# APPENDIX G-1: Draft Plan of Study: Aquatic Monitoring Plan in Upper Sheep Creek Basin in Meagher County, Montana

**DRAFT PLAN OF STUDY**

# AQUATIC MONITORING PLAN FOR THE BLACK BUTTE COPPER PROJECT IN UPPER SHEEP CREEK BASIN IN MEAGHER COUNTY, MT

**Prepared for:**
**TINTINA RESOURCES INC.**
**White Sulphur Springs, Montana 59645**


**Prepared by:**
**David Stagliano, Montana Biological Survey**
**1901 Peosta Ave**
**Helena, Montana 59601**
**[www.montanabiologicalsurvey.com](http://www.montanabiologicalsurvey.com)**


**June 2017**

Montana Biological Survey
Aquatic Ecology Fisheries Taxonomy Assessments

# A.1 Aquatic Biological Resource Monitoring

## A.1.1 Introduction

Tintina Resources Inc. (Tintina) will conduct aquatic biological monitoring using a before-after/control-impact (BACI) approach prior to, during and after the Black Butte Copper (BBC) project construction and operation. The monitoring will be performed at 11 stream stations located: (1) within and downstream of potential project disturbances (Impact), (2) at stations upstream of potential project influences (Control), and (3) outside of the project sub-basin (Control/Reference) (**Table A1, Map 1**). Replicated stream sections within each BACI class will be assessed for habitat and biological parameters documented to be correlated with water quality and quantity (**Table A2**). Stream locations were selected to be as geomorphically similar as possible across stations and to correspond with 4 surface water quality monitoring stations (Hydrometrics 2015). This BACI sampling design allows for the robust analysis of the data using both univariate and multivariate statistical methods between years, streams and stations. Baseline aquatic sampling will have been completed for three years prior to project construction to identify the existing natural variability and the current influence of water quality and other anthropogenic effects on stream communities and habitat.

No previous standardized biological sampling had been conducted within the Sheep Creek project area (Montana Department of Environmental Quality [MDEQ] 2007), (Montana Department of Fish, Wildlife and Parks [MFWP] 2014), (Montana Natural Heritage Program [MNHP] 2015); this could have provided a long-term perspective on the aquatic conditions. Although, the upstream Sheep Creek control site (AQ2) had two fish population estimates in 1973 and 1992 (MFWP 2014) and a stream-wide assessment of nutrients, sediment and *E. coli* in Sheep Creek was recently completed (MDEQ 2017)

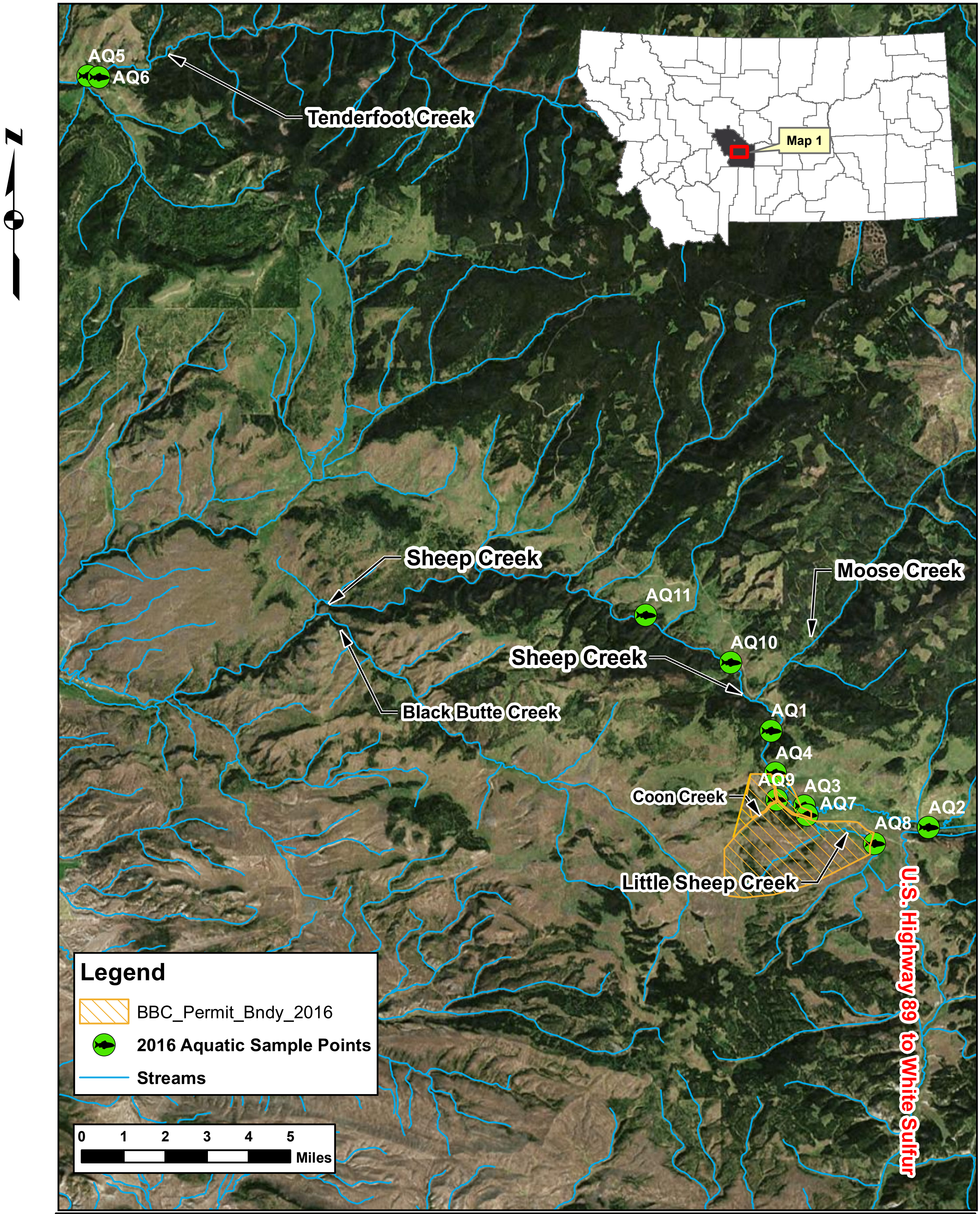
Hydrometrics, Inc. will continue to collect surface water quality samples, temperature and discharge data at four of the aquatic biological monitoring stations during each monitoring period to assist in interpretation of the biological data (**Table A1**, see Hydrometrics 2015). Montana Biological Survey (MBS) will conduct fisheries population surveys, habitat assessments, macroinvertebrate and periphyton sampling; and redd counts to provide the scientifically-robust field data in order to assess the influence of the project on stream biota. Rhithron Associates will perform the periphyton/chlorophyll laboratory analysis and Energy Laboratories will provide the fish tissue metals analysis.

## A.1.2 Monitoring Locations and Sampling Periods

Tintina will conduct aquatic biological monitoring at 11 stations (**Table A1, Map 1**). Four stations on Sheep Creek and one each on Little Sheep and Coon Creeks are within or downstream of the proposed project disturbance boundaries (Impact). Two Sheep Creek stations and one Little Sheep Creek station are upstream of potential project impacts and will serve as control stations. Two Tenderfoot Creek stations are outside of the project sub-basin and will serve as a reference, control stream (**Table A1, Map 1**). Stream reach length per station was delineated based on 40 times the average wetted channel width at baseflow or 150m minimum length (MDEQ 2012a) (**Table A1**). Fish sampling stream reach length varied by station and included a minimum of 4 riffle/pool habitat units (**Table A1**). Eleven equidistant transects were established along each reach length during the stream mapping phase; these randomly encompass all stream habitats (MDEQ 2012, shown on **Figure A1**). Biological monitoring frequency will vary, depending on the monitoring task and station (**Table A2**). Fish population estimates and water quality measures will be conducted three times annually: prior to runoff in the spring (typically late-April or early-May), during summer (mid-July), and fall (typically mid-September). Spawning redd counts for brown and brook trout will be conducted in late-October. Rainbow trout redd counts were not included in the spring due to lack of use of this stream section for spawning (pers. obs. 2015-2017). Most other tasks will be conducted annually during the summer period, or less frequently as described below.

**Table A1.** Aquatic Monitoring Station GPS locations at the downstream (D/S) and upstream (U/S) ends of the original assessment reach. Stations denoted with SW are associated with Hydrometrics surface water monitoring sites. Wetted width (WW) was measured at summer baseflow.

| Site Code | Station Name | BACI Type | Avg. WW (m) | Reach Length (m) | Latitude | Longitude | Elev. (m) | Comment |
|---|---|---|---|---|---|---|---|---|
| SHEEP AQ1 | Sheep Creek @ SW1 (D/S)<br>Sheep Creek @ SW1 (U/S) | Impact | 15.0 | 600 | 46.795122<br>46.793008 | -110.910367<br>-110.911062 | 1697 | Downstream Canyon Reach on USFS land. |
| SHEEP AQ2 | Sheep Creek @ SW2 (D/S)<br>Sheep Creek @ SW2 (U/S) | Control | 8.2 | 320 | 46.772124<br>46.771973 | -110.855661<br>-110.853445 | 1743 | Upstream of Castle Mtn Ranch off US 89 |
| SHEEP AQ3 | Sheep Creek (D/S)<br>Sheep Creek (U/S) | Control | 9.0 | 360 | 46.777247<br>46.777667 | -110.898818<br>-110.898003 | 1718 | Hansen meadow Reach U/S of Little Sheep Creek |
| SHEEP AQ4 | Sheep Creek (D/S)<br>Sheep Creek (U/S) | Impact | 8.0 | 320 | 46.785116<br>46.784465 | -110.908826<br>-110.906504 | 1707 | Lower Reach on the USFS boundary |
| SHEEP AQ10 | Sheep Creek (D/S)<br>Sheep Creek (U/S) | Impact | 16.7 | 660 | 46.81100<br>46.81112 | -110.92567<br>-110.92398 | 1652 | Fishing Access Site 1.9 miles D/S of AQ1 |
| SHEEP AQ11 | Sheep Creek (D/S)<br>Sheep Creek (U/S) | Impact | 14.3 | 575 | 46.81598<br>46.81436 | -110.94058<br>-110.93067 | 1631 | Lowest Monitoring Reach 0.6 miles below FAS |
| TEND AQ5 | Tenderfoot Creek (D/S)<br>Tenderfoot Creek (U/S) | Control/ Reference | 10.0 | 400 | 46.95049<br>46.95077 | -111.14739<br>-111.14447 | 1435 | Lower Reach at South Fork Tenderfoot confluence |
| TEND AQ6 | Tenderfoot Creek (D/S)<br>Tenderfoot Creek (U/S) | Control/ Reference | 11.2 | 440 | 46.95018<br>46.95032 | -111.14362<br>-111.14365 | 1438 | Upper Reach U/S of USFS boundary |
| LSHEEP AQ7 | Little Sheep Creek (D/S)<br>Little Sheep Creek (U/S) | Impact | 2.1 | 150 | 46.775038<br>46.775897 | -110.89779<br>-110.89849 | 1718 | 500m D/S of County Road Culvert |
| LSHEEP AQ8 | L. Sheep Creek @ SW8 (U/S)<br>L. Sheep Creek @ SW8 (D/S) | Control | 1.5 | 150 | 46.768352<br>46.769087 | -110.874397<br>-110.874899 | 1738 | 100m U/S of the Haul Road Culvert. Mass wasting of stream banks |
| COON AQ9 | Coon Creek @ SW3 (D/S)<br>Coon Creek @ SW3 (U/S) | Impact | 0.5 | 150 | 46.77871<br>46.77842 | -110.90834<br>-110.90921 | 1708 | Upstream of County Road at SW3 site, culvert non-functional |




Montana Biological Survey

DRAWN BY: DS
CHK'D BY: AK
APPR. BY: AK
DATE: April 2016

**Tintina Resources**
Black Butte Copper Mine Project
Meagher County MT

**Aquatic Sampling Sites Overview**

PROJECT NO.
T01.2016

FIGURE NUMBER
**MAP 1**

E:\Tintina\Tintina Site Maparea_new.mxd

**Table A2.** Schedule of Aquatic Monitoring Tasks.

| Category | Task | Timeframe | | | Methods | Stations (see Map 1) |
|---|---|---|---|---|---|---|
| | | Spring | Summer | Fall | | |
| **Fish Populations** | **Population Estimates** | X | X | X | Multi-pass depletion and mark/recapture electrofishing | All sites, except Coon Creek (AQ9) which was determined to be fishless in 2014 & 2015. |
| | **Fish Tissue Metals** | | X | | Whole body Sculpin (n=5) and juvenile trout (n=5) analysis: Cu, Cd, Hg, Pb, Zn | AQ1, AQ2, AQ4, AQ7 |
| | **Redd Counts** | | | X | Visual survey counts | AQ1, AQ2, AQ3, AQ4, AQ7, AQ8, AQ10, AQ11 |
| **Benthic Taxa** | **Quantitative Macroinvertebrates** | | X | | Riffle Hess Samples (n=3) | All sites |
| | **Qualitative Macroinvertebrates** | | X | | Reach-Wide Dipnet Sample (11 Transects) | All sites |
| | **Quantitative Periphyton** | | X | | Chlorophyll-a (11 Transects) If determined TBN. | All sites |
| | **Qualitative Periphyton** | | X | | Peri-Mod1 (11 Transects) | All sites |
| **Substrate** | **Substrate Size Distribution** | | X | | Wolman Pebble Count (1 riffle) | AQ1, AQ2, AQ3, AQ4, AQ7, AQ8, AQ9, AQ10, AQ11 |
| | **Surface Fines** | | X | | Riffle Grid Toss | Same as above |
| | **Embeddedness** | | X | | Tally <50% embedded cobbles in Hess (n=3) | Same as above |
| **Habitat** | **Channel Bed Morphology** | | X | | % Riffle/Pool, Wetted Width Reach mapping | All sites |
| | **Fish Habitat Survey** | | X | | USFS R1/R4 LWD count, Pool Residual Depths | All sites |
| **Water Quality** | **Air & $H_2O$ Temperature (°C) pH, TDS, Conductivity** | X | X | X | Hanna Multi-meter Instrument calibrated for low conductivity | All sites |

## A.1.3 Substrate and Fine Sediments

Fine stream sediment (<6.3 mm) will be monitored during the summer base flow period every year beginning in 2017; this will continue through the initial year of the BBC project site disturbance and continuing through the construction period and into the operational phase. Benthic surface fines will be quantified using a 49-grid sampling device at each quantitative macroinvertebrate sample (Hess sampler) riffle location as described in Montana DEQ methodology (MDEQ 2012, section A.1.3.1). A pebble-count will be performed in the same riffle chosen for macroinvertebrate Hess sampling (Wolman 1954, see section A.1.3.2). Embeddedness will also be quantified at each Hess sample location by tallying each stone within the Hess sampler frame that is <50% embedded. Substrate size will be quantified by measuring the narrow dimension of these same stones. By conducting these tasks at the Hess sample locations, the data will provide quantitative measures of substrate at all stations in similar habitat and under similar depth and flow conditions, and will improve the ability to determine the influence of water quality and fine sediments on benthic macroinvertebrates (see section A.1.6 below). Tintina will follow MDEQ methods for assessing sediment impairment during the stable summer base flow period at all monitoring stations, by completing Wolman pebble counts, riffle grid tosses and embeddedness measures (Wolman 1954, MDEQ 2012).

### *A.1.3.1 Riffle Grid Toss*

The riffle grid toss will be performed at the same riffle location as the pebble count measurement. The riffle grid toss measures fine sediment accumulation on the surface of the streambed. Riffle grid tosses (n=3) will be performed prior to the pebble count to avoid disturbances to surface fine sediments according to MDEQ protocols (MDEQ 2011b).

### *A.1.3.2 Riffle Pebble Count*

One Wolman pebble count (Wolman 1954) will be performed at the first riffle encountered in the sample reach providing a minimum of 400 particles measured within each assessment reach. Particle sizes will be measured along their intermediate length axis (b-axis) and results were grouped into size categories. The pebble count will be performed from bankfull to bankfull channel edges using the “heel to toe” method.

## A.1.4 Fish Habitat

Habitat surveys will be conducted annually during the summer period across the entire stream reach (11 equidistance transects) (**Figure A1**). Stream reach habitat was initially mapped at 9 monitoring stations in 2014, and two additional downstream sites (AQ10 & AQ11) in 2016. Instream habitat data collection will follow the USFS R1/R4 methods (Overton et al. 1997). Habitat types (riffle/pool) within the stream reaches will be identified and measured individually (section A.1.4.1). Measurements within each habitat type will include feature length, wetted width, average depth, maximum depth, substrate type, bank vegetation, percent undercut bank, and percent eroded bank. Additionally, other measurements, such as pool frequency, pool quantity (section A.1.4.2 and A.1.4.3) and number of large woody debris pieces in the bankfull channel will be recorded (MDEQ 2011b).

### *A.1.4.1 Channel Bed Morphology*

In the process of mapping each reach, the length of each monitoring site occupied by pools and riffles will be recorded progressing in an upstream direction from transect A to K (**Figure A1**). The upstream and downstream stations of “dominant” riffle and pool features will be recorded. Dominant features (occupying over 50% of the bankfull channel width) will be recorded.

### *A.1.4.2 Residual Pool Depth*

At each pool encountered, the maximum depth and the depth of the pool tail crest at its deepest point will be measured. The difference between the maximum depth and the tail crest depth is considered the residual pool depth (basically the water depth remaining in a pool if the channel is drained). No pool tail crest depth will be recorded for dammed pools.

### *A.1.4.3 Pool Habitat Quality*

Qualitative assessments of each pool feature will be evaluated, including pool type (i.e., scour or dammed), size (i.e., small or large), formative feature (i.e., lateral scour, plunge, boulder, woody debris), and cover type (i.e., overhanging vegetation, depth, undercut, boulder, woody debris, none). The total number of pools will be quantified.

## A.1.5 Routine Physical/Chemical Parameters

Tintina will measure the following physical and chemical parameters at all aquatic biological monitoring stations during all monitoring periods: air and water temperature, pH, total dissolved solids (TDS) and specific conductance (µS/cm). A recently calibrated water quality measuring device will be used in the monitoring plan. Hydrometrics, Inc. has long-term, surface water quality monitoring stations that overlap with four aquatic biological monitoring sites (**Table A1**).

## A.1.6 Benthic Macroinvertebrates

Tintina will collect three quantitative Hess samples and one reach-wide (RW) qualitative sample of the benthic macroinvertebrates from all aquatic monitoring stations during the summer index period (**Table A2**). Methods will follow the guidelines described in the MDEQ's macroinvertebrate sampling protocol (MDEQ 2012b). Quantitative samples will be collected from a representative riffle habitat in the stream reach using a 500-µm mesh Hess sampler. Macroinvertebrates collected with the Hess sampler will be processed entirely and represent 0.1 $m^2$ of benthic substrate area. Specific sampling locations at each station will be standardized, to the extent possible, for riffle depths between 0.2 and 0.5 meter and flow velocities of less than 1.5 feet per second. Tintina will collect the semi-qualitative RW sample from 11 equidistant transects encompassing all habitats in the reach with a 500-µm mesh D-frame net (**Figure A1**). Macroinvertebrates collected with the RW dip net sample will be randomly sub-sampled on a gridded tray until 500-600 organisms are obtained (MDEQ 2012b). This data will provide supplemental information on species composition at the sites and to determine the relative abundance of the taxa inhabiting all aquatic habitats at the sampling station.

Macroinvertebrate community parameters analyzed will include density, taxa richness, total number of *Ephemeroptera*, *Plecoptera*, and *Trichoptera* (EPT) taxa, number of Ephemeroptera taxa, number of Plecoptera taxa, percent non-insect taxa, percent burrower taxa, the percent Heptageniidae, percent EPT individuals, Shannon-Weaver diversity index and the Hilsenhoff Biotic Index (HBI) modified for Montana (Jessup et al. 2006). Several of these parameters are metrics calculated by MDEQ as part of its data analysis (MDEQ 2012b) and will allow for the calculation of the Montana multi-metric index (Jessup et al. 2006). Additionally, these data will be analyzed using the Observed/Expected (O/E) Model developed for Montana (Jessup et al. 2006). To summarize these data, typical statistical measures will be used (mean, standard deviation, coefficient of variation, and standard error of the mean) and compared for differences between control and impact sites using ANOVA and T-tests with significance p-values $<0.05$

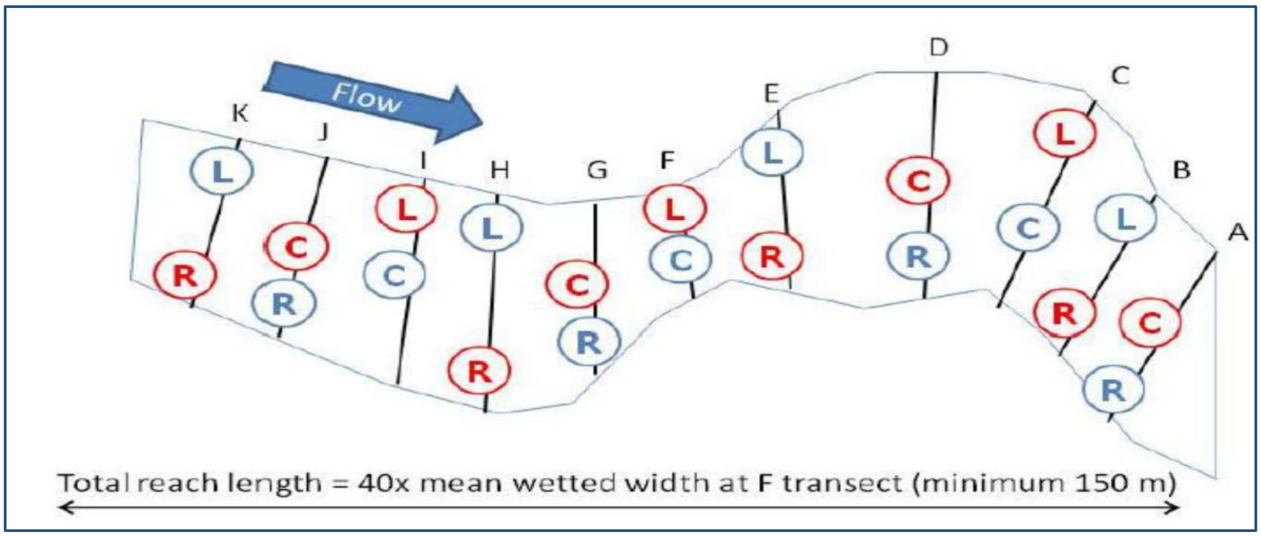
Quality assurance for macroinvertebrate data will follow MDEQ guidelines (MDEQ 2012b). Tintina will also maintain a permanent taxonomic reference collection of all benthic species collected from the project area streams. Taxa identification in this collection will be documented and confirmed by a qualified, independent macroinvertebrate taxonomists (MDEQ 2012b). This reference collection will be maintained by Tintina through the period of post-operational monitoring. Following this period, the collection will be transferred to a repository selected by the agencies for permanent scientific reference.

### A.1.7 Periphyton and Benthic Chlorophyll-a

Tintina will sample periphyton and estimate benthic chlorophyll-a at all aquatic biological monitoring stations concurrent with the benthic macroinvertebrate population sampling during the summer period (**Figure A1**). Qualitative periphyton samples will be collected following MDEQ's standard operation procedure using the appropriate methods for the stream habitat to be sampled (MDEQ 2011). The modified PERI-1 method will be used at all stream locations, which designates a specific longitudinal length of stream to be sampled at each site.

Algal material will be collected from each of the 11 transect locations, with all material composited into a single sample per site (MDEQ 2011). Collection methods will include using a toothbrush or knife to collect material from hard substrates and a turkey baster for soft substrates.

**Figure A1.** Transect locations for macroinvertebrate reach-wide (RW) (blue circles) and periphyton (Peri-Mod1) (red circles) samples (following MDEQ 2011).




Quantitative benthic chlorophyll-a samples will be collected from each site sampled for periphyton following MDEQ's standard operation procedure (MDEQ 2011). Eleven transects will be established throughout the site reach (**Figure A1**). The samples collected at each transect will be kept separate rather than combining them into one composite sample as was required for the periphyton samples. The collection method used at each transect will be based on the substrate and conditions at each location. For example, the hoop method may be used for transects dominated by the presence of filamentous algae, regardless of stream substrate. If heavy filamentous algal growth is not observed, the template sampling method will be used at transects dominated by small boulders, cobble, and gravel (MDEQ 2011). If field personnel visually assess the site and decide benthic algal chlorophyll-a is low (<50 mg/m$^2$, ½ the nuisance level of 100 mg/m$^2${Dodds et al. 1997}) at all transects of a stream reach, photographs of the stream substrate at all 11 transects will be taken in accordance with Section 7 of DEQ's standard operation procedure (MDEQ 2011) rather than collecting chlorophyll-a samples. Based on these assessment methods, one composite periphyton sample and 11 chlorophyll-a samples will be collected at each site from the reach transects prior to collecting the macroinvertebrate RW samples (see section A.1.6; **Figure A1**).

### A.1.8 Fish Populations

Tintina will monitor fish populations at six stream reaches in Sheep Creek (AQ1, AQ2, AQ3, AQ4, AQ10, and AQ11), two reaches at Little Sheep Creek (AQ7 and AQ8), and two reaches in Tenderfoot Creek (AQ5 and AQ6) (**Table A1 & A2, Map 1**) to determine possible changes in fish population characteristics (density estimates, species composition, age structure or condition) associated with development of the BBC Project. These sites were chosen based on accessibility, stream geomorphology and arranged in a BACI design (**Table A1**, Section A.1.1). The fish sampling reach length per station was delineated based on 40 times the average wetted channel width at base flow, and encompassed at least 4 habitat units (riffle/pool sequences) (**Table A1**). Standardized fish electrofishing collection procedures (i.e., pulsed direct current, adjusting voltage, pulse {2–6 ms}, and frequency {30–40 Hz} to maximize capture probability without causing fish injury, MFWP 2002) will be used across all stream habitat units (Dunham et al. 2009) at all monitoring stations. All fish collected in this study will be identified to species (Holton and Johnson 2003), measured for total length (TL) (mm) and weighed (grams) on mass balance scales to determine species composition, densities and biomass.
Stream monitoring sites less than 10 meters average wetted width and/or on the Hanson Ranch (AQ2, AQ3, AQ4, AQ7, AQ8) will be block-seined at the upstream and downstream riffles to prevent fish movement into or out of the sample section and electro-fished with 2 Smith Root (Model LR-24 or 20B) backpack electro-fishers. This sampling will be accomplished in one site visit, which is imperative due to fishing clients on the private ranch. This sampling procedure will include multiple-pass depletion, where the 1$^{st}$ pass salmonids collected will be held in live cars until the 2$^{nd}$ electrofishing pass is completed. If salmonid numbers (N) collected during the 2$^{nd}$ pass are more than 25% of the 1$^{st}$ pass (i.e. 1$^{st}$ pass efficiency is <75%) using the formula: $(1 - [(N_2 * Effort_1) / (N_1 * Effort_2)]) * 100 = \text{Pass Depletion}$), then a 3$^{rd}$ pass will be performed. Two-pass and multiple-pass depletion population estimates for salmonids will be calculated with MicroFish 3.0 Software (Van Deventer 1989). Non-salmonid fish species collected will be reported as catch-per unit-effort (CPUE). The block-seine, multi-pass depletion population estimate procedures have been used on similar-sized streams in other Mine Aquatic Monitoring Plans (MDEQ 2016).

Stream sites larger than 10 meters wide (AQ1, AQ5, AQ6, AQ10, AQ11) will be electro-fished with a Tote Barge equipped with a Smith Root VVP-15 rectifying unit and 2 anodes. The towable unit can effectively sample larger streams because it has additional power capabilities and employs two anodes, thus increasing the electrified zone. The initial electrofishing capture run will be conducted starting at the downstream riffle and proceeding in an upstream direction with 2 collectors fishing all habitat types until the top reach riffle is reached and a minimum of 50 salmonids are collected. Salmonids collected from the initial marking pass will be anesthetized in batches with tricaine methanesulfonate (MS-222) and all individuals greater than 60 mm in length will be marked by a fin clip taken from the dorsal tip of the caudal fin. In-stream live cars will hold all captured fish during processing and recovery until being released back into the same reach. We will allow at least 1 to 2 days (24-48 hours) for marked fish to recover and become mixed within the population before we will then collect a random sample of fish during a subsequent recapture run (Rosenberger and Dunham 2005). This sampling will proceed in the same reach and manner as the mark electrofishing run. Data collection will record the ratio of marked to unmarked fish by species and size (e.g., 50mm group classes). Population densities of each salmonid species and size groups captured during the study will be estimated on a per unit length of stream, where adequate sample sizes permit, using the maximum likelihood model and Petersen's equation with the Chapman modification (Ricker 1975, Van Deventer 1989). Population estimates with the smaller confidence intervals (CI) will be reported. Non-salmonid fish species collected during the marking pass will be reported as catch-per unit-effort (CPUE). The condition of all captured salmonids will be recorded following an examination for external signs of disease, parasites, or other anomalies. The initial 3 years of baseline fisheries assessment has detected opercular reduction in approximately 10% of the brook trout from the Little Sheep Creek monitoring sites. We will continue to track this anomaly to enable us to detect increases in its frequency of occurrence during construction or post-mine operation.

Length-frequency data will be analyzed to determine salmonid cohort strength and whether species are reproducing in or near the stream reaches. Young-of-the-year fish less than 30 mm (total length) will be recorded on the field sheet, if species can be determined, and immediately released to prevent mortality, except for 5 individuals vouchered for metals analysis at 4 sites during the summer sampling (**Table A2**). All salmonids captured during the monitoring surveys will be scanned with a Biomark 601 pit-tag reader to record fish that may have been tagged in a FWP/MSU fish movement study on the Smith River. Tag numbers will be recorded and reported in the appropriate data column on the Scientific Collection Report.

Fall-spawning, brown trout and brook trout redd counts will be completed for all Sheep and Little Sheep Creek reaches using methods outlined in Thurow et al (2012). Two observers wearing polarized sunglasses will proceed in an upstream direction on both sides of the stream enumerating all true redds observed. We will not count false redds resulting from test digging by females. Redds were counted only if the disturbed area contained two features: 1) a pit resulting from excavation of the redd and covering of the eggs and, 2) a pillow of loose substrate material immediately downstream of the excavated pit. On smaller stream width sections, the two observers divided the entire reach transect into 100m segments and "leap-frogged" one another, flagging the survey end points. Observers will maintain continuous visibility of the streambed and both stream banks to prevent overlooking redds and fish. All fish observed during the redd count will be enumerated. We differentiated salmonid species' redds based on size, visibly identifying fish on the redd, or habitat selection preferences between brown and brook trout (Witzel and Maccrimmon 1983), although a small percentage of overlap may be occurring.

If the required fish collection permits are not granted by MFWP for some or all of the fish population monitoring, relative fish abundance by species and size classes will be determined using the direct enumeration snorkeling technique (Thurow 1994, cited in Overton et al. 1997). Day and night snorkel surveys would be conducted by 2 observers in the delineated monitoring reaches working in an upstream direction and using an underwater dive light during the night-time surveys. Fish species and lengths would be documented to the extent practical (calibrated to plexiglass fish cut-outs in 50 mm increments). Fish counts, species identifications, and length determinations would be tallied for each macrohabitat type in each reach. If portions of reaches were too shallow for snorkeling, they would be surveyed from the banks. Bank surveys would also be conducted to tally young of the year fish.

A fish sampling report in the form of the Scientific Collection Report will be submitted annually to MFWP by Dec 31st of the sampling year the permit was granted.

### A.1.9 Bioaccumulation of Metals in Fish Tissue

Tintina will conduct monitoring studies to measure background (pre-impact) concentrations of copper, cadmium, mercury, lead, and zinc from the fish in Sheep Creek and Little Sheep Creek to provide a baseline level in which to compare potential changes in fish tissue metals concentrations due to construction and operation of the BBC Project. These metals of interest have been used on similar-sized streams in other Mine Aquatic Monitoring Plans (MDEQ 2016).
Prior to construction, during construction and operation, and post-operation, Tintina will collect five adult Rocky mountain sculpin (*Cottus bondi*) (60-100mm) and 5 juvenile rainbow trout, (*Oncorhynchus mykiss)* (<100 mm) annually from Sites AQ1, AQ2, AQ4, and AQ7 (**Table A2**). Fish collections will be completed during the summer period, concurrent with the fish population surveys. Fish specimens will be humanly euthanized in an overdose solution of MS-222, rinsed with stream water and placed on ice for transport to Helena within 48 hours of capture. Homogenized whole-body fish tissue samples will be analyzed at Energy Laboratories in Helena to determine copper, cadmium, mercury, zinc, and lead concentrations. Tintina will resample each site annually through the operational period to document any increasing trends in the bioaccumulation of these metals compared to pre-impact values. Test procedures will be the same used for the baseline testing, unless amended by the agencies.

### A.1.10 Sampling Trip and Annual Reporting

Within one week of completing biological sampling, Tintina will submit a brief report to appropriate review personnel in MDEQ and MFWP. This report will include brief statements about stream conditions observed at each monitoring station and will alert the review personnel to any marked changes in monitoring data relative to the cumulative monitoring record.

On or before March 1 of each year, Tintina will submit an annual aquatic monitoring report that summarizes aquatic monitoring data collected during the previous year. Each report will discuss trends in population patterns and evaluate changes in stream habitat quality, based on all monitoring data collected to date for the BBC project. Recommendations in these reports will include modifications to increase monitoring efficiency or to provide additional data needs.

### A.1.11 Annual Review and Possible Revision of the Monitoring Plan

Within one month of submitting the annual report, an annual meeting will be held to review the aquatics monitoring plan and results and to evaluate possible modifications to the plan. This meeting will include personnel from Tintina, MDEQ, MFWP, and other interested parties.

### A.1.12 Literature Cited

Dodds, W.K., V.H. Smith, B. Zander. 1997. Developing nutrient targets to control benthic chlorophyll levels in streams: A case study of the Clark Fork River, Water Research, Volume 31 (7); 1738-1750.

Dunham, J. B.; Rosenberger, A. E.; Thurow, R.F; Dolloff, C. A; Howell, P.J. 2009. Coldwater fish in wadeable streams [Chapter 8]. In: Bonar, S A.; Hubert, W.A.; Willis, D.W., eds. Standard methods for sampling North American freshwater fishes. Bethesda, MD: American Fisheries Society. 20 pp.

Hydrometrics, Inc. 2015. Tintina Resources Water Resources Monitoring Field Sampling and Analysis Plan Black Butte Copper Project. March.

Jessup, B. K., C. Hawkins and J. B. Stribling. 2006. Biological indicators of stream condition in Montana using benthic macroinvertebrates. Prepared by Tetra Tech, Inc. for the Department of Environmental Quality, Helena, Montana. http://www.deq.state.mt.us/wqinfo/Standards/Montana/Indicators/Report.pdf.

Montana Department of Environmental Quality (MDEQ) 2007. Water Quality and Biological Characteristics of Montana Streams in a Statewide Monitoring Network, 1999-2005. Water Quality Planning Bureau. Helena, MT.

MDEQ 2011. Periphyton Sample Collection and Laboratory Analysis: Standard Operation Procedure. Water Quality Planning Bureau, WQPBWQM-011.

MDEQ 2012a. Water Quality Planning Bureau Field Procedures Manual for Water Quality Assessment Monitoring Version 3.0. Helena, MT: Montana Dept. of Environmental Quality.

MDEQ 2012b. Sample Collection, Sorting, and Taxonomic Identification of Benthic Macroinvertebrates Standard Operating Procedure. Helena, MT: Montana Department of Environmental Quality. WQPBWQM-012. http://deq.mt.gov/wqinfo/qaprogram/PDF/SOPs/WQPBWQM-009rev2_final_web.pdf

MDEQ 2016. Record of Decision for Amending Operating Permit No. 00150; the Montanore Project. Attachment 1: Conceptual Monitoring Plans.

MDEQ 2017. Draft Sheep Creek *E. coli* TMDL and Water Quality Improvement Plan. Helena, MT: Montana Dept. of Environmental Quality.

Montana Department of Fish, Wildlife and Parks (MFWP) 2014. Montana Fisheries Information System (MFISH). http://fwp.mt.gov/fishing/mFish/

Montana Fish Wildlife and Parks (MFWP). 2002. Fisheries Division Electrofishing Policy.

Montana Natural Heritage Program (MNHP) 2015. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks. MT Animal Species of Concern Report. [web application] http://mtnhp.org/SpeciesOfConcern/ Retrieved 1/5/2015.

Overton, C.K., S.P. Wollrab, B.C. Roberts, and M.A. Radko. 1997. R1/R4 (Northern/Intermountain Regions) Fish and Fish Habitat Standard Inventory Procedures Handbook. General Technical Report INT-GTR-346. Ogden, UT: USDA Forest Service, Intermountain Research Station. 73 p.

Ricker, W. E. 1975. Computation and interpretation of biological statistics of fish populations. Fisheries Research Board of Canada, Bulletin 191.

Rosenberger, A.E. and Dunham, J.B., 2005. Validation of abundance estimates from mark–recapture and removal techniques for rainbow trout captured by electrofishing in small streams. North American Journal of Fisheries Management 25(4): 1395-1410.

Rosgen, D. 1996 Applied River Morphology. Wildland Hydrology, Pagosa Springs, Colorado.

Stagliano, D.M. 2005. Aquatic Community Classification and Ecosystem Diversity in Montana's Missouri River Watershed. Report to the Bureau of Land Management. Montana Natural Heritage Program, Helena, Montana. 65 pp. plus appendices. http://www.mtnhp.org/reports.asp#Ecology

Thurow, R. F., C. A. Dolloff, and J.E. Marsden. 2012. Chapter 17: Visual Observation of Fishes and Aquatic Habitat in Fisheries Techniques, third edition. Editors: A. V. Zale, D. L. Parrish, and T. M. Sutton. American Fisheries Society, Bethesda, Maryland.

Wolman, M.G., 1954. A method of sampling coarse river-bed material: Trans. Am. Geophys. Union, v. 35, p. 951-956.

Van Deventer, J. 1989. Microcomputer software system for generating population statistics from electrofishing data—user's guide for MicroFish 3.0. USDA Forest Service General Technical Report INT-254.