Little Blackfoot River Watershed Restoration Plan

Prepared by Molly Barth, Larissa Lee, Rob Roberts, and Casey Hackathorn
Trout Unlimited
Missoula, Montana

February 10, 2016

Table of Contents

Chapter 1: Introduction 1

1.1 Watershed characterization 2

1.2 Document layout 3

Chapter 2: Metals Restoration Strategy 5

2.1 Causes and sources of pollution 5

2.2 Load Reductions 10

2.3 Management Measures 12

2.4 Prioritization 18

2.5 Technical and Financial Assistance Needed 20

2.6 Education and Outreach 24

2.7 Implementation Schedule 25

2.8 Interim Milestones 25

2.9 Criteria/Evaluation Procedures 26

2.10 Monitoring 27

Chapter 3: Restoration Strategy for Sediments, Nutrients, and Non-pollutant Impairments 30

3.1 Sources of pollution 31

3.2 Estimated loadings and potential reductions 37

3.3 Management measures 39

3.4 Financial and technical assistance 54

3.5 Education and outreach 55

3.6 Stream Summaries and Implementation Schedule 56

3.7 Interim milestones and Criteria/Evaluation Procedures 61

3.8 Monitoring 63

References 68

Appendix A 74

Appendix B: Mine Reclamation Summaries 76

Appendix C: Abandoned Mines Prioritization Framework 92

Appendix D: Draft Sampling and Analysis Plan 94

LIST OF ACRONYMS

AML	Abandoned Mine Lands
BCY	Bank Cubic Yards
BLM	Bureau of Land Management
CDNR	Colorado Department of Natural Resources
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFS	Cubic Feet per Second
CSP	Conservation Stewardship Program
CWA	Clean Water Act
CY	Cubic Yards
DEQ	Montana Department of Environmental Quality
DLVCD	Deer Lodge Valley Conservation District
DNRC	Montana Department of Natural Resource Conservation
DOJ	Montana Department of Justice
eDNA	Environmental DNA
EE/CA	Engineering Evaluation and Cost Assessment
EPA	Environmental Protection Agency
EQIP	Environmental Quality Incentives Program
FWP	Montana Fish, Wildlife & Parks
GIS	Geographic Information System
HMO	Hazardous Mine Opening
HNF	Helena National Forest
HNF	Helena National Forest
ITRC	Interstate Technology and Regulatory Council
LBFTDML	*Little Blackfoot River Watershed TMDL and Framework Water Quality Improvement Plan*
LWD	Large woody debris
MBMG	Montana Bureau of Mines and Geology
MNHP	Montana Natural Heritage Program
MNWTF	Montana Noxious Weed Trust Fund
MWCB	Montana Waste Cleanup Bureau
NPS	Nonpoint Source Pollution
NRCS	National Resource Conservation Service
NRDP	Natural Resource Damage Program
RDG	Reclamation and Development Grants
SAP	Sampling and Analysis Plan
SI	Site Investigation
TMDL	Total Maximum Daily Load
TN	Total nitrogen
TP	Total phosphorus
TPA	TMDL Planning Area
UCFRP	*Upper Clark Fork River Basin Aquatic and Terrestrial Resources Restoration Plan for the Little Blackfoot watershed*
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
WMP	Watershed Management Plan
WRP	Watershed Restoration Plan

Chapter 1: Introduction

The Little Blackfoot River extends approximately 47 miles from its headwaters to its mouth, where it enters the Clark Fork River near Garrison, MT, and drains an approximately 413 square mile watershed. In 2010, the Montana Department of Environmental Quality (DEQ) identified numerous stream segments in the Little Blackfoot watershed impaired by metals, sediment, nutrients, and non-pollutant impairments, listed on the 303(d) list of water-quality-limited stream segments (DEQ, 2010). The 303(d) list biennially identifies all waterbodies that fail to meet water quality standards. The *Little Blackfoot River Watershed TMDL and Framework Water Quality Improvement Plan* (*LBFTMDL*) (DEQ and EPA, 2011) sought to identify the sources of the pollutants and estimate current loadings and potential reductions by compiling the best available empirical data, utilizing ecological models, performing contemporary assessments of individual stream segments, and talking with landowners throughout the watershed.

Additionally, the Little Blackfoot watershed includes a number of streams which the Montana Natural Resource Damage Program (NRDP) designates as high priority for restoration, including the Lower Little Blackfoot River, Spotted Dog Creek, Dog Creek, and Snowshoe Creek. The NDRP identified priority tributaries within the Upper Clark Fork River Basin (UCFRB) where fishery habitat protection and enhancement activities would have a high probability of helping to recover the aquatic and terrestrial resources lost in the UCFRB, which occurred due to the release of hazardous substances from decades of extensive mining and mineral processing in Butte and Anaconda, MT (Saffell et al., 2011). Streams are listed as "Priority 1", "Priority 2", or "other impaired" throughout this document, which reflects NRDP priority determination. As opposed to establishing a set priority list of streams specific to this WRP, we seek to establish functional priorities for each impaired stream, such as establishing bank stability or improving in-channel habitat, to give stakeholders working at many different scales ideas for restoration projects. However, we reference the NDRP priorities because of the common goals of the UCFRB restoration and that of the Little Blackfoot watershed and the specific funding opportunities available for projects occurring on NRDP priority streams.

Some restoration has occurred since the development of the *LBFTMDL*, but no planning for a holistic watershed approach to achieve TMDLs and restoration goals has been completed. After TMDLs are developed, implementation of a strategy to achieve TMDL goals is voluntary for non-point source pollution, and thus requires the cooperation of multiple stakeholders. Stakeholders from Trout Unlimited, the Helena National Forest, DEQ, the Environmental Protection Agency (EPA), the Watershed Restoration Coalition (WRC) , and private landowners came together to try to address water quality in the Little Blackfoot watershed. This document is a product of the stakeholders' collaborative efforts and aims to define a restoration strategy for the metals, sediment, nutrients, and non-pollutant impairments identified in the *LBFTMDL* while also considering the complementary restoration planning efforts by the NRDP.

Funding for this project was made available through a DEQ 319 grant, which allocates funds towards the planning and implementation of projects addressing non-point source pollution. The EPA requires a Watershed Restoration Plan (WRP) in order to receive 319 funds for project implementation. This WRP will identify the primary causes of water-quality impairments, describe management measures needed to achieve the TMDL reductions, and prioritize future remedial and restoration actions. Additionally, this plan will identify data gaps and suggest future monitoring. While this plan is intended to guide future restoration projects, adaptive management is essential as projects are evaluated and new information becomes available. Restoration activities to remediate past damages and improve current management practices will help to reestablish resilient aquatic communities and ensure that waters remain cold, clean, and fishable for future generations.

1.1 WATERSHED CHARACTERIZATION

The Little Blackfoot watershed is dominated by private land ownership (56%), while the remainder is public land, managed by the USFS (37%), Montana State Trust (6%) and BLM (1%) (Figure 1). Population density is low throughout the watershed, with roughly half of the 600 people living in the towns of Avon and Ellison. US Highway 12 and the Burlington Northern Santa Fe Railroad line transect the watershed and both lie in close proximity to the lower Little Blackfoot River.

The uplands consist of coniferous forests, which transition to shrublands and grasslands in the lower elevations. USFS lands were harvested for timber in the 1970s and 1980s, although little known logging occurred between 1998-2008 and ongoing logging intensity throughout the watershed is low (DEQ and EPA, 2011). In the late 2000s, mountain pine beetle infestations increased rapidly across the lodgepole pine and subalpine forest lands of the Little Blackfoot watershed, leaving thousands of acres of dead trees. In the vicinity of McDonald Pass at the top of the watershed, nearly 2/3 of the lodgepole pine were infested by 2007 (Gibson, 2007). The lowlands are dominated by agriculture, specifically dry land pasture, irrigated pasture, and hay crops to support cattle grazing (Land & Water Consulting, 2002). Roughly 11,000 acres in the watershed are irrigated by numerous surface water diversions (Berkas et al., 2005).

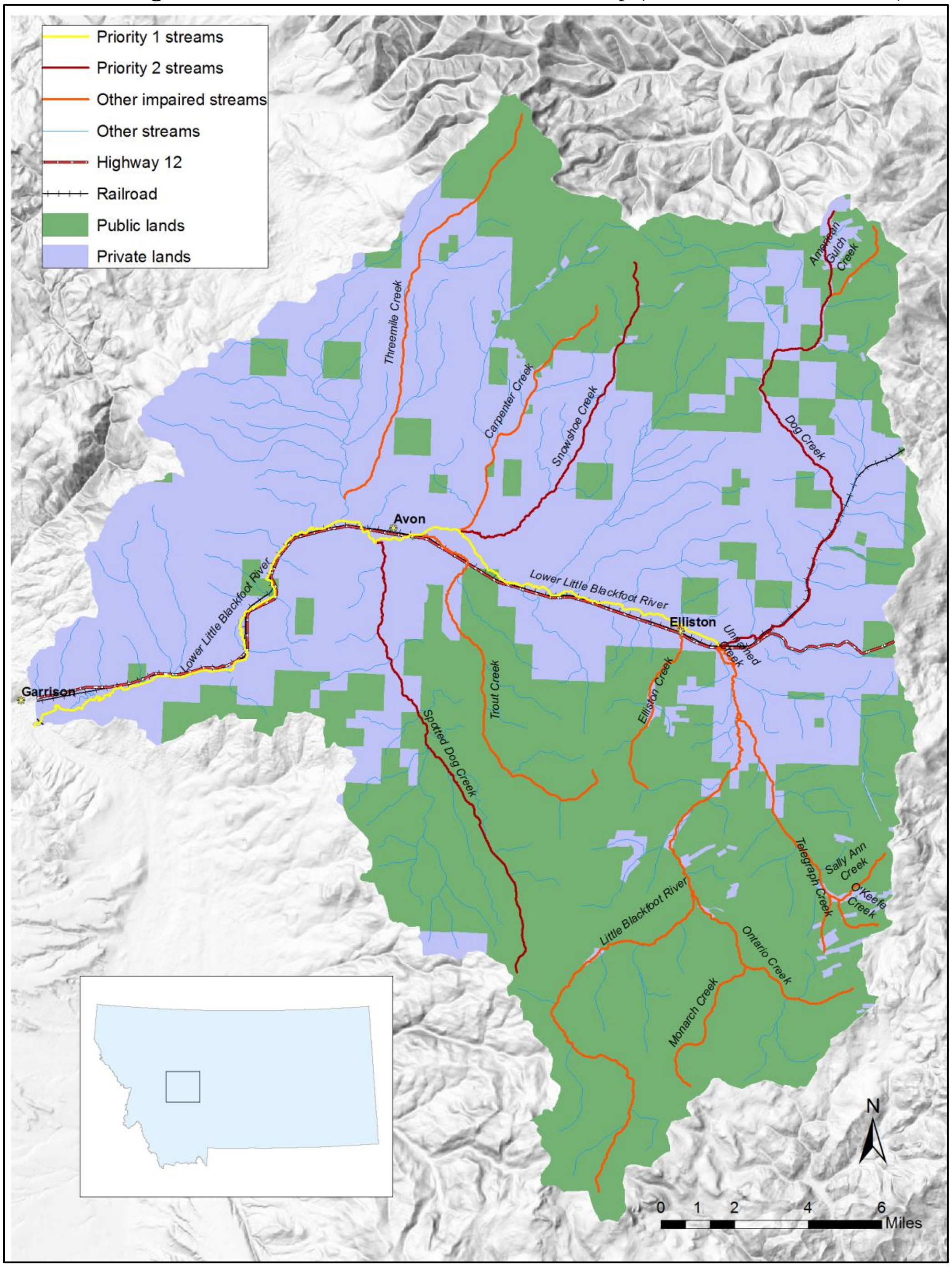
The watershed is home to multiple mining districts, and waste rock and tailings deposits still exist in the area. Historically, placer and lode mining occurred on many of the tributaries of the Little Blackfoot and hard rock mining occurred near Elliston and Avon. Metals mining with gold-bearing placers began in the 1860s, but in the early 1900s miners became more interested in extracting lode deposits of gold, silver, copper, lead, and zinc (DEQ and EPA 2011). Most mining occurred on what is now USFS land. The Elliston District, where most of the mining in this watershed occurred, is near the headwaters of the Little Blackfoot River. Based on Montana Bureau of Mines and Geology (MBMG) and DEQ databases, approximately 200 mines exist in the watershed; 15 of these mines are on the DEQ list of priority abandoned mines in MT. Two of the mining claims in the Little Blackfoot watershed are active (McCullough, 2012): the American Gulch silver mine, located in the American Gulch sub-watershed, and the Ophir Placer silver mine, located in the Lower Little Blackfoot sub-watershed. Additionally, there is an active dredge permit for gold ore on Carpenter Creek, but is seasonally restricted to May 16th through August 31st to protect fish (DEQ and EPA 2011).

The Little Blackfoot River was previously designated core habitat area for the threatened bull trout (*Salvelinus confluentus*), however recent surveys suggest the population in the Little Blackfoot is nearing extirpation (USFS & FWP, 2013) and is now no longer designated critical habitat (USFWS, 2010).

1.2 DOCUMENT LAYOUT

This document is organized into two main chapters: the Metals Restoration Strategy and the Sediment, Nutrient, and Non-pollutant Impairments Restoration Strategy. The Metals Restoration Strategy was originally written and accepted as a standalone document by DEQ in November, 2014. In 2015, Trout Unlimited completed the WRP for the Little Blackfoot watershed by developing a restoration strategy for the remaining impairments. The nature of metals pollution and funding sources available for mine reclamation warrants the division of the WRP into two separate, but linked strategies. Mining-related waste sources (e.g., adit discharges, tailings accumulations, and waste rock deposits) are considered non-permitted point sources subject to waste load allocations (WLA). The TMDLs gave most metals sources in the Little Blackfoot watershed a composite WLA due to uncertainties involved with allocating loads to specific mines and data lacking from reference sites not impacted by mining. This approach is based on the assumption that reductions in metals loading can be achieved through the remediation of abandoned mines and associated waste rock/tailings. Future targeted monitoring could help refine composite WLAs. Despite technically being point sources, Section 319(h) funding can be used to pay for abandoned mine-land reclamation projects designed to protect water quality if those activities meet both of the following conditions: (1) the activities are not specifically required by a draft or final NPDES (a.k.a. MPDES) permit and (2) the activities do not directly implement a draft or final NPDES/MPDES permit.. However, many abandoned mines reclamation efforts will likely have sediment and nutrient reduction components and considering how to maximize ecological benefits from these projects will be important. We integrate the completed metals strategy into this document to formulate a complete, user-friendly WRP to achieve TMDLs in the Little Blackfoot watershed.

Figure 1. Little Blackfoot watershed overview map (USDA-NRCS et al., 2013)**.**



Chapter 2: Metals Restoration Strategy

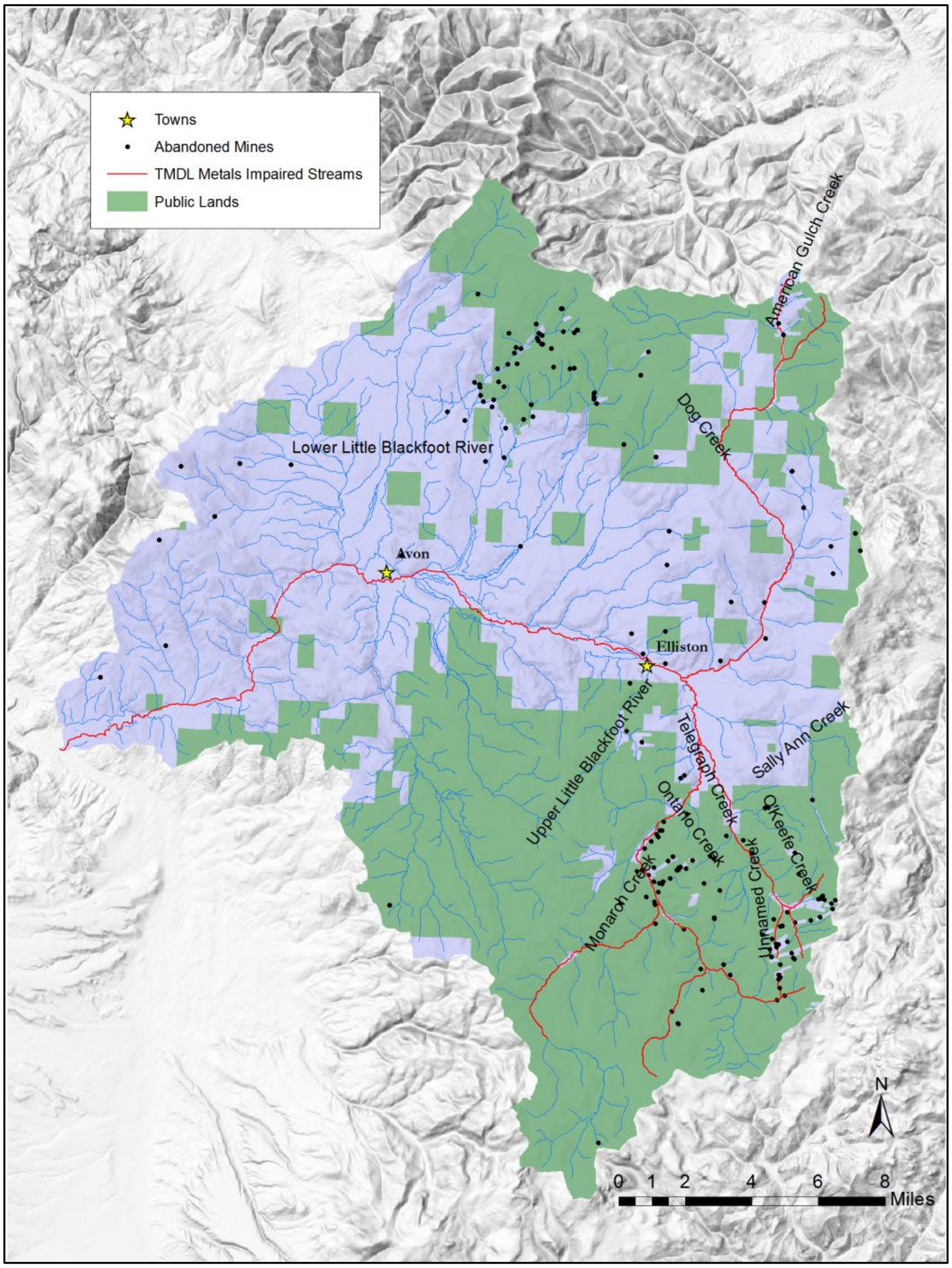


Figure 2. Abandoned mines in the Little Blackfoot watershed (DEQ, 1995; MBMG, 2005; USDA-NRCS et al., 2013).

2.1 Causes and sources of pollution

The 2011 *LBFTMDL* listed 12 stream segments within the TMDL Planning Area (TPA) as impaired by metals (arsenic, beryllium, cadmium, copper, cyanide, iron, lead, mercury, and zinc). Forty-five individual TMDLs were written addressing these impairments. The 2014 *Little Blackfoot River Watershed Metals TMDL Addendum* established 10 additional TMDLs for metals (aluminum and zinc) impairments in addition to the 9 stream segments listed in the 2011 *LBFTMDL*. The *LBFTMDL* listed "natural background loading from mineralized geology; abandoned mines, including adit discharge/drainage from abandoned mines and runoff/drainage from abandoned mine tailings; upland, in-stream, and floodplain metals deposits from historical mining operations; and permitted point sources" as potential sources of metals loading (DEQ and EPA 2011). Metals reductions necessary to achieve TMDL levels ranged from 5-95%. One objective of this document is to describe the primary causes of metals impairment within the watershed. This section identifies mine sites by stream segment, starting with the segment highest in the watershed. The mine sites listed in bold are of the most concern to the metals restoration strategy stakeholder group and will be addressed in this restoration strategy.

2.1.1 Un-named Creek (MT76G006_010)

TMDLs were developed in 2011 for arsenic, cadmium, copper, lead, mercury, zinc, and iron, with an additional TMDL written in 2014 for aluminum in Un-named Creek (0.8 mi). The area encompasses both private land and Helena National Forest land, with the "most probable impairment source," **Ontario Mine**, located mostly on private land (DEQ and EPA 2014). The *LBFTMDL* gives a single wasteload allocation to Ontario Mine because all human related metals loading to Un-named Creek is associated with this mine (DEQ and EPA 2011). DEQ Abandoned Mine Lands (AML) had Ontario Millsite on its priority list, whereas the *LBFTMDL* refers to the Ontario Mine as the primary cause of impairment. Further research and a site investigation are necessary to better understand the impairments from each source and the distinction between the two. Ontario Millsite was ranked as priority number 99 on the original DEQ Priority Abandoned Mine list, but is currently considered reclaimed by the Montana Waste Cleanup Bureau (MWCB) after removal action in 2005 (DEQ 2013). The MWCB oversees the cleanup of abandoned mine lands and National Priority List (NPL) facilities (DEQ 2014). The area also includes two prospect mines and a hardrock mine called Amanda mine, but these are thought to be insignificant sources of metals impairment (DEQ and EPA 2011).

2.1.2 Monarch Creek (MT76G004_060)

TMDLs were developed in 2011 for copper, lead, mercury with an additional TMDL written for aluminum in 2014 in the Monarch Creek segment (4.7 mi). The area is located on Helena National Forest land. **Monarch mine,** the only hardrock mine in the area, is considered the "primary source of metals loading to Monarch Creek" and is currently ranked as DEQ priority number 78 (DEQ and EPA 2011). In 1998, Hargrave, et al. observed "a collapsed mill building, an open but locked adit, another adit that is caved-in but discharging and approximately 0.75 acres of well-vegetated tailings." The Abandoned Mine Reclamation Bureau (AMRB) reported a hazardous structure and a hazardous adit opening based on observations in the early 1990s in the

Summary Report of Abandoned Mine Sites (DEQ 1995). A few prospect mines also exist in the area.

2.1.3 Ontario Creek (MT76G004_130)

TMDLs were developed in 2011 for cadmium, copper, and lead, with additional TMDLs developed for aluminum and zinc in 2014 in the Ontario Creek sub-basin**. Hard Luck Mine,** a 0.3 acre site 1,000 feet from Ontario Creek, upstream of confluence with Monarch Creek, has 3 waste rock piles, 2 adits, and 1 building, with a diversion system present that could use improvement (DEQ 1995). This mine is thought to be the primary source of metals impairment (DEQ and EPA 2011). The Montana Bureau of Mines and Geology (MBMG) has found the site to be dry on occasional visits. (Hargrave, et al. 1998). Hard Luck Mine is currently ranked number 96 on the DEQ Prioritized Short List of AML Sites (DEQ 2013). Three other non-priority mines exist in the area, where water flowing out of mine adits could be impacting water quality (DEQ and EPA 2011).

2.1.4 Sally Ann Creek (MT76G004_055)

TMDLs were developed in 2011 for cadmium, copper, and zinc for Sally Ann Creek. The area contains about five abandoned mines, including **Telegraph Mine**, which is DEQ priority number 119 on the most current Prioritized Short List of AML Sites (DEQ 2013). Telegraph mine had a discharging adit and water flowing through waste rock in 1995. Other non-priority mines in the area with waste rock or water in mine shafts include Home Stake and Excelsior. MBGB determined that Bullion Mine, also in the Sally Ann Creek Basin, had no visible impact in 1993.

2.1.5 O'Keefe Creek (MT76G004_054)

TMDLs were developed in 2011 for cadmium, copper, and zinc for O'Keefe Creek. There are approximately 15 mines in the O'Keefe Creek Basin, including **Sure Thing Mine**, which is DEQ priority number 19 (DEQ 2013). In 1993, Sure Thing Mine consisted of a discharging adit flowing through tailings and waste rock. Another non-priority mine thought to be contributing to metals impairment in O'Keefe Creek is O'Keefe Creek/Copper King Mine.

2.1.6 Telegraph Creek, Upper Segment (MT76G004_051)

The 2011 TMDL listed metals impairments for arsenic, beryllium, cadmium, copper, lead, and zinc, with an additional TMDL written for aluminum in the 2014 addendum for Upper Telegraph Creek. The area contains approximately 25 mines, including DEQ Priority mines **Lily/Orphan Boy, Third Term, Julia, Anna R/Hattie M,** and **SE SW Section 10.** These mines are currently ranked numbers 10, 127, 38, 44, and 97 respectively on the DEQ Prioritized Short List of AML Sites (DEQ 2013). Other mines in the area include **Hub Camp Mine, Viking Mine**, Unnamed Mine 8N5W6ABDB, Champion, and Moonlight Cabin Mine, but these are not ranked on the DEQ priority list.

2.1.7 Telegraph Creek, Lower Segment (MT76G004_052)

The 2011 TMDL listed metals impairments for lead, mercury, cadmium, copper, and zinc for Lower Telegraph Creek. An additional TMDL was written for aluminum in 2014. There is no record of abandoned mines in the Lower Telegraph Creek sub-basin (DEQ and EPA 2011). Therefore, this restoration strategy will focus on mines in the Upper Telegraph sub-basin, with the intention that cleaning up mines upstream will improve metals impairments downstream as well. Further monitoring in Lower Telegraph Creek will be conducted to determine the sources of metals impairments for this stream segment.

2.1.8 American Gulch Creek (MT76G004_079)

A TMDL was written for American Gulch Creek for arsenic in 2011. Although the American Gulch Creek basin has no mines that appear on the DEQ priority abandoned mine list, at least five abandoned mines exist in the basin (DEQ and EPA 2011). These mines include Neenan, NE SE Section 10, Carbonate Marysville, Pine Ridge, and Unnamed 11N06W10CADD, but few details are known about these mines. The 2011 TMDL recommended further monitoring of this stream segment because there was only one sample site at the mouth of American Gulch Creek at Dog Creek, even though most of the mines are located closer to the headwaters (DEQ and EPA 2011). This restoration strategy calls for further monitoring of this site in order to assess a more specific source of impairment and develop a plan for remediation.

2.1.9 Dog Creek, Upper Segment (MT76G004_071)

TMDLs were written in 2011 for arsenic, lead, zinc, cadmium, and copper impairments to Upper Dog Creek, with an additional TMDL written in 2014 for aluminum. **Bald Butte Mine** was a significant contributor to metals impairments in Dog Creek, but has been the site of an extensive reclamation project, which addressed this site and multiple others in the area. Because this is a DEQ priority site, this metals restoration strategy addresses it, but monitoring is necessary to understand the success of reclamation at this site and whether any issues or metals impairments remain. This site is considered “reclaimed by MWCB” due to the removal action that took place in 2012 (DEQ 2013).

2.1.10 Dog Creek, Lower Segment (MT76G004_072)

The 2011 TMDL and the 2014 addendum determined a need for reductions of copper, lead, and aluminum. Although numerous mines exist within this stream segment, none are DEQ priority mines. Additional monitoring is recommended in order to determine more specific source allocations of metals impairment in the lower segment of Dog Creek.

2.1.11 Little Blackfoot River, Upper Segment (MT76G004_020)

TMDLs were written in 2011 for the Upper segment of the Little Blackfoot River for arsenic, cadmium, copper, cyanide, and lead. There are five additional DEQ priority mines in the Upper Little Blackfoot sub-basin not already discussed in tributary sub-basins: **Charter Oak, Kimball,**

Mountain View, Golden Anchor, and SE SW Section 10. Charter Oak is listed as a mine site reclaimed by other programs/agencies, due to the USFS removal action. The site had waste rock removed, tailings removed, hazardous openings closed, and an onsite repository constructed from 1996-1998 (Oaks 2014). It was originally ranked number 12 on the DEQ priority list. Kimball, Mountain View, Golden Anchor, and SE SW Section 10 are ranked 77, 65, 59, and 97 respectively in the most updated Prioritized Short List of AML Sites (DEQ 2013). The **Hope Mine and Blackfeet No.1 Mine** have not been listed as a DEQ priority site, but are also addressed in this metals restoration strategy due to their significance to stakeholder groups.

2.1.12 Little Blackfoot River, Lower Segment (MT76G004_010)

TMDLs were written in 2011 and 2014 for the lower Little Blackfoot for arsenic, lead, and aluminum. Nearly 100 mines exist throughout this sub-basin; however, only one is a DEQ priority mine: **Victory/Evening Star**. This mine is currently ranked 118 on the Prioritized Short List of AML Sites (DEQ 2013). Although this restoration strategy focuses primarily on the Upper Little Blackfoot, this mine is addressed in the restoration strategy because it is a priority mine and located near a stream segment addressed in the Little Blackfoot TMDL. Table 2-1 summarizes the significant mine sites mentioned above by stream segment, which will be addressed in this restoration strategy.

Impaired sub-watersheds identified in the *LBFTMDL* that do not have abandoned mine reclamation addressed in this strategy include: Lower Dog Creek, Lower Telegraph Creek, and American Gulch Creek. No records of abandoned mines were found for Lower Telegraph Creek. Lower Dog Creek and American Gulch Creek both have records of mines in the area, but specific sources have yet to be identified. Monitoring will take place in these sub-watersheds to determine specific source allocations.

Table 2-1. Mines addressed in Metals Restoration Strategy listed by sub-watershed.

Mine Site	Sub-Watershed
Ontario Mine	Unnamed Creek
Monarch Mine	Monarch Creek
Hard Luck Mine	Ontario Creek
Telegraph Mine	Sally Ann Creek
Sure Thing Mine	O'Keefe Creek
Lily/Orphan Boy Mine	Upper Telegraph
Third Term Mine	Upper Telegraph
Julia Mine	Upper Telegraph
Anna R/Hattie M	Upper Telegraph
Hub Camp	Upper Telegraph
Viking Mine	Upper Telegraph
Bald Butte	Upper Dog Creek
Charter Oak	Upper Little Blackfoot

Kimball	Upper Little Blackfoot
Mountain View	Upper Little Blackfoot
Golden Anchor	Upper Little Blackfoot
Hope Mine	Upper Little Blackfoot
SE SW Section 10	Upper Little Blackfoot
Blackfeet No. 1	Upper Little Blackfoot
Victory/Evening Star	Lower Little Blackfoot

2.2 Load Reductions

Load reductions from the 2011 *LBFTMDL* and 2014 addendum are listed in below by each stream section. Allowable loads vary depending on streamflow and water hardness, so instantaneous loads and necessary reductions may not always match

Table 2-2. The loading reductions developed in 2011 and presented in

Table 2-2 are based on available water quality data. Reductions necessary at high flow but not at low flow suggest that one mechanism of elevated metals loading is via metals bound in the sediment that become mobile when there is a significant disturbance, such as high flow events. Runoff associated with high flow events can also increase discharges from adits. Low flow exceedances may indicate other loading pathways, such as groundwater.

Table 2-2. Metals impairments and load reductions in the Little Blackfoot.

Waterbody	Waterbody ID Number	Impaired Use	Metals	Load Reductions	
				High Flow	Low Flow
American Gulch Creek	**MT76G004_079**	Drinking Water	Arsenic	23%	38%
Dog Creek (upper)	**MT76G004_71**	Aquatic Life, Cold Water Fishery	Arsenic	23%	62%
		Aquatic Life, Cold Water Fishery	Lead	68%	30%
		Aquatic Life, Cold Water Fishery	Zinc	0%	0%
		Aquatic Life, Cold Water Fishery	Cadmium	62%	0%
		Aquatic Life, Cold Water Fishery	Copper	0%	0%
		Aquatic Life, Cold Water Fishery	Aluminum	38%	0%
Dog Creek (lower)	**MT76G004_072**	Aquatic Life, Cold Water Fishery	Copper	28%	0%
		Aquatic Life, Cold Water Fishery	Lead	80%	0%
		Aquatic Life, Cold Water Fishery	Aluminum	33%	0%

Little Blackfoot River (upper)	**MT76G004_020**	Aquatic Life, Cold Water Fishery	Lead	29%	0%
		Drinking Water	Arsenic	79%	0%
		Aquatic Life, Cold Water Fishery	Aluminum	3%	0%
Little Blackfoot River (lower)	**MT76G004_010**	Aquatic Life, Cold Water Fishery	Arsenic	38%	0%
		Aquatic Life, Cold Water Fishery	Cyanide	77%	0%
		Aquatic Life, Cold Water Fishery	Cadmium	25%	0%
		Aquatic Life, Cold Water Fishery	Copper	48%	0%
		Aquatic Life, Cold Water Fishery	Lead	92%	0%
		Aquatic Life, Cold Water Fishery	Aluminum	21%	0%
Monarch Creek	**MT76G004_060**	Aquatic Life, Cold Water Fishery, Primary Contact Recreation	Copper	5%	0%
		Aquatic Life, Cold Water Fishery, Primary Contact Recreation	Lead	33%	0%
		Aquatic Life, Cold Water Fishery, Primary Contact Recreation	Mercury	0%	0%
		Aquatic Life, Cold Water Fishery, Primary Contact Recreation	Aluminum	33%	0%
O'Keefe Creek	**MT76G004_054**	Aquatic Life, Cold Water Fishery	Cadmium	95%	0%
		Aquatic Life, Cold Water Fishery	Copper	43%	0%
		Aquatic Life, Cold Water Fishery	Zinc	47%	0%
Ontario Creek	**MT76G004_130**	Aquatic Life, Cold Water Fishery	Cadmium	55%	0%
		Aquatic Life, Cold Water Fishery	Copper	29%	0%
		Aquatic Life, Cold Water Fishery	Lead	89%	0%
		Aquatic Life, Cold Water Fishery	Aluminum	33%	0%
		Aquatic Life, Cold Water Fishery	Zinc	0%	72%
Sally Ann Creek	**MT76G004_055**	Aquatic Life, Cold Water Fishery	Cadmium	93%	0%
		Aquatic Life, Cold Water Fishery	Copper	29%	0%
		Aquatic Life, Cold Water Fishery	Zinc	26%	0%
Telegraph Creek (upper)	**MT76G004_051**	Drinking Water	Lead	61%	0%
		Drinking Water	Mercury	0%	0%

		Aquatic Life, Cold Water Fishery	Cadmium	9%	0%
		Aquatic Life, Cold Water Fishery	Copper	43%	0%
		Aquatic Life, Cold Water Fishery	Zinc	26%	0%
		Aquatic Life, Cold Water Fishery	Aluminum	49%	0%
Telegraph Creek (lower)	**MT76G004_052**	Aquatic Life, Cold Water Fishery	Arsenic	0%	0%
		Aquatic Life, Cold Water Fishery	Beryllium	0%	0%
		Aquatic Life, Cold Water Fishery	Cadmium	17%	0%
		Aquatic Life, Cold Water Fishery	Copper	43%	0%
		Aquatic Life, Cold Water Fishery	Zinc	26%	0%
		Aquatic Life, Cold Water Fishery	Lead	61%	0%
		Aquatic Life, Cold Water Fishery	Aluminum	46%	0%
Un-named Creek	**MT76G006_010**	Drinking Water	Arsenic	N/A	82%
		Aquatic Life, Cold Water Fishery	Cadmium	N/A	94%
		Aquatic Life, Cold Water Fishery	Copper	N/A	82%
		Aquatic Life, Cold Water Fishery	Lead	N/A	88%
		Drinking Water	Mercury	N/A	0%
		Aquatic Life, Cold Water Fishery	Zinc	N/A	84%
		Aquatic Life, Cold Water Fishery	Iron	N/A	36%
		Aquatic Life, Cold Water Fishery	Aluminum	N/A	76%

Following the identification of primary sources of metals pollution by stream segment, the next goal of this document is to describe management measures needed to achieve TMDL reductions and to prioritize these remedial actions. The following section enumerates management measures to accomplish these load reductions, focusing on abandoned mine reclamation.

2.3 Management Measures

Significant management measures are necessary to achieve load reductions established in the *LBFTMDL*. Management measures vary for each stream segment, although the *LBFTMDL* recognized that abandoned mine reclamation is the most significant restoration method in achieving TMDL goals. The *LBFTMDL* suggested the following goals for addressing metals impairments in the TPA:

- "Prevent soluble metal contaminants or metals contaminated solid materials in the waste rock and tailings materials/sediments from migrating into adjacent surface waters to the extent practicable.
- Reduce or eliminate concentrated runoff and discharges that generate sediment and/or heavy metals contamination to adjacent surface waters and ground water to the extent practical.
- Identify, prioritize, and select response and restoration actions based on a comprehensive source assessment and streamlined risk analysis of areas affected by historical mining" (DEQ and EPA 2011)

The Helena National Forest has implemented mine reclamation projects on the following mines in the Little Blackfoot watershed: Charter Oak, Ontario, Lily-Orphan Boy, Evening Star, Lower and Upper Kimball, Hope, Hub Camp, Telegraph, and Third Term. Many of these sites have remaining issues that necessitate further investigation or remediation. Site Investigations (SI) and Engineering Evaluation/Cost Assessments (EE/CA) were completed by Maxim Technologies for the Helena National Forest in 2006 for Hope Mine, Monarch Mine, and Lily-Orphan Boy Mine. A lack of funding prohibited contracting and construction for these sites. Mine reclamation in the Little Blackfoot watershed has occurred most recently at Bald Butte mine site, as part of the Bald Butte/Great Divide Sand Tailings project. The table below describes restoration techniques that have already been applied at each site that this restoration strategy addresses.

Table 2-3. Previous metals restoration efforts in the Little Blackfoot watershed.

Waterbody	Mine Site	Previous Restoration Efforts	Responsible party	Land Ownership
Unnamed Creek	Ontario Mine	2002: removed 14,700 cubic yards (cy) tailings on dominantly FS grounds 2011: silt fencing removed from wetlands and riparian areas	Forest Service	Private/Public (Private Land upstream of HNF administered land)
Monarch Creek	Monarch Mine	2006: Designed in-place stabilization and amendment of mine waste – SI & EE/CA completed, not initiated due to funding	Forest Service	Public
Ontario Creek	Hard Luck Mine	No remediation listed		Public
Sally Ann Creek	Telegraph Mine	2006: 2,087 cy hauled to Luttrell Repository, cover soil buffer applied to reclamation area and access road, infiltration basin constructed	Forest Service	Public- HNF administered land
O'Keefe Creek	Sure Thing Mine	No remediation listed		Private/Public

Telegraph Creek	Lilly/Orphan Boy Mine	2010: Mine workings dewatered for engineering investigation and feasibility assessments, project on hold due to funding	DEQ Abandoned Mines Section	Private/Public
	Third Term Mine	2006: In-place consolidation and stabilization of mine wastes, 56 tons $CaCO_3$ applied to 2,700 sq yrds waste rock surface, turf matting, seeded, and silt fence applied	Forest Service	Public
	Julia Mine	No remediation listed		Public
	Anna R/Hattie M	No remediation listed		Private/Public
	Hub Camp	2006: 1,250 cy mine waste hauled to the Luttrell repository, access road reclaimed, seeding applied	Forest Service	Public – HNF administered land
	Viking Mine	2006: 1,144 cy mine waste hauled to the Luttrell Repository, infiltration basin constructed, access road reclaimed, cover soil, seeding, and composed cover applied	Forest Service	Public – HNF administered land
Upper Dog Creek	Bald Butte	2010-2013: Bald Butte/Great Divide restoration project	DEQ Abandoned Mines Section	Private
Upper Little Blackfoot	Charter Oak	1996: onsite repository construction and tailings removal (12,400 cy) 1998: removed 6,000 cy waste rock, remaining volumes stabilized in-place, HMO closures	Forest Service	Public
	Kimball	2005: 3,363 cy from Lower and 4295 cy from Upper hauled to Luttrell Repository, Lower hazardous mine opening (HMO) mitigated with culvert insert and locking grate cap, Lower collapsed adit backfilled with boulders & adit discharge channel constructed with erosion matting installed	Forest Service	Public
	Mountain View	No remediation listed		Public
	Golden Anchor	No remediation listed		Private/Public
	Hope Mine	2006: 117 cy waste hauled to Luttrell Repository Designed removal of remaining 2,000 cy waste rock to Luttrell Repository, SI & EE/CA completed, not initiated due to funding	Forest Service	Public – HNF administered land
	SE SW Section 10	No remediation listed		Private
	Blackfeet No. 1	No remediation listed		Private
Lower Little Blackfoot	Victory Evening Star	2005: In-drainage tailings pile removed 1,224 bank cubic yards (bcy) hauled to Luttrell Repository, removal area diversion ditch installed	Forest Service	Private/Public

The following remedial and restorative measures will be implemented to address non-point sources of metals impairments in the Little Blackfoot watershed, emphasizing those that have historically demonstrated success in reducing metals impairments in this watershed. Due to the complexity of abandoned mine issues, reclamation strategies will vary to address site specific issues. Although this restoration strategy identifies specific management strategies to address problems identified at each site, this management plan is adaptive and strategies may change as more information becomes available. Further information about mine reclamation techniques is available in the Colorado Division of Natural Resources (CDNR) publication *Best Practices in Abandoned Mine Reclamation* (2002).

2.3.1 Waste rock/tailings removal and consolidation

Thirteen of the 19 sites addressed in this restoration strategy have remaining waste rock or tailings that need removal, consolidation, or in-place stabilization. This remedial technique will vary depending on the volume of material, the topography and hydrology of the site, access to the site, and proximity to the Luttrell Pit. The Luttrell Pit is a joint repository between the Forest Service and the Bureau of Land Management, and has already been used for storage of mine waste from the Little Blackfoot watershed. If waste from a site cannot be moved to the Luttrell Pit, on-site repositories or in-place stabilization are potential alternative solutions. Removal of waste rock reduces the potential for contact with water, and thereby reduces contamination of surface water. Heavy equipment would generally be necessary to handle the amount of waste rock identified at sites using this restoration strategy. Once the waste material is consolidated or placed in a repository, it would be capped to prevent any further environmental contact.

2.3.2 Phytostabilization

Phytostabilization involves the amendment of soil to mine waste, followed by revegetation. It can often involve the addition of lime ($Ca(OH)_2$) and/or limestone ($CaCO_3$) (See **neutralization with lime amendments** below). This in-place treatment reduces the mobility of metals, preventing them from entering surface or groundwater, while decreasing the acidity to simultaneously reduce the metals' solubility (Kerber Creek WMP 2012). The EPA emphasizes soil cover installations that "stabilize soil and waste piles and reduce their exposure" (EPA 2012). Phytostabilization is a less costly alternative to excavation of waste rock at some sites. Costs at Kerber Creek, a site in Colorado with similar metals impairments due to abandoned mines, demonstrated phytostabilization costs of $11,200/acre as opposed to removal costs of $40,034/acre. These costs will vary based on the site location, geology, and topography, and the quantity and composition of waste rock (Kerber Creek WMP 2012).

2.3.3 Capping

Phytostabilization and capping often occur in conjunction. Capping involves placing an impermeable or minimally permeable surface over mine waste to limit water infiltration from precipitation. This cap can be a soil cover, which is then phytostabilized with the addition of fertilizer and seeding. According to the EPA, BMPs for designing a cap include mimicking the site's natural setting, accounting for effects of climate change, exploring industrial waste products as a partial substitute for productive soil, and considering anticipated site reuse options (EPA 2012).

2.3.4 Closure of hazardous mine openings

Many mine sites have hazardous mine openings (HMO). These openings can be dangerous for recreationalists. Injuries related to abandoned mine openings occur each year, and with increased development and population growth, access to these locations is increasing (CDNR 2002). Shafts, stopes, and adits can be closed with barriers, seals, or plugs. Each solution depends on the conditions of the hazard and has different benefits. Land managers must consider the life span, costs, maintenance, and environmental concerns of each solution. Barriers keep visitors away, while seals prevent mine entry, and plugs close the opening fully to completely eliminate the hazard (CDNR 2002).

2.3.5 Revegetation

Revegetation of mine areas helps restore a degraded site to a more natural state. Vegetation provides improved wildlife habitat and can help contain waste rock or tailings if planted over these materials (CDNR 2002). Studies have also shown that certain plants help with metals uptake, removing metals from the groundwater (Wang Q.R., et al. 2003).

Uncontaminated soils should be used to revegetate sites, followed by the application of fertilizer. Sites will be seeded with a seed-mix of native plants in the area that have demonstrated metals tolerance. After seeding, it is best to apply mulch to protect the seeds while they sprout (CDNR 2002).

2.3.6 Streambank stabilization

Where necessary, streambank stabilization will occur using appropriate techniques and materials, including vegetated soil lifts, vegetated fascines, and slope adjustments to reshape the streambank. These management practices help to physically protect the stream bank, while simultaneously improving ecological function (Christiensen 2014). Metals contamination from migrating waste rock and tailings piles adjacent to streams can be exasperated by eroding streambanks. Additionally, in some locations, placer mining has destabilized stream morphology and contributes to excessive streambank erosion. Bank stabilization will vary based on the condition of the streambank, which will need to be assessed at specific sites.

2.3.7 Mine drainage neutralization with lime amendments

The addition of lime helps neutralize acidic waste and waters, helping metals precipitate out. Lime ($Ca(OH)_2$) raises soil pH, while limestone ($CaCO_3$) can provide a buffer between the waste and the new soil to preventing contamination of surface or groundwater (Kerber Creek WMP 2012). Anoxic limestone drains can also be used to treat acid mine drainage from discharging adits or openings. The limestone dissolves in the water and raises its pH, causing the metals to drop out of solution into a settling pond (CDNR 2002). Lime amendments can occur in conjunction with other methods, such as phytostabilization, but can also be used as an independent management measure.

2.3.8 Passive treatment of adit drainage

Discharging adits were identified at 14 of the 19 sites in the Little Blackfoot watershed. There are numerous passive water treatment techniques including chemical amendment, anoxic limestone drains, sulfate-reducing wetlands, aeration and settling ponds, and oxidation wetlands. Passive treatment of adit discharge is less costly than active treatment, and is therefore preferred over creating any type of active water treatment plant. Constructed wetlands must be considered semi-permanent, because although they are long-term solutions, eventually the wetlands will fill with metal-contaminated sediment that must be removed or capped (ITRC 2010). Many types of passive treatment are identified in this section, and each is described briefly below.

Chemical amendment

Chemical amendments involve adding a basic material like lime to acidic water with metals impairments in order to increase the pH of the water (Kerber Creek WMP 2012). This method is often used in conjunction with other strategies.

Anoxic limestone drain

These are drains with limestone that help increase the pH and alkalinity of acid mine drainage relatively cheaply and effectively under the right conditions. After exiting the drain, water must discharge to a settling pond to allow for metals precipitation prior to re-entering the stream (Skousen 1992). Previously, anoxic limestone drains were implemented where wetlands were insufficient, but they are now being installed as independent systems (Skousen 1992).

Sulfate-reducing wetlands

Sulfate-reducing wetlands are used to improve the quality of acid mine drainage by employing bacteria to remove the heavy metals. These bacteria prefer acidic environments and produce sulfides that combine with the metals to form metal sulfides. These metal sulfides precipitate out, leaving improved water quality (CDNR 2002).

Aeration and settling ponds

Aeration and settling ponds use oxidation to help heavy metals like iron, zinc, and manganese precipitate out. The water is aerated by a steep slope or rough areas that create turbulence, and then it lands in the settling pond at the base where oxidized metals can precipitate out (CDNR 2002).

Oxidation wetlands

Oxidation wetlands use aquatic plants and algae to help metals precipitate out. The plants help aerate the area, and then when they die, they provide surfaces for the metals to adsorb. The area is usually rough and variable with a diverse array of plants along with gravel and organic material (CDNR 2002).

2.3.9 Other techniques

Other techniques listed in Colorado's Division of Minerals and Geology Best Practices report include diversion ditches, stream diversion, and erosion control by re-grading. These may be applicable to some mine sites in the Little Blackfoot watershed, depending on the outcome of further investigations.

2.3.10 Preferred techniques:

For the purposes of this metals restoration strategy, preferred techniques are those that are most cost-effective, and those that are in line with techniques that have been successful historically within the Little Blackfoot watershed, keeping in line with previous Forest Service techniques. Passive treatment systems are preferred to any active treatment, due to the limited accessibility of many of these sites and lower costs of passive treatment systems. Past Forest Service projects favor hauling waste rock to a nearby repository as a primary form of restoration where necessary.

2.4 PRIORITIZATION

The numerous abandoned mine sites in the Little Blackfoot watershed were narrowed down based on whether or not they were on the most current DEQ priority mine list and were of concern to watershed managers and geologists at the Helena National Forest. After the list was narrowed to 19 sites, the sites were prioritized based on a matrix that accounted for a number of parameters. These included each mine site's proximity to roads, proximity to residences, proximity to campsites, land ownership, proximity to streams, native fish presence, state fisheries value rating, the severity of metals impairments (looking at both the frequency at which water quality standards were exceeded and the magnitude of those exceedances), potential cost, the duration of mitigation, site complexity, the probability of successfully reducing metals impairments, and the potential for future mining. These parameters were weighted based on their relative importance, and the mine sites were ranked accordingly (Table C1**Table C1**). The ranking and total points (based on a scale from 50-150) are listed in .

Table 2-4 below. The table also lists comparisons to the most recent (2013) DEQ Abandoned and Inactive Mine Site Scoring rank and those relative DEQ ranks when looking only at mine sites within the Little Blackfoot watershed.

Table 2-4. Mine reclamation prioritized list based on quantitative prioritization matrix.

Prioritized List of Mine Sites	Totals	Relative	Land

			DEQ rank	Ownership
1	Julia	134	3	Public
2	Third Term	124	13	Public
3	Victory/Evening Star	110	11	Private/public
4	Charter Oak	109	R	Public
5	Anna R/Hattie M	107	4	Private/public
6	Bald Butte	106	R	Private
7	Kimball	105	7	Public
7	Hope	105	NL	Public
9	Hard Luck	104	9	Public
9	Monarch	104	8	Public
9	Golden Anchor	104	5	Private/public
12	Ontario Mill	103	R	Private/public
12	Hub Camp	103	NL	Public
14	Lily/Orphan Boy	99	1	Private/public
15	Mountain View	94	6	Public
16	Viking	92	NL	Public
17	Telegraph	87	12	Public
18	Sure Thing	83	2	Private/Public
19	SE SW Section 10	NL	10	Private

NL =Not Listed, R = Reclaimed

A new ranking system, different from the DEQ ranking, was created because not all of the mines of concern were ranked according to the DEQ system. The rankings differ from DEQ rankings for a multitude of reasons. DEQ takes into account air quality, which these rankings do not. Additionally, the two rankings weigh factors differently, but do take into account many of the same issues, including water quality, public visibility, property ownership, potential for future mining, probability of success, and costs. In certain cases, the rankings differed on the classification of these factors. For example, at Lily/Orphan Boy mine, DEQ had a minimal potential for future mining, whereas our rankings demonstrated a moderate potential. No dramatic differences were noted between each factor, but due to the different weighting factors, multiple small differences could lead to larger differences in overall outcomes. Overall, the updated ranking system was used to be able to compare all mine sites across the same standards. This ranking system is able to focus more on water quality standards for the impaired uses in the Little Blackfoot, such as aquatic life and cold water fisheries, whereas the DEQ ranking focuses more on human health.

2.4.1 2015 prioritization update

After the Metals Restoration Strategy was first published in 2014, further research regarding water quality impacts of abandoned mines and past planning efforts for reclamation work prompted stakeholders to develop a refined priority list for on-the-ground actions in the near future. These further investigations were largely made possible when Trout Unlimited hired a full-time staff person dedicated to coordinating restoration efforts in the Little Blackfoot watershed in early 2015. Trout Unlimited met with stakeholders (USFS, DEQ, and private landowners) to develop a short list of mines to focus immediate reclamation planning, based on subjective measures, including water quality impacts, previous investigation work completed, funding opportunities, and landowner agreement for reclamation work. New mines were added to the list as a result of these discussions. Many of the mines on the list were visited as part of the investigation, and TU also compiled information on mining history, soil sampling, and specialist reports to further prioritize future projects. The mines listed in Table 2-5 are a priority for field investigation and discussions with partners in the near future.

Table 2-5. Priority reclamation list based on subjective measures by stakeholders, organized by geographic area.

Sub-watershed	Prioritized List of Mine Sites		Rationale
Ontario Creek	1	Ontario Mine	Water quality impacts in headwaters
	2	Monarch Mine	Headwaters location
Upper Telegraph Creek	1	Lilly Orphan Boy	Waste rock in stream channel. High DEQ rank
	2	Sure Thing	High DEQ rank
	3	Telegraph	Water quality impacts, significant past planning work completed.
	4	Anna R/Hattie M	High DEQ rank
	5	Julia	High DEQ rank
Upper Little Blackfoot/Tramway Creek	1	Kimball	Forest Service high priority
	2	Blackfeet No. 1	Waste rock eroding into mainstem river
	3	Golden Anchor	Past mine adit blowout
	4	Treasure Mountain	Waste Rock in drainage
	5	Mountain View	High DEQ rank
	6	Big Dick	Tailings impoundment
	7	Charter Oak	Water quality impacts

2.5 Technical and Financial Assistance Needed

Abandoned mine reclamation requires significant financial investment, as well as scientific expertise, to successfully reduce metals impairments in streams and hazards from these sites. Cost and assistance for each site depend on the land ownership, the issues remaining at the mine site, and the type of restoration necessary. A study by the Political Economy Research Center estimated that sites with heavy metal contamination of surface water range in average cleanup costs from $1 to $3 million dollars per site (Buck and Gerard 2001). The same study estimates that those with landscape disturbances such as waste piles, erosion and poor vegetation cost an average of $4,400 while those with safety hazards such as shafts, adits, and collapsed structures average $19,500. All sites addressed in this restoration strategy have heavy metals contaminated surface water, and many have additional landscape disturbances and safety hazards. Costs of recent DEQ abandoned mine projects averaged $36 dollars per cubic yard placed in the repository (DEQ-AML 2014). In order to address the wide disparity among cost estimates, in this restoration strategy each project's costs were estimated to be either over $1 million or under $1 million, depending on the need to address more expensive issues like discharging adits as opposed to waste rock removal. A cost per unit effort is difficult to estimate due to the complexity of addressing discharging adits and the number of options for doing so. Cost estimates per cubic yard of removal often increase for small volumes of waste, so costs will likely vary (DEQ-AML 2014). Currently there is not a good response mechanism to address discharging adits; therefore, costs are largely unknown, but usually very expensive. The costs are expressed as either over or under $1 million to take into account the expense, complexity, and variability involved in addressing discharging adits. Project expenses can vary widely and are difficult to predict without further evaluation. Future monitoring efforts are suggested in order to better understand costs and feasibility of restoration and reclamation at these sites.

The following table lists the abandoned mine sites in each sub-watershed, the expected tasks necessary to remediate metals impairments from these sites, and the technical resources and costs needed to complete those tasks. Because the total costs were difficult to estimate, an overall anticipated cost of more than $1 million or less than $1 million is listed, based on the presence of discharging adits. The removal costs accounts for the removal of the estimated waste rock volume based on DEQ AML average costs of $36 per cubic yard.

Table 2-6. Tasks, necessary resources, and costs of abandoned mine reclamation.

Waterbody	Mine Site	Tasks	Technical Resources Necessary	Anticipated Cost ($)	Removal cost & volume
Unnamed Creek	Ontario Mine	Waste rock removal, wet tailings removal, adit discharge treatment, revegetation	Engineering/Hydrology consulting, construction costs	Over 1 million	$396,000 (11,000 cy)
Monarch Creek	Monarch Mine	Stabilization of mine waste, treatment of discharging adits, revegetation, improve roads	Engineering/Hydrology consulting, construction costs, EE/CA completed	Over 1 million	$151,200 (4,200 cy)
Ontario Creek	Hard Luck Mine	Waste rock removal, adit treatment, plug/gate openings and remove hazards, revegetation	Engineering/Hydrology consulting, construction costs	Over 1 million	$23,400 (650 cy)
Sally Ann Creek	Telegraph Mine	Remove contaminated horizon and remaining mine waste, adit discharge treatment, repair road drainage, erosion controls, and fencing, revegetation	Engineering/Hydrology consulting, construction costs	Over 1 million	Remaining WR volume unknown
O'Keefe Creek	Sure Thing Mine	Remove waste rock, treat adit discharge, remove hazardous highwall, revegetation	Engineering/Hydrology consulting, construction costs	Over 1 million	$277,200 (7,700 cy)

Telegraph Creek	Lily/Orphan Boy Mine	Control flooded shaft, treat adit discharge, repair stream channel dam made of mine waste (was breached)	Engineering/Hydrology consulting, construction costs, EE/CA completed	Over 1 million	$93,600 (2,600 cy)
	Third Term Mine	Weed treatment (2014), netting repair, reinforce silt fencing, add topsoil and reseed	Engineering/Hydrology consulting, construction costs	Under 1 million	No removal needed
	Julia Mine	Remove waste rock, plug or gate adit, remove hazardous structures/restrict access, revegetation	Engineering/Hydrology consulting, construction costs	Under 1 million	$385,920 (10,720 cy)
	Anna R/Hattie M	Remove waste rock, treat adit discharge, remove hazardous structures and close openings, revegetation	Engineering/Hydrology consulting, construction costs	Over 1 million	$80,280 (2,230 cy)
	Hub Camp	In-place stabilization of remaining waste (if any), treat discharging adits, noxious weed control	Engineering/Hydrology consulting, construction costs	Over 1 million	No WR removal needed
	Viking Mine	Treatment/removal of contaminated fines, possible application of $CaCO_3$ (soil cover already applied)	Engineering/Hydrology consulting, construction costs	Under 1 million	No WR removal needed
Upper Dog Creek	Bald Butte	Monitor stream water quality and success of Bald Butte/Great Divide restoration project	Monitoring and lab analyses	Under 1 million	No WR removal needed
Upper Little Blackfoot	Charter Oak	Remove submerged tailings, maintain adit discharge collection, fencing, gates, and weeds, repair possible leak in repository	Engineering/Hydrology consulting, construction costs	Over 1 million	No WR removal needed
	Kimball	Increase adit monitoring to better understand the problem and metals contamination pathways	Monitoring and lab analyses	Under 1 million	No WR removal needed
	Mountain View	Remove waste rock, treat discharging adit, revegetation	Engineering/Hydrology consulting, construction costs	Over 1 million	$234,000 (6,500 cy)
	Golden Anchor	Remove waste rock, treat discharging adit, remove collapsed structures, revegetation	Engineering/Hydrology consulting, construction costs	Over 1 million	$180,000 (5,000 cy)
	Hope Mine	Remove waste rock, treat discharging adit, revegetation	Engineering/Hydrology consulting, construction costs, EE/CA completed	Over 1 million	$72,000 (2,000 cy)
	SE SW Section 10	Monitoring and investigation to understand issues at site	Monitoring and lab analyses	Under 1 million (initial)	More information needed
	Blackfeet No. 1	Monitoring and investigation to understand issues at site . Remove waste rock, treat discharging adit, revegetation	Monitoring and lab analyses. Engineering/Hydrology consulting, construction costs	Under 1 million (initial)	More information needed
	Big Dick Mill	Monitoring and investigation to understand issues at site . Remove waste rock, revegetation	Monitoring and lab analyses. Engineering/Hydrology consulting, construction costs	Under 1 million (initial)	More information needed
	Treasure	Monitoring and investigation to	Monitoring and lab	Under 1	More

	Mountain	understand issues at site . Remove waste rock, revegetation	analyses. Engineering/Hydrology consulting, construction costs	million (initial)	information needed
Lower Little Blackfoot	Victory Evening Star	Waste rock removal, maintain diversion ditch, noxious weed control, road maintenance, revegetation	Engineering/Hydrology consulting, construction costs	Under 1 million	$298,800 (8,300 cy)

2.5.1 Financial Assistance

Previously, similar projects have been funded in a variety of ways. Organizations in collaboration, such as the Forest Service, DEQ, county governments, Trout Unlimited and other watershed organizations can work together to leverage funds. The *LBFTMDL* lists possible funding sources for all types of impairment to the watershed, and the following list narrows down funding to five sources that can apply to metals restoration and abandoned mines in the Little Blackfoot and provide the most significant resources for these activities.

Reclamation and Development Grants (RDG) and Project Planning Grants
These Department of Natural Resource Conservation (DNRC) grants can be used for projects that benefit Montana lands that were affected by exploration and mining (DNRC 2014). The DNRC lists abandoned mine reclamation as an example of appropriate use of these funds. Cities, counties, and state or tribal government entities can apply for up to $50,000 for project planning each year (DNRC 2014). These same entities can apply for up to $500,000 by May 15th only in even numbered years to cover implementation of these projects. Applications must be approved by the Montana legislature.

Forest Service Annual Funds
The U.S. Forest Service has an annual appropriation of approximately $20 million for abandoned mine monitoring, planning, and cleanup (Limerick, et al. 2005). Each forest must apply to receive money from these appropriated funds. These funds can often be used in combination with state funding.

DEQ 319 Grants
The Montana Department of Environment Quality annually allocates funds to government entities and nonprofit organizations under the 319 (h) section of the Federal Clean Water Act (CWA) for projects that help Montana reach its Nonpoint Source Pollution (NPS) goals (DEQ 2014). For fiscal year 2015, DEQ recommended requesting $50,000 – $300,000 for on the ground projects.

DEQ Abandoned Mine Lands Funds
The DEQ Abandoned Mine Lands program focuses on restoration and reclamation of abandoned mine lands on private lands. The program currently focuses on abandoned coal mines, but has

shown interest and commitment to assisting in abandoned mine cleanup in the Little Blackfoot watershed through expertise and funding.

Superfund (Comprehensive Environmental Response, Compensation, and Liability Act or CERCLA)

Due to the large area of the watershed and the numerous sources of metals impairments, designating the area as a state or federal Superfund site may be the most effective way to garner resources necessary to clean up the metals contamination in the Little Blackfoot watershed. The problems in the Little Blackfoot watershed are large in scope and complex enough to warrant state or federal superfund status. Gaining either status would provide access to larger sums of money, which are necessary to cleanup these sites. Gaining Superfund status involves a site assessment and evaluation process through the EPA in which data is collected to identify, evaluate and rank hazardous waste sites. Based on these hazard indices, sites may be then places on the National Priorities List, and can then be eligible for Superfund funding. Citizens, states, tribes, or other environmental programs may formally notify EPA of hazardous waste sites, which are prescreened by EPA to determine if a formal site assessment is appropriate.

2.6 Education and Outreach

This restoration strategy resulted from common concerns among various stakeholders. Trout Unlimited, Helena National Forest, and the Department of Environmental Quality came together to address abandoned mines and water quality in the Little Blackfoot watershed after the DEQ published information about impairments in the watershed. A report that compiled water quality and mine site data throughout the watershed was developed in collaboration with the stakeholder group. Using this information and supporting documents, such as the *LBFTMDL*, Forest Service reports, and DEQ data, the group developed a way to prioritize projects. The following organizations were contacted for input to prepare this document:

- Helena National Forest
- National Forest Service Region 1 Office
- DEQ Nonpoint Source Program
- DEQ Abandoned Mine Lands Program
- United States Environmental Protection Agency Region 8

The public will be involved in the project in numerous ways. Public meetings will be held to inform local stakeholders of these plans and solicit their input. A presentation at the Deer Lodge Conservation District meeting occurred on September 9, 2014. A public meeting was held on October 21, 2014 at the Avon Community Center in Avon, MT. About 20 people attended to learn more about the metals restoration strategy, ask questions, and provide comments. Additionally, the public will provide input to this Metals Restoration Strategy. Public outreach and education will continue as project planning and implementation moves forward in order to provide information on the effects of metals impairments reclamation/restoration activities, and to maintain support from landowners and within the adjacent communities. Once project implementation begins, community volunteers will be utilized where possible for aspects of these projects, such as water quality monitoring and revegetation.

2.7 IMPLEMENTATION SCHEDULE

Because the mine sites in this restoration strategy have limited amounts of waste rock, it is expected that the removal process can take place during one field season for each site. Another field season would be required prior to removal action for planning and completing both a Site Investigation (SI) and an Engineering Evaluation and Cost Assessment (EE/CA). Lastly, this plan allows a third year for addressing discharging adits or dealing with delays that may occur. An estimated three years should be sufficient for reclamation of most of these sites. The schedule does not include the years following restoration, which will include post-project monitoring and maintenance. Additionally, this schedule assumes that only one restoration project would take place at a time, but that timing for planning would overlap with the final year of the previous schedule. Of course, if multiple projects can take place at one time due to proximity, this would be ideal, as it would increase implementation efficiency as well reduce funding requirements. This schedule is in line with the two-year funding cycle of reclamation and development grants. Based on these assumptions and the prioritization described earlier, the schedule for project implementation is as follows:

Table 2-7. Implementation schedule.

Mine Site		Schedule
1	Lilly Orphan Boy	2017-2019
2	Blackfeet No. 1	2017-2019
3	Kimball	2021-2023
4	Monarch	2023-2025
5	Anna R/Hattie M	2025-2027
6	Telegraph	2027-2029
7	Sure Thing	2029-2031
8	Golden Anchor	2031-2033
9	Ontario	2033-2035
10	Mountain View	2035-2037

This implementation schedule is subject to changes in the prioritization, and also would be adapted to address projects in close proximity at the same time in order to cut costs and increase efficiency. For example, a project season could include both Lilly Orphan Boy and Telegraph mines if funding allows, due to their close proximity within the Telegraph Creek sub-watershed.

2.8 Interim Milestones

Milestones for this restoration strategy will fall into three different categories: Planning, Monitoring, and Reclamation/Restoration (Ockey 2011). Interim milestones will follow the implementation schedule, with the completion of site specific plans, environmental engineering and cost assessments, and site investigation being important steps in the planning process. Monitoring is another important milestone that will occur to fill data gaps before moving forward with project implementation and also after project completion to help demonstrate the effectiveness of the restoration techniques and determine the need for future action. For reclamation and restoration, milestones will be measured by the completion of waste removal, implementation of passive treatment systems where necessary, and finally capping and revegetation of waste. Securing funding for planning, monitoring, and reclamation/restoration is also a key step in moving forward with any aspect of the strategy. Ultimately, the goal is to remove metals impairments from the headwaters of the Little Blackfoot watershed. Completing planning tasks, continued monitoring, and implementation of reclamation and restoration activities will insure progress towards this goal.

2.9 Criteria/Evaluation Procedures

Several parameters will help to evaluate the effectiveness of the projects and techniques in this metals restoration strategy. Comparable restoration plans have evaluated performance based on two criteria, environmental outcomes and organizational outcomes, which will also be used to evaluate implementation of this metals restoration strategy (Littman & Roberts 2013).

2.9.1 Environmental Outcomes

Since all projects are on TMDL-listed streams, the successful completion of all projects in a specific stream section will be measured by meeting the TMDLs. The necessary load reductions are listed in

Table 2-2. These will be assessed by completing water quality monitoring according to the associated Sampling and Analysis Plan (SAP). If TMDL reductions for metals are not fully achieved, the restoration and reclamation practices will be re-evaluated.

Removal of waste rock and implementation of passive adit treatment systems will be measureable outcomes of this strategy. Additional outcomes will include the removal/closure of hazardous mine openings and revegetation of waste removal areas.

The ultimate goal is to improve water quality in the Little Blackfoot watershed so that all stream segments can fully support their designated beneficial uses and be removed from the 303(d) list. Because this strategy addresses only metals impairments, other restoration projects will need to be implemented to achieve this goal.

2.9.2 Organizational Outcomes

Trout Unlimited, the Helena National Forest, and the Department of Environmental Quality will continue to collaborate in order to achieve the goals of this metals restoration strategy. Implementation of this strategy will take place as a partnership, with each partner contributing to the planning and restoration work. Communication among partners will ensure successful collaboration.

Communication and collaboration with private land owners is also essential in implementation of the metals restoration strategy. Landowner input will be incorporated in the restoration planning and landowners will be informed of activities in the watershed. Efforts will be made to work with landowners in a way that is mutually beneficial, considerate of any landowner concerns, and improves relationships between landowners and partner organizations.

2.10 MONITORING

Monitoring in the Little Blackfoot watershed began in the mid-1990s with efforts by Montana Bureau of Mines and Geology (MBMG) to inventory abandoned mine sites throughout Montana. In 2008, monitoring for the development of the 2011 *LBFTMDL* resulted in more recent data for water quality in the TPA. The *LBFTMDL* recommends that monitoring occur both pre- and post-restoration, with water quality tests to determine if load reduction targets are achieved.

Sites with unknown sources of metals impairment will be monitored to fill these data gaps. New sites for monitoring water quality will be established along these stream segments. Site investigations will help to assess loads from mines in these sections, and sampling and analysis of waste rock and discharging adits will help to determine sources of metal contaminants.

One of the first monitoring steps of this restoration strategy, in order to better understand the sources of metals impairments and the feasibility of remedial measures for individual sites, would be to hire an environmental engineering firm to complete a feasibility study one sub-basin at a time. Looking at the areas with the highest concentration of mines of concern and using the prioritization as a guideline, this strategy recommends completing feasibility studies in the Upper Telegraph Creek sub-basin (Upper Telegraph Creek, O'Keefe Creek, and Sally-Ann Creek, looking specifically at Julia Mine, Third Term Mine, Anna R/Hattie M Mine, Hub Camp Mine, Lily Orphan Boy Mine, Viking Mine, Telegraph Mine, and Sure Thing Mine), Ontario Creek sub-basin (Ontario Creek, Un-named Creek, and Monarch Creek, specifically at Hard Luck Mine, Monarch Mine, and Ontario Mine), and the Upper Little Blackfoot River sub-basin (specifically Tramway Creek and the Charter Oak Mine, Kimball Mine, Blackfeet No. 1 Mine, Mountain View Mine, Golden Anchor and nearby mines). The majority of mines in this strategy fall within these three sub-watersheds.

Next feasibility studies would need to take place in the Upper Dog sub-basin and the Lower Little Blackfoot sub-basin, particularly along Ophir Creek where Victory/Evening Star Mine is located. Conducting more detailed feasibility studies by sub-watershed would allow for a better understanding of the remediation needs at each site.

Each site addressed in the restoration strategy will be monitored for the development of an EE/CA and SI prior to any restoration work. After restoration is complete, the sites will be monitored for at least 3 years to ensure success of the restoration projects and assess any further needs.

The methods for monitoring in the Little Blackfoot watershed will mirror water quality sampling for the establishment of the *LBFTMDL* and will follow the SAP written in conjunction with this metals restoration strategy. Monitoring indicators were adapted from the Ninemile Watershed Restoration Plan for indicators that are applicable to metals restoration. Monitoring addressed in the SAP will include water quality monitoring in 8 stream segments where source assessments need to be refined and monitoring of 20 discharging adits at 12 mine sites (see

Table 2-8 and

Table 2-9). The post- restoration monitoring schedule and procedures are summarized in Table 2-10.

Table 2-8. Water quality monitoring needs for metals in the Little Blackfoot watershed

Waterbody ID	Waterbody Segment Name	Pollutant Group	Sampling Period
MT76G004_079	American Gulch Creek	Metals	High and low flow
MT76G004_072	Dog Creek, Lower Segment	Metals	High and low flow
MT76G004_052	Telegraph Creek, Lower Segment	Metals	High and low flow
MT76G004_054	O'Keefe Creek	Metals	High and low flow
MT76G004_055	Sally Ann Creek	Metals	High and low flow
MT76G006_010	Un-named Creek	Metals	High flow
MT76G004_020	Upper Little Blackfoot (around Charter Oak Mine)	Cyanide	High and low flow
MT76G004_071	Dog Creek, Upper Segment (around Bald Butte Mine)	Metals, Cyanide	High and low flow

Table 2-9. Monitoring needs for discharging adits in the Little Blackfoot watershed.

Mine Site	# of Adits	Pollutant Group	Sampling Period
Ontario Mine	2	Metals	High and low flow
Monarch Mine	3	Metals	High and low flow
Hard Luck Mine	1	Metals	High and low flow
Telegraph Mine	2	Metals	High and low flow
Sure Thing Mine	1	Metals	High and low flow
Lily/Orphan Boy Mine	1	Metals	High and low flow
Anna R/Hattie M	1	Metals	High and low flow
Hub Camp	2	Metals	High and low flow
Viking	Unknown	Metals	High and low flow
Charter Oak	2	Metals	High and low flow
Kimball	2	Metals	High and low flow
Mountain View	1	Metals	High and low flow
Golden Anchor	1	Metals	High and low flow
Hope	1	Metals	High and low flow
Blackfeet No. 1	1	Metals	High and low flow

Table 2-10. Monitoring for the Little Blackfoot watershed post-restoration.

Indicator	Frequency	Timeframe	Term
Macroinvertebrates	1st, 3rd, and 5th years after reclamation	Summer	3-5 years
Water Quality (pH and conductivity)	1st, 3rd, and 5th years after reclamation	High and low flow	3-5 years
Water Quality (specific metals)	1st, 3rd, and 5th years after reclamation	High and low flow	3-5 years
Vegetation	1st, 3rd, and 5th years after reclamation	Summer	3-5 years

Chapter 3: Restoration Strategy for Sediments, Nutrients, and Non-pollutant Impairments

Sediment and nutrient pollution in the Little Blackfoot watershed cause significant environmental degradation, damage aquatic life, and pose problems for water users throughout the area. A total of 13 waterbody segments within the Little Blackfoot watershed are listed as impaired on the 2014 Montana Water Quality Integrated Report for sediment, nutrient, and/or non-pollutant impairments (including alterations of stream-side or littoral vegetation covers, physical substrate habitat alterations, and low flow alterations, which are commonly linked to sediment and nutrient impairments) (Table 3-1). Many streams are additionally listed for metals.

This chapter highlights the most prominent sources of sediment and nutrient inputs in the Little Blackfoot watershed, explains how these sources contribute pollution, and describes management efforts that can address these sources to work towards achieving TMDLs and improving watershed health. We integrate these findings alongside the restoration framework established by the in *Upper Clark Fork River Basin Aquatic and Terrestrial Resources Restoration Plan for the Little Blackfoot watershed* (*UCFRP*) (NRDP, 2012), which details approved activities to restore, rehabilitate, replace, or acquire the equivalent of the injured natural resources of the Upper Clark Fork River Basin with funds from the Natural Resource Damage Program (NRDP).

We prioritize restoration needs, and, through stakeholder involvement, identify specific, feasible projects that will help reach TMDL allocations, and can also help achieve goals established in the *UCFRP*. Furthermore, we identify additional monitoring that would improve understanding of the watershed as it relates to restoration planning, thereby increasing efficacy of restoration efforts.

Table 3-1. Streams in the Little Blackfoot watershed with sediment and nutrient and non-pollutant impairments as listed on the 2010 and 2014 Montana Water Quality Integrated Report.

Stream segment	2014 Impairments	TMDLs Prepared (2011)	Metals Impairments?
Dog Creek (Upper)	sediment/siltation; alteration in stream-side or littoral vegetative covers	sediment	X
Dog Creek (Lower)	sediment/siltation; alteration in stream-side or littoral vegetative covers; TP	Sediment TP	X
Little Blackfoot River (Upper)	alteration in stream-side or littoral vegetative covers; sediment/siltation	sediment	X
Little Blackfoot River (Lower)	sediment/siltation; alteration in stream-side or littoral vegetative covers; low flow alterations; TP	Sediment TP	X

Snowshoe Creek headwaters to the mouth (Little Blackfoot River)	sediment/siltation; alteration in stream-side or littoral vegetative covers; low flow; NO_{3+} NO_2	Sediment NO_{3+} NO_2	
Spotted Dog Creek (Lower)	sediment/siltation; alteration in stream-side or littoral vegetative covers; TP	Sediment TP	
Telegraph Creek (Upper)	sediment/siltation; alteration in stream-side or littoral vegetative covers	sediment	X
Elliston Creek	alteration in stream-side or littoral vegetative covers; sediment/siltation	sediment	
Threemile Creek (Lower)	alteration in stream-side or littoral vegetative covers; low flow alterations; TN; TP; Sediment/Siltation	Sediment TP, TN	
Trout Creek	Sedimentation/siltation	sediment	
Carpenter Creek (Upper)	Alteration in stream-side or littoral vegetative covers; other anthropogenic substrate alterations; physical substrate habitat alterations	none	
Carpenter Creek (Lower)	alteration in stream-side or littoral vegetative covers; other anthropogenic substrate alterations; physical substrate habitat alterations; TP	TP	
Woodson Gulch	physical substrate habitat alterations	none	

3.1 SOURCES OF POLLUTION

Identification of the sources of sediment and nutrient inputs and of non-pollutant impairments (including alterations to stream-side and littoral vegetative cover, physical substrate habitat, and flow) is a crucial step in restoration planning. However, sediments and nutrients are generally nonpoint source pollutants and occur naturally within streams, and as such it is not only difficult to quantify the relative contribution of each possible source, but also to estimate potential load reductions.

The TMDL relied heavily on computer models to develop estimates of current pollutant loads, allocate these loads to various sources, and estimate potential reduction of loads given application of BMPs. Although watershed models and their results are inherently uncertain, they represent our best option for attributing sediments and nutrients in streams to potential sources. While loads presented throughout this document should not be taken as actual pollutant loading, the modeled results help define the most likely sources of nutrient and sediment pollution and are very useful for prioritizing restoration efforts within the Little Blackfoot watershed.

This section seeks to define the most significant sources of sediment and nutrient loadings in the Little Blackfoot watershed and to explain how these sources contribute to watershed pollution. Since nutrients and sediments occur at natural background rates, we focus the discussion on sources that can be controlled to reduce anthropogenic loadings. We hope to create awareness of land management practices that may be impairing streams and prioritize future restoration efforts.

3.1.1 Sources of sediment

Excess sediment in the Little Blackfoot watershed has resulted in cloudy waters and degraded aquatic communities, reducing native fish populations and recreational opportunities throughout the area. Sediment pollution can cause problems for watershed landowners as well. For example, sediments can become deposited in irrigation intakes and canals (Lawrence and Atkinson, 1998) and over-widening of the river channel as a result of sedimentation can reduce surface flow and availability of water for irrigation. Sediment deposits can also cause unpredictable channel migration events, possibly causing damage to surrounding infrastructure. The sources listed below are ranked in order of their relative contribution to the total annual sediment load as determined in the *LBFTMDL*.

3.1.1.1 Upland erosion (About 12,000 tons/year, 80% of total[1])

Upland erosion (i.e., sediment inputs originating from outside of the stream channel and riparian zone) represents the largest source of sediment inputs into the Little Blackfoot watershed, **including all stream segments with completed sediment TMDLs**. Upland sources are generally the largest sediment source in watersheds (Julien, 2010). Sediment transport to streams and rivers via upland erosion occurs naturally in every watershed and therefore a large majority of upland sediment cannot be controlled through management activities. However, human alterations of land cover and management practices can cause accelerated erosion rates and limit the capacity of the surrounding landscape to attenuate the effects of water and wind transportation of sediments.

There are some opportunities to control upland sources of sediment in the Little Blackfoot watershed. About a third of the watershed is grazed and livestock are generally pastured on USFS rangelands during the summer and in irrigated hay fields during the winter. Grazing can contribute to upland erosion when soil disruption and compaction result in reduced soil water infiltration rates (Belsky and Blumenthal, 1997). Hay production can also expose the soil to erosion and result in sediment transport into streams.

Timber harvest on forested uplands, which results in land cover change and reduced soil water infiltration capacity, also influences sediment transport, however was not classified as a major

[1] Note: "Total" sediment values presented here and elsewhere in this section are existing loads calculated for the lower Little Blackfoot River (see Table 5-38 in the *LBFTMDL*),the most downstream waterbody segment in the TPA.

cause of sedimentation in the Little Blackfoot watershed. Logging intensity within the watershed is generally low and the enactment of the MT Streamside Management Zones (SMZ) law in 1991 continues to restrict logging within riparian areas.

3.1.1.2 Historical mining

Another source of sediment into the Little Blackfoot watershed is substrate left as a result of historical mining, including waste rock dumps, tailing piles, and dredge dams. Additionally, mining has resulted in substantial alterations to channel morphology in some reaches. Effects of historical mining exist throughout the watershed, but are cited as likely sediment sources on **upper Dog Creek** (streamside tailings, dredge damns, mining within riparian zone and placer mining), **Snowshoe Creek** (altered channel morphology and gradient), and **Telegraph Creek** (placer mining effects, including residual large cobbles and boulders and an entrenched channel). Historical mining contributions to sediment loads were considered as upland erosion during the TMDL process, but in planning for restoration efforts should be considered separately due to the site-specific nature of the mining-related sources.

3.1.1.3 Stream bank erosion (About 2,187 tons/year, 15% of total)

Stream bank erosion is a localized process, whereby the banks of individual stream reaches degrade due to instability and mass wasting, resulting in the release of sediment from the stream bank directly to the stream. While stream bank erosion is a naturally-occurring process, human-caused disturbances and alterations within the riparian areas within the Little Blackfoot watershed have caused increased levels of stream bank erosion. Stream bank erosion and resultant sediment inputs can be attributed to numerous causes, many of which are linked.

Livestock grazing in the riparian zone can contribute to stream bank erosion. Cattle may trample on the stream banks, causing hoofshear and bank instability. Cattle may reduce native riparian vegetation, via over-browsing and initiation of shifts in species distribution. In heavily grazed areas, shallowly-rooted disturbance-induced grasses and noxious weeds may grow in place of woody, deeply-rooted native vegetation. Native riparian vegetation provides bank stability and also traps and filters sediment, therefore a lack of native vegetation further exacerbates sediment inputs. Stream assessments noted particularly heavy grazing in **upper Dog Creek**, **upper and lower reaches of the Little Blackfoot River**, and **lower Spotted Dog Creek**.

Certain reaches, including **Snowshoe Creek** and **lower Dog Creek** lack accumulations of large woody debris (LWD), potentially due to removal of riparian vegetation, past riparian timber harvest, and/or reduction in beaver activity compared to historical levels. A scarcity of LWD and beaver damns contributes to stream bank erosion, because each serves to reduce river velocity and trap sediment. Although riparian harvesting is currently restricted with the MT SMZ law, historical riparian harvesting continues to affect stream bank stability along some reaches.

3.1.1.4 Roads (77 tons/year, 0.005% of total)

Road density throughout the watershed is about 1.5 mi/mi^2; 92.6% of these roads are unpaved. Soil erodes from unpaved roads and contributes roughly 38 tons of sediment per year. Inputs into individual stream segments are largely dependent on the road density per mile within the subwatersheds, how many times individual streams cross unpaved roads, the number of miles of unpaved roads within stream vicinity, as well as road construction and maintenance factors. Numerous "high-risk" roads and road segments exist throughout the watershed. "High-risk" roads are defined as those which are hydrologically connected to a stream and have the potential to deliver excessive amounts of sediments, pose significant risks to stream channel morphology (including limiting sinuosity and floodplain connectivity), and impact valuable native fish habitat (USFS, 2015) (see figures A.1 and A.2 in Appendix A). Many high-risk roads have unimproved fords crossings, which are particularly destructive to stream banks and are a persistent source of sediment (USFS, 2015). Additionally, user-created dispersed campsites are often associated with road stream crossings. These recreational areas, which are frequently located directly on streambanks, contribute to riparian vegetation loss and streambank erosion.

The **Telegraph Creek** subwatershed has the most high-risk road segments (15.61 miles) (USFS, 2015), and **Upper Telegraph Creek** has the highest density of unimproved crossings (3.31/mi^2). The **Ontario Creek** subwatershed has 8.84 miles of high-risk road segments (USFS, 2015) and the most sediment delivery points (40). **Upper Dog Creek** has the most unimproved road crossings open to wheeled motorized traffic (38) and the **Dog Creek** subwatershed has the largest sediment inputs from unpaved roads (5.2 tons/year). Many popular dispersed camping areas exist on the Little Blackfoot River, Telegraph Creek, and Ontario Creek and are often occupied on weekends during summer and fall (USFS, 2015). Nine dispersed campsites in these drainages are documented as having adverse impacts on native fish habitat. See Appendix A for maps detailing high-risk roads.

Traction sand, which is applied to paved roads in the wintertime, contributes roughly 39 tons of sediment per year throughout the watershed, most notably on the **lower Little Blackfoot River**.

Channelization and river confinement, often coupled with the presence of riprap and gravel dikes, are present throughout the Little Blackfoot watershed where the river is near Highway 12, and other paved and unpaved roads. Channelization, in which the river channel is artificially engineered to restrict its flow, has significant impact on river function. Channelization can result in increased river velocity, furthering stream bank erosion downstream, and rapid transport of sediments downstream that would otherwise be deposited on a floodplain or streambed (EPA, 2007). Along some stream segments in the Little Blackfoot watershed, the stream is not channelized per se, but rather its floodplain is restricted by roads. The **lower Little Blackfoot River** is most affected by channel alterations due to the presence of Highway 12 and the railroad.

Railroad. The Burlington Northern Santa Fe (BNSF) railroad line travels along the lower Little Blackfoot River and then up Dog Creek and Uncle George Creek over Mullan Pass (Figure

1). The significant amount of gravel dikes and riprap present along the railroad results in channelization and floodplain restriction along these streams.

3.1.1.5 Flow alterations

In some cases, the channel is over-widened and/or instream flow is diverted, which can result in shallow, slow-flowing water and a reduction in the stream's ability to attenuate sediment loading (EPA, 2007). High width/depth radios were most commonly noted on **Trout Creek**, **Elliston Creek**, and the **upper Little Blackfoot River** (DEQ and EPA, 2011).

3.1.2 Sources of nutrients

As with sediments, nutrients occur naturally within streams and are essential components of healthy riparian systems. However, when nutrient inputs exceed quantities required by vegetation, soil fauna, and bacteria, nutrients can be readily leached from soils and transported to streams (Hubbard et al., 2004). When they occur in excess, certain nutrients, commonly nitrogen (nitrate & ammonia) and phosphorus, can cause deleterious effects on aquatic communities and livestock and can also pose significant human health concerns. Elevated nutrient levels can cause blue-green algae blooms which can produce toxins that are lethal to wildlife, livestock and humans (Priscu, 1987) and elevated nitrate in drinking water can inhibit normal hemoglobin function in infants (WHO, 2011). Excessive algae can also clog irrigation intakes and reduce carrying capacity of ditches and canals. This section focuses on identifying controllable, human-related sources of elevated nutrient concentrations throughout the Little Blackfoot watershed.

3.1.2.1 Livestock

Livestock contribute to elevated nutrients into the Little Blackfoot watershed via a number of interrelated pathways. Grazing can alter the nutrient uptake capacity of the soil and vegetation, by reducing vegetation biomass and causing soil compaction. Livestock excrete urine and feces, both onto land surfaces and directly into streams, which is a source of nitrate inputs, and to some extent phosphorus inputs when waste is deposited directly into the water. Winter grazing reduces biomass at a time of year when it is already low, yet since nutrients continue to be added to the system from excrement, excess nutrient levels are high. Precipitation can leach and transports excess nutrients to streams, especially in soils with decreased water infiltration capacity as a result of compaction.

Lack of management to control the effects of grazing in riparian zones can contribute to elevated levels of nutrients in streams. Riparian vegetation can help uptake nutrients from runoff and ground water, but when it is removed, nutrients more readily enter streams. Furthermore, if there is a lack of riparian vegetation to stabilize stream banks, phosphorus in soils and substrates which compose the stream bank are directly deposited in the water as stream banks erode.

3.1.2.2 Fertilizers

Cattle manure is applied to pastures and croplands as a fertilizer, in higher quantities on pasture lands than in range and forested areas. Commercial fertilizers are applied infrequently throughout the watershed (DEQ and EPA, 2011). When these fertilizers are applied in late spring, excess nutrients are transported to streams via overland flow and groundwater.

3.1.2.3 Irrigation

Irrigation diversions irrigate roughly 11,000 acres throughout the watershed (Berkas et al., 2005) and occur on many stream segments. Irrigation diversions reduce instream flow, decreasing a stream's ability to attenuate excess nutrients from upstream. Low irrigation efficiency can cause pasture saturation, which can mobilize phosphorus and irrigation-related alterations to groundwater flow can cause more nitrogen to be transported from pastures and cropland to streams.

3.1.2.4 Residential development and septic systems

Developed areas make up little land area in the Little Blackfoot watershed, but runoff from impervious surfaces, deposition by machines/automobiles, and fertilization and irrigation of lawns do make measurable phosphorus contributions to **Dog Creek** (15% TP), **Threemile Creek** (15% TP) and the lower **Little Blackfoot River** (13% TP). Septic systems release nitrogen (usually in nitrate form) and phosphorus (mostly organic) into soils surrounding septic tanks. While there is a low septic density throughout the watershed, septic systems are estimated to contribute significant TP to Threemile Creek (12% TP) and the **lower Little Blackfoot River** (11% TP).

3.1.2.5 Mining

Portions of the watershed are underlain by the Phosphoria Formation, which was historically mined in the **Dog Creek** and **Threemile Creek** subwatersheds. Historical mining likely increased the exposure of this underlying parent material, causing phosphorus contributions above natural background rates which may continue today. However, this source is not well understood and was not evaluated in the TMDL process.

3.1.3 Sources of non-pollutant impairments

Non-pollutant impairments are indicators of impairment but lack direct quantifiable links to stream pollution. The non-pollutant impairments listed below are often linked to sediment and nutrient pollution and should be considered in planning efforts to reduce sediment and nutrient loading.

3.1.3.1 Alteration of streamside or littoral vegetation covers

All streams listed for sediment are also listed for alteration of streamside or littoral vegetation covers (Table 3-1). This non-pollutant signifies that riparian vegetation has been significantly removed or altered (i.e., species composition), which can cause streambank erosion, altered stream morphology, and increased nutrient transport. Riparian vegetation may be removed for pasture land, infrastructure development, or from historical timber harvest and can be heavily grazed by livestock and wildlife. As discussed above, deeply-rooted native riparian vegetation is extremely important for stream function. It provides for bank stability and floodplain connectivity, attenuates nutrients and reduces nutrient transport to streams, reduces water temperatures, and provides wildlife habitat.

3.1.3.2 Physical substrate habitat alterations

Upper Dog Creek, **Snowshoe Creek**, **Telegraph Creek**, and **Woodson Gulch** are listed for physical substrate habitat alterations. Streams with this impairment are characterized by significant direct and indirect changes to stream morphology, such as channelization/confinement, downcutting, loss of complexity, and loss of instream habitat. These changes may be the result of historical mining practices, as discussed above in section 3.1.1.2: Historical mining.

3.1.3.3 Other anthropogenic substrate alterations

Upper and lower Carpenter Creek are listed for other anthropogenic substrate alterations, which means that there are clearly human-caused changes to stream channel morphology even though monitoring parameters are within expected values.

3.1.3.4 Low flow alterations

Lower Little Blackfoot River, **Snowshoe Creek**, and **lower Threemile Creek** are listed for low flow alterations, which is often caused by irrigation withdrawal. Low flow alterations contribute to morphological changes (high width to depth ratio), increased temperatures, and reduced instream habitat, and can reduce a stream's ability to attenuate sediment and nutrients from upstream.

3.2 ESTIMATED LOADINGS AND POTENTIAL REDUCTIONS

The TMDL document details ten sediment TMDLs and six nutrient TMDLs for individual stream segments within the Little Blackfoot watershed. Current estimated sediment and nutrient loads and potential reductions with the application of best management practices (BMPs) as detailed in the *LBFTMDL* are presented in Table 3-2 and Table 3-3. As discussed, due to inherent methodological limitations in calculating loads and the relative contributions of each source, values presented here are estimates only, and should not be considered actual loading values.

3.2.1 Sediment loading and reductions

Potential sediment load reductions are presented as percent reductions, because there is no numeric standard to calculate allowable sediment loads and because of the high uncertainty associated with the estimates. Also, setting target percent reductions allow us to focus on improving water quality through management practices rather than drawing attention to uncertain loading values. Loads and reductions are presented on a yearly scale, because cumulative sediment loads generally correlate to ecological consequences. While the TMDL models suggest that upland erosion contributes both the largest sediment loads and represents the greatest potential for reduction, it should not necessarily be the focus of restoration efforts, as anthropogenic upland sources are difficult to quantify and manage due to high the natural background loading from the uplands.

Table 3-2. Waterbodies with sediment impairments within the Little Blackfoot watershed. Estimated current sediment loads, TMDLs, and potential reductions when BMPs are employed. Note that no reductions were allocated to natural sources of erosion, only human-caused sources. Loads were evaluated at the watershed scale, because sources deliver sediments to tributaries which carry loads further downstream.

Stream segment	Current Load (tons/yr)	TMDL (tons/yr)	Reduction
Dog Creek (Upper)	132	101	23%
Dog Creek (Lower)	2,426	2,076	14%
Little Blackfoot River (Upper)	4,326	3,813	12%
Little Blackfoot River (Lower)	14,828	12,068	19%
Snowshoe Creek headwaters to the mouth (Little Blackfoot River)	384	295	23%
Spotted Dog Creek (Lower)	1,774	1,383	22%
Telegraph Creek (Upper)	179	151	16%
Ellison Creek	121	88	27%
Threemile Creek (Lower)	744	418	44%
Trout Creek	545	416	24%

3.2.2 Nutrient loading and reductions

Nutrient TMDL allocations are composited into a single load allocation to all nonpoint sources, including natural background sources. These TMDLs are based on flow in cubic feet per second (cfs) and therefore allowable load increases with increasing discharge rates. The *LBFTMDL* displays load duration curves of allowable loading with increasing flow (DEQ &EPA 2011, Section 6.6). For example purposes, load values are displayed in Table 3-3 illustrate loads from the 80th percentile of the growing season sample data.

Table 3-3. Waterbodies with nutrient impairments within the Little Blackfoot watershed. Estimated current nutrient loads, TMDLs, and potential reductions when BMPs are employed.

Stream segment	Nutrient	Current Load (lbs/day)	TMDL (lbs/day)*	Reduction
Dog Creek (Lower)	TP	4.29	4.19	2%
Little Blackfoot River (Lower)	TP	15.25	13.95	2%
Snowshoe Creek headwaters to the mouth (Little Blackfoot River)	NO_{3+} NO_2[3]	4.82	4.38	9%
Spotted Dog Creek (Lower)	TP	2.27	1.59	30%
Threemile Creek (Lower)	TP	2.61	1.06	59%
	TN[4]	21.61	10.59	51%
Carpenter Creek (lower)	TP	0.91	0.49	46%

[2]Total phosphorus; [3]Nitrate + Nitrite; [4]Total nitrogen

3.3 Management measures

Implementation of management measures for reducing nonpoint source pollution will rely on voluntary participation by watershed stakeholders, including private landowners. Activities recommended here will require the support of the people who live, work, and recreate in the watershed for long-term success. These management measures are designed to achieve TMDLs, work towards the restoration goals of the *UCRFP*, and help landowners make economical improvements to their land management practices. Many goals of restoration activities are to balance the needs of agriculture with the needs of other watershed uses, including drinking water, fish and wildlife habitat, and recreation.

Many recommended restoration activities listed here are drawn from work completed during the *LBFTMDL* and the *Little Blackfoot River Riparian Assessment* (herein after referred to as the *2014 Assessment*) (Geum & River Design Group, 2014), which is a direct follow up to NRDP's *UCFRP* and identifies factors affecting stream function and fish habitat on select streams throughout the watershed. These *LBFTMDL* and *2014 Assessment* documents are the result of two long-term planning efforts to achieve water quality standards and restore natural resources in the Little Blackfoot watershed and are the most current and comprehensive assessments of existing conditions to date. While this WRP and the *UCFRP* are somewhat different in scope, each plan seeks to achieve similar projects and goals and current partners involved in each process agree that working together is mutually beneficial. If different conservation groups with similar goals work together to identify restoration projects, engage in discussions with landowners, and match funding, this will increase the probability of project implementation and success.

The riparian component of the *UCFRP* and follow-up *2014 Assessment* address restoration actions on priority 1 streams (lower Little Blackfoot) and priority 2 streams (Dog Creek, Spotted Dog Creek, and Snowshoe Creek), which are streams with significant impairments where remediation will likely be effective at restoring fisheries in the Upper Clark Fork (see Chapter 1: Introduction). The *LBFTMDL* and this WRP encompass a larger scope, addressing additional impaired streams throughout the watershed, including Elliston Creek, upper Telegraph Creek, lower Threemile Creek, Trout Creek and lower Carpenter Creek. While the riparian component of the *UCFRP* is restricted to priority 1 and 2 streams, it is important to note that the terrestrial component can be leveraged to support projects on these non-priority streams.

A number of stream segments are listed for non-pollutant impairments, which are probable causes of impairment on these streams and may be closely linked to sediment and nutrient pollution. Restoration goals and management measures here address these non-pollutant issues in addition to sediment and nutrient reductions. In localized areas, historical mining has left a legacy of altered streambank morphology, often in addition to toxic waste. Abandoned mines projects should consider the potential for sediment reductions and channel restoration in conjunction with other reclamation work.

BMPs listed in the tables below are intended to give readers a sense of possible options for the watershed; the narrative which precedes each table represents the most specific needs in the Little Blackfoot watershed. Practices employed, however, should be considered based on site-specific needs, landowner involvement, and implementation feasibility. Suggested management practices presented here and the BMPs outlined in the tables are by no means an exhaustive list of ways to mitigate and control pollutants in the watershed. Other practices not mentioned here may work as well or better to achieve restoration goals. Presentation and discussion of management measures here are intended to inform stakeholders about encouraged activities as a starting point for discussions.

Table 3-4. Little Blackfoot watershed restoration goals by category. Note that these goals are not listed by priority.

Project category	Goals
Landowner outreach	• Form working relationships with watershed landowners and ranch managers • Assess potential projects and land management opportunities on private land • Identify mutually beneficial projects with long-lasting, ecologically significant impacts • Use demonstration projects to build trust and support throughout the

	watershed
Grazing management	• Control livestock access to stream • Allow for streambank recovery in locally degraded areas
Crop production	• Increase vegetative ground cover to reduce soil erosion • Allow for vegetation to filter cropland runoff before it enters waterways
Streambank and aquatic habitat recovery	• Improve stream access to floodplain • Increase presence of native, deeply-rooted vegetation along stream banks • Reduce presence of invasive plant species in riparian zones • Reconstruct channel in areas where other options will likely be unsuccessful at achieving restoration goals • Improve complexity of within stream habitat to slow down water and provide fish habitat and reduce water temperature
Forestry	• Maintain upland forest to be resilient towards disturbances such as bark beetles and fire. • Limit ecological disturbance, especially in riparian areas, during and after timber harvest.
Transportation	• Reduce sediment transport from roads to streams • Ensure priority culverts can withstand 100-year events • Enhance upstream travel for fish populations
Irrigation and drought response	• Increase instream flow, especially in low-water months • Improve irrigation efficiency • Reduce fish entrainment in ditches and movement over damns • Consolidate diversions
Developed areas	• Mitigate stormwater run off • Ensure construction follows stormwater permitting regulations
Protection	• Maintain robust stream segments in their current state • Protect reaches with high potential to recover naturally

3.3.1 Landowner outreach

Privately owned land encompasses a significant portion of the Little Blackfoot watershed and achievement of TMDLs will require voluntary participation by private landowners in restoration efforts. Outreach to these landowners is therefore a necessary component of the restoration plan. Efforts will involve working with landowners one-on-one as well as creating general community consciousness of water-related issues and ways to get involved with restoration efforts. Furthermore, landowners should be informed of available economic incentives for engaging in conservation practices and the other benefits that can arise from helping to reduce non-point source pollution. It is essential that organizations involved in outreach work together and communicate past and future planned efforts so as not to duplicate actions or cause confusion.

Assessments of private lands and current management practices will help organizations identify specific opportunities to improve riparian habitat and water quality and quantity. WRC has reached out to numerous landowners along the mainstem **Little Blackfoot River** and some agreed to have land assessments completed. WRC is currently in discussion with these landowners to find agreed upon projects to implement.

One major challenge in the Little Blackfoot is gaining private landowner interest to get involved with restoration efforts. One way to do so is through public education events and workshops that debunk myths and provide information about irrigation improvement opportunities, state and federal conservation incentive programs, and water rights leasing. Conservation projects can have significant benefits for private landowners – for example irrigation efficiency projects can increase arable land and reduce labor costs, while at the same time reducing surface water withdrawal and reducing fish entrainment. Similarly, managing stock access to stream banks can eliminate the need for landowners to deal with costly bank stabilization projects to prevent high flows from eroding pastureland. See Section 3.5: Education and Outreach below for more information. Additionally, creating more awareness of water issues in the community and the importance of restoration efforts can increase people's desire to get involved.

3.3.2 Grazing management

The goals of improving grazing management in the Little Blackfoot watershed are not to limit agricultural operations, but rather to find practices that may benefit agricultural operations and riparian zones. Modern grazing management in riparian zones involves changes in timing, duration and intensity of grazing activity, which has differential impacts on grass, shrub and tree growth and reproduction. Additionally, clean off-site watering sources can reduce impacts to stream banks while also improving cattle weight gain (Surber et al., 2003). It is very possible to have high functioning riparian systems with grazing presence, but the grazing must be managed so that it is sustainable over time and works within the ecosystem's tolerance.

Grazing management in the riparian zone should be tailored to the specific riparian area under consideration (DNRC, 1999). The *LBFTMDL* highlights the need for application of BMPs which minimize livestock disturbance of the streambank and channel, including creation of water gaps, fencing to restrict livestock access to a stream in heavily impacted areas, and creation of off-site watering sources (Table 3-5). Creating grazing management plans, which may include establishing a rotational grazing system, will help landowners work sustainably on the land.

Table 3-5. Examples of grazing management BMPs (DEQ, 2012; DNRC, 1999).

BMP	Description
Grazing management plan	• Manage grazing frequency, duration, season of use, and intensity to promote desirable plant communities, maintain vegetative cover, and prevent soil erosion. • The plan should identify the stocking density, season, duration, and location of grazing activities field by field. • Set target grazing use levels in accordance with production limitations and plant sensitivities.
Livestock distribution	• Distribute livestock to promote dispersion and decomposition of manure to prevent delivery to water sources. • Periodically rotate winter feeding areas and feed placement within

	winter feeding area • Relocate corals and pens away from riparian zones .
Promote livestock travel away from riparian zones	• Provide off-stream water sources where adequate forage is available. • Place salt and supplemental feed in upland areas • Rest or defer riparian pastures when needed for recovery and plant growth. • Fence off riparian zones • Seed uplands with preferred forage species • Avoid grazing in riparian areas during rainy season. • Provide shelter structures to protect livestock from weather as an alternative to riparian vegetation
Stream crossings	• Create stabilized area or structure built across a stream to provide a travel way for livestock, people, vehicles and equipment.
Water gap	• Create a controlled access point from which livestock can obtain water from a stream; if possible should only permit one animal to access at a time.
Manure storage	• Keep manure piles ≥ 100 ft away from streams, cover them to prevent storm runoff
Filter strip	• A strip of permanent perennial vegetation placed on the down gradient edge of a field, pasture, barnyard, or animal confinement area.

3.3.3 Crop production

The main goals for BMPs related to crop production (Table 3-6) are to reduce the amount of erodible soil and to engage in practices which trap or attenuate pollutants before entering streams. A riparian buffer is a zone of vegetation along the banks of streams which is composed of native grasses and deeply rooted woody vegetation. This buffer can not only trap and filter sediment, nutrients, and pesticides but also provides bank stabilization, shade, and wildlife habitat, and slows flood waters (Helmers et al., 2008). These buffers should be maintained where existing and their creation should be considered in conjunction with other streambank restoration work. Vegetative filter strips can be planted downgradient and adjacent to croplands and pastures to filter runoff before the water is transported to waterways (Helmers et al., 2008). Additionally, careful consideration of fertilizer application and manure storage is important to prevent excess nutrient additions to streams.

Hay is a common crop grown throughout the Little Blackfoot watershed and in many places the floodplain and riparian zones have been cleared to establish hayfields. Haying in the riparian zone should be avoided if possible. If floodplains are cleared of native vegetation and converted to hayfields, famers should ensure that there is established woody vegetation to act as a riparian buffer to reduce haying impacts on water quality. Additionally, many of the riparian/floodplain hayfields are used for winter grazing and feeding, which can lead to a buildup of manure that can become washed into the stream during spring floods. Cattle should be wintered away from the floodplain if possible and manure should be properly stored to reduce its transport to the stream. Native vegetation should be reestablished in riparian and wetland areas that have been cleared in the past but are no longer in use, which may require active planting and seeding.

Table 3-6. BMPs associated with crop growing practices.

BMP	Description
Riparian buffer	• Planted perennial vegetation located adjacent to and upgradient from a waterbody which can filter sediment and nutrients from upstream and upland sources. Buffer width, slope, species composition, and target pollutants must be considered in the design.
Filter strip	• A strip of permanent perennial vegetation placed on the downgradient edge of a field, pasture, barnyard, or animal confinement area. If the purpose of the strip is to take up nutrients, the vegetation must be periodically harvested in order to prevent nutrient buildup.
Fertilizer application	• Avoid near waterways
Cover crop	• Vegetation planted on what would otherwise be fallow ground. Designed to prevent mobilization and transport of pollutants by precipitation and runoff during periods when the primary agricultural crop is unable or unavailable to perform similar a function.
Conservation tillage	• May include, but are not limited to, reduced tillage or minimum till, no till, strip till, direct seeding, mulch till, or ridge till to prevent soil erosion and reduce surface or subsurface runoff potential.
Alley cropping	• Trees, shrubs, or tall, rigid, perennial herbaceous vegetation planted in sets of single or multiple rows with agronomic horticultural crops or forages produced in the alleys between the sets of woody plants to reduce soil erosion.
Waste management	• Store, transport and using agricultural wastes, such as manure, wastewater, and organic residues, in a manner that reduces nonpoint source pollution.
Erodible land conversion	• Converting highly erodible lands to permanent vegetative cover.

3.3.4 Streambank and aquatic habitat recovery

Streambank and aquatic habitat recovery projects will address bank stabilization, streamside revegetation, floodplain connectivity, and within-stream habitat. These projects can directly improve alterations in streamside or littoral vegetative covers and alterations to physical substrate habitat. Candidate reaches for recovery efforts should be prioritized based on potential for improvement and existing condition. In areas that are actively grazed, any streambank work should only be implemented in conjunction with riparian protection measures.

Streambank efforts should establish or help maintain vigorous streamside vegetation composed of diverse age classes of deeply rooted native woody species to stabilize streambanks and filter transported sediment and nutrients. In some areas, this may be dependent on eradication and control of invasive plants. Improvement of within-stream habitat may involve LWD placement, shade creation via streamside vegetation, or beaver habitat protection. The presence of beaver dams and/or beaver dam analogues can have significant positive impacts on stream function and morphology, by slowing flows, reducing stream bank erosion downstream, trapping and filtering sediments and pollutants, and improving water temperature (Błędzki et al., 2011; Pollock et al., 2015; Westbrook et al., 2006). Where possible on headwaters streams, improving beaver habitat and populations should be considered.

Passive restoration is desired over intensive streambank engineering to achieve bank stability due to high costs of bank reconstruction and disturbance caused by equipment. Examples of passive restoration options to achieve streambank stability include riparian fencing and access restrictions for people and/or livestock, allowing for natural ecological processes to resume. Active restoration options which are less intensive than channel reconstruction include LWD placement, beaver dam analogues, reseeding, and planting, which may accelerate natural processes and help achieve restoration goals over time.

Channel reconstruction may be needed in heavily impacted areas with little potential to return to historical conditions without intensive intervention, such as areas where the stream is significantly incised and has no access to its floodplain or where past mining operations have significantly altered streambank morphology. When streambank rebuilding is needed, bank building materials should be natural or bioengineered – riprap and other "hard" bank armoring approaches should be avoided unless required to protect existing infrastructure.

Table 3-7. Selected projects to improve streambanks and aquatic habitat.

Options	Description
Aquatic habitat improvements	• LWD/ log jam placement • Pool creation/ riffle creation • Streamside shade establishment
Passive restoration	• Access/use restriction • Beaver damn analogues
Channel reconstruction	• Should only be considered in heavily impacted areas with little potential for natural recovery • Use natural/bioengineered building materials

3.3.5 Forestry

Maintaining healthy, resilient forestland is a key component of upland management in the Little Blackfoot watershed. Much of the upland forest in the Little Blackfoot watershed is dominated by dense, even-aged lodgepole pine. In recent years, bark beetles have caused widespread tree mortality and fuel loading is at dangerously high levels. Increasing forest resilience to future disturbances, especially wildfire, has positive impacts on the streams which flow through these forests while also helping protect existing infrastructure, including homes, from destruction. Creation of diverse forest conditions, including varying species, age-classes, and density across the landscape, can attenuate future fire severity and extent as well as lessen the impacts of future insect outbreaks. The **Telegraph Vegetation Project** is being undertaken by the Helena NF and seeks to remove hazardous fuels and recover the economic value of dead and dying trees from 23,669 acres in the Telegraph Creek drainage five miles south of Elliston. The draft environmental impact statement (EIS) for this project was released at the time of this writing, with project implementation planned for 2016.

Landowners may choose to engage in timber harvesting on their own land. Any private timber harvesting should adhere to the Streamside Management Zone laws and BMPs for Montana (Logan, 2001) to reduce direct and indirect impacts to riparian systems (Table 3-8). Landowners are required to notify MT DNRC prior to any timber harvesting.

Table 3-8. Selected BMPs associated with timber harvesting (Logan, 2001).

BMP	Description
Streamside Management Zone (SMZ)	• Designated area least 50 feet wide from each side of a stream, lake or other body of water, measured from the ordinary highwater mark in which management actions are limited • Refer to SMZ laws (see MT DNRC, 2006)
Harvest	• Avoid wet areas including moisture-laden or unstable toe slopes, seeps, wetlands, wet meadows and natural drainage channels. • Avoid operation of wheeled or tracked equipment within isolated wetlands, except when the ground is frozen. • Use directional felling or alternative skidding systems for harvest operation in isolated wetlands.
Road use	• Use existing roads where practical, unless use of such roads would cause or aggravate an erosion problem. • Locate roads to provide access to suitable (relatively flat and well-drained) log landing areas to reduce soil disturbance.

3.3.6 Transportation

There have been substantial assessments of existing road conditions, including number of stream crossings, parallel stream segments, and unpaved road density throughout the watershed in recent years, including the Helena National Forest Roads Analysis (USFS, 2004), *LBFTMDL* (DEQ, 2012),and the environmental impact and biological assessments for the Divide Travel Plan (USFS, 2015). These efforts have helped prioritize projects and road work to improve sediment delivery and riparian habitat throughout the watershed. Table 3-9 below lists high-risk roads throughout the Little Blackfoot watershed that have the potential to deliver excessive amounts of sediments, pose significant risks to stream channel morphology, and impact valuable native fish habitat, as determined during the biological assessments during the Divide Travel Plan development process (USFS, 2015).

There are a few current and upcoming projects that will address transportation-related sediment sources including making improvements to high-risk roads. The **Divide Travel Plan**, which identifies roads, trails, and areas that are open and closed for motor vehicle use in the Helena National Forest is currently up for revision and will impact motorized use in the Little Blackfoot watershed. The preferred alternative (Alternative 5) would close 29.23 miles of high-risk roads and 67 stream crossings. Five fords located in high-value fish habitat would be closed permanently and two others would be closed until they are replaced with culverts that can withstand a 100-year event. It is important to note that many roads are not under Forest Service jurisdiction but still have significant ecological impacts. For example, 25% of stream crossings (110) and 24% of high-risk roads in the Divide Travel Plan area are outside of Forest Service jurisdiction. Outreach to landowners with private roads should promote proper BMP use to limit sediment delivery (Table 3-10), especially improving stream crossings and reducing parallel stream road segments. See Appendix A for maps of high-risk roads on USFS lands in the Little Blackfoot watershed.

The **Golden Anchor Bridge** project on the **upper Little Blackfoot River** near its confluence with **Ontario Creek** will involve installing a bridge on what was an unimproved ford crossing (NFS Road #4100) and removing a road section which restricts the Little Blackfoot from accessing its floodplain (non-system road #123-013). This project will facilitate timber harvest for the Telegraph Vegetation Project, increase floodplain connectivity, improve fish passage on the upper Little Blackfoot, and reduce sediment inputs. Additionally, the upcoming **Telegraph Vegetation Project** will involves closing and decommissioning of numerous forest service roads – final project plans are yet to be released at this time of writing.

Other planned road improvement projects on USFS roads in the Little Blackfoot watershed include about 54 miles of re-blading and re-shaping with approximately 286 drain dips installed, 12 cattle guards cleaned of silt, and one new 18-inch diameter corrugated metal pipe culvert at an existing crossing. These improvements will occur on USFS **roads #136 (Ophir Cr), #314 (Elliston Cr to Spotted Dog Cr), #571 (Dog/Hope Cr), #708 (Snowshoe Cr), and #1855 (Upper Dog Cr).**

The Divide Travel Plan identifies both priority ford crossings and dispersed campsites for improvement. Priority fords for improvements include: 2 on the Little Blackfoot River (1 on USFS road #4100 at the access to Golden Anchor mine site which will be addressed by the Golden Anchor Bridge Project); 3 on Ontario Creek (1 near confluence with the Little Blackfoot near non-system road # 123-013, which will also be addressed by the Golden Anchor Bridge project, 1 near Bison Creek between NFS roads 4104-A2 and 495-D1, and 1 on an unnamed tributary to Ontario Creek); and 1 on Sawmill Creek in the Upper Dog Creek drainage. Nine priority dispersed campsites occur on the Upper Little Blackfoot River and Ontario Creek. Future work that is not currently proposed should seek to improving ford stream crossings with hardened structures (ideally bridges), especially on high-risk roads, and reduce use of dispersed campsites in valuable fish habitat. Culverts should be prioritized for replacement and or removal. On fish bearing streams, any new culverts, in addition to those which replace failed culverts, should be designed for a 100-year flood event; on non-fish bearing streams, culverts should be designed to withstand at least a 25-year flood event. When considering fish passage around a barrier, both upstream and downstream fish populations should be evaluated to preserve genetics of native populations if isolated populations exist upstream. The highest priority fish passage projects are those where native fish production is moderate to strong and improvement could reconnect the tributary watershed to the mainstem Little Blackfoot or Clark Fork River.

The railroad significantly restricts the lower Little Blackfoot River as well as Dog Creek. Partners should outreach to Burlington Northern Santa Fe to discuss opportunities to reduce the presence of railroad infrastructure in the floodplains of these streams and to mitigate impacts of existing infrastructure.

While the use of traction sand to reduce safety hazards during winter driving conditions cannot be eliminated, certain practices can help reduce the amount of sand that is transported from roads to streams, including improved training of sand appliers and sand recovery (Staples et al., 2004).

Table 3-9. Roads in the Little Blackfoot watershed under Helena National Forest jurisdiction that pose negative impacts to valuable fish habitat and have potential for substantial sediment delivery (USFS, 2015). See maps in Appendix A.

Subwatershed	High Risk Roads (miles)	High Risk Segments
Ontario Cr	8.84	123, 123-A1, 1801, [2]123-001, 495, 495-D1, 4104-A1/A2, 4101-B1, 1859-E1
Upper Little Blackfoot – Larabee Gulch	13.04	123, 123-018, 227, 227-E1, MTR 501
Telegraph Cr	15.61	495, 495-C1/C2, 527, 527-A1/A2, 1856, 1856-D1/D2, 1857, 1857-B1, 1859, 1859-B1
Mike Renig G	3.11	1856
Upper Dog Cr	13.77	256, 571, 571-C1, 708, 708-I1, 1851, 1852, 1852-A1, 1852-C1/C2, 1855, 1855-E1, U-203
Lower Dog Cr	2.11	1855, 1855-A1,1855-A5, 571
Upper Little Blackfoot – Hat Creek	10.9	227, 227-B1, 1857-A5, 1871, 1871-A3, 4100

North Trout Cr	4.62	4005, 4005-A1/A2 4005-A3/A4
Snowshoe Cr	6.63	708, 708-A1, 708-(B1,B2,B3), 708-C1, 708-E1, 4026-B1
Lower Little Blackfoot – Elliston Creek	4.22	314, 314-A1, 314-E1, [2]1871-001
Carpenter Creek	7.16	136, 136-A1, 136-B5, 708-A1, 4026, 4026-B1, 4045, 4045-A1, 1849
Trout Creek	3.52	314, 314-G1
South Fork Dog Creek	0.94	314-J1
Upper Dog Creek	5.01	314, 314-J1, 314-J3
Threemile Creek	none	None on forest

Table 3-10. Selected transportation BMPs. In general, transportation projects should focus on reducing the hydrologic connectivity between roads and streams and reestablishing streams ability to access its floodplain. (CDM, 2004; Logan, 2001; Staples et al., 2004).

BMP	Description
Transportation planning	• Minimize the number of roads constructed and utilized in a watershed through comprehensive road planning. • Decommission/recontour closed roads to reduce sediment transport
Road design	• Roads should not be built in a manner that restricts a stream's access to its floodplain during high flow events. • Locate roads on stable geology, including well-drained soils and rock formations. • Route road drainage through adequate filtration zones or other sediment settling structures to ensure sediment doesn't reach surface water.
Drainage	• Provide energy dissipaters (rock piles, slash, log chunks, etc.) to reduce erosion at the outlet of drainage features. • Maintain erosion-control features through periodic inspection and maintenance, including cleaning dips and crossdrains, repairing ditches, marking culvert inlets to aid in location, and clearing debris from culverts.
Stream crossings	• Bridges should be installed whenever possible instead of culverts; ford crossings, especially unimproved ford crossing should be avoided. • Design stream crossings for adequate passage of fish, and at a minimum, the 25-year frequency runoff.

3.3.7 Irrigation and drought response

Irrigation and instream flow projects can directly address streams with low flow alterations. Improvements to irrigation systems throughout the Little Blackfoot watershed can increase irrigation efficiency (which may allow for increased instream flow), reduce transportation of sediment and nutrients to waterways, and improve fish passage. Discussing these types of irrigation projects and their benefits with private landowners may be an effective way to gain traction for other types of stream restoration projects in the community. Further research about the existing irrigation network throughout the Little Blackfoot watershed and the impacts on groundwater storage and late season recharge will help in project development.

Reducing the amount of stream water diverted is important so that streams can attenuate pollutants and provide adequate aquatic habitat. Programs such as the Montana Water Project (Trout Unlimited) can help with water rights leasing and water rights conversion to instream flows. Rights leasing and conversion helps ensure that water remains in the streams – additional water left in the stream by one user is not available for downstream water use. Reducing water usage in July and August when flow is already naturally low and temperatures are warm is of highest priority.

Promoting natural water storage can be another way to increase drought resiliency throughout the watershed. Some ways to increase the natural storage capacity of a stream system is by encouraging beavers to build damns (via beaver population management or habitat improvements) or by creating beaver dam analogues, which are structures that mimic or reinforce natural beaver dams (Pollock et al., 2015). Beaver impoundments and complexes increase water storage capacity within a stream system by slowing down surface flows and encouraging lateral water spreading. Thus, these dams create wetland areas, promote groundwater recharge, and elevate the water table (Pollock et al., 2015). Additionally, properly functioning floodplains slow runoff and promote groundwater recharge, which allows water to be slowly released back to the surface water system (DNRC, 2015). In low precipitation years or in the hottest, driest months of summer, this stored water can provide a buffer for base flows in streams.

Table 3-11. Selected BMPs associated with irrigation. Additional BMPs can be found in Baum-Haley (2014).

BMP	Description
Irrigation system conversion	• Converting flood irrigation system with a sprinkler system if conversion can result in a decreased pollutant transport to streams.
Canal conversion	• Replace irrigation canal with a pipe
Canal lining	• Line irrigation canal with and impermeable layer or improve existing lining
Irrigation structure improvements	• Allow for better control of timing and quantity of water withdrawals.

3.3.8 Protection and passive restoration

It is a high priority to conserve stream reaches that are well-functioning and sustainable. These reaches are characterized by having intact floodplains and limited channel incision, are not confined by roads or the railroad, are generally well vegetated, and often have nearby active beaver presence. Reaches which exhibit many of the same characteristics with some small impacts but a high potential to return to a functioning state with minimal intervention should also be protected. The *Little Blackfoot River Riparian Assessment* (Geum and River Design Group, 2014) identifies high-functioning reaches and reaches with a high potential to recover naturally on priority 1 and 2 streams (see Tables 5-1 to 5-4 in the *Little Blackfoot River Riparian Assessment*).

Efforts to protect high priority reaches may include installing riparian fencing to reduce grazing pressure, establishing use or access restrictions, or engaging in land conservation easements to prevent future development. Purchase and acquisition of lands for conservation easements would help ensure habitat connectivity and long-term protection of upland areas. Recent acquisitions include the 1,500 acre **Schatz Ranch Conservation Easement** on lower Dog Creek, which was secured in 2008 and adjoins USFS and state land. The 26,616 acre **Spotted Dog Wildlife Management Area** was established in 2010 after being acquired by MT FWP.

3.3.9 Reach specific conditions and recommendations

Appropriate management actions will be highly variable depending on reach conditions and landowner willingness to participate in restoration projects. Table 3-12 summarizes observations and conditions from the most recent assessments of the impaired stream segments. The *2014 Assessment* lists detailed reach-by-reach conditions and recommended actions for the lower Little Blackfoot River, Snowshoe Creek, Dog Creek, and Spotted Dog Creek (see Tables 5-1 to 5-4 in the *Little Blackfoot River Riparian Assessment* (Geum & River Design Group, 2014)).

Table 3-12. Summary of existing conditions and observations from recent assessments (DEQ and EPA, 2011; Geum and River Design Group, 2014; Liermann et al., 2009; Lindstrom et al., 2008) on impaired streams throughout the Little Blackfoot watershed.

Waterbody	Land ownership	Major observations
Dog Creek	Primarily private; USFS/BLM land in headwaters with many private mining claims	Upper: Livestock trampled banks (high grazing pressures in Helena NF), channelization from the road/railroad, timber harvest up to the stream, dredge damns, streamside tailings, and many beaver complexes. General decline in riparian habitat from upstream to downstream. Lower: Marginal fish habitat, limited cottonwood recruitment, highly manipulated floodplain, channelization by the railroad, overutilization of the riparian area by livestock, haying along streambanks, streambank erosion, irrigation return flows saturating stream banks, sediment inputs from the road.
Little Blackfoot River	USFS in upper reaches with interspersed parcels of private land; primarily private ownership in lower 29 miles.	Riparian conditions highly variable throughout with some reaches exemplifying near-optimal conditions. Upper: Channelization by roads, road erosion, channel modifications, historic mine disturbances, waste rock/tailings piles, logging. Predominately in good riparian habitat upstream of Telegraph Ck, degrading conditions downstream. Lower: Channelization by the road /railroad, channel modifications, haying near the channel, extensive removal of riparian vegetation, noxious weeds, flood levees; numerous irrigation diversions (30 diversions and 8 pump sites),
Snowshoe Creek headwaters to the mouth	Headwaters: USFS, with several existing private mining claims; lower section is privately owned	Lack of LWD and riparian shrub cover, unstable banks, disconnected floodplain, upstream fish barriers associated with private reservoir (Lois Lake), haying in the riparian zone, past logging near the stream, channelization from the road, unscreened irrigation diversions, historical mining effects on channel morphology, some reaches have adequate riparian buffers.
Spotted Dog Creek (Lower)	Upper 5 mi: USFS; Middle 5 mi: MT FWP; Lowest 5 mi: Private.	Upper reaches: excellent riparian vegetation, LWD accumulations, pool habitat, fish cover, minimal streambank erosion; lower reaches: recent timber harvest, cattle throughout reach, LWD and riparian cover sparse, disturbance induced grasses along channel, lateral bank erosion, limited flow, fine sediment accumulations, downcutting, two on-channel water storage reservoirs (upstream fish passage barriers), generally good fish habitat.
Telegraph Creek (Upper)	Primarily USFS with some private inholdings and privately owned mining claims	Channel disturbances associated with mining (large cobble berms along stream and tailings in the stream channel), generally good riparian habitat, but lack of deep pools and LWD, high unpaved road density in the watershed.
Elliston Creek	Primarily USFS; private parcels near Elliston	Riparian habitat removal near Elliston, noxious weeds common, little overhead cover, low flows, pugging and hummocking in the valley bottom ; habitat impairment linked to historical activities persists but is

		improving; mixed management practices across various reaches.
Threemile Creek (lower)	Privately owned	Localized trampling of banks and channel, low flow, grazing pressure generally light, few pools.
Trout Creek	Primarily public (MT State, MT FWP, USFS); private near Avon.	Limited riparian woody vegetation, weeds common, bank trampling, overwidened and shallow channel, effects of logging in the upper watershed, naturally low flow, irrigation diversions near Avon
Carpenter Creek (Lower)	Upper 2.5 mi: USFS, BLM (2 privately owned mining claims); Lower 5.5 mi: private	Altered channel morphology due to placer mining (narrowing of floodplain), large piles of placer tailings along the channel, low flow, irrigation diversions (upstream fish barriers), riparian vegetation generally good, although weeds and disturbance induced grasses present, variable grazing pressure.

3.4 FINANCIAL AND TECHNICAL ASSISTANCE

Funds to implement this WRP can be acquired from a number of different sources:

- DEQ: 319 Grants, 319 Mini Grants
- MT DOJ: NRDP grants, NRDP planning grants
- MT DNRC: Numerous grant opportunities (see http://dnrc.mt.gov/grants-and-loans)
- MT FWP: Future Fisheries, Living with Wildlife
- NRCS: Environmental Quality Incentive Program, Conservation Stewardship Program, Wetland Reserve Program, Farm and Ranch Lands Protection Program, Conservation Innovation Grants, Conservation Reserve Program
- MT Dept. of Agriculture: Noxious Weed Trust Fund
- Private grants
- In-kind services and financial support from landowners

The MT NPS Management Plan includes a non-exhaustive list of grant opportunities to target nonpoint source pollution, available to communities, homeowners associations, conservation districts, governmental entities, and non-governmental organizations. The most up-to-date list of these funding opportunities is available on their Wiki page: http://montananps319grants.pbworks.com/w/page/21640335/NPS%20Home.

Landowners are encouraged to participate in voluntary environmental incentives programs, many of which are administered by the NRCS. For example, the **Environmental Quality Incentive Program (EQIP)** provides financial assistance to help plan and implement conservation practices that address natural resource concerns on agricultural land and non-industrial private forestland. Additionally, the **Conservation Stewardship Program (CSP)** provides money to farmers and ranchers who maintain a high level of conservation on their land. Interested parties can contact the Deer Lodge Valley Conservation District for more information and assistance in applying to these and other programs.

NRDP aquatic restoration funds are a potential funding source for projects on the Little Blackfoot River (priority 1), Snowshoe Creek (priority 2), Dog Creek (priority 2), and Spotted Dog Creek (priority 2) which address water quantity, fish passage, fish entrainment, bank/channel restoration, and riparian habitat. **NRDP terrestrial restoration funds** are available for the Garnet landscape (priority 2 landscape), which includes the Little Blackfoot watershed, and are available to riparian habitat projects on both priority and non-priority streams. In addition, NRDP terrestrial funds may be used for land acquisition for conservation easements.

In 2015, Trout Unlimited secured funding through the **Tiffany and Co. Foundation Responsible Mining** grant program to help fund a full time staff person to work on restoration efforts throughout the Little Blackfoot watershed, with a focus on abandoned mines reclamation.

The *UCFRP* developed a preliminary estimate of **$3.4 million** to implement the proposed actions to address riparian habitat, water quantity, fish passage, fish entrainment, streambank and channel reconstruction, and data gaps for the priority 1 and 2 streams in the Little Blackfoot watershed.

3.4.1 Technical assistance

Collaboration between government agencies, private organizations, and local landowners will be required to leverage funds and accomplish projects. There are a number of conservation partners in the Upper Clark Fork who have worked on Little Blackfoot watershed restoration efforts thus far, including Watershed Restoration Coalition of the Upper Clark Fork, Clark Fork Coalition, Trout Unlimited, Deer Lodge Conservation District, Helena NF, NRCS, MT DNRC, DEQ, MT FWP, NRDP, and EPA, among others. Local landowner efforts will be instrumental to the implementation of this WRP. The Trout Unlimited staff person dedicated to riparian restoration efforts and mine reclamation in the Little Blackfoot will play an important technical role in generating funding and coordinating efforts to achieve restoration goals.

3.5 EDUCATION AND OUTREACH

Throughout this planning process, we have engaged both public and private stakeholders for input regarding desired future conditions in the watershed and possible restoration projects to include in this plan. Planning entities included the Helena NF, DEQ, MT FWP, NRDP, DLVCD, TU, WRC, and landowners throughout the watershed. As this WRP is implemented, updated and adapted over time, this collaborative process will continue and other parties not currently involved are encouraged to join.

Education and involvement of the local community will be important to garner support for project implementation on public lands and to establish willing partners to participate in best management practices on private land. Efforts such as the **Little Blackfoot River Irrigation Demonstration Project** serve as way to educate landowners and irrigators throughout about water quality and fish passage issues and provide a tangible example of restoration projects that are mutually beneficial to the watershed and to the landowners. Future projects may follow a similar example to gain support.

Other outreach efforts will include:

- Attendance and presentations at the DLVCD to communicate project updates and solicit input.
- Attendance of WRC board meetings to coordinate planning efforts.
- Hosting tours of projects for partners and the public.
- Working with local watershed education groups to develop a volunteer monitoring program and engage local students and community members to participate.

- Distribute information regarding upcoming projects, workshops and volunteer days at community centers in Avon and Elliston.
- Keeping up to date with posting online resources on relevant websites.
- Providing technical assistance to landowners interested in participating in restoration projects, such as a BMP training workshop.
- One on one contact with private landowners.

3.6 Stream Summaries and Implementation Schedule

This section describes in detail each waterbody impaired by sediment, nutrient, and/or non-pollutant impairments and highlights the highest restoration needs, current projects, project partners, and planned implementation dates of upcoming projects. Restoration activities are meant to be realistic goals, and as such are recommended in the context of existing constraints, such as presence of infrastructure and present land use activities.

Little Blackfoot River (Upper – headwaters to Dog Creek)

Highest priority restoration needs: Reduce channelization by roads, reduce sediment inputs from roads, reduce grazing pressure along banks, increase native riparian vegetative cover.

Current Projects addressing needs:

- *Golden Anchor Bridge*. Installing a bridge on what was an unimproved ford crossing (NFS Road #4100)Removal of a high-impact segment of road within the floodplain (Helena NF, MT DNRC – **planned implementation 2015**)
- *Divide Travel Plan*. Will close some high-risk roads (Helena NF – **planned implementation 2015**)
- *Telegraph Vegetation Project.* Harvest and removal of hazardous fuels on 23,669 acres in Telegraph Cr. Drainage; closing and decommissioning of roads. (Helena NF – **planned implementation 2016**)
- *Blackfeet No. 1 Mine Reclamation Project.* Will reduce sediment input to Little Blackfoot River through removal of mine waste and streambank reconstruction (TU – **planned implementation 2017**)

Potential future projects:

- *Little Blackfoot Meadows Trail Bridge*. Puncheon bridge to address a widened trail crossing (Helena NF).
- Work with private landowners on grazing management plans
- Establish conservation easements on high-functioning reaches
- Sediment reductions as components of mine reclamation work

Completed Projects: None at this time.

Little Blackfoot River (lower – Dog Creek to mouth)

Highest priority restoration needs: Increase year-round flows, increase native riparian vegetative cover, reduce haying along banks, reduce grazing pressure along banks, eliminate fish entrainment in irrigation diversions.

Current Projects addressing needs:

- *Landowner outreach*. Engagement of landowners to gain cooperation, assess restoration possibilities, and promote potential projects (NRDP, WRC, TU – **2015-2017**).

Potential future projects:

- Work with private landowners on grazing management plans.
- Engage Burlington Northern Sante Fe railroad regarding opportunities to mitigate impacts of railroad infrastructure in the floodplain
- Install fish screens on irrigation diversions.
- Establish conservation easements on high-functioning reaches.

Completed projects:

- *Little Blackfoot Irrigation Demonstration Project.* Improved an irrigation diversion to ensure year-round upstream fish passage, improved control of water withdrawal, reduced diversion maintenance, and provide a demonstration site for other irrigators in the watershed (TU, DLVCD, MT DNRC, landowner – **2014)**
- *Flow monitoring.* Flow studies assessed water levels along the lower Little Blackfoot River, including impacts of irrigation diversions (**2006-2007** – NRDP, Pat Barnes Chapter TU, MT Water Trust).
- *Little Blackfoot River channel restoration project.* Streambank bioengineering using vegetated soil lifts and log vanes, habitat creation, riparian plantings, weed removal, and grazing exclusions along a 1.9 mile stretch of the Little Blackfoot River upstream of Elliston (**2009** – NRDP, DLVCD, MT FWP, NRCS, MNWTF).

Telegraph Creek (upper)

Highest priority restoration needs: Restore channel disturbances associated with mining, decrease sediment inputs from high-density of unpaved roads

Current Projects addressing needs:

- *Lilly/Orphan Boy Mine Reclamation:* Remove waste rock and tailings piles sitting in stream channel, rebuild and revegetate streambanks (TU, Helena NF, DNRC, DLVDC – **2017**)
- *Telegraph vegetation project*. Recover economic value of dead and dying wood, reduce hazardous fuels, promote desirable regeneration, maintain diverse wildlife habitats, and decommission roads. (Helena NF **-- 2016**)
- *Divide travel plan* – Address road network (**2016** – Helena NF)

Potential future projects:

- Continue to work on abandoned mines reclamation
- Reduce road density and make improvements to high-risk roads.

Completed Projects: None at this time.

Elliston Creek

Highest priority restoration needs: Increase year-round flows, reduce grazing pressure along creek, improve overhead vegetative cover.

Current Projects addressing needs: None at this time.

Potential future projects:

- Work with private landowners on grazing management plans.
- *Divide Travel Plan*: Proposed roadwork to improve FS #314

Completed projects: None at this time.

Trout Creek

Highest priority restoration needs: Increase woody vegetation in riparian zone, improve bank stability.

Current Projects addressing needs: None at this time.

Potential future projects:

- Work with private landowners on grazing management plans.

Completed projects: None at this time.

Spotted Dog Creek (lower)

Highest priority restoration needs: Reduce grazing pressure in riparian zone, increase native riparian vegetative cover and LWD presence to provide for habitat, increase year-round flow levels, improve bank stability.

Current Projects addressing needs:

- *Landowner outreach*. Engagement of landowners to gain cooperation, assess restoration possibilities, and promote potential projects (NRDP, WRC, TU – **2015-2017**).
- *Cross Canyon Ranch.* Improvement of irrigation diversions and offstream watering to improve agricultural practices and fisheries/riparian habitat (NRDP, WRC, TU – 2016)

Potential future projects:

- Work with private landowners on grazing management plans and riparian fencing projects.
- Establish conservation easements on high-functioning reaches.
- Install fish screens on irrigation diversions.
- Manage noxious weeds.

Completed projects:

- *Spotted Dog Acquisition*. 26,616 acre purchase to create a Wildlife Management Area (NRDP, MT FWP – **2010**).

Dog Creek

Highest priority restoration needs: Reduce grazing pressure in riparian zone, increase riparian vegetative cover, reduce sediment inputs from the road, restore floodplain connectivity, remove streamside tailings.

Current Projects addressing needs: None at this time.

Potential future projects:

- Address channelization due to presence of the railroad
- Engage Burlington Northern Sante Fe railroad regarding opportunities to mitigate impacts of railroad infrastructure in the floodplain
- Work with private landowners on grazing management plans and riparian fencing projects.

- *Divide Travel Plan*: Proposed roadwork to improve FS road #571 & #1855
- Establish conservation easements on high-functioning reaches.

Completed projects:

- *Schatz Ranch Conservation Easement*. 1,500 acres (Vital Ground, Prickly Pear Land Trust --**2008**)

Snowshoe Creek

Highest priority restoration needs: Increase riparian vegetation cover, improve bank stability, restore floodplain connectivity, eliminate fish entrainment in irrigation diversions, improve upstream fish passage.

Current Projects addressing needs:

- *Landowner outreach*. Engagement of landowners to gain cooperation, assess restoration possibilities, and promote potential projects (NRDP, WRC, TU – **2015-2017**).
- *Snowshoe Ranch.* Improvement of irrigation diversions and offstream watering to improve agricultural practices and fisheries/riparian habitat (NRDP, WRC, TU – 2016)

Potential future projects:

- Work with private landowners on grazing management plans.
- *Divide Travel Plan*: Proposed road improvements to FS Road #78
- Establish conservation easements on high-functioning reaches.
- Install fish screens on irrigation diversions; relocate diversions that are upstream fish barriers.
- Address road encroachment on channel.
- Remove dredge tailing piles.

Completed projects: None at this time.

Carpenter Creek (lower)

Highest priority restoration needs: Restore mining-altered channel morphology, remove placer tailings piles along channel, increase year-round flows, improve upstream fish passage.

Current Projects addressing needs: None at this time.

Potential future projects:

- Work with private landowners on grazing management plans.

Completed projects: None at this time.

Threemile Creek (lower)

Highest priority restoration needs: Reduce trampling of banks and channel, increase year-round flows, create more pool habitat.

Current Projects addressing needs: None at this time.

Potential future projects:

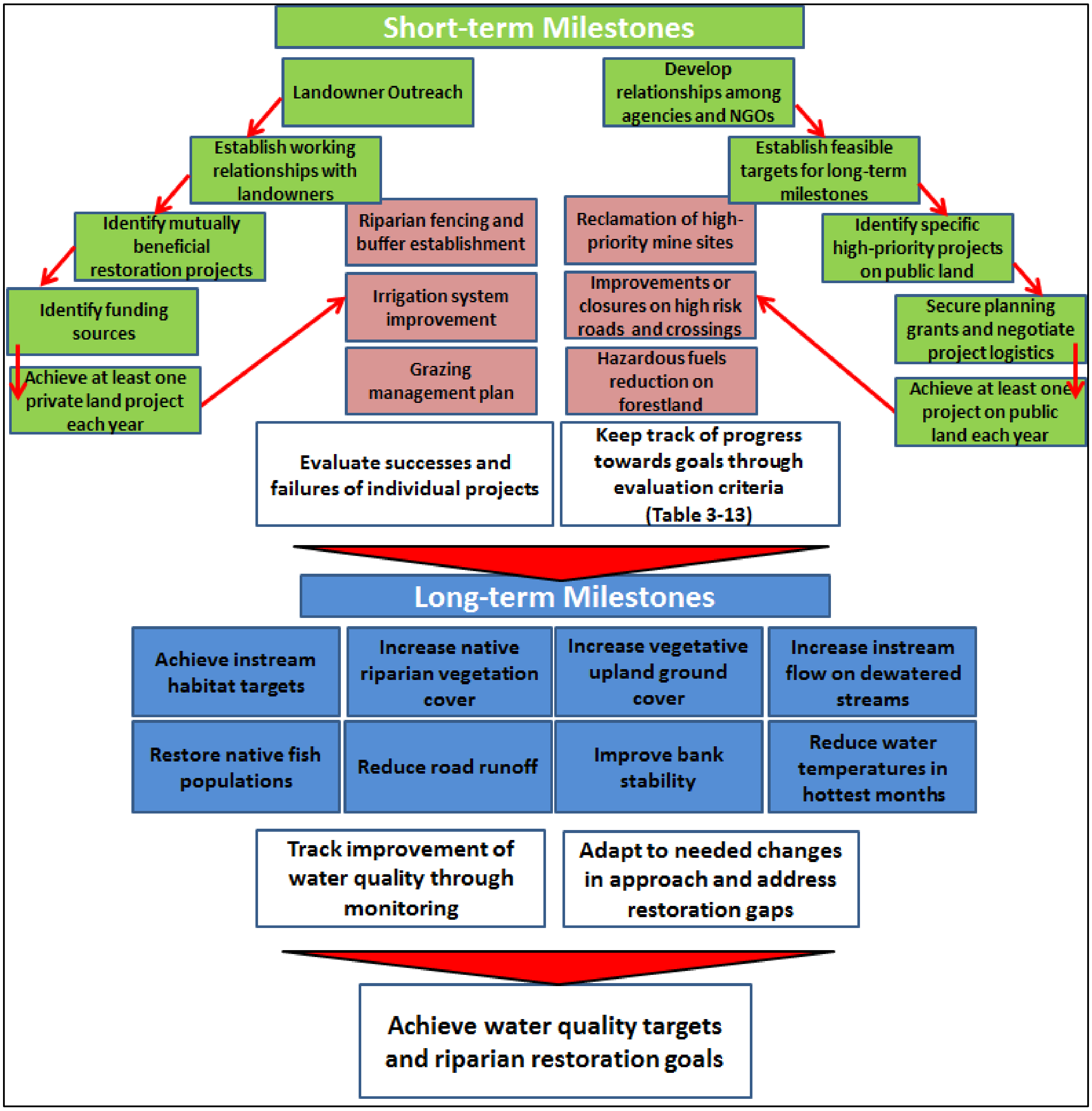
- Work with private landowners on grazing management plans.

Completed projects: None at this time.

3.7 Interim milestones and Criteria/Evaluation Procedures

Milestones are individual steps towards achieving the ultimate restoration goals. Setting milestones is important because of the extremely wide scope of watershed-scale restoration. Bringing the focus towards smaller, measurable objectives helps involved parties stay on task while working towards achieving big picture changes throughout a watershed. A pathway to achieving water quality targets is laid out in Figure 3 below. Short-term milestones (green boxes) should be achievable on a yearly basis starting immediately, while long-term milestones (blue boxes) may take 10+ years to achieve (2025 and beyond). This framework is not linear, but rather a continual process, and requires regular evaluation to assess if projects are helping to achieve water quality and restoration goals. Strategies should be adapted based on new information, stakeholder involvement, and lessons learned through project implementation.

Figure 3. Pathway towards achieving restoration and water quality goals in the Little Blackfoot watershed. Short term milestones (in green) should be achieved on a rolling basis each year, working towards to the long-term milestones (in blue). Example high-priority projects are listed in red. Progress towards achieving water quality and other restoration goals must be evaluated to ensure projects are working towards targets.



Evaluation criteria can help various partners track progress towards achieving long term milestones. At this point, establishing quantitative goals (e.g., 50 miles of riparian fencing installed by 2020) is not necessarily helpful given that watershed-wide restoration planning for the Little Blackfoot is in its infancy and the great uncertainties regarding time requirements for project implementation. However, the evaluation criteria listed in Table 3-13 is a general tool to track work throughout the watershed over the next 5 to 10 years to see if there are gaps that need to be addressed in project work. For example, in 10 years one might find that while numerous grazing management plans have been implemented, little has been done to improve the transportation network, and thus more effort must be put towards transportation projects. In the future (perhaps by 2025) it will be possible to establish quantitative targets for the following 10 year time period, given what we have learned during this early period. At this point we can also evaluate if this pathway is effective – are we restoring beneficial uses throughout the watershed? If not, what about our approach needs to be changed? Based on our evaluation criteria, where are we missing our mark?

Table 3-13. Evaluation criteria for tracking restoration progress.

Project category	Evaluation criteria
Grazing management	• Miles of riparian fencing installed • Number of landowners participating in grazing management strategies • Number of improved livestock crossings • Number of off-stream water sources installed
Crop production	• Acres of vegetative ground cover • Number of BMPs installed to filter pasture runoff
Streambank and aquatic habitat recovery	• Miles of improved floodplain functionality • Miles of reconstructed channel • Fish habitat scores throughout sample reaches • Water temperature throughout sample reaches • Composition and abundance of the riparian vegetative community
Forestry	• Acres of forestland treated for fuels reduction and insect management.
Transportation	• Miles of high-risk roads improved • Number of stream crossings improved or closed to motorized use • Number of culverts replaced or upgraded
Irrigation and drought response	• Discharge in streams during hottest months • Number of irrigation efficiency projects implemented • Number of diversions screened to reduce fish entrainment • Number of fish passage barriers removed • Number of consolidated diversions
Developed areas	• Adherence to stormwater permitting regulations • Number of BMPs installed to filter/reduce stormwater runoff
Protection	• Acres of land set aside in conservation easements or other forms of long-term protection

3.8 MONITORING

Agencies and organizations other than DEQ may assist with monitoring, but should follow the standardized protocols discussed below so that results can be compared and progress towards goals tracked over time. Two types of monitoring should be addressed throughout the implementation of this WRP: effectiveness monitoring and trend monitoring. Effectiveness monitoring evaluates the effects of implemented management measures and can be used to determine if these measures have been or will be successful at achieving restoration goals (Mulder et al., 1999). Trend monitoring, on the other hand, is used to better understand the impairment status of the watershed and existing conditions.

3.8.1 Effectiveness monitoring

Effectiveness monitoring will depend on the collaborative efforts of various stakeholders who implement restoration projects throughout the watershed. Any projects carried out should be well-documented, both before and after implementation. Methods to determine the effectiveness of newly installed BMPs will vary for sediment and nutrients, especially because nutrient levels in a stream segment can be assessed with a water quality sample, while sediment lacks a numeric standard and sediment within a stream is the result of cumulative upstream inputs. More importantly, it may not always be feasible, practical, or informative to measure sediment or nutrient loads after project implementation. Rather assessing achievement of direct goals (i.e., "Did the installed fence reduce bank erosion?" , or, "Do the cattle utilize the offstream water source?") will be more realistic to measure rather than if the project contributed to pollutant load reductions. Effectiveness monitoring will likely also include some subjective measures, such as photopoint documentation (e.g., installing a riparian fence and tracking vegetation establishment overtime). Installed BMPs should be revisited frequently, especially after significant flow events.

3.8.2 Trend monitoring

Trend monitoring can assess how watershed conditions are changing over time and if cumulative effects of restoration project are helping to meet TMDLs. Monitoring should follow the Sampling and Analysis Plan (SAP) originally utilized when existing stream conditions were assessed during the TMDL process (PBS&J, 2008). Field techniques for sediment monitoring follow the Water Quality Planning Bureau Field Procedures Manual for Water Quality Assessment Monitoring (DEQ, 2012). These techniques and extrapolation methods are detailed in the *LBFTMDL* (Appendix C) and are summarized in Table 3-14 below. Nutrient monitoring should follow *Assessment Methodology for Determining Wadeable Stream Impairment due to Excess Nitrogen and Phosphorus Levels* (DEQ, 2011); target values for nutrients and environmental indicators of nutrients are listed in Table 3-14 below.

Additionally, TU and CFC have recently partnered with the USFS to implement **environmental DNA (eDNA) monitoring** throughout the watershed (Thomsen and Willerslev, 2015). This effort involves filtering water samples at 1km intervals along streams whose gradient and elevation are indicative of bull trout habitat. Filters are then analyzed for genetic markers to determine presence/absence of a species of interest in a given waterbody. While the 2015 the samples will be analyzed for bull trout, filters collected this year will be stored and can be analyzed in the future for additional genetic markers of other species. Future eDNA sampling can allow for assessments of changes in species presence over time.

Table 3-14. Field methods to monitor sediments and target values for environmental indicators of sediment.

Parameter	Indicators	Target	Field Measures
Fine sediment	Percentage of fine surface sediment in riffles via pebble count (reach average)	Comparable with reference values for the appropriate Rosgen stream type	Riffle Wolman pebble count Riffle grid toss Pool tail-out grid toss Riffle Stability Index
	Percentage of fine surface sediment < 6 mm in riffles and pool tails via grid toss (reach average)	≤ 9% for B/C streams ≤ 21% for E streams	
Channel form and stability	Bankfull width to depth ratio (reach median)	B stream types with bankfull width < 30 ft: < 16 C stream types with bankfull width < 30 ft: < 23 C stream types with > 30 ft bankfull width: < 35 E stream types: < 8	Field determination of bankfull Channel cross sections Floodplain width measurements Water surface slope
	Entrenchment ratio (reach median)	B stream types: > 1.4 C stream types: > 3.2 E stream types: > 3.7 C stream types with > 30 ft bankfull width : > 3.8	
Instream habitat	Residual pool depth (reach average)	< 15 ft bankfull width : > 0.9 ft 15 – 30 ft bankfull width : > 1.4 ft > 30 ft bankfull width : > 1.4 ft	Channel bed morphology Residual pool depth Pool habitat quality Woody debris quantification
	Pools/mile	< 15 ft bankfull width : ≥ 90 15 – 30 ft bankfull width: ≥ 52 > 30 ft bankfull width : ≥ 15	
	LWD/mile	< 15 ft bankfull width : ≥ 222 15 – 30 ft bankfull width : ≥ 186 >30 ft bankfull width : ≥ 122	
Riparian health	Percent of streambank with understory shrub cover (reach average)	≥ 40% understory shrub cover (where potential exists) ≥ 10% understory shrub cover for conifer-dominated reaches	Riparian greenline assessment
Macro-invertebrates	Multi-metric index (MMI) Observed/expected Model (O/E)	Mountain MMI: ≥ 63 Low Valley MMI: ≥ 48 O/E: ≥ 0.80	Macroinvertebrate bioassessment

Table 3-15. Nutrient measurement parameters and targets for the Little Blackfoot watershed.

Parameter	Target
Nitrate + Nitrite ($NO_3 + NO_2$)	≤ 0.100 mg/L
Total nitrogen (TN)	≤0.300 mg/L
Total phosphorus (TP)	≤0.03 mg/L
Chlorophyll-α (or ash free dry weight)	≤120 mg/m^2 (≤35 AFDW/m^2)

3.8.2.1 Data gaps and further research needs

The *LBFTMDL* and *2014 Assessment* identify a number of data gaps that up until this writing have yet to be addressed. Source assessments for nutrients and sediments were largely determined by models and as such only represent a general understanding of pollutant sources. More thorough sampling and field assessments to identify the specific "on the ground" source areas within each tributary will help determine where implementation of management measures will be most effective at achieving TMDLs. Some examples of data needs that future research efforts should address are listed below. See the *LBFTMDL* section 10.4.1 and 10.4.2 for detailed descriptions of data refinement needs.

- ***Culverts:*** Only 15 culverts were assessed in the TMDL process, therefore the remaining culverts need to be assessed for effectiveness and fish passage. A priority list of culverts in need of repair or replacement would help focus efforts on road crossings in need of improvements.
- ***Geology:*** Historical mining impacts on nutrient inputs should be investigated, especially with regards to the underlying phosphoria formation and its contribution to phosphorus loads.
- ***Irrigation*****:** We have a limited understanding about the irrigation network throughout the watershed and a thorough investigation of opportunities for improvements in irrigation efficiency would be very useful for drought management.
- ***Flow:*** The *2014 Assessment* was completed when flows were at bankfull and the irrigation diversions were not active, therefore all reaches appeared to have sufficient flows. A more thorough evaluation of where dewatering might occur and potential effects of dewatering is necessary.
- ***Septic*****:** The contribution of septic systems to nutrient loading should be further investigated, particularly in segments with nearby septic systems and elevated nutrient concentrations that cannot be explained by other sources.
- ***Temperature:*** While no stream segments in the Little Blackfoot watershed are listed for temperature impairments, existing data (Liermann et al., 2009; Lindstrom et al., 2008) indicate that temperatures in the Little Blackfoot River may exceed fish tolerances during the summer. The *LBFTMDL* suggests that "existing data be reviewed and additional data

be collected if necessary to fully evaluate temperature conditions and sources within the Little Blackfoot River watershed" (DEQ and EPA, 2011).

- ***Macroinvertebrates:*** Macroinvertebrate data is sparse throughout the watershed and additional sampling is recommended for all listed reaches.
- ***Trout Creek:*** Trout Creek has never been formally assessed for beneficial use support, but was included in the *LBFTMDL* due to stakeholder consensus of existing ecological problems.
- ***Threemile and Carpenter Creek:*** More nutrient data needed. Total and dissolved phosphorous should be monitored during the growing and non-growing season in multiple locations within the Threemile Creek watershed to better evaluate phosphorus sources, especially the geologic contribution.
- ***Dispersed camping:*** A comprehensive inventory of dispersed camp sites that pose high risks to riparian areas has only been implemented in Upper Little Blackfoot River, Ontario Creek, and Telegraph Creek. A further investigation of diverse campsites in other areas would assist future travel planning as it relates riparian health and sediment reduction.

References

Baum-Hailey, M. (Ed.), 2014. Landscape Irrigation Best Management Practices. Irrigation Association and American Society of Irrigation Consultants.

Belsky, A.J., Blumenthal, D.M., 1997. Effects of livestock grazing on stand dynamics and soils in upland forests of the Interior West. Conservation Biology 11, 315–327.

Berkas, W.R., White, M.K., Ladd, P.B., Baily, F.A., Kent, A., 2005. Water Resources Data, Montana, Water Year 2005: Volume 2, Yellowstone and Upper Columbia River Basins and Ground-Water Levels. U.S. Geological Survey.

Błędzki, L.A., Bubier, J.L., Moulton, L.A., Kyker-Snowman, T.D., 2011. Downstream effects of beaver ponds on the water quality of New England first- and second-order streams. Ecohydrology 4, 698–707. doi:10.1002/eco.163

Buck, Stuart and Gerard, David. 2001 *Cleaning up Mining Waste*. Political Economy Research Center: Research Study 01-1 – November 2001. Retrieved 5/20/14 from: http://perc.org/sites/default/files/rs01_1.pdf

CDM, 2004. Erosion and sediment control Best Management Practices: Reference manual. Montana Department of Transportation.

Colorado Department of Natural Resources (CDNR). 2002. *Best Practices in Abandoned Mine Land Restoration: The Remediation of Past Mining Activities*. Colorado Dept. of Natural Resources, Division of Minerals and Geology, Denver, CO. Retrieved 3/13/2014 from: http://mining.state.co.us/bmp.pdf

DEQ, 1995. Priority Abandoned Hard Rock Mine Sites Summary Report. 9 Priority Sites Powell to Yellowstone. Montana Dept. of Environmental Quality, Helena, MT.

DEQ, 2010. Final water quality integrated report and 303(d) list. Montana Dept. of Environmental Quality, Helena, MT.

DEQ, 2012. Montana Nonpoint Source Management Plan. Montana Dept. of Environmental Quality, Water Quality Planning Bureau, Helena, MT.

DEQ, EPA, 2011. Little Blackfoot River Watershed TMDLs and framework water quality improvement plan. Montana Dept. of Environmental Quality; U.S. Environmental Protection Agency, Region 8, Helena, MT.

DEQ. Stormwater management during construction field guide for Best Management Practices. Montana Dept. of Environmental Quality. Helena, MT.

DEQ. 1995. *Priority Abandoned Hard Rock Mine Sites Summary Report*. 9 Priority Sites Powell to Yellowstone. Montana Dept. of Environmental Quality, Helena, MT.

DEQ, 2009. Longitudinal Field Methods for the Assessment of TMDL Sediment and Habitat Impairments. Montana Dept. of Environmental Quality, Helena, MT.

DEQ, 2011. Assessment Methodology for Determining Wadeable Stream Impairment due to Excess Nitrogen and Phosphorus Levels. MT Department of Environmental Quality. Helena, MT.

DEQ. 2013. *DEQ-MWCB Priority Site List: DEQ Prioritized Short List of AML Sites.* October 9, 2013. Helena, MT: Montana Dept. of Environmental Quality. Retrieved from: http://deq.mt.gov/AbandonedMines/priority.mcpx

DEQ. 2014. *Hazardous Waste Site Cleanup Bureau*. Helena, MT: Montana Dept. of Environmental Quality; Remediation Division. Retrieved 5/14/2015, from http://deq.mt.gov/rem/hwc/default.mcpx

DEQ-AML. 2014. *Project Costs: Updated March 2014*. Helena, MT: Montana Dept. of Environmental Quality; Abandoned Mine Lands. Retrieved 6/27/2014.

DNRC, 1999. Montana Best Management Practices for Grazing: Montana. Conservation Districts Bureau, DNRC, Helena, MT.

DNRC, 2015. Montana State Water Plan: A watershed approach to the 2015 Montana State Water Plan. Helena, MT.

DNRC. 2014. *Conservation and Resource Development: Grant and Loan Program*. Helena, MT: Dept. of Natural Resource Conservation. Retrieved 07/28/14 from: http://www.dnrc.mt.gov/cardd/LoansGrants/Default.asp

EPA, 2007. National Management Measures to Control Nonpoint Source Pollution from Hydromodification. US Environmental Protection Agency, Office of Water.

EPA, 2012. *Green Remediation Best Practices: Mining Sites*. U.S. Environmental Protection Agency: Office of Solid Waste and Emergency Response (5102G). Retrieved 06/18/14 from: http://cluin.org/greenremediation/docs/GR_factsheet_miningsites.pdf

Geum, River Design Group, 2014. Little Blackfoot River Riparian Assessment. Geum Environmental Consulting, Inc., Hamilton, MT.

Gibson, K., 2007. Bark beetle conditions 2007 Northern Region. USDA Forest Service, Forest Health Protection, Missoula Field Office, Missoula, MT.

Hargrave, Phyllis A, Tom P. Bowler, Jeff D. Lonn, James P. Madison, John J. Metesh, Robert Wintergerst. 1998. Abandoned Inactive Mines of the Blackfoot and Little Blackfoot River Drainages. Helena National Forest, Volume II. Open File Report 368, Montana Bureau of Mines and Geology.

Helmers, M.J., Isenhard, T.M., Dosskey, M.G., Dabney, S.M., Strock, J.S., 2008. Buffers and vegetative filter strips, in: Agricultural and Biosystems Engineering Publications. American Society of Agricultural and Biological Engineers.

Hubbard, R.K., Newton, G.L., Hill, G.M., 2004. Water quality and the grazing animal. Journal of Animal Science 82, E255–E263.

ITRC. 2010. *Technology Overview: Constructed Treatment Wetland.* Washington, DC: Interstate Technology & Regulatory Council Mine Waste Team, August 2010.

Kerber Creek Watershed Management Plan (WMP). 2012 Kerber Creek Restoration Project, Draft Restoration Plan, Colorado. Received 2/15/14 via e-mail from ERussell@tu.org.

Land & Water Consulting, 2002. Little Blackfoot River Physical Features Inventory and Riparian Assessment. Land & Water Consulting, Inc., Helena, MT.

Lawrence, P., Atkinson, E., 1998. Deposition of fine sediments in irrigation canals. Irrigation and Drainage Systems 12, 371–385. doi:10.1023/A:1006156926300

Liermann, B., Lindstrom, J., Kreiner, R., 2009. An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin: Phase II. Montana Fish Wildlife and Parks.

Limerick, P.N., Ryan, J.N., Brown, T.R., and Comp, T.A, 2005. *Cleaning Up Abandoned Hardrock Mines in the West: Prospecting for a Better Future.* Boulder, CO: Center of the American West; University of Colorado at Boulder.

Lindstrom, J., Liermann, B., Kreiner, R., 2008. An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin. MT Fish, Wildlife and Parks.

Littman, Nick and Roberts, Rob. 2013. *Watershed Restoration Plan for the Ninemile Creek TMDL Planning Area*. Missoula, MT: Trout Unlimited.

Logan, R., 2001. Water Quality BMPs for Montana Forests. Montana State Univeristy Extension Service, Bozeman, MT.

MBMG, 2005. Interactive mine dataset.

McCullough, R., 2012. Mines and exploration in Montana [WWW Document]. URL http://www.mbmg.mtech.edu/gmr/gmr-mines_exploration.asp (accessed 8.7.14).

MT DNRC, 2006. Montana guide to the Streamside Management Zone law and rules. Montana Department of Natural Resources and Conservation, Missoula, MT.

Mulder, B.S., Noon, B.R., Spies, T.A., Raphael, M.G., Palmer, C.J., Olsen, A.R., Reeves, G.H., Welsh, H.H.J.;, 1999. The strategy and design of the effectiveness monitoring program for the Northwest Forest Plan. (USDA Forest Service General Technical Report No. PNW-GTR-437). Pacific Northwest Research Station.

NRDP, 2012. Final Upper Clark Fork River Basin Aquatic and Terrestrial Resources Restoration Plans. Montana Dept. of Justice National Resource Damage Program, Helena, MT.

Oaks, Hans. 2014. *Upper Little Blackfoot River Mine Sites (Vicinity – SE of Elliston, MT)*. Minerals & Geology and Abandoned Mine Lands Program, Helena National Forest, Region 1, USFS.

Ockey, Mark. 2011. Cooke City TMDL Implementation Evaluation. Helena, MT: Montana Dept. of Environmental Quality.

PBS&J, 2008. Little Blackfoot River TMDL Planning Area Sediment Monitoring: Sampling and Analysis Plan. Bozeman, MT.

Pollock, M., Lewalen, G., Woodruff, K., Jordon, C., Castro, J. (Eds.), 2015. The Beaver Restoration Guidebook: Working with Beaver to Restore Streams, Wetlands, and Floodplains. United States Fish and Wildlife Service, Portland, Oregon.

Priscu, J.C., 1987. Factors regulating nuisance and potentially toxic blue-green algal blooms in Canyon Ferry Reservoir. Montana University System Water Resources Center, Montana State University, Bozeman, MT.

Saffell, P., Liermann, B., Lindstrom, J., Knotek, L., MT FWP, Mostad, T., Fox, C., NRDP, 2011. Prioritization of Areas in the Upper Clark Fork River Basin for Fishery Enhancement. Natural Resource Damages Program, Helena, MT.

Skousen, Jeff. 1992. *Anoxic Limestone Drains for Acid Mine Drainage Treatment*. Charleston, WV: West Virginia Surface Mining and Reclamation Association, Green Lands, p.30-35 Retrieved 6/28/14 from: http://www.wvu.edu/~Agexten/landrec/Anoxic_Limestone_Drains_for_AMD_Treatment_LD-F91.pdf

Staples, J.M., Gamradt, L., Stein, O., Shi, 2004. Recommendations for winter traction materials management on roadways adjacent to bodies of water. Montana Department of Transportation, Helena, MT.

Surber, G., K. Williams, and M. Manoukian. 2003. Drinking water quality for beef cattle: An environment friendly & production management enhancement technique. Montana State University, Natural Resources Informations & Publications, Bozeman, MT.

Thomsen, P.F., Willerslev, E., 2015. Environmental DNA – An emerging tool in conservation for monitoring past and present biodiversity. Biol. Conserv., Special Issue: Environmental DNA: A powerful new tool for biological conservation 183, 4–18. doi:10.1016/j.biocon.2014.11.019

USDA-NRCS, USGS, EPA, 2013. National Hydrography Dataset.

USFS, 2004. Helena National Forest Roads Analysis Report. USDA Forest Service, Helena, MT.

USFS, 2015. Divide Travel Plan Final Environmental Impact Statement. US Forest Service, Helena, MT.

USFS & FWP, 2013. Conservation Strategy for Bull Trout on USFS lands in Western Montana. USDA Forest Service.

USFWS, 2010. Revised Designation of Critical Habitat for Bull Trout in the Coterminous United States; Final Rule, Federal Register. Department of the Interior US Fish and Wildlife Service.

Wang Q.R. et al. *Soil contamination and plant uptake of heavy metals at polluted sites in China.* Journal of Environmental Science Health A Tox Hazard Subst Environ Eng. 2003 May;38(5):823-38. Wang QR[1], Cui YS, Liu XM, Dong YT, Christie P.

Westbrook, C.J., Cooper, D.J., Baker, B.W., 2006. Beaver dams and overbank floods influence groundwater–surface water interactions of a Rocky Mountain riparian area. Water Resour. Res. 42, W06404. doi:10.1029/2005WR004560

WHO, 2011. Nitrate and nitrite in drinking-water. World Health Organization.

APPENDIX A

Figure A.1. Roads which pose a high risk to water quality and fish habitat on USFS lands in the Little Blackfoot watershed (north half). *Map created by Helena National Forest*.

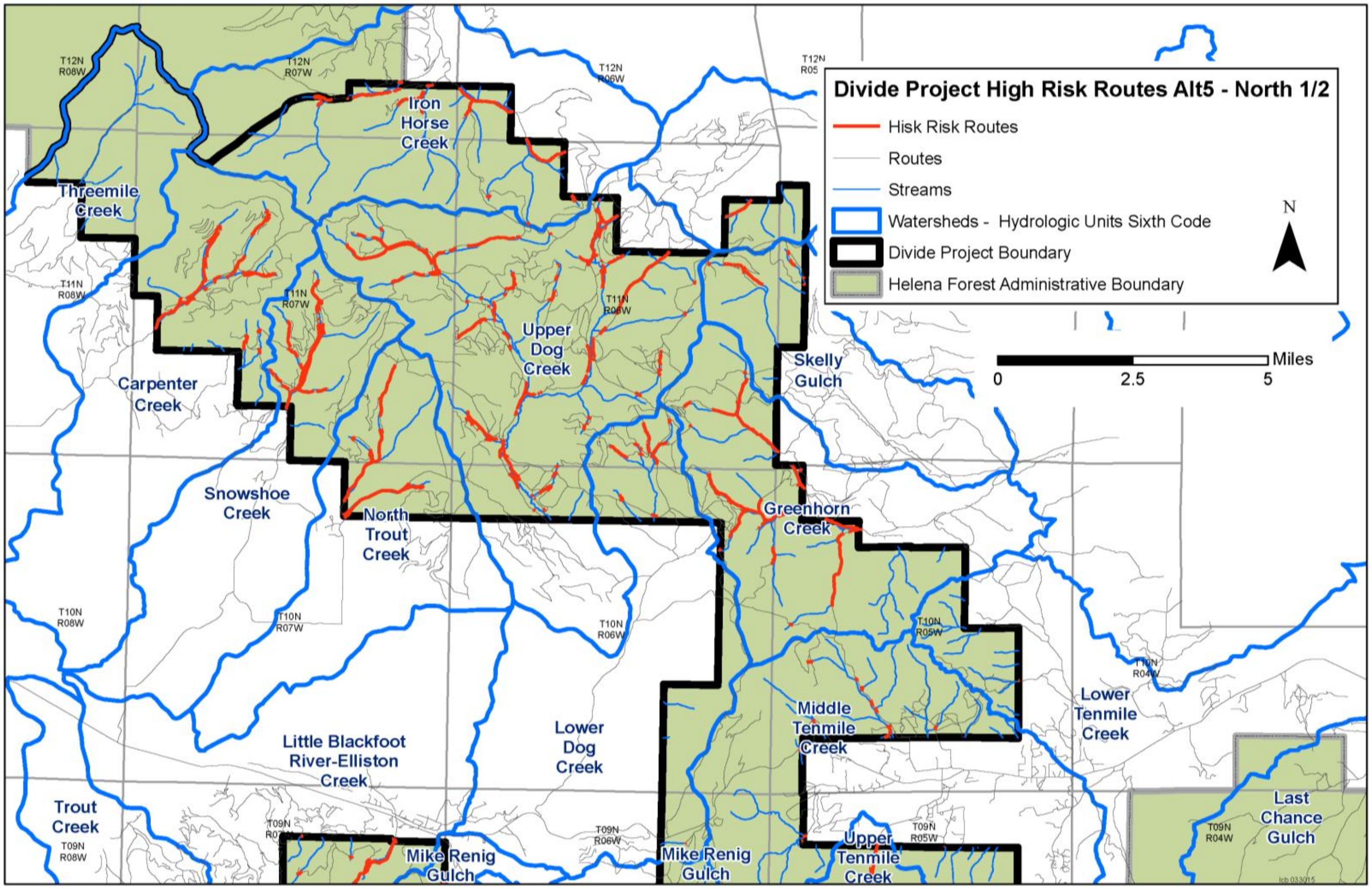
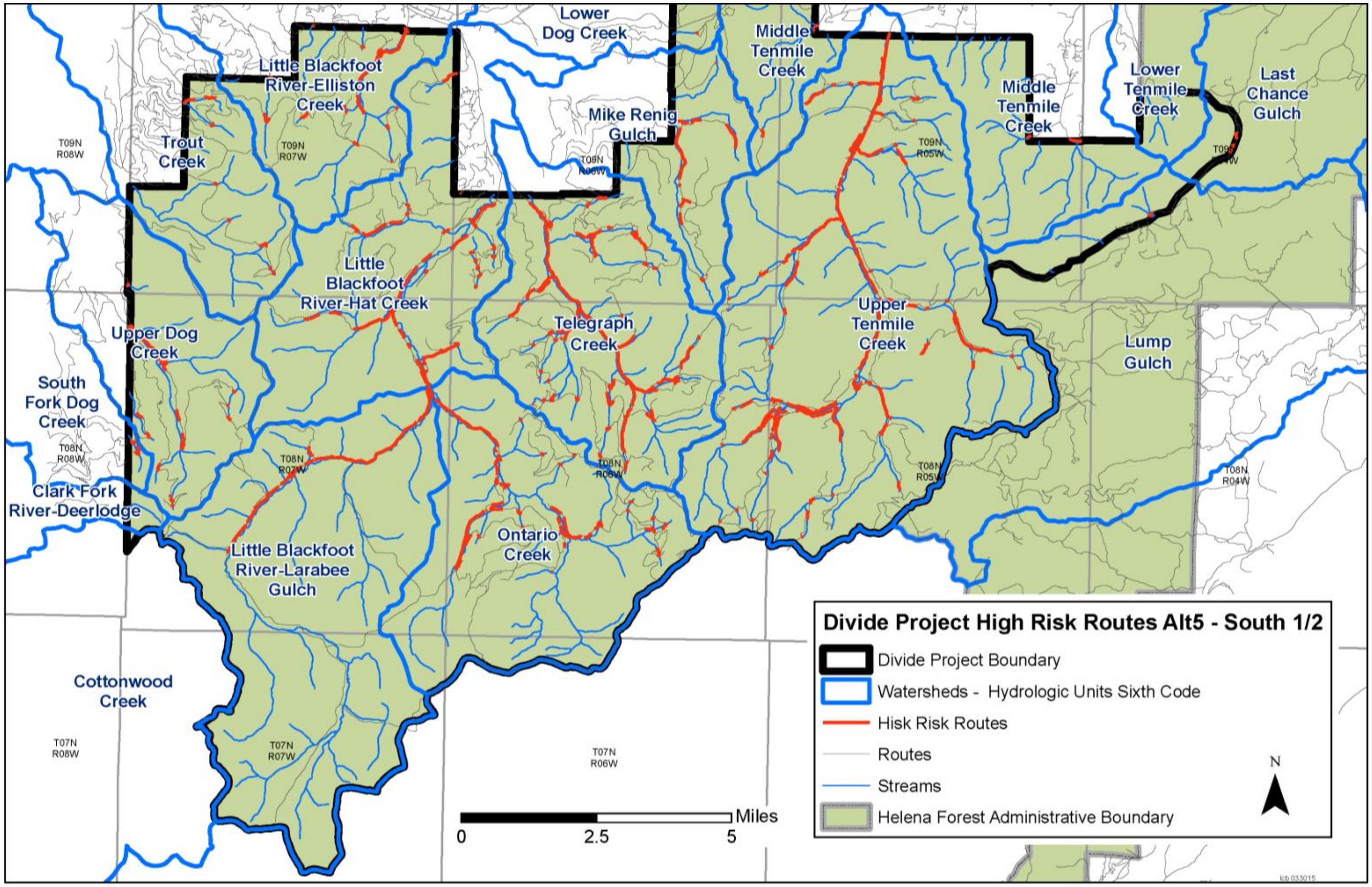


Figure A.2. Roads which pose a high risk to water quality and fish habitat on USFS lands in the Little Blackfoot watershed south half). *Map created by Helena National Forest.*



APPENDIX B: MINE RECLAMATION SUMMARIES

Multiple mine sites must be reclaimed to achieve the goals of the *LBFTMDL*. The following section summarizes the problems, load reductions, management measures, status, prioritization, and resources needed for each mine site addressed in this restoration strategy. All management measures can be fully or partially implemented.

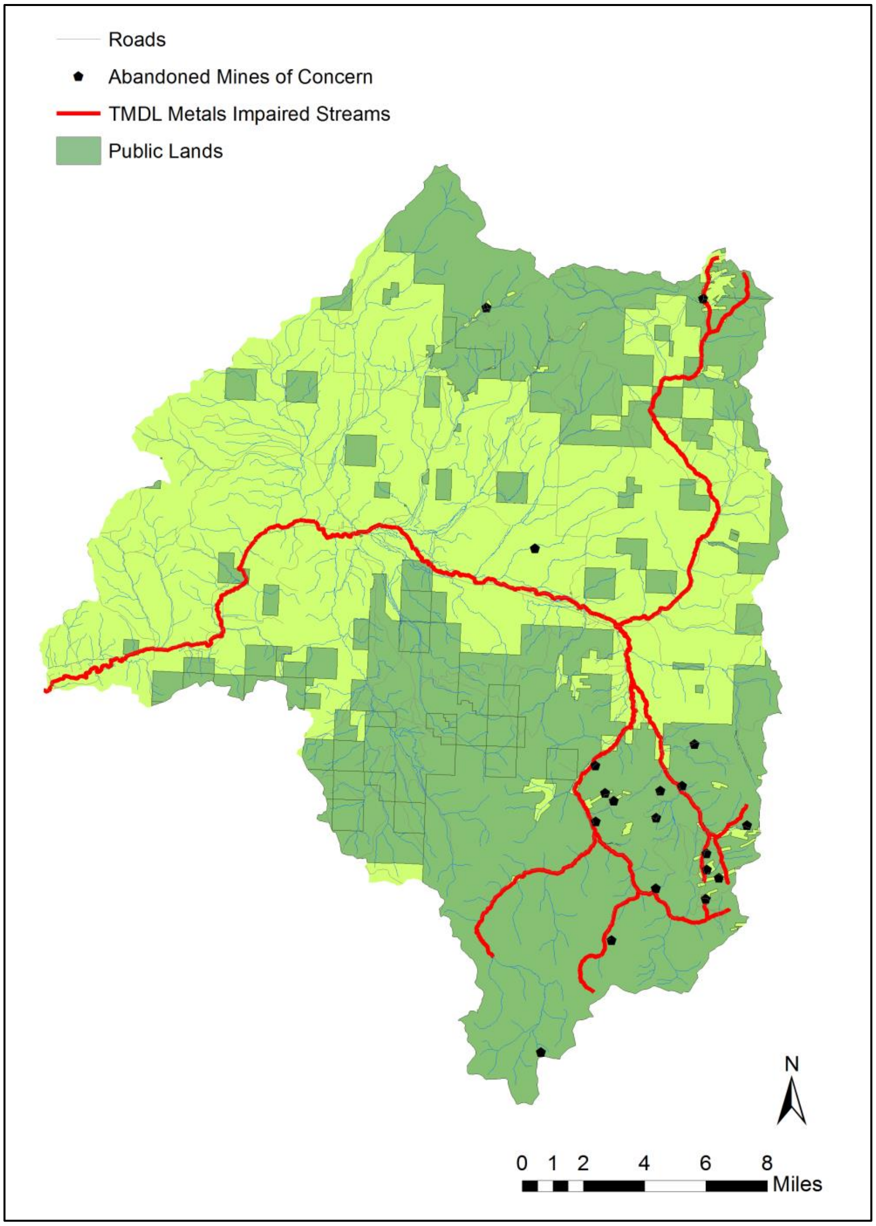


Figure 4. Mines in the Little Blackfoot watershed addressed in the Metals Restoration Strategy (DEQ, 1995; MBMG, 2005; USDA-NRCS et al., 2013) .

Julia Mine

Problem (Upper Telegraph Creek): The *LBFTMDL* listed Upper Telegraph Creek as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load reductions for Upper Telegraph Creek (from *LBFTMDL*):

arsenic: 0%	zinc: 26%
beryllium: 0%	lead: 61%
cadmium: 17%	aluminum: 46%
copper: 43%	

Management Measures: Waste rock (10,720 cy) removal could significantly decrease metals impairments from this site. One open adit exists that could be closed with a plug or gate. Removing the loadout structures or somehow restricting access could eliminate and reduce hazards at this site. After removing the large volume of waste rock, this area would need to be revegetated to return to a more natural state.

Status: No remediation efforts have been completed to date.

Priority Number: 1

Resources Needed: Engineering/Hydrology consulting, partnership with Helena National Forest

Costs: Over $1 million

Duration of Mitigation: Less than 1 year for initial implementation, with monitoring and maintenance in subsequent years

---

Third Term Mine

Problem (Upper Telegraph Creek): The *LBFTMDL* listed Upper Telegraph Creek as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load reductions for Upper Telegraph Creek (from *LBFTMDL*):

arsenic: 0%	zinc: 26%

beryllium: 0%	lead: 61%
cadmium: 17%	aluminum: 46%
copper: 43%	

Management Measures: This site has had initial restoration, but is in need of netting repair, and reinforcement of silt fencing. Additionally, low vegetation success occurred on the site, so the addition of top-soil and reseeding and weed removal could improve native vegetation.

Status: Helena National Forest plans to treat weeds at this site in 2014, but no further restoration efforts have been planned. In 2006, stabilization and in-place consolidation of mine waste took place, along with application of 56 tons of $CaCO_3$ and 2,700 square yards of turf matting over waste rock.

Priority Number: 2

Resources Needed: Partnership with Helena National Forest

Costs: Less than $1 million

Duration of Mitigation: Less than 1 year

Victory / Evening Star

Problem (Lower Little Blackfoot River): The *LBFTMDL* listed the lower Little Blackfoot River as impaired by metals for aquatic life, drinking water, and as a cold water fishery. Numerous mine sites exist in this sub-basin, but Victory/Evening Star is the only mine in this area on the DEQ priority mine site list.

Necessary Load Reductions needed for the Lower Little Blackfoot River (from *LBFTMDL*):

arsenic:	79%	aluminum: 3%
lead: 29%		

Management Measures: Although the diversion ditch was repaired in 2012, it requires maintenance. Additionally, noxious weed control is necessary at this site. Additional waste rock may be on site and needs further investigation and removal or consolidation if present. In 1993, the volume of waste rock was recorded at 8,300 cy. The adjacent road delivers sediment to the stream and should be addressed in a non-metals related restoration strategy.

Status: The forest service removed 1,224 bcy of in-drainage tailings and hauled it to the Luttrell Repository in 2005. A removal area diversion ditch was installed at the time and was repaired with riprap and fabric in 2012.

Priority Number: 3

Resources Needed: Engineering/hydrology consulting, partnership with private land owners

Costs: Less than $1 million

Duration of Mitigation: 1 year for initial waste rock removal and maintenance, then continual maintenance of diversion ditch in perpetuity.

Charter Oak

Problem (Upper Little Blackfoot River): The *LBFTMDL* listed the Upper Little Blackfoot River as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load Reductions needed for the Upper Little Blackfoot River (from *LBFTMDL*):

arsenic: 38%	cyanide: 48%
cadmium: 77%	lead: 92%
copper: 25%	aluminum: 21%

Management Measures: The removal of 3,000 bcy of remaining submerged tailings would help reduce metals impairments from this source and could be placed in the onsite repository. Additionally, the adit discharge collection cell must be continually maintained. There is a potential leak in the repository possibly due to a failure of interior grouting that must also be repaired.

Status: Numerous restoration efforts have taken place at Charter Oak from 1996 through 2011. These efforts include the placement of 18,400 cy of tailings, contaminated soil, waste rock, and debris in an onsite repository, closure of hazardous mine openings, and installation and repair of a discharge collection cell. The site still displays numerous problems, which are addressed above in the management measures.

Priority Number: 4

Resources Needed: Engineering/Hydrology consulting, partnership with Helena National Forest

Costs: over $1 million

Duration of Mitigation: less than 1 year for initial implementation of restoration, then maintenance of adit discharge cell in perpetuity

---

Anna R./Hattie M. Mine

Problem (Upper Telegraph Creek): The *LBFTMDL* listed Upper Telegraph Creek as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load reductions for Upper Telegraph Creek (from *LBFTMDL*):

arsenic: 0%	zinc: 26%
beryllium: 0%	lead: 61%
cadmium: 17%	aluminum: 46%
copper: 43%	

Management Measures: Removal of 2,230 cy of waste rock could significantly decrease metals impairments from this site. Additionally, setting up a passive treatment system for the one discharging adit at this mine site would help further reduce metals impairments. The hazardous structures and openings, which include one shaft, one loadout structure, and one collapsing cabin, must be either removed or closed. Lastly, revegetation will help restore this site to its natural state.

Status: No remediation efforts have been completed to date.

Priority Number: 5

Resources Needed: Engineering/Hydrology consulting, partnership with Helena National Forest

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial restoration, then monitoring and upkeep of passive adit treatment

---

Bald Butte Mine

Problem (Upper Dog Creek): The *LBFTMDL* listed Upper Dog Creek as impaired by metals for aquatic life and as a cold water fishery. Multiple mines exist in the area, and have been reclaimed as part of the Bald Butte/Great Divide restoration projects.

Necessary Load Reductions needed for Upper Dog Creek (from *LBFTMDL*):

arsenic:23%	cadmium: 62%
lead: 68%	copper: 0%
zinc: 0%	aluminum: 38%

Management Measures: Bald Butte mine site has been recently reclaimed as part of the Bald Butte/Great Divide Restoration Project. The next steps for this site would be to implement a stream water quality monitoring plan, if a plan is not already in place.

Status: Major restoration has taken place at this site and was expected to finish in 2013. No post-monitoring data of water quality at this site is available.

Priority Number: 6

Resources Needed: Partnership with private land owners and contractors who completed restoration would help facilitate a better understanding of restoration at these sites and any next steps, lab analyses

Costs: less than 1 million

Duration of Mitigation: Multiple years of monitoring (3-5 years)

Kimball

Problem (Upper Little Blackfoot River): The *LBFTMDL* listed the Upper Little Blackfoot River as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load Reductions needed for the Upper Little Blackfoot River (from *LBFTMDL*):

arsenic: 38%	cyanide: 48%
cadmium: 77%	lead: 92%
copper: 25%	aluminum: 21%

Management Measures: This site is in need of increased adit monitoring to understand the inputs from this source, especially at Upper Kimball where an adit discharges directly into Tramway Creek. Monitoring is limited due to river crossings and private lands.

Status: Waste rock removal took place in 2005, which placed 3,363 bcy of waste rock in the Luttrell Repository from Lower Kimball, and 4,295 bcy from Upper Kimball. At the upper site, an adit discharge channel was constructed with erosion matting installed, and a partially collapsed adit was backfilled with boulders. Additionally an adit culvert cover at the lower site was repaired in 2011 after damage from vandalism.

Priority Number: 7

Resources Needed: Engineering/Hydrology consulting, partnerships with private land owners and Helena National Forest, lab analyses

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial adit discharge treatment implementation, monitoring and upkeep of passive adit treatment in perpetuity

---

Hope Mine

Problem (Upper Little Blackfoot River): The *LBFTMDL* listed the Upper Little Blackfoot River as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load Reductions needed for the Upper Little Blackfoot River (from *LBFTMDL*):

arsenic: 38%	cyanide: 48%
cadmium: 77%	lead: 92%
copper: 25%	aluminum: 21%

Management Measures: Removal of 2,000 cy of waste rock at this site would help reduce metals impairments from this site. A passive adit treatment is also suggested for the one discharging adit. Lastly, revegetation would help return the site to its natural state.

Status: Maxim Technologies completed a SI and an EE/CA in 2006 for waste rock removal at this site, including design information and a haul route to the Luttrell Repository. According to the Forest Service, the restoration was not initiated due to a lack of funding.

Priority Number: 7

Resources Needed: Available funding to implement restoration plan, Engineering/Hydrology Consulting, partnership with Helena National Forest

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial restoration, then monitoring and upkeep of passive adit treatment in perpetuity

---

Hard Luck Mine

Problem (Ontario Creek): The *LBFTMDL* listed Ontario Creek as impaired by metals for aquatic life and as a cold water fishery. Hard Luck Mine is thought to be the primary source of metals impairment to Ontario Creek.

Necessary Load Reductions for Ontario Creek (from *LBFTMDL*):

cadmium: 55%	aluminum: 33%
copper: 29%	zinc: 72%
lead: 26%	

Management Measures: Removal of 650 cy of mine waste would help eliminate metals impairments from this source. Two potentially hazardous mine openings must be backfilled, gated, or taken down to eliminate hazard. One discharging adit has been recorded on site, which needs some type of passive treatment system.

Status: No remediation efforts have been completed to date.

Priority Number: 9

Resources Needed: Engineering/Hydrology consulting, partnership with Helena National Forest, construction & labor

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial restoration, then monitoring and upkeep of passive adit treatment

---

Monarch Mine

Problem (Monarch Creek): The *LBFTMDL* listed Monarch Creek as impaired by metals for aquatic life, as a cold water fishery, and for primary contact recreation. Monarch mine is the most probable source of metals impairment.

Necessary Load Reductions for Monarch Creek (from *LBFTMDL*):

copper: 5%	mercury: 0%
lead: 33%	aluminum: 33%

Management Measures: In-place stabilization and amendment of mine wastes would decrease the concentration of metals entering Monarch Creek. Access must be improved to address issues at this site. Three discharging adits need mitigation through a constructed wetland, a drainage ditch, or a lime amendment to avoid further metals inputs from these adits. Revegetation of the area would help return the site back to its natural state.

Status: The in-place stabilization and amendment of mine waste was designed in 2006 and an EE/CA developed, but it was not initiated in 2007 due to a lack of funding (Oaks 2014).

Priority Number: 9

Resources Needed: Engineering/Hydrology Consulting, construction & labor

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial restoration, then monitoring

---

Golden Anchor

Problem (Upper Little Blackfoot River): The *LBFTMDL* listed the Upper Little Blackfoot River as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load Reductions needed for the Upper Little Blackfoot River (from *LBFTMDL*):

arsenic: 38%	cyanide: 48%
cadmium: 77%	lead: 92%
copper: 25%	aluminum: 21%

Management Measures: Removing the 5,000 cy of waste rock at Golden Anchor could significantly decrease the metals impairments from this site. Creating a passive adit treatment from the one discharging adit would reduce metals impairment further. Additionally the collapsed millsite and other collapsed structures and load-out would need to be removed to eliminate hazards. Revegetation would help return the site to its natural state, especially where waste rock is removed.

Status: No remediation efforts have been completed to date.

Priority Number: 9

Resources Needed: Engineering/Hydrology consulting, partnerships with private landowners

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial restoration, then monitoring and upkeep of passive adit treatment in perpetuity

---

Ontario Mine and Millsite

Problem (Un-named Creek): The *LBFTMDL* listed Un-named Creek as impaired by metals for aquatic life and as a cold water fishery. Ontario Mine is the primary source of metals impairment for this stream, and another mine (Amanda Mine) is a possible source of metals impairment.

Necessary Load Reductions for Unnamed Creek (from *LBFTMDL*):

arsenic: 82%	mercury: 0%
cadmium: 94%	zinc: 84%
copper: 82%	iron: 36%
lead: 88%	aluminum: 76%

Management Measures: Placing the remaining waste rock in the Luttrell repository will prevent metals from waste rock from entering the water. The Luttrell repository is suggested because waste rock was hauled to this site in 2006, meaning that a route has already been developed. Improving the constructed wetlands for filtering adit discharge, and possibly adding lime could help metals precipitate out and neutralize the water's pH before it enters Un-named Creek. The removal of wet tailings would also take these metals sources out of the stream. Revegetation will help return the site to its natural state.

Status: 16,000 cy of tailings and waste rock was hauled to Luttrell repository in 2006; however 11,000 cy of tailings remain on private land. The adit discharge contains high metals contamination even after flowing through a reclaimed wetland, as documented by Helena National Forest.

Priority Number: 12

Resources Needed: Engineering/Hydrology consulting, construction vehicles & labor, cooperation with private land owners

Cost: Over $1 million, $396,000 for waste rock removal

Duration of Mitigation: Less than 1 year for the initial implementation, plus monitoring passive treatment system in perpetuity

---

Hub Camp Mine

Problem (Upper Telegraph Creek): The *LBFTMDL* listed Upper Telegraph Creek as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load reductions for Upper Telegraph Creek (from *LBFTMDL*):

arsenic: 0%	zinc: 26%
beryllium: 0%	lead: 61%
cadmium: 17%	aluminum: 46%
copper: 43%	

Management Measures: More information is needed to understand if and how much waste remains at the site. If any volume exists, it would need to be stabilized in place because access hinders waste rock removal at this site. Two discharging adits were recorded at this site, and establishing a passive adit treatment would help reduce metals impairments at this site. Additionally, although the area was seeded in 2006, noxious weeds remain a problem and must be treated.

Status: The Forest Service hauled 1,250 cy of waste rock to the Luttrell Repository in 2006, the access road was reclaimed, and the area was seeded. Steep terrain hinders further waste removal.

Priority Number: 12

Resources Needed: Engineering consulting, partnership with Helena National Forest

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial implementation restoration, then monitoring and upkeep of passive adit treatment

Lily/Orphan Boy Mine

Problem (Upper Telegraph Creek): The *LBFTMDL* listed Upper Telegraph Creek as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load reductions for Upper Telegraph Creek (from *LBFTMDL*):

arsenic: 0%	zinc: 26%
beryllium: 0%	lead: 61%
cadmium: 17%	aluminum: 46%
copper: 43%	

Management Measures: Potential management measures for Lily/Orphan Boy mine are listed in the EE/CA completed in 2010. These were not implemented due to a lack of funding, so securing funding for these projects would be essential moving forward.

Status: An EE/CA was completed in 2010, already costing over $1 million. The EE/CA determined "some kind of flow control technology… would be cost effective," but it was not initiated due to funding.

Priority Number: 14

Resources Needed: Funds for project, Engineering/Hydrology consulting, partnership with private land owners and Helena National Forest.

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial restoration, then monitoring and upkeep of passive adit treatment

---

Mountain View

Problem (Upper Little Blackfoot River): The *LBFTMDL* listed the Upper Little Blackfoot River as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load Reductions needed for the Upper Little Blackfoot River (from *LBFTMDL*):

arsenic: 38%	cyanide: 48%
cadmium: 77%	lead: 92%
copper: 25%	aluminum: 21%

Management Measures: This site has at least 3 waste rock dumps, estimated at about 6,500 cy, within the Tramway Creek drainage that are restricting stream migration. Removal of this waste could significantly reduce metals impairments from this site. Additionally, one open discharging adit has been recorded, whose influence to metals impairments could be mitigated by installing a passive adit discharge treatment system. After removal of the waste rock dumps, revegetation of the site and stream bank stabilization may be necessary.

Status: No remediation efforts have been completed to date.

Priority Number: 15

Resources Needed: Engineering/Hydrology consulting, partnership with Helena National Forest

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial restoration, then monitoring and upkeep of passive adit treatment in perpetuity

---

Viking Mine

Problem (Upper Telegraph Creek): The *LBFTMDL* listed Upper Telegraph Creek as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load reductions for Upper Telegraph Creek (from *LBFTMDL*):

arsenic: 0%
beryllium: 0%
cadmium: 17%
copper: 43%
zinc: 26%
lead: 61%
aluminum: 46%

Management Measures: Remaining problems on site include contaminated fines with high metals concentrations, but terrain hinders further removal from this site. Suggested management includes the addition of lime to neutralize pH and drop out metals, since a soil cover was already applied to prevent transport/exposure of these fines.

Status: The Forest Service hauled 1,144 cy of waste rock to the Luttrell Repository in 2006, and an infiltration basin was constructed, followed by a soil buffer, seed, and compost application. Additionally, the access road was reclaimed.

Priority Number: 16

Resources Needed: Engineering Consulting, partnership with Helena National Forest

Costs: less than 1 million

Duration of Mitigation: Less than 1 year for initial implementation restoration, then monitoring and upkeep

---

Telegraph Mine

Problem (Sally Ann Creek): The *LBFTMDL* listed Sally Ann Creek as impaired by metals for aquatic life and as a cold water fishery. Telegraph Mine is the most probable source of metals impairment in the watershed.

Necessary Load reductions for Sally Ann Creek (from *LBFTMDL*):

cadmium: 93%	zinc: 26%
copper: 29%	

Management Measures: The Forest Service recorded contaminated horizon and remaining mine waste, road drainage and erosion controls need repair, inadequate fencing, and disturbed precipitate pools due to ATV travel. Removal of the contaminated horizon and remaining mine waste could help decrease metals impairment from this source. Additional maintenance and repair of erosion controls, fencing, and precipitate pools could help improve the existing management measures.

Status: In 2006, 2,087 cy of waste was hauled to Luttrell Repository, a cover soil buffer was applied to the reclamation area and access road, and an infiltration basin was constructed.

Priority Number: 17

Resources Needed: Engineering/Hydrology consulting, partnership with Helena National Forest

Costs: Less than $1 million

Duration of Mitigation: less than 1 year for initial removal and repairs, then monitoring and upkeep in perpetuity

---

Sure Thing Mine

Problem (O'Keefe Creek): The *LBFTMDL* listed O'Keefe Creek as impaired by metals for aquatic life and as a cold water fishery. Sure Thing Mine is the only DEQ priority mine in this drainage. O'Keefe/Copper King Mine is also suspected to contribute somewhat to the metals impairments, but will not be addressed in this restoration strategy (DEQ and EPA 2011).

Necessary Load reductions for O'Keefe Creek (from *LBFTMDL*):

Cadmium: 95%	Zinc: 47%
Copper: 43%	

Management Measures: Removal of 7,700 cy of waste rock on site could significantly decrease the metals impairments from this source, and should be the initial cleanup option. Developing a passive treatment for the discharging adit could further reduce impairments from this site. Dismantling the highwall is necessary to remove hazards on site, and lastly revegetation would help return this site to its natural state.

Status: No remediation efforts have been completed to date.

Priority Number: 18

Resources Needed: Engineering/Hydrology consulting, cooperation with private landowners

Costs: Over $1 million

Duration of Mitigation: less than 1 year for initial restoration, then monitoring and upkeep of passive adit treatment in perpetuity

---

SE SW Section 10

Problem (Upper Little Blackfoot River): The *LBFTMDL* listed the Upper Little Blackfoot River as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage.

Necessary Load Reductions needed for the Upper Little Blackfoot River (from *LBFTMDL*):

arsenic: 38%	cyanide: 48%
cadmium: 77%	lead: 92%
copper: 25%	aluminum: 21%

Management Measures: A site investigation is the first step necessary for this site.

Status: SE SW Section 10 is on the DEQ priority mine site list ranking number 97, but little is known about problems at this site.

Priority Number: Not enough data to assess and rank in prioritization matrix

Resources Needed: Engineering/Hydrology consulting

Costs: Unknown – initially just monitoring to learn more about the site through water quality monitoring and a site investigation

Duration of Mitigation: Multiple years of monitoring (3-5)

Blackfeet No. 1

Problem (Upper Little Blackfoot River): The *LBFTMDL* listed the Upper Little Blackfoot River as impaired by metals for aquatic life and as a cold water fishery. This restoration strategy lists multiple mine sites for reclamation in this drainage. The Blackfeet No. 1 Mine site includes a historical lodeout that stretches along the Little Blackfoot River for approximately 150 feet. The mine waste is approximately 15-20 feet high and 25 feet wide. There is also a small draining adit and another waste pile immediately upstream of the primary waste pile that is flowing into the Little Blackfoot River.

Necessary Load Reductions needed for the Upper Little Blackfoot River (from *LBFTMDL*): Unknown

Management Measures: A site investigation is the first step necessary for this site. Waste rock removal could significantly decrease metals impairments from this site. A draining adit exists that could be closed with a plug or water quality treatment cell. After removing the large volume of waste rock, this area would need to be revegetated to return to a more natural state.

Status: Under investigation. Little is known about this site.

Priority Number: Not enough data to assess and rank in prioritization matrix

Resources Needed: Engineering/Hydrology consulting

Costs: Unknown – initially just monitoring to learn more about the site through water quality monitoring and a site investigation

Duration of Mitigation: less than 1 year for initial removal and repairs, then monitoring and upkeep in perpetuity

---

APPENDIX C: ABANDONED MINES PRIORITIZATION FRAMEWORK

Table C1. Abandoned mines prioritization framework.

Method for Value Determination									
Parameter			1 Pt.	2 Pts.	3 Pts.		Multiplier	Score	Total Max
Human Risk									
1	Proximity to roads	GIS measurement	> 500 ft	Ø	< 500 ft		4		36
2	Proximity to residences	GIS measurement	> 1000 ft	Ø	< 1000 ft		3		
3	Proximity to campsites	Number of campsites within 0.5 miles (GIS Measurement)	0	Ø	>1		3		
4	Land Ownership	Montana Cadastral Evaluation	Private	Ø	Public		2		
Environmental / Ecological									
5	Proximity to stream	GIS measurement	> 1,000	500-1,000 ft	< 500 ft		7		63
6	Native Fish Habitat	Presence of Species of Concern (Westslope Cutthroat) within the past 10 years (FWP)	WCT not present	WCT present in some areas	WCT present		5		
7	State Fisheries Value Rating	Based on FWP stream rating for Stream of concern	No Data Found	3-4 (substantial – moderate)	1-2 (high – outstanding)		5		
	Frequency of metals exceedances (stream)	mean frequency exceedances of chronic standards	< 30%	30%-50%	> 50%		1		

8	Magnitude of metals impairment (stream)	Sum of TMDL % reduction required during high flow (where available)	< 100%	100%-250%	> 250%		3		
Economic									
9	Potential Cost of restoration	Estimated based on previous restoration activities	$1,000,000 +	Ø	< $1,000,000	Justification Narrative	5		
10	Duration of Mitigation	Estimated based on previous restoration activities	6 years – In perpetuity (monitoring)	2-5 years	1 year or less	Justification Narrative	3		30
11	Site Complexity	E.g. discharging adits, waste rock, wet/dry tailings, HMOs	High	Moderate	Low	Justification Narrative	2		
Additional									
12	Probability of Successfully reducing metals impairment	Probability of success	Low	Moderate	High	Justification Narrative	5		21
13	Potential for Future Mining	Future Land Use Options based on mining claims and land ownership	High	Moderate	Low	Justification Narrative	2		
							50		150
							Total		

FWP = Fish, Wildlife & Parks , GIS = Geographic Information System, HMO = Hazardous Mine Opening

Appendix D: Draft Sampling and Analysis Plan

Metals Restoration Strategy Sampling – 2015:

Water Quality and Metals Impairment Sampling

Sampling and Analysis Plan

Prepared for:

Montana Department of Environmental Quality
Water Quality Planning Bureau
P.O. Box 200901
Helena, MT 59620-0901

Approvals

______________________________________	________________
Eric Trum (Project Manager)	Date
______________________________________	________________
Darrin Kron (Monitoring and Assessment Supervisor)	Date
______________________________________	________________
Mindy McCarthy (Quality Assurance Officer)	Date
______________________________________	________________
Add additional signatories as needed	Date

Contents

Chapter 1: Introduction 1

1.1 Watershed characterization 2

1.2 Document layout 3

Chapter 2: Metals Restoration Strategy 5

2.1 Causes and sources of pollution 5

2.1.1 Un-named Creek (MT76G006_010) 6

2.1.2 Monarch Creek (MT76G004_060) 6

2.1.3 Ontario Creek (MT76G004_130) 7

2.1.4 Sally Ann Creek (MT76G004_055) 7

2.1.5 O'Keefe Creek (MT76G004_054) 7

2.1.6 Telegraph Creek, Upper Segment (MT76G004_051) 7

2.1.7 Telegraph Creek, Lower Segment (MT76G004_052) 8

2.1.8 American Gulch Creek (MT76G004_079) 8

2.1.9 Dog Creek, Upper Segment (MT76G004_071) 8

2.1.10 Dog Creek, Lower Segment (MT76G004_072) 8

2.1.11 Little Blackfoot River, Upper Segment (MT76G004_020) 8

2.1.12 Little Blackfoot River, Lower Segment (MT76G004_010) 9

2.1 Load Reductions 10

2.2 Management Measures 12

2.2.1 Waste rock/tailings removal and consolidation 15

2.2.2 Phytostabilization 15

2.2.3 Capping 15

2.2.4 Closure of hazardous mine openings 16

2.2.5 Revegetation 16

2.2.6 Streambank stabilization 16

2.2.7 Mine drainage neutralization with lime amendments 16

2.2.8 Passive treatment of adit drainage 17

2.2.9 Other techniques 18

2.2.10 Preferred techniques: ... 18
2.3 Prioritization ... 18
2.3.1 2015 prioritization update ... 19
2.4 Technical and Financial Assistance Needed ... 20
2.4.1 Financial Assistance ... 23
2.5 Education and Outreach ... 24
2.6 Implementation Schedule ... 25
2.7 Interim Milestones ... 25
2.8 Criteria/Evaluation Procedures ... 26
2.8.1 Environmental Outcomes ... 26
2.8.2 Organizational Outcomes ... 26
2.9 Monitoring ... 27
Chapter 3: Restoration Strategy for Sediments, Nutrients, and Non-pollutant Impairments ... 30
3.1 Sources of pollution ... 31
3.1.1 Sources of sediment ... 32
3.1.2 Sources of nutrients ... 35
3.1.3 Sources of non-pollutant impairments ... 36
3.2 Estimated loadings and potential reductions ... 37
3.2.1 Sediment loading and reductions ... 37
3.2.2 Nutrient loading and reductions ... 38
3.3 Management measures ... 39
3.3.1 Landowner outreach ... 41
3.3.2 Grazing management ... 42
3.3.3 Crop production ... 43
3.3.4 Streambank and aquatic habitat recovery ... 44
3.3.5 Forestry ... 45
3.3.6 Transportation ... 46
3.3.7 Irrigation and drought response ... 49
3.3.8 Protection and passive restoration ... 50
3.3.9 Reach specific conditions and recommendations ... 51

3.4 Financial and technical assistance 54
3.4.1 Technical assistance 55
3.5 Education and outreach 55
3.6 Stream Summaries and Implementation Schedule 56
3.7 Interim milestones 61
3.8 Criteria/Evaluation procedures ..... **Error! Bookmark not defined.**
3.9 Monitoring 63
3.9.1 Effectiveness monitoring 64
3.9.2 Baseline monitoring 64
..... References 68
..... Appendix A: Mine Reclamation Summaries 74
..... Appendix B: Abandoned Mines Prioritization Framework 92
..... Appendix C: Draft Sampling and Analysis Plan 94
A. Section 1 – Introduction and Background Information 99
B. Section 2 – Project Objectives and Sampling Design 101
C. Project Objectives and Goals 101
D. Sampling Planning and Site Selection 102
E. Selecting monitoring sites 102
F. Sampling Timeframe 102
G. Section 3 – Field Procedures 102
H. General sampling sequence 103
I. Collecting *In Situ* Chemistry Field Measurements 103
J. Using Field Meters 103
K. Collecting Chemistry Samples in Streams and Rivers 103
L. Collecting water samples for total recoverable fractions (unfiltered, acid-preserved) 104
M. Collecting water samples for total recoverable fractions (unfiltered, frozen) 104

N. Water samples for dissolved luminum (filtered) 104
O. Water samples for low-level total mercury 104
P. Measuring Physical Parameters 105
Q. Measuring flow (total discharge) 105
R. Taking digital photographs to document the site 105
S. Site Comments 105
T. Section 4 – Sample Handling Procedures 106
U. Section 5 – Laboratory Analytical Methods 106
V. Section 6 – Quality Assurance and Quality Control Requirements 107
W. Calibrating Field Meters 107
X. In the Laboratory 107
Y. In the Field 107
Z. Field Quality Control Samples 107
AA. Duplicate Samples 107
BB. Field Blanks 108
CC. Section 7 – Handling Sampling Records 108
DD. Section 8 – Schedule 108
EE. Section 9 – Project Team and Responsibilities 108
FF. Section 10 - References 108

List of Appendices

List of Tables

A. Section 1 – Introduction and Background Information

This document presents a plan for completing metals monitoring and source assessment in the Upper Little Blackfoot watershed in 2015. It identifies the process for completing this assessment, which will help in deciding specific remediation strategies at each site. This sampling is necessary to identify proper remediation techniques based on specific sources of metals impairment in the Little Blackfoot watershed. Post-project sampling written into this SAP is important for assessing the success of the restoration strategies and the need for any future restoration. This SAP was developed in conjuction with the 2014 Little Blackfoot Metals Restoration Strategy.

The Little Blackfoot River watershed is contained within Powell, and Lewis and Clark counties. The Little Blackfoot River extends approximately 47 miles from its headwaters to the mouth where it meets with the Clark Fork River. The watershed encompasses 264,124 acres (approximately 413 square miles) and is part of the Upper Clark Fork (17010201) hydrologic unit (DEQ & EPA 2011). The area includes the 170102015 and 170102016 fifth-code watersheds, representing the Little Blackfoot River Headwaters and the Lower Little Blackfoot River watersheds respectively. According to a GIS analysis of public lands within the watershed, approximately 50% of the watershed falls within Helena National Forest.

The most recent assessment of metals in the area is the 2011 Little Blackfoot watershed TMDLs and Framework Water Quality Improvement Plan (LBFWP)and its 2014 addendum (MDEQ 2011). The report used data from the past ten years (2001-2011), but data collected specifically for this report was from 2008 and 2009 (DEQ & EPA 2011). DEQ completed a reassessment of existing data from the same years to complete the 2014 Addendum (DEQ & EPA 2014). This report based its assessment on water quality data for stream segments within the watershed, clumping mining sources into composite allocations. Previous reports of abandoned mines in the Little Blackfoot watershed include the Montana Bureau of Mines and Geology (MBMG) Open-File Report 368 (Hargrave et al 1998), the Abandoned Hard Rock Mine Priority Sites Summary Report, commonly known as the "Red Book" (DEQ 1995). Both these reports sampled sediment and water quality.

This document calls for further monitoring in order to better understand the sources of metals impairments in each sub-watersheds, and the feasibility and needs for remediation at abandoned mine sites. The LBFWP identified data gaps where further water quality assessment is necessary to complete source assessment in the watershed (DEQ & EPA 2011). This monitoring plan will fill those gaps. Collecting more water quality data and at more locations will help determine the sources of metals impairments and help decide where to focus funding and remedial efforts.

Additionally, the Metals Restoration Strategy brought attention to the lingering problems in addressing discharging adits. By sampling these adits, this monitoring effort will identify how significant contributions from discharging adits are to metals impairment in each stream segment. Site assessments will provide information for future feasibility assessments that will determine the possibility of implementing remedial measures at each abandoned mine site. Addressing adit discharge is expensive and complex, so understanding the contamination from these adits would help to plan remedial measures.

Numerous management measures have also taken place to address metal contaminants in the Little Blackfoot watershed. For more information on previous reclamation and restoration activities in this watershed, please refer to the Metals Restoration Strategy.

Tables 1.1 and 1.2 list the waterbody segments to be sampled in 2015. Seven waterbody segments will be monitored for metals and two will be monitored for cyanide. At least 20 discharging adits will be monitored at 14 mine sites. In addition to metals monitoring, general site investigations will take place to visually assess the impact of each mine site listed in table 1.2.

Table 1.1 – Waterbody segments in the Little Blackfoot Metals Restoration Strategy to be sampled in 2015 and their associated pollutant group 303(d) listings for which monitoring will occur.

Waterbody ID	Waterbody Segment Name	Pollutant Group	Sampling Period
MT76G004_079	American Gulch Creek	Metals	High and low flow
MT76G004_072	Dog Creek, Lower Segment	Metals	High and low flow
MT76G004_052	Telegraph Creek, Lower Segment	Metals	High and low flow
MT76G004_054	O'Keefe Creek	Metals	High and low flow
MT76G004_055	Sally Ann Creek	Metals	High and low flow
MT76G006_010	Un-named Creek	Metals	High flow
MT76G004_020	Upper Little Blackfoot (around Charter Oak Mine)	Cyanide	High and low flow
MT76G004_071	Dog Creek, Upper Segment (around Bald Butte Mine)	Metals, Cyanide	High and low flow

Table 1.2 indicates the pollutant groups for which monitoring will occur at each of the discharing adits at the listed mine sites.

Mine Site	# of Adits	Pollutant Group	Sampling Period
Ontario Mine	2	Metals	High and low flow
Monarch Mine	3	Metals	High and low flow
Hard Luck Mine	1	Metals	High and low flow
Telegraph Mine	2	Metals	High and low flow
Sure Thing Mine	1	Metals	High and low flow
Lily/Orphan Boy Mine	1	Metals	High and low flow
Anna R/Hattie M	1	Metals	High and low flow
Hub Camp	2	Metals	High and low flow
Viking	Unknown	Metals	High and low flow
Charter Oak	2	Metals	High and low flow
Kimball	2	Metals	High and low flow
Mountain View	1	Metals	High and low flow
Golden Anchor	1	Metals	High and low flow
Hope	1	Metals	High and low flow

B. Section 2 – Project Objectives and Sampling Design

C. Project Objectives and Goals

The primary objectives of this project are:

1. To fill remaining data gaps to aid in the determination of site specific metals remediation plans within the Little Blackfoot watershed.

2. To better understand sources of metals impairment within each impaired waterbody segment in the Little Blackfoot.

DEQ assessment methods for metals will guide the analysis of the resulting dataset (cite relevant assessment methods). These methods define the data quality requirements for metals sampling, including minimum sample size and sample independence requirements.

The study design for this monitoring project are as follows:

- Collect metals (dissolved aluminum, and total recoverable suite) from adit discharge to better understand the input to streams.
- Collect metals (dissolved aluminum, and total recoverable suite) on 7 waterbody segments.
- Collect cyanide samples for 2 stream segments.
- Collect ultra-low-level total mercury samples on 7 waterbody segments.
- Collect physical parameters (temperature, dissolved oxygen, pH, and conductivity) in situ and monitor instantaneous flow all sampling sites.
- Complete site documentation including photographs and general comments on the state of the mine site.

The study design is intended to provide sufficient data for source assessments of metals contamination to the Little Blackfoot waterbody segments.

D. Sampling Planning and Site Selection

E. Selecting monitoring sites

The sampling at each location is based on data gaps in each stream segment and at sites where restoration projects are planned in the Metals Restoration Strategy. Sites will be identified using existing site locations from the LBFWP, GIS, topographic maps, and coordination with Helena National Forest, Department of Environmental Quality Abandoned Mine Lands program, and the Environmental Protection Agency. Exact coordinates for sampling locations will be gathered in the field.

Table 2. Proposed Monitoring sites

F. Sampling Timeframe

Sampling for metals will take place during both high and low flows to get an accurate representation of metals concentrations during different times of the year and water levels.

The initial metals sampling event will occur during high flow conditions (anticipated in early- to mid-June). Additional sampling events will occur during low flow conditions, in July, August and September. At least seven days will pass between metals monitoring events at any individual monitoring site (cite metals assessment method). This sampling plan allows one field season (2015) for all sampling to occur.

G. Section 3 – Field Procedures

All field procedures described throughout this Sampling and Analysis Plan are documented in DEQ's Water Quality Planning Bureau Field Procedures Manual For Water Quality Assessment Monitoring (DEQ 2012b) unless otherwise noted.

H. General sampling sequence

To minimize site disturbance that may bias samples, we will collect parameters at each site that are most sensitive to disturbance before monitoring parameters that are less sensitive to disturbance. The general sequence is as follows:

1. Chemistry parameters (e.g., *in situ* field measurements, water chemistry)
2. Physical parameters (e.g., flow, photographs, channel morphology)

I. Collecting *In Situ* Chemistry Field Measurements

J. Using Field Meters

The following section describes all instruments that will be used for taking field measurements. This monitoring effort will only be collecting instantaneous field measurements.

Collecting Instantaneous Field Measurements *In Situ*

Instantaneous field measurements of will be collected *in situ* during each sampling event at each sampling site. These measurements will be collected prior to the collection of water samples or other physical disturbances to the water column or substrate. Instrument-specific operations manuals contain instructions on use of individual field meters used to record continuous field measurements. See Section 6 for information on calibrating instruments.

Specific Conductivity – The specific conductance value (μS) recorded on the Site Visit Form is the temperature compensated conductivity value obtained from the YSI 85 shown when the ^{o}C symbol is flashing on and off on the display screen. The YSI 85 automatically adjusts this reading to a calculated value which would have been read if the sample had been at 25^{o}C.

Dissolved Oxygen – *In situ* calibration will be performed before use at each site to allow the YSI 85 meter to account for the approximate altitude of the region in which the monitoring site is located. After, a measurement of oxygen (mg/L) will be recorded from the YSI 85 onto the Site Visit Form.

Water Temperature – A measurement of water temperature (^{o}C) will be recorded from the YSI 85 meter onto the Site Visit Form.

pH –A measurement of pH will be recorded from the hand-held pH meter onto the Site Visit Form.

Air temperature – A hand-held thermometer will be placed in a shaded area with sufficient air circulation and allowed to stabilize for approximately 15 minutes. A measurement of air temperature (^{o}C) will be recorded from the hand-held thermometer onto the Site Visit Form.

K. Collecting Chemistry Samples in Streams and Rivers

After *in situ* measurements are complete, chemistry samples will be collected at each site. All water samples will be collected in new acid-washed high-density polyethylene (HDPE) bottles unless otherwise noted. Detailed methodology for each type of sample collection described below can be found in DEQ (2012b). Table 3.1 summarizes sample containers, holding times and preservation.

L. Collecting water samples for total recoverable fractions (unfiltered, acid-preserved)

Bottles and lids will be triple-rinsed with ambient stream water prior to grabbing the final sample. Total recoverable metals will be collected in a single 250ml HDPE bottle, will be preserved with nitric acid and kept on ice (not frozen) until analyzed. Hardness will be calculated from the total recoverable metals bottle.

M. Collecting water samples for total recoverable fractions (unfiltered, frozen)

Bottles and lids will be triple-rinsed with ambient stream water prior to grabbing the final sample. TN will be collected in a single 250ml HDPE bottle and kept below 6° C and analyzed within seven days or frozen (on dry ice) until analyzed within 28 days. TP and NO_{2+3} will be collected in a single 250ml HDPE bottle and and kept below 6° C and analyzed within seven days or frozen (on dry ice) until analyzed within 28 days. No sulfuric acid or any other preservative will be added to the samples prior to freezing them.

N. Water samples for dissolved 104luminum (filtered)

Samples will be filtered through a 0.45 µm filter into 250 ml HDPE bottles using a 60 cm^3 syringe connected to a disposal 0.45 µm filter capsule. A small amount of the sample will be wasted through the filter first, and the sample bottle and lid will be triple-rinsed with filtrate before the final filtered sample is collected. For dissolved aluminum, 50 ml of the filtrate will be placed in a 250 ml HDPE bottle, preserved with nitric acid and kept on ice (not frozen) until analyzed (Table 3.1).

O. Water samples for low-level total mercury

Samples will be collected using the ultra-low level method involving a "clean hands/dirty hands" procedure (DEQ 2012). Samples will be collected using new 100 ml glass bottles, preserved with hydrochloric acid and will be kept on ice (not frozen) until analyzed.

Table 3.1 – Sampling Volumes, Containers, Preservation, and Holding Times

Analyte	Bottle Size	Container	Preservation and Storage	Holding Time
Total Recoverable Metals	250 ml	Acid-washed high density polyethylene (HDPE) bottle	Nitric acid; Cool to <6° (on ice)	180 days
Dissolved Aluminum	250 ml	Acid-washed high density polyethylene (HDPE) bottle	0.45 mm field filtered, nitric acid; Cool to <6° (on ice)	180 days
Ultra-Low Level Mercury	100 ml	Glass	0.5 ml 12N HCl; Cool to <6° (on ice)	28 days

P. Measuring Physical Parameters

Q. Measuring flow (total discharge)

Flow will be measured at each site during each sampling event using the quantitative flow meter method or the semi-quantitative float method (DEQ 2012b). The quantitative flow meter method is preferred, although the float method is acceptable when high flows or other conditions pose a safety hazard and prevent wading.

R. Taking digital photographs to document the site

Digital photographs will be taken (at a minimum) at the "F" site of each monitoring location (DEQ 2012b), facing upstream, downstream and across the channel. Additional photos may be taken to document any relevant site-specific characteristics that are observed. For each photo, the photo number and a brief description will be recorded on the Photograph Locations and Description Form.

S. Site Comments

Pertinent site comments or observations by field personnel will be recorded on the Summary Form.

Temperature datalogger deployment

(Important field forms for these loggers can be found WQPBWQM-020 Version 3.0 Water Quality Planning Bureau Field Procedures Manual for Water Quality Assessment Monitoring)

Some one-time field measurement instruments, particularly hand-held pH and YSI 85 dissolved oxygen meters, require *in situ* field calibration at the time of use in addition to pre-deployment calibration. For all DO field calibrations, record in the instrument logbook the date, time, site location and elevation, and the initials of the analyst performing the calibrations.

Refer to instrument-specific operations manuals for instructions on use and calibration.

Dissolved oxygen, specific conductivity, and water temperature

Immediately upon arrival at the "F" site, turn the YSI 85 (or similar model) instrument on, open the case and allow it to remain undisturbed for ≥15 minutes in a shaded location.

Perform field calibration of dissolved oxygen, using the calibration values appendix in the operations manual to verify measurement accuracy.

At the "F" site, submerge the probe in the water, shake vigorously to remove any air bubbles trapped near the probe, and position it facing upstream into the flow. Ensure that there are no obstructions in front of the probe (i.e., rocks, macrophytes, debris). If the water is not flowing, gently move the probe from side to side to circulate the water around the probe.

Allow a few moments for measurements to stabilize and record dissolved oxygen (mg/L), specific conductivity (µS), and water temperature ($_{o}$C).

pH

At the “F” site, submerge the probe in the water. Allow a few moments for instrument measurements to stabilize and record pH.
While in the field at the end of each day of sampling, perform a two-point calibration check to verify performance of the meter.

Air temperature
Place the thermometer in a location with adequate shade and air circulation and allow it to stabilize for several moments. Record temperature ($_o$C).

T. Section 4 – Sample Handling Procedures

Field samples will be collected and preserved in accordance to Section 3. Monitoring crews will be responsible for proper labeling, sample custody documentation and storage in accordance to the specifications in the Field Procedures Manual and QAPP (cite appriopriate QAPP).

Water chemistry samples will be delivered to Energy Labs in Helena.

U. Section 5 – Laboratory Analytical Methods

Chemistry samples will be analyzed according to the methods listed in Table 5.1. In addition, table 5.1 lists the required reporting limits to effectively evaluate the data to meet the project objectives.

Table 5.1 – Analytical Methods and Required Reporting Values

Analyte	Method	Required Reporting Limit (ug/L)
Water Sample – Dissolved Metals		
Aluminum	EPA 200.7	30
Water Sample – Total Metals		
Mercury (ultra-low level)	EPA 245.7	0.005
Water Sample – Total Recoverable Metals		
Arsenic	EPA 200.8	3
Cadmium	EPA 200.8	0.08
Calcium	EPA 200.7	1,000
Chromium	EPA 200.8	1
Copper	EPA 200.8	1
Iron	EPA 200.7	50
Lead	EPA 200.8	0.5

Magnesium	EPA 200.7	1,000
Zinc	EPA 200.7	10
Total Recoverable Metals Disgestion	EPA 200.2	N/A

V. Section 6 – Quality Assurance and Quality Control Requirements

Quality Assurance/Quality Control (QA/QC) procedures for the monitoring will consist of calibrating field meters and collecting field QC samples.

W. Calibrating Field Meters

DEQ uses several models of one-time and continuous field instruments for measuring parameters including dissolved oxygen, pH, specific conductivity, water temperature, turbidity, and stage height.

X. In the Laboratory

All field instruments will be calibrated in the laboratory before they are taken into the field. These calibrations will be performed in accordance with instrument-specific acceptance criteria, operations manuals, and SOPs. Calibration information will be recorded in the instruments' calibration log(s) and will remain with the instrument at all times (DEQ 2012b).

Y. In the Field

Some field meters require *in situ* field calibration in addition to laboratory calibration before they are used in the field. YSI 85 field meters must be calibrated for dissolved oxygen before they are used at each monitoring site. For all dissolved oxygen field calibrations, the following information is recorded in the instrument logbook: 1) date, 2) time, 3) site location, 4) elevation, and 5) the initials of the analyst performing the calibrations. Hand-held pH meters must be calibrated daily using a two-point calibration. Calibration instructions for each meter are located in the user manual kept in each instrument's case.

Z. Field Quality Control Samples

AA. Duplicate Samples

For each type of routine water chemistry parameter, duplicate samples will be collected for at least 10% of the total number collected throughout the sampling season. Sites where duplicate samples will be prepared will be randomly selected. When collecting duplicate samples, a sampling location will be chosen that allows for two samples to be taken side-by-side upstream from any previous disturbances. To collect duplicate samples, all procedures performed in collecting, labeling and preserving the routine sample will be followed so that two identical samples have been collected at the same site. Duplicate samples will be submitted to the analytical laboratory along with routine samples.

BB. Field Blanks

Field blanks are prepared in the field each time that routine water samples are to be delivered to the analytical laboratory. Field blanks are prepared in the field after sampling the last site of a multi-site sampling trip, or mid-trip if sample holding times require samples to be delivered to the lab part-way through a multi-site sampling trip. Field blanks will be prepared using distilled water provided by the analytical laboratory which field personnel will keep in clean, triple-rinsed HDPE bottles. One field blank will be prepared and submitted per routine sample type collected throughout the trip. Preparing field blanks will follow the same sample collection, labeling and preservation procedures as those used to collect routine samples except distilled water is used instead of stream or lake water.

CC. Section 7 – Handling Sampling Records

Site Visit Forms, field forms, and digital photos will be processed the monitoring team using QA/QC procedures described in the QAPP (site appropriate QAPP). Analytical laboratories will provide results to DEQ in the required EDD format. DEQ will perform the necessary data evaluations and will manage the data in accordance with the QAPP.

DD. Section 8 – Schedule

The Water Quality Monitoring team will sample 7 streams and at least 20 discharging adits at 14 mine sites within the Little Blackfoot watershed at the proposed sites (Appendix A). The high flow sampling events for metals will occur in June 2015, whereas the low flow sampling events for metals will occur in July and August 2015. Data collection should be completed no later than September 30, 2015.

EE. Section 9 – Project Team and Responsibilities

Currently, specific individuals and organizations responsible for completing the water quality monitoring have not been identified. However, a Water Quality Monitoring team will be created to complete the tasks layed out in this document. Further involvement in these monitoring efforts will come from DEQ AML, DEQ Non-Point Source Program, Trout Unlimited, and Helena National Forest.

FF. Section 10 - References

APHA (American Public Health Association). 2005. Standard methods for the examination of water and wastewater. 21st ed. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. Washington, DC.

Cole, G.A., 1983. Textbook of Limnology, 3rd Edition. Waveland Press.

DEQ (Montana Department of Environmental Quality). 2005. Temperature Data Logger Protocols Standard Operating Procedure. Helena, MT: Montana Department of Environmental Quality. Report WQPBWQM-006.

DEQ (Montana Department of Environmental Quality). 2006. Sample Collection, Handling and Analysis of *Escherichia Coli*. Water Quality Planning Bureau. WQPBWQM-014. Available at: http://deq.mt.gov/wqinfo/qaprogram/sops.mcpx.

DEQ (Montana Department of Environmental Quality). 2011a. Water Quality Assessment Method. Helena, MT: Montana Department of Environmental Quality.

DEQ (Montana Department of Environmental Quality). 2011b. Sample Collection and Laboratory Analysis of Chlorophyll *a* Standard Operating Procedure. Prepared by Suplee, M., February 2011. Document No. WQPBWQM-011, Revision 5.

DEQ (Montana Department of Environmental Quality). 2012a. Administrative Rules of Montana.

DEQ (Montana Department of Environmental Quality). 2012b. Water Quality Planning Bureau Field Procedures Manual For Water Quality Assessment Monitoring Version 3.0. Helena, MT: Montana Dept. of Environmental Quality.

DEQ (Montana Department of Environmental Quality). 2012c. Sample Collection, Sorting, Taxonomic Identification, and Analysis of Benthic Macroinvertebrate Communities Standard Operating Procedure. Document No. WQPBWQM-009, Revision 3.

DEQ (Montana Department of Environmental Quality). 2012d. Field Methodology For The Assessment of TMDL Sediment and Habitat Impairments. Helena, MT: Montana Dept. of Environmental Quality. Document No. WQPBWMSSOP-04.

IDEXX, Inc. 2011. How to Use Colilert. [Available at http://www.idexx.com/water/colilert/index.jsp]. Accessed on May 17, 2011.

Kusnierz, Paul., Andy Welch and Darrin Kron. 2013. The Montana Department of Environmental Quality Sediment Assessment Method: Considerations, Physical and Biological Parameters, and Decision Making. Helena, MT: Montana Dept. of Environmental Quality.

Nevers, M.B., and R. L. Whitman. Accessed 2012. Lake Monitoring Field Manual. US Geological Survey, Lake Michigan Ecological Research Station, Porter, Indiana. Accessed 6/4/2012. Available at http://www.glsc.usgs.gov/_files/research/InlandLakesManual.pdf.

Peck, D.V., A.T. Herlihy, B.H. Hill, R.M. Hughes, P.R. Kaufmann, D.J. Klemm, J.M. Lazorchak, F.H. McCormick, S.A. Peterson, P.L. Ringold, T. Magee, and M.R. Cappaert. 2006. Environmental Monitoring and Assessment Program – Surface Waters Western Pilot Study: Field Operations Manual for Wadeable Streams. EPA 620/R-06/003. U.S. Environmental Protection Agency, Office of Research and Development, Washington, D.C.

Suplee, M.W., and R. Sada de Suplee. 2011. Assessment Methodology for Determining Wadeable Stream Impairment Due to Excess Nitrogen and Phosphorus Levels. Helena, MT: Montana Dept. of Environmental Quality.

Suplee, Michael W., Vicki Watson, Walter K. Dodds, and Chris Shirley, 2012. Response of Algal Biomass to Large-Scale Nutrient Controls in the Clark Fork River, Montana, United States. *Journal of the American Water Resources Association* (JAWRA): 1-14. DOI: 10.1111/j.1752-1688.2012.00666.x.