APPENDIX D - JUDITH MOUNTAINS PROJECT AREA METALS SOURCE ASSESSMENT

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D1.0 INTRODUCTION

This appendix is taken from a an assessment of potential sources of metals loading to 303(d) listed metals impaired stream segments in the Judith Mountains project area was performed in 2011 to facilitate development of metals TMDLs (Atkins North America, Inc., 2011). Stream segments of concern included Chicago Gulch, Chippewa Creek, Collar Gulch, Armells Creek, Cow Creek and Fargo Coulee. Metals impaired stream segments in the project area are shown in **Table D1** and **Figure A-7** (**Appendix A**).

The metals source assessment included: 1) a review of relevant literature sources, 2) compilation and review of GIS layers pertaining to land uses, land ownership, and locations of abandoned and inactive mines, and 3) field data collection activities, including water quality and streamflow monitoring, and field inspections of the subject watersheds. Because water quality data are summarized in the main document, this appendix summarizes the literature review, GIS analysis, and field assessment of metals sources.

It should be noted here that the primary focus of this study was on drainages with abandoned mines in the Judith Mountains: Chicago Gulch, Chippewa Creek, Collar Gulch and Armells Creek. Metals source assessment activities on Cow Creek and Fargo Coulee were limited to water quality monitoring and evaluation and excluded any on-the-ground investigations of former (coal) mining sites or other potential metals sources.

Table D-1. Metals impaired waters in the Judith Mountains TMDL Project Area.

Segment ID	Waterbody Name	303(d) Listing
MT40B002_020	CHICAGO GULCH, headwaters to the mouth (Fords Creek)	Lead, pH, Zinc
MT40B002_040	CHIPPEWA CREEK, headwaters to confluence with Manitoba Gulch	Antimony, Arsenic, Cyanide, Iron, Mercury, Zinc
MT40B002_030	COLLAR GULCH, headwaters to mouth (Fords Creek)	Lead, pH, Zinc
MT40E002_022	ARMELLS CREEK, headwaters to Deer Creek	Cadmium, Copper, Mercury, pH, Zinc
MT40E002_040	COW CREEK, Als Creek to the mouth (Missouri River)	Aluminum, Copper, Iron, Lead
MT40E002_130	FARGO COULEE, headwaters to mouth at Amells Creek	Aluminum, Iron, Lead

D2.0 METHODS

D2.1 METALS SOURCE ASSESSMENT DATA COLLECTION AND ANALYSIS

The metals source assessment employed 1) a review of literature pertaining to historical mining and minerals processing activities in the Judith Mountains, 2) GIS analysis of the watershed settings, including geography, land ownership, hydrography, and locations of impaired stream segments in relation to abandoned and inactive mines, and 3) on-the-ground surveys of the impaired segments and adjacent mine sites. Each of these study elements is described in more detail below.

D2.1.1 Literature Review

Prior to field data collection, an Internet search of relevant documents pertaining to the history of mining in the Judith Mountains was performed, together with topical searches for information pertaining to each of the subject streams. Sites searched included websites and associated information repositories hosted by Montana Department of Environmental Quality (DEQ), the Montana State Library/Natural Resources Information System (NRIS), Montana Bureau of Mines and Geology (MBMG), U.S. Bureau of Land Management (BLM), and various non-governmental locations.

During the Internet search, a 2011 solicitation by the BLM for assessment work in several drainages in the project area to evaluate natural versus human sources of acid mine drainage and metals was found. The streams identified in the solicitation that are within the TMDL project area are Collar Gulch, Chicago Gulch, and Armells Creek. Chad Krause, a BLM hydrologist, was contacted regarding the assessment project and confirmed it is underway; a limited amount of reconnaissance sampling was conducted in 2011 but most sampling will occur in 2012 and 2013 (personal communication, May 2011).

D2.1.2 GIS Analysis

Prior to field data collection, GIS data layers representing road networks, stream hydrography, land ownership, land elevation/topography, and the locations of abandoned and inactive mines catalogued by the Montana DEQ and Montana Bureau of Mines and Geology were assembled and used to create a series of planning maps. The maps were used in the office and in the field to help establish appropriate water quality monitoring locations on the impaired stream segments in relation to abandoned mines, land ownership, land uses and access points, and to catalogue abandoned mine sites for inspection.

D2.1.3 Field Source Assessment

Most of each impaired stream segment for Chicago Gulch, Chippewa Creek, Collar Gulch and Armells Creek was visually surveyed on foot or by vehicle during the week of May 16, 2011. Due to a cool spring and higher than normal mountain snowpack, the extreme headwaters segments of Chicago Gulch, Collar Gulch and Armells Creek could not be accessed during the survey period. In these cases, metals source assessment monitoring locations were established at the upstream limits of access. A number of abandoned mine sites included on the DEQ and MBMG abandoned mines GIS coverages were accessed and visually inspected. In most cases, these sites were located some distance from the active stream courses and, in many cases, in upland areas well away from live drainages. No active seeps or adit discharges were identified in the field, only one adit discharge was described in the abandoned mines inventory data (inaccessible due to deep snow), and none were sampled. However, an attempt was made in each watershed to bracket potential mine related source areas, on the basis of mine or mill location in relation to the stream drainage pattern, closely enough that any increases in loading could be associated with those specific mines or mill sites.

D3.0 RESULTS

D3.1 CHICAGO GULCH

D3.1.1 Literature Review

The literature review for Chicago Gulch did not identify references to historical mining activities in this drainage, although numerous information sources were identified for adjacent drainages in the Judith Mountains.

D3.1.2 GIS Analysis

Chicago Gulch flows for about 3 miles from its headwaters on the southeast slope of Red Mountain in the Judith Mountains to its confluence with the East Fork of Fords Creek. The upper half of the Chicago Gulch watershed consists of BLM managed public lands and the lower half is private ranch lands. Elevation of the stream varies from about 5400 feet in it headwaters to about 4500 feet at the East Fork confluence. The Montana DEQ abandoned mines database shows one exploration prospect or abandoned mine site in the extreme headwaters of Chicago Gulch (located between the two headwater forks) at an elevation of about 5700 feet. It is not named or described in the database and a field survey was not possible due to deep snow. The site did not appear in the MBMG abandoned mines coverage. The MBMG database includes one additional abandoned mine site in this watershed that is not included in the DEQ inventory. It is called the Big Chicago Mine, and is an underground gold exploration prospect located on private property on the south side of Chicago Gulch at an elevation of about 4880 feet. The MBMG site description indicates no impacts associated with the site, which was observed from a distance.

D3.1.3 Field Source Assessment

Water quality monitoring was conducted at two sites in Chicago Gulch on August 18, 2010, and at three sites on May 19, 2011. The 2010 monitoring locations included one site at about the mid-point of the listed segment (CHIG-M1) and a lower site just above the confluence of the East Fork of Fords Creek (CHIG-M2). Both locations were on privately owned ranch lands. The 2011 monitoring sites included a new upper watershed location near the BLM/private boundary (CHIG-MSA1), the former upstream 2010 site (CHIG-M1), and a site just below the confluence of the East Fork Fords Creek (FORDS-M2) (**Figure 7-1** and **Table 7-7** in TMDL). Note, site FORDS-M2 is not shown on **Figure 7-1** because it is downstream of the listed portion of the stream.

The creek was low, clear and flowing less than 1 cubic foot per second (cfs) in August 2010. In contrast, the stream was slightly turbid with fine suspended sediment particles in May 2011, with elevated flows ranging from 12.1 cfs in the upper reaches, to more than 25 cfs below the East Fork. Snow was present on the trail at the upper monitoring site in May 2011 and snowmelt conditions were well underway.

During the 2011 monitoring, the entire portion of the listed segment from the BLM boundary downstream to the East Fork of Fords Creek was observed from a trail which parallels the creek. No apparent mining related or other anthropogenic sources of metals loading were observed in this segment of Chicago Gulch. Water quality data indicated a metals source in the upper reaches of the watershed upstream of the BLM boundary.

D 3.2 CHIPPEWA CREEK

D3.2.1 Literature Review

The literature review for Chippewa Creek and the town of Giltedge revealed a colorful mining history. Placer prospectors worked the area in 1880 and some lode mining began in 1881. Lode deposits associated with the Giltedge Mine were discovered in upper Chippewa Creek in 1884. A crude cyanide mill was built in the drainage near the base of the mountains to process the ore and was operated for a short time. In 1893, the mine ownership changed and new investors rebuilt the cyanide mill allowing 100 tons of $20 ore to be worked each day. About 50 workers and their families established the mining camp of Giltedge near the mill site. Management problems plagued the mill and Giltedge was nearly deserted in the mid-1890's. The property then changed ownership again in 1898 and a new 150 ton

cyanide mill was built closer to the mine mouth. The mill was later expanded to 350 tons and included six leaching tanks with capacities of 175 tons each. The mine operated until 1912 and the mill was dismantled before 1916. A cyanide plant was erected at the first mill site in 1918 to rework 8,200 tons of tailings. The series of mines in the Chippewa Creek drainage were said to contain 2.5 miles of underground workings and are credited with production of $1.25 million in gold (Montana DEQ historic narratives available at: http://www.deq.mt.gov/abandonedmines). According to John Koerth at the DEQ Abandoned Mine Cleanup Bureau, Golden Maple Company developed a cyanide heap leach operation in the Chippewa Creek drainage in the 1980's to reprocess old mill tailings from the Giltedge Mine (personal communication July 2011). Prior to the close of the mine in 1985, the operators were cited for violations including an inadequate leach pad liner and surface discharges from treatment ponds, and elevated cyanide concentrations were documented in groundwater down gradient from the mine. After the mine was abandoned, DEQ used the bond money to treat and land apply the contents of the treatment ponds and to bury sediment from the treatment ponds on-site. In 1993, approximately 700 feet of channel was reconstructed and the floodplain was recontoured to minimize erosion. Some of the reprocessed tailings remain along lower Chippewa Creek near Giltedge.

D3.2.2 GIS Analysis

The 303(d) listed segment of Chippewa Creek extends for 3.8 miles from its headwaters to the confluence of Manitoba Gulch about one mile below the former Giltedge town site. Land ownership is BLM managed lands in portions of the upper reaches and private lands scattered over much of the rest of the watershed. Elevation of the stream varies from about 5600 feet in it headwaters to about 4500 feet at the Manitoba Gulch confluence. The Montana DEQ abandoned mines database shows a cluster of abandoned mines in the upper Chippewa Creek drainage, including the Giltedge Mines, the Cliff Mine, and the Upper and Lower Ox Frame Gulch Mines. The DEQ database also includes the Giltedge Tailings near the town of Giltedge, and several coal mines within the drainage. The MBMG database includes the Giltedge Mine, the Giltedge Tailings, and the Giltedge coal mine. The databases do not mention problems associated with any of the mine and mill sites, but do indicate the Giltedge Mine was active in 1995 (presumably the Golden Maple activities).

D3.2.3. Field Source Assessment

Water quality monitoring was conducted at two sites on Chippewa Creek on August 19, 2010, and at three sites on May 18, 2011. The 2010 monitoring locations included one site just upstream of the Maiden Road crossing at Giltedge, within the lower half of the listed segment (CIPC-M2), and a lower site a short distance below the Manitoba Gulch confluence (CIPC-M3) at the county road crossing (**Figure 7-2** and **Table 7-10** in TMDL). Note, site CIPC-M3 is not shown on Figure 7-2 because it is downstream of the listed portion of the stream. Chippewa Creek was dry from its headwaters to a short distance above CIPC-M2 and could not be sampled in August 2010. The 2011 monitoring included a new upper site (CIPC-MSA1) located just downstream from an area of upwelling groundwater and a developed off-channel stock watering tank. Site CIPC-MSA1 was located near the upstream limit of perennial flow in Chippewa Creek based on late-summer 2010 and spring 2011 observations. Former monitoring sites CIPC-M2 and CIPC-M3 were also sampled again on May 18, 2011.

Streamflows in May 2011 increased three-fold from CIPC-MSA1 to CIPC-M2 (0.26 to 0.78 cfs), and increased four-fold from CIPC-M2 to CIPC-M3 (0.78 to 3.14 cfs). Stations CIPC-MSA1 and CIPC-M2 bracket the original Giltedge cyanide mill site and a large nearby pile of reworked mile tailings. There is also a small impoundment on Chippewa Creek at Giltedge which may serve as a temporary sink for

sediment associated pollutants such as TR metals and TSS. The stream also gains flows from groundwater discharge through this reach.

During each of the 2010 and 2011 monitoring events, the portion of the listed segment from just upstream of the Giltedge Mine downstream to the Manitoba Gulch confluence was examined. There was no little or no surface flow present in Chippewa Creek from upstream of the Giltedge Mine downstream nearly to the location of monitoring site CIPC-MSA1 during both visits, and no surface discharges were observed from mines or mill sites. However, mill tailings were observed to be eroding into the channel and may be a source of metals loading. Diffuse, very small volume groundwater seeps began appearing across the floodplain downstream of the reclaimed area associated with Golden Maple's former heap leach operations. Flows slowly increased from this area downstream to the Maiden Road, where flows of 0.07 and 0.78 cfs were measured in August 2010 and May 2011, respectively. TSS concentrations were 23 and 26 mg/L at site CIPC-M2 on these two occasions and fine sediment particles were suspended in the water, although the water appeared mostly clear. Snow appeared to be largely gone from the watershed during the mid-May 2011 visit, although the very upper-most reaches of the watershed were not visited (due to no flow present).

D3.3 COLLAR GULCH

D3.3.1 Literature Review

The literature review for Collar Gulch provided considerable information on the history of minerals exploration and development in this watershed, as well as other resources. The Collar Mine was one of the first mines to be developed in the Maiden area and is the most important mine in the Collar Gulch watershed. The mine is located on the south side of Collar Gulch in the upper half of the stream's 6.4 mile length. This underground lode mine was discovered in August 1880. A 350 foot adit was driven into the mountain and a 190 foot shaft was sunk to meet the adit. Drifts were driven on the 70 foot and 120 foot levels. The mill was operated for only a short time. In 1882, a 20-stamp mill was erected at the mine featuring 850 pound stamps, 12 pans and 6 settlers. In 1884, the mine was sold and resold. The mill was dismantled and moved to another mine. The mine was reopened and expanded in 1906, and cyanide ores were shipped out. By 1906 the mine was reported to have shipped $125,000 in ore (http://www.deq.mt.gov/abandonedmines).

The Tail Holt Mine is located high on a hillside on the west side of the upper Collar Gulch drainage. This mine was discovered in 1911, worked for a short time and then abandoned. In 1927, the mine was actively developed and ore was shipped. A mill and a cyanide plant were erected on-site to work the ore. From 1927-1934, the mine was credited with producing 1,166 ounces of gold and 647 ounces of silver from 2,961 tons of ore (http://www.deq.mt.gov/abandonedmines). The mine continued to be worked intermittently through the 1930's and was an active claim as late as 1995. Other mines or prospects in the Collar Gulch Watershed include the Black Diamond (dry prospect), the Silver Bullion (active in 1995), the Montago (same location as the Collar Mine), and the Hardscramble (dry, no impact).

The literature review also revealed a description of a cooperative fish habitat enhancement project on Collar Gulch in the vicinity of the Collar Mine and mill site. In 2006-2007, BLM, Montana Fish, Wildlife and Parks, and a private contractor routed Collar Gulch around an old log crib dam and enhanced habitat features to protect what is described as the eastern-most known population of genetically pure westslope cutthroat trout (Flentie, 2008). Another publication described the importance of natural caves

and abandoned mines in Collar Gulch and other areas in the Judith Mountains as overwintering hibernaculum for several native bat species (Hendricks, 2000).

D3.3.2 GIS Analysis

The 303(d) listed segment of Collar Gulch extends for 6.4 miles from the headwaters to its mouth on Fords Creek. Land ownership is BLM managed lands in the upper half of the watershed drainage area with some scattered private in-holdings likely associated with mining claims, private ranch lands in its central and lower reaches, and state lands (former Fort McGinnis historical site) in the lower 1.5 mile of stream extending to where it meets Fords Creek. Elevation of the stream varies from about 5500 feet in it headwaters to about 4200 feet at the Fords Creek confluence. The MBMG and/or Montana DEQ abandoned mines databases show the previously described abandoned mines and assorted prospects in the Collar Gulch drainage, including the Collar Mine, the Tail Holt, the Silver Bullion, the Montago, and the Hardscramble. All of these mines and prospects are located in the upper half of the watershed. The MBMG database mentions an adit discharge at the Tail Holt Mine, which was not observed during an August 2010 visit to the mine. Problems are not indicated for the other sites within these databases.

D3.3.3 Field Source Assessment

Water quality monitoring was conducted at one site on Collar Gulch on August 18, 2010 (CLRG-M1; a second site was dry and could not be sampled), and at three sites on May 19, 2011 (**Figure 7-3** and **Table 7-13** in TMDL). The 2010 monitoring locations included one site a short distance downstream from the Collar Mine and mill (CLRG-M1), and the lower dry site was at a road crossing on private land (CLRG-M3). The creek channel went dry between CLRG-M1 and CLRG-M3 in August 2010 and sample collection could not be conducted at CLRG-M3 as noted. The May 2011 monitoring included a new upper site (CLRG-MSA1), which was located one-half to three-quarters of a mile upstream of the previously established site CLRG-M1. CLRG-MSA1 was the practical upper limit of access into the Collar Gulch headwaters area during this visit due to deep snow and heavy vegetation. Former monitoring sites CLRG-M1 and CLRG-M3 were also re-sampled on May 19, 2011, during which time the lower site had active streamflow. Station CLRG-M1 is located downstream from the Tail Holt and Silver Bullion Mines, both of which are some distance from the Collar Gulch stream channel. Stations CLRG-MSA1 and CLRG-M1 bracket the Collar Mine and mill site, and the Hardscramble Mine. Monitoring sites CLRG-M1 and CLRG-M3 bracket the Black Diamond dry prospect and the newer vertical exploration shaft adjacent to Collar Gulch near the BLM/private land boundary.

Collar Gulch is known to lose surface flow to groundwater downstream of the Collar Mine, as was observed during August 2010, and this has contributed to the survival and isolation of the population of pure westslope cutthroat trout. In May 2011, several small tributaries were observed discharging to Collar Gulch between sites CLRG-M1 and CLRG-M3. Despite these inflows, the streamflow in Collar Gulch remained a relatively steady 11.28 to 11.88 cfs in this reach, suggesting that any losses to groundwater were offset by tributary surface discharges. TSS concentrations in Collar Gulch were less than detection at all monitoring sites in both August 2010 and May 2011 indicating low levels of suspended sediment despite moderate turbidity levels observed in May 2011. Any sediment present in Collar Gulch in May was obviously in the form of very fine particles that gave a cloudy appearance despite TSS concentrations less than the 4 mg/L detection limit. Most snow was gone from the lower elevation portions of the watershed during the May 19, 2011 visit.

During the 2011 monitoring event, the entire 4 mile portion of the listed segment from the private ranch road crossing to upper-most monitoring site CLRG-MSA1 was observed from a trail which parallels the

creek. The Collar Mine site was examined in August 2010 and again in May 2011. Another more recent mine prospect was examined further downstream in the drainage, consisting of a vertical shaft sunk in a limestone outcrop adjacent to Collar Gulch. The Tail Holt Mine was examined in August 2010, as indicated earlier, and no adit discharge was observed at that time. Together, no readily apparent mining related or other anthropogenic sources of metals loading to Collar Gulch were observed during either survey. Snowmelt runoff was observed running down the road below the Collar Mine site during the May 2011 visit and it eventually discharged to Collar Gulch or its immediate floodplain.

D3.4 ARMELLS CREEK

D3.4.1 Literature Review

The literature review for Armells Creek produced limited findings and no detailed information on the mining history of this watershed. From the reference documents located for the other Judith Mountains streams, most of the producing mines were located on the east and west side of the mountains. Mine exploration in the Armells Creek drainage on the north side of the Judith Mountains produced limited success. According to landowners along Armells Creek, whose relatives came to this area in 1895, no significant producing mines or mills were ever developed in the Armells Creek drainage (personal communication with Steve Gilpatrick, Landowner. May 2011).

D3.4.2 GIS Analysis

The 303(d) listed segment of Armells Creek extends for 19.3 miles from the headwaters to the confluence of Deer Creek. Land ownership is BLM managed lands surrounding several miles of the headwaters area, and private ranch lands throughout the remainder of the listed segment.
Elevation of the stream varies from about 5200 feet in it headwaters to less than 3800 feet at the Deer Creek confluence. The MBMG and Montana DEQ abandoned mines databases show: 1) the Iron King underground prospect (iron) and the Hamilton Copper Prospect (copper, silver) on the north side of Judith Peak above upper Armells Creek, 2) the White and Gilpatrick exploration prospect (lead, zinc, copper), the West Armells Creek claim (iron, manganese), and the Armells Creek Number 1 claim (unlisted details) adjacent to the headwaters fork of Armells Creek which drains Red Mountain, and 3) the Sutter Mine (iron, copper, silver – past producer), the Cave prospect (silver, lead), and the Independent Numbers 3 and 4 (iron prospect) adjacent to Armells Creek in the area near the BLM/private land boundary. The mines database indicates that most of these sites are dry with no associated environmental impacts, and no specific problems are indicated for any of the sites.

D3.4.3 Field Source Assessment

Water quality monitoring was conducted at three sites on Armells Creek on August 16, 2010, and at five sites on May 17-18, 2011 (**Figure 7-4** and **Table 7-16** in TMDL). The 2010 monitoring locations included one site in the headwaters of Armells Creek on BLM lands downstream from the confluence of the two headwaters tributaries (ARMC-M1), a site on a private ranch at the Gilpatrick Road crossing near Hilger (ARMC-M2), and a site below the confluence of the East Fork Armells Creek at the county road crossing on a privately owned ranch (ARMC-M3). Access permission was not granted to private lands in the lower portion of the listed segment of Armells Creek near the Deer Creek confluence. The May 2011 monitoring included two new upper watershed monitoring locations: ARMC-MSA1 on the headwaters fork of Armells Creek which drains the north side of Judith Peak, and ARMC-MSA2 on the headwaters fork of Armells Creek which drains Red Mountain. During the May 2011 monitoring event, ARMC-M1 and AMC-M2 were also re-sampled. Also during the May monitoring event, the former lower-most site ARMC-M3 was relocated downstream a half mile to a second (abandoned) county bridge crossing on the

private ranch and named ARMC-M4. This site was relocated downstream to ensure complete mixing of the East Fork Armells Creek inflow at the very high flow conditions that were encountered on May 18.

The water appeared moderately turbid or turbid at all the monitoring sites in May 2011, but sediment present at the upper sites was obviously in the form of very fine particles that gave a cloudy appearance despite the low TSS measurement values. All snow was gone from the lower elevation portions of the Armells Creek watershed during the May 17-18, 2011 visit.

During the May 2011 monitoring, most of the segment of Armells Creek from its headwater forks downstream to Highway 236, and a half mile or more of each of the two headwater tributaries, was observed from adjacent roads or on foot. The extreme headwaters of the tributaries could not be accessed due to remaining deep snow. Extensive flood damage to the road, culverts and stream channel from peak snowmelt runoff the previous week was observed along upper Armells Creek on BLM and privately owned lands. Many of the accessible, previously listed mine prospect sites were examined for discharges or potential metals source areas. The high elevation Iron King and Hamilton Copper Prospect sites were not accessible. No readily apparent mining related or other anthropogenic sources of metals loading to Armells Creek were observed during the survey. However, actively eroding streambanks on BLM lands revealed brilliant red soils that may have been natural sources of iron and possibly other metals.

D3.5 COW CREEK

D3.5.1 Literature Review

As was noted on page 3 of this report, the primary focus of this study was on Chicago Gulch, Chippewa Creek, Collar Gulch and Armells Creek. Cow Creek was not extensively researched for literature pertaining to former coal or metals mining within its watershed area. No relevant documents were identified.

D3.5.2 GIS Analysis

GIS mapping and analysis for Cow Creek show several abandoned coal and placer mines within the MBMG abandoned mines database in the lower portion of the drainage downstream of the reach monitored as part of this study.

D3.5.3 Field Source Assessment

Water quality monitoring was conducted at three sites on Cow Creek on August 17, 2010, and was repeated at the three same sites on May 16, 2011 (**Figure 7-5** and **Table 7-19** in TMDL). The 2010-2011 monitoring locations included an upper site accessed off the Birdtail Road (COWC-M1), a site at the Cow Island Road Crossing (COWC-M2), and a lower site accessed from the Spencer Ridge Road (COWC-M3). Surface flows present in Cow Creek during the August 2010 visit ranged from 1.85 cfs at COWC-M1 to 1.49 cfs at COWC-M3. In mid-May 2011, snowmelt runoff had likely peaked in the previous week based on evidence of previous over bank flows and flooding. Flows on May 16 ranged from 50.68 cfs at COWC-M1 to 52.31 cfs at COWC-M3 during a (likely) declining hydrograph. Snow was no longer present in the visible watershed during May 2011 sampling and roads were drying out from heavy rainfall that occurred several days earlier. TSS concentrations in Cow Creek in August 2010 were 5 mg/L at COWC-M1, 17 mg/L at COWC-M2, and 13 mg/L at COWC-M3. In May 2011, TSS concentrations ranged from 47 mg/L at COWC-M1 to 254 mg/L at COWC-M3, reflecting the high turbidity and sediment loads carried by

this stream during spring runoff. Turbidity levels at all stations were described as opaque during sampling in May 2011.

No direct sources of metals were identified in the reach of Cow Creek that was examined. Concentrations and loads for most metals increased in a downstream manner in conjunction with increasing TSS concentrations. Concentrations of most metals were higher during runoff conditions in May than during base flow conditions in August, suggesting a diffuse metals source associated with runoff and/or suspension of sediment.

D3.6 FARGO COULEE

D3.6.1 Literature Review

As was noted on page 3 of this report, the primary focus of this study was on Chicago Gulch, Chippewa Creek, Collar Gulch and Armells Creek. Fargo Coulee was not extensively researched for literature pertaining to former mining within its watershed area and no pertinent information was identified that would shed light on that question.

D3.6.2 GIS Analysis

A GIS mapping and analysis exercise was not conducted for Fargo Coulee as a part of this study. The DEQ and MBMG abandoned and inactive mines database did not reveal any former mines in the Fargo Coulee drainage.

D3.6.3 Field Source Assessment

Water quality monitoring was attempted at each of three sites on Fargo Coulee on August 17, 2010 and again on May 17, 2011 (**Figure 7-6** in TMDL). The monitoring locations included an upper site at the Birdwell Road crossing (FRGC-M1), a middle site accessed from private ranch lands north of Roy (FRGC-M2), and a site at the mouth of Fargo Coulee on Armells Creek (FRGC-M3). All three sites were dry in August 2010, and one of three sites, FRGC-M1, was dry in May 2011.

Surface flows present in Fargo Coulee during the May 2011 monitoring event ranged from 0.55 cfs at FRGC-M2 to 6.78 cfs at site FRGC-M3 at the mouth. During this visit, snowmelt runoff had likely peaked in the previous week based on evidence of previous over bank flows and flooding. Snow was no longer present in the visible watershed and roads were drying out from heavy rainfall that occurred several days earlier. TSS concentrations in Fargo Coulee were less than the analytical detection limit of 4 mg/L at FRGC-M2 and 379 mg/L at FRGC-M3 on May 17, 2011. Turbidity was 3.07 NTU at FRGC-M2 and 434 NTU at FRGC-M3. The water was tannin stained and very clear at FRGC-M2, and opaque with a very heavy sediment load at FRGC-M3. Specific conductance was 7985 µS/cm at FRGC-M2 and 6958 µS/cm at FRGC-M3 indicating very high levels of dissolved solids. Saline seeps were observed entering Fargo Coulee from adjacent coulees just upstream of the FRGC-M2 sampling location and salt crusts were present along the margins of the stream channel.

No mining or other direct human source of metals was identified during the field assessment. Monitoring of Fargo Coulee in May 2011 showed that concentrations and loads for most metals increased in a downstream manner in conjunction with increasing TSS concentrations. This suggests that diffuse sediment associated nonpoint sources in the segment of Fargo Coulee between FRGC-M2 and FRGC-M3 were the largest source of metals in this system.

D5.0 REFERENCES

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