

Review of Use Attainability Analysis for Bucktail Creek



**State of Idaho
Department of Environmental Quality**



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Acknowledgments

Photo from atop Bucktail Creek watershed, India Southern.

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Acronyms, Abbreviations, and Symbols

µg	microgram
AERA	aquatic ecological risk assessment
BLM	biotic ligand model
CCC	criterion continuous concentration
CMC	criterion maximum concentration
COPEC	chemicals of potential ecological concern
CWA	Clean Water Act
DEQ	Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
HQ	hazard quotient
L	liter
LC	lethal concentration
mg	milligram
MTI	metals tolerance index
NPL	National Priority List
SFI	stream fish index
SHI	stream habitat index
SMI	stream macroinvertebrate index
UAA	use attainability analysis

Executive Summary

In 2002, the Idaho Department of Environmental Quality (DEQ) evaluated aquatic life and contact recreation designated beneficial uses for Bucktail Creek resulting in the *Use Attainability Analysis, Bucktail Creek, Lemhi County Idaho* (DEQ 2002). The use attainability analysis (UAA) concluded that two of six factors specified in 40 CFR 131.10(g) justified removing beneficial uses in Bucktail Creek: (1) sources of metals pollution in Bucktail Creek are human caused and cannot be remedied to meet the criteria in the future and (2) natural low flow conditions prevent the attainment of uses.

In this UAA, DEQ examined designated beneficial uses and determined aquatic life was not existing or attainable as a designated use based on copper and cobalt concentrations that were many times greater than the acute and chronic water quality criteria. The 2002 UAA removed the contact recreation use designation based on natural low flow conditions in Bucktail Creek that preclude recreation, and this condition has not changed. The original rationale based on copper and cobalt concentrations to support removing aquatic life and flow to support removing contact recreation use designations in Bucktail Creek is still valid, but improvements have been made. Total and dissolved copper and cobalt concentrations in Bucktail Creek decreased from 2003 to 2022 due to extensive remediation work within the drainage. Copper and cobalt concentrations in Bucktail Creek were measurably reduced in downstream waters in South Fork Big Deer Creek. However, pollutant concentrations (specifically copper) are still above criteria due to human-caused conditions and have not been remedied to a point where the water body meets water quality standards.

Future increase in the presence of fish and improvements in macroinvertebrates populations is limited for aquatic life or contact recreation use designation in Bucktail Creek because flow in Bucktail Creek is limited. The flow of Bucktail Creek is a natural condition and remains unchanged; consequently, no change is recommended in the use designation of *none* for contact recreation.

1 Introduction

In March 2002, the Idaho Department of Environmental Quality (DEQ) recommended removing aquatic life and contact recreation beneficial uses for Bucktail Creek as designated uses based on the conclusions of the *Use Attainability Analysis, Bucktail Creek, Lemhi County Idaho* (DEQ 2002). The use attainability analysis (UAA) concluded that two of six factors specified in 40 CFR 131.10(g) justified removing beneficial uses in Bucktail Creek, and “the sources of metals pollution in Bucktail Creek are principally human caused and cannot be remedied to the point of meeting criteria in the foreseeable future and that natural low flow conditions prevent the attainment of uses” (DEQ 2002). The United States Environmental Protection Agency (EPA) approved removing the designated uses in September 2002 (EPA 2002). Since the removal of beneficial uses, substantial remediation work has occurred along with water quality and biological monitoring in Bucktail and South Fork Big Deer Creeks. This review evaluates the data collected to determine if human-caused metals pollution in Bucktail Creek is still prohibiting the attainment of aquatic life and if flow is still a limiting factor in the attainment of any contact recreation beneficial use.

Background

In 1972, the US Congress passed the Federal Water Pollution Control Act, or Clean Water Act (CWA). The CWA was passed to “restore and maintain the chemical, physical and biological integrity of the Nation’s waters.” The CWA included the goals of protecting and managing the nation’s water for “fishable and swimmable” conditions. These goals focused the range of monitoring and managing the nation’s waters from simple chemical analysis of water samples to a more holistic approach of evaluating the aquatic life and human use of the water.

Beneficial uses are designated for water bodies to define the expectation of the use of that water body. When the designated beneficial uses are inappropriate, the method for changing those uses (by removing or adding uses) is the UAA. The legal basis for UAAs comes from the CWA §101(a)(2), stating “It is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water” Idaho Code § 39-3604 and § 39-3607 and IDAPA 58.01.02.050.02(a) state “Wherever attainable, surface waters of the state shall be protected for beneficial uses which for surface waters includes all recreational use in and on the water surface and the preservation and propagation of desirable species of aquatic life.”

A UAA is a structured, scientific assessment of the attainability of a designated use, as described in 40 CFR 131.3(g). The assessment is a process required by federal regulation that allows states to change or remove designated uses that are not existing uses, or to establish subcategories of uses, if the state demonstrates that attaining the designated use is not feasible for any of the following reasons:

1. Naturally occurring pollutant concentrations prevent the attainment of the use.
2. Natural, ephemeral, intermittent, or low-flow conditions or water levels prevent the attainment of the use, unless these conditions may be compensated for by the discharge of sufficient volume of effluent discharges without violating state water conservation requirements to enable uses to be met.
3. Human-caused conditions or sources of pollution prevent the attainment of the use and cannot be remedied or would cause more environmental damage to correct than to leave in place.
4. Dams, diversions, or other types of hydrologic modifications preclude the attainment of the use, and it is not feasible to restore the water body to its original condition or to operate such modification in a way that would result in the attainment of the use.
5. Physical conditions related to the natural features of the water body, such as the lack of a proper substrate cover, flow depth, pools, riffles, and the like, unrelated to water quality preclude attainment of aquatic life protection uses.
6. Controls more stringent than those required by the CWA § 301(b) and § 306 would result in substantial and widespread economic and social impact.

A UAA is required to change the designated uses on a particular water body if the state wants to apply use classifications that do not address the aquatic life and recreation goals of the CWA. In Idaho, aquatic life beneficial uses typically require applying criteria that protect fish and aquatic macroinvertebrate species.

If the designated uses are not attainable, a cause must be determined to address why they are not attainable. As listed above, 40 CFR 131.10(g) specifies six acceptable causes for changing designated uses. The Bucktail Creek UAA removed contact recreation and aquatic life beneficial uses for the creek because it was determined that (1) natural, ephemeral, intermittent, or low flow conditions or water levels prevented use attainment, unless these conditions could be compensated for by discharging a sufficient volume of effluent without violating state water conservation requirements to enable uses to be met and (2) human-caused conditions or sources of pollution prevented use attainment and could not be remedied or would cause more environmental damage to correct than to leave in place (DEQ 2002).

Federal regulations state “Any water body segment with water quality standards that do not include the uses specified in section 101(a)(2) of the Act shall be re-examined every three years to determine if any new information has become available. If such new information indicates that the uses specified in section 101(a)(2) of the Act are attainable, the State shall revise its standards accordingly.” The CWA § 101(a)(2) uses are often referred to as “fishable and swimmable” uses and address the aquatic life and recreational uses of a water body. Removing contact recreation and aquatic life from the designated uses for Bucktail Creek results in water quality standards for this water body that do not include the uses specified in the CWA § 101(a)(2), so the water body must be reexamined every 3 years.

2 Watershed Description and History

Bucktail Creek is a small, 1st-order stream draining the north side of the Blackbird Mine, in Lemhi County, Idaho (Figure 1). An open pit mine and numerous waste rock piles are located at the creek's headwaters. Bucktail Creek drops precipitously from its emergence as springs at about 7,200 feet to its confluence with South Fork Big Deer Creek at about 4,000 feet in elevation. The stream drains north from the open pit for about 1.8 miles before joining South Fork Big Deer Creek (Figure 2). South Fork Big Deer Creek joins Big Deer Creek about one-half-mile downstream of this confluence.

The Blackbird cobalt and copper mine is located on one of the largest cobalt deposits in North America. The primary sulfide ores are a cobalt-arsenic sulfide called cobaltite (CoAsS), chalcopyrite (CuFeS_2), pyrite (FeS_2), and pyrrhotite (FeS). Mining began in the late 1890s and continued intermittently until 1982. The mine has approximately 14 miles of underground workings (12 levels with 8 portals), a 12-acre open pit, and roughly 85 acres of exposed metals-contaminated mine waste (EPA 2003). Open pit mining began around 1954, resulting in contaminated mine drainage transported to Panther Creek via Bucktail and Big Deer Creeks.

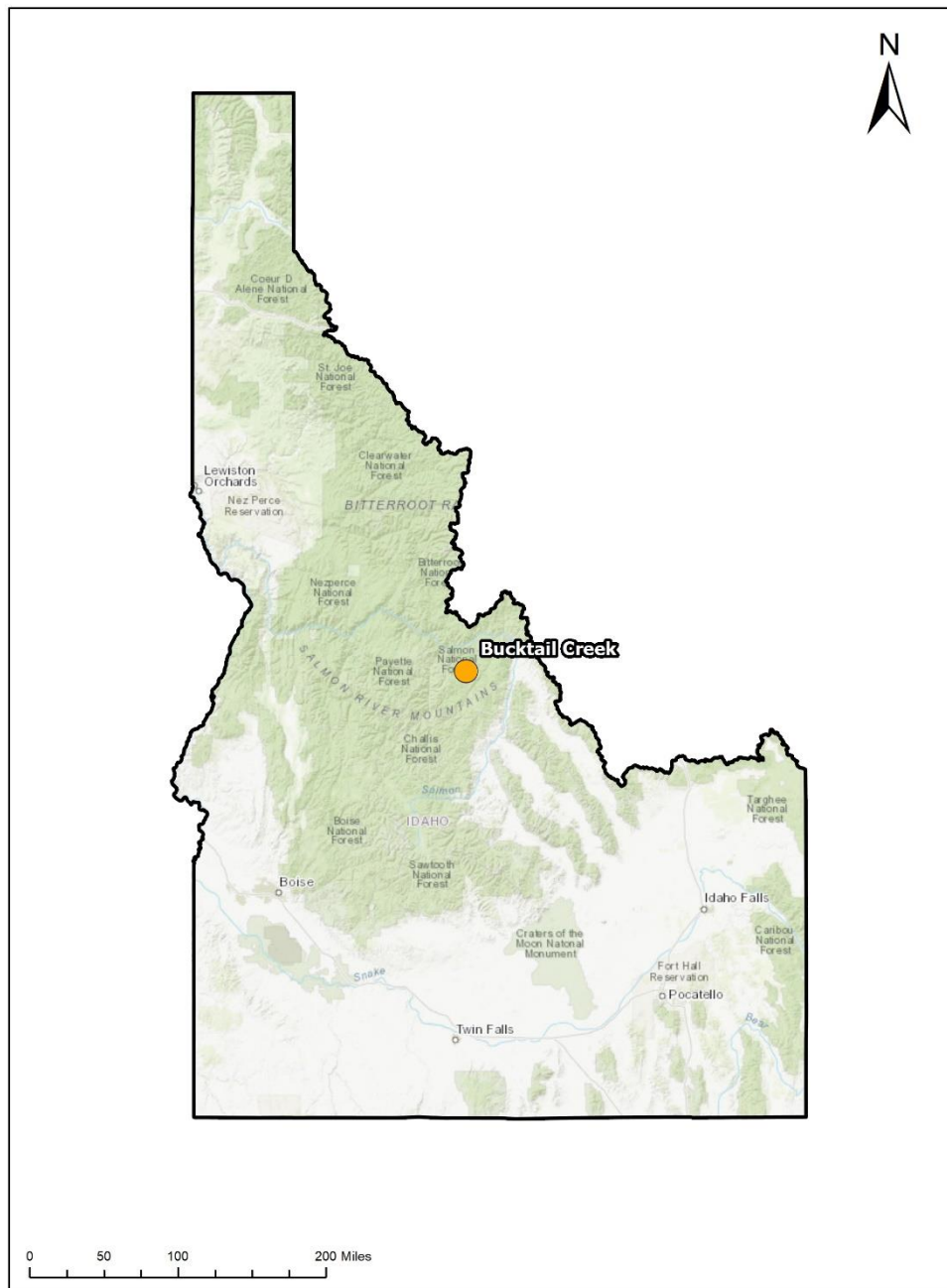


Figure 1. Location of Bucktail Creek within Idaho.

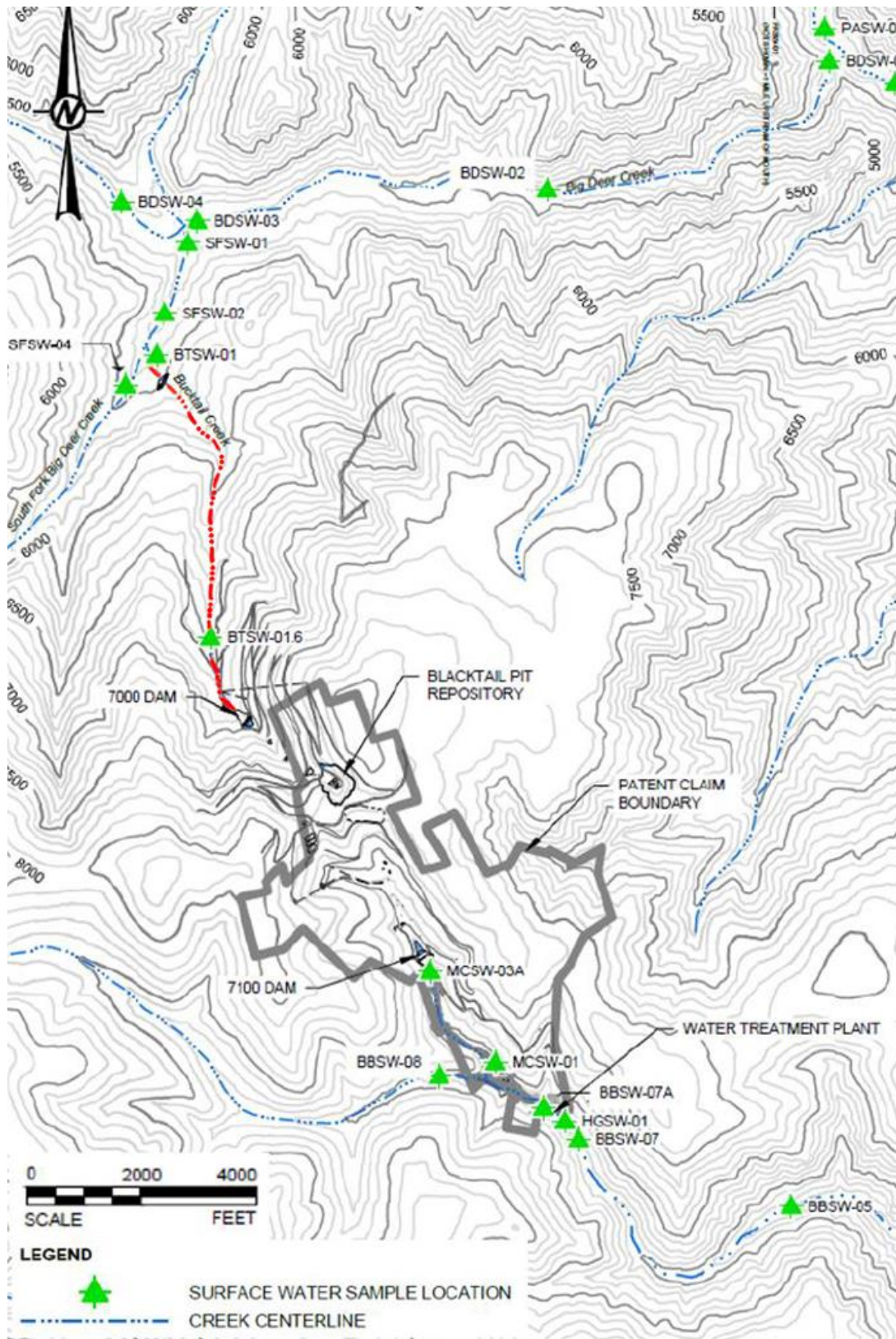


Figure 2. Blackbird Mine site overview, with sample locations. Bucktail Creek in red (Golder Associates 2021).

2.1 History

Environmental investigations into the cause and effects of mining on Panther Creek began as early as 1967 with detailed analyses conducted from 1979 to 1981 as part of an environmental impact statement conducted before a planned reopening of the Blackbird Mine. In 1983, the State of Idaho filed suit against current and former owners and operators of the mine site to recover damages for injuries to natural resources. In 1985, a restoration investigation for Panther Creek was funded by the Bonneville Power Administration (Reiser 1986). Ten years later, the EPA, National Oceanic and Atmospheric Administration, and United States Forest Service joined the suit, which was resolved in 1995. In lieu of paying damages to the natural resource trustee agencies to restore the site, the responsible parties agreed to restore water quality and biota in Panther Creek below the confluence of Blackbird Creek to levels capable of supporting all life stages of anadromous and resident salmonids, and to restore water quality and aquatic biota in Big Deer Creek to levels capable of supporting all life stages of resident salmonids.

Blackbird, Bucktail, and South Fork Big Deer Creeks were omitted from the restoration requirements due to consensus reached during settlement negotiations that their full restoration (i.e., meet water quality standards) was probably infeasible. A “Biological Restoration and Compensation Program” for additional habitat improvements in and beyond the Panther Creek basin and Chinook Salmon restocking was agreed on to mitigate the loss of salmon and salmon habitat over the years from the mine’s pollution. Bucktail Creek had been evaluated as a discharge pathway to impaired downstream waters, but no specific restoration or compensation was included for the creek based on its own biological resources.

Likewise, no specific restoration or compensation measures were included for Blackbird Creek because those measures were based on biological injury to anadromous fish and Blackbird Creek likely only historically supported resident fish. EPA has overseen cleanup actions and site investigations since 1993, and the investigations are ongoing. EPA proposed placing the site on the National Priorities List (NPL) in May 1993, but the action has not been finalized on the NPL (EPA 2023).

In 1995, engineering design and construction of early action measures (i.e., actions implemented before EPA’s selection of a final remedy) to improve water quality in Panther and Big Deer Creeks began. Construction of most major features was completed by fall 1998. The early action phase was followed by 3 years of monitoring the attenuation and stabilization of areas disturbed by the remedial construction, and further evaluations and iterative cleanups of remaining sources of contamination. Water quality is expected to be fully restored in Big Deer and Panther Creeks. About \$110 million has been spent by responsible parties since 1995 implementing early actions to reduce risk to the environment, through remedial investigation/feasibility studies and biological actions.

Initial response actions at Panther and Big Deer Creeks were conducted under EPA’s removal authority and included both time-critical removals and nontime-critical removals. EPA proposed placing the site on the NPL in May 1993, but the action has not been finalized on the NPL.

In 2003, CH2M Hill performed an aquatic ecological risk assessment (AERA) as part of a comprehensive study of the Blackbird Mine Superfund Site Record of Decision, which included an assessment of Bucktail and South Fork Big Deer Creeks. The AERA evaluated the effects of copper, cobalt, iron, and arsenic on Blackbird, Bucktail, Big Deer, and Panther Creeks. The results and conclusion for Bucktail and South Fork Big Deer Creek are summarized below.

The AERA identifies chemicals of potential ecological concern (COPECs), develops conceptual site models, details the exposure of benthic macroinvertebrates and fish to the COPECs, identifies the interactions of the COPECs with the aquatic ecosystem, and provides results that estimate the risks to the aquatic environment. One outcome of the AERA was identifying ecological goals for remediation activities at the mine site for Blackbird Creek (CH2M Hill 2001). The remedial goal for Bucktail Creek was to improve water and sediment quality so that cleanup levels were not exceeded downstream in South Fork Big Deer Creek or in Big Deer Creek.

In the AERA, the potential risks to ecological receptors were predicted with a hazard quotient (HQ). An HQ in excess of 1 indicates a potential for adverse effects to the receptor as a result of exposure, whereas an HQ below 1 indicates little potential for adverse effects. The AERA found that Bucktail Creek had very poor water quality. The HQs for surface water were the highest along this creek and exceeded 2,000 for copper. Samples for South Fork Big Deer Creek indicated the potential for adverse effects due to mine wastes. Surface water HQs were lower in 2000 than 1999; this may reflect continued improvements as a result of implementing early actions. Surface water HQs for copper ranged from 4 to 66 during high flow and up to 13 during low flow. Surface water cobalt HQs protective of aquatic life ranged from 2 to 9 during high flow and from 2 to 4 during low flow. Surface water cobalt HQs for the protection of salmonids were 2 in 2000. Sediment HQs ranged from less than 1 to 203. Arsenic concentrations were 5 times higher than background conditions, and copper concentrations were 10 times higher than background conditions. The benthic community along South Fork Big Deer Creek continued to be impacted, with most of the indices evaluated at the downstream monitoring locations not resembling those at the reference monitoring location.

In the 2002 UAA, DEQ recommended removing aquatic life and contact recreation beneficial uses for Bucktail Creek because (a) the sources of metals pollution were principally human-caused and could not be remedied to the point of meeting criteria in the foreseeable future and (b) flow was a naturally limiting factor.

2.2 Monitoring Locations

Water quality and biological monitoring has been ongoing in the Bucktail and South Fork Big Deer Creek watersheds. The surface water monitoring locations are provided in Table 1.

Table 1. Bucktail Creek surface water monitoring locations.

Monitoring Location	Stream Name and Description	Coordinates		Data Available
BTSW-01	Bucktail Creek—Upstream of South Fork Big Deer Creek	45° 09' 31.37" N	114° 22' 15.76" W	Chemistry, flow
BTSW-1.6	Bucktail Creek—Downstream of upper Bucktail Creek, Remedial Action System	45° 08' 32.57" N	114° 21' 59.50" W	Chemistry, flow
SFB-0.1	South Fork Big Deer Creek—Downstream Bucktail Creek, about 0.1 miles from Big Deer Creek	45° 09' 53.7" N	114° 22' 05.1" W	Biology, habitat
SFB-0.6	South Fork Big Deer Creek—Upstream Bucktail Creek, about 0.6 miles from Big Deer Creek	45° 09' 26.7" N	114° 22' 20.6" W	Biology, habitat
SFSW-01	South Fork Big Deer Creek—Downstream of Bucktail Creek confluence	45° 09' 54.79" N	114° 22' 06.71" W	Chemistry
SFSW-02	South Fork Big Deer Creek—Downstream of Bucktail Creek confluence	45° 09' 40.18" N	114° 22' 13.49" W	Chemistry
SFSW-04	South Fork Big Deer Creek—Upstream of Bucktail Creek confluence	45° 09' 24.99" N	114° 22' 24.88" W	Chemistry

3 Restoration Progress

The Blackbird Mine site restoration began in the early 1990s with work specifically aimed at Bucktail Creek (EPA 2003). Initial response actions at the site were conducted under EPA's removal authority and included both time-critical removals and nontime-critical removals. Downstream water quality restoration commenced in 1995 with sediment basin construction. Since the initial work in 1995, intensive remediation has occurred, resulting in dramatic declines in both total and dissolved copper and cobalt. Table 2 highlights remediation work in the watershed.

Based on the following total and dissolved copper and cobalt data, pollutant concentrations (specifically copper) are still above criteria due to human-caused conditions and have not been remedied to a point where the water body meets water quality standards.

Table 2. Remedial actions taken at Blackbird Mine site.

Year	Restoration Progress
1995 (Early action, Phase 1)	• Construction of upper and lower sediment basins to retain sediments generated during early actions. • Partial removal of debris flow material within and along Bucktail Creek between upper and lower sediment basins and relocation to the Blacktail Pit (former open pit mine area). • Blacktail Pit was converted into a repository with underdrains connected to underground mine workings.
1997–1998 (Early action, Phase3)	• Construction of 7000 dam and 6930 adit to collect and convey contact water through the underground mine workings to the water treatment system. • Construction of upper pump station for seepage collected downstream of the 7000 dam. • Construction of clean water diversion and contact water collection ditches and piping systems, debris traps, and sediment control systems. • Relocation of West Lobe waste rock and other waste rock to the Blacktail Pit that would not be within the 7000-dam capture system.
2002–2003 (Remedial action, Bucktail Phase 1)	• Construction of East Fork Bucktail Creek cutoff wall located between the toe of the 7000 dam and upper pump station. • Collection and conveyance of seep BTSP-01 to the upper pump station. • Modifications to upper pump station and piping to accommodate the additional flow.
2004–2007 (Remedial action, Bucktail Phase 2)	• Removal of upper sediment basin to accommodate groundwater and seepage collection. • Construction of the lower pump station and associated piping systems. • Construction of collection systems for three additional groundwater seepage areas. • Installation and connection of three groundwater pumping wells to the lower pump station. • Modification of upper pump station and piping for transfer of additional flow to the 6930 adit.
2010	• Removal and reclamation of the lower sediment basin located at mouth of Bucktail Creek.

4 Surface Water Chemistry

The Bucktail Creek UAA focused on copper as a single pollutant because cobalt had no national or state numeric standard. Mebane (1994) showed that copper and cobalt covary in the drainage. At the time of the original UAA, it was unknown at what concentration cobalt would be excessive enough to be considered a deleterious substance (DEQ 2002). Both copper and cobalt data have been collected in Bucktail Creek by Goulder Associates from 2003 through 2021, and WSP in 2022 (Goulder and Associates 2004-2021; WSP 2022).

Copper concentrations in Bucktail Creek typically peak during high-flow regimes, whereas cobalt concentrations tend to peak during low-flow periods. Implementing remedial actions at the Blackbird Mine site has significantly reduced both copper and cobalt concentrations within the Bucktail Creek drainage, although copper concentrations remain approximately an order of magnitude above the standard for support of aquatic life. Aquatic life water quality criteria are typically presented as chronic criteria (criterion continuous concentration [CCC]) or acute criteria (criterion maximum concentration [CMC]). A chronic criterion (CCC) is defined as the 4-day average concentration of a toxic substance or effluent. This criterion ensures adequate protection of sensitive species of aquatic organisms from chronic toxicity due to exposure to the toxic substance or effluent. Chronic criteria are expected to adequately protect the designated aquatic life use if not exceeded more than once every 3 years. An acute criterion (CMC) is defined as the maximum instantaneous or 1-hour average concentration of a toxic substance or effluent. This criterion ensures adequate protection of sensitive species of aquatic organisms from acute toxicity due to exposure to the toxic substance or effluent. As with chronic criteria, acute criteria are expected to adequately protect the designated aquatic life use if the frequency of exceedance is not more than once every 3 years.

In 2019, Idaho's copper aquatic life criteria were updated to the copper biotic ligand model (copper BLM). Before the update, Idaho's copper aquatic life criteria were calculated using a hardness-dependent equation. Goulder Associates have sampled copper BLM parameters in South Fork Big Deer Creek at SFSW-01 and SFSW-02 since 2019. Data from 2019-2022 were used as inputs to the copper BLM, of which the minimum CMC and CCC values were chosen (See Appendix J for data used in the copper BLM, from Goulder Associates 2019-2022). The resulting criteria are 3.66 µg/L (0.0036 mg/L) for CMC, and 2.28 µg/L (0.00228 mg/L) for CCC.

Idaho, nor EPA, have water quality standards for cobalt. However, in the record of decision, 0.038 mg/L was established as the site clean-up goal for cobalt (EPA 2003). This value was formulated using a weight of evidence approach to select an appropriate toxicity reference value (TRY). Available literature data, site-specific testing data, and screening criteria were all considered. The goal of the TRY selection process was to establish a cobalt TRY protective of individual threatened or endangered salmonids, and to be protective of populations of all other aquatic life (EPA 2003). This review will use that value as a benchmark to evaluate the ability of the stream to achieve support status of aquatic life beneficial uses.

Water chemistry data for the watershed are presented in Appendix A.

4.1 Copper

Dissolved copper has varied over time, and concentrations have generally decreased in Bucktail and South Fork Big Deer Creeks. Dissolved copper concentrations have varied annually in response to remediation activity and flow regimes. At BSW-01, dissolved copper ranged from a minimum average concentration of 0.038 mg/L (2022) to a maximum average concentration of 0.322 mg/L (2003). At BSW-01.6, concentrations ranged from a minimum average concentration of 0.060 mg/L (2012) to a maximum average concentration of 3.06 mg/L (2003).

While dissolved copper has been reduced in Bucktail Creek, concentrations of dissolved copper remain high. Dissolved copper concentrations exceeded the CMC criterion 100% of the time from 2003 to 2022 at both Bucktail Creek locations (BTSW-0.1 and BTSW-01.6). Figure 5 illustrates copper concentrations in Bucktail Creek at the Log_{10} scale for a visually easier comparison to the CMC criterion.

Appendix B compares the dissolved copper data to the BLM CMC copper criterion from 2003 to 2022. In Figure 3 and **Error! Reference source not found.**, the 2003 to 2022 copper concentrations are compared in Bucktail Creek (BTSW-01 and BTSW-01.6) to the copper criterion. The data show that while concentrations decreased over time, they have not yet met the copper criteria.

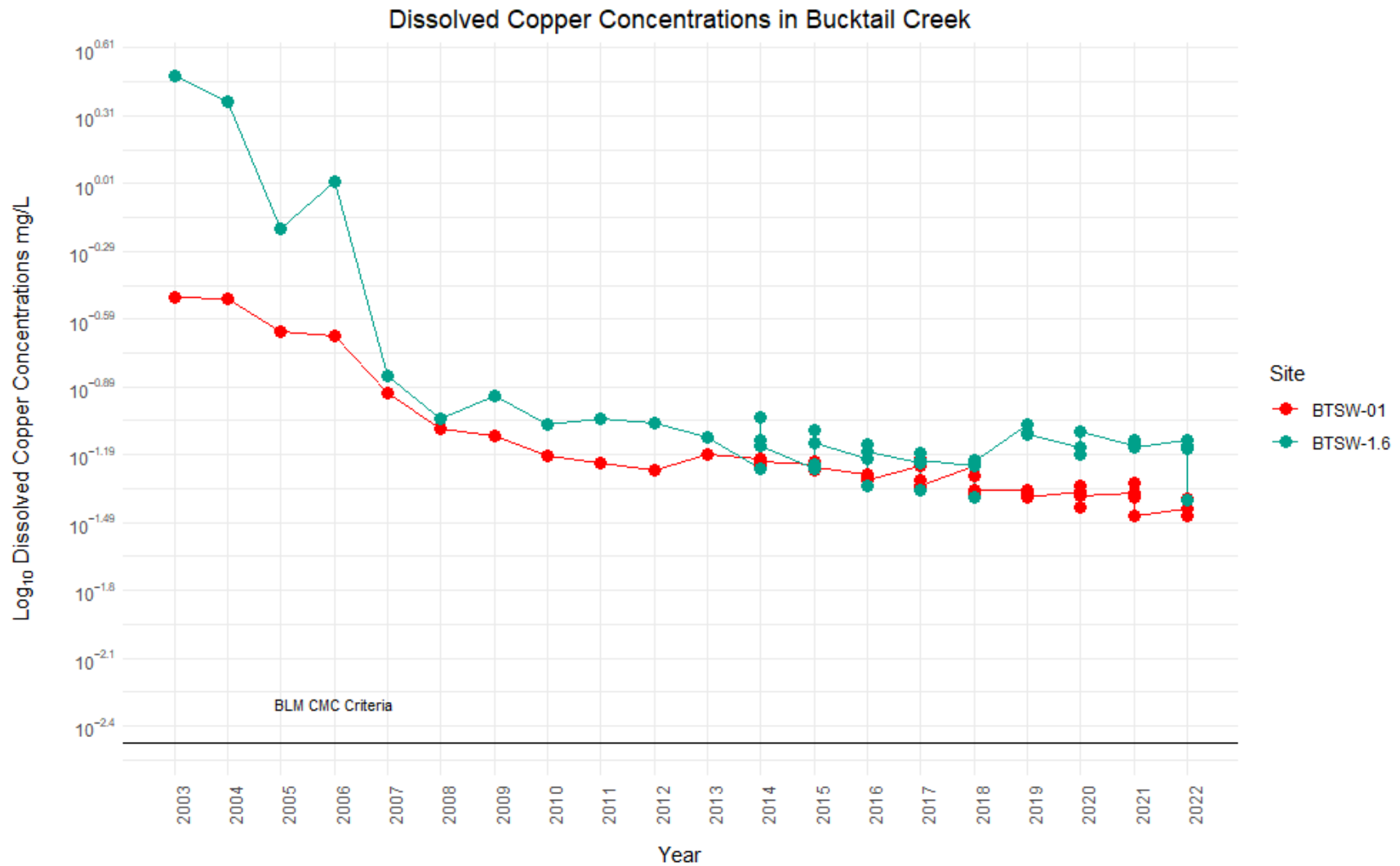


Figure 3. Copper concentrations (Log base 10) in Bucktail Creek (BTSW-0.1 & BTSW-1.6) compared to the copper BLM acute copper criterion (CMC) (2003–2022).

As a tributary of South Fork Big Deer Creek, Bucktail Creek contributes copper and cobalt to South Fork Big Deer Creek and other downstream water bodies. Total and dissolved copper has been monitored at three locations on South Fork Big Deer Creek: SFSW-04, above the confluence with Bucktail Creek and SFSW-01 and SFSW-02, below the confluence of Bucktail Creek. SFSW-04, upstream of the confluence with Bucktail Creek, is indicative of background copper levels, while the downstream sites are impacted.

At SFSW-01, the location nearest the confluence with Bucktail Creek, total copper ranged from a minimum average concentration of 0.015 mg/L (2017) to a maximum average concentration of 1.22 mg/L (2006).

Total copper levels at SFSW-02, just below the confluence with Bucktail Creek, ranged from a minimum average concentration of 0.003 mg/L (2011) to a maximum concentration of 0.053 mg/L (2003). Data were collected at this location intermittently from 2003 and 2007 to 2022.

Background levels of total copper are considered to be relatively low and are measured at SFSW-04, South Fork Big Deer Creek above the confluence with Bucktail Creek. At SFSW-04, total copper ranged from a minimum concentration of 0.00025 mg/L (2015) to a maximum average concentration of 0.0027 mg/L (2011).

At SFSW-01, dissolved copper ranged from a minimum average concentration of 0.0002 mg/L (2012) to a maximum average concentration of 0.054 mg/L (2003). Dissolved copper at SFSW-02 ranged from a minimum average concentration of 0.0076 mg/L (2016) to a maximum average concentration of 0.043 mg/L (2003). Data were collected at this location intermittently from 2003 and 2007 to 2022. Background levels of dissolved copper, measured at SFSW-04, ranged from a minimum average concentration of 0.0002 mg/L (2012) to a maximum average concentration of 0.002 mg/L (2022).

Dissolved copper concentrations exceeded the acute BLM criterion at the two locations on South Fork Big Deer Creek (SFSW-01 and SFSW-02) throughout the evaluation period (Appendix D). Background concentrations of dissolved copper at SFSW-04, the furthest upstream location, met the acute BLM criterion 100% of the time (Appendix D).

A comparison of copper concentrations in the water column at monitoring locations on South Fork Big Deer Creek is illustrated in Figure 4–Figure 6. The observed copper concentrations were consistently above the acute copper criterion (CMC) for all samples at SFSW-01 and SFSW-02, except for one sample in 2012 at SFSW-02. SFSW-04 illustrates background levels of copper in South Fork Big Deer Creek.

Error! Reference source not found. and **Error! Reference source not found.** illustrate total and dissolved copper concentrations at all South Fork Big Deer Creek locations (SFSW-01, 02, and 04) from 2003 to 2022. Copper data for SFSW-01, SFSW-02, and SFSW-04 are provided in Appendix C.

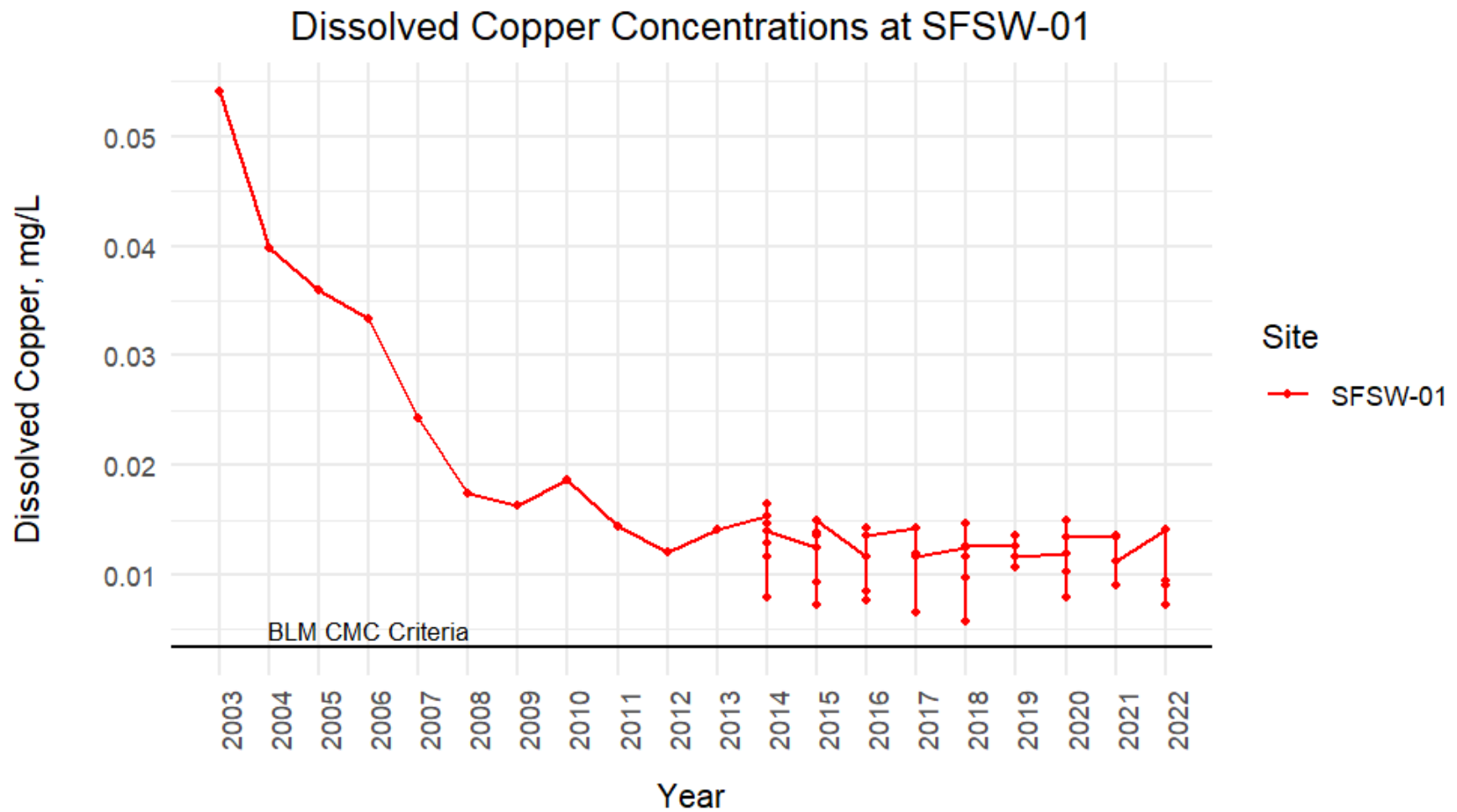


Figure 4. Copper concentrations in SFSW-01 compared to the acute copper criterion.

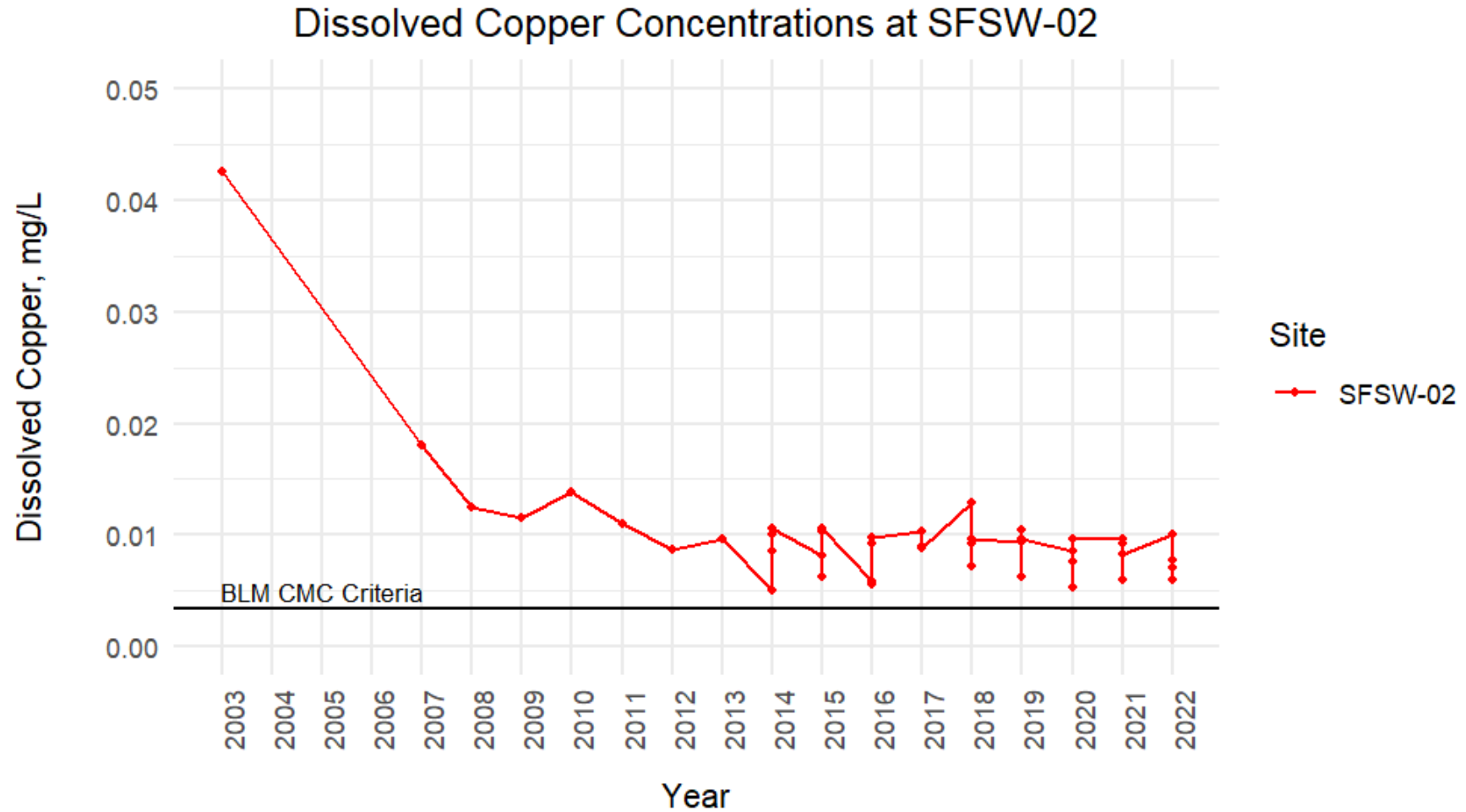


Figure 5. Copper concentrations in SFSW-02 compared to the acute copper criterion.

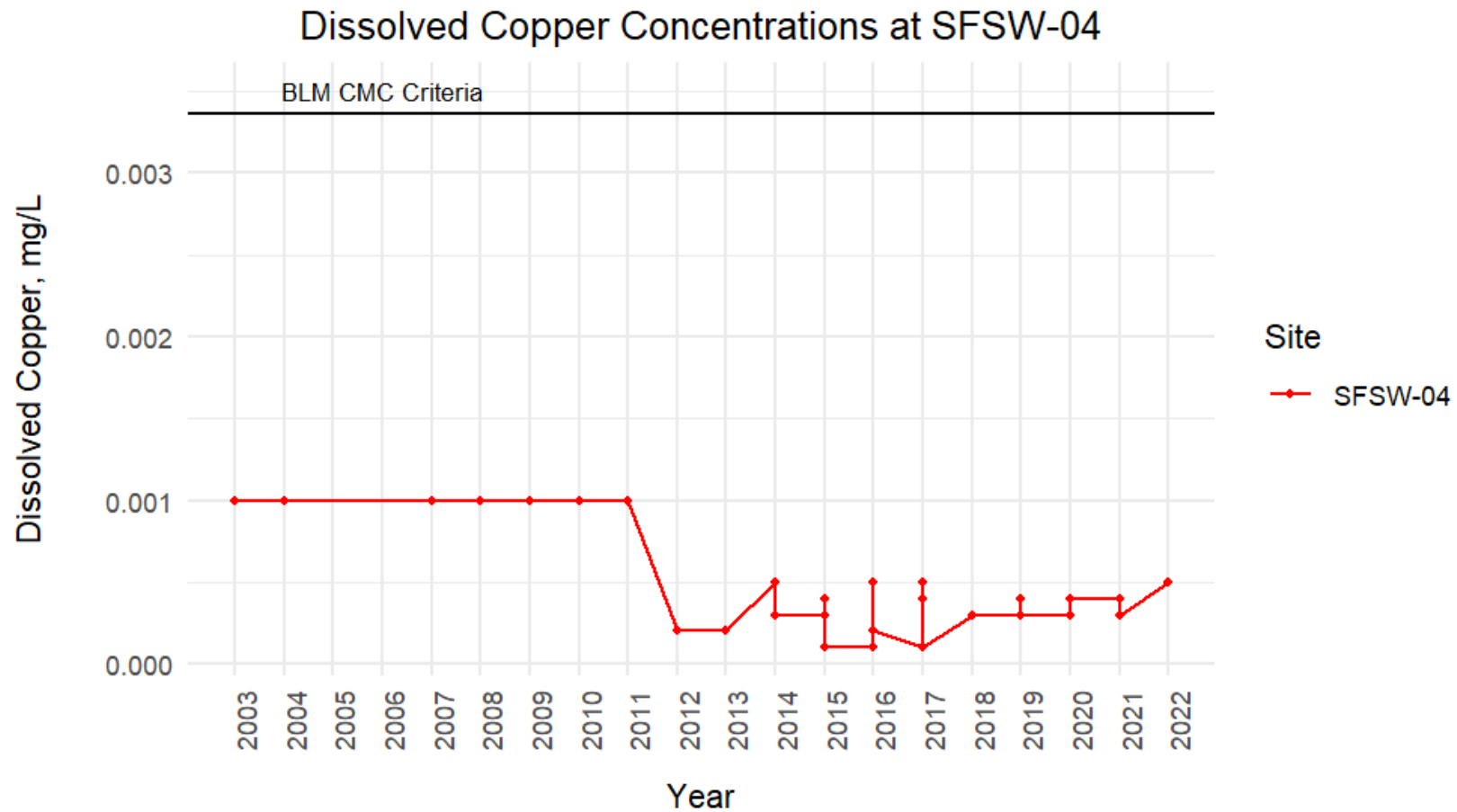


Figure 6. Copper concentrations in SFSW-04 compared to the acute copper criterion. SFSW-04 is considered background.

4.2 Cobalt

Cobalt has no state or federal water quality criteria, although cobalt data have historically been collected in addition to copper at the same monitoring locations on Bucktail Creek (BTSW-01 and BTSW-01.6) from 2003 to 2013 and on South Fork Big Deer Creek (SFSW-01, SFSW-02, and SFSW-04). However, EPA established a risk-based surface water cleanup goal of 0.038 mg/L dissolved cobalt in the 2003 Record of Decision for the Blackbird Mine Site (EPA 2003).

Total cobalt has decreased substantially from its high concentrations in 2003 throughout Bucktail and South Fork Big Deer Creeks. In Bucktail Creek at BTSW-01, total cobalt ranged from a minimum average concentration of 0.0803 mg/L (2018) to a maximum average concentration of 0.590 mg/L (2003). At BTSW-01.6, total cobalt ranged from a minimum average concentration of 0.040 mg/L (2015) to a maximum average concentration of 1.53 mg/L (2003) (Figure 7). Total cobalt data for BTSW-01 and BTSW-01.6 are provided in Appendix E.

In South Fork Big Deer Creek, cobalt has also trended downward since high concentrations in 2003. At the furthest downstream site on South Fork Big Deer Creek above the confluence with Big Deer Creek (SFSW-01), total cobalt ranged from a minimum average concentration of 0.0064 mg/L (2016) to maximum concentration of 0.093 mg/L (2003). Upstream of this location and just below the confluence of Bucktail Creek (SFSW-02), total cobalt ranged from a minimum average concentration of 0.0056 mg/L (2019) to a maximum concentration of 0.069 mg/L (2003).

Background concentrations of total cobalt measured at South Fork Big Deer Creek above the confluence with Bucktail Creek (SFSW-04) ranged from a minimum average concentration of 0.0001 mg/L, which occurred 45% of the sampling years, to a maximum average concentration of 0.006 mg/L (2003) (Figure 7). Total cobalt data for SFSW-01, SFSW-02, and SFSW-04 are shown in Appendix F.

Dissolved cobalt concentrations follow a similar trend as total cobalt and have trended downward from peaks observed in 2003. In Bucktail Creek at BTSW-01, dissolved cobalt ranged from a minimum average concentration of 0.069 mg/L (2014) to a maximum average concentration of 0.611 mg/L (2003). At BTSW-01.6, dissolved cobalt ranged from a minimum average concentration of 0.0047 mg/L (2018) to a maximum average concentration of 1.50 mg/L (2003). The cleanup goal of 0.038 mg/L dissolved cobalt was exceeded at both sites for all samples, except for one sample taken on April 29, 2015 at BTSW-1.6 which was 0.037 mg/L. Figure 13 illustrates the Log_{10} values of concentrations of dissolved cobalt in Bucktail Creek, due to the high variance of values over time. This allows for an easier comparison to the EPA cleanup goal. Dissolved cobalt data for BTSW-01 and BTSW-1.6 are shown in Appendix E.

South Fork of Big Deer Creek also experienced declining dissolved cobalt concentrations. At the furthest downstream location (SFSW-01), dissolved cobalt ranged from a minimum average concentration of 0.0058 mg/L (2015) to a maximum average concentration of 0.0727 mg/L (2003). Upstream of this location near the confluence with Bucktail Creek (SFSW-02), dissolved

cobalt ranged from a minimum average concentration of 0.0055 mg/L (2019) to a maximum average concentration of 0.0711 mg/L (2003). Background concentrations of dissolved cobalt measured at SFSW-04 ranged from a minimum concentration of 0.0001 mg/L in 22% of sampling years, to a maximum average concentration of 0.0060 mg/L (2003). The South Fork Big Deer Creek has been below the cleanup goal at all sites for a majority of the sampling period, barring the first year at SFSW-01 and SFSW-02 (Figure 8). Dissolved cobalt data for SFSW-01, SFSW-02, and SFSW-04 are shown in Appendix F.

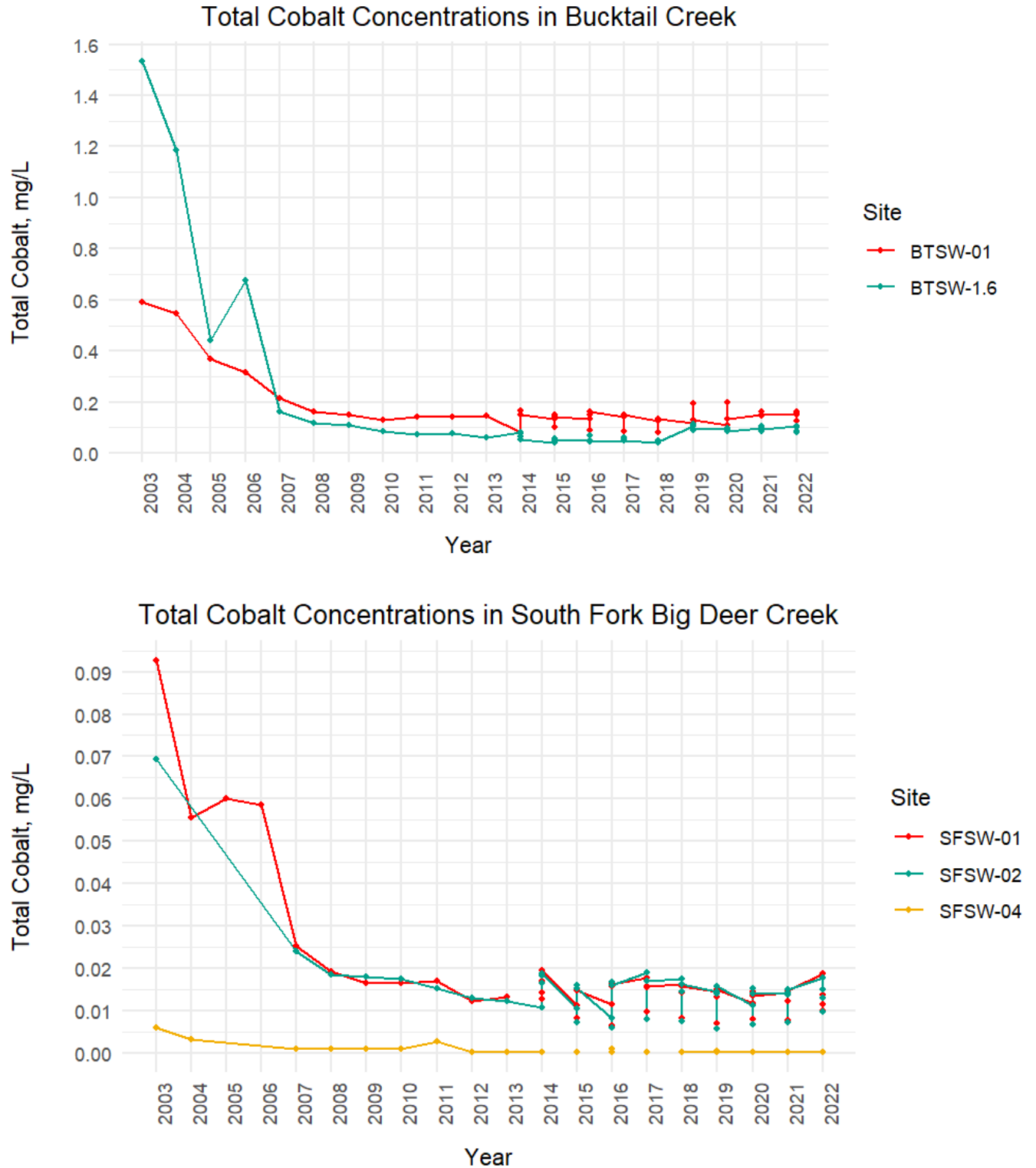
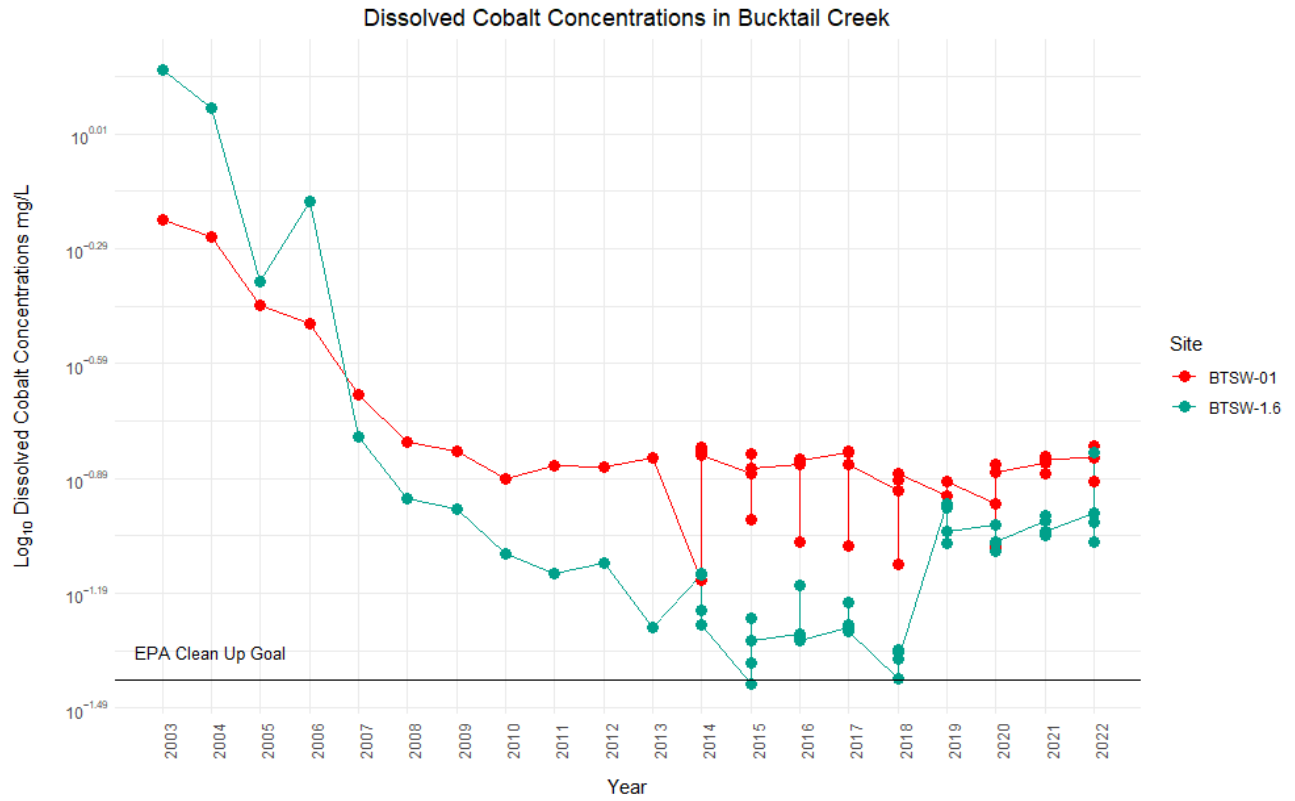


Figure 7. Total cobalt concentrations in Bucktail Creek (BTSW-0.1 and 01.6) and South Fork Big Deer Creek (SFSW-01, 02, and 04) (2003–2022).



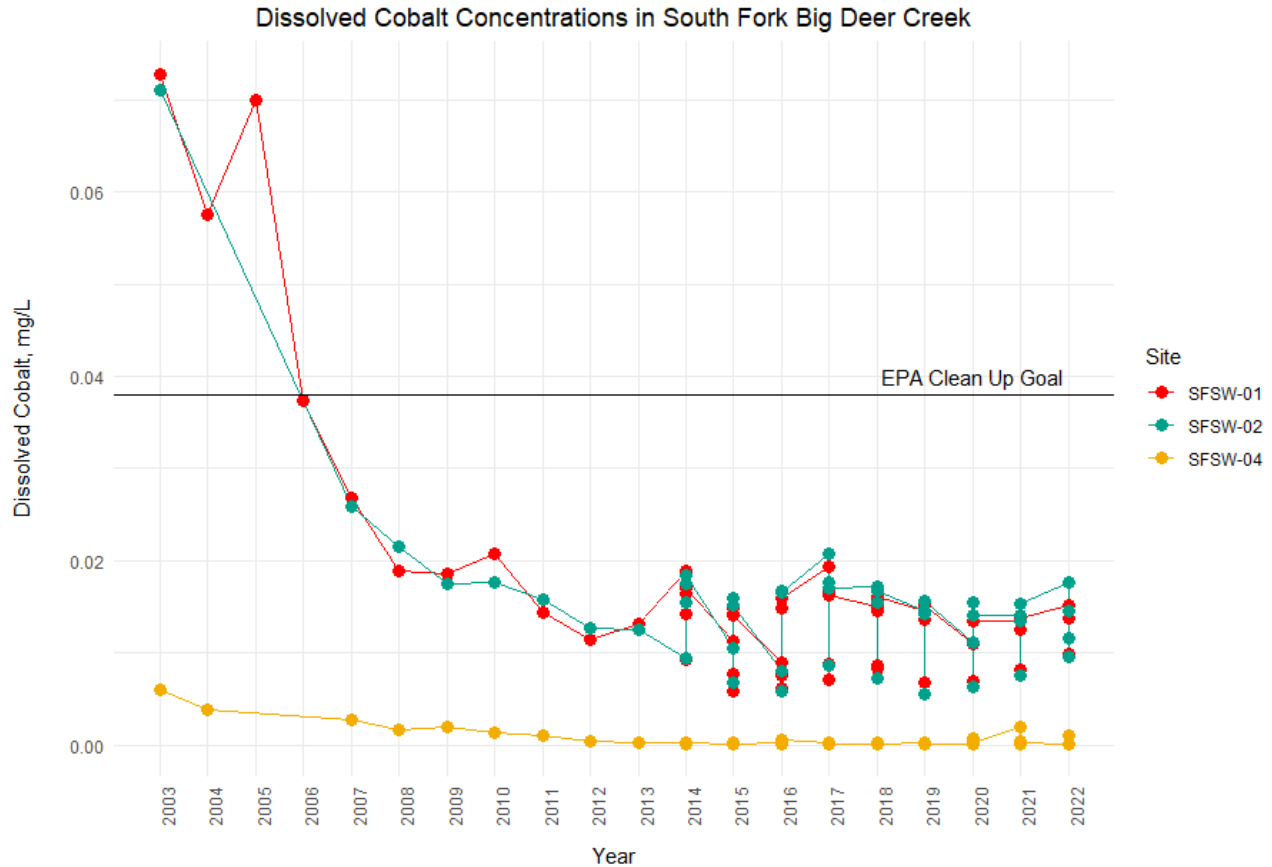


Figure 8. Dissolved cobalt concentrations (Log_{10}) at Bucktail Creek (BTSW-01 and BTSW-1.6) and South Fork Big Deer Creek (SFSW-01, SFSW-02, SFSW-04) as compared to the EPA cleanup goal.

4.3 Flow

Flow data were collected in conjunction with surface water sampling for copper and cobalt at two monitoring locations on Bucktail Creek (BTSW-01 and BTSW-01.6) from 2009 to 2022 (Figure 9). Flow conditions are natural and impacted. Bucktail Creek contributes minimum flow to South Fork Big Deer Creek. The flow conditions are comparable to historic flows that the original UAA was based on (DEQ 2002).

4.4 Biological Conditions

Biomonitoring was conducted at South Fork Big Deer Creek in 2003-2013, 2015, 2017, and 2022 by EcoMetrix (Santec 2003; EcoMetrix 2004-2013, 2015, 2017, 2022). Biomonitoring at the site incorporated the Idaho DEQ aquatic life use support (ALUS) framework and bioassessment methodologies of the Idaho Beneficial Use Reconnaissance Program (BURP) (EcoMetrix 2022).

4.4.1 Benthic Macroinvertebrates

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greater) results in only 60% of larvae surviving to pupae and 40% surviving to swimming pupae (Nebeker et al. 1984).

Benthic macroinvertebrates were collected at two locations on South Fork Big Deer Creek (SFB-0.1 and SFB-0.6) from 2003 to 2022. SFB-0.6 is upstream of the confluence with Bucktail Creek and represents reference conditions, while SFB-0.1 represents impacted conditions. No benthic macroinvertebrates have been collected on Bucktail Creek due to limited flow. Condition ratings and scores for macroinvertebrate communities in South Fork Big Deer Creek are determined based on the BURP reference conditions for mountain streams.

EcoMetrix uses DEQ's benthic macroinvertebrate taxa attribute list which includes functional feeding group, habit, tolerance values and life cycle values for individual taxa. All SMI2 scores were calculated using the DEQ taxa attributes list. The present biomonitoring study incorporates the current DEQ ALUS framework and methodologies (Jessop 2011). Past biomonitoring studies (2002 to 2015) incorporated the state's previous ALUS framework and methodologies. To allow for comparison, 2015 data were reanalyzed using the new framework.

SMI2 scores are assigned a condition rating based on thresholds at the 10th and 50th quantile of reference condition. Index scores above the 50th quantile are assigned condition rating 3; scores from the 10th quantile to median are assigned condition rating 2; and scores less than the 10th quantile of reference condition are assigned a rating of 1. For the SMI2, condition rating category 3 for scores >69; condition rating category 2 for scores of 52 to 69; and condition rating category 1 for scores of <52.

Previous biomonitoring studies (2002-2015) incorporated the Stream Macroinvertebrate Index (SMI) developed by Jessup and Gerritsen (2002). For the 2017 and 2022 surveys, benthic data were evaluated using the Stream Macroinvertebrate Index 2 (SMI2), which was developed by DEQ as part of their ecological assessment approach to determine cold water Aquatic Life Use Support (ALUS) in Idaho streams in 2011 (Jessup 2011).

Macroinvertebrate data is shown in Appendix G.

Benthic macroinvertebrate data indicate some improvement at SFB-0.1, below the confluence of Bucktail Creek. The stream macroinvertebrate index (SMI) score ranged from a low of 19 (2004) to a high of 64 (2015), representing a dramatic increase in score. A decrease occurred in 2017 to a score of 38, with some improvement in 2022 at 51. The stream macroinvertebrate condition rating varied from 0 (2003) to 1 (2022), and from 2011 to 2022, the condition rating consistently ranked at 1 except in 2015, when the condition ranked 3. SFB-0.1 has consistently indexed lower than the reference site, SFB-0.6.

At SFB-0.6 above the confluence of Bucktail Creek, the SMI score ranged from a low of 54 in the most recent biomonitoring survey (2022) to a high of 98 (2012); the condition rating has consistently ranked at 3 (Figure 10). The SMI of 54 in 2022 is the lowest score since monitoring began in 2002 and is potentially attributable to the effects of the 2021 Mud Lick Fire (Ecometrix 2022).

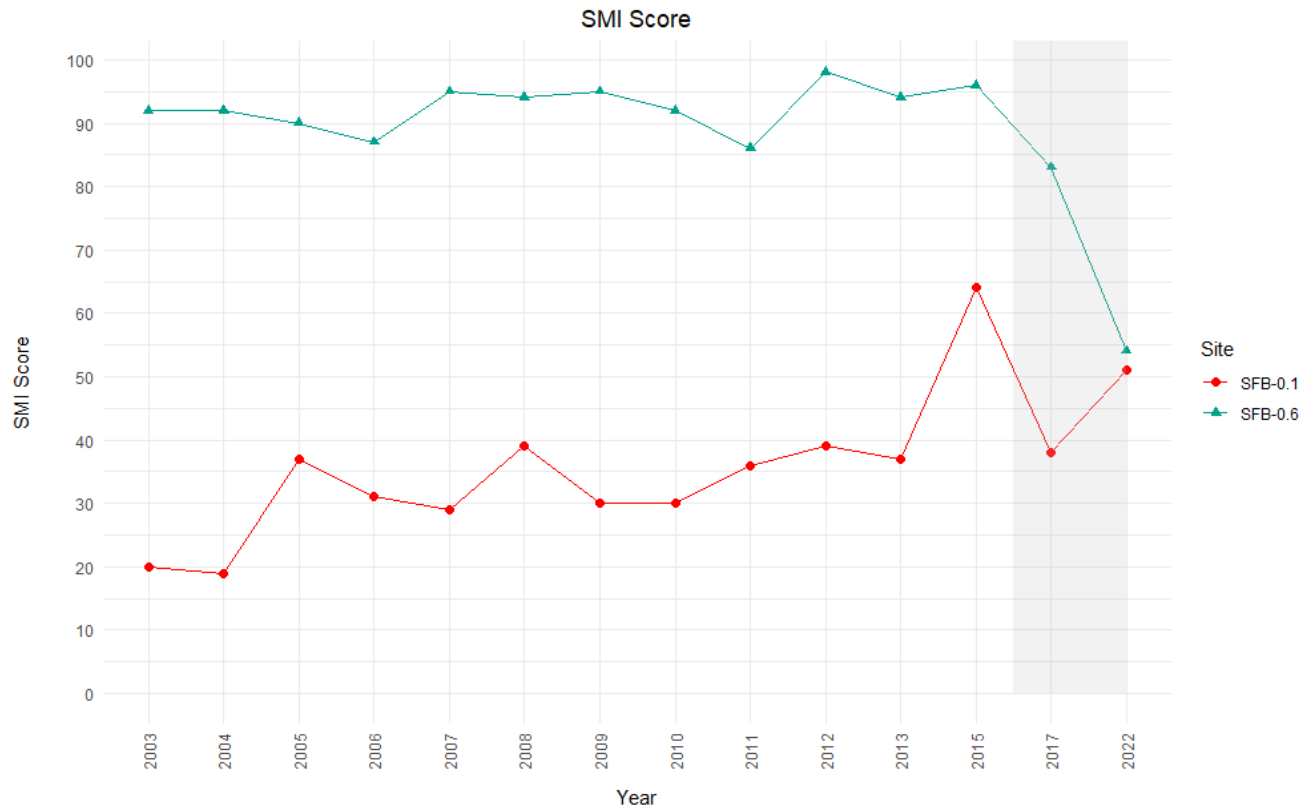


Figure 10. SMI scores at SFB-0.1 and SFB-0.6 (2003–2022). Grey area indicates years that the SMI2 was used.

Total invertebrate abundance (density) per square meter, or total abundance, at SFB-0.1 has generally trended upward from a low of 134 organisms (2003) to a high of 1,715 organisms (2007). However, recent biomonitoring surveys show a decline in total abundance, from 1,101 in 2014 and 500 in 2015, to 70 in 2017. In 2022, abundance increased to 230 at SFB-0.1.

Total abundance at SFB-0.6 ranged from 1,893 (2003) to 6,706 (2007). Similar to SFB-0.1, there was a marked decrease in total abundance at SFB-0.6 from 2,626 in 2013, to 500 in 2015 and 2017, and to 157 in the most recent survey (2022). Total taxa at SFB-0.6 ranged from a low of 26 in the last survey (2022) to a high of 42 (2010) (Figure 11). A change in abundance at the reference site suggests a change in physical habitat could be contributing to the decrease in abundance in South Fork Big Deer Creek from 2008 onward.

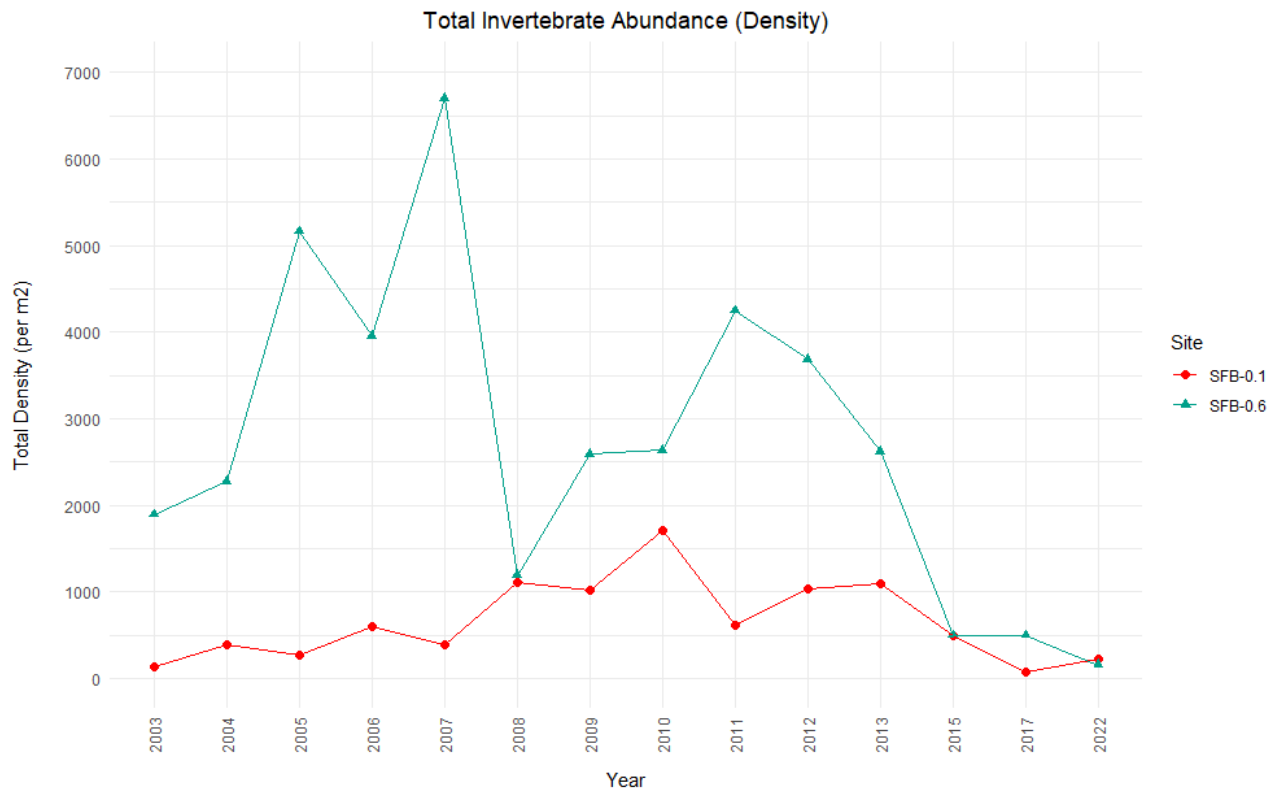


Figure 11. Total macroinvertebrate abundance at SFB-01 and SFB-06 (2003–2022).

An increase in the total taxa found was observed at SFB-0.1, from a low of 8 in 2004, to a high of 30 in 2015. In the most recent survey, 28 total taxa were found at SFB-0.1. A drop in the number of taxa was found at SFB-0.6 to 26 total taxa from a high of 51 in 2017 (Figure 12).

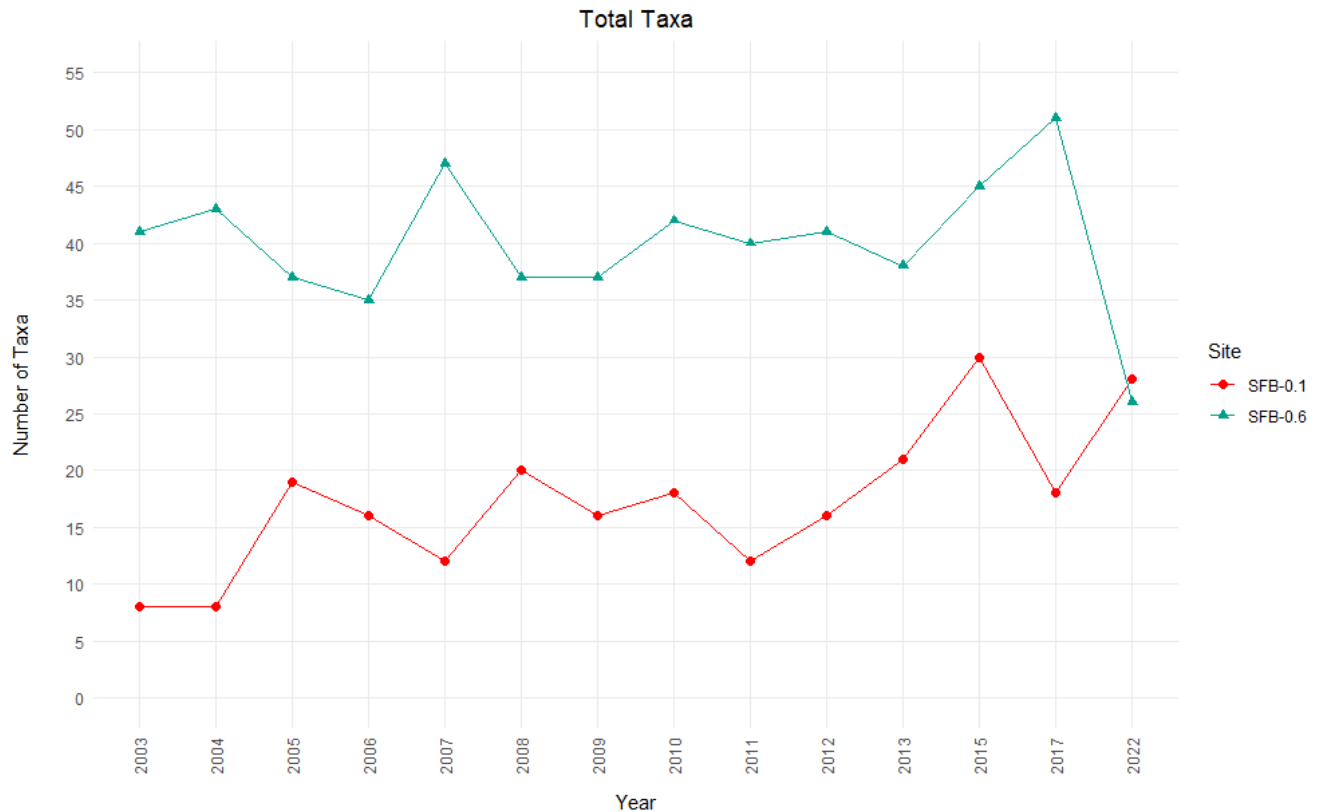


Figure 12. Total number of taxa found at SFB-0.1 and SFB-0.6 (2003–2022).

At SFB-0.1, Trichoptera species have been the dominant taxa, particularly early on, with 6 species of Trichoptera found at the site in 2005 and 2006, and a maximum of 9 in 2015. Ephemeroptera ranged from 1 to 4 (2003–2008). However, in 2022, 12 Ephemeroptera taxa were found at the site. Plecoptera ranged from 0 (2003) to 2 (2013) in the early years at the site (2003–2007), but from 2008 onward, more have been found, with a high of 6 Plecoptera taxa found at the site in 2015, and 4 in the most recent survey (2022). Trichoptera ranged from 1 (2003) to 9 (2015), with 7 Trichoptera taxa identified in 2022 (**Error! Reference source not found.**).



Figure 13. Number of each taxa found at SFB-0.6 (2003–2022).

Data collected at SFB-0.1 from 2003 to 2022 indicate that macroinvertebrate numbers and diversity are frequently below the reference condition found in South Fork Big Deer Creek upstream of the confluence of Bucktail Creek.

In general, the number of Ephemeroptera taxa identified at SFB-0.1 is less than SFB-0.6, where Ephemeroptera ranged from 8 (2003) to 13 (2015). In the most recent survey, SFB-0.1 had more Ephemeroptera than SFB-0.6 (12 at SFB-0.1 and 11 at SFB-0.6), and which marked a shift in the aquatic community from largely Trichoptera dominant to Ephemeroptera dominant. Plecoptera were found consistently at a greater frequency at SFB-0.6 than at SFB-0.1, with a range from 9 (2005) to 13 (2007). Trichoptera taxa are usually the least dominant taxa in SFB-0.6, with counts ranging from 4 in the most recent survey (2022) to 10 in the first year of biomonitoring (2003) (Figure 13).

A metals tolerance index (MTI) was calculated and reported for each monitoring location on South Fork Big Deer Creek (Figure 20). MTI scores range from 0 (highly intolerant) to 10 (highly tolerant). MTI was calculated as a density-weighted average using metals tolerance values. The 2003–2013 MTI scores for Big Fork South Creek in SFB-0.6, upstream of Bucktail Creek, are relatively low, < 3, while scores at SFB-0.1, downstream of the Bucktail Creek confluence, range from > 3 to 6. The MTI scores indicate that the macroinvertebrate community upstream of Bucktail Creek (SFB-0.6) is somewhat susceptible to metals, while the macroinvertebrate community below the confluence (SFB-0.1) ranges from intermediate-to-moderate tolerance or

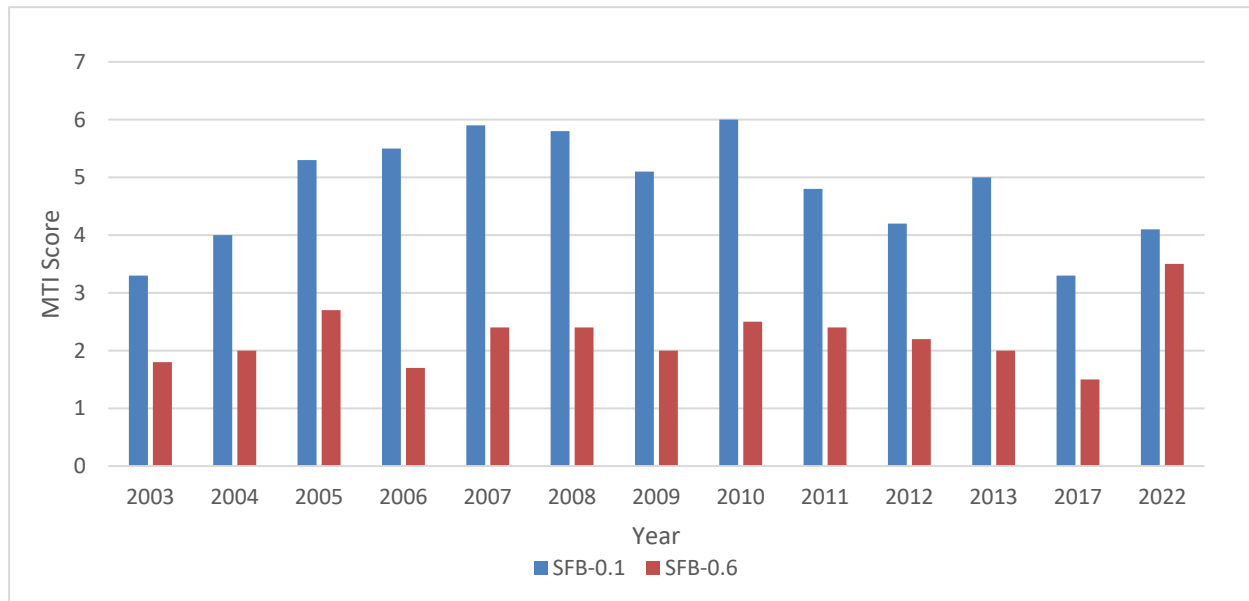


Figure 14: Metals tolerance index scores for South Fork Bucktail Creek (SFB-0.1 and 0.6) (2003–2022).

susceptibility to metals. The score for SFB-0.6 increased in 2022, potentially due to aftereffects of the Mud Lick Fire, which may have contributed to metals in the stream as well as the result of reduction in water uptake and evapotranspiration. It is typical that the MTI for SFB-0.1 is around twice that of the reference site SFB-0.6, indicating that the macroinvertebrate

community in South Fork Big Deer Creek is still being impacted by contaminants from Bucktail Creek.

4.4.2 Fish

One goal of the CWA is to provide for the protection and propagation of fish, shellfish, and wildlife. Under Idaho's beneficial uses, salmonid fish populations are protected through the cold water aquatic life use designation or the seasonally more protective salmonid spawning use designation.

The Bucktail Creek UAA determined that aquatic life was not an existing use because aquatic life had not been present in the creek at any time since November 1975; therefore, cold water aquatic life was removed as a use for the creek (DEQ 2002). EPA approved the UAA recommendation for removing cold water aquatic life as a beneficial use for Bucktail Creek. DEQ changed the aquatic life use designation in its water quality standards to reflect this; consequently, Bucktail Creek currently has an aquatic life designation of *none*.

Several studies document the toxic effect of copper on fish. Typically, fish in early life stages are more susceptible to the effects of increased copper concentrations. For example, exposure to copper was shown to reduce the hatchability of fish eggs and growth in fry (Updegraff and Sykora 1976). Degeneration of olfactory receptors in Rainbow Trout was observed following exposure to copper concentrations of 0.050 mg/L (Klima and Applehans 1990), and intake of copper through dietary sources was determined to result in greater accumulation and toxicity in fish than exposure through surface waters (Woodward et al. 1994). The CH2M Hill (2001) avoidance study performed as part of the AERA found that both juvenile Rainbow Trout and juvenile Chinook Salmon avoided water containing copper at concentrations above a threshold of 0.003 mg/L.

Although cobalt does not have a national criterion for toxicity, studies reported in the AERA (EPA 2003) showed lethal concentration (LC₂₀) estimates (concentrations where 20% of the population dies) of 0.42 mg/L for cobalt. The no-effect concentration for growth and survival of Rainbow Trout was estimated at 0.125 mg/L, and the lowest concentration with an observed effect was 0.250 mg/L. Testing under the chronic criterion showed reductions in growth associated with cobalt and bioaccumulation of cobalt in fry. The Hagler/Bailley (1995) avoidance study found that juvenile Rainbow Trout and juvenile Chinook Salmon avoided water containing cobalt at concentration thresholds above 0.180 mg/L. Additionally, Hagler/Bailley (1995) evaluated the combined toxicity of cobalt and copper and determined that when cobalt concentrations exceed 0.050 mg/L in the presence of copper, a synergistic effect occurs on toxicity.

Previous biomonitoring studies (2002-2015) incorporated the Stream Fish Index (SFI) developed by Mebane (2002). For the 2017 and 2022 biomonitoring surveys, the fish community data were evaluated using the Stream Fish Index 2 (SFI2), which was developed by DEQ in 2011 (Jessup 2011).

Bucktail Creek has been a nonfish-bearing stream due to naturally occurring low flow and is not monitored for fish. As a tributary of South Fork Big Deer Creek, Bucktail Creek contributes significant loads of copper and cobalt, so fish monitoring on South Fork Big Deer Creek has been conducted to evaluate the impact of inflows of Bucktail Creek have on the fish community. Two fish monitoring locations exist on South Fork Big Deer Creek: SFB-0.1, below the confluence with Bucktail Creek and SFB-0.6, above the confluence with Bucktail Creek (Appendix H). In 2002, the stream fish index (SFI) at SFB-0.1 was 0, with no fish observed. Since 2002, the number of fish have ranged from 1 (2005) to 27 (2008). The SFI at SFB-0.1 has ranged from 0 (2002) to 86 (2017). The last survey in 2022 had a SFI score of 78, and a rating of 2, with a total of 14 fish found at the site.

A log jam/waterfall was observed between 2002 to 2017 at the lower end of South Fork Big Deer Creek, approximately 50 meters from the confluence with Big Deer Creek. At this location, a buildup of logs, sediment, rocks, and debris created a structure forming a 1.2-meter waterfall. In 2017, this structure appeared to be slowly deteriorating and by 2022 was no longer an impediment to the passage of fish into the upper reaches of South Fork Big Deer Creek. In 2022, fish were observed for the first time since 2002 in South Fork Big Deer Creek above Bucktail Creek. One adult Rainbow Trout was captured. The absence of fish observed during prior studies was attributed to potential overwintering habitat limitations combined with the presence of passage barriers downstream (Ecometrix 2022).

4.5 Physical Habitat Conditions

Physical instream characteristics influence how a water body reacts to pollution and the effects of pollutants on the aquatic community. These characteristics, when favorable, support aquatic species' habitat, which in turn supports a viable population. Understanding the nature of physical instream characteristics and the effects of changes upon these characteristics is important in describing the ability of a water body to attain an aquatic life beneficial use. Important physical instream characteristics include habitat measures such as substrate size distribution, percent pool, substrate embeddedness, percent cover for fish, depth, flow, and suspended sediment. Table 3 provides the values for the stream habitat index (SHI). Selected habitat metrics and values are listed in Appendix I.

Table 3. Stream habitat index scores and ratings for South Fork Big Deer Creek (SFB-0.1 and 0.6) (2003–2022).

Site	SHI	Year													
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2017	2022
SFB-0.1	Score	72	9	74	71	74	75	85	84	79	84	77	75	75	78
	Rating	3	3	3	3	3	3	3	3	3	3	3	3	2	3
SFB-0.6	Score	75	67	74	74	71	79	85	85	75	86	89	87	79	77
	Rating	3	3	3	3	3	3	3	3	3	3	3	3	3	2

Habitat conditions in lower South Fork Big Deer Creek have maintained high SHI scores throughout the evaluation period. The SHI rating was 3 upstream and downstream of Bucktail

Creek. Although South Fork Big Deer Creeks represents limited fish habitat, the presence of multiple age classes of trout, including fry, as well as fish occurring upstream of the logjam barrier are encouraging signs. Habitat metrics at SFB-0.1 are similar to those at reference site SFB-0.6 (Appendix I).

5 Conclusions and Recommendations

In this review, the original UAA (DEQ 2002) and new data acquired from 2014 to 2022 were reviewed, in addition to data from the 2015 UAA review. The review evaluated the chemical, biological, and physical conditions of Bucktail Creek related to the factors specified in 40 CFR 131.10(g) and used in the UAA to determine that aquatic life uses and contact recreation should be removed. The UAA examined both existing and designated beneficial uses and determined that neither aquatic life nor contact recreation were an existing use in Bucktail Creek. The UAA also determined that aquatic life was not attainable as a designated use based on copper and cobalt concentrations that were many times greater than the acute and chronic water quality criteria. Removing the contact recreation use designation was based on the natural low flow conditions in Bucktail Creek that preclude recreation. This condition has not changed. The original rationale based on copper and cobalt concentrations to support removing aquatic life and flow to support removing contact recreation use designations in Bucktail Creek is still valid.

Overall, total and dissolved copper and cobalt concentrations in Bucktail Creek decreased from 2003 to 2022 due to extensive remediation work within the drainage. As expected, copper and cobalt concentrations in Bucktail Creek were measurably reduced in downstream waters in South Fork Big Deer Creek. Improvements to the cobalt levels in Bucktail have resulted in South Fork Big Deer Creek meeting the EPA cleanup goal for cobalt in South Fork Big Deer Creek.

However, water quality in Bucktail Creek still consistently exceeds criteria in both sites on Bucktail Creek. Concentrations of copper and cobalt are also elevated in SFSW-01 and SFSW-02 as compared to SFSW-04, illustrating the sustained contribution of metals from Bucktail Creek in South Fork Big Deer Creek. Thus, it is unlikely that the stream would be able to sustain a healthy aquatic community. Biomonitoring for macroinvertebrates in Bucktail Creek has been proposed to the Blackbird Mining Site Group and will be conducted in the next biomonitoring survey.

Biological indices have shown some positive variation over the years, but sustained improvements to the aquatic communities have yet to be seen, as compared to the reference site (SFB-0.6). From 2003 to 2012, the SFI in South Fork Big Deer Creek below Bucktail Creek (SFB-0.1) ranged from 0–2, and from 2013 onward, the SFI has been rated at 2. Upstream of the confluence with Bucktail Creek, the SFI was 0 from 2002 to 2017. Rainbow Trout were captured in South Fork Big Deer Creek upstream of Bucktail Creek for the first time since fish sampling began in 2002, indicating the logjam approximately 50-meters upstream of the confluence with Big Deer Creek is no longer a significant impediment to upstream fish passage. Rainbow Trout adults and juveniles were observed again in lower South Fork Big Deer Creek; however, the

benthic community continues to demonstrate likely responses to drainages with historic mine influence (Ecometrix 2022).

The contact recreation use designation was removed based on natural low flow conditions. The flow of Bucktail Creek is a natural condition and remains unchanged; consequently, no change is recommended in the use designation of *none* for contact recreation.

Any future increase in the presence of fish and improvements in macroinvertebrates populations in South Fork Big Deer Creek has limited implication for the use designation of aquatic life or contact recreation in Bucktail Creek because flow in Bucktail Creek is limited. However, future biomonitoring in Bucktail Creek will provide macroinvertebrate data that will allow analysis of the stream's capacity to support aquatic life.

Data do not exist to determine aquatic life use within the creek, nor does water quality data appear to be appropriate for protecting and maintaining a viable aquatic life community for cold water species. While copper and cobalt concentrations have decreased, it is unlikely that cold water aquatic life use would be supported in Bucktail Creek. DEQ recommends that no change take place to the current designation of *none* for aquatic life uses in Bucktail Creek.

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Appendix A. Total and Dissolved Copper Data in Bucktail Creek (BTSW-01 and BTSW-1.6) from 2003–2022.

BTSW-01

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2003	Average	0.603	0.322
	Median	0.603	0.322
	Std. dev.	0.013	0.009
	Minimum	0.594	0.315
	Maximum	0.612	0.328
	No. of samples	2	2
2004	Average	0.399	0.317
	Median	0.403	0.311
	Std. dev.	0.050	0.050
	Minimum	0.338	0.263
	Maximum	0.451	0.384
	No. of samples	4	4
2005	Average	0.348	0.226
	Median	0.334	0.227
	Std. dev.	0.054	0.073
	Minimum	0.303	0.153
	Maximum	0.408	0.299
	No. of samples	3	3
2006	Average	0.332	0.215
	Median	0.332	0.213
	Std. dev.	0.094	0.037
	Minimum	0.219	0.172
	Maximum	0.444	0.262
	No. of samples	4	4
2007	Average	0.137	0.120
	Median	0.127	0.108
	Std. dev.	0.032	0.035
	Minimum	0.112	0.095
	Maximum	0.183	0.170
	No. of samples	4	4
2008	Average	0.098	0.084
	Median	0.073	0.058
	Std. dev.	0.012	0.016
	Minimum	0.089	0.072
	Maximum	0.106	0.095
	No. of samples	2	2

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2009	Average	0.097	0.078
	Median	0.097	0.078
	Std. dev.	0.006	0.006
	Minimum	0.093	0.074
	Maximum	0.101	0.082
	No. of samples	2	2
2010	Average	0.098	0.063
	Median	0.076	0.065
	Std. dev.	0.042	0.018
	Minimum	0.070	0.032
	Maximum	0.185	0.090
	No. of samples	7	7
2011	Average	0.097	0.059
	Median	0.067	0.058
	Std. dev.	0.058	0.005
	Minimum	0.058	0.054
	Maximum	0.198	0.066
	No. of samples	5	5
2012	Average	0.063	0.055
	Median	0.062	0.056
	Std. dev.	0.004	0.002
	Minimum	0.060	0.052
	Maximum	0.069	0.057
	No. of samples	4	4
2013	Average	0.071	0.064
	Median	0.063	0.058
	Std. dev.	0.016	0.014
	Minimum	0.061	0.055
	Maximum	0.095	0.086
	No. of samples	4	4
2014	Average	0.069	0.060
	Median	0.065	0.060
	Std. dev.	0.009	0.002
	Minimum	0.065	0.058
	Maximum	0.084	0.062
	No. of samples	4	4
2015	Average	0.067	0.057
	Median	0.068	0.057
	Std. dev.	0.006	0.002
	Minimum	0.059	0.055

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2016	Maximum	0.072	0.060
	No. of samples	4	4
	Average	0.072	0.051
	Median	0.060	0.051
	Std. dev.	0.030	0.002
	Minimum	0.051	0.049
	Maximum	0.117	0.052
2017	No. of samples	4	4
	Average	0.063	0.053
	Median	0.064	0.053
	Std. dev.	0.005	0.007
	Minimum	0.056	0.047
	Maximum	0.068	0.061
	No. of samples	4	4
2018	Average	0.056	0.049
	Median	0.056	0.048
	Std. dev.	0.007	0.006
	Minimum	0.049	0.043
	Maximum	0.063	0.057
	No. of samples	4	4
2019	Average	0.114	0.043
	Median	0.057	0.042
	Std. dev.	0.119	0.001
	Minimum	0.048	0.041
	Maximum	0.292	0.045
	No. of samples	4	4
2020	Average	0.057	0.034
	Median	0.055	0.043
	Std. dev.	0.012	0.020
	Minimum	0.045	0.004
	Maximum	0.072	0.047
	No. of samples	4	4
2021	Average	0.078	0.042
	Median	0.078	0.042
	Std. dev.	0.028	0.006
	Minimum	0.044	0.034
	Maximum	0.113	0.048
	No. of samples	4	4

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2022	Average	0.044	0.038
	Median	0.045	0.038
	Std. dev.	0.005	0.003
	Minimum	0.038	0.034
	Maximum	0.049	0.041
	No. of samples	4	4

Notes: milligram per liter (mg/L); standard deviation (std. dev.)

BTSW-1.6

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2003	Average	4.379	3.055
	Median	3.510	3.040
	Std. dev.	2.389	1.394
	Minimum	1.800	1.060
	Maximum	9.130	4.940
	No. of samples	10	10
2004	Average	3.006	2.352
	Median	2.110	2.090
	Std. dev.	1.600	0.821
	Minimum	1.660	1.550
	Maximum	6.650	3.930
	No. of samples	11	11
2005	Average	5.540	0.644
	Median	2.105	0.525
	Std. dev.	7.825	0.308
	Minimum	0.749	0.425
	Maximum	17.200	1.100
	No. of samples	4	4
2006	Average	1.282	1.038
	Median	1.370	1.013
	Std. dev.	0.848	0.761
	Minimum	0.169	0.164
	Maximum	2.220	1.960
	No. of samples	4	4
2007	Average	0.167	0.143
	Median	0.165	0.136
	Std. dev.	0.032	0.026
	Minimum	0.132	0.123
	Maximum	0.206	0.179
	No. of samples	4	4
2008	Average	0.172	0.093
	Median	0.172	0.093
	Std. dev.	0.053	0.031
	Minimum	0.134	0.071
	Maximum	0.209	0.115
	No. of samples	2	2
2009	Average	0.183	0.117
	Median	0.183	0.117
	Std. dev.	0.049	0.015

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2010	Minimum	0.148	0.106
	Maximum	0.218	0.127
	No. of samples	2	2
	Average	0.173	0.087
	Median	0.146	0.073
	Std. dev.	0.098	0.034
2011	Minimum	0.083	0.049
	Maximum	0.335	0.134
	No. of samples	5	5
	Average	0.109	0.092
	Median	0.101	0.092
	Std. dev.	0.026	0.017
2012	Minimum	0.088	0.067
	Maximum	0.152	0.111
	No. of samples	5	5
	Average	0.111	0.089
	Median	0.107	0.090
	Std. dev.	0.014	0.021
2013	Minimum	0.101	0.063
	Maximum	0.131	0.113
	No. of samples	4	4
	Average	0.084	0.077
	Median	0.074	0.068
	Std. dev.	0.022	0.021
2014	Minimum	0.072	0.064
	Maximum	0.117	0.108
	No. of samples	4	4
	Average	0.084	0.073
	Median	0.081	0.072
	Std. dev.	0.014	0.016
2015	Minimum	0.073	0.056
	Maximum	0.103	0.093
	No. of samples	4	4
	Average	0.075	0.067
	Median	0.072	0.065
	Std. dev.	0.014	0.013
2016	Minimum	0.064	0.055
	Maximum	0.094	0.093
2016	No. of samples	4	4
	Average	0.074	0.061

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
	Median	0.078	0.063
	Std. dev.	0.013	0.010
	Minimum	0.055	0.047
	Maximum	0.083	0.071
	No. of samples	4	4
2017	Average	0.070	0.057
	Median	0.073	0.059
	Std. dev.	0.012	0.009
	Minimum	0.054	0.044
	Maximum	0.080	0.065
	No. of samples	4	4
2018	Average	0.061	0.183
	Median	0.064	0.060
	Std. dev.	0.008	0.258
	Minimum	0.049	0.042
	Maximum	0.066	0.570
	No. of samples	4	4
2019	Average	0.089	0.084
	Median	0.090	0.083
	Std. dev.	0.004	0.004
	Minimum	0.084	0.079
	Maximum	0.092	0.088
	No. of samples	4	4
2020	Average	0.077	0.071
	Median	0.076	0.069
	Std. dev.	0.003	0.007
	Minimum	0.074	0.064
	Maximum	0.081	0.081
	No. of samples	4	4
2021	Average	0.076	0.072
	Median	0.076	0.072
	Std. dev.	0.004	0.002
	Minimum	0.071	0.069
	Maximum	0.080	0.074
	No. of samples	4	4
2022	Average	0.229	0.063
	Median	0.082	0.069
	Std. dev.	0.299	0.015
	Minimum	0.074	0.040

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
	Maximum	0.678	0.074
	No. of samples	4	4

Notes: milliliter (mg/L); standard deviation (std. dev.)

Appendix B. Comparison of Dissolved Copper Concentrations to Acute Copper Criteria in Bucktail Creek (BTSW-01 and BTSW-1.6) from 2003–2022.

BTSW-01

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)	Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
4/11/03	0.315	Yes	7/15/13	0.058	Yes
5/29/03	0.328	Yes	10/9/13	0.058	Yes
2/18/04	0.244	Yes	11/11/13	0.055	Yes
5/19/04	0.263	Yes	5/20/2014	0.062	Yes
6/15/04	0.384	Yes	7/16/2014	0.061	Yes
8/2/04	0.310	Yes	9/15/2014	0.058	Yes
9/24/04	0.311	Yes	11/4/2014	0.060	Yes
5/9/05	0.153	Yes	4/29/2015	0.059	Yes
9/14/05	0.299	Yes	5/12/2015	0.060	Yes
5/20/06	0.172	Yes	9/9/2015	0.055	Yes
10/20/06	0.211	Yes	10/2/2015	0.056	Yes
4/25/07	0.170	Yes	5/4/2016	0.052	Yes
5/8/07	0.095	Yes	5/18/2016	0.052	Yes
5/21/07	0.096	Yes	9/14/2016	0.050	Yes
10/8/07	0.119	Yes	10/5/2016	0.049	Yes
6/4/08	0.072	Yes	4/24/2017	0.057	Yes
9/30/08	0.095	Yes	5/15/2017	0.061	Yes
6/2/09	0.074	Yes	9/25/2017	0.049	Yes
9/29/09	0.082	Yes	10/2/2017	0.047	Yes
5/11/10	0.090	Yes	4/23/2018	0.057	Yes
5/26/10	0.058	Yes	5/14/2018	0.052	Yes
6/8/10	0.052	Yes	9/24/2018	0.043	Yes
6/15/10	0.032	Yes	10/1/2018	0.045	Yes
8/5/10	0.065	Yes	4/29/2019	0.045	Yes
8/16/10	0.074	Yes	5/13/2019	0.042	Yes
9/22/10	0.069	Yes	9/23/2019	0.043	Yes
2/10/11	0.054	Yes	10/7/2019	0.041	Yes
6/14/11	0.066	Yes	5/5/2020	0.044	Yes
9/23/11	0.058	Yes	5/26/2020	0.047	Yes
10/12/11	0.063	Yes	9/9/2020	0.004	Yes
11/8/11	0.054	Yes	9/28/2020	0.042	Yes
5/23/12	0.057	Yes	5/3/2021	0.043	Yes
7/12/12	0.052	Yes	5/24/2021	0.048	Yes
9/20/12	0.056	Yes	9/20/2021	0.042	Yes
10/10/12	0.056	Yes	10/4/2021	0.034	Yes
5/13/13	0.086	Yes	4/25/2022	0.037	Yes
			5/24/2022	0.034	Yes

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
8/18/2022	0.040	Yes

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
9/27/2022	0.041	Yes

Notes: Exceedances of the copper criterion are shown in red; criterion maximum concentration (CMC)

BTSW-1.6

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)	Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
1/21/03	4.940	Yes	11/8/11	0.084	Yes
3/4/03	4.870	Yes	5/23/12	0.063	Yes
4/11/03	1.060	Yes	7/12/12	0.113	Yes
4/30/03	4.470	Yes	9/20/12	0.098	Yes
5/29/03	1.150	Yes	10/10/12	0.082	Yes
6/24/03	2.950	Yes	5/13/13	0.069	Yes
7/10/03	2.710	Yes	7/15/13	0.108	Yes
8/12/03	3.130	Yes	10/9/13	0.067	Yes
10/7/03	3.150	Yes	11/11/13	0.064	Yes
11/22/03	2.120	Yes	5/20/14	0.056	Yes
1/13/04	2.960	Yes	7/16/14	0.093	Yes
4/13/04	3.660	Yes	9/15/14	0.075	Yes
5/19/04	1.620	Yes	11/4/14	0.070	Yes
5/26/04	1.550	Yes	4/29/15	0.055	Yes
6/2/04	1.810	Yes	5/12/15	0.058	Yes
6/9/04	2.090	Yes	9/9/15	0.082	Yes
6/15/04	1.880	Yes	10/2/15	0.072	Yes
8/1/04	2.370	Yes	5/4/16	0.061	Yes
9/24/04	2.280	Yes	5/18/16	0.047	Yes
5/9/05	0.512	Yes	9/14/16	0.071	Yes
5/13/05	1.100	Yes	10/5/16	0.066	Yes
9/14/05	0.538	Yes	4/24/17	0.058	Yes
5/20/06	0.766	Yes	5/15/17	0.044	Yes
10/20/06	0.164	Yes	9/25/17	0.065	Yes
4/25/07	0.124	Yes	10/2/17	0.060	Yes
5/8/07	0.147	Yes	4/23/18	0.570	Yes
5/21/07	0.179	Yes	5/14/18	0.042	Yes
10/8/07	0.123	Yes	9/24/18	0.060	Yes
6/4/08	0.071	Yes	10/1/18	0.060	Yes
9/30/08	0.115	Yes	4/29/19	0.088	Yes
6/2/09	0.127	Yes	5/13/19	0.087	Yes
9/29/09	0.106	Yes	9/23/19	0.080	Yes
5/11/10	0.049	Yes	10/7/19	0.079	Yes
5/26/10	0.068	Yes	5/5/20	0.069	Yes
6/8/10	0.073	Yes	5/26/20	0.064	Yes
8/5/10	0.134	Yes	9/9/20	0.069	Yes
9/22/10	0.110	Yes	9/28/20	0.081	Yes
2/10/11	0.067	Yes	5/3/21	0.070	Yes
6/14/11	0.111	Yes	5/24/21	0.073	Yes
9/23/11	0.105	Yes	9/20/21	0.074	Yes
10/12/11	0.092	Yes	10/4/21	0.069	Yes

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)	Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
4/25/22	0.074	Yes	8/18/22	0.040	Yes
5/24/22	0.070	Yes	9/27/22	0.068	Yes

Notes: Exceedances of the copper criterion are shown in red; criterion maximum concentration (CMC)

Appendix C. Total and Dissolved Copper and Hardness Data for South Fork Big Deer Creek (SFSW-1, SFSW-02, SFSW-04) from 2003–2022.

SFSW-01

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2003	Average	0.4561	0.0541
	Median	0.0745	0.0537
	Std. dev.	0.8247	0.0095
	Minimum	0.0622	0.0460
	Maximum	1.9300	0.0693
	No. of samples	5	5
2004	Average	0.0637	0.0398
	Median	0.0610	0.0410
	Std. dev.	0.0186	0.0117
	Minimum	0.0430	0.0190
	Maximum	0.1060	0.0640
	No. of samples	13	13
2005	Average	0.2475	0.0360
	Median	0.2475	0.0360
	Std. dev.	0.2779	0.0099
	Minimum	0.0510	0.0290
	Maximum	0.4440	0.0430
	No. of samples	2	2
2006	Average	1.2240	0.0333
	Median	0.0635	0.0330
	Std. dev.	2.3374	0.0061
	Minimum	0.0390	0.0260
	Maximum	4.7300	0.0410
	No. of samples	4	4
2007	Average	0.0265	0.0243
	Median	0.0280	0.0230
	Std. dev.	0.0100	0.0039
	Minimum	0.0130	0.0210
	Maximum	0.0370	0.0300
	No. of samples	4	4
2008	Average	0.0320	0.0174
	Median	0.0300	0.0170
	Std. dev.	0.0073	0.0044
	Minimum	0.0260	0.0100
	Maximum	0.0420	0.0250

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
	No. of samples	4	45
2009	Average	0.0370	0.0163
	Median	0.0240	0.0180
	Std. dev.	0.0315	0.0047
	Minimum	0.0180	0.0100
	Maximum	0.0930	0.0300
	No. of samples	5	45
2010	Average	0.0253	0.0187
	Median	0.0230	0.0195
	Std. dev.	0.0076	0.0044
	Minimum	0.0190	0.0110
	Maximum	0.0400	0.0250
	No. of samples	6	10
2011	Average	0.0514	0.0144
	Median	0.0260	0.0150
	Std. dev.	0.0654	0.0033
	Minimum	0.0170	0.0070
	Maximum	0.2200	0.0200
	No. of samples	9	10
2012	Average	0.0178	0.0121
	Median	0.0192	0.0120
	Std. dev.	0.0028	0.0033
	Minimum	0.0142	0.0075
	Maximum	0.0206	0.0155
	No. of samples	5	7
2013	Average	0.0205	0.0141
	Median	0.0184	0.0148
	Std. dev.	0.0066	0.0031
	Minimum	0.0160	0.0076
	Maximum	0.0321	0.0168
	No. of Samples	5	7
2014	Average	0.0202	0.013
	Median	0.0167	0.014
	Std. dev.	0.0092	0.003
	Minimum	0.0137	0.008
	Maximum	0.0338	0.017
	No. of samples	7	7
2015	Average	0.0161	0.012
	Median	0.0165	0.013
	Std. dev.	0.0020	0.003
	Minimum	0.0133	0.007

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2016	Maximum	0.0180	0.015
	No. of samples	6	6
	Average	0.0339	0.011
	Median	0.0152	0.012
	Std. dev.	0.0398	0.003
	Minimum	0.0119	0.008
	Maximum	0.0935	0.014
2017	No. of samples	5	5
	Average	0.0149	0.011
	Median	0.0147	0.012
	Std. dev.	0.0017	0.003
	Minimum	0.0131	0.007
	Maximum	0.0177	0.014
	No. of samples	5	5
2018	Average	0.0151	0.011
	Median	0.0148	0.012
	Std. dev.	0.0021	0.003
	Minimum	0.0131	0.006
	Maximum	0.0177	0.015
	No. of samples	6	6
2019	Average	0.0161	0.012
	Median	0.0156	0.012
	Std. dev.	0.0022	0.001
	Minimum	0.0140	0.011
	Maximum	0.0192	0.014
	No. of samples	4	4
2020	Average	0.0168	0.012
	Median	0.0165	0.012
	Std. dev.	0.0008	0.003
	Minimum	0.0162	0.008
	Maximum	0.0179	0.015
	No. of samples	5	5
2021	Average	0.0172	0.012
	Median	0.0177	0.012
	Std. dev.	0.0052	0.002
	Minimum	0.0110	0.009
	Maximum	0.0224	0.014
	No. of samples	4	4

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2022	Average	0.0266	0.010
	Median	0.0141	0.009
	Std. dev.	0.0266	0.003
	Minimum	0.0117	0.007
	Maximum	0.0665	0.014
	No. of samples	4	4

Notes: milligram per liter (mg/L); standard deviation (std. dev.)

SFSW-02

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2003	Average	0.0528	0.0425
	Median	0.0528	0.0425
	Std. dev.	0.0081	0.0106
	Minimum	0.0470	0.0350
	Maximum	0.0585	0.0500
	No. of samples	2	2
2007	Average	0.0225	0.0180
	Median	0.0220	0.0180
	Std. dev.	0.0074	0.0066
	Minimum	0.0140	0.0100
	Maximum	0.0320	0.0260
	No of samples	4	4
2008	Average	0.0155	0.0125
	Median	0.0155	0.0125
	Std. dev.	0.0035	0.0049
	Minimum	0.0130	0.0090
	Maximum	0.0180	0.0160
	No. of samples	2	2
2009	Average	0.0375	0.0115
	Median	0.0375	0.0115
	Std. dev.	0.0290	0.0049
	Minimum	0.0170	0.0080
	Maximum	0.0580	0.0150
	No. of samples	2	2
2010	Average	0.0162	0.0138
	Median	0.0150	0.0130
	Std. dev.	0.0027	0.0058
	Minimum	0.0150	0.0070
	Maximum	0.0210	0.0230
	No. of samples	5	5
2011	Average	0.0172	0.0110
	Median	0.0140	0.0110
	Std. dev.	0.0062	0.0016
	Minimum	0.0130	0.0090
	Maximum	0.0280	0.0130
	No. of samples	5	5
2012	Average	0.0111	0.0087
	Median	0.0111	0.0095
	Std. dev.	0.0030	0.0020

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2013	Minimum	0.0074	0.0049
	Maximum	0.0150	0.0108
	No. of samples	4	4
	Average	0.0117	0.0096
	Median	0.0119	0.0099
	Std. dev.	0.0010	0.0010
	Minimum	0.0103	0.0080
2014	Maximum	0.0126	0.0106
	No. of samples	4	4
	Average	0.0130	0.0086
	Median	0.0125	0.0094
	Std. dev.	0.0024	0.0025
	Minimum	0.0106	0.0050
	Maximum	0.0163	0.0106
2015	No. of samples	4	4
	Average	0.0115	0.0088
	Median	0.0116	0.0092
	Std. dev.	0.0024	0.0020
	Minimum	0.0085	0.0063
	Maximum	0.0141	0.0106
	No. of samples	4	4
2016	Average	0.0098	0.0076
	Median	0.0098	0.0076
	Std. dev.	0.0022	0.0022
	Minimum	0.0072	0.0056
	Maximum	0.0122	0.0098
	No. of samples	4	4
	Average	0.0116	0.0093
2017	Median	0.0110	0.0090
	Std. dev.	0.0015	0.0007
	Minimum	0.0106	0.0089
	Maximum	0.0138	0.0103
	No. of samples	4	4
	Average	0.0112	0.0097
	Median	0.0111	0.0094
2018	Std. dev.	0.0024	0.0024
	Minimum	0.0084	0.0072
	Maximum	0.0143	0.0129
	No. of samples	4	4
	Average	0.0112	0.0097
	Median	0.0111	0.0094
	Std. dev.	0.0024	0.0024

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2019	Average	0.0109	0.0089
	Median	0.0111	0.0095
	Std. dev.	0.0014	0.0018
	Minimum	0.0090	0.0063
	Maximum	0.0126	0.0104
	No. of samples	4	4
2020	Average	0.0105	0.0078
	Median	0.0102	0.0081
	Std. dev.	0.0017	0.0019
	Minimum	0.0090	0.0053
	Maximum	0.0126	0.0097
	No. of samples	4	4
2021	Average	0.0104	0.0083
	Median	0.0112	0.0088
	Std. dev.	0.0020	0.0016
	Minimum	0.0074	0.0060
	Maximum	0.0117	0.0097
	No. of samples	4	4
2022	Average	0.0098	0.0078
	Median	0.0095	0.0075
	Std. dev.	0.0019	0.0017
	Minimum	0.0079	0.0060
	Maximum	0.0124	0.0101
	No. of samples	4	4

Notes: milligram per liter (mg/L); standard deviation (std. dev.)

SFSW-04

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2003	Average	0.0010	0.0010
	Median	0.0010	0.0010
	Std. dev.	0.0000	0.0000
	Minimum	0.0010	0.0010
	Maximum	0.0010	0.0010
	No. of samples	2	2
2004	Average	0.0015	0.0010
	Median	0.0010	0.0010
	Std. dev.	0.0010	0.0000
	Minimum	0.0010	0.0010
	Maximum	0.0030	0.0010
	No. of samples	4	4
2007	Average	0.0010	0.0010
	Median	0.0010	0.0010
	Std. dev.	0.0000	0.0000
	Minimum	0.0010	0.0010
	Maximum	0.0010	0.0010
	No. of samples	4	4
2008	Average	0.0010	0.0010
	Median	0.0010	0.0010
	Std. dev.	0.0000	0.0000
	Minimum	0.0010	0.0010
	Maximum	0.0010	0.0010
	No. of samples	4	47
2009	Average	0.0010	0.0010
	Median	0.0010	0.0010
	Std. dev.	0.0000	0.0000
	Minimum	0.0010	0.0010
	Maximum	0.0010	0.0010
	No. of samples	4	47
2010	Average	0.0010	0.0010
	Median	0.0010	0.0010
	Std. dev.	0.0000	0.0000
	Minimum	0.0010	0.0010
	Maximum	0.0010	0.0010
	No. of samples	3	7

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2011	Average	0.0027	0.0010
	Median	0.0010	0.0010
	Std. dev.	0.0040	0 ^a
	Minimum	0.0010	0.0010
	Maximum	0.0100	0.0010
	No. of samples	6	7
2012	Average	0.0005	0.0002
	Median	0.0005	0.0001
	Std. dev.	0.0002	0.0002
	Minimum	0.0004	0.0001
	Maximum	0.0007	0.0005
	No. of samples	3	5.0000
2013	Average	0.0005	0.0002
	Median	0.0002	0.0001
	Std. dev.	0.0004	0.0003
	Minimum	0.0002	0.0001
	Maximum	0.0010	0.0007
	No. of samples	3	5
2014	Average	0.0006	0.0004
	Median	0.0006	0.0005
	Std. dev.	0.0001	0.0001
	Minimum	0.0005	0.0003
	Maximum	0.0007	0.0005
	No. of samples	3	3
2015	Average	0.0003	0.0002
	Median	0.0003	0.0003
	Std. dev.	0.0001	0.0001
	Minimum	0.0002	0.0001
	Maximum	0.0003	0.0004
	No. of samples	5	5
2016	Average	0.0004	0.0003
	Median	0.0004	0.0004
	Std. dev.	0.0003	0.0002
	Minimum	0.0002	0.0001
	Maximum	0.0006	0.0005
	No. of samples	4	4
2017	Average	0.0004	0.0003
	Median	0.0004	0.0003
	Std. dev.	0.0002	0.0002

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)
2018	Minimum	0.0002	0.0001
	Maximum	0.0005	0.0005
	No. of samples	4	4
	Average	0.0008	0.0003
	Median	0.0008	0.0003
	Std. dev.	0	0.0000
	Minimum	0.0008	0.0003
2019	Maximum	0.0008	0.0003
	No. of samples	2	4
	Average	0.0008	0.0003
	Median	0.0008	0.0003
	Std. dev.	0	0.0001
	Minimum	0.0008	0.0003
	Maximum	0.0008	0.0004
2020	No. of samples	4	4
	Average	0.0005	0.0003
	Median	0.0004	0.0003
	Std. dev.	0.0002	0.0000
	Minimum	0.0004	0.0003
	Maximum	0.0008	0.0004
	No. of samples	5	5
2021	Average	0.0004	0.0004
	Median	0.0004	0.0004
	Std. dev.	0	0.0001
	Minimum	0.0004	0.0003
	Maximum	0.0004	0.0004
	No. of samples	4	4
	Average	0.0006	0.0016
2022	Median	0.0005	0.0005
	Std. dev.	0.0003	0.0023
	Minimum	0.0005	0.0005
	Maximum	0.001	0.0050
	No. of samples	4	4

Notes: milligram per liter (mg/L); standard deviation (std. dev.)

Appendix D. Comparison of Copper Criteria to Copper Concentrations in South Fork Big Deer Creek (SFSW-01, SFSW-02, SFSW-04) from 2003-2022.

SFSW-01

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)	Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
3/4/2003	0.056	Yes	5/16/2008	0.024	Yes
4/11/2003	0.069	Yes	5/16/2008	0.024	Yes
5/29/2003	0.046	Yes	5/27/2008	0.015	Yes
6/17/2003	0.046	Yes	5/27/2008	0.015	Yes
9/23/2003	0.054	Yes	5/27/2008	0.025	Yes
2/18/2004	0.046	Yes	5/28/2008	0.014	Yes
4/8/2004	0.049	Yes	5/28/2008	0.015	Yes
4/14/2004	0.064	Yes	5/28/2008	0.014	Yes
4/21/2004	0.043	Yes	5/29/2008	0.015	Yes
4/28/2004	0.038	Yes	5/29/2008	0.014	Yes
5/5/2004	0.019	Yes	5/29/2008	0.015	Yes
5/19/2004	0.036	Yes	5/30/2008	0.022	Yes
5/26/2004	0.041	Yes	5/30/2008	0.016	Yes
6/2/2004	0.032	Yes	5/30/2008	0.016	Yes
6/9/2004	0.023	Yes	6/4/2008	0.012	Yes
6/15/2004	0.033	Yes	6/23/2008	0.011	Yes
8/2/2004	0.045	Yes	6/23/2008	0.011	Yes
9/24/2004	0.048	Yes	6/23/2008	0.011	Yes
5/9/2005	0.029	Yes	6/24/2008	0.011	Yes
9/14/2005	0.043	Yes	6/24/2008	0.01	Yes
5/20/2006	0.026	Yes	6/24/2008	0.011	Yes
10/20/2006	0.033	Yes	6/25/2008	0.011	Yes
4/25/2007	0.03	Yes	6/25/2008	0.011	Yes
5/8/2007	0.023	Yes	6/25/2008	0.012	Yes
5/21/2007	0.021	Yes	6/26/2008	0.012	Yes
10/8/2007	0.023	Yes	6/26/2008	0.012	Yes
5/12/2008	0.017	Yes	6/26/2008	0.013	Yes
5/12/2008	0.018	Yes	9/29/2008	0.021	Yes
5/12/2008	0.018	Yes	9/29/2008	0.021	Yes
5/13/2008	0.017	Yes	9/30/2008	0.021	Yes
5/13/2008	0.019	Yes	9/30/2008	0.021	Yes
5/13/2008	0.017	Yes	9/30/2008	0.022	Yes
5/14/2008	0.018	Yes	10/1/2008	0.022	Yes
5/14/2008	0.018	Yes	10/1/2008	0.021	Yes
5/15/2008	0.02	Yes	10/1/2008	0.023	Yes
5/15/2008	0.024	Yes	10/2/2008	0.022	Yes

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)	Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
10/2/2008	0.021	Yes	9/29/2009	0.021	Yes
10/2/2008	0.022	Yes	9/29/2009	0.022	Yes
5/11/2009	0.02	Yes	9/29/2009	0.022	Yes
5/11/2009	0.02	Yes	9/30/2009	0.021	Yes
5/11/2009	0.019	Yes	9/30/2009	0.021	Yes
5/12/2009	0.018	Yes	9/30/2009	0.021	Yes
5/12/2009	0.019	Yes	10/1/2009	0.021	Yes
5/12/2009	0.018	Yes	10/1/2009	0.021	Yes
5/13/2009	0.018	Yes	10/1/2009	0.021	Yes
5/13/2009	0.018	Yes	5/10/2010	0.021	Yes
5/13/2009	0.021	Yes	5/10/2010	0.021	Yes
5/14/2009	0.019	Yes	5/10/2010	0.022	Yes
5/14/2009	0.018	Yes	5/11/2010	0.025	Yes
5/14/2009	0.018	Yes	5/11/2010	0.023	Yes
5/26/2009	0.014	Yes	5/26/2010	0.016	Yes
5/26/2009	0.014	Yes	6/8/2010	0.011	Yes
5/26/2009	0.013	Yes	6/15/2010	0.014	Yes
5/27/2009	0.013	Yes	8/5/2010	0.016	Yes
5/27/2009	0.013	Yes	9/22/2010	0.018	Yes
5/27/2009	0.013	Yes	2/10/2011	0.016	Yes
5/28/2009	0.013	Yes	5/11/2011	0.02	Yes
5/28/2009	0.013	Yes	6/10/2011	0.015	Yes
5/28/2009	0.013	Yes	6/14/2011	0.013	Yes
5/29/2009	0.012	Yes	6/20/2011	0.007	Yes
5/29/2009	0.012	Yes	6/23/2011	0.013	Yes
5/29/2009	0.013	Yes	9/20/2011	0.016	Yes
6/2/2009	0.03	Yes	9/23/2011	0.015	Yes
6/8/2009	0.01	Yes	10/12/2011	0.015	Yes
6/8/2009	0.01	Yes	11/8/2011	0.014	Yes
6/8/2009	0.01	Yes	5/10/2012	0.011	Yes
6/9/2009	0.01	Yes	5/23/2012	0.008	Yes
6/9/2009	0.01	Yes	6/5/2012	0.008	Yes
6/9/2009	0.01	Yes	7/12/2012	0.012	Yes
6/10/2009	0.01	Yes	9/20/2012	0.015	Yes
6/10/2009	0.011	Yes	9/26/2012	0.016	Yes
6/10/2009	0.011	Yes	10/10/2012	0.015	Yes
6/11/2009	0.011	Yes	5/2/2013	0.016	Yes
6/11/2009	0.01	Yes	5/13/2013	0.016	Yes
6/11/2009	0.011	Yes	5/29/2013	0.008	Yes
9/28/2009	0.02	Yes	7/15/2013	0.014	Yes
9/28/2009	0.02	Yes	9/19/2013	0.017	Yes
9/28/2009	0.022	Yes	10/9/2013	0.015	Yes

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)	Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
11/11/2013	0.014	Yes	4/23/2018	0.012	Yes
4/30/2014	0.0154	Yes	4/26/2018	0.015	Yes
5/20/2014	0.0165	Yes	5/14/2018	0.010	Yes
6/11/2014	0.0079	Yes	6/12/2018	0.006	Yes
7/16/2014	0.0116	Yes	9/24/2018	0.012	Yes
9/15/2014	0.0129	Yes	10/1/2018	0.013	Yes
10/2/2014	0.0146	Yes	4/29/2019	0.013	Yes
11/4/2014	0.014	Yes	5/13/2019	0.011	Yes
4/29/2015	0.0125	Yes	9/23/2019	0.014	Yes
5/12/2015	0.0093	Yes	10/7/2019	0.012	Yes
5/27/2015	0.0073	Yes	5/5/2020	0.012	Yes
9/9/2015	0.0139	Yes	5/26/2020	0.008	Yes
9/30/2015	0.0136	Yes	9/9/2020	0.010	Yes
10/2/2015	0.015	Yes	9/24/2020	0.015	Yes
5/4/2016	0.012	Yes	9/28/2020	0.013	Yes
5/18/2016	0.009	Yes	5/3/2021	0.014	Yes
6/1/2016	0.008	Yes	5/24/2021	0.009	Yes
9/14/2016	0.014	Yes	9/20/2021	0.013	Yes
10/5/2016	0.014	Yes	10/4/2021	0.011	Yes
4/27/2017	0.014	Yes	4/25/2022	0.014	Yes
5/15/2017	0.012	Yes	5/24/2022	0.009	Yes
6/12/2017	0.007	Yes	8/18/2022	0.007	Yes
9/25/2017	0.012	Yes	9/27/2022	0.009	Yes
10/2/2017	0.012	Yes			

Notes: Exceedances of the copper criterion are shown in red; criterion maximum concentration (CMC)

SFSW-02

Date	Cu-D (mg/L)	Exceeds Conservative CMC criteria (0.001 mg/L)	Date	Cu-D (mg/L)	Exceeds Conservative CMC criteria (0.001 mg/L)
6/17/2003	0.035	Yes	4/29/2015	0.008	Yes
9/23/2003	0.05	Yes	5/12/2015	0.006	Yes
4/25/2007	0.026	Yes	9/9/2015	0.010	Yes
5/8/2007	0.019	Yes	10/2/2015	0.011	Yes
5/21/2007	0.01	Yes	5/4/2016	0.006	Yes
10/8/2007	0.017	Yes	5/18/2016	0.006	Yes
6/4/2008	0.009	Yes	9/14/2016	0.009	Yes
9/30/2008	0.016	Yes	10/5/2016	0.010	Yes
6/2/2009	0.008	Yes	4/27/2017	0.010	Yes
9/29/2009	0.015	Yes	5/15/2017	0.009	Yes
5/11/2010	0.023	Yes	9/25/2017	0.009	Yes
5/26/2010	0.012	Yes	10/2/2017	0.009	Yes
6/8/2010	0.007	Yes	4/23/2018	0.013	Yes
8/5/2010	0.013	Yes	5/14/2018	0.007	Yes
9/22/2010	0.014	Yes	9/24/2018	0.009	Yes
2/10/2011	0.009	Yes	10/1/2018	0.010	Yes
6/14/2011	0.01	Yes	4/29/2019	0.009	Yes
9/23/2011	0.013	Yes	5/13/2019	0.006	Yes
10/12/2011	0.012	Yes	9/23/2019	0.010	Yes
11/8/2011	0.011	Yes	10/7/2019	0.010	Yes
5/23/2012	0.005	Yes	5/5/2020	0.009	Yes
7/12/2012	0.008	Yes	5/26/2020	0.005	Yes
9/20/2012	0.011	Yes	9/9/2020	0.008	Yes
10/10/2012	0.011	Yes	9/28/2020	0.010	Yes
5/13/2013	0.008	Yes	5/3/2021	0.010	Yes
7/15/2013	0.01	Yes	5/24/2021	0.006	Yes
10/9/2013	0.011	Yes	9/20/2021	0.009	Yes
11/11/2013	0.01	Yes	10/4/2021	0.008	Yes
5/20/2014	0.005	Yes	4/25/2022	0.010	Yes
7/16/2014	0.009	Yes	5/24/2022	0.006	Yes
9/15/2014	0.010	Yes	8/18/2022	0.007	Yes
11/4/2014	0.011	Yes	9/27/2022	0.008	Yes

Notes: Exceedances of the copper criterion are shown in red; criterion maximum concentration (CMC)

SFSW-04

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)	Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
4/11/2003	0.001	No	6/24/2008	0.001	No
9/23/2003	0.001	No	6/25/2008	0.001	No
5/20/2006	0.001	No	6/25/2008	0.001	No
10/20/2006	0.001	No	6/25/2008	0.001	No
4/25/2007	0.001	No	6/26/2008	0.001	No
5/8/2007	0.001	No	6/26/2008	0.001	No
5/21/2007	0.001	No	6/26/2008	0.001	No
10/8/2007	0.001	No	9/29/2008	0.001	No
5/12/2008	0.001	No	9/29/2008	0.001	No
5/12/2008	0.001	No	9/29/2008	0.001	No
5/12/2008	0.001	No	9/30/2008	0.001	No
5/13/2008	0.001	No	9/30/2008	0.001	No
5/13/2008	0.001	No	9/30/2008	0.001	No
5/13/2008	0.001	No	10/1/2008	0.001	No
5/14/2008	0.001	No	10/1/2008	0.001	No
5/14/2008	0.001	No	10/1/2008	0.001	No
5/15/2008	0.001	No	10/2/2008	0.001	No
5/15/2008	0.001	No	10/2/2008	0.001	No
5/16/2008	0.001	No	10/2/2008	0.001	No
5/16/2008	0.001	No	5/11/2009	0.001	No
5/27/2008	0.001	No	5/11/2009	0.001	No
5/27/2008	0.001	No	5/11/2009	0.001	No
5/27/2008	0.001	No	5/12/2009	0.001	No
5/28/2008	0.001	No	5/12/2009	0.001	No
5/28/2008	0.001	No	5/12/2009	0.001	No
5/28/2008	0.001	No	5/13/2009	0.001	No
5/29/2008	0.001	No	5/13/2009	0.001	No
5/29/2008	0.001	No	5/13/2009	0.001	No
5/29/2008	0.001	No	5/14/2009	0.001	No
5/30/2008	0.001	No	5/14/2009	0.001	No
5/30/2008	0.001	No	5/14/2009	0.001	No
5/30/2008	0.001	No	5/26/2009	0.001	No
6/4/2008	0.001	No	5/26/2009	0.001	No
6/23/2008	0.001	No	5/26/2009	0.001	No
6/23/2008	0.001	No	5/27/2009	0.001	No
6/23/2008	0.001	No	5/27/2009	0.001	No
6/24/2008	0.001	No	5/27/2009	0.001	No
6/24/2008	0.001	No	5/28/2009	0.001	No

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)	Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
5/28/2009	0.001	No	6/14/2011	0.001	No
5/28/2009	0.001	No	6/20/2011	0.001	No
5/29/2009	0.001	No	6/23/2011	0.001	No
5/29/2009	0.001	No	9/20/2011	0.001	No
5/29/2009	0.001	No	9/23/2011	0.001	No
6/2/2009	0.001	No	5/10/2012	0.0005	No
6/8/2009	0.001	No	5/23/2012	0.0003	No
6/8/2009	0.001	No	6/5/2012	0.0001	No
6/8/2009	0.001	No	9/20/2012	0.0001	No
6/9/2009	0.001	No	9/26/2012	0.0001	No
6/9/2009	0.001	No	5/2/2013	0.0001	No
6/9/2009	0.001	No	5/13/2013	0.0007	No
6/10/2009	0.001	No	5/29/2013	0.0001	No
6/10/2009	0.001	No	9/19/2013	0.0001	No
6/10/2009	0.001	No	10/9/2013	0.0001	No
6/11/2009	0.001	No	5/20/2014	0.0005	No
6/11/2009	0.001	No	9/15/2014	0.0005	No
6/11/2009	0.001	No	10/2/2014	0.0003	No
9/28/2009	0.001	No	4/30/2015	0.0003	No
9/28/2009	0.001	No	5/12/2015	0.0003	No
9/28/2009	0.001	No	5/27/2015	0.0004	No
9/29/2009	0.001	No	9/9/2015	0.0001	No
9/29/2009	0.001	No	9/30/2015	0.0001	No
9/29/2009	0.001	No	5/4/2016	0.0001	No
9/30/2009	0.001	No	5/18/2016	0.0005	No
9/30/2009	0.001	No	6/1/2016	0.0005	No
9/30/2009	0.001	No	9/14/2016	0.0002	No
10/1/2009	0.001	No	4/27/2017	0.0001	No
10/1/2009	0.001	No	5/15/2017	0.0004	No
10/1/2009	0.001	No	9/25/2017	0.0005	No
5/10/2010	0.001	No	10/2/2017	0.0001	No
5/10/2010	0.001	No	4/26/2018	0.0003	No
5/10/2010	0.001	No	5/14/2018	0.0003	No
5/11/2010	0.001	No	6/12/2018	0.0003	No
5/26/2010	0.001	No	9/24/2018	0.0003	No
6/8/2010	0.001	No	4/29/2019	0.0003	No
9/22/2010	0.001	No	5/13/2019	0.0004	No
5/11/2011	0.001	No	9/23/2019	0.0003	No
6/10/2011	0.001	No	10/7/2019	0.0003	No

Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)	Date	Cu-D (mg/L)	Exceeds BLM CMC criteria (0.00336 mg/L)
5/5/2020	0.0003	No	9/20/2021	0.0003	No
5/26/2020	0.0003	No	10/4/2021	0.0003	No
9/9/2020	0.0003	No	4/25/2022	0.0005	No
9/24/2020	0.0003	No	5/24/2022	0.005	No
9/28/2020	0.0004	No	8/18/2022	0.0005	No
5/3/2021	0.0004	No	9/27/2022	0.0005	No
5/24/2021	0.0004	No			

Notes: Exceedances of the copper criterion are shown in red; criterion maximum concentration (CMC)

Appendix E. Total and dissolved cobalt data for Bucktail Creek (BTSW-01 and BTSW-02) from 2003–2022.

BTSW-01

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2003	Average	0.590	0.611
	Median	0.590	0.611
	Std. dev.	0.170	0.178
	Minimum	0.470	0.485
	Maximum	0.710	0.737
	No. of samples	2	2
2004	Average	0.545	0.551
	Median	0.545	0.554
	Std. dev.	0.038	0.040
	Minimum	0.503	0.499
	Maximum	0.589	0.595
	No. of samples	4	4
2005	Average	0.370	0.365
	Median	0.370	0.365
	Std. dev.	0.099	0.106
	Minimum	0.300	0.290
	Maximum	0.440	0.440
	No. of samples	2	2
2006	Average	0.318	0.326
	Median	0.319	0.328
	Std. dev.	0.030	0.025
	Minimum	0.281	0.296
	Maximum	0.351	0.352
	No. of samples	4	4
2007	Average	0.216	0.213
	Median	0.211	0.200
	Std. dev.	0.068	0.072
	Minimum	0.143	0.146
	Maximum	0.298	0.304
	No. of samples	4	4
2008	Average	0.161	0.160
	Median	0.147	0.148
	Std. dev.	0.053	0.057
	Minimum	0.123	0.120
	Maximum	0.198	0.200
	No. of samples	2	2
2009	Average	0.149	0.151

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
	Median	0.149	0.151
	Std. dev.	0.026	0.027
	Minimum	0.130	0.132
	Maximum	0.167	0.170
	No. of samples	2	2
2010	Average	0.131	0.128
	Median	0.147	0.151
	Std. dev.	0.030	0.036
	Minimum	0.088	0.084
	Maximum	0.159	0.168
	No. of samples	7	7
2011	Average	0.141	0.138
	Median	0.142	0.135
	Std. dev.	0.031	0.027
	Minimum	0.099	0.098
	Maximum	0.186	0.172
	No. of samples	5	5
2012	Average	0.142	0.137
	Median	0.147	0.139
	Std. dev.	0.016	0.014
	Minimum	0.119	0.120
	Maximum	0.154	0.151
	No. of samples	4	4
2013	Average	0.147	0.145
	Median	0.150	0.151
	Std. dev.	0.017	0.014
	Minimum	0.125	0.123
	Maximum	0.165	0.153
	No. of samples	4	4
2014	Average	0.138	0.130
	Median	0.151	0.149
	Std. dev.	0.039	0.041
	Minimum	0.081	0.069
	Maximum	0.168	0.154
	No. of samples	4	4
2015	Average	0.133	0.129
	Median	0.139	0.134
	Std. dev.	0.021	0.021
	Minimum	0.103	0.100
	Maximum	0.152	0.149

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
	No. of samples	4	4
2016	Average	0.135	0.128
	Median	0.143	0.141
	Std. dev.	0.032	0.027
	Minimum	0.090	0.087
	Maximum	0.163	0.144
	No. of samples	4	4
2017	Average	0.132	0.131
	Median	0.146	0.145
	Std. dev.	0.030	0.031
	Minimum	0.087	0.086
	Maximum	0.150	0.151
	No. of samples	4	4
2018	Average	0.117	0.114
	Median	0.126	0.123
	Std. dev.	0.024	0.025
	Minimum	0.080	0.077
	Maximum	0.134	0.132
	No. of samples	4	4
2019	Average	0.140	0.121
	Median	0.125	0.121
	Std. dev.	0.036	0.006
	Minimum	0.116	0.115
	Maximum	0.193	0.126
	No. of samples	4	4
2020	Average	0.134	0.117
	Median	0.124	0.122
	Std. dev.	0.047	0.025
	Minimum	0.090	0.085
	Maximum	0.199	0.139
	No. of samples	4	4
2021	Average	0.153	0.141
	Median	0.152	0.143
	Std. dev.	0.007	0.006
	Minimum	0.145	0.132
	Maximum	0.162	0.146
	No. of samples	4	4

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2022	Average	0.150	0.144
	Median	0.154	0.148
	Std. dev.	0.015	0.013
	Minimum	0.128	0.126
	Maximum	0.162	0.156
	No. of samples	4	4

Notes: milligram per liter (mg/L); standard deviation (std. dev.)

BTSW-01.6

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2003	Average	1.534	1.503
	Median	1.425	1.410
	Std. dev.	0.483	0.459
	Minimum	0.750	0.739
	Maximum	2.210	2.190
	No. of samples	10	10
2004	Average	1.186	1.196
	Median	1.120	1.120
	Std. dev.	0.341	0.323
	Minimum	0.793	0.827
	Maximum	1.710	1.740
	No. of samples	11	11
2005	Average	0.440	0.420
	Median	0.440	0.420
	Std. dev.	0.028	0.028
	Minimum	0.420	0.400
	Maximum	0.460	0.440
	No. of samples	2	2
2006	Average	0.678	0.684
	Median	0.683	0.640
	Std. dev.	0.432	0.477
	Minimum	0.155	0.158
	Maximum	1.190	1.300
	No. of samples	4	4
2007	Average	0.163	0.164
	Median	0.165	0.165
	Std. dev.	0.052	0.052
	Minimum	0.106	0.110
	Maximum	0.216	0.215
	No. of samples	4	4
2008	Average	0.117	0.113
	Median	0.117	0.113
	Std. dev.	0.026	0.013
	Minimum	0.098	0.103
	Maximum	0.135	0.122
	No. of samples	2	2
2009	Average	0.109	0.106
	Median	0.109	0.106
	Std. dev.	0.026	0.025
	Minimum	0.090	0.088

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2010	Maximum	0.127	0.124
	No. of samples	2	2
	Average	0.087	0.081
	Median	0.083	0.084
	Std. dev.	0.013	0.025
	Minimum	0.075	0.044
	Maximum	0.109	0.106
2011	No. of samples	5	5
	Average	0.073	0.072
	Median	0.073	0.070
	Std. dev.	0.024	0.022
	Minimum	0.043	0.046
	Maximum	0.110	0.106
	No. of samples	5	5
2012	Average	0.079	0.077
	Median	0.077	0.077
	Std. dev.	0.020	0.017
	Minimum	0.061	0.059
	Maximum	0.101	0.095
	No. of samples	4	4
2013	Average	0.061	0.052
	Median	0.055	0.053
	Std. dev.	0.017	0.026
	Minimum	0.049	0.019
	Maximum	0.087	0.083
	No. of samples	4	4
2014	Average	0.070	0.064
	Median	0.072	0.065
	Std. dev.	0.013	0.010
	Minimum	0.055	0.053
	Maximum	0.083	0.072
	No. of samples	4	4
2015	Average	0.047	0.046
	Median	0.046	0.045
	Std. dev.	0.007	0.008
	Minimum	0.040	0.037
	Maximum	0.057	0.055
	No. of samples	4	4
2016	Average	0.053	0.054
	Median	0.049	0.050

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
	Std. dev.	0.010	0.009
	Minimum	0.046	0.048
	Maximum	0.068	0.067
	No. of samples	4	4
2017	Average	0.053	0.054
	Median	0.051	0.052
	Std. dev.	0.005	0.004
	Minimum	0.050	0.051
	Maximum	0.061	0.060
	No. of samples	4	4
2018	Average	0.045	0.033
	Median	0.045	0.041
	Std. dev.	0.003	0.019
	Minimum	0.040	0.005
	Maximum	0.048	0.046
	No. of samples	4	4
2019	Average	0.101	0.099
	Median	0.100	0.100
	Std. dev.	0.010	0.011
	Minimum	0.091	0.087
	Maximum	0.112	0.110
	No. of samples	4	4
2020	Average	0.091	0.088
	Median	0.090	0.087
	Std. dev.	0.006	0.006
	Minimum	0.085	0.082
	Maximum	0.099	0.097
	No. of samples	4	4
2021	Average	0.095	0.096
	Median	0.095	0.096
	Std. dev.	0.007	0.005
	Minimum	0.087	0.090
	Maximum	0.104	0.102
	No. of samples	4	4
2022	Average	0.093	0.110
	Median	0.093	0.101
	Std. dev.	0.012	0.028
	Minimum	0.081	0.088
	Maximum	0.106	0.150

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
	No. of samples	4	4

Notes: milligram per liter (mg/L); standard deviation (std. dev.)

Appendix F. Total and dissolved cobalt data for South Fork Big Deer Creek (SFSW-01, SFSW-02, and SFSW-04) from 2003–2022.

SFSW-01

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved mg/L)
2003	Average	0.0927	0.0727
	Median	0.0772	0.0752
	Std. dev.	0.0342	0.0386
	Minimum	0.0550	0.0250
	Maximum	0.1310	0.1310
	No. of samples	5	5
2004	Average	0.0555	0.0576
	Median	0.0600	0.0620
	Std. dev.	0.0116	0.0135
	Minimum	0.0330	0.0260
	Maximum	0.0700	0.0710
	No. of samples	13.0000	13.0000
2005	Average	0.0600	0.0700
	Median	0.0600	0.0700
	Std. dev.	-	-
	Minimum	0.0600	0.0700
	Maximum	0.0600	0.0700
	No. of samples	1	1
2006	Average	0.0585	0.0373
	Median	0.0405	0.0390
	Std. dev.	0.0370	0.0121
	Minimum	0.0390	0.0210
	Maximum	0.1140	0.0500
	No. of samples	4.0000	4.0000
2007	Average	0.0253	0.0268
	Median	0.0245	0.0270
	Std. dev.	0.0074	0.0094
	Minimum	0.0170	0.0150
	Maximum	0.0350	0.0380
	No. of samples	4	4
2008	Average	0.0193	0.0189
	Median	0.0185	0.0160
	Std. dev.	0.0046	0.0070
	Minimum	0.0150	0.0100
	Maximum	0.0250	0.0320

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved mg/L)
2009	No. of samples	4	45
	Average	0.0164	0.0186
	Median	0.0160	0.0220
	Std. dev.	0.0055	0.0064
	Minimum	0.0110	0.0100
	Maximum	0.0230	0.0270
	No. of samples	5	45
2010	Average	0.0165	0.0208
	Median	0.0160	0.0240
	Std. dev.	0.0061	0.0074
	Minimum	0.0100	0.0090
	Maximum	0.0260	0.0290
	No. of samples	6	10
2011	Average	0.0170	0.0144
	Median	0.0170	0.0165
	Std. dev.	0.0024	0.0041
	Minimum	0.0140	0.0070
	Maximum	0.0200	0.0180
	No. of samples	9	10
2012	Average	0.0121	0.0115
	Median	0.0120	0.0124
	Std. dev.	0.0041	0.0043
	Minimum	0.0071	0.0059
	Maximum	0.0170	0.0164
	No. of samples	5	7
2013	Average	0.0131	0.0132
	Median	0.0150	0.0158
	Std. dev.	0.0033	0.0050
	Minimum	0.0076	0.0057
	Maximum	0.0154	0.0189
	No. of samples	5	7
2014	Average	0.0159	0.0146
	Median	0.0157	0.0164
	Std. dev.	0.0030	0.0039
	Minimum	0.0127	0.0093
	Maximum	0.0195	0.0189
	No. of samples	7	7
2015	Average	0.0122	0.0113
	Median	0.0129	0.0127
	Std. dev.	0.0032	0.0038

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved mg/L)
2016	Minimum	0.0081	0.0058
	Maximum	0.0149	0.0149
	No. of samples	6	6
	Average	0.0124	0.0107
	Median	0.0136	0.0089
	Std. dev.	0.0046	0.0045
2017	Minimum	0.0064	0.0061
	Maximum	0.0161	0.0159
	No. of samples	5	5
	Average	0.0147	0.0136
	Median	0.0157	0.0162
	Std. dev.	0.0035	0.0053
2018	Minimum	0.0096	0.0071
	Maximum	0.0177	0.0193
	No. of samples	5	5
	Average	0.0136	0.0131
	Median	0.0150	0.0148
	Std. dev.	0.0037	0.0036
2019	Minimum	0.0083	0.0083
	Maximum	0.0162	0.0161
	No. of samples	6	6
	Average	0.0124	0.0126
	Median	0.0138	0.0141
	Std. dev.	0.0037	0.0039
2020	Minimum	0.0070	0.0068
	Maximum	0.0150	0.0152
	No. of samples	4	4
	Average	0.0119	0.0117
	Median	0.0125	0.0123
	Std. dev.	0.0029	0.0036
2021	Minimum	0.0079	0.0070
	Maximum	0.0145	0.0154
	No. of samples	5	5
	Average	0.0122	0.0120
	Median	0.0132	0.0130
	Std. dev.	0.0032	0.0026
2021	Minimum	0.0077	0.0081
	Maximum	0.0147	0.0138
	No. of samples	4	4

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved mg/L)
2022	Average	0.0135	0.0121
	Median	0.0127	0.0119
	Std. dev.	0.0038	0.0028
	Minimum	0.0099	0.0095
	Maximum	0.0186	0.0151
	No. of samples	4	4

Notes: milligram per liter (mg/L); standard deviation (std. dev.)

SFSW-02

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2003	Average	0.0693	0.0711
	Median	0.0693	0.0711
	Std. dev.	0.0174	0.0199
	Minimum	0.0570	0.0570
	Maximum	0.0816	0.0851
	No. of samples	2	2
2007	Average	0.0240	0.0258
	Median	0.0235	0.0255
	Std. dev.	0.0102	0.0106
	Minimum	0.0120	0.0130
	Maximum	0.0370	0.0390
	No. of samples	4	4
2008	Average	0.0185	0.0215
	Median	0.0185	0.0215
	Std. dev.	0.0092	0.0134
	Minimum	0.0120	0.0120
	Maximum	0.0250	0.0310
	No. of samples	2	2
2009	Average	0.0180	0.0175
	Median	0.0180	0.0175
	Std. dev.	0.0071	0.0106
	Minimum	0.0130	0.0100
	Maximum	0.0230	0.0250
	No. of samples	2	2
2010	Average	0.0174	0.0176
	Median	0.0180	0.0190
	Std. dev.	0.0067	0.0067
	Minimum	0.0090	0.0090
	Maximum	0.0260	0.0260
	No. of samples	5	5
2011	Average	0.0152	0.0158
	Median	0.0170	0.0170
	Std. dev.	0.0025	0.0029
	Minimum	0.0120	0.0110
	Maximum	0.0170	0.0180
	No. of samples	5	5
2012	Average	0.0129	0.0127
	Median	0.0140	0.0137
	Std. dev.	0.0048	0.0047
	Minimum	0.0064	0.0063

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2013	Maximum	0.0173	0.0169
	No. of samples	4	4
	Average	0.0123	0.0125
	Median	0.0138	0.0141
	Std. dev.	0.0052	0.0057
	Minimum	0.0052	0.0047
	Maximum	0.0166	0.0171
2014	No. of samples	4	4
	Average	0.0161	0.0152
	Median	0.0174	0.0165
	Std. dev.	0.0036	0.0041
	Minimum	0.0108	0.0094
	Maximum	0.0187	0.0184
	No. of samples	4	4
2015	Average	0.0122	0.0121
	Median	0.0129	0.0129
	Std. dev.	0.0041	0.0043
	Minimum	0.0072	0.0067
	Maximum	0.0159	0.0159
	No. of samples	4	4
2016	Average	0.0117	0.0118
	Median	0.0121	0.0123
	Std. dev.	0.0054	0.0057
	Minimum	0.0060	0.0058
	Maximum	0.0167	0.0167
	No. of samples	4	4
2017	Average	0.0153	0.0160
	Median	0.0170	0.0174
	Std. dev.	0.0049	0.0052
	Minimum	0.0080	0.0086
	Maximum	0.0190	0.0207
	No. of samples	4	4
2018	Average	0.0139	0.0141
	Median	0.0154	0.0161
	Std. dev.	0.0044	0.0046
	Minimum	0.0075	0.0073
	Maximum	0.0174	0.0171
	No. of samples	4	4

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2019	Average	0.0124	0.0125
	Median	0.0142	0.0145
	Std. dev.	0.0046	0.0047
	Minimum	0.0056	0.0055
	Maximum	0.0156	0.0156
	No. of samples	4	4
2020	Average	0.0117	0.0117
	Median	0.0126	0.0126
	Std. dev.	0.0038	0.0041
	Minimum	0.0066	0.0063
	Maximum	0.0151	0.0155
	No. of samples	4	4
2021	Average	0.0447	0.0126
	Median	0.0144	0.0137
	Std. dev.	0.0656	0.0034
	Minimum	0.0071	0.0076
	Maximum	0.1430	0.0153
	No. of samples	4	4
2022	Average	0.0138	0.0133
	Median	0.0139	0.0131
	Std. dev.	0.0033	0.0035
	Minimum	0.0097	0.0095
	Maximum	0.0176	0.0176
	No. of samples	4	4

Notes: milligram per liter (mg/L); standard deviation (std. dev.)

SFSW-04

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2003	Average	0.0060	0.0060
	Median	0.0060	0.0060
	Std. dev.	0.0000	0.0000
	Minimum	0.0060	0.0060
	Maximum	0.0060	0.0060
	No. of samples	2	2
2004	Average	0.0033	0.0038
	Median	0.0010	0.0020
	Std. dev.	0.0045	0.0042
	Minimum	0.0010	0.0010
	Maximum	0.0100	0.0100
	No. of samples	4	4
2007	Average	0.0010	0.0028
	Median	0.0010	0.0030
	Std. dev.	0.0000	0.0005
	Minimum	0.0010	0.0020
	Maximum	0.0010	0.0030
	No. of samples	4	4
2008	Average	0.0010	0.0016
	Median	0.0010	0.0010
	Std. dev.	0.0000	0.0014
	Minimum	0.0010	0.0010
	Maximum	0.0010	0.0070
	No. of samples	4	47
2009	Average	0.0010	0.0020
	Median	0.0010	0.0020
	Std. dev.	0.0000	0.0008
	Minimum	0.0010	0.0010
	Maximum	0.0010	0.0040
	No. of samples	4	47
2010	Average	0.0010	0.0014
	Median	0.0010	0.0010
	Std. dev.	0.0000	0.0008
	Minimum	0.0010	0.0010
	Maximum	0.0010	0.0030
	No. of samples	3	7
2011	Average	0.0027	0.0010
	Median	0.0010	0.0010
	Std. dev.	0.0036	0.0000
	Minimum	0.0010	0.0010

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
	Maximum	0.0100	0.0010
	No. of samples	6	7
2012	Average	0.0001	0.0004
	Median	0.0001	0.0003
	Std. dev.	0.0000	0.0003
	Minimum	0.0001	0.0001
	Maximum	0.0001	0.0008
	No. of samples	3	5
2013	Average	0.0001	0.0003
	Median	0.0001	0.0002
	Std. dev.	0.0000	0.0003
	Minimum	0.0001	0.0001
	Maximum	0.0001	0.0008
	No. of samples	3	5
2014	Average	0.0001	0.0002
	Median	0.0001	0.0002
	Std. dev.	0.0000	0.0001
	Minimum	0.0001	0.0001
	Maximum	0.0001	0.0003
	No. of samples	3	3
2015	Average	0.0001	0.0001
	Median	0.0001	0.0001
	Std. dev.	0.0000	0.0001
	Minimum	0.0001	0.0001
	Maximum	0.0001	0.0002
	No. of samples	5	5
2016	Average	0.0006	0.0003
	Median	0.0006	0.0003
	Std. dev.	0.0006	0.0002
	Minimum	0.0001	0.0001
	Maximum	0.0010	0.0006
	No. of samples	4	4
2017	Average	0.0002	0.0002
	Median	0.0002	0.0001
	Std. dev.	0.0001	0.0001
	Minimum	0.0001	0.0001
	Maximum	0.0002	0.0003
	No. of samples	4	4

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2018	Average	0.0001	0.0002
	Median	0.0001	0.0002
	Std. dev.	0.0000	0.0001
	Minimum	0.0001	0.0001
	Maximum	0.0001	0.0002
	No. of samples	4	4
2019	Average	0.0002	0.0002
	Median	0.0001	0.0002
	Std. dev.	0.0002	0.0001
	Minimum	0.0001	0.0001
	Maximum	0.0004	0.0003
	No. of samples	4	4
2020	Average	0.0001	0.0003
	Median	0.0001	0.0002
	Std. dev.	0.0001	0.0003
	Minimum	0.0001	0.0001
	Maximum	0.0002	0.0007
	No. of samples	5	5
2021	Average	0.0001	0.0007
	Median	0.0001	0.0003
	Std. dev.	0.0000	0.0009
	Minimum	0.0001	0.0001
	Maximum	0.0001	0.0020
	No. of samples	4	4
2022	Average	0.0001	0.0003
	Median	0.0001	0.0001
	Std. dev.	0.0000	0.0005
	Minimum	0.0001	0.0001
	Maximum	0.0001	0.0010
	No. of samples	4	4

Notes: milligram per liter (mg/L); standard deviation (std. dev.)

Appendix G. Benthic macroinvertebrate data for South Fork Big Deer Creek (SFB-0.1 and 0.6) (2003–2022).

Monitoring location	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2017	2022
Stream Macroinvertebrate Index Score														
SFB-0.1	20	19	37	31	29	39	30	30	36	39	37	52	38	51
SFB-0.6	92	92	90	87	95	94	95	92	86	98	94	85	83	54
Stream Macroinvertebrate Condition Rating														
SFB-0.1	0	0	1	0	0	1	0	0	1	1	1	3	1	1
SFB-0.6	3	3	3	3	3	3	3	3	3	3	3	3	3	2
Total Abundance														
SFB-0.1	134	389	272	594	396	1,104	1,017	1,715	614	1,030	1,101	500	70	230
SFB-0.6	1,893	2,280	5,165	3,960	6,706	1,191	2,595	2,635	4,251	3,692	2,626	500	500	157
Total Taxa														
SFB-0.1	8	8	19	16	12	20	16	18	12	16	21	30	18	28
SFB-0.6	41	43	37	35	47	37	37	42	40	41	38	45	51	26
Ephemeroptera Taxa														
SFB-0.1	1	0	1	1	2	4	2	2	2	3	2	2	2	12
SFB-0.6	8	9	10	9	11	11	9	10	8	11	11	13	12	11
Plecoptera Taxa														
SFB-0.1	0	0	1	0	0	2	1	1	2	2	4	6	2	4
SFB-0.6	11	10	9	13	13	9	10	9	10	11	9	10	12	7
Trichoptera Taxa														
SFB-0.1	1	3	6	6	3	3	3	3	4	4	2	9	4	7
SFB-0.6	10	6	8	5	8	6	7	6	6	8	8	8	9	4

Monitoring location	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2017	2022
%Ephemeroptera														
SFB-0.1	2.5	0	1.2	1.1	18.6	9.4	14.9	3.7	12.6	10.4	2.4	-	10	-
SFB-0.6	20.2	15.2	35	23.3	26.3	41.4	32.4	32.2	32.4	35.4	30.2	-	38.2	-
%Plecoptera														
SFB-0.1	0	0	2.5	0	0	0.6	0.3	1.2	7.1	3.3	3.7	-	7.1	-
SFB-0.6	53.6	28.1	20.2	50.7	25.7	29	36.9	17.8	38	27.4	16.4	-	17	-
Hilsenhoff Biotic Index (HBI)														
SFB-0.1	2.3	3.3	4.5	4.3	4.1	4.2	3.6	4.5	3.6	3	4.5	2.8	4.6	5.0
SFB-0.6	2.6	2.4	3.4	2.7	2.4	1.8	2	2.9	2.2	2.2	1.6	2.6	4.5	4.3
%5 Dominant														
SFB-0.1	92.5	96.6	79	91	91.5	92.7	90.1	90.2	83.6	80.8	81.4	73.8	-	-
SFB-0.6	61.4	57.5	62	69.8	49.8	58.6	59.5	36.9	67.4	39.8	57.6	40.6	-	-

Appendix H. Fish condition ratings for South Fork Big Deer Creek (SFB-0.1 and 0.6) (2002–2022).

Site	Metric	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2017	2022
SFB-0.1	SFI score	0	69	64	54	54	67	73	68	69	53	66	74	68	86	78
	SFI rating	0	2	1	1	1	2	2	2	2	1	1	2	2	2	2
	No. of fish	0	8	5	1	3	10	27	18	9	3	13	25	5	5	14
	CPUE	0.00	0.59	0.45	0.1	0.23	1.02	1.69	1.33	0.67	0.28	0.9	1.67	0.36	0.54	1.07
SFB-0.6	SFI score	0	0	0	0	0	0	0	0	0	0	0	0	0	0	85
	SFI rating	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
	No. of fish	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	CPUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.10

Notes: stream fish index (SFI); catch per unit effort (CPUE)

Appendix I. Habitat metrics and values for South Fork Big Deer Creek (SFB-0.1 and 0.6) (2003–2022).

Metric	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2015	2017	2022
SFB-0.1														
Instream cover	15	15	15	16	16	18	18	18	18	19	19	11	17	18
Large organic debris (number of pieces)	50	62	65	70	82	150	81	94	108	85	121	162	94	130
Percent fines (<2 mm in wetted width)	0	6	2	10	3	12	16	6	4	9	15	5	14	8
Embeddedness	18	18	18	18	18	19	16	16	8	14	14	10	15	16
Wolman size classes (number)	8	9	8	8	8	9	9	8	10	9	7	8	8	7
Channel shape	11	12	12	13	13	13	14	14	12	13	13	9	9	8
Percent bank vegetation cover	100	80	100	100	100	100	100	100	100	100	95	99	100	100
Percent canopy cover	4	6	0	0	3	14	51	28	32	35	19	43	28	32
Disruptive pressures	6	6	6	6	6	6	10	10	6	10	10	9	8	9
Zone of influence	5	5	5	5	5	5	8	8	8	8	8	7	9	7
SFB-0.6														
Instream cover	9	15	15	15	15	17	17	17	18	19	19	18	18	18
Large organic debris (number of pieces)	72	120	112	110	120	170	173	181	105	108	130	159	60	91
Percent fines (<2 millimeter (mm) in wetted width)	0	4	6	2	6	4	12	5	6	11	3	5	5	12
Embeddedness	18	18	18	18	18	17	18	18	8	17	17	19	18	14
Wolman size classes (number)	9	8	7	7	6	7	10	8	10	8	8	8	9	8
Channel shape	6	8	8	8	8	9	11	11	9	12	12	12	7	8
Percent bank vegetation cover	100	50	100	100	100	100	95	95	90	100	95	95	100	100
Percent canopy cover	48	9	10	6	3	35	55	45	23	51	52	36	43	44
Disruptive pressures	8	8	8	8	8	8	9	9	7	10	10	9	9	9
Zone of influence	6	6	6	6	6	6	8	8	9	8	8	9	9	9

Appendix J: Data Used to Calculate CMC and CCC Criteria Using the Copper Biotic Ligand Model.

Site	Date	Temp C	pH	CU mg/L	DOC mg/L	*HA %	Ca mg/l	Mg mg/L	Na mg/L	K mg/L	SO4 mg/L	Cl mg/L	Alkalinity mg/L	*S mg/L
SFSW-01	4/25/2022	6.2	7.74	0.0141	0.9	10	28.3	2.9	4	2	13	1	75	8.00E-6
SFSW-01	5/24/2022	5.9	7.86	0.0094	1.5	10	22.9	1.9	3	2	8	1	64	8.00E-6
SFSW-01	8/18/2022	10.3	8.08	0.0072	1.2	10	26.6	2.4	3	2	9	1	75	8.00E-6
SFSW-01	9/27/2022	6.9	8.19	0.009	1	10	29.2	2.4	3	2	11	1	76	8.00E-6
SFSW-02	4/25/2022	6.8	7.59	0.0101	0.9	10	27.7	2.8	4	2	12	1	75	8.00E-6
SFSW-02	5/24/2022	5.6	7.71	0.006	1.6	10	23.1	1.9	3	2	8	1	64	8.00E-6
SFSW-02	8/18/2022	9.9	8.1	0.0071	1.4	10	27	2.3	3	2	9	1	75	8.00E-6
SFSW-02	9/27/2022	6.8	7.94	0.0078	1	10	29.1	2.4	3	2	11	1	75	8.00E-6
SFSW-01	5/3/2021	6.1	8.1	0.0224	1.5	10	4.9	2.2	3	2	11	1	71	8.00E-6
SFSW-01	5/24/2021	5.4	8	0.011	1.5	10	21.2	1.7	2	1	7	1	61	8.00E-6
SFSW-01	9/20/2021	8.5	8.1	0.0149	1.8	10	28.7	2.5	4	2	10	1	77	8.00E-6
SFSW-01	10/4/2021	5.2	8.1	0.0204	1.1	10	27	2.4	3	2	11	1	77	8.00E-6
SFSW-02	5/3/2021	5.7	8.1	0.0115	1.4	10	25	2.1	3	2	10	1	71	8.00E-6
SFSW-02	5/24/2021	5.2	8	0.0074	1.5	10	21.7	1.7	2	1	6	1	61	8.00E-6
SFSW-02	9/20/2021	8.1	8.1	0.0117	1.9	10	28.6	2.5	4	2	10	1	77	8.00E-6
SFSW-02	10/4/2021	5.2	8.1	0.0109	1	10	26.9	2.4	3	2	11	1	77	8.00E-6

SFSW-01	5/5/2020	6.2	8.1	0.0162	29	10	24.4	2.2	3	2	8	1	66	8.00E-6
SFSW-01	5/26/2020	6.1	8	0.0163	2.3	10	18.4	1.4	2	1	5	1	51	8.00E-6
SFSW-01	9/9/2020	4.1	8	0.0167	1	10	28.3	2.4	3	2	10	1	77	8.00E-6
SFSW-01	9/28/2020	8.1	8.1	0.0179	1.1	10	25.1	2.4	3	2	10	1	78	8.00E-6
SFSW-02	5/5/2020	6	8	0.011	2.4	10	24.4	2.2	3	2	8	1	65	8.00E-6
SFSW-02	5/26/2020	6	8	0.009	2.3	10	18.3	1.4	2	1	4	1	51	8.00E-6
SFSW-02	9/9/2020	4	8.1	0.0093	0.9	10	28.3	2.4	3	2	9	1	74	8.00E-6
SFSW-02	9/28/2020	8.2	8.1	0.0126	1.1	10	25.6	2.4	3	2	10	1	77	8.00E-6
SFSW-01	4/29/2019	3.2	8	0.0159	1.3	10	26.3	2.4	3	2	9	1	70	8.00E-6
SFSW-01	5/13/2019	4.3	8	0.0192	2.2	10	19.2	1.5	2	1	4	1	53	8.00E-6
SFSW-01	9/23/2019	8.3	8.1	0.0153	1.7	10	27.5	2.4	4	2	11	1	74	8.00E-6
SFSW-01	10/7/2019	3.5	8	0.014	1.6	10	27.1	2.6	3	2	11	1	74	8.00E-6
SFSW-02	4/29/2019	2.8	8	0.0111	1.3	10	25.9	2.4	3	2	9	1	70	8.00E-6
SFSW-02	5/13/2019	4.2	8	0.0091	2	10	19.3	1.5	2	1	4	1	52	8.00E-6
SFSW-02	9/23/2019	7	8	0.0124	1.6	10	27.6	2.4	3	2	11	1	73	8.00E-6

*Default values referenced in the Idaho *Implementation Guidance for the Idaho Copper Criteria for Aquatic Life* (2021).

Appendix K: Response to Public Comments

All comments from EPA Region 10.

Comment	Rule Section / Subject Matter	Comment Summary	Response
1.	Monitoring Data	The draft review does not clearly identify who provided the data and does not provide references to quality assurance project plans, field protocols, analytical methods, or data reports that were used in the provided analysis. In addition, biological monitoring results are presented, but there are no references provided that describe the macroinvertebrate identification and enumeration methods, such as the qualifications of the taxonomists, the sorting procedures, or the level of taxonomic effort. Please include appropriate references, including who collected and provided the data and the laboratories performing analyses.	In-text references for the monitoring data have been added to the report. Please refer to the monitoring reports for further information on sampling efforts, macroinvertebrate identification, and enumeration methods.

2.	Copper Monitoring and Comparison to Criteria	Any comparison of ambient copper concentrations to criteria in Idaho should reference the BLM, and not the previously applicable hardness-based copper criterion.	DEQ previously included the estimated copper criterion derived from the BLM based on regional averages (as referenced in the Idaho DEQ Copper Guidance) but has since updated the criteria using BLM criteria generated using data obtained from the site.
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3.	Copper analysis	EPA suggests that the discussion in the review focus on dissolved copper, and that the ambient concentrations and criterion concentrations be reported in the same units ($\mu\text{g/L}$) and that figures are presented in a logarithmic scale to make direct comparison easier.	Total copper has been removed from the report to focus on the dissolved copper fraction, to which the criteria apply. Concentrations are presented in mg/L to maintain consistency. Log_{10} has been applied to two graphs for Bucktail Creek to make interpretation of the graphs easier.
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4.	Copper criteria	The regional conservative estimated copper BLM criteria are highly stringent. In the absence of site-specific data, it would be more appropriate to use copper BLM outputs from the upper end of the regional distribution to determine if dissolved copper approaches concentrations that would lead to the attainment of aquatic life uses. Alternatively, DEQ could compare ambient dissolved copper concentrations to BLM outputs from nearby streams (if available) rather than to regional criteria estimates. All future monitoring efforts and UAA reviews should include collection and presentation of the appropriate BLM inputs to generate a copper criterion that complies with the currently applicable Idaho water quality standard.	Copper BLM data was obtained from Goulder and Associates for the years 2019-2022 for SFSW-01 and SFSW-02. The minimum of the instantaneous water quality criteria generated values were selected and are now included in the report.
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5.	Biological Monitoring	The review should make it clear how all biological and habitat metrics, indices, and ratings were calculated.	Some discussion of this has been added to the report, with references to the biomonitoring studies for more information.
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6.		Although it might not be appropriate to use Beneficial Use Reconnaissance Program methods and analysis in Bucktail Creek, it should be possible to survey for the presence of aquatic life such as periphyton and aquatic invertebrates at times when Bucktail Creek is flowing. The EPA recommends that future monitoring efforts include direct monitoring for the presence of aquatic life in Bucktail Creek.	Biomonitoring in Bucktail Creek has been recommended to the Blackbird Mine Site Group, and will be included in the next biomonitoring survey (2027).
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7.	Water chemistry and biological data presented in the UAA review indicate that conditions have improved in both Bucktail Creek and downstream in South Fork Big Deer Creek. Although fish were not identified in South Fork Big Deer Creek near the confluence with Bucktail Creek in 2002, since then fish have been identified both immediately downstream and upstream of Bucktail Creek and may have access to Bucktail Creek. The document also states that at SF1, Bucktail Creek contributes loads of cobalt and copper to this downstream location with resultant concentrations of these metals comparable to Bucktail, however, fish have been found in South Fork Big Deer Creek, indicating that conditions have improved. Federal regulations at 40 C.F.R. 131.10(g) require that when revising water quality standards based on a UAA, states must adopt the highest attainable use. The EPA recommends that DEQ develop monitoring procedures to directly document presence or absence of aquatic life in Bucktail Creek, identify the highest attainable aquatic life use in Bucktail Creek, and consider whether a modified aquatic life use designation and associated	In addition to copper and cobalt concentrations, low flow is also an impedance to aquatic life uses in Bucktail Creek. However, in future biomonitoring efforts, the capacity for Bucktail Creek to support aquatic life uses will be accessed.
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		criteria (IDAPA 58.01.02.250.05) or other WQS revisions are warranted.	
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8.	Section 4.4.1	Beginning in Section 4.4.1, the review discusses both macroinvertebrate abundance and taxa richness. However, at times it appears that the language in the draft is using the term total abundance to indicate taxa richness (see specifically bottom of page 30, "... in recent years, total abundance has been around 2..."). Please clarify whether data presented represented abundance of individuals or taxa richness.	The section has been rewritten for clarity.
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