Review of Designated Uses for Blackbird Creek

State of Idaho
Department of Environmental Quality

December 2014

Photo of Blackbird Creek by David Jackson.

Printed on recycled paper, DEQ, November 2014, PID WUAAA0503, CA code 82998. Costs associated with this publication are available from the State of Idaho Department of Environmental Quality in accordance with Section 60-202, Idaho Code.

Table of Contents

1 Introduction ... 1
1.1 Purpose ... 1
1.2 Background ... 1
2 Watershed Description and History ... 2
2.1 Watershed ... 2
2.2 History ... 3
2.3 Monitoring Locations ... 4
3 Restoration Progress ... 7
3.1 Surface Water Chemistry ... 8
3.1.1 Copper ... 8
3.1.2 Cobalt ... 18
3.1.3 Temperature ... 22
3.2 Biological Conditions ... 22
3.2.1 Benthic Macroinvertebrates ... 23
3.2.2 Fish ... 25
3.2.3 Aquatic Ecological Risk Assessment ... 27
3.3 Physical Habitat Conditions ... 28
4 Conclusions and Recommendation ... 29
5 References ... 31

List of Tables

Table 1. Monitoring locations in the Blackbird Creek drainage. ... 5
Table 2. Restoration work completed in the Blackbird Creek Watershed. ... 7
Table 3. Descriptive statistics for total and dissolved copper, 2003–2013. ... 10
Table 4. Dissolved copper concentrations and corresponding criterion maximum concentrations, 2003–2013. ... 13
Table 5. Descriptive statistics for total and dissolved cobalt in Blackbird Creek, 2003–2013. ... 19
Table 6. Benthic macroinvertebrate data for BBB0.1. ... 23
Table 7. Macroinvertebrate condition rating. ... 24
Table 8. Fish collected at BBB0.1 from 2003 through 2013. ... 26
Table 9. Blackbird Creek fish survey results, 2009 and 2013. ... 27
Table 10. Stream habitat index values for BBB0.1 from 2003 through 2013. ... 28
Table 11. Values for select habitat metrics for BBB0.1 from 2003 through 2013. ... 29

List of Figures

Figure 1. Location of Blackbird Creek and monitoring locations. 6
Figure 2. Box plot of annual dissolved copper concentrations at BBSW01A, near the confluence of Panther Creek. 12
Figure 3. Copper concentrations at the mouth of Blackbird Creek, 2003–2006. 15
Figure 4. Box plot of total and dissolved cobalt concentrations for Blackbird Creek, 2003–2013. 21
Figure 5. Mean daily water temperatures in Blackbird Creek (BBB0.1). 22
Figure 6. Metals tolerance index scores from sampling locations BBB0.1 and DEB0.1, 2003–2013. 25

1 Introduction

1.1 Purpose

A significant amount of remediation has occurred in the Blackbird Creek watershed in an effort to reduce copper and cobalt concentrations and loading to Blackbird Creek. The previous review of the use attainability analysis (UAA), which removed beneficial uses on Blackbird Creek, was conducted in 2011. This review builds upon the data presented in the 2011 UAA review and evaluates new information regarding the removal of aquatic life uses from Blackbird Creek in an effort to determine if an aquatic life beneficial use is attainable in Blackbird Creek. Aquatic life uses were removed from the creek's designated uses based on the conclusion of the original UAA (Mebane 1997). This UAA focused on 1 of 6 factors specified in 40 CFR 131.10(g) as the only possible justification for such removal. The original UAA concluded that "The sources of metals pollution in this segment of Blackbird Creek are principally human caused and cannot be remedied to the point of meeting criteria in the foreseeable future." The UAA conclusion was accompanied by the recommendation that aquatic life uses should be removed as designated uses for Blackbird Creek.

The purpose of this review is to determine if that factor is still applicable; if the principally human-caused metals pollution in the specified segment of Blackbird Creek still cannot be remedied to the point of supporting aquatic life.

1.2 Background

In 1972, the United States Congress passed the Federal Water Pollution Control Act commonly known as the Clean Water Act (CWA). The CWA was passed with the purpose to "restore and maintain the chemical, physical and biological integrity of the Nation's waters." CWA amendments, made in 1977, added the goals of protecting and managing the nation's water for "fishable and swimmable" conditions. These goals effectively changed the focus 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 reference for UAAs comes from the CWA, where it states, "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 …." (33 USC §1252). Idaho Code §39-3604 and §39-3607 and IDAPA 58.01.02.050.02(a) state that "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). It is a tool 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 CWA §301(b) and §306 would result in substantial and widespread economic and social impact.

A UAA is required not just for changing the designated uses on a particular water body but also if the state wants to create use classifications that do not address the aquatic life and recreation goals of CWA. In Idaho, aquatic life beneficial uses typically require application of criteria that protect fish species.

If the designated uses are not attainable, a cause must be determined why they are not attainable. As listed above, 40 CFR 131.10(g) specifies six acceptable factors for changing designated uses. The UAA for Blackbird Creek resulted in removing beneficial uses for Blackbird Creek because it was determined that 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.

Federal regulations state that “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.” 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. The removal of aquatic life uses from the designated uses for Blackbird Creek results in water quality standards for this water body that do not include the uses specified in CWA §101(a)(2), so it must be reexamined.

2 Watershed Description and History

2.1 Watershed

Blackbird Creek is a 2nd-order perennial tributary of Panther Creek in the Middle Salmon-Panther subbasin of the Salmon River in east-central Idaho. The creek flows southeast for about

9 miles to its confluence with Panther Creek. The two major tributaries of concern in the Blackbird Creek drainage are Meadow Creek in the headwaters and West Fork Blackbird Creek. The Blackbird Creek drainage is affected by both dissolved heavy metals loading from acid mine drainage and historic mine waste that was disposed of and spilled into the creek.

The Blackbird cobalt and copper mine is near the headwaters of Blackbird Creek and is 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). Early reports on mining in the area (circa 1930) suggest that mine tailings were directly channeled into Blackbird Creek (Reiser 1986). Additionally, settling ponds built in the 1940s and 1950s for containments frequently failed resulting in tailing spills going unchecked in both Blackbird and Panther Creeks.

2.2 History

The Blackbird Mine has been the subject of significant remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and has been studied and reported on numerous times over the past decades (CH2M Hill 2001; EPA 2003, 2008; Golder Associates 1995, 2002; Iadanza and Shutler 1995; Mebane 1997; Reiser 1986; RMC 1995; USFS 2008) and most recently in Golder Associates (2013) and Ecometrix (2013). In a 1995 consent decree the responsible parties, including several natural resource management agencies and the M.A. Hanna Company, in lieu of paying damages, agreed to complete the following:

- Restore water quality and aquatic biota in Panther Creek below the confluence of Blackbird Creek to levels capable of supporting all life stages of anadromous and resident salmonids.
- Restore water quality and aquatic biota in Big Deer Creek below its confluence with South Fork Big Deer Creek to levels capable of supporting all life stages of resident salmonids.
- The narrative recovery goal for Blackbird Creek is to restore the creek to a condition that could support aquatic life similar to other creeks in the area.

The foundation for the original removal of aquatic life uses in Blackbird Creek consisted of three major engineering studies that examined alternatives for reducing metals pollution in the Blackbird watershed (Golder Associates 1995; Reiser 1986; RMC 1995). The first of these studies was done in 1984 and 1985 and estimated that implementing the recommended alternative would reduce dissolved copper concentrations in Panther Creek below Blackbird Creek to approximately 0.010 to 0.020 milligrams per liter (mg/L) (Reiser 1986). Based on a 10:1 ratio of Blackbird Creek flow to Panther Creek flow, this would equate to approximately 0.100–0.200 mg/L dissolved copper in Blackbird Creek, making concentrations in Blackbird Creek about 8–17 times the acute criterion for copper. This alternative was not implemented primarily due to litigation at the time between the State of Idaho and Blackbird Mine owners.

In 1995, the second study was produced by Rocky Mountain Consultants (RMC), who estimated the costs of water quality restoration in the drainage by analyzing site conditions and developing

alternatives for restoration. The best-case scenario that RMC developed estimated a maximum 90% reduction in copper concentrations (RMC 1995). This equates to concentrations under high-flow conditions of 0.024 to 0.590 mg/L, or 2 to 50 times the acute criterion for copper.

The third study was produced by Golder Associates, hired by the Blackbird Mine Site Group as the prime contractor for the project. Their tasks were to direct characterization of site conditions, perform engineering design and construction of facilities, and manage the project. Golder Associates also considered various configurations for improving water quality at the site and, in the selected alternative, used the assumption that cleanup of the mine site would be 100% effective. This effective cleanup was expected to result in dissolved copper concentrations in Blackbird Creek near the confluence with Panther Creek in the predicted range of 0.052 to 0.332 mg/L. Geochemical modeling to predict future conditions in Blackbird Creek estimated dissolved copper concentrations of 0.025 to 0.800 mg/L under high-flow conditions expected in the spring and 0.003 to 0.026 mg/L for low-flow conditions expected in the fall (Golder Associates 1995).

The Idaho Department of Environmental Quality's (DEQ's) 1997 UAA, which recommended removing the aquatic life beneficial uses for Blackbird Creek, relied on these studies to conclude that the sources of metals pollution were principally human-caused and could not be remedied to the point of meeting criteria in the foreseeable future (Mebane 1997). The UAA evaluated the physical, chemical, and biological data available at the time. At this time other contaminants were considered for inclusion in the UAA, ultimately contact recreation was not removed because the arsenic standard of 50 micrograms per liter (µg/L) was being met. The standard for arsenic has since changed to 10 µg/L.

Data for the Blackbird drainage has been collected periodically over more than two decades. The original report focused on data submitted by the Blackbird Mine Site Group and their consultants since the last UAA review (Eakins and Fraser 2007, 2010a, 2010b; McKee and Eakins 2005; Stantec 2004) as well as data used in developing of the US Environmental Protection Agency's (EPA's) final aquatic ecological risk assessment (CH2M Hill 2001), 2003 record of decision (EPA 2003), and 5-year CERCLA review (EPA 2008). This review will include that data described above and the most recent data provided by Ecometrix (2013) and Golder Associates (2013).

2.3 Monitoring Locations

Historically, there have been multiple monitoring locations on Blackbird Creek. Data collected at each site have varied and may be limited in time. Macroinvertebrate, fish, and habitat data have been collected along with water chemistry, including copper and cobalt. Table 1 contains a list of historical and current monitoring locations on Blackbird Creek.

Table 1. Monitoring locations in the Blackbird Creek drainage.

Station	Stream	Location	Coordinates	Year(s) Sampled	Types of Data Available
BBB6.6	Blackbird Creek	Upstream of the water treatment plant, about mi 6.0 from Panther Creek	45° 6' 55.0" N 114° 21' 10.0" W	2003	Water chemistry, benthic macroinvertebrates, fish
BBB5.7	Blackbird Creek	Downstream of wastewater treatment plant, about mi 5.7 from Panther Creek	45° 06' 51.2" N 114° 20' 10.4" W	2009	Fish
BBB3.2	Blackbird Creek	Upstream of West Fork Blackbird Creek, about mi 3.2 from Panther Creek	45° 05' 56.5" N 114° 18' 06.9" W	2009	Fish
WFB0.5	West Fork Blackbird Creek	West Fork Blackbird Creek above the West Fork Tailings Impoundment	45° 5' 26.6" N 114° 18' 39.1" W	2003	Water chemistry, benthic macroinvertebrates, fish
BBB2.1	Blackbird Creek	Downstream West Fork Blackbird Creek, about mi 2.1 from Panther Creek	45° 05' 26.4" N 114° 17' 41.7" W	2009	Fish
BBB1.2	Blackbird Creek	Downstream West Fork Blackbird Creek, about mi 1.2 from Panther Creek	45° 05' 02.1" N 114° 16' 42.3" W	2009	Fish
BBB0.7	Blackbird Creek	About mi 0.7 from Panther Creek	45° 04' 54.7" N 114° 16' 07.2" W	2009	Fish
BBB0.1	Blackbird Creek	About mi 0.1 from Panther Creek	45° 04' 41.3" N 114° 15' 30.8" W	1999–2009	Water chemistry, benthic macroinvertebrates, fish
BBSW-01A	Blackbird Creek	About mi 0.1 from Panther Creek, near BBB0.1		2002–2014	Copper, Cobalt

Currently the monitoring site with the most data is BBB0.1 (Ecometrix 2013). This site closely corresponds to Golder and Associates BBSW01A monitoring location for copper and cobalt. This monitoring site is located on Blackbird Creek about 100 meters upstream from the confluence with Panther Creek (Figure 1). This site has data from 1999 through 2013 for both chemical and biological parameters and is used as the trend monitoring location for the Blackbird drainage, although it may be influenced somewhat by the biology of Panther Creek due to its proximity to the confluence. While this site is most likely to detect improvements in biology and reflects copper and cobalt loads being delivered to Panther Creek, it is not representative of biological conditions throughout most of Blackbird Creek and results from this site should be evaluated carefully when considering whether they apply to the entire water body. The additional monitoring locations on Blackbird Creek are not as data rich; however, they do provide a limited amount of corroborating evidence. Additional upstream data would be valuable in assessing the overall status of Blackbird Creek and in assessing data from BBB 0.1 in relation to Blackbird Creek and the influence of Panther Creek biology.

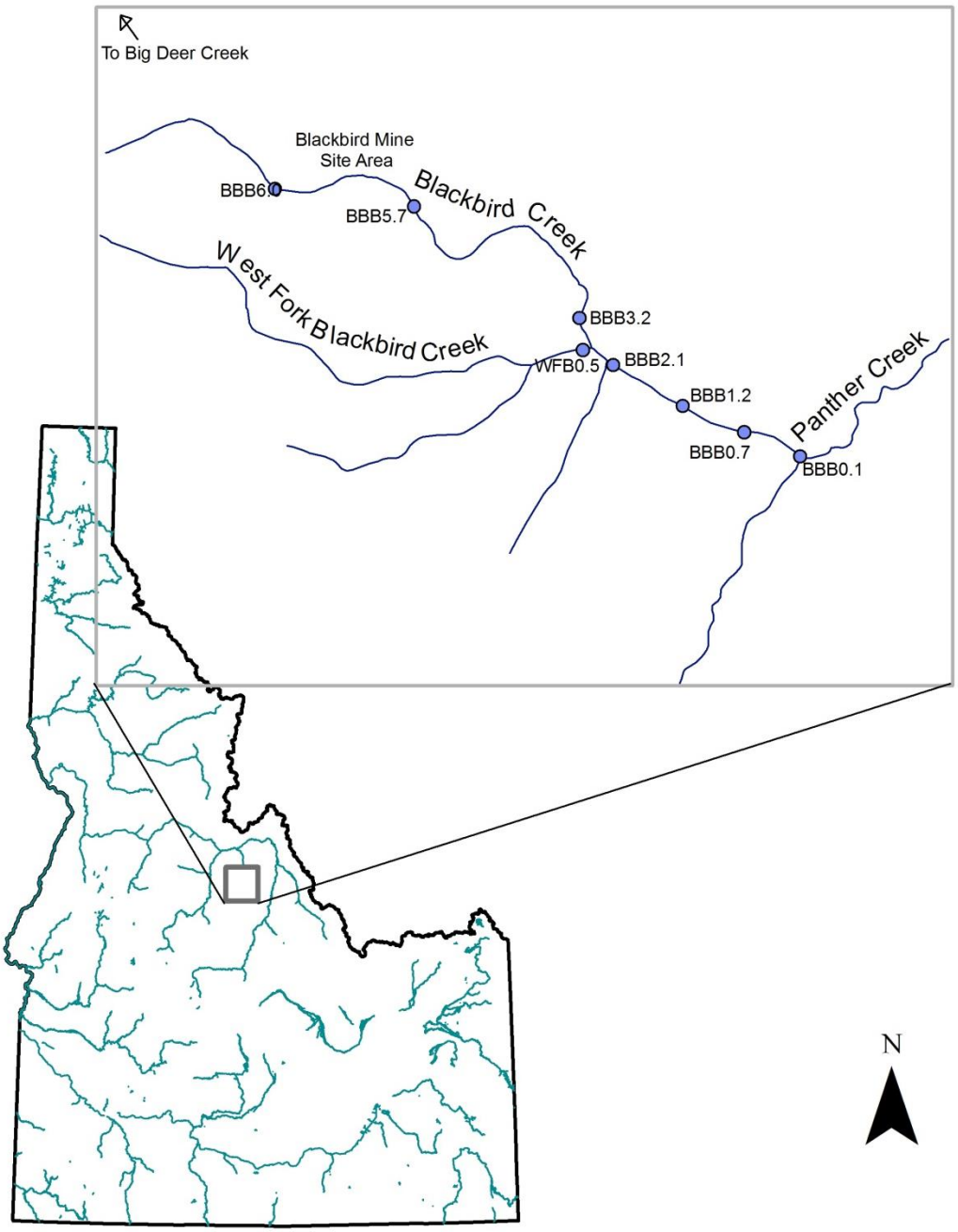

Figure 1. Location of Blackbird Creek and monitoring locations.

Some biological data have been collected at sites upstream of the confluence of Blackbird and Panther Creeks. From 1999 to 2003, two reference sites were monitored upstream of mining influences, one in Blackbird Creek and one in West Fork Blackbird Creek. Monitoring at these sites was discontinued in 2003 in favor of establishing a reference monitoring site in Deep Creek. It was determined that a site location in Deep Creek was more similar to the natural conditions that should be found at the mouth of Blackbird Creek than the two sites in the headwater areas of Blackbird and West Fork Blackbird Creeks.

3 Restoration Progress

Restoration of the Blackbird mine and the Blackbird Creek watershed has been ongoing since 1993. Table 2 includes a list of the major work that has been completed from 1993-2014. Recent work completed since the last review includes improvements to existing infrastructure, including water collection, the water treatment facility and an installation of a sand filter. Additional tailings have also been removed, eliminating a significant source of copper and cobalt.

Table 2. Restoration work completed in the Blackbird Creek Watershed.

Year	Restoration Progress
1993	• Response actions at West Fork Tailings Facility to place West Fork Blackbird Creek in an engineered channel across the surface of the facility. • Placement of fill material on the face of the dam for stability and road construction.
1995 (Early Action, Phase 1	• Construction of Blackbird Creek cutoff wall 300-feet upstream from water treatment plant.
1996–1998 (Early Action, Phase 2)	• Construction of the 7100 dam for storage of contact water for treatment. • Construction of clean water diversion and contact water collection systems. • Relocation of waste rock that would not be within the 7100 dam capture system. • Major modification of the water treatment plant to increase the capacity from 400 gallons per minute (gpm) to 1,000 gpm. • Construction of the Meadow Creek and Blackbird Creek cap system and concrete channels to convey clean water, and installation of a contact water collection system beneath the cap.
1998–1999 (Early Action, Phase 4)	• Construction of sediment basins in Blackbird Creek, one near the West Fork Tailings Facility and two near the mouth. • Removal of visually identified, erodible tailings materials from the banks of Blackbird Creek and relocation to the West Fork Tailings Facility.
2003	• Installation of 7550 clean water collection dam and associated piping and ditches in upper Meadow Creek. • Removal of the 7350 dam and converted the drainage above the dam to a contact water collection area.
2004	• Installation of pumping well BBPW-1, located downstream of the Blackbird Creek cutoff wall.
2002–2005	• Removal and stabilization of overbank deposits along Blackbird Creek and placement of a soil cover on the West Fork Tailings Facility.

2005–006	• Blackbird Creek concrete channel improvements. • Collection system for Old Blackbird Creek pipeline.
2009–2010	• Instream stabilization actions (grade control structures, bendway weirs), additional removals, and bank stabilization actions along Blackbird Creek.
2011	• Improvements to collection system at the Blackbird Creek cutoff wall.
2012–2013	• Water treatment plant upgrades and construction of a permanent supplemental treatment system to increase total peak treatment capacity to approximately 2,500 gpm.
2013	• Removal of hillside tailings from the slopes of Blackbird Creek upstream of the West Fork Tailings Facility.
2014	• Construction of a sand filter on the culvert outlet below the West Fork Tailings Facility.

3.1 Surface Water Chemistry

The original Blackbird Creek UAA focused on copper as a single pollutant because cobalt had no national or state numeric standard, and it was shown that copper and cobalt co-vary 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.

From 1993 to 1995 surface water chemistry was studied extensively as part of contamination and restoration studies. At that time, under high-flow conditions dissolved copper concentrations were up to 550 times greater than the acute criterion for copper specified in water quality standards, while under low-flow conditions copper concentrations were about 10 times greater than the criterion. Copper concentrations in Blackbird Creek typically peak during high-flow regimes whereas cobalt concentrations tend peak during low-flow periods. Implementation of remedial actions at the Blackbird Mine site has significantly reduced both copper and cobalt concentrations within the Blackbird Creek drainage.

3.1.1 Copper

The water quality criterion for copper is dependent upon the hardness of the water measured as milligrams per liter of calcium carbonate ($CaCO_3$). Hardness varies in Blackbird Creek with each sample (1–106 mg/L) resulting in an acute criterion range of 0.0046 to 0.018 mg/L for dissolved copper. The copper criterion is derived from a formula that accounts for varying levels of hardness. The formula used to calculate the criteria has a hardness cap of 25 mg/L; for any hardness value below 25 mg/L, the criteria by default is calculated using a hardness value of 25 mg/L.

Copper data collected at the farthest downstream sampling location on Blackbird Creek BBSW-01A, near the biomonitoring location BBB 0.1, are given in Table 3. Within Blackbird Creek copper concentrations tend to peak with high flow and reach their highest concentrations during the spring and early summer months. Low flows observed in the fall tend to be associated with lower copper concentrations.

Dissolved copper concentrations have varied annually in response to remediation activity and flow regimes. Dissolved copper concentrations range from 0.002 mg/L to 0.040 mg/L. General descriptive statistics and data ranges for total and dissolved copper are shown in Table 3.

While dissolved copper concentrations remain on average several times greater than the acute criterion, current data indicate that copper concentrations are occasionally below criteria for part of the year (Figure 2). Calculation and comparison of corresponding copper criteria values for the 136 dissolved copper data points at site BBSW-01A indicate the acute copper criterion for this site was exceeded 72% of the time between 2003 through 2013. Exceedances of the acute criterion ranged from 0.17 to 7.5 times the criterion value (Table 4). The standard is generally exceeded during the high-flow spring run-off period and met in the fall. The standard has been met at least one time in all years from 2003 to 2013 (Figure 3).

Table 3. Descriptive statistics for total and dissolved copper, 2003–2013.

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)	Hardness, (mg/L $CaCO_3$)
2003	Average	0.057	0.010	66.7
	Median	0.060	0.009	68.8
	Standard deviation	0.018	0.007	22.6
	Minimum	0.029	0.003	30.2
	Maximum	0.084	0.028	104.0
	Number of samples	12	12	12
2004	Average	0.052	0.014	51.7
	Median	0.042	0.017	48.1
	Standard deviation	0.025	0.008	18.6
	Minimum	0.025	0.002	28.0
	Maximum	0.100	0.027	88.3
	Number of samples	21	21	22
2005	Average	0.048	0.013	43.9
	Median	0.040	0.018	42.3
	Standard deviation	0.027	0.008	26.6
	Minimum	0.028	0.002	21.0
	Maximum	0.098	0.023	70.0
	Number of samples	9	9	4
2006	Average	0.060	0.019	44.0
	Median	0.045	0.018	47.0
	Standard deviation	0.064	0.011	13.8
	Minimum	0.019	0.003	20.0
	Maximum	0.269	0.036	67.0
	Number of samples	13	13	12
2007	Average	0.031	0.015	43.3
	Median	0.023	0.014	45.5
	Standard deviation	0.022	0.005	14.9
	Minimum	0.015	0.002	24.4
	Maximum	0.096	0.021	69.8
	Number of samples	13	13	13
2008	Average	0.063	0.012	41.4
	Median	0.019	0.013	36.6
	Standard deviation	0.107	0.005	20.0
	Minimum	0.015	0.003	23.3
	Maximum	0.324	0.018	86.0
	Number of samples	8	8	8

Year	Measure	Copper (total, mg/L)	Copper (dissolved, mg/L)	Hardness, (mg/L $CaCO_3$)
2009	Average	0.059	0.012	42.5
	Median	0.029	0.011	43.5
	Standard deviation	0.062	0.006	17.8
	Minimum	0.013	0.005	16.0
	Maximum	0.196	0.021	72.9
	Number of samples	13	13	13
2010	Average	0.041	0.015	59.5
	Median	0.045	0.014	61.6
	Standard deviation	0.019	0.005	28.0
	Minimum	0.018	0.004	24.0
	Maximum	0.088	0.025	106.0
	Number of samples	12	16	16
2011	Average	0.052	0.020	39.0
	Median	0.029	0.018	32.0
	Standard deviation	0.048	0.009	21.4
	Minimum	0.024	0.010	1.0
	Maximum	0.146	0.040	78.0
	Number of samples	10	12	12
2012	Average	0.017	0.010	46.0
	Median	0.015	0.011	37.3
	Standard deviation	0.005	0.003	23.1
	Minimum	0.011	0.005	24.3
	Maximum	0.024	0.014	90.0
	Number of samples	12	13	13
2013	Average	0.016	0.008	52.0
	Median	0.016	0.007	47.0
	Standard deviation	0.005	0.006	21.9
	Minimum	0.010	0.003	25.0
	Maximum	0.026	0.024	89.7
	Number of samples	13	13	12

Notes: mg/L—milligrams per liter; $CaCO_3$—calcium carbonate

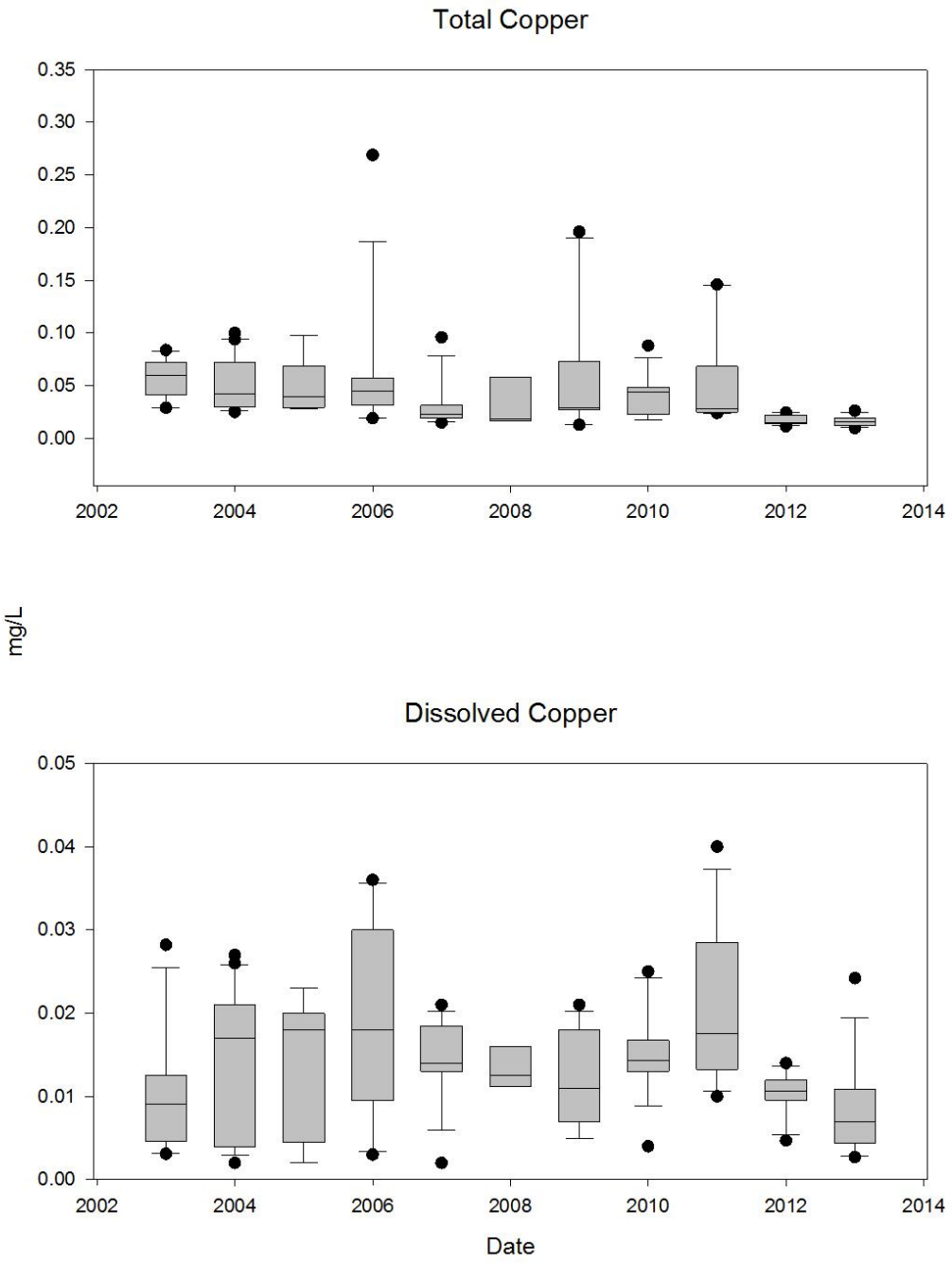

Figure 2. Box plot of annual dissolved copper concentrations at BBSW01A, near the confluence of Panther Creek.

Table 4. Dissolved copper concentrations and corresponding criterion maximum concentrations, 2003–2013.

Date	Dissolved Copper (µg/L)	CMC (µg/L)	Date	Dissolved Copper (µg/L)	CMC (µg/L)
1/15/03	10.9	12.6	7/10/03	6.0	8.1
2/18/03	10.7	11.3	8/12/03	7.4	15.4
3/19/03	5.1	9.1	9/24/03	3.1	17.7
4/4/03	10.9	7.9	10/17/03	4.5	12.8
5/22/03	28.2	5.5	11/21/03	3.4	16.4
6/17/03	19.0	9.6	12/30/03	13.0	12.7
1/20/04	12.0	12.8	5/11/04	17.0	5.1
2/18/04	11.0	11.0	5/20/04	27.0	5.4
3/9/04	8.0	10.7	5/25/04	rejected	4.6
3/17/04	15.0	8.7	6/3/04	19.0	5.9
3/24/04	25.0	6.3	6/10/04	21.0	7.7
4/1/04	26.0	5.6	7/28/04	4.0	15.1
4/8/04	21.0	8.4	8/27/04	3.0	14.7
4/14/04	21.0	8.3	9/23/04	2.0	9.0
4/20/04	21.0	10.4	10/26/04	3.0	11.2
4/28/04	19.0	7.3	11/29/04	4.0	12.6
5/4/04	17.0	6.3	12/21/04	4.0	12.1
1/24/05	7.0	11.1	5/17/05	18.0	4.6
5/10/05	18.0	4.6	9/22/05	2.0	12.2
3/9/06	4.0	10.0	5/11/06	21.0	5.9
3/22/06	5.0	9.8	5/16/06	18.0	4.6
4/10/06	36.0	7.4	5/24/06	14.0	5.5
4/14/06	35.0	9.0	6/2/06	14.0	7.8
4/26/06	30.0	8.9	6/7/06	15.0	8.9
5/3/06	25.0	5.3	9/20/06	3.0	11.7
3/20/07	19.0	10.0	5/2/07	18.0	4.6
3/27/07	19.0	8.4	5/8/07	15.0	5.7
4/3/07	12.0	10.9	5/15/07	12.0	5.2
4/10/07	15.0	8.1	5/22/07	14.0	6.9
4/17/07	14.0	9.2	5/29/07	14.0	5.2
4/24/07	14.0	9.1	7/18/07	2.0	12.1
5/1/07	21.0	4.9	—	—	—
5/15/08	17.0	4.9	6/12/08	12.0	6.4
5/20/08	18.0	7.4	6/19/08	13.0	6.8
5/29/08	13.0	4.6	6/25/08	11.0	9.0
6/6/08	12.0	5.5	10/6/08	3.0	14.8
3/18/09	5.0	9.7	5/7/09	21.0	6.4
3/25/09	5.0	12.6	5/14/09	19.0	5.4

Date	Dissolved Copper (µg/L)	CMC (µg/L)	Date	Dissolved Copper (µg/L)	CMC (µg/L)
4/2/09	6.0	10.5	5/21/09	14.0	4.6
4/8/09	8.0	10.9	5/29/09	10.0	4.6
4/14/09	18.0	9.7	6/2/09	11.0	4.6
4/21/09	17.0	7.8	6/9/09	10.0	6.1
4/29/09	18.0	8.1	—	—	—
3/4/10	24.0	12.6	4/27/10	13.0	10.0
3/9/10	25.0	12.4	5/6/10	11.0	9.2
3/16/10	17.0	11.6	5/13/10	15.0	7.4
3/24/10	18.0	16.3	5/19/10	13.6	4.6
3/30/10	16.0	14.6	5/26/10	13.0	5.3
4/7/10	16.0	13.6	6/4/10	13.0	4.6
4/13/10	15.0	18.0	6/8/10	12.0	4.6
4/19/10	4.0	15.8	6/15/10	13.0	5.6
4/5/11	12.0	11.7	5/17/11	21.0	4.6
4/12/11	10.0	13.5	5/24/11	31.0	4.6
4/19/11	17.0	10.0	6/1/11	17.0	5.1
4/26/11	13.0	8.9	6/10/11	31.0	5.1
5/3/11	14.0	4.6	6/14/11	40.0	5.3
5/10/11	19.0	6.3	7/1/11	18.0	8.2
4/4/12	10.1	13.8	5/16/12	10.2	4.6
4/10/12	4.7	13.6	5/23/12	10.0	6.4
4/18/12	10.6	10.0	5/30/12	10.8	6.7
4/25/12	13.0	5.0	6/6/12	11.3	7.1
5/2/12	14.0	5.6	6/14/12	9.1	8.0
5/9/12	11.3	5.1	10/19/12	6.3	15.4
5/15/12	12.6	4.6	—	—	—
4/3/13	24.2	15.4	5/10/13	10.4	5.2
4/10/13	4.0	12.3	5/15/13	12.3	4.6
4/17/13	3.1	11.8	5/22/13	8.3	5.0
4/24/13	2.7	12.3	5/29/13	8.4	7.4
5/1/13	11.3	8.7	6/5/13	7.0	8.0
5/8/13	6.8	6.2	11/6/13	4.8	13.0

Notes: CMC–criterion maximum concentration; µg/L—micrograms per liter, red values indicate exceedance of criterion. Samples qualified by lab or samples without corresponding hardness data are not included.

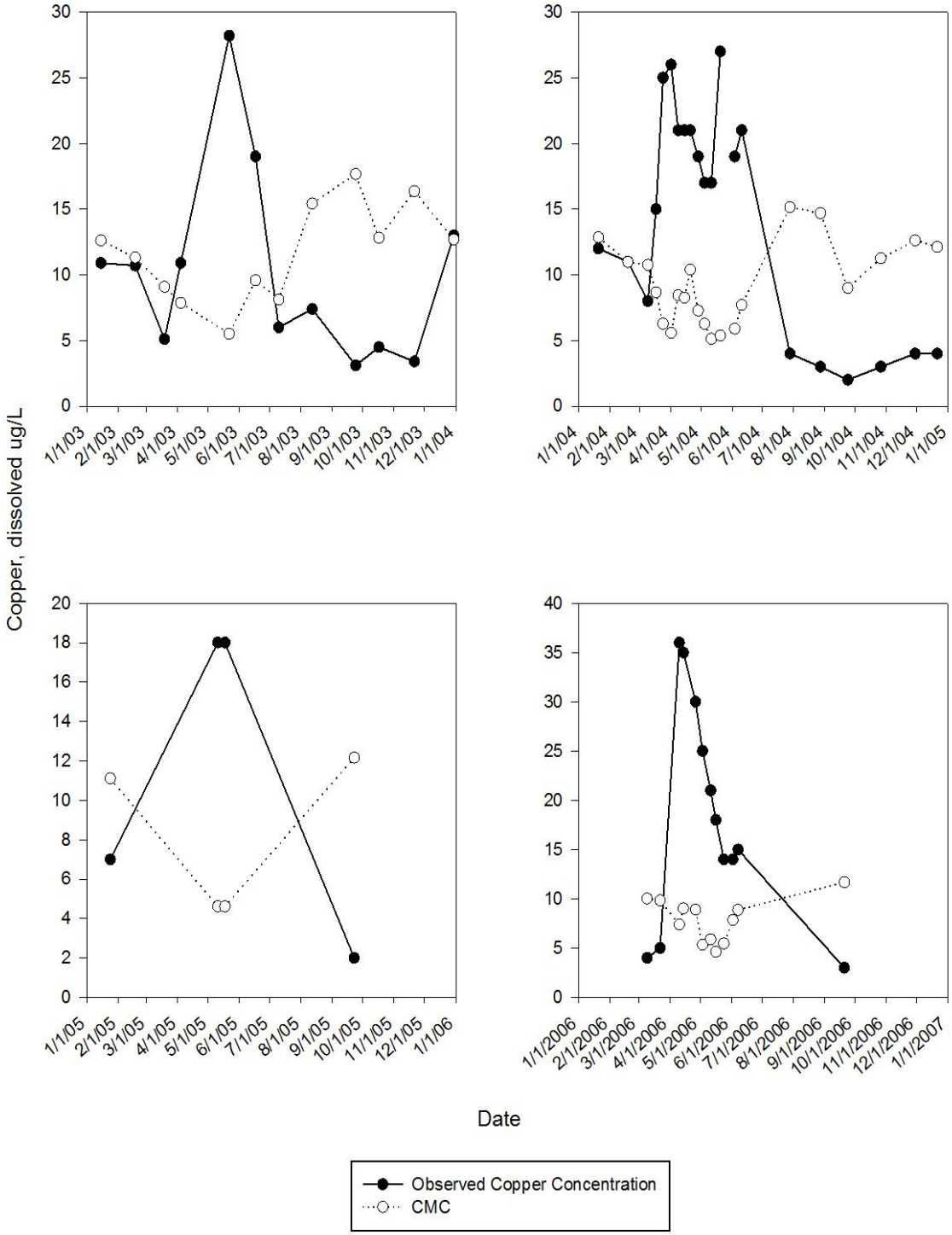

Figure 3. Copper concentrations at the mouth of Blackbird Creek, 2003–2006.

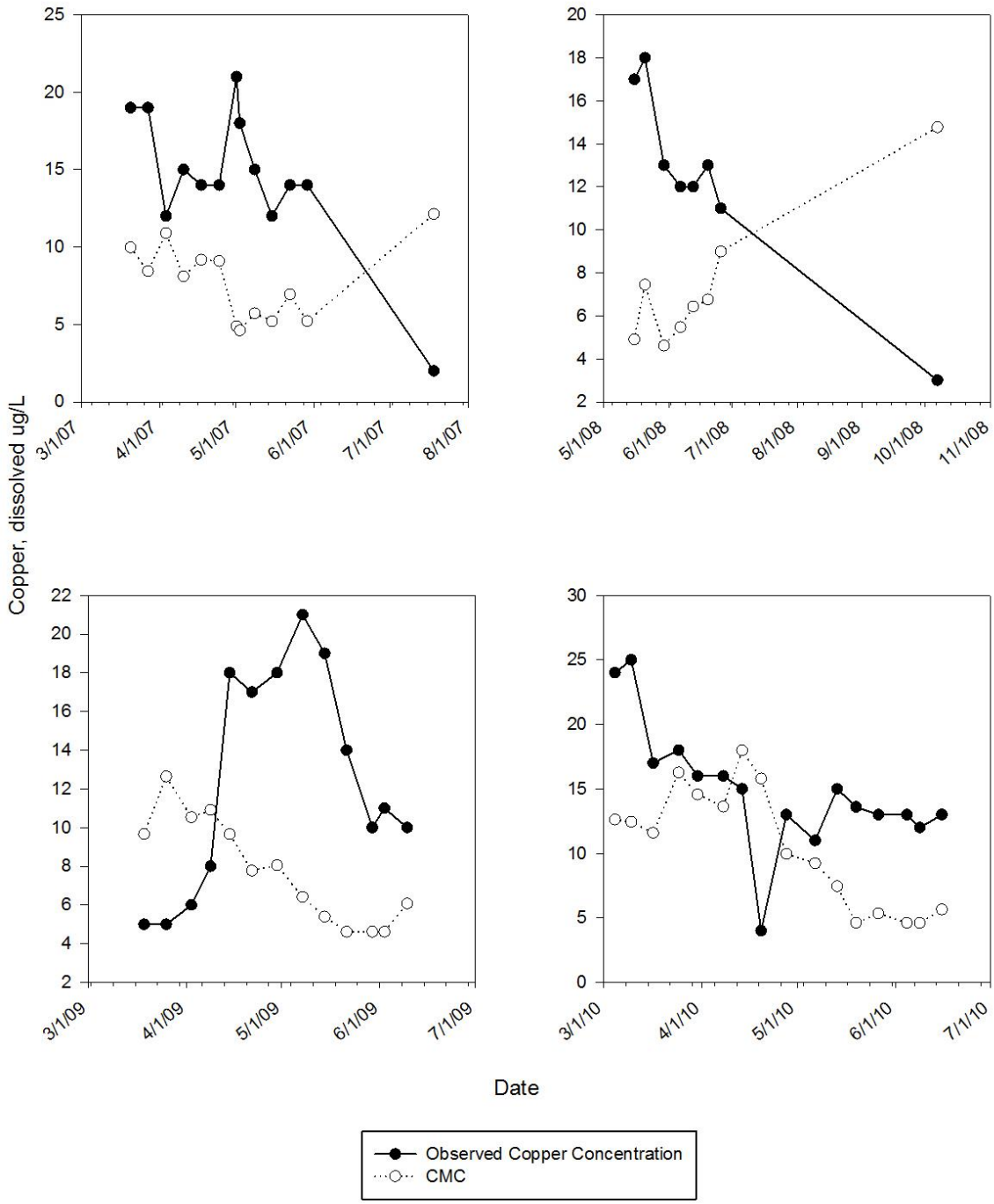

Figure 3 (continued). Copper concentrations at the mouth of Blackbird Creek, 2007–2010.

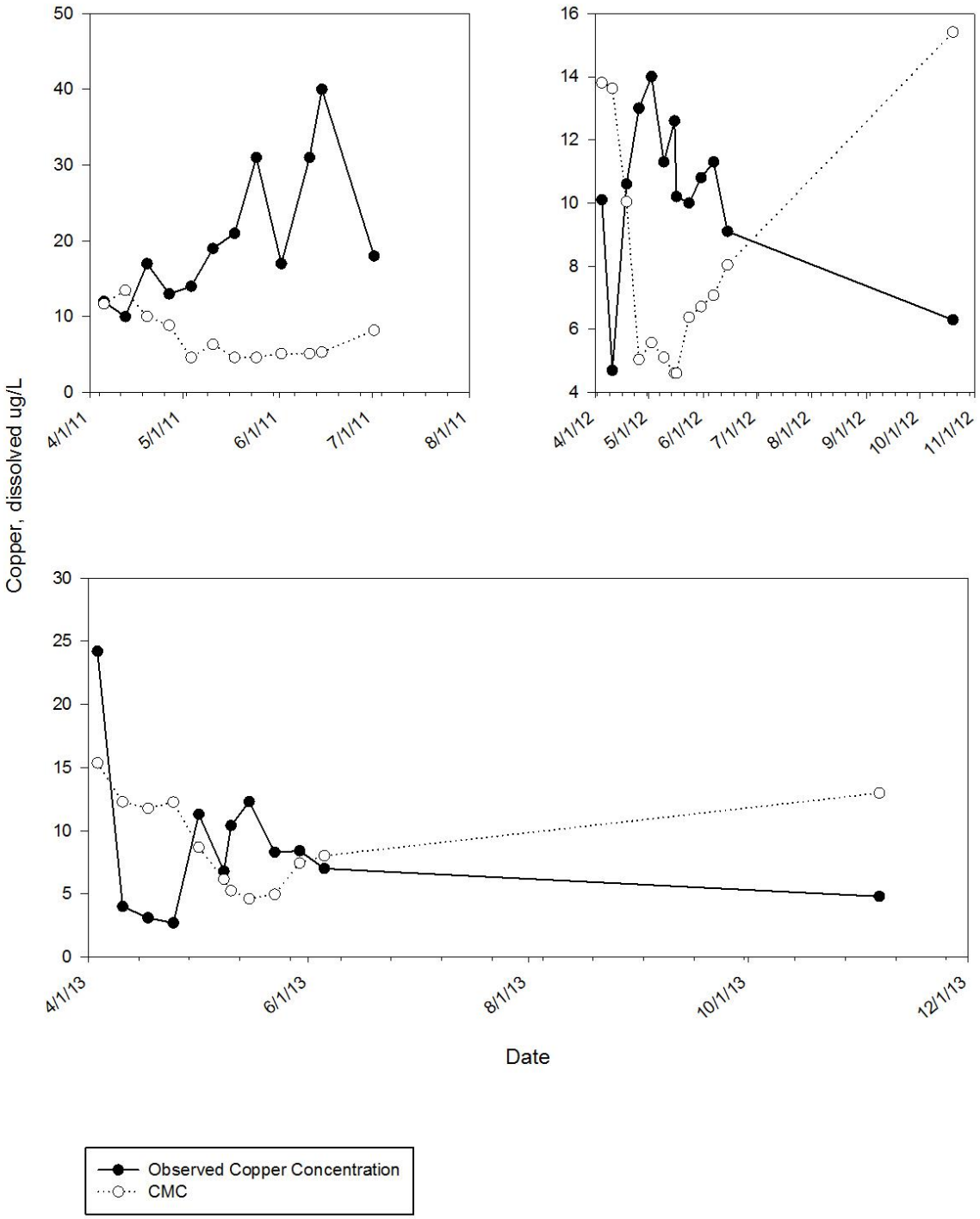

Figure 3 (continued). Copper concentrations at the mouth of Blackbird Creek, 2011–2013.

3.1.2 Cobalt

Cobalt has no state or national criteria. However, cobalt data has historically been collected in addition to copper at the same monitoring location (BBSW-01A) from 2003-2013. Cobalt data are given in Table 3.

Both total and dissolved cobalt vary annually as a result of precipitation, flow regimes and remediation activity in the watershed. Total cobalt has ranged from a low concentration of 0.054 mg/L (2007) to a maximum observed concentration of 0.589 mg/L (2004). The minimum dissolved cobalt concentration of 0.034 mg/L was observed in 2011 and the maximum observed concentration of 0.590 mg/L was observed in 2003. Total and dissolved cobalt tend to generally trend together suggesting that most of the cobalt is in a dissolved form. General descriptive statistics and data ranges for total and dissolved cobalt are shown in Table 3. A box plot of total and dissolved cobalt concentrations are shown in Figure 4. There appears to be a downward trend in dissolved and total cobalt concentrations (Figure 4).

Table 5. Descriptive statistics for total and dissolved cobalt in Blackbird Creek, 2003–2013.

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2003	Average	0.396	0.395
	Median	0.444	0.448
	Standard deviation	0.188	0.192
	Minimum	0.077	0.066
	Maximum	0.589	0.590
	Number of samples	12	12
2004	Average	0.237	0.234
	Median	0.148	0.146
	Standard deviation	0.165	0.164
	Minimum	0.079	0.065
	Maximum	0.589	0.554
	Number of samples	22	22
2005	Average	0.231	0.225
	Median	0.203	0.201
	Standard deviation	0.133	0.138
	Minimum	0.080	0.050
	Maximum	0.478	0.493
	Number of samples	8	8
2006	Average	0.215	0.202
	Median	0.123	0.118
	Standard deviation	0.141	0.156
	Minimum	0.068	0.038
	Maximum	0.406	0.406
	Number of samples	7	7
2007	Average	0.110	0.106
	Median	0.105	0.103
	Standard deviation	0.048	0.047
	Minimum	0.054	0.048
	Maximum	0.233	0.219
	Number of samples	13	13
2008	Average	0.133	0.111
	Median	0.084	0.072
	Standard deviation	0.124	0.124
	Minimum	0.054	0.042
	Maximum	0.421	0.413
	Number of samples	8	8

Year	Measure	Cobalt (total, mg/L)	Cobalt (dissolved, mg/L)
2009	Average	0.169	0.183
	Median	0.118	0.083
	Standard deviation	0.128	0.158
	Minimum	0.037	0.035
	Maximum	0.380	0.491
	Number of samples	12	13
2010	Average	0.362	0.304
	Median	0.467	0.314
	Standard deviation	0.177	0.203
	Minimum	0.063	0.055
	Maximum	0.520	0.524
	Number of samples	12	17
2011	Average	0.091	0.070
	Median	0.081	0.061
	Standard deviation	0.033	0.038
	Minimum	0.063	0.034
	Maximum	0.139	0.136
	Number of samples	4	5
2012	Average	0.314	0.244
	Median	0.314	0.244
	Standard deviation	0.369	0.270
	Minimum	0.053	0.053
	Maximum	0.575	0.435
	Number of samples	2	2
2013	Average	0.201	0.198
	Median	0.173	0.155
	Standard deviation	0.163	0.183
	Minimum	0.066	0.050
	Maximum	0.395	0.434
	Number of samples	4	4

Notes: mg/L—milligrams per liter

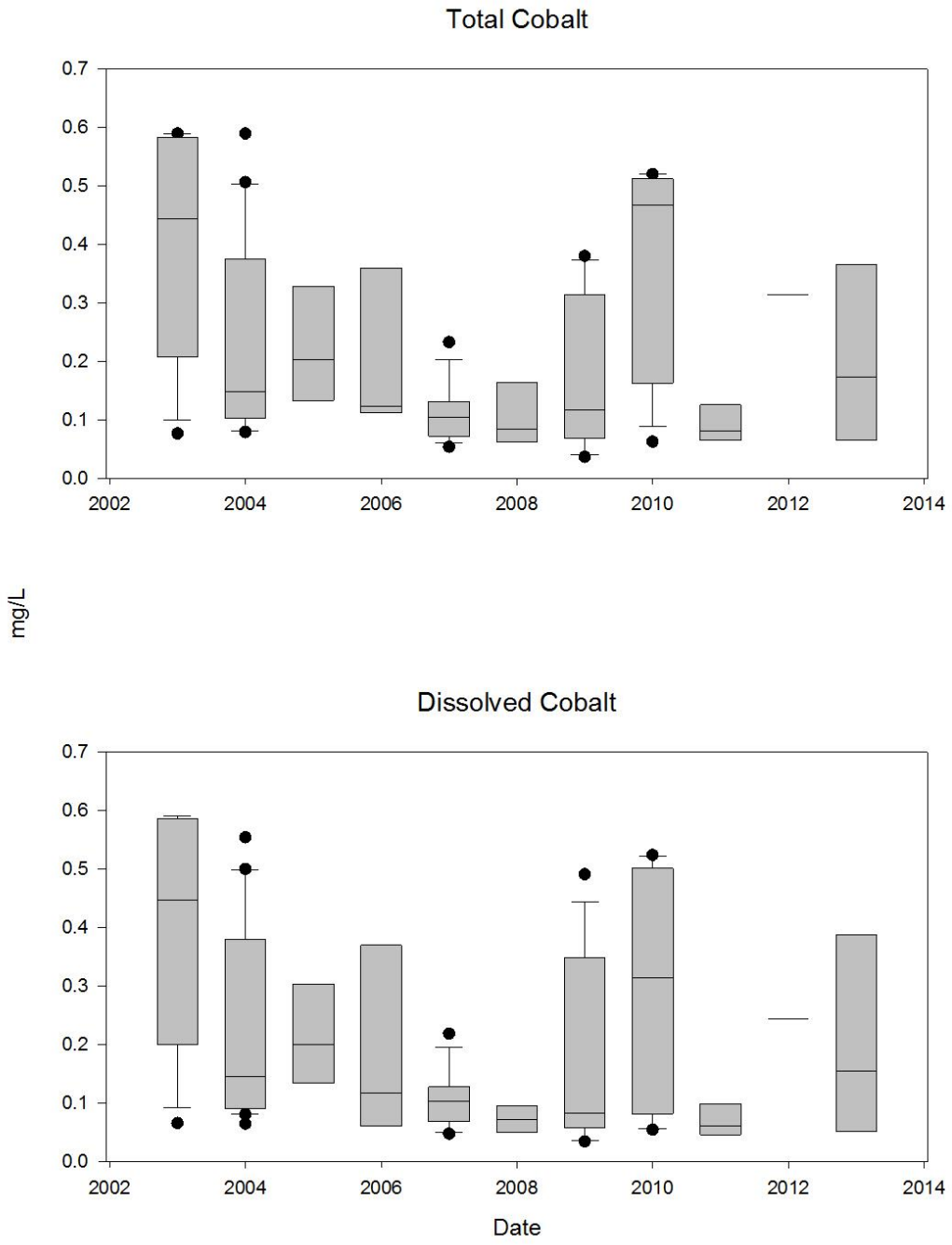

Figure 4. Box plot of total and dissolved cobalt concentrations for Blackbird Creek, 2003–2013.

Pollutant concentrations are still above criteria due to human-caused conditions and have not been remedied to a point where the Blackbird Creek meets water quality standards or supports cold water aquatic life. Continuing remediation at the Blackbird Mine site may over time result in further reductions in pollutant loading in Blackbird Creek; however, the relevant conditions that existed for copper and cobalt, when the designated aquatic life use was removed from Blackbird Creek are still apparent. Copper and cobalt concentration have generally leveled off over the past decade; any future reductions will be difficult, timely and costly.

3.1.3 Temperature

Water temperatures were recorded using temperature data loggers that were typically installed around mid-May to mid-June in Blackbird Creek at BBB0.1 The loggers were set to record the temperature every 2 hours. Mean daily water temperatures are presented in (Figure 5). The mean daily water temperature for Blackbird Creek at BBB0.1 ranged from 3.5 °C to 17.2 °C. The temperature range and maximum value are below the protective criterion of 19 °C established for cold water aquatic life; therefore, temperature does not appear to be a limiting factor in the use of Blackbird Creek by cold water species.

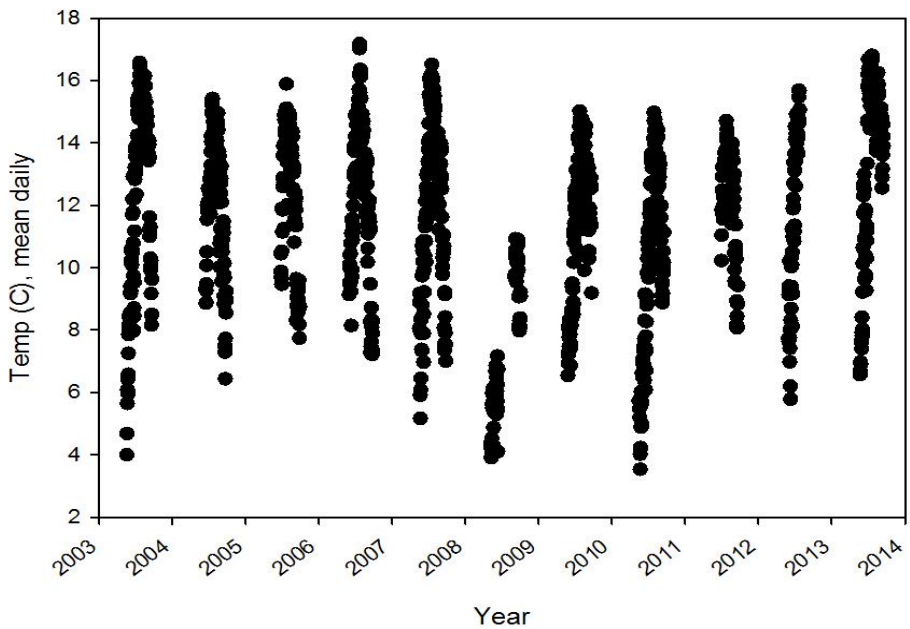

Figure 5. Mean daily water temperatures in Blackbird Creek (BBB0.1).

3.2 Biological Conditions

Aquatic ecosystems are characterized by the condition of the biological communities that inhabit them. Communities that are typically evaluated to determine the overall condition of aquatic ecosystems include benthic macroinvertebrates, periphyton, fish, and riparian habitat. Data collected over the last decade include measures of the benthic macroinvertebrate, fish, and habitat within Blackbird Creek. These data aid in determining whether an aquatic beneficial use

may be attained in Blackbird Creek. While reviewing the available biological data, one consideration given significant weight was an assertion made in EPA's aquatic ecological risk assessment:

> It should be noted that survival alone or a species persistence at future sampling times does not indicate sustainability or community health capable of supporting higher trophic levels such as salmonids, as is outlined in the Ecological Management Goals. (CH2M Hill 2001)

3.2.1 Benthic Macroinvertebrates

Benthic macroinvertebrates are valuable indicator organisms in determining the overall health of an aquatic system. Macroinvertebrates are good indicators of long-term exposures to pollutants or pollution in the water because they are relatively stationary. Copper is known to be toxic to benthic macroinvertebrates and has been shown to adversely affect the life cycle of *Clistoronia magnifica*, a species of caddisfly (Nebeker et al. 1984). The highest concentration at which no effect on *C. magnifica* is observed is 0.0083 mg/L, while exposure to 0.013 mg/L results in significant reductions in adult emergence. Exposure to higher concentrations (0.017 mg/L and 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 the farthest downstream site on Blackbird Creek (BBB0.1) from 2003 through 2013. The data from this site indicate a general increase in the overall macroinvertebrate density from a low of 46 organisms collected in 2004 to high of 505 organisms collected in 2009. The most recent survey revealed a decrease from the high numbers observed in 2009. In 2013, 332 organisms were identified (Table 6). Although the number of organisms collected at this site has increased, the number of distinct taxa has remained relatively consistent from 2003 to 2013. The average number of taxa during this period was 21; in 2013, the number of taxa was 20. Generally, both the number of taxa has remained constant, while the number of individual organisms has increased over time.

Table 6. Benthic macroinvertebrate data for BBB0.1.

Year	SMI	Total Taxa	E Taxa	P Taxa	T Taxa	%P	HBI	%5Dom	No. of organisms
2003	31	23	0	1	6	1	5.74	76	142
2004	46	15	1	3	5	11	5.6	72	46
2006	44	22	1	3	7	2.2	4	85.6	181
2007	28	ND	ND	ND	ND	ND	ND	ND	ND
2008	53	20	4	4	5	7.4	3.5	78	500
2009	62	24	1	5	8	29	3.1	82.8	505
2010	ND	ND	ND	ND	ND	ND	ND	ND	ND
2011	ND	ND	ND	ND	ND	ND	ND	ND	ND
2012	ND	ND	ND	ND	ND	ND	ND	ND	ND
2013	32	20	1	2	4	1.2	5.2	91.6	332

Notes: SMI—stream macroinvertebrate index; E taxa—Ephemeroptera taxa; P taxa—Plecoptera taxa; T taxa—Trichoptera; % P—percent of individuals in sample that are Plecoptera; HBI—Hilsenhoff Biotic

Index; %5Dom—percent of sample comprised of the dominant five taxa; ND-no data

Both 2008 and 2009 data suggested that the macroinvertebrate communities were improving. The stream macroinvertebrate index (SMI) increased from a low value of 0 in 2003 to 2 and 3, respectively. This was supported by the substantial increase in numbers of organisms. However in 2013, the SMI score was a zero, indicating the gains made in 2008 and 2009 were not sustained (Table 7.). While the score decreased, the number of individuals remained over 300, and the number of unique taxa decreased to pre-2008 levels. Overall, the benthic macroinvertebrate community appears to be slightly improving at this site. Data on macroinvertebrates from other sites on Blackbird Creek, if available, might corroborate this conclusion for the entire water body; however, there are no other sites where benthic macroinvertebrates were collected.

Table 7. Macroinvertebrate condition rating.

Year	Stream Macroinvertebrate Index
2003	0
2004	1
2006	1
2007	0
2008	2
2009	3
2013	0

A metals tolerance index (MTI) was calculated and reported for each year at the farthest downstream sampling site (BBB0.1). The MTI is calculated as a density weighted average using metals tolerance values supplied by Montana DEQ. Scores for this index range from 0 (highly intolerant) to 10 (highly tolerant). Figure 6 contains MTI values for Blackbird and Big Deer Creeks. The MTI scores in Blackbird Creek are intermediate scores and are not indicative of a macroinvertebrate community that is either highly tolerant or highly susceptible to metals. These values are similar to background levels observed in Big Deer Creek (DEB0.1).

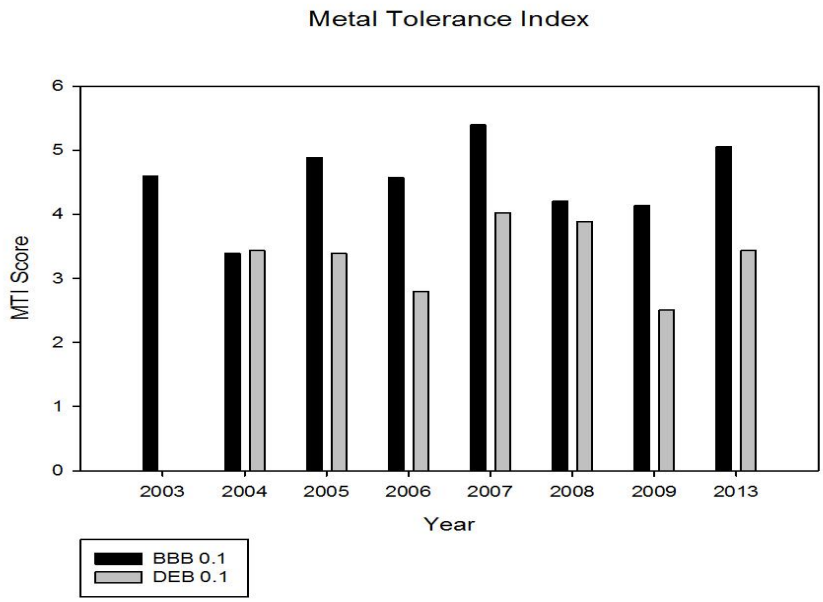

Figure 6. Metals tolerance index scores from sampling locations BBB0.1 and DEB0.1, 2003–2013.

3.2.2 Fish

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

The UAA for Blackbird Creek 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. Because aquatic life was not shown to be an existing use, cold water aquatic life could be removed as a use for Blackbird Creek. The UAA recommended removing the cold water aquatic life beneficial use for Blackbird Creek, which was approved by EPA. DEQ changed the aquatic life use designation in its standards to reflect this, and Blackbird Creek currently has an aquatic life designation of "none."

In 2003, as part of the overall study of Blackbird Creek and the record of decision (EPA 2003), CH2M Hill was contracted to perform an aquatic ecological risk assessment (AERA). The AERA evaluated the effects of copper, cobalt, iron, and arsenic on Blackbird, Bucktail, Big Deer, and Panther Creeks. At the time, arsenic was meeting the water quality standard of 50.0 µg/L and was not considered in the UAA, consequently the recreation beneficial use was left in place; since then, the arsenic standard has been changed to 10.0 µg/L. For the purposes of this report, only those AERA results that apply to Blackbird Creek are discussed.

Several studies have demonstrated the overall 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

(EPA 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). An 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 (CH2M Hill 2001).

Although cobalt does not have a national criterion for toxicity, studies reported in the AERA showed LC_{20} 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. Chronic testing showed reductions in growth associated with cobalt as well as bioaccumulation of cobalt in fry. The avoidance study found that juvenile Rainbow Trout and juvenile Chinook Salmon avoided water containing cobalt at concentration thresholds above 0.180 mg/L (Hagler/Bailley 1995).

Additionally, a study was performed to evaluate the combined toxicity of cobalt and copper. This study suggests that when cobalt concentrations exceed 0.050 mg/L in the presence of copper there is a synergistic effect on toxicity (Hagler/Bailley 1995).

Fish surveys were performed at the farthest downstream sampling site on Blackbird Creek (BBB0.1). Table 8 shows the number of fish collected, catch per unit effort (CPUE), and resulting stream fish index (SFI) score from 2003 through 2013. Data indicate the number of fish and CPUE show wide variation over the last decade with significant increases observed in 2008 and 2009. The 2013 data indicate fish numbers are similar to data from 2003 to 2006. Future monitoring will provide more insight into whether the increases observed in 2008–2009 were the beginning of positive increases in the number of fish in the watershed or a reflection of natural variation.

Table 8. Fish collected at BBB0.1 from 2003 through 2013.

Year	Condition Rating	SFI	Number of Fish	CPUE
2003	69	2	36	1.91
2004	70	2	5	0.88
2005	66	1	—	—
2006	66	1	53	2.88
2007	74	2	—	—
2008	92	3	98	3.35
2009	92	3	129	4.47
2013	73	2	42	1.82

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

In 2009, Ecometrix performed electroshocking at sites upstream of the lowest Blackbird Creek site (BBB0.1). The purpose of the electroshocking was to determine fish utilization of the upper reaches of Blackbird Creek. Fish were not found at two sites upstream of the confluence of West

Fork Blackbird Creek with Blackbird Creek (BBB5.7 and BBB3.2) or at the site immediately below this confluence (BBB2.1). Fish were collected at sites BBB1.2 and BBB0.7, which are roughly 1 mile or less from the confluence of Blackbird with Panther Creeks. These fish surveys were conducted in late September 2009. Species captured during these surveys include Rainbow Trout, Bull Trout, Mountain Whitefish, and a hybrid Rainbow-Cutthroat Trout. All of these fish species tend to have a wide range of distributions and movement patterns (Henderson et al. 2000; McIntyre and Rieman 1995; Schoby and Curet 2007; Zurstadt and Stephan 2004). In 2013, five sites on Blackbird Creek were resurveyed (BBB0.1, BBB0.7, BBB1.2, BBB2.1, and BBB3.2). Fish were only observed at two of these monitoring locations: BBB0.1 and BBB0.7. The results of this survey, including those of 2009, are provided in Table 9.

Table 9. Blackbird Creek fish survey results, 2009 and 2013.

Sampling Site	Date	Number of Fish	CPUE
BBB0.1	Sept-2009	129	4.47
BBB0.7	Sept-2009	27	1.97
BBB1.2	Sept-2009	42	4.16
BBB2.1	Sept-2009	0	0
BBB3.2	Sept-2009	0	0
BBB5.7	Sept-2009	0	0
BBB0.1	Sept-2013	42	1.82
BBB0.7	Sept-2013	40	2.42
BBB1.2	Sept-2013	0	0
BBB2.1	Sept-2013	0	0
BBB3.2	Sept-2013	0	0

Notes: CPUE— catch per unit effort

3.2.3 Aquatic Ecological Risk Assessment

An 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. In 2001, EPA contracted with CH2M Hill to perform an AERA for the Blackbird Mine site. One outcome of the AERA was identifying ecological goals for Blackbird Creek remediation activities at the mine site:

- Restore and maintain water and sediment quality for the survival, growth, and behavior that would support habitat use and reproduction by resident fishes and their food sources in lower Blackbird Creek.
- Restore and maintain water and sediment quality for the survival, growth, and behavior that would support habitat use and reproduction by individual representatives of threatened and endangered resident fishes and their food sources in lower Blackbird Creek.

In the AERA, the potential risks to ecological receptors were predicted with a hazard quotient (HQ). A 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. Surface water HQs for the protection of aquatic life and salmonids in Blackbird Creek were consistently greater than 10 for copper and cobalt during high-flow conditions. During low-flow conditions, HQs were less than 10 but generally were greater than 10 for both copper and cobalt. For copper and cobalt, the sediment HQs were only slightly greater than 1. The dietary HQs for copper based on sediment uptake ranged from 7 to 12. The benthic macroinvertebrate community data also indicated the potential for adverse effects to the aquatic system since the station at BBB0.1 did not resemble the reference station with regard to these macroinvertebrates.

The AERA for the Blackbird Mine site determined that while the early actions (i.e., implementation of restoration activities that are classified as early actions) have significantly improved water and sediment quality in the watershed, all evidence indicated that water and sediment quality in Blackbird Creek is having a potentially adverse effect on the aquatic ecosystem.

3.3 Physical Habitat Conditions

Physical instream characteristics influence the reaction of the system to pollution and the effects of pollutants on the aquatic community. These characteristics, when favorable, also support habitat for aquatic species necessary to support a viable population. Understanding the nature of these characteristics and 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. Values for stream habitat index (SHI) as calculated by the contracting company are shown in Table 10 and for select habitat metrics are listed in Table 11.

Table 10. Stream habitat index values for BBB0.1 from 2003 through 2013.

Year	Condition Rating	Stream Habitat Index
2003	47	1
2004	33	1
2005	39	1
2006	48	1
2007	49	1
2008	53	1
2009	47	1
2013	42	1

Table 11. Values for select habitat metrics for BBB0.1 from 2003 through 2013.

Physical Habitat Metric	2003	2004	2006	2007	2008	2009	2013
Bottom substrate	19	9	19	—	18	—	—
Instream cover	15	4	18	—	18	—	12
Embeddedness	20	20	19	—	18	18	18
Velocity/depth	10	11	10	—	14	—	—
Channel shape	10	10	5	—	5	3	10
Pool/riffle ratio	0	1	0	—	8	—	—
Width/depth ratio	1	2	2	—	7	—	—
Bank vegetation protection	3	0	10	—	10	—	—
Bank stability	10	10	10	—	9	—	—
Disruptive pressures	0	0	0	—	0	0	0
Zone of Influence	0	0	0	—	0	0	0
Large organic debris	0	0	0	—	12	3	7
Percent fines	1	28	0	—	3	0	4
Pebble size classes (Wolman)	8	10	6	—	9	—	8
Percent bank vegetation cover	53	0	100	—	100	100	10
Percent canopy cover	0	0	0	—	0	0	1

4 Conclusions and Recommendation

This review evaluated data submitted since the original 1997 UAA and more recent 2011 UAA review of the chemical, biological, and physical conditions of Blackbird Creek relating to factors specified in 40 CFR 131.10(g) and used in the original UAA, which determined that the aquatic life uses should be removed. The original UAA examined both existing and designated beneficial uses and determined that aquatic life was not an existing use in Blackbird Creek. The original UAA also determined that aquatic life was not attainable as a designated use based on the copper and cobalt concentrations that were many times greater than the acute and chronic water quality criteria.

Since the original UAA and review of the UAA over the past decade, overall, copper and cobalt concentrations in Blackbird Creek have decreased due to extensive remediation work within the drainage. While no state standard exists for cobalt, both total cobalt and dissolved cobalt have continued to show overall decreases in concentrations from 2003 to 2013. Total cobalt has ranged from a high annual median concentration of 0.47 mg/L to a low concentration of 0.081 mg/L to the current median concentration of 0.17 mg/L. The concentrations show some natural variation as sediment works its way through the system and additional remediation work occurs. Dissolved cobalt has followed a similar trend over the same time period and has ranged from low median concentration of 0.08 mg/L to a high median concentration of 0.45 mg/L. The annual median dissolved cobalt concentration was 0.16 mg/L.

Remediation has decreased dissolved copper significantly from levels observed in the 1990s. Dissolved copper concentrations in the water column at BBB0.1 have remained relatively flat from 2003 to 2013. Because the dissolved copper water quality standard is based on the hardness of the water body, the standard varies in response to hardness. Consequently in some years, the water quality standard for dissolved copper is met more often than other years. From 2009 to 2013, the water quality standard for dissolved copper was met 23% of the time at BBB0.1.

Biological indices have shown some positive variation over the years but have not made any real sustained improvements as indicated by 2013 data. From 2003 to 2013, the macroinvertebrate indices had a SMI score that ranged from 0 to 2; the most current survey indicates that the SMI for Blackbird Creek (BBB0.1) was 0. During this same time frame, the fish indices ranged from 1 to 3; in 2013, the fish indices ranked 2. Additionally, the habitat indices had SHI scores that have consistently ranked 1. The SHI has not shown any improvement since the last review of the Blackbird Creek UAA. The SMI score has decreased from a high value of 3 in 2009 to 0 in 2013. The SFI scored 2 in 2013 and has consistently scored 2–3 since 2007.

The effects of copper upon salmonid species are well documented (NOAA 2007). Dissolved copper concentration as low as 2 µg/L have been shown to impair fish (NOAA 2007). Elevated copper concentrations affect salmonid behavior by inducing avoidance and disrupting migration. Dissolved copper can affect salmonids in as little as 10 minutes with longer duration exposure having more significant impact on fish species (NOAA 2007). The biomonitoring location on Blackbird Creek near the confluence of Panther Creek is informative, albeit limited in nature. Salmonids moving upstream in Panther Creek are likely to investigate Blackbird Creek, if only briefly; fish may or may not continue upstream in Blackbird Creek but rather move back into Panther Creek where they may move upstream or downstream. This would be the natural form of recolonization of Blackbird Creek from Panther Creek, and the biomonitoring location is likely detecting this in the form of fish, macroinvertebrates, and riparian plant species. However, the increase in the presence of fish and macroinvertebrates species at this location has limited implication for the overall health of upstream Blackbird Creek. Future surveys of Blackbird Creek should include additional upstream sites to assess how the stream system is recovering. It is also noted that failure to meet the copper criterion does not preclude the attainment of some other aquatic life use aside from a normal cold water aquatic life community.

It is recommended that no change take place to the current designation of “none” for aquatic life uses in Blackbird Creek. The data do not appear to support a determination of existing aquatic life use within the creek nor does water quality data appear to be appropriate for the protection and maintenance of a viable aquatic life community for cold water species. Because information is not available regarding benthic macroinvertebrates at sites other than the mouth of Blackbird Creek, any further determination on aquatic life use based on macroinvertebrates cannot be made. The original evidence using copper and cobalt concentrations to support the removal of aquatic life use are still valid with dissolved copper concentrations exceeding both acute and chronic criteria and cobalt concentrations many times greater than the established reference values (CH2M Hill 2001). Although as copper and cobalt concentrations are further reduced in the future and water quality conditions improve, Blackbird Creek may once again be designated for an aquatic life beneficial use.

5 References

CH2M Hill. 2001. *Final Aquatic Ecological Risk Assessment, Blackbird Mine Site*. Prepared for US Environmental Protection Agency. Denver: CO.

Eakins, R. and B. Fraser. 2007. *Biomonitoring Study: Panther Creek Watershed September 2006*. Brampton, Ontario: Blackbird Mine Site Group. Report 06-1357.1.

Eakins, R. and B. Fraser. 2010a. *Biomonitoring Study: Panther Creek Watershed September 2008*. Brampton, Ontario: Blackbird Mine Site Group. Report 08-1527.

Eakins, R. and B. Fraser. 2010b. *Biomonitoring Study: Panther Creek Watershed September 2009.* Brampton, Ontario: Blackbird Mine Site Group. Report 09-1628.

Ecometrix. 2013. *Biomonitoring Study: Panther Creek Watershed.*EPA (US Environmental Protection Agency). 1976. *Quality Criteria for Water*. EPA-440/9-79-023. Springfield, VA: EPA.

EPA (US Environmental Protection Agency). 2003. *Blackbird Mine Superfund Site Record of Decision*. Seattle, WA: EPA.

EPA (US Environmental Protection Agency). 2008. *First Five-Year Review Report Blackbird Mine Site.* Seattle, WA: EPA.

Golder Associates. 1995. *Analysis of Early Action Alternatives, Blackbird Mine Remediation, Final Report*. Redmond, WA.

Golder Associates. 2002. *Focused Feasibility Study for the Blackbird Mine Site Lemhi County, Idaho*. Redmond, WA.

Golder Associates. 2013. *Blackbird Mine Site 2013 Monitoring Report Lemhi County, Idaho*.

Hagler/Bailley, R. 1995. *Fisheries Injuries Study.*

Henderson, R., J. Kershner, and C.A. Tolines. 2000. "Timing and Location of Spawning by Nonnative Wild Rainbow Trout and Native Cutthroat Trout in the South Fork Snake River, Idaho, with Implications for Hybridization." *North American Journal of Fisheries Management.* 20: 584–596.

Iadanza, N. and S. Shutler. 1995. *Physical Restoration Analysis*. Longmont, CO: National Oceanic and Atmospheric Administration.

Klima, K.E. and F.M. Applehans. 1990. "Copper Exposure and the Degeneration of Olfactory Receptors in Rainbow Trout (*Oncorhynchus Mykiss*)." *Chemical Speciation and Bioavailability*. 2: 149–154.

McIntyre, J.D. and B.E. Rieman. 1995. "Westslope Cutthroat Trout." *Conservation Assessment for Inland Cutthroat Trout*. Edited by M.K. Young. Fort Collins, CO: USDA. Forest Service.

McKee, P. and R. Eakins. 2005. *Biomonitoring Study: Panther Creek Watershed September 2004.* Brampton, Ontario: Blackbird Mine Site Group. Report 04-1101.3.

Mebane, C. 1997. *Use Attainability Analysis, Blackbird Creek, Lemhi County, Idaho*. Boise, ID: Idaho Department of Environmental Quality.

Nebeker, A.V., C. Savonen, R.J. Baker, and J.K. McCardy. 1984. "Effects of Copper, Nickel and Zinc on the Life Cycle of the Caddisfly *Clistoronia Magnifica* (Limnephilidae)." *Environmental Toxicology and Chemistry.* 3: 645–649.

NOAA (National Atmospheric and Oceanic Administration). 2007. *An Overview of Sensory Effects on Juvenile Salmonids Exposed to Dissolved Copper: Applying a Benchmark Concentration Approach to Evaluate Sublethal Neurobehavioral Toxicity*. Technical Memorandum NMFS-NWFSC-83.

Reiser, D.W. 1986. *Panther Creek, Idaho, Habitat Rehabilitation*. Portland, OR: US Department of Energy, Bonneville Power Administration, Division of Fish and Wildlife. Contract No. DE-AC79-84BP174449. BPA Project No. 84-29.

RMC (Rocky Mountain Consultants). 1995. *Physical Restoration Analysis, Blackbird Mine, Lemhi County, Idaho.* Prepared for the National Oceanographic and Atmospheric Administration.

Schoby, G. and T. Curet. 2007. *Seasonal Migrations of Bull Trout, Westslope Cutthroat Trout and Rainbow Trout in the Upper Salmon River Basin, Idaho* Boise, ID: Idaho Department of Fish and Game.

Stantec, Inc. 2004. *Biomonitoring Study: Panther Creek Watershed September 2003*. Brampton, Ontario: Blackbird Mine Site Group. Report 631.22481.3.

USFS (US Forest Service). 2008. *Final Environmental Impact Statement*. Salmon, ID: USFS.

Woodward, D.F., W.G. Brumbaugh, A.J. Deloney, E.E. Little, and C.E. Smith. 1994. "Effect on Rainbow Trout Fry of a Metals-Contaminated Diet of Benthic Invertebrates from the Clark Fork River, Montana." *Transactions of the American Fisheries Society* 123: 51–62.

Zurstadt, C. and K. Stephan. 2004. *Bear Valley Westslope Cutthroat Trout: Migration, Spawning and Habitat*. Boise, ID: US Forest Service.