopulation is fluctuating around an equilibrium or is growing.[1]	Fine sediments, stream temperatures, or the availability of suitable habitats have been altered and will not recover to predisturbance conditions within one generation (5 years). Survival or growth rates have been reduced from those in the best habitats. The subpopulation is reduced in size, but the reduction does not represent a long-term trend. The subpopulation is stable or fluctuating in a downward trend. Connectivity among subpopulations occurs but habitats are more fragmented.[1]	Cumulative disruption of habitat has resulted in a clear declining trend in the subpopulation size. Under current management, habitat conditions will not improve within two generations (5 to 10 years). Little or no connectivity remains among subpopulations. The subpopulation survival and recruitment responds sharply to normal environmental events. [1]

[1] Rieman, B.E. and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. U.S.D.A. Forest Service, Intermountain Research Station, Boise, ID.

[2] Rieman, B.E. and D.L. Meyers. 1997. Use of redd counts to detect trends in bull trout (*Salvelinus confluentus)* populations. Conservation Biology 11(4): 1015-1018.

[3] Buchanan, D.V. and S.V. Gregory. 1997. Development of water temperature standards to protect and restore habitat for bull trout and other cold water species in Oregon. *In* W.C. Mackay, M.K. Brewin, and M. Monita, eds. Friends of the Bull Trout Conference Proceedings. P8.

[4] Washington Timber/Fish Wildlife Cooperative Monitoring Evaluation and Research Committee, 1993. Watershed Analysis Manual (Version 2.0). Washington Department of Natural Resources.

[5] Overton, C.K., J.D. McIntyre, R. Armstrong, S.L. Whitewell, and K.A. Duncan. 1995. User□s guide to fish habitat: descriptions that represent natural conditions in the Salmon River Basin, Idaho. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Rep. INT-GTR-322.

[6] Overton, C.K., S.P. Wollrab, B.C. Roberts, and M.A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Gen Tech. Rep. INT-GTR-346.

[7] Biological Opinion on Land and Resource Management Plans for the: Boise, Challis, Nez Perce, Payette, Salmon, Sawtooth, Umatilla, and Wallowa-Whitman National Forests. March 1, 1995.

[8] A Federal Agency Guide for Pilot Watershed Analysis (Version 1.2), 1994.

[9] Biological Opinion on Implementation of Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and Portions of California (PACFISH). National Marine Fisheries Service, Northwest Region, January 23, 1995.

[10] Shepard, B.B., K.L. Pratt, and P.J. Graham. 1984. Life histories of westslope cutthroat and bull trout in the Upper Flathead River Basin, MT. Environmental Protection Agency Rep. Contract No. R008224-01-5.

[11] Interior Columbia Basin Ecosystem Management Project Draft Environmental Impact Statement and Appendices.

[12] Frissell, C.A., Liss, W.J., and David Bayles, 1993. An Integrated Biophysical Strategy for Ecological Restoration of Large Watersheds. Proceedings from the Symposium on Changing Roles in Water Resources Management and Policy, June 27-30, 1993 (American Water Resources Association), p. 449-456.

[13] Lee, D.C., J.R. Sedell, B.E. Rieman, R.F. Thurow, J.E. Williams and others. 1997. Chapter 4: Broadscale Assessment of Aquatic Species and Habitats. *In* T.M. Quigley and S. J. Arbelbide eds □An Assessment of Ecosystem Components in the Interior Columbia Basin and Portions of the Klamath and Great Basins Volume III□. U.S. Department of Agriculture, Forest Service, and U.S. Department of Interior, Bureau of Land Management, Gen Tech Rep PNW-GTR-405.

[14] Northwest Forest Plan, 1994. Standards and Guidelines for Management of Habitat for Late-Successional and Old-Growth Forest Related Species Within the Range of the Northern Spotted Owl. USDA Forest Service and USDI Bureau of Land Management.

[16] Winward, A.H., 1989 Ecological Status of Vegetation as a base for Multiple Product Management. Abstracts 42nd annual meeting, Society for Range Management, Billings MT, Denver CO: Society For Range Management: p277.