# Little Blackfoot River Watershed TMDLs and Framework Water Quality Improvement Plan

**December 2011**

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*Richard Opper, Director DEQ*

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# ERRATA SHEET FOR:
# DECEMBER 28, 2011 EPA SUBMITTAL VERSION OF THE "LITTLE BLACKFOOT RIVER WATERSHED TMDLS AND FRAMEWORK WATER QUALITY IMPROVEMENT PLAN"

These TMDLs were submitted to EPA on December 28, 2011 and were approved on December 30, 2011. EPA identified an error in the submittal document and requested that it be corrected. As a result, a minor change was made to the submittal document as shown on this errata sheet. The final document, with this change incorporated, is dated December 30, 2011.

The edit made to the EPA Submittal Version of the "Little Blackfoot River Watershed TMDLs and Framework Water Quality Improvement Plan" was contained in Figure 6-4. On the following page, the location of the figure is provided, followed by the original figure, and the corrected figure.

# EDIT 1

### *Document Location:*

*Page 6-20, Section 6.6, Figure 6-4*

### *Original Figure and Caption:*

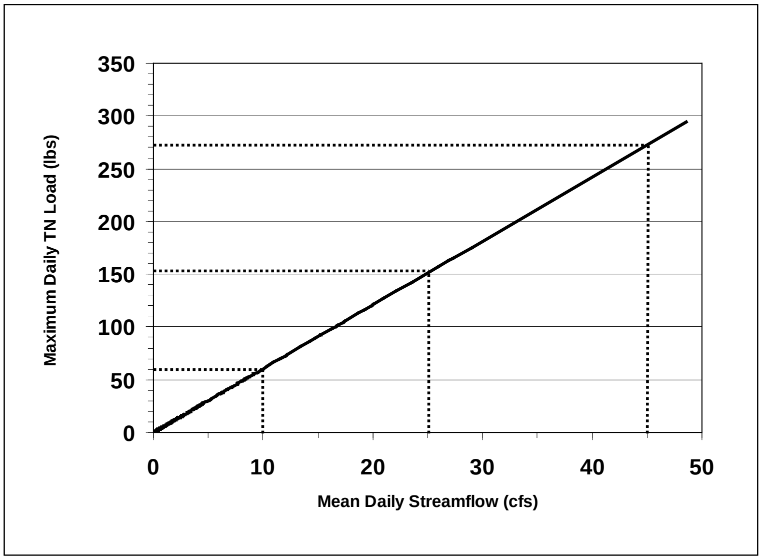

**Figure 6-4. Graph of the TN TMDLs for mean daily flows from zero to 48 cfs.**

### *Corrected Figure and Caption:*

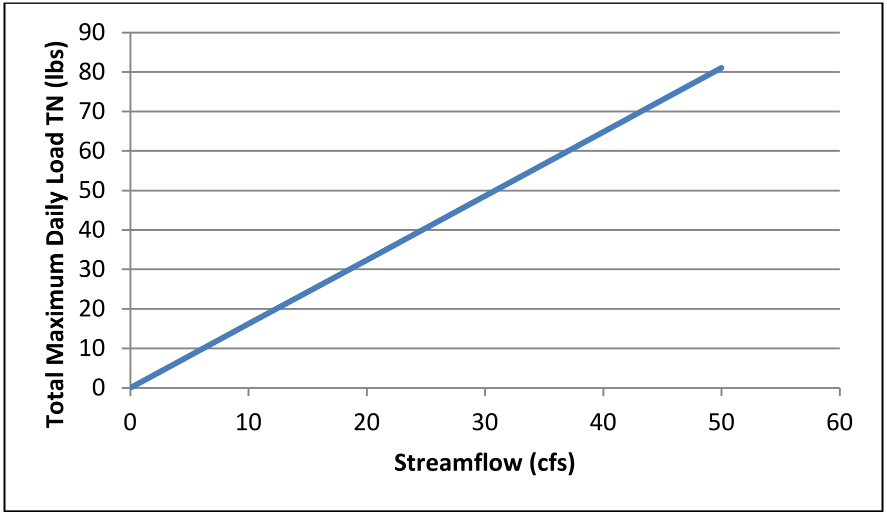

**Figure 6-4. Graph of the TN TMDLs for mean daily flows from zero to 50 cfs.**

# ACKNOWLEDGEMENTS

DEQ would like to acknowledge multiple entities for their contributions in the development of the TMDLs contained in this document. Various versions of sections of this document were sent to stakeholders for review and input. The involvement of all reviewers and members of the technical advisory group led to improvements in this document and is greatly appreciated. In particular, DEQ would like to thank Jeff Janke for sharing his knowledge of the watershed and assistance in obtaining access to sampling sites and Beth Ihle, Dave Callery, and Hans Oak of the Helena National Forest for their contributions as well as for sharing USFS data. Additionally, we would like to thank the Powell County Conservation District and the Montana Department of Transportation.

Eric Sivers, a water quality planner with DEQ, provided significant support for **Section 2.0**, Watershed Characterization. We would like to thank Carrie Greeley, an administrative assistant for the Watershed Management Section of DEQ, for her time and efforts formatting this document.

Multiple consultants provided significant contributions in the development of several appendices. Atkins (formerly PBS&J) provided contribution to the development of **Appendix C**, 2009 *Sediment and Habitat Assessment*. Water & Environmental Technologies provided contribution to the development of **Appendix E,** *Road Sediment Assessment*. HydroSolutions, Inc. collected nutrient and metals data in 2008 and 2009.

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# ACRONYM LIST

| **Acronym** | **Definition** |
|---|---|
| AFDW | Ash Free Dry Weight |
| AFO | Animal Feeding Operation |
| AL | Aquatic Life |
| AML | Abandoned Mine Lands |
| ARARS | Applicable or Relevant and Appropriate Requirements and Standards |
| ARCO | Atlantic Richfield Company |
| ARM | Administrative Rules of Montana |
| BDNF | Beaverhead Deerlodge National Forest |
| BEHI | Bank Erosion Hazard Index |
| BFW | Bankfull Width |
| BLM | Bureau of Land Management (federal) |
| BMP | Best Management Practices |
| BNSF | Burlington Northern Santa Fe |
| CAFO | Concentrated (or Confined) Animal Feed Operations |
| CALA | Controlled Allocation of Liability Act |
| CECRA | [Montana] Comprehensive Environmental Cleanup and Responsibility Act |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| CFR | Code of Federal Regulations |
| CFS | Cubic Feet Per Second |
| CWA | Clean Water Act |
| DEQ | Department of Environmental Quality (Montana) |
| DNRC | Department of Natural Resources & Conservation |
| EPA | Environmental Protection Agency (US) |
| EQIP | Environmental Quality Initiatives Program |
| FWP | Fish, Wildlife, and Parks |
| GIS | Geographic Information System |
| GWIC | Groundwater Information Center |
| HBI | Hilsenhoff Biotic Index |
| HRU | Hydrologic Response Units |
| INFISH | Inland Native Fish Strategy |
| IR | Integrated Report |
| LA | Load Allocation |
| LULC | Land Use and Land Cover |
| LWD | Large Woody Debris |
| MBMG | Montana Bureau of Mines and Geology |
| MCA | Montana Codes Annotated |
| MDT | Montana Department of Transportation |
| MMI | Multi-Metric Index |
| MOS | Margin of Safety |
| MPDES | Montana Pollutant Discharge Elimination System |
| MSU | Montana State University |
| MWCB | Mine Waste Cleanup Bureau (DEQ) |
| NBS | Near Bank Stress |
| NHD | National Hydrography Data(set) |

| **Acronym** | **Definition** |
|---|---|
| NLCD | National Land Cover Dataset |
| NOAA | National Oceanographic and Atmospheric Administration |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NPS | Nonpoint Source |
| NRCS | National Resources Conservation Service |
| NRDP | Natural Resource Damage Program |
| NRIS | Natural Resource Information System (Montana) |
| PELs | Probable Effects Levels |
| PIBO | PACFISH/INFISH Biological Opinion |
| RDG | Reclamation and Development Grants Program |
| RIT | Reach Indexing Tool |
| SAP | Sampling and Analysis Plan |
| SMCRA | Surface Mining Control & Reclamation Act |
| SMZ | Streamside Management Zone |
| STORET | EPA STOrage and RETrieval database |
| SWAT | Soil & Water Assessment Tool |
| SWPPP | Storm Water Pollution Prevention Plan |
| SWTS | Subsurface Wastewater Treatment System |
| TIE | TMDL Implementation Evaluation |
| TKN | Total Kjeldahl Nitrogen |
| TMDL | Total Maximum Daily Load |
| TN | Total Nitrogen |
| TP | Total Phosphorus |
| TPA | TMDL Planning Area |
| TSS | Total Suspended Solids |
| USDA | United States Department of Agriculture |
| USEPA | United States Environmental Protection |
| USFS | United States Forest Service |
| USFWS | US Fish and Wildlife Service |
| USGS | United States Geological Survey |
| USLE | Universal Soil Loss Equation |
| VCRA | Voluntary Cleanup and Redevelopment Act |
| VFS | Vegetated Filter Strips |
| WEPP:Road | Water Erosion Prediction Project Methodology |
| WLA | Waste Load Allocation |
| WRP | Watershed Restoration Plans |

# DOCUMENT SUMMARY

This document presents a Total Maximum Daily Load (TMDL) and framework water quality improvement plan for 18 impaired waterbody segments in the Little Blackfoot River watershed. The document contains 62 TMDLs addressing impairments associated with sediment, nutrients, and metals (see **Table DS-1**). Future assessments may require additional TMDLs in this watershed.

The Montana Water Quality Act requires TMDLs to be developed for streams and lakes that do not meet, or are not expected to meet, Montana water quality standards. A TMDL is the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. TMDLs provide an approach to improve water quality so that streams and lakes can support and maintain their state-designated beneficial uses.

The Little Blackfoot River TMDL Planning Area (TPA) is located in predominantly in Powell County, and contains a small portion in Lewis and Clark County. The TPA is bounded by the continental divide to the northeast and southeast, the Garnet Mountains to the northwest, and the divide between Spotted Dog Creek and the Clark Fork River to the southwest. The watershed area is approximately 264,124 acres, and includes the towns of Elliston and Avon. The watershed historically was an active area for mining, timber harvest, and agriculture. Today, the uplands are primarily forested and owned by the USFS, and the valley is primarily private land used for agricultural purposes.

**Sediment** - Sediment TMDLs are provided for ten waterbody segments in the Little Blackfoot TPA. Sediment is affecting beneficial uses in these streams by altering aquatic insect communities, reducing fish spawning success, and increasing turbidity. Water quality restoration goals for sediment were established on the basis of fine sediment levels in trout spawning areas and the stability of streambanks. DEQ believes that once these water quality goals are met, all water uses currently affected by sediment will be restored.

Sediment loads are quantified for natural background conditions and for the following sources: bank erosion, hillslope erosion, roads, and permitted point sources. The most significant sources include: streambank erosion associated with loss of riparian vegetation, upland erosion associated with grazing, and natural sources. The Little Blackfoot River watershed sediment TMDLs indicate that reductions in sediment loads ranging from 12% to 44% will satisfy the water quality restoration goals. Recommended strategies for achieving the sediment reduction goals are also presented in this plan. They include best management practices (BMPs) for building and maintaining roads, grazing, and harvesting timber, as well as improving riparian vegetation.

**Nutrients** – Seven nutrient TMDLs (nitrogen and/or phosphorus) are provided for six waterbody segments in the Little Blackfoot TPA. Nutrients are affecting beneficial uses in these streams by being present in concentrations that are linked to nuisance algal growth. Water quality restoration goals for nutrients were established based on concentrations that will prevent the formation of nuisance algal growth. DEQ believes that once these water quality goals are met, all water uses currently affected by nutrients will be restored.

Nutrient loads are quantified for the following sources: rangeland, cropland, forests, and suburban areas. A component of each source is the natural background load, but the natural background load is not estimated as a separate source category. The most significant sources include: livestock grazing, haying, and natural sources. The Little Blackfoot River watershed nutrient TMDLs indicate that reductions in phosphorus loads ranging from 3% to 72% and nitrogen loads ranging from 9% to 68% will satisfy the water quality restoration goals. Recommended strategies for achieving the nutrient reduction goals are also presented in this plan. They include BMPs for livestock grazing and irrigation, as well as improving riparian vegetation.

**Metals** – Forty five metals TMDLs are provided for 12 waterbody segments in the Little Blackfoot TPA. There are also two waterbody segments with pH impairments; metals TMDLs for those streams are surrogates for pH TMDLs because providing pH TMDLs is not practical and addressing sources of metals impairments will also address sources of pH impairment. The metals of concern include: arsenic, beryllium, cadmium, copper, cyanide, iron, lead, mercury, selenium, and zinc. Water quality restoration goals for metals are established based on the numeric water quality criteria as defined in Circular DEQ-7. DEQ believes that once these water quality goals are met, all water uses currently affected by metals will be restored.

Metals loads are quantified for natural background conditions, abandoned mines, and permitted point sources. The Little Blackfoot River watershed metals TMDLs indicate that reductions in metals loads ranging from 5% to 95% will satisfy the water quality restoration goals. Achieving the metals reduction goals presented in this plan will mostly rely on abandoned mine reclamation. The state and federal programs as well as potential funding resources to address metals sources are summarized in this plan.

Implementation of most water quality improvement measures described in this plan is based on voluntary actions of watershed stakeholders. Ideally, local watershed groups and/or other watershed stakeholders will use this TMDL, and associated information, as a tool to guide local water quality improvement activities. Such activities can be documented within a watershed restoration plan consistent with DEQ and EPA recommendations.

A flexible approach to most nonpoint source TMDL implementation activities may be necessary as more knowledge is gained through implementation and future monitoring. The plan includes a monitoring strategy designed to track progress in meeting TMDL objectives and goals and to help refine the plan during its implementation.

**Table DS-1. List of Impaired Waterbodies and their Impaired Uses in the Little Blackfoot TPA with Completed Sediment, Nutrient, and Metals TMDLs Contained in this Document**

| Waterbody Name & Location | Waterbody ID | TMDL Prepared | Pollutant Category | Impaired Use |
|---|---|---|---|---|
| AMERICAN CREEK, headwaters to mouth (Dog Creek) | MT76G004_079 | Arsenic | Metals | Drinking Water |
| CARPENTER CREEK, Basin Creek to mouth (Little Blackfoot River) | MT76G004_092 | Total Phosphorus | Nutrients | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |

**Table DS-1. List of Impaired Waterbodies and their Impaired Uses in the Little Blackfoot TPA with Completed Sediment, Nutrient, and Metals TMDLs Contained in this Document**

| Waterbody Name & Location | Waterbody ID | TMDL Prepared | Pollutant Category | Impaired Use |
|---|---|---|---|---|
| DOG CREEK, headwaters to Meadow Creek | MT76G004_071 | Sediment | Sediment | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| | | Arsenic | Metals | Aquatic Life, Cold Water Fishery |
| | | Lead | Metals | Aquatic Life, Cold Water Fishery |
| | | Zinc | Metals | Aquatic Life, Cold Water Fishery |
| | | Cadmium | Metals | Aquatic Life, Cold Water Fishery |
| | | Copper | Metals | Aquatic Life, Cold Water Fishery |
| DOG CREEK, Meadow Creek to mouth (Little Blackfoot River) | MT76G004_072 | Sediment | Sediment | Aquatic Life, Cold Water Fishery |
| | | Total Phosphorus | Nutrients | Aquatic Life, Cold Water Fishery |
| | | Copper | Metals | Aquatic Life, Cold Water Fishery |
| | | Lead | Metals | Aquatic Life, Cold Water Fishery |
| ELLISTON CREEK, headwaters to mouth (Little Blackfoot River) | MT76G004_040 | Sediment | Sediment | Aquatic Life, Cold Water Fishery |
| LITTLE BLACKFOOT RIVER, Dog Creek to mouth (Clark Fork River) | MT76G004_010 | Sediment | Sediment | Aquatic Life, Cold Water Fishery |
| | | Lead | Metals | Aquatic Life, Cold Water Fishery, Drinking Water |
| | | Arsenic | Metals | Drinking Water |
| | | Total Phosphorus | Nutrients | Aquatic Life, Cold Water Fishery |
| LITTLE BLACKFOOT RIVER, the headwaters to Dog Creek | MT76G004_020 | Sediment | Sediment | Aquatic Life, Cold Water Fishery |
| | | Arsenic | Metals | Aquatic Life, Cold Water Fishery |
| | | Cyanide | Metals | Aquatic Life, Cold Water Fishery |
| | | Cadmium | Metals | Aquatic Life, Cold Water Fishery |
| | | Copper | Metals | Aquatic Life, Cold Water Fishery |
| | | Lead | Metals | Aquatic Life, Cold Water Fishery |

**Table DS-1. List of Impaired Waterbodies and their Impaired Uses in the Little Blackfoot TPA with Completed Sediment, Nutrient, and Metals TMDLs Contained in this Document**

| Waterbody Name & Location | Waterbody ID | TMDL Prepared | Pollutant Category | Impaired Use |
|---|---|---|---|---|
| MONARCH CREEK, headwaters to mouth (Ontario Creek) | MT76G004_060 | Copper | Metals | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| | | Lead | Metals | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| | | Mercury | Metals | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| O'KEEFE CREEK, headwaters to mouth (Telegraph Creek) | MT76G004_054 | Cadmium | Metals | Aquatic Life, Cold Water Fishery |
| | | Copper | Metals | Aquatic Life, Cold Water Fishery |
| | | Zinc | Metals | Aquatic Life, Cold Water Fishery |
| ONTARIO CREEK, headwaters to mouth (Little Blackfoot River) | MT76G004_130 | Cadmium | Metals | Aquatic Life, Cold Water Fishery |
| | | Copper | Metals | Aquatic Life, Cold Water Fishery |
| | | Lead | Metals | Aquatic Life, Cold Water Fishery |
| SALLY ANN CREEK, headwaters to mouth (O'Keefe Creek) | MT76G004_055 | Cadmium | Metals | Aquatic Life, Cold Water Fishery |
| | | Copper | Metals | Aquatic Life, Cold Water Fishery |
| | | Zinc | Metals | Aquatic Life, Cold Water Fishery |
| SNOWSHOE CREEK, headwaters to mouth (Little Blackfoot River) | MT76G004_080 | Sediment | Sediment | Aquatic Life, Cold Water Fishery |
| | | Nitrate/Nitrite | Nutrients | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| SPOTTED DOG CREEK, forest boundary to mouth (Little Blackfoot River) | MT76G004_032 | Sediment | Sediment | Aquatic Life, Cold Water Fishery |
| | | Total Phosphorus | Nutrients | Aquatic Life, Cold Water Fishery |
| TELEGRAPH CREEK, Hahn Creek to mouth (Little Blackfoot River) | MT76G004_052 | Lead | Metals | Drinking Water |
| | | Mercury | Metals | Drinking Water |
| | | Cadmium | Metals | Aquatic Life, Cold Water Fishery |
| | | Copper | Metals | Aquatic Life, Cold Water Fishery |
| | | Zinc | Metals | Aquatic Life, Cold Water Fishery |

**Table DS-1. List of Impaired Waterbodies and their Impaired Uses in the Little Blackfoot TPA with Completed Sediment, Nutrient, and Metals TMDLs Contained in this Document**

| Waterbody Name & Location | Waterbody ID | TMDL Prepared | Pollutant Category | Impaired Use |
|---|---|---|---|---|
| TELEGRAPH CREEK, headwaters to Hahn Creek | MT76G004_051 | Sediment | Sediment | Aquatic Life, Cold Water Fishery |
| | | Arsenic | Metals | Aquatic Life, Cold Water Fishery |
| | | Beryllium | Metals | Aquatic Life, Cold Water Fishery |
| | | Cadmium | Metals | Aquatic Life, Cold Water Fishery |
| | | Copper | Metals | Aquatic Life, Cold Water Fishery |
| | | Zinc | Metals | Aquatic Life, Cold Water Fishery |
| | | Lead | Metals | Aquatic Life, Cold Water Fishery |
| THREEMILE CREEK, Quigley Ranch Reservoir to mouth (Little Blackfoot River) | MT76G004_112 | Sediment | Sediment | Aquatic Life, Cold Water Fishery |
| | | Total Phosphorus | Nutrients | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| | | Total Nitrogen | Nutrients | Aquatic Life, Cold Water Fishery, Primary Contact Recreation |
| TROUT CREEK, headwaters to the mouth (Little Blackfoot River) | MT76G004_120 | Sediment | Sediment | Aquatic Life, Cold Water Fishery |
| UN-NAMED CREEK, headwaters to mouth (Ontario Creek), T8N R6W S27 | MT76G006_010 | Arsenic | Metals | Drinking Water |
| | | Cadmium | Metals | Aquatic Life, Cold Water Fishery |
| | | Copper | Metals | Aquatic Life, Cold Water Fishery |
| | | Lead | Metals | Aquatic Life, Cold Water Fishery |
| | | Mercury | Metals | Drinking Water |
| | | Zinc | Metals | Aquatic Life, Cold Water Fishery |
| | | Iron | Metals | Aquatic Life, Cold Water Fishery |

# 1.0 INTRODUCTION

This document presents an analysis of water quality information and establishes total maximum daily loads (TMDLs) for sediment, nutrients, and metals problems in the Little Blackfoot TPA. This document also presents a general framework for resolving these problems. **Figure A-1** in **Appendix A**, shows a map of waterbodies in the Little Blackfoot TPA with sediment, nutrients, and metals pollutant listings.

## 1.1 BACKGROUND

In 1972, the U.S. Congress passed the Water Pollution Control Act, more commonly known as the Clean Water Act (CWA). The CWA's goal is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The CWA requires each state to designate uses of their waters and to develop water quality standards to protect those uses. Each state must monitor their waters to track if they are supporting their designated uses.

Montana's water quality designated use classification system includes the following uses:

- fish and aquatic life
- wildlife
- recreation
- agriculture
- industry
- drinking water

Each waterbody has a set of designated uses. Montana has established water quality standards to protect these uses. Waterbodies that do not meet one or more standards are called impaired waters. Every two years DEQ must file a Water Quality Integrated Report (IR), which lists all impaired waterbodies and their identified impairment causes. Impairment causes fall within two main categories: pollutant and non-pollutant.

Montana's biennial IR identifies all the state's impaired waterbody segments. All waterbody segments within the IR are indexed to the National Hydrography Dataset (NHD). The 303(d) list portion of the IR includes all of those waterbody segments impaired by a pollutant, which require a TMDL. TMDLs are not required for non-pollutant impairments. **Table A-1** in **Appendix A** identifies impaired waters for the Little Blackfoot TPA from Montana's 2010 303(d) List, as well as non-pollutant impairment causes included in Montana's "2010 Water Quality Integrated Report." **Table A-1** provides the current status of each impairment cause, identifying whether it has been addressed by TMDL development.

Both Montana state law (Section 75-5-701 of the Montana Water Quality Act) and section 303(d) of the federal CWA require the development of total maximum daily loads for all impaired waterbodies when water quality is impaired by a pollutant. A TMDL is the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards.

Developing TMDLs and water quality improvement strategies includes the following components, which are further defined in **Section 4.0**:

- Determining measurable target values to help evaluate the waterbody's condition in relation to the applicable water quality standards
- Quantifying the magnitude of pollutant contribution from their sources

- Determining the TMDL for each pollutant based on the allowable loading limits for each waterbody-pollutant combination
- Allocating the total allowable load (TMDL) into individual loads for each source

In Montana, restoration strategies and monitoring recommendations are also incorporated in TMDL documents to help facilitate TMDL implementation.

Basically, developing a TMDL for an impaired waterbody is a problem-solving exercise: The problem is excess pollutant loading that impairs a designated use. The solution is developed by identifying the total acceptable pollutant load (the TMDL), identifying all the significant pollutant-contributing sources, and identifying where pollutant loading reductions should be applied to achieve the acceptable load.

## 1.2 WATER QUALITY IMPAIRMENTS AND TMDLS ADDRESSED BY THIS DOCUMENT

**Table 1-1** below lists all of the pollutant impairment causes from the “2010 Water Quality Integrated Report” that are addressed in this document. Each pollutant impairment falls within a TMDL pollutant category (e.g., metals, nutrients, or sediment), and this document is organized by those categories.

New data assessed during this project identified 31 new sediment, nutrient, and metals impairment causes for 15 waterbodies. These impairment causes are identified in **Table 1-1** as not being on the 2010 303(d) List (within the integrated report). Additionally, as shown in **Table 1-1**, new data evaluated during this project did not support the impairment listings for six pollutants and no TMDLs were developed for those pollutants.

TMDLs are completed for each waterbody – pollutant combination, and this document contains 62 TMDLs addressing 64 impairments (**Table 1-1**). There are several non-pollutant types of impairment that are also addressed in this document. As noted above, TMDLs are not required for non-pollutants, although in many situations the solution to one or more pollutant problems will be consistent with, or equivalent to, the solution for one or more non-pollutant problems. The overlap between the pollutant TMDLs and non-pollutant impairment causes is discussed in **Section 8.0. Section 8.0** also provides some basic water quality solutions to address those non-pollutant causes not specifically addressed by TMDLs in this document. **Table A-1** in **Appendix A** includes all 70 pollutant impairment causes as well as the 18 non-pollutant impairment causes that were addressed within this document.

**Table 1-1. Pollutant Impairment Causes for the Little Blackfoot TPA Addressed within this Document**

| Waterbody & Location Description | Waterbody ID | Impairment Cause | Pollutant Category | Impairment Cause Status | Included in 2010 IR |
|---|---|---|---|---|---|
| AMERICAN CREEK, headwaters to mouth (Dog Creek) | MT76G004_079 | Arsenic | Metals | Metals TMDL contained in this document | No |
| CARPENTER CREEK, Basin Creek to mouth (Little Blackfoot River) | MT76G004_092 | Total Phosphorus | Nutrients | TP TMDL contained in this document | No |
| DOG CREEK, headwaters to Meadow Creek | MT76G004_071 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | Yes |
| | | Arsenic | Metals | Metals TMDL contained in this document | Yes |
| | | Lead | Metals | Metals TMDL contained in this document | Yes |
| | | Zinc | Metals | Metals TMDL contained in this document | Yes |
| | | Cadmium | Metals | Metals TMDL contained in this document | No |
| | | Copper | Metals | Metals TMDL contained in this document | No |
| DOG CREEK, Meadow Creek to mouth (Little Blackfoot River) | MT76G004_072 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | Yes |
| | | Nitrate/Nitrite | Nutrients | No TMDL based on review of recent data | Yes |
| | | Total Phosphorus | Nutrients | TP TMDL contained in this document | No |
| | | Copper | Metals | Metals TMDL contained in this document | No |
| | | Lead | Metals | Metals TMDL contained in this document | No |
| ELLISTON CREEK, headwaters to mouth (Little Blackfoot River) | MT76G004_040 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | No |
| LITTLE BLACKFOOT RIVER, Dog Creek to mouth (Clark Fork River) | MT76G004_010 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | Yes |
| | | Copper | Metals | No TMDL based on review of recent data | Yes |
| | | Lead | Metals | Metals TMDL contained in this document | Yes |
| | | Arsenic | Metals | Metals TMDL contained in this document | No |
| | | Nitrate/Nitrite | Nutrients | No TMDL based on review of recent data | Yes |
| | | Total Phosphorus | Nutrients | TP TMDL contained in this document | No |
| LITTLE BLACKFOOT RIVER, the headwaters to Dog Creek | MT76G004_020 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | Yes |
| | | Arsenic | Metals | Metals TMDL contained in this document | Yes |
| | | Cyanide | Metals | Metals TMDL contained in this document | Yes |
| | | Cadmium | Metals | Metals TMDL contained in this document | No |
| | | Copper | Metals | Metals TMDL contained in this document | No |
| | | Lead | Metals | Metals TMDL contained in this document | No |

**Table 1-1. Pollutant Impairment Causes for the Little Blackfoot TPA Addressed within this Document**

| Waterbody & Location Description | Waterbody ID | Impairment Cause | Pollutant Category | Impairment Cause Status | Included in 2010 IR |
|---|---|---|---|---|---|
| MONARCH CREEK, headwaters to mouth (Ontario Creek) | MT76G004_060 | Arsenic | Metals | No TMDL based on review of recent data | Yes |
| | | Copper | Metals | Metals TMDL contained in this document | Yes |
| | | Lead | Metals | Metals TMDL contained in this document | Yes |
| | | Mercury | Metals | Metals TMDL contained in this document | Yes |
| | | pH | Metals | Addressed by metals TMDLs in this document (surrogate) | Yes |
| | | Selenium | Metals | No TMDL based on review of recent data | Yes |
| O'KEEFE CREEK, headwaters to mouth (Telegraph Creek) | MT76G004_054 | Cadmium | Metals | Metals TMDL contained in this document | No |
| | | Copper | Metals | Metals TMDL contained in this document | No |
| | | Zinc | Metals | Metals TMDL contained in this document | No |
| ONTARIO CREEK, headwaters to mouth (Little Blackfoot River) | MT76G004_130 | Cadmium | Metals | Metals TMDL contained in this document | No |
| | | Copper | Metals | Metals TMDL contained in this document | No |
| | | Lead | Metals | Metals TMDL contained in this document | No |
| SALLY ANN CREEK, headwaters to mouth (O'Keefe Creek) | MT76G004_055 | Cadmium | Metals | Metals TMDL contained in this document | No |
| | | Copper | Metals | Metals TMDL contained in this document | No |
| | | Zinc | Metals | Metals TMDL contained in this document | No |
| SNOWSHOE CREEK, headwaters to mouth (Little Blackfoot River) | MT76G004_080 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | Yes |
| | | Nitrate/Nitrite | Nutrients | Nitrate/Nitrite TMDL contained in this document | Yes |
| SPOTTED DOG CREEK, forest boundary to mouth (Little Blackfoot River) | MT76G004_032 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | Yes |
| | | Total Phosphorus | Nutrients | TP TMDL contained in this document | Yes |
| TELEGRAPH CREEK, Hahn Creek to mouth (Little Blackfoot River) | MT76G004_052 | Lead | Metals | Metals TMDL contained in this document | Yes |
| | | Mercury | Metals | Metals TMDL contained in this document | Yes |
| | | Cadmium | Metals | Metals TMDL contained in this document | No |
| | | Copper | Metals | Metals TMDL contained in this document | No |
| | | Zinc | Metals | Metals TMDL contained in this document | No |

**Table 1-1. Pollutant Impairment Causes for the Little Blackfoot TPA Addressed within this Document**

| Waterbody & Location Description | Waterbody ID | Impairment Cause | Pollutant Category | Impairment Cause Status | Included in 2010 IR |
|---|---|---|---|---|---|
| TELEGRAPH CREEK, headwaters to Hahn Creek | MT76G004_051 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | Yes |
| | | Arsenic | Metals | Metals TMDL contained in this document | Yes |
| | | Beryllium | Metals | Metals TMDL contained in this document | Yes |
| | | Cadmium | Metals | Metals TMDL contained in this document | Yes |
| | | Copper | Metals | Metals TMDL contained in this document | Yes |
| | | Iron | Metals | No TMDL based on review of recent data | Yes |
| | | Zinc | Metals | Metals TMDL contained in this document | Yes |
| | | Lead | Metals | Metals TMDL contained in this document | No |
| THREEMILE CREEK, Quigley Ranch Reservoir to mouth (Little Blackfoot River) | MT76G004_112 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | No |
| | | Total Phosphorus | Nutrients | TP TMDL contained in this document | No |
| | | Total Nitrogen | Nutrients | TN TMDL contained in this document | No |
| TROUT CREEK, headwaters to the mouth (Little Blackfoot River) | MT76G004_120 | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in this document | No |
| UN-NAMED CREEK, headwaters to mouth (Ontario Creek), T8N R6W S27 | MT76G006_010 | Arsenic | Metals | Metals TMDL contained in this document | Yes |
| | | Cadmium | Metals | Metals TMDL contained in this document | Yes |
| | | Copper | Metals | Metals TMDL contained in this document | Yes |
| | | Lead | Metals | Metals TMDL contained in this document | Yes |
| | | Mercury | Metals | Metals TMDL contained in this document | Yes |
| | | pH | Metals | Addressed by metals TMDLs in this document (surrogate) | Yes |
| | | Zinc | Metals | Metals TMDL contained in this document | Yes |
| | | Iron | Metals | Metals TMDL contained in this document | No |

## 1.3 DOCUMENT LAYOUT

This document addresses all of the required components of a TMDL and includes an implementation and monitoring strategy, as well as a strategy to address impairment causes other than [pollutant groups]. The TMDL components are summarized within the main body of the document. Additional technical details are contained in the appendices. In addition to this introductory section, this document includes:

**Section 2.0** Little Blackfoot River Watershed Description:
Describes the physical characteristics and social profile of the watershed.

**Section 3.0** Montana Water Quality Standards
Discusses the water quality standards that apply to the Little Blackfoot River watershed.

**Section 4.0** Defining TMDLs and Their Components
Defines the components of TMDLs and how each is developed.

**Sections 5.0 – 7.0** Sediment, Nutrients, and Metals TMDL Components (sequentially):
Each section includes (a) a discussion of the affected waterbodies and the pollutant's effect on designated beneficial uses, (b) the information sources and assessment methods used to evaluate stream health and pollutant source contributions, (c) water quality targets and existing water quality conditions, (d) the quantified pollutant loading from the identified sources, (e) the determined TMDL for each waterbody, (f) the allocations of the allowable pollutant load to the identified sources.

**Section 8.0** Other Identified Issues or Concerns:
Describes other problems that could potentially be contributing to water quality impairment and how the TMDLs in the plan might address some of these concerns. This section also provides recommendations for combating these problems.

**Section 9.0** Restoration Objectives and Implementation Strategy:
Discusses water quality restoration objectives and presents a framework for implementing a strategy to meet the identified objectives and TMDLs.

**Section 10.0** Monitoring Strategy:
Describes a water quality monitoring plan for evaluating the long-term effectiveness of the "Little Blackfoot River Watershed TMDLs and Framework Water Quality Improvement Plan".

**Section 11.0** Public Participation & Public Comments:
Describes other agencies and stakeholder groups who were involved with the development of the plan and the public participation process used to review the draft document. Addresses comments received during the public review period.

# 2.0 LITTLE BLACKFOOT RIVER WATERSHED DESCRIPTION

This report describes the general physical, ecological, and cultural characteristics of the Little Blackfoot River watershed and is intended to provide some background for the watershed to support total maximum daily load (TMDL) development.

## 2.1 PHYSICAL CHARACTERISTICS

The following information describes the physical characteristics of the Little Blackfoot River watershed.

### 2.1.1 Location

The majority of the Little Blackfoot TPA is within Powell County, with a minor area in Lewis & Clark County. The total extent is 264,124 acres, or approximately 413 square miles. The TPA is located in the Pend Oreille River Basin of western Montana, as shown on **Figure A-1**. The TPA is located within the Upper Clark Fork (17010201) hydrologic unit, and is coincident with the combined 170102015 and 170102016 fifth-code watersheds.

The TPA is located in the Middle Rockies Level III Ecoregion. Four Level IV Ecoregions are mapped within the TPA (Woods, et al., 2002), as shown on **Figure A-2**. These include: Deer Lodge-Philipsburg-Avon Grassy Intermontane Hills and Valleys (17ak), Eastern Divide Mountains (17aj), Elkhorn Mountains-Boulder Batholith (17ai), Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains (17x), and Southern Garnet Sedimentary-Volcanic Mountains (17al). The TPA is bounded by the continental divide to the northeast and southeast, the Garnet Mountains to the northwest, and the divide between Spotted Dog Creek and the Clark Fork River to the southwest.

### 2.1.2 Topography

Elevations in the Little Blackfoot TPA range from approximately 4,350 - 8,600 feet above mean sea level (**Figure A-3**). The lowest point is where the Little Blackfoot River drains into the Clark Fork River. The highest point is Thunderbolt Mountain, at the southernmost point of the TPA (8,597 feet). The uplands are characterized by steep-sided valleys with gently sloping ridgelines and peaks.

### 2.1.3 Geology

**Figure A-4** provides an overview of the geology, based on the most recent geologic map of the Butte 1° x 2° quadrangle (Lewis, 1998).

**Bedrock**

The bedrock of the TPA includes Precambrian (i.e. Belt Series), Paleozoic and Mesozoic sedimentary rocks, granitic rocks of the Boulder batholith, and Cretaceous to Tertiary volcanic rocks (Schmidt, et al.,1994; Alden, 1953). The Mesozoic sedimentary rocks, and the Cretaceous age rocks in particular, are more susceptible to erosion, as they are not as hardened as the other units. The Cretaceous units include terrestrial, nearshore and offshore facies, and commonly feature weakly lithified fine-grained sediments. In contrast, the older sedimentary rocks, by virtue of their greater age, have been subject to further consolidation and lithification. In very general terms, the Precambrian sedimentary rocks and the granitic rocks of the batholith occupy the highest elevations in the TPA.

**Basin Sediments**

Tertiary and Quaternary sedimentary deposits are widespread in the Little Blackfoot TPA. The Tertiary sediments are commonly fine-grained with isolated bodies of coarser material. Tertiary sediments commonly occur in benches or dry terraces. Quaternary sediments include fluvial, colluvial, glacial and proglacial deposits. The most prominent glacial features in the TPA are the terminal moraines east of Elliston, in the broad valley bottom where Dog Creek meets the Little Blackfoot River. These features were deposited by glaciers descending from the Little Blackfoot headwaters (Ruppel,1962).

### 2.1.4 Soil Erodibility and Slope

The USGS Water Resources Division (Schwartz and Alexander, 1995) created a dataset of hydrology-relevant soil attributes, based on the USDA Natural Resources Conservation Service (NRCS) STATSGO soil database. Soil erodibility is based on the Universal Soil Loss Equation (USLE) K-factor (Wischmeier and Smith, 1978). K-factor values range from 0 to 1, with a greater value corresponding to greater potential for erosion. Susceptibility to erosion is mapped on **Figure A-5**, with soil units assigned to the following ranges: low (0.0-0.2), moderate-low (0.2-0.29) and moderate-high (0.3-0.4). Values of >0.4 are considered highly susceptible to erosion.

There are no values greater than 0.34 (moderate-high), and the majority of the TPA (65.5%) is mapped with moderate-low susceptibility soils. A sizeable percentage (31%) is mapped with moderate-high susceptibility, and only 3.3% is mapped with low susceptibility soils. Soils with low susceptibility to erosion are confined to bedrock uplands. The moderate-low susceptibility soils are generally found in the areas of higher elevation and steeper slope. The areas of lower slope (generally valleys) are associated with soils of moderate-high susceptibility to erosion. The exception to this pattern is that the soils along the Little Blackfoot River floodplain are mapped as moderate-low susceptibility soils. The majority of the TPA has slopes less than 20°, and that steeper slopes are limited to the edges of valleys (**Figure A-6**).

### 2.1.5 Surface Water

The TPA includes the entire Little Blackfoot River watershed. The river flows a distance of approximately 47 miles. Hydrography of the Little Blackfoot TPA is illustrated on **Figure A-7**. Stream mapping at 1:24,000 (Montana Department of Natural Resources and Conservation, 2008) includes 346 miles of named streams, with a total of 534 miles of streams mapped in the TPA.

USGS maintains one gage within the TPA (#12324590), which is located near Garrison (**Figure A-7**) and has been active since 1972. Flows in the Little Blackfoot River vary considerably over a calendar year but on average (over a 33-year period of record), low flows occur in September, and peak flows occur in May (**Figure 2-1**).

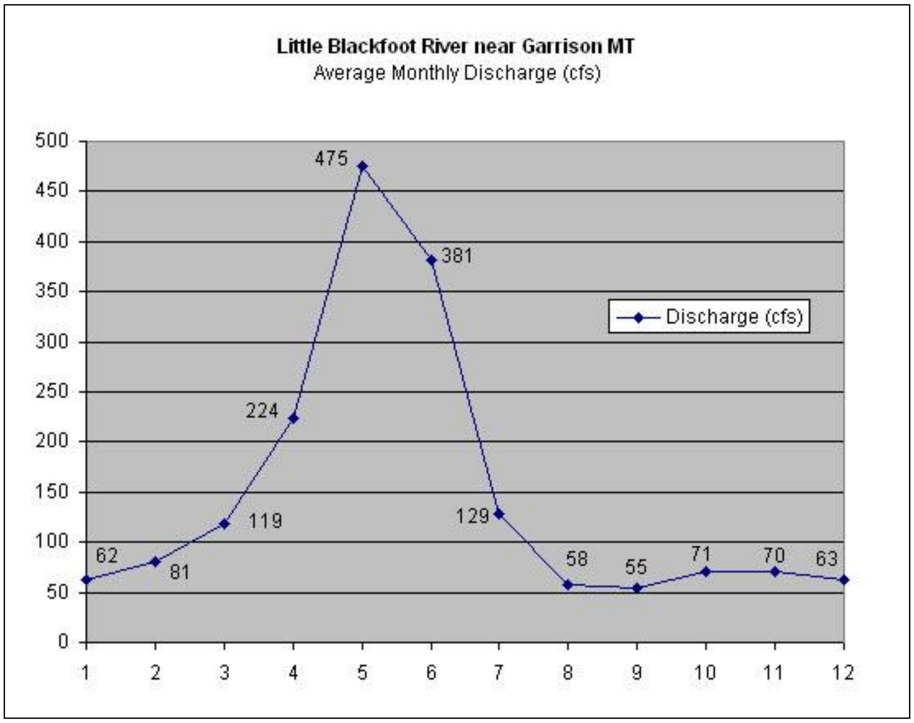

**Figure 2-1. Average monthly discharge based on the period of record (1972 – 2006).**

Peak annual discharges in the Little Blackfoot River vary over nearly two orders of magnitude. During the period of record, annual peaks ranged from 8,650 cfs (May 22, 1981) to 175 cfs (April 30, 1992). The mean peak annual discharge during the 33-year period of record is 1,505 cfs. Of the annual peak discharges, 13 occurred prior to May, and 7 occurred prior to April. Annual peaks have occurred as early as January 11 and late as July 4.

### 2.1.6 Groundwater

No basin-specific hydrogeology studies have been completed, but Kendy and Tresch (1996) described the groundwater system of the Avon Valley in general terms, assuming that groundwater flow within the valley is typical of intermontane basins and flows toward the center of the basin from the head and sides, and then down valley along the central axis. Kendy and Tresch (1996) report that groundwater of the Avon Valley is characterized by a calcium-bicarbonate chemistry, with dissolved solids generally less than 250 mg/L. Dissolved solids are higher (250-500 mg/L) in the glacial sediments north of Avon, and in water from Avon Warm Springs (650 mg/L). Low-hydraulic conductivity glacial sediments, combined with generally shallow bedrock, have created isolated bogs in the upper reaches of the Little Blackfoot and some of its tributaries in the Boulder Mountains. The average groundwater flow velocity in the bedrock is probably several orders of magnitude lower than in the valley fill sediments. However, carbonate and siliciclastic sedimentary rocks in the mountains may have zones of significant permeability. The hydrologic role of the structural geology (faults and folds) is uncertain because faults may act as flow conduits or barriers. Natural recharge occurs from infiltration of precipitation, stream loss, and flow out of the adjacent bedrock aquifers. Flood irrigation is an additional source of recharge to the valley aquifers, particularly along the floodplain.

The Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center (GWIC) program monitors and samples a statewide network of wells (Montana Bureau of Mines and Geology, 2008). As of August 2007, the GWIC database reports 401 wells within the TPA (Montana Department of Natural Resources and Conservation, 2008), and water quality data are available for 27 of the wells (**Figure A-8**). The water quality data include general physical parameters: temperature, pH and specific conductance, in addition to inorganic chemistry (common ions, metals and trace elements).

### 2.1.7 Climate

Climate in the area is typical of mid-elevation intermontane valleys in western Montana. Precipitation is most abundant in May and June and annual average precipitation ranges from 13-43 inches in the Little Blackfoot TPA (**Table 2-1**). The mountains receive most of the moisture, and the mouth of the TPA receives the least. The precipitation data (**Figure A-9**) is mapped by Oregon State University's PRISM Group, using records from NOAA stations (PRISM Group, 2004).

National Oceanographic and Atmospheric Administration (NOAA) currently operates three weather stations in the TPA, and several more have been discontinued (**Figure A-9**). The USDA Natural Resources Conservation Service (NRCS) operates twelve SNOTEL snowpack monitoring stations within the TPA (**Figure A-9**). Climate data are provided by the Western Regional Climate Center, operated by the Desert Research Institute of Reno, Nevada.

**Table 2-1. Monthly Climate Summary for Elliston.**

Elliston, Montana (242738) Period of Record : 4/25/1951 to 12/31/2005

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Ave. Max. Temp (F)** | 30.6 | 35.3 | 40.0 | 50.6 | 60.8 | 68.8 | 80.8 | 78.6 | 67.5 | 55.7 | 40.3 | 32.6 | 53.5 |
| **Ave. Min. Temp. (F)** | 9.3 | 12.7 | 16.2 | 25.5 | 33.2 | 39.7 | 43.9 | 41.7 | 34.0 | 26.5 | 17.6 | 11.8 | 26.0 |
| **Ave Tot. Precip. (in.)** | 1.04 | 0.67 | 0.94 | 1.46 | 2.03 | 2.90 | 1.15 | 1.47 | 1.30 | 1.06 | 0.86 | 0.89 | 15.78 |
| **Ave.. Snowfall (in.)** | 15.8 | 10.1 | 13.3 | 11.4 | 2.6 | 0.2 | 0.0 | 0.0 | 0.3 | 3.7 | 8.9 | 14.1 | 80.5 |
| **Ave Snow Depth (in.)** | 6 | 5 | 4 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 2 |

## 2.2 ECOLOGICAL PARAMETERS

### 2.2.1 Vegetation

The primary cover in the uplands is conifer forest. Conifers are dominated by Lodgepole pine, giving way to Douglas fir at lower elevations, with lesser amounts of White pine, Western larch and juniper. The valleys are characterized by grassland and irrigated agricultural land, with minor shrublands. Landcover is shown on **Figures A-10** and **A-11**. Data sources include the University of Montana's Satellite Imagery land Cover (SILC) project (University of Montana, 2002), and USGS National Land Cover Dataset (NLCD) mapping (Montana State Library, 1992).

### 2.2.2 Aquatic Life

Native fish species present in the TPA include: bull trout, westslope cutthroat trout, mountain whitefish, mottled sculpin, and slimy sculpin. Bull trout and westslope cutthroat trout are designated "Species of Concern" by Montana Department of Fish, Wildlife and Parks (FWP). Bull trout are further listed as "threatened" by the US Fish and Wildlife Service (USFWS). Introduced species are also present in streams, including: brook, rainbow and brown trout. Hybrids (rainbow-cutthroat and brook-bull) are reported in streams. Data on fish species distribution (**Figure A-12**) are collected, maintained and provided by FWP (2006).

### 2.2.3 Fires

The United States Forest Service (USFS) Region 1 office and the USFS remote sensing applications center provide data on fire locations from 1940 to the present, and no fires are mapped within the TPA for this period.

## 2.3 CULTURAL PARAMETERS

### 2.3.1 Population

An estimated 622 persons lived within the TPA in 2000 (Montana Department of Natural Resources and Conservation, 2008). Population estimates are derived from census data (United States Census Bureau, 2000), based upon the populations reported from census blocks within and intersecting the TPA boundary. Elliston and Avon had reported populations of 225 and 124 in the 2000 census, respectively, and the remainder of the population is sparsely distributed (**Figure A-13**).

### 2.3.2 Transportation Networks

The principal transportation route in the TPA is US Highway 12. Highway 12 connects Garrison Junction and I-90 to Helena. The network of unpaved roads on public and private lands will be further characterized as part of the sediment source assessment (**Section 5.7.3 and Appendix E**). The Burlington Northern Santa Fe (BNSF) railroad line between Helena and Missoula passes through the TPA.

### 2.3.3 Land Ownership

Land ownership data are provided by the State of Montana CAMA database via the NRIS website (Montana Department of Natural Resources and Conservation, 2008). Slightly more than one-half of the TPA is under private ownership. The dominant landholder is the USFS, which administers 37% of the TPA. Montana State Trust Lands occupy 6% of the TPA. Land ownership is shown on **Figure A-14**.

**Table 2-2. Land ownership in the Little Blackfoot watershed**

| Owner | Acres | Square Miles | % of Total |
|---|---|---|---|
| Private | 148,413 | 231.9 | 56% |
| USFS | 98,016 | 153.1 | 37% |
| BLM | 2,723 | 4.3 | 1% |
| State Trust Land | 14,971 | 23.4 | 6% |
| Total | 264,124 | 412.7 | 100% |

### 2.3.4 Land Use

Land use within the TPA is dominated by forest and agriculture. Agriculture in the lowlands is primarily related to the cattle industry: irrigated hay and dry grazing. Information on land use is based on land use and land cover (LULC) mapping completed by the USGS in the 1980s. The data are at 1:250,000 scale, and are based upon manual interpretation of aerial photographs. Agricultural land use is illustrated on **Figure A-15**.

**Table 2-3. Land Use and Cover in the Little Blackfoot watershed.**

| Land Use | Acres | Square Miles | % of Total |
|---|---|---|---|
| Evergreen Forest | 132,807.2 | 207.5113 | 50.28% |
| Grasslands/Herbaceous | 81,847.6 | 127.8869 | 30.99% |
| Shrubland | 31,068.0 | 48.54367 | 11.76% |
| Pasture/Hay | 11,998.0 | 18.74694 | 4.54% |

**Table 2-3. Land Use and Cover in the Little Blackfoot watershed.**

| Land Use | Acres | Square Miles | % of Total |
|---|---|---|---|
| Transitional | 2,204.7 | 3.444848 | 0.83% |
| Woody Wetlands | 1,749.4 | 2.733444 | 0.66% |
| Deciduous Forest | 1,162.7 | 1.816717 | 0.44% |
| Emergent Herbaceous Wetlands | 710.1 | 1.109537 | 0.27% |
| Open Water | 204.6 | 0.319679 | 0.08% |
| Commercial/Industrial/Transportation | 187.6 | 0.293113 | 0.07% |
| Small Grains | 80.5 | 0.125792 | 0.03% |
| Bare Rock/Sand/Clay | 37.2 | 0.058103 | 0.014% |
| Row Crops | 21.6 | 0.033707 | 0.008% |
| Mixed Forest | 12.5 | 0.01946 | 0.005% |
| Urban/Recreational Grasses | 11.4 | 0.01788 | 0.004% |
| Low Intensity Residential | 7.5 | 0.011676 | 0.003% |
| Perennial Ice/Snow | 4.1 | 0.006466 | 0.002% |
| High Intensity Residential | 2.4 | 0.003822 | 0.001% |

Berkas et al.(2005) reported that roughly 11,000 acres upstream of the Garrison gage are irrigated with surface water diversions. Additional information on agricultural land use can be obtained from Department of Revenue data. The Department of Revenue assigns a predominant agricultural use only if more than 50% of a given parcel is so used. A total of 5,502 acres of irrigated land is reported in the TPA. The dominant designated agricultural use is grazing, corresponding to 95,140 acres (441 square miles), or 36%, of the TPA area (Montana Department of Natural Resources and Conservation, 2008).

## 2.3.5 Mining

Milling was widely performed within the TPA and waste rock and tailings are still present in many locations. Like many Montana mining districts, much of the metal production began in the 1860s with gold-bearing placers. Later, lode deposits of lead, zinc, gold, silver, and copper came to be of importance. Much of the mining was concentrated in the Elliston district, which is near the Little Blackfoot headwaters. MBMG completed an environmental survey of 468 abandoned mining sites in the Helena National Forest in the 1990s (Hargrave, et al., 1998); because the study was for the entire forest, it also included mines outside of the Little Blackfoot TPA. Twenty sites in the TPA were determined to have potential to adversely affect soil or water on USFS land. Based on public health risks, DEQ has identified 15 priority abandoned mines within the watershed. Priority and non-priority abandoned mine locations as recorded by DEQ and MBMG are plotted on **Figure A-16**. No active mines are present as of September 2011, according to DEQ Environmental Management Bureau files.

## 2.3.6 Point Sources

There are four point sources permitted under the Montana Pollution Discharge Elimination System (MPDES) within the TPA that will be addressed within this document (**Figure A-16**). None of the permits are for point sources that continuously discharge; three are under the general permit for construction stormwater (MTR100000) and one is under the general permit for suction dredging (MTG370000), which is a portable and seasonal operation.

### 2.3.7 Wastewater

The towns of Elliston and Avon are not sewered, and wastewater treatment within the TPA is provided by on-site septic tanks and drainfields. Septic system density is estimated from the 2000 census block data, based on the assumption of one septic tank and drainfield for each 2.5 persons (Montana Department of Natural Resources and Conservation, 2008). Septic system density is classified as low (<50 per square mile), moderate (51-300 per square mile) or high (>300 per square mile). Nearly all of the TPA is mapped as low septic system density, with very limited areas of moderate (245 acres) and high (67.5 acres) density. The high and moderate density locations are found primarily around Elliston and Avon (**Figure A-16**).

# 3.0 MONTANA WATER QUALITY STANDARDS

The federal Clean Water Act provides for the restoration and maintenance of the chemical, physical, and biological integrity of the nation's surface waters so that they support all designated uses. Water quality standards are used to determine impairment, establish water quality targets, and to formulate the TMDLs and allocations.

Montana's water quality standards include four main parts:

1. Stream classifications and designated uses
2. Numeric and narrative water quality criteria designed to protect designated uses
3. Nondegradation provisions for existing high-quality waters
4. Prohibitions of practices that degrade water quality

Those components that apply to this document are reviewed briefly below. More detailed descriptions of Montana's water quality standards that apply to the Little Blackfoot TPA streams can be found **Appendix B**.

## 3.1 LITTLE BLACKFOOT TPA STREAM CLASSIFICATIONS AND DESIGNATED BENEFICIAL USES

Waterbodies are classified based on their designated uses. All Montana waters are classified for multiple uses. All streams and lakes within the Little Blackfoot River watershed are classified as B-1, which specifies that the water must be maintained suitable to support all of the following uses:

- drinking, culinary, and food processing purposes after conventional treatment
- bathing, swimming, and recreation
- growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers
- agricultural and industrial water supply

While some of the waterbodies might not actually be used for a designated use (e.g., drinking water supply), their water quality still must be maintained suitable for that designated use. More detailed descriptions of Montana's surface water classifications and designated uses are provided in **Appendix B**.

Ten waterbody segments in the Little Blackfoot TPA are listed in the "2010 Water Quality Integrated Report" as not supporting or partially supporting one or more designated uses (**Table 3-1**). Waterbodies that are "not supporting" or "partially supporting" a designated use are impaired and require a TMDL. TMDLs are written to protect all designated uses for a waterbody and not just those identified as being non or partially supported. DEQ describes impairment as either partially supporting or not supporting, based on assessment results. Not supporting is applied to not meeting a drinking water standard, and is also applied to conditions where the assessment results indicate a severe level of impairment of aquatic life or coldwater fishery. A non-supporting level of impairment does not equate to complete elimination of the use. Detailed information about Montana's use support categories can be found in DEQ's water quality assessment methods(Montana Department of Environmental Quality, 2011).

**Table 3-1. Impaired Waterbodies and their Designated Use Support Status on the "2010 Water Quality Integrated Report" in the Little Blackfoot TPA**

| Waterbody & Location Description | Waterbody ID | Use Class | Aquatic Life | Cold Water Fishery | Agriculture | Industry | Drinking Water | Primary Contact Recreation |
|---|---|---|---|---|---|---|---|---|
| DOG CREEK, headwaters to Meadow Creek | MT76G004_071 | B-1 | N | N | F | F | F | P |
| DOG CREEK, Meadow Creek to mouth (Little Blackfoot River) | MT76G004_072 | B-1 | P | P | F | F | F | F |
| LITTLE BLACKFOOT RIVER, Dog Creek to mouth (Clark Fork River) | MT76G004_010 | B-1 | P | P | F | F | P | P |
| LITTLE BLACKFOOT RIVER, the headwaters to Dog Creek | MT76G004_020 | B-1 | P | P | F | F | F | F |
| MONARCH CREEK, headwaters to mouth (Ontario Creek) | MT76G004_060 | B-1 | P | P | F | F | F | P |
| SNOWSHOE CREEK, headwaters to mouth (Little Blackfoot River) | MT76G004_080 | B-1 | P | P | F | F | F | P |
| SPOTTED DOG CREEK, forest boundary to mouth (Little Blackfoot River) | MT76G004_032 | B-1 | P | P | F | F | F | F |
| TELEGRAPH CREEK, Hahn Creek to mouth (Little Blackfoot River) | MT76G004_052 | B-1 | F | F | F | F | N | F |
| TELEGRAPH CREEK, headwaters to Hahn Creek | MT76G004_051 | B-1 | N | N | F | F | N | F |
| Un-Named Creek, headwaters to mouth (Ontario Creek), T8N R6W S27 | MT76G006_010 | B-1 | N | N | P | F | N | P |

F = Fully Supporting, P = Partially Supporting, N= Not Supporting, T = Threatened, X = Not Assessed

## 3.2 LITTLE BLACKFOOT TPA WATER QUALITY STANDARDS

In addition to the use classifications described above, Montana's water quality standards include numeric and narrative criteria that protect the designated uses. Numeric criteria define the allowable concentrations of specific pollutants so as not to impair designated uses. Narrative criteria are more "free form" descriptions, or statements, of unacceptable conditions. **Appendix B** defines both the numeric and narrative water quality criteria for the Little Blackfoot River watershed. For sediment and nutrient TMDL development in the Little Blackfoot TPA, only the narrative standards are applicable.

Numeric standards apply to pollutants that are known to have adverse effects on human health or aquatic life (e.g., metals, organic chemicals, and other toxic constituents). Human health standards are set at levels that protect against long-term (lifelong) exposure, as well as short-term exposure through direct contact such as swimming. Numeric standards for aquatic life include chronic and acute values. Chronic aquatic life standards prevent long-term, low level exposure to pollutants. Acute aquatic life standards protect from short-term exposure to pollutants. Chronic standards are usually more stringent than acute standards.

Narrative standards are developed when there is insufficient information to develop specific numeric standards. Narrative standards describe either the allowable condition or an allowable increase of a pollutant above “naturally occurring” conditions. DEQ uses the naturally occurring condition, called a “reference condition,” to determine whether or not narrative standards are being met (see **Appendix B**).

Reference defines the condition a waterbody could attain if all reasonable land, soil, and water conservation practices were put in place. Reasonable land, soil, and water conservation practices usually include, but are not limited to, best management practices (BMPs).

# 4.0 DEFINING TMDLS AND THEIR COMPONENTS

A Total Maximum Daily Load (TMDL) is a tool for implementing water quality standards and is based on the relationship between pollutant sources and water quality conditions. More specifically, a TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive from all sources and still meet water quality standards.

Pollutant sources are generally defined as two categories: point sources and nonpoint sources. Point sources are discernible, confined and discrete conveyances, such as pipes, ditches, wells, containers, or concentrated animal feeding operations, from which pollutants are being, or may be, discharged. Some sources such as return flows from irrigated agriculture are not included in this definition. All other pollutant loading sources are considered nonpoint sources. Nonpoint sources are diffuse and are typically associated with runoff, streambank erosion, most agricultural activities, atmospheric deposition, and groundwater seepage. Natural background loading is a type of nonpoint source.

As part of TMDL development, the allowable load is divided among all significant contributing point and nonpoint sources. For point sources, the allocated loads are called “wasteload allocations” (WLAs). For nonpoint sources, the allocated loads are called “load allocations” (LAs).

A TMDL is expressed by the equation: TMDL = $\Sigma$WLA + $\Sigma$LA, where:

$\Sigma$WLA is the sum of the wasteload allocation(s) (point sources)
$\Sigma$LA is the sum of the load allocation(s) (nonpoint sources)

TMDL development must include a margin of safety (MOS), which can be explicitly incorporated into the above equation. Alternatively, the MOS can be implicit in the TMDL. A TMDL must also ensure that the waterbody will be able to meet and maintain water quality standards for all applicable seasonal variations (e.g., pollutant loading or use protection).

Development of each TMDL has four major components:

- Determining water quality targets
- Quantifying pollutant sources
- Establishing the total allowable pollutant load
- Allocating the total allowable pollutant load to their sources

Although the way a TMDL is expressed can vary by pollutant, these four components are common to all TMDLs, regardless of pollutant. Each component is described in further detail in the following subsections.

**Figure 4-1** illustrates how numerous sources contribute to the existing load and how the TMDL is defined. The existing load can be compared to the allowable load to determine the amount of pollutant reduction needed.

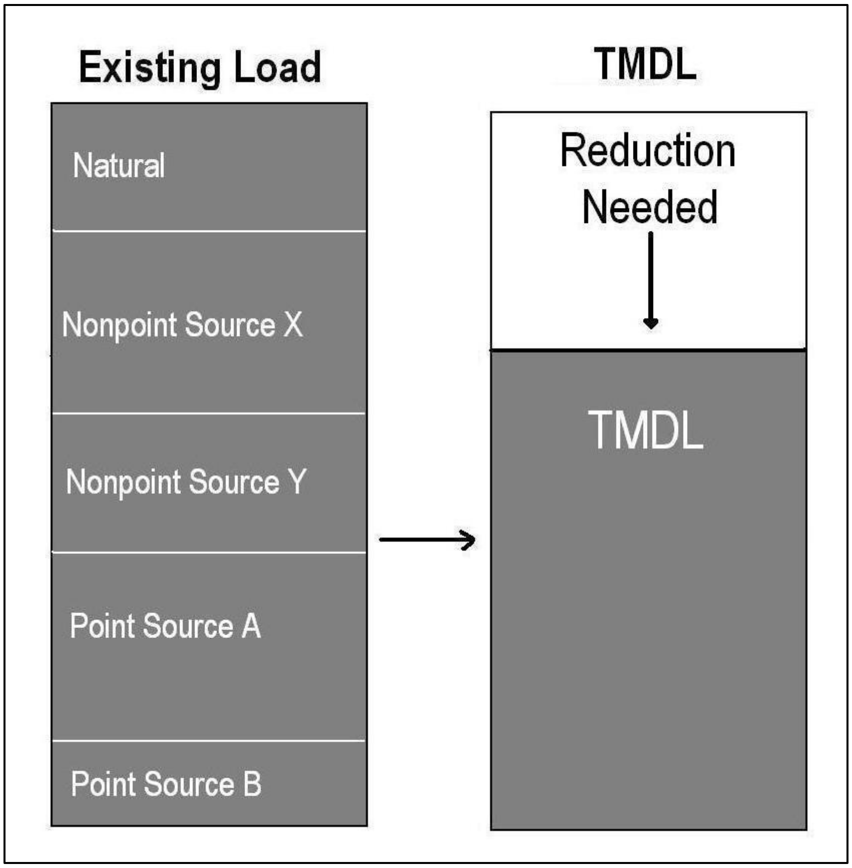

**Figure 4-1. Schematic Example of TMDL Development**

## 4.1 DEVELOPING WATER QUALITY TARGETS

TMDL water quality targets are a translation of the applicable numeric or narrative water quality standard(s) for each pollutant. For pollutants with established numeric water quality standards, the numeric value(s) are used as the TMDL targets. For pollutants with narrative water quality standard(s), the targets provide a waterbody-specific interpretation of the narrative standard(s).

Water quality targets are typically developed for multiple parameters that link directly to the impaired beneficial use(s) and applicable water quality standard(s). Therefore, the targets provide a benchmark by which to evaluate attainment of water quality standards. Furthermore, comparing existing stream conditions to target values allows for a better understanding of the extent and severity of the problem.

## 4.2 QUANTIFYING POLLUTANT SOURCES

All significant pollutant sources, including natural background loading, are quantified so that the relative pollutant contributions can be determined. Because the effects of pollutants on water quality can vary throughout the year, assessing pollutant sources must include an evaluation of the seasonal variability of the pollutant loading. The source assessment helps to define the extent of the problem by linking the pollutant load to specific sources in the watershed.

A pollutant load is usually quantified for each point source permitted under the Montana Pollutant Discharge Elimination System (MPDES) program. Nonpoint sources are quantified by source categories (e.g., unpaved roads) and/or by land uses (e.g., crop production or forestry). These source categories and land uses can be divided further by ownership, such as federal, state, or private. Alternatively, most, or all, pollutant sources in a sub-watershed or source area can be combined for quantification purposes.

Because all potentially significant sources of the water quality problems must be evaluated, source assessments are conducted on a watershed scale. The source quantification approach may produce reasonably accurate estimates or gross allotments, depending on the data available and the techniques used for predicting the loading (40 CFR Section 130.2(I)). Montana TMDL development often includes a combination of approaches, depending on the level of desired certainty for setting allocations and guiding implementation activities.

## 4.3 ESTABLISHING THE TOTAL ALLOWABLE LOAD

Identifying the TMDL requires a determination of the total allowable load over the appropriate time period necessary to comply with the applicable water quality standard(s). Although "TMDL" implies "daily load," determining a daily loading may not be consistent with the applicable water quality standard(s), or may not be practical from a water quality management perspective. Therefore, the TMDL will ultimately be defined as the total allowable loading during a time period that is appropriate for applying the water quality standard(s) and which is consistent with established approaches to properly characterize, quantify, and manage pollutant sources in a given watershed. For example, sediment TMDLs may be expressed as an allowable annual load.

If a stream is impaired by a pollutant for which numeric water quality criteria exist, the TMDL, or allowable load, is typically calculated as a function of streamflow and the numeric criteria. This same approach can be applied when a numeric target is developed to interpret a narrative standard.

Some narrative standards, such as those for sediment, often have a suite of targets. In many of these situations it is difficult to link the desired target values to highly variable, and often episodic, instream loading conditions. In such cases the TMDL is often expressed as a percent reduction in total loading based on source quantification results and an evaluation of load reduction potential (**Figure 4-1**). The degree by which existing conditions exceed desired target values can also be used to justify a percent reduction value for a TMDL.

Even if the TMDL is preferably expressed using a time period other than daily, an allowable daily loading rate will also be calculated to meet specific requirements of the federal Clean Water Act. Where this occurs, TMDL implementation and the development of allocations will still be based on the preferred time period, as noted above.

## 4.4 DETERMINING POLLUTANT ALLOCATIONS

Once the allowable load (the TMDL) is determined, that total must be divided among the contributing sources. In addition to basic technical and environmental analysis, DEQ also considers economic and social costs and benefits when developing allocations. The allocations are often determined by quantifying feasible and achievable load reductions through application of a variety of best management practices and other reasonable conservation practices.

Under the current regulatory framework (40 CFR 130.2) for developing TMDLs, flexibility is allowed in allocations in that "TMDLs can be expressed in terms of either mass per time, toxicity, or other appropriate measure.” Allocations are typically expressed as a number, a percent reduction (from the current load), or as a surrogate measure (e.g., a percent increase in canopy density for temperature TMDLs).

**Figure 4-2** illustrates how TMDLs are allocated to different sources using WLAs for point sources and LAs for natural and nonpoint sources. Although some flexibility in allocations is possible, the sum of all allocations must meet the water quality standards in all segments of the waterbody.

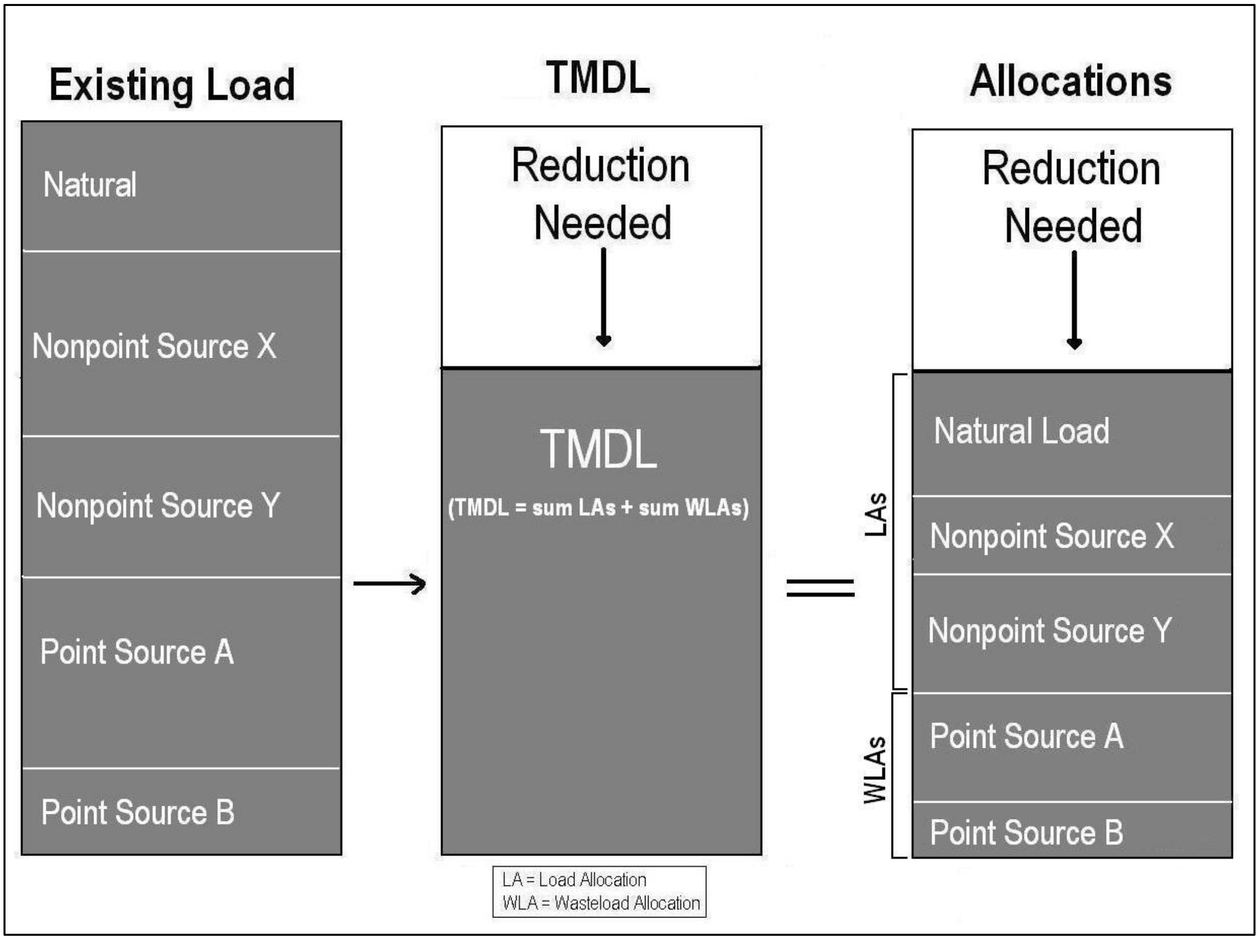

**Figure 4-2. Schematic Diagram of a TMDL and its Allocations**

Incorporating an MOS is required when developing TMDLs. The MOS accounts for the uncertainty between pollutant loading and water quality and is intended to ensure that load reductions and allocations are sufficient to support beneficial uses. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. Environmental Protection Agency, 1999b).

# 5.0 SEDIMENT TMDL COMPONENTS

This portion of the document focuses on sediment as a cause of water quality impairment in the Little Blackfoot TPA. It describes: 1) the mechanisms by which sediment can impair beneficial uses, 2) the specific stream segments of concern, 3) the presently available data pertaining to sediment impairment characterization in the watershed, including target development and a comparison of existing water quality to targets, 4) quantification of the various contributing sources of sediment based on recent studies, and 5) identification of and justification for the sediment TMDLs and the TMDL allocations.

## 5.1 MECHANISM OF EFFECTS OF EXCESS SEDIMENT ON BENEFICIAL USES

Sediment is a naturally occurring component of healthy and stable stream and lake ecosystems. Regular flooding allows sediment deposition to build floodplain soils and point bars, and it prevents excess scour of the stream channel. Riparian vegetation and natural instream barriers such as large woody debris, beaver dams, or overhanging vegetation help trap sediment and build channel and floodplain features. When these barriers are absent or excessive sediment loading enters the system from increased bank erosion or other sources, it may alter channel form and function and affect fish and other aquatic life by increasing turbidity and causing excess sediment to accumulate in critical aquatic habitat areas not naturally characterized by high levels of fine sediment.

More specifically, sediment may block light and cause a decline in primary production, and it may also interfere with fish and macroinvertebrate survival and reproduction. Fine sediment deposition reduces availability of suitable spawning habitat for salmonid fishes and can smother eggs or hatchlings. Effects from excess sediment are not limited to suspended or fine sediment; an accumulation of larger sediment (e.g. cobbles) can fill pools, reduce the percentage of desirable particle sizes for fish spawning, and cause channel overwidening (which may lead to additional sediment loading and/or increased temperatures). This larger sediment can also reduce or eliminate flow in some stream reaches where sediment aggrades within the channel, causing flow to go subsurface (May and Lee, 2004). Although fish and aquatic life are typically the most sensitive beneficial uses regarding sediment, excess sediment may also affect other uses. For instance, high concentrations of suspended sediment in streams can also cause water to appear murky and discolored, negatively impacting recreational use, and excessive sediment can increase filtration costs for water treatment facilities that provide safe drinking water.

## 5.2 STREAM SEGMENTS OF CONCERN

A total of seven waterbody segments in the Little Blackfoot TPA appeared on the 2010 Montana 303(d) List due to sediment impairments (**Table 5-1**): Dog Creek (upper and lower segments), Little Blackfoot River (upper and lower segments), Snowshoe Creek, Spotted Dog Creek (lower segment), and Telegraph Creek (upper segment). All waterbody segments listed for sediment impairment are also listed for habitat alterations (i.e., alteration in stream-side or littoral vegetative covers), which is a non-pollutant listing commonly associated with sediment impairment. TMDLs are limited to pollutants, but implementation of land, soil, and water conservation practices to reduce pollutant loading will inherently address some non-pollutant impairments.

**Table 5-1. Waterbody segments in the Little Blackfoot TPA with sediment listings on the 2010 303(d) List**

| Stream Segment | Waterbody ID | Sediment Pollutant Listing |
|---|---|---|
| DOG CREEK, headwaters to Meadow Creek | MT76G004_071 | Sedimentation/Siltation |
| DOG CREEK, Meadow Creek to the mouth (Little Blackfoot River) | MT76G004_072 | Sedimentation/Siltation |
| LITTLE BLACKFOOT RIVER, the headwaters to Dog Creek | MT76G004_020 | Sedimentation/Siltation |
| LITTLE BLACKFOOT RIVER, Dog Creek to the mouth (Clark Fork River) | MT76G004_010 | Sedimentation/Siltation |
| SNOWSHOE CREEK, headwaters to the mouth (Little Blackfoot River) | MT76G004_080 | Sedimentation/Siltation |
| SPOTTED DOG CREEK, forest boundary to the mouth (Little Blackfoot River) | MT76G004_032 | Sedimentation/Siltation |
| TELEGRAPH CREEK, headwaters to Hahn Creek | MT76G004_051 | Sedimentation/Siltation |

Three additional waterbody segments were also identified as streams of concern and were evaluated as part of the sediment TMDL development process. They include Elliston Creek (MT76G004_040) and the lower segment of Threemile Creek (MT76G004_112), which are listed for habitat alterations, a non-pollutant impairment commonly linked to sediment impairment. Lastly, Trout Creek (MT76G004_120), which is a tributary to the Little Blackfoot River, has never been formally assessed for beneficial use support but was also evaluated based on stakeholder concerns regarding fish and aquatic life beneficial use support.

## 5.3 INFORMATION SOURCES AND ASSESSMENT METHODS TO CHARACTERIZE SEDIMENT CONDITIONS

For TMDL development, information sources and assessment methods fall within two general categories. The first category, discussed within this section, is focused on characterizing overall stream health with focus on sediment and related water quality conditions. The second category, discussed within **Section 5.6**, is focused on quantifying sources of sediment loading within the watershed.

To characterize sediment conditions for TMDL development purposes, a sediment data compilation was completed and additional monitoring was performed during 2009. The below listed data sources represent the primary information used to characterize water quality and/or develop TMDL targets.

- DEQ Assessment Files
- DEQ 2009 Sediment and Habitat Assessments
- Montana Fish, Wildlife and Parks and Natural Resource Damage Program fish and riparian habitat assessments from 2007 and 2008 (Lindstrom, et al., 2008; Liermann, et al., 2009)
- Little Blackfoot River Physical Features Inventory and Riparian Assessment report
- PACFISH/INFISH Biological Opinion Effectiveness (PIBO) Monitoring Program reference and non-reference data
- USFS Regional Reference Data
- GIS data layers

### 5.3.1 DEQ Assessment Files

The DEQ assessment files contain information used to make the existing sediment impairment determinations. The files include a summary of physical, biological, and habitat data collected between 1998 and 2005 as well as other historical information collected or obtained by DEQ. The most common quantitative data that will be incorporated from the assessment files are pebble counts and macroinvertebrate index scores. The files also include information on sediment water quality characterization and potentially significant sources of sediment, as well as information on non-pollutant impairment determinations and associated rationale. Files are available electronically on DEQ's Clean Water Act Information Center website: http://cwaic.mt.gov/.

### 5.3.2 DEQ's 2009 Sediment and Habitat Assessments

Field measurements of channel morphology and riparian and instream habitat parameters were collected in 2009 from 19 reaches to aid in TMDL development (**Figure 5-1**). Reaches were dispersed among the 10 segments of concern listed in **Section 5.2** as well as the lower segment of Telegraph Creek (MT76G004_052), which is listed as fully supporting but was evaluated to broaden the range of conditions in the sample dataset and so newer sediment-related data can be incorporated into the assessment file. Initially, all streams of interest underwent an aerial assessment procedure by which reaches were characterized by four main attributes not linked to human activity: stream order, valley gradient, valley confinement, and ecoregion. These four attributes represent main factors influencing stream morphology, which in turn influences sediment transport and deposition. The next step in the aerial assessment involved identification of near-stream land uses since land management practices can have a significant influence on stream morphology and sediment characteristics. The resulting product was streams stratified into reaches that allow for comparisons among those reaches of the same natural morphological characteristics, while also indicating stream reaches where land management practices may further influence stream morphology. The stream stratification, along with field reconnaissance, provided the basis for selecting the above-referenced monitoring reaches. Although ownership is not part of the reach type category, because of the distribution of private and federal land within the watershed, most reach type categories contain predominantly either private or public lands.

Monitoring reaches were chosen with the goal of being representative of various reach characteristics, land use categories, and anthropogenic influence. There was a preference toward sampling those reaches where anthropogenic influences would most likely lead to impairment conditions since it is a primary goal of sediment TMDL development to further characterize sediment impairment conditions. Thus, it is not a random sampling design intended to sample stream reaches representing all potential impairment and non-impairment conditions. Instead, it is a targeted sampling design that aims to assess a representative subset of reach types while ensuring that reaches within each [sediment] 303(d) listed waterbody with potential impairment conditions are incorporated into the overall evaluation. Typically, the effects of excess sediment are most apparent in low gradient, unconfined streams larger than 1st order (i.e. having at least one tributary); therefore, this stream type was the focus of the field effort (**Table 5-2**). Although the TMDL development process necessitates this targeted sampling design, it is acknowledged that this approach results in less certainty regarding conditions in 1st order streams and higher gradient reaches, and that conditions within sampled reaches are not necessarily representative of conditions throughout the entire stream.

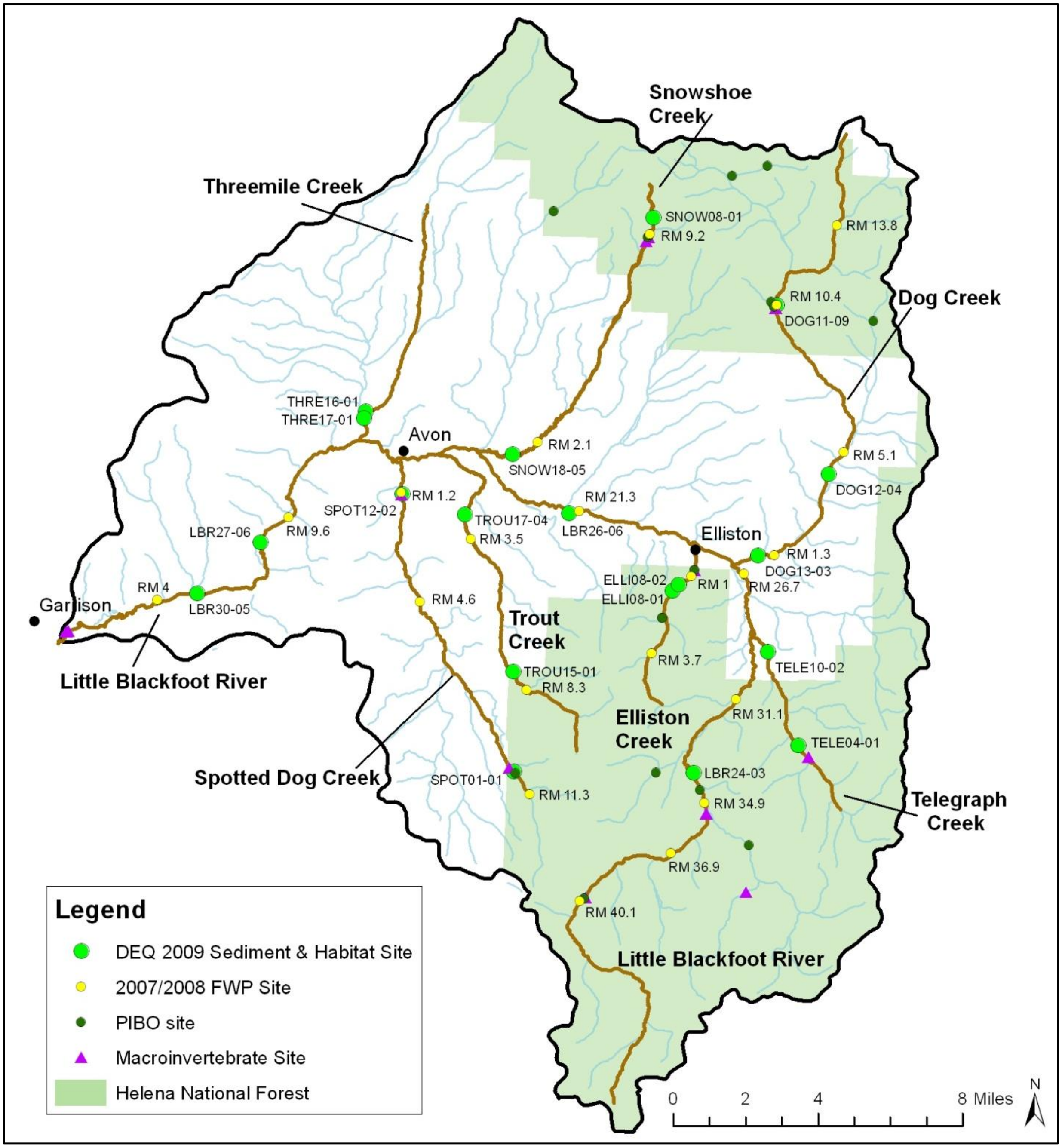

**Figure 5-1. DEQ 2009 Sampling Sites and Other Sediment-Related Sampling Sites**

The field parameters assessed in 2009 include standard measures of stream channel morphology, fine sediment, stream habitat, riparian vegetation, and streambank erosion. Although the sampling areas are frequently referred to as “sites” within this document, to help increase sample sizes and capture variability within assessed streams, they were actually sampling reaches ranging from 500 to 2000 feet (depending on the channel bankfull width) that were broken into five cells. Generally, channel morphology and fine sediment measures were performed in three of the cells, and stream habitat, riparian, and bank erosion measures were performed in all cells. Field parameters are briefly described in **Section 5.4**, and summaries of all field data and sampling protocols are contained in the 2009 Sediment and Habitat Assessment report (**Appendix C**).

**Table 5-2. Stratified reach types and sampling site representativeness within the Little Blackfoot TPA.**

| Level III Ecoregion | Valley Gradient | Strahler Stream Order | Confinement* | Reach Type | Number of Reaches | Number of Monitoring Sites |
|---|---|---|---|---|---|---|
| Middle Rockies | 0 - 2% | 1 | U | MR-0-1-U | 1 | |
| | | 2 | C | MR-0-2-C | 2 | |
| | | | U | MR-0-2-U | 28 | 2 |
| | | 3 | C | MR-0-3-C | 4 | |
| | | | U | MR-0-3-U | 33 | 4 |
| | | 4 | U | MR-0-4-U | 34 | 3 |
| | | 5 | U | MR-0-5-U | 30 | 3 |
| | 2 - 4% | 1 | U | MR-2-1-U | 5 | |
| | | 2 | C | MR-2-2-C | 8 | 2 |
| | | | U | MR-2-2-U | 45 | 2 |
| | | 3 | C | MR-2-3-C | 1 | |
| | | | U | MR-2-3-U | 11 | 1 |
| | 4 - 10% | 1 | C | MR-4-1-C | 7 | |
| | | | U | MR-4-1-U | 21 | 1 |
| | | 2 | C | MR-4-2-C | 9 | |
| | | | U | MR-4-2-U | 10 | |
| | | 3 | U | MR-4-3-U | 5 | 1 |
| | > 10% | 1 | C | MR-10-1-C | 7 | |
| | | | U | MR-10-1-U | 14 | |
| **Totals:** | | | | | **275** | **19** |

*U = Unconfined, C = Confined per DEQs stratification methodology

### 5.3.3 Montana Fish, Wildlife and Parks/Natural Resource Damage Program: An Assessment of Fish Populations and Riparian Habitat in Tributaries of the Upper Clark Fork River Basin

In 2007 and 2008, FWP and NRDP assessed streams in the Upper Clark Fork River Basin to help prioritize stream and fishery restoration needs that are “1) focused in areas that will provide the most benefit to the target fisheries of Silver Bow Creek and the Upper Clark Fork River; and 2) focused on addressing factors that currently limit fish populations” (Lindstrom, et al., 2008). The need for prioritization was largely driven by a monetary settlement between the State of Montana and the Atlantic Richfield Company for natural resource damages caused by historic mining activities in the Upper Clark Fork River Basin.

“In addition to fishery data, riparian and fish habitat assessment data were collected. This data was collected to document current habitat conditions at locations where fish were sampled, as well as to highlight potential habitat deficiencies at these sites. This effort, however, was not aimed at identifying all potential impacts to riparian and fish habitat in the sample drainages, and was limited in its spatial and temporal scope” (Lindstrom, et al., 2008). FWP performed riparian assessments using a modified version of the Natural Resources Conservation Service Riparian Assessment Methodology. This information is based on qualitative analysis and best professional judgment of existing conditions. Results of the assessment are tallied and an overall score is determined of Sustainable (>80%), At Risk (50-80%), or Not Sustainable (<50%). These ratings serve as a benchmark for analysis of overall stream condition and were not developed to provide direct interpretation of Montana state water quality standards. However, this information provides good qualitative supplemental information to the DEQ 2009 field effort, and allows for additional linkage to the analysis of aquatic life and fishery beneficial uses within this document. Within the Little Blackfoot TPA, the Little Blackfoot River and Dog, Elliston, Snowshoe, Spotted Dog, Telegraph, and Trout creeks are the relevant waterbodies that were evaluated (**Figure 5-1**).

## 5.3.4 Little Blackfoot River Physical Features Inventory and Riparian Assessment

Land and Water Consulting (now Atkins) performed a physical features inventory and riparian assessment along the Little Blackfoot River in 2001 under a contract with the Deer Lodge Valley Conservation District and the Little Blackfoot Watershed Group (Land & Water Consulting, 2002). The primary goals of the study were to document existing conditions and identify the most significant problems to help prioritize areas for implementation of habitat restoration projects. During this assessment, the Little Blackfoot River was divided into 16 contiguous reaches extending from the headwaters to the mouth. In August 2001, a detailed assessment was performed while walking reaches 7 through 16, which extend from the confluence of Dog Creek and the Little Blackfoot River downstream to its mouth at the Clark Fork River. The report contains detailed descriptions of conditions within each reach, data summaries, field and aerial photos, and a prioritization matrix. This document summarizes the reach descriptions and presents relevant data from the report. Pertinent data collected during this assessment include width/depth ratio, entrenchment ratio, Rosgen stream type, riffle pebble counts, pool frequency, large woody debris frequency, length of eroding streambank, and NRCS Riparian Assessments. In addition, sediment sources were identified along the mainstem of the Little Blackfoot River.

## 5.3.5 PIBO Data

The PACFISH/INFISH Biological Opinion Effectiveness (PIBO) monitoring program collects data from reference and managed (i.e., non-reference) stream sites on USFS and BLM land within the Columbia River basin. Reference sites are defined as having catchment road densities less than 0.5 km/km$^2$, riparian road densities less than 0.25 km/km$^2$, no grazing within 30 years, and no known in-channel mining upstream of the site. Within the Little Blackfoot TPA, data were collected in 2002 and 2007 at six non-reference sites on the Little Blackfoot River and Elliston, Snowshoe, and Spotted Dog creeks (**Figure 5-1**). There are 17 reference sites within the Helena National Forest, but because that is a small dataset for target development and ecoregion is a primary stratification category, all PIBO reference data from the Middle Rockies ecoregion were used for target development. This consists of all sites within the Helena National Forest as well as data from 56 other sites collected between 2001 and 2009. Data was collected following protocols described in *"Effectiveness Monitoring for Streams and Riparian Areas within the Pacific Northwest: Stream Channel Methods for Core Attributes" (USDA Forest Service, 2006).* Relevant data collected during these assessments include width/depth ratios, residual pool depths, pool frequency, large woody debris frequency, pebble counts, and the percentage of fine sediment in pool tails <6mm via grid toss.

## 5.3.6 USFS Regional Reference Data

Regional reference data are available from the Beaverhead Deerlodge National Forest (BDNF). BDNF data were collected between 1991 and 2002 from approximately two hundred reference sites: seventy of the sites are located in the Greater Yellowstone Area and the remaining sites are in the BDNF, which is also located in southwestern Montana (Bengeyfield, 2004). Applicable reference data are width/depth ratios, entrenchment ratios, and fine sediment <6mm from pebble counts.

## 5.4 WATER QUALITY TARGETS

The concept of water quality targets was presented in **Section 4.1**, but this section provides the rationale for each sediment-related target parameter and discusses the basis of the target values.

In developing targets, natural variation throughout the river continuum must be considered. As discussed in more detail in **Section 3.0** and **Appendix B**, DEQ uses the reference condition to gage natural variability and assess the effects of pollutants with narrative standards, such as sediment. The preferred approach to establishing the reference condition is utilizing reference site data, but modeling, professional judgment, and literature values may also be used. The DEQ defines "reference" as the condition of a waterbody capable of supporting its present and future beneficial uses when all reasonable land, soil, and water conservation practices have been applied. In other words, the reference condition reflects a waterbody's greatest potential for water quality given historic and current land use activities. Although sediment water quality targets typically relate most directly to the aquatic life use, the targets are protective of all designated beneficial uses because they are based on the reference approach, which strives for the highest achievable condition.

Waterbodies used to determine reference conditions are not necessarily pristine. The reference condition approach is intended to accommodate natural variations due to climate, bedrock, soils, hydrology and other natural physiochemical differences yet allow differentiation between natural conditions and widespread or significant alterations of biology, chemistry or hydrogeomorphology due to human activity.

The basis for each water quality target value varies depending on the availability of reference data and sampling method comparability to 2009 DEQ data. As discussed in **Appendix B**, there are several statistical approaches the DEQ uses for target development; they include using percentiles of reference data or of the entire sample dataset, if reference data are limited. For example, if low values are desired (like with fine sediment) and there is a high degree of confidence in the reference data, the 75th percentile of the reference dataset is typically used; if reference data are not available and the sample streams are predominantly degraded, the 25th percentile of the entire sample dataset is typically used. However, percentiles may be used differently depending on whether a high or low value is desirable, the representativeness and range of data variability, the severity of human disturbance to streams within the watershed, and size of the dataset. For each target, descriptive statistics were generated relative to any available reference data (e.g. BDNF or PIBO) as well as for the entire sample dataset. The preferred approach for setting target values is to use reference data, where preference is given towards the most protective reference dataset. Additionally, the target value for some parameters may apply to all streams in the Little Blackfoot watershed, whereas others may be stratified by bankfull width, reach type characteristics (i.e. ecoregion, gradient, stream order, and/or confinement), or by Rosgen stream type if those factors are determined to be important drivers for certain target parameters. Although the basis for target values may differ by parameter, the goal is to develop values that incorporate an implicit margin of safety (MOS) and are achievable. The MOS is discussed in additional detail in **Section 5.8.2**.

### 5.4.1 Water Quality Target Summary

The sediment water quality targets for the Little Blackfoot watershed are summarized in **Table 5-3** and described in detail in the sections that follow. Consistent with EPA guidance for sediment TMDLs (U.S. Environmental Protection Agency, 1999b), water quality targets for the Little Blackfoot watershed are comprised of a combination of measurements of instream siltation, channel form, biological health, and habitat characteristics that contribute to loading, storage, and transport of sediment, or that demonstrate those effects. Water quality targets most closely linked to sediment accumulation or sediment-related effects to aquatic life habitat are given the most weight (i.e. fine sediment and biological indices).

Target parameters and values are based on the current best available information, but they will be assessed during future TMDL reviews for their applicability and may be modified if new information provides a better understanding of reference conditions or if assessment metrics or field protocols are modified. For all water quality targets, future surveys should document stable (if meeting criterion) or improving trends. The exceedance of one target value does not necessarily equate to a determination that the information supports impairment; the degree to which one or more targets are exceeded are taken into account (as well as the current 303(d) listing status), and the combination of target analysis, qualitative observations, and sound, scientific professional judgment is crucial when assessing stream condition. Site-specific conditions such as recent wildfires, natural conditions, and flow alterations within a watershed may warrant the selection of unique indicator values that differ slightly from those presented below, or special interpretation of the data relative to the sediment target values.

**Table 5-3. Sediment Targets for the Little Blackfoot TPA**

| Parameter Type | Target Description | Criterion |
|---|---|---|
| **Fine Sediment** | Percentage of fine surface sediment in riffles via pebble count (reach average) | Comparable with reference values for the appropriate Rosgen stream type (**Tables 5-4** and **5-5**) |
| | Percentage of fine surface sediment < 6 mm in riffles and pool tails via grid toss (reach average) | ≤ 9% for B/C streams<br>≤ 21% for E streams |
| **Channel Form and Stability** | Bankfull width/depth ratio (reach median) | B stream types with bankfull width < 30 ft: ≤ 16<br>C stream types with bankfull width < 30 ft: ≤ 23<br>C stream types with > 30 ft bankfull width: ≤ 35<br>E stream types: ≤ 8 |
| | 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 |
| | 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)<br>≥ 10% understory shrub cover for conifer-dominated reaches |

**Table 5-3. Sediment Targets for the Little Blackfoot TPA**

| Parameter Type | Target Description | Criterion |
|---|---|---|
| **Sediment Source** | Significant and controllable sediment sources | Identification of significant and controllable anthropogenic sediment sources throughout the watershed |
| **Biological Indices** | Macroinvertebrate bioassessment impairment thresholds | Mountain MMI: ≥ 63<br>Low Valley MMI: ≥ 48 |
| | | O/E: ≥ 0.80 |

## 5.4.2 Fine Sediment

The percent of surface fines less than 6 mm and 2 mm is a measurement of the fine sediment on the surface of a streambed and is directly linked to the support of the cold water fish and aquatic life beneficial uses. Increasing concentrations of surficial fine sediment can negatively affect salmonid growth and survival, clog spawning redds, and smother fish eggs by limiting oxygen availability (Irving and Bjorn, 1984; Weaver and Fraley, 1991; Shepard, et al., 1984; Suttle, et al., 2004). Excess fine sediment can also decrease macroinvertebrate abundance and taxa richness (Mebane, 2001; Zweig and Rabeni, 2001). Because similar concentrations of sediment can cause different degrees of impairment to different species, and even age classes within a species, and because the particle size defined as “fine” is variable and some assessment methods measure surficial sediment while other measures also include subsurface fine sediment, literature values for harmful fine sediment thresholds are highly variable. Some studies of salmonid and macroinvertebrate survival found an inverse relationship between fine sediment and survival (Suttle, et al., 2004) whereas other studies have concluded the most harmful percentage falls within 10 to 40 % fine sediment (Bjorn and Reiser, 1991; Mebane, 2001; Relyea, et al., 2000). Bryce et al. (2010) evaluated the effect of surficial fine sediment (via reach transect pebble counts) on fish and macroinvertebrates and found that the minimum effect level for sediment < 2 mm is 13% for fish and 10% for macroinvertebrates. Literature values are taken into consideration during fine sediment target development, but because increasing concentrations of fine sediment are known to be harmful to aquatic life, targets are developed using a conservative statistical approach consistent with **Appendix B**, and consistent with Montana’s water quality standard for sediment as described in **Section 3.2.1**.

### *5.4.2.1 Percent Fine Sediment < 6 mm and < 2 mm in Riffles via Pebble Count*

Surface fine sediment measured in riffles by the modified Wolman (1954) pebble count indicates the particle size distribution across the channel width and is an indicator of aquatic habitat condition that can point to excessive sediment loading. Pebble counts in 2009 were performed in three riffles per sampling reach for a total of at least 300 particles. For DEQ data collected independently of the TMDL development process (i.e., prior to 2009) and the 2001 Physical Features Inventory (Land & Water Consulting, 2002), pebble counts at each reach were performed from bankfull to bankfull in a single representative riffle for a total of at least 100 particles.

Less than 6 mm

The BDNF reference dataset is broken out by Rosgen channel type and dominant particle size but the PIBO reference dataset is not. Because the dominant particle sizes in streams within the Little Blackfoot TPA range from cobble to sand, the fine sediment target for particles < 6 mm is based on BDNF reference data according to Rosgen channel type. The target for riffle substrate percent fine sediment < 6 mm is set at less than or equal to the median of the reference value based on the BDNF reference dataset (**bold** in **Table 5-4**). The median was chosen instead of the 75th percentile because pebble counts in the BDNF reference dataset were performed using the "zigzag" method, which includes both riffles and pools, and likely results in a higher percentage of fines than a riffle pebble count, which was the method used for TMDL related data collection in the Little Blackfoot watershed. Because several assessed reaches are transitioning between a B or C and an E channel type, there is a separate category for those reaches (i.e., B/C/E4). The 2009 DEQ data are also summarized in **Table 5-4**, and in general, the 75th percentile of the sample dataset is comparable to the median of the reference dataset, indicating much of the sample dataset has low percent fines < 6 mm in riffles.

**Table 5-4. 2009 DEQ Data Summary and BDNF Reference Dataset Median Percent Fine Sediment < 6 mm. Target values are indicated in bold.**

| Data Source | Parameter | All | B3/C3 | B4/C4 | B/C/E4 | E3/E4 | E4 |
|---|---|---|---|---|---|---|---|
| BDNF | Sample Size (n) | 129 | 26 | 27 | 59 | 75 | 63 |
| | Median | 20 | **8** | **21** | **23** | **25** | **30** |
| Sample Data | Sample Size (n) | 19 | 3 | 10 | 10 | 1 | 3 |
| | Median | 9 | 6 | 6 | 11 | 13 | 19 |
| | 75th | 16 | 7 | 14 | 17 | N/A | 29 |

Less than 2 mm

For fine sediment < 2 mm, PIBO is the only reference data. Like the BDNF data, the PIBO pebble count data are also a composite of riffle and pool particles, and likely to be higher in fines than the DEQ riffle only pebble count. Also similarly to the BDNF reference dataset, the 75th percentile of the sample dataset compares favorably to the median of the PIBO reference dataset (**Table 5-5**). Therefore, because the sample dataset are broken out by channel type, the target is based on the 75th percentile of the sample dataset (**bold** in **Table 5-5**). Using this approach to target development acknowledges that fine sediment throughout assessed portions of the Little Blackfoot watershed are predominantly close to reference values, and that areas beyond the target value represent outlier conditions where excess fine sediment deposition may indicate a water quality problem. With the exception of E4 channels, which tend to have higher levels of fine sediment, all targets for < 2 mm are close to or less than the macroinvertebrate minimum effect level of 10% found by Bryce et al. (2010). Target values should be compared to the reach average value from pebble counts.

**Table 5-5. 2009 DEQ Data Summary and PIBO Reference Dataset Percent Fine Sediment < 2 mm. Target values are indicated in bold.**

| Data Source | Parameter | All | B3/C3 | B4/C4 | B/C/E4 | E3/E4 | E4 |
|---|---|---|---|---|---|---|---|
| PIBO | Sample Size (n) | 64 | Data not broken out by channel type | | | | |
| | Median | 11 | | | | | |
| | 75th | 21 | | | | | |
| Sample Data | Sample Size (n) | 19 | 3 | 10 | 5 | 1 | 3 |
| | Median | 5 | 4 | 3 | 5 | 5 | 10 |
| | 75th | 9 | **5** | **7** | **10** | N/A* | **15** |

*Because E3/E4 sample size is 1, use B/C/E4 target

### *5.4.2.2 Percent Fine Sediment < 6 mm in Riffle and Pool Tails via Grid Toss*

Grid toss measurements in riffles and pool tails are an alternative measure to pebble counts that assess the level of fine sediment accumulation in macroinvertebrate habitat and potential fish spawning sites. A 49-point grid toss (Kramer, et al., 1993) was used to estimate the percent surface fine sediment < 6 mm in riffles and pool tails in the Little Blackfoot watershed, and three tosses, or 147 points, were performed and then averaged for each riffle and pool tail assessed.

Grid toss reference data are contained in the PIBO dataset but only for pool tails. The 75th percentile of the PIBO reference data for pool tails is 18% and the median is 9% (**Table 5-6**). In the 2009 Little Blackfoot sample dataset, pool tail grid toss values for the 75th percentile of the sample dataset for B and C channels was equal to the median of the PIBO dataset. Therefore, the PIBO reference median value and sample 75th percentile value of 9% is set as the pool grid toss target for B and C channels. The 75th percentile for E channels in the sample dataset is 21% and will be applied as the target for E channels.

Because there is no reference data to use as a basis for the riffle grid toss target and the 75th percentile of pool tail grid toss values in the sample dataset equaled the PIBO reference target value, the 75th percentile of the sample dataset was evaluated for the riffle grid toss target. The 75th percentile for B and C channels is 6% and for E channels is 33%. The B/C channel value seems reasonable but the E channel value does not seem protective of fisheries and aquatic life and is elevated due to much higher riffle fines in Elliston Creek than other E channel riffles. The E channel riffle median (22%) is similar to the E channel pool tail 75th percentile (21%). Therefore, to help simplify grid toss target values and because pool grid toss values seem achievable and protective of fisheries and aquatic life, the pool grid toss target values will also be applied as the riffle grid toss target (**bold** in **Table 5-6**). For each habitat area, the target should be assessed based on the reach average grid toss value.

**Table 5-6. PIBO Reference and 2009 DEQ Data Percentiles for Percent Fine Sediment < 6 mm via Grid Toss in Pool Tails and Riffles. Riffle and pool tail target values are indicated in bold.**

| Data Source | Parameter | All | B/C | E |
|---|---|---|---|---|
| PIBO Pool Tail | Sample Size (n) | 70 | Data not broken out by channel type | |
| | Median | 9 | | |
| | 75th | 18 | | |
| DEQ 2009 Sample Data Pool Tail | Sample Size (n)* | 93 | 53 | 40 |
| | Median | 7 | 5 | 10 |
| | 75th | 13 | **9** | **21** |
| DEQ 2009 Sample Data Riffle | Sample Size (n)* | 48 | 36 | 12 |
| | Median | 5 | 3 | 22 |
| | 75th | 10 | 6 | 33 |

*Each grid toss was counted as a sample

## 5.4.3 Channel Form and Stability

### *5.4.3.1 Width/Depth Ratio and Entrenchment Ratio*

The width/depth ratio and the entrenchment ratio are fundamental aspects of channel morphology and each provides a measure of channel stability, as well as an indication of the ability of a stream to transport and naturally sort sediment into a heterogeneous composition of fish habitat features (i.e. riffles, pools, and near bank zones). Changes in both the width/depth ratio and entrenchment ratio can be used as indicators of change in the relative balance between the sediment load and the transport capacity of the stream channel. As the width/depth ratio increases, streams become wider and shallower, suggesting an excess coarse sediment load (MacDonald, et al., 1991). As sediment accumulates, the depth of the stream channel decreases, which is compensated for by an increase in channel width as the stream attempts to regain a balance between sediment load and transport capacity. Conversely, a decrease in the entrenchment ratio signifies a loss of access to the floodplain. Low entrenchment ratios signify that stream energy is concentrated in-channel during flood events versus having energy dissipation on the floodplain. Accelerated bank erosion and an increased sediment supply often accompany an increase in the width/depth ratio and/or a decrease in the entrenchment ratio (Rosgen, 1996; Knighton, 1998; Rowe, et al., 2003). Width/depth and entrenchment ratios were calculated for each 2009 assessment reach based on five riffle cross section measurements.

Width/Depth and Entrenchment Ratio Target Development

Although PIBO reference data exists for width/depth ratio, the target values for width/depth ratio and entrenchment ratio are based on the BDNF reference dataset because channel morphology tends to vary by Rosgen channel type. Width/depth ratios are measured the same way for the reference and sample dataset; the target for streams in the Little Blackfoot TPA is set at less than or equal to the 75th percentile of the reference value by Rosgen channel type (**Table 5-7**). The C channel target is too low for the Little Blackfoot River downstream of Ontario Creek, where it becomes a 4th order stream (and then a 5th order stream in the lower segment). Downstream of Ontario Creek, the Little Blackfoot width/depth ratio target is based on the 75th percentile of BDNF reference C channels with a bankfull width greater than 30 feet. The width/depth ratio target for the Little Blackfoot River downstream of Ontario Creek is less than or equal to 35.

For entrenchment ratio, because it is desirable to have a greater value, the target is based on the 25th percentile of the BDNF reference dataset (**Table 5-7**). When comparing assessment results to target values, more weight will be given to those values that fail to satisfy the identified target and fail to meet the minimum value associated with literature values for Rosgen stream type (i.e. B=1.4-2.2 ± 0.2, C & E>2.2 ± 0.2) (Rosgen, 1996) and reaches with multiple potential channel types will be evaluated using the lowest target value (e.g. Target for B3/C3 = 1.4). The target value applies to the median value for each sample reach.

**Table 5-7. Width/depth and Entrenchment Ratio Targets Based on BDNF Reference Data.**

| **Parameter** | **B** | **C** | **E** | **C channels bankfull width > 30 ft** |
|---|---|---|---|---|
| Sample Size (n) | 40 | 30 | 115 | 13 |
| Width/Depth Ratio (75th percentile) | 16 | 23 | 8 | 35 |
| Entrenchment Ratio (25th percentile) | 1.4 | 3.2 | 3.7 | 3.8 |

## 5.4.4 Instream Habitat Measures

For all instream habitat measures (i.e. residual pool depth, pool frequency, and large woody debris frequency), there is available reference data from PIBO. Because these parameters are largely influenced by stream size, target values will be expressed by bankfull width category. All of the instream habitat measures are important indicators of sediment input and movement as well as fish and aquatic life support, but they may be given less weight in the target evaluation if they do not seem to be directly related to sediment impacts. The use of instream habitat measures in evaluating or characterizing impairment needs to be considered from the perspective of whether these measures are linked to fine, coarse, or total sediment loading.

### *5.4.4.1 Residual Pool Depth*

Residual pool depth, defined as the difference between the maximum depth and the tail crest depth, is a discharge-independent measure of pool depth and an indicator of pool habitat quality. Deep pools are important resting and hiding habitat for fish, and provide refugia during temperature extremes and high flow periods (Nielson, et al., 1994; Bonneau and Scarnecchia, 1998; Baigun, 2003). Similar to channel morphology measurements, residual pool depth integrates the effects of several stressors; pool depth can be decreased as a result of filling with excess sediment (fine or coarse), a reduction in channel obstructions (such as large woody debris), and changes in channel form and stability (Bauer and Ralph, 1999). A reduction in pool depth from channel aggradation may not only alter surface flow during the critical low flow periods, but may also harm fish by altering habitat, food availability, and productivity (May and Lee, 2004; Sullivan and Watzin, 2010). Residual pool depth is typically greater in larger systems. During DEQ sampling in 2009, pools were defined as depressions in the streambed bounded by a “head crest” at the upstream end and “tail crest” at the downstream end with a maximum depth that was 1.5 times the pool-tail depth (Kershner, et al., 2004).

The definition of pools for the PIBO protocol is fairly similar to the definition used for the 2009 Little Blackfoot sample dataset; both use the same criterion to calculate the difference between the maximum depth and pool tail depth. However, the DEQ dataset could potentially have a greater pool frequency and more pools with a smaller residual pool depth because the DEQ protocol has no minimum pool size requirement whereas the PIBO protocol only counts pools greater than half the wetted channel.

In comparing the PIBO reference data to the sample data, the PIBO 25th percentile residual pool depth values are all less than the median from the sample dataset (**Table 5-8**), indicating the protocol differences likely did not result in smaller residual pool depths in the DEQ dataset, and that the median of the PIBO reference is a more appropriate target. The residual pool depth target is equal to or greater than the PIBO median value (**bold** in **Table 5-8**). Target comparisons should be based on the reach average residual pool depth value. Because residual pool depths can indicate if excess sediment is limiting pool habitat, this parameter will be particularly valuable for future trend analysis using the data collected in 2009 as a baseline. Future monitoring should document an improving trend (i.e. deeper pools) at sites which fail to meet the target criteria, while a stable trend should be documented at established monitoring sites that are currently meeting the target criteria.

**Table 5-8. PIBO Reference and 2009 DEQ Sample Data Percentiles for Residual Pool Depth (ft). Targets are shown in bold.**

| Category | PIBO Reference | | | DEQ Sample Data | | |
|---|---|---|---|---|---|---|
| | n | Median | 25th | n | Median | 75th |
| < 15 ft bankfull width | 9 | **0.9** | 0.7 | 7 | 1.0 | 1.2 |
| 15 - 30 ft bankfull width | 40 | **1.4** | 1.2 | 8 | 1.4 | 1.7 |
| > 30 ft bankfull width | 17 | **1.4** | 1.2 | 4 | 2.4 | 2.7 |

### *5.4.4.2 Pool Frequency*

Pool frequency is another indicator of sediment loading that relates to changes in channel geometry and is an important component of a stream’s ability to support the fishery beneficial use (Muhlfeld and Bennett, 2001). Sediment may limit pool habitat by filling in pools with fines. Alternatively, aggradation of larger particles may exceed the stream’s capacity to scour pools, thereby reducing the prevalence of this critical habitat feature. Pool frequency generally decreases as stream size (i.e. watershed area) increases.

The PIBO 25th percentile pool frequency values compare favorably to the median and 75th percentile from the sample dataset, as well as to the USFS Inland Native Fish (aka. INFISH) Riparian Management Objectives (U.S. Department of Agriculture, Forest Service, 1995) (**Table 5-9**), indicating the protocol differences likely did not result in smaller residual pool depths in the DEQ dataset, and that the 25th percentile of PIBO values are an appropriate target. The pool frequency target is greater than or equal to the 25th percentile of the PIBO dataset (**bold** in **Table 5-9**). Pools per mile should be calculated based the number of measured pools per reach and then scaled up to give a frequency per mile.

**Table 5-9. PIBO Reference and 2009 DEQ Sample Data Percentiles for Pool Frequency (pools/mile) and INFISH Riparian Management Objective Values. Targets are shown in bold.**

| Category | PIBO Reference | | | DEQ Sample Data | | |
|---|---|---|---|---|---|---|
| | N | Median | 25th | n | Median | 75th |
| < 15 ft bankfull width | 9 | 108 | **90** | 7 | 111 | 121 |
| 15 - 30 ft bankfull width | 40 | 62 | **52** | 8 | 45 | 65 |
| > 30 ft bankfull width | 17 | 17 | **15** | 4 | 20 | 24 |
| | | | | | | |
| INFISH<br>Riparian Management Objectives | < 20 ft bankfull width: 96-56<br>25 ft bankfull width: 47 | | | 50 ft bankfull width: 26<br>100 ft bankfull width: 18 | | |

### 5.4.4.3 Large Woody Debris

Large woody debris (LWD) is a critical component of stream ecosystems, providing habitat complexity, quality pool habitat, cover, and long-term nutrient inputs. LWD also constitutes a primary influence on stream function, including sediment and organic material transport, channel form, bar formation and stabilization, and flow dynamics (Bilby and Ward, 1989). LWD numbers generally are greater in smaller, low order streams, and then decrease as streams get larger and the composition of the riparian vegetation shifts. The application of a LWD target will carry very little weight for sediment impairment verification purposes, but may have significant implications as an indicator of a non-pollutant type of impairment.

For DEQ sampling in 2009, wood was counted as LWD if it was greater than 9 feet long or two-thirds of the wetted stream width, and 4 inches in diameter at the small end (Overton, et al., 1997). The LWD count for PIBO was compiled using a different definition of LWD; if measurements were conducted by DEQ and PIBO protocols within the same reach, the PIBO LWD count would likely be greater because it includes pieces 3 feet long and 4 inches in diameter. For streams with a bankfull width of less than 15 feet, the DEQ sample dataset 75th percentile was similar to the 25th percentile of the PIBO reference data, but for other channel widths, the sample dataset had much lower LWD counts than the PIBO dataset (**Table 5-9**). This difference for larger channel widths may partially be a result of different measurement protocols but is also likely a result of historic land conversion and riparian vegetation removal within the wider valley sections of streams. Given these considerations and the similarity of the reference 25th percentile to the sample dataset 75th percentile for streams with a bankfull width less than 15 feet, the PIBO 25th percentile is an appropriate target for streams with a bankfull width less than 30 feet (**bold** in **Table 5-10**). However, for streams greater than 30 feet, the PIBO value of 277 LWD/mile was determined to be an unfeasible target and the target value will be 122 LWD/mile based on the 75th percentile of the 2009 DEQ sample dataset.

**Table 5-10. PIBO Reference and 2009 DEQ Sample Data Percentiles for Large Woody Debris Frequency (LWD/mile). Targets are shown in bold.**

| Category | PIBO Reference | | | DEQ Sample Data | | |
|---|---|---|---|---|---|---|
| | n | Median | 25th | n | Median | 75th |
| < 15 ft bankfull width | 9 | 315 | **222** | 7 | 53 | 246 |
| 15 - 30 ft bankfull width | 40 | 319 | **186** | 8 | 24 | 85 |
| > 30 ft bankfull width | 17 | 438 | 277 | 4 | 75 | **122** |

## 5.4.5 Riparian Health

Interactions between the stream channel and the riparian vegetation along the streambanks are a vital component in the support of the beneficial uses of cold water fish and aquatic life. Riparian vegetation provides organic material used as food by aquatic organisms and supplies LWD that influences sediment storage and channel morphology. Riparian vegetation helps filter sediment from upland runoff, stabilize streambanks, and it can provide shading, cover, and habitat for fish. During DEQ assessments conducted in 2009, ground cover, understory shrub cover and overstory vegetation were cataloged at 10 to 20 foot intervals along the riparian zone (aka. greenline) at the bankfull channel margin along both sides of the stream channel for each monitoring reach. The percent of understory shrub cover is of particular interest in valley bottom streams historically dominated by willows and other riparian shrubs. While shrub cover is important for stream health, not all reaches have the potential for dense shrub cover and are instead well armored with rock or have the potential for a dense riparian community of a different composition, such as wetland vegetation or mature pine forest.

At the 2009 assessment sites, the understory shrub cover median value was 35% and the 75th percentile was 50%. The median of the sample dataset is a common target basis for understory shrub cover but a review of target values from other TMDLs within the Middle Rockies ecoregion indicate removal of riparian shrubs in the Little Blackfoot TPA has resulted in a median value that is too low for target setting; other target values range from 41-58% in the Upper Big Hole TPA and 49% in the Upper Jefferson TPA based on reference median values to 53% in the Bitterroot and 70% in the Upper Clark Fork tributaries and Flint TPAs based on sample data. Based on other target values, the 75th percentile may be a reasonable target, but field notes from the 2009 Little Blackfoot assessments indicate an Elliston Creek site (ELLI08-02) is meeting its potential because of riparian fencing; the median understory shrub cover at that site is 40%. Therefore, 40% will be applied as the target for understory shrub cover. This target value should be assessed based on the reach average greenline understory shrub cover value.

Because not all reaches have the potential for dense shrub cover, for any reaches that do not meet the target value, the greenline assessment results will be more closely examined to evaluate the potential for dense riparian shrub cover and identify if streambanks in the reach are stabilized instead by rocks, a mature pine forest, and/or wetland vegetation. For reaches that have less than 40% understory shrub cover because they are conifer-dominated, a target value of 10% is set based on the median value at a site on USFS land in upper Spotted Dog Creek (SPOT01-01) identified during the field assessment as having reference riparian conditions.

## 5.4.6 Human Sources

The presence of anthropogenic sediment sources does not always result in sediment impairment of a beneficial use. When there are no significant identified anthropogenic sources of sediment within the watershed of a 303(d) listed steam, no TMDL will be prepared since Montana's narrative criteria for sediment cannot be exceeded in the absence of human causes. There are no specific target values associated with sediment sources, but the overall extent of human sources will be used to supplement any characterization of impairment conditions. This includes evaluation of human induced and natural sediment sources, along with field observations and watershed scale source assessment information obtained using aerial imagery and GIS data layers. Because sediment transport through a system can take years or decades, and because channel form and stability can influence sediment transport and deposition, any evaluation of anthropogenic sediment impacts must consider both historical sediment loading as well as historical impacts to channel form and stability since the historical impacts still have the potential to contribute toward sediment and/or habitat impairment. Source assessment analysis will be provided by 303(d) listed waterbody in **Section 5.6**, with additional information in **Appendices C, D**, and **E**.

### 5.4.7 Macroinvertebrates

Siltation exerts a direct influence on benthic macroinvertebrates assemblages by filling in spaces between gravel and by limiting attachment sites. Macroinvertebrate assemblages respond predictably to siltation with a shift in natural or expected taxa to a prevalence of sediment tolerant taxa over those that require clean gravel substrates. Macroinvertebrate bioassessment scores are an assessment of the macroinvertebrate assemblage at a site, and the DEQ uses two bioassessment methodologies to evaluate impairment condition and aquatic life beneficial use support. Aquatic insect assemblages may be altered as a result of different stressors such as nutrients, metals, flow, and temperature, and the biological index values must be considered along with other parameters that are more closely linked to sediment.

The two macroinvertebrate assessment tools are the Multi-Metric Index (MMI) and the Observed/Expected model (O/E). The rationale and methodology for both indices are presented in the DEQ Benthic Macroinvertebrate Standard Operating Procedure (Montana Department of Environmental Quality, Water Quality Planning Bureau, 2006). Unless noted otherwise, macroinvertebrate samples discussed within this document were collected according to DEQ protocols. USFS data were collected according to the PIBO protocol, which is done with a kick net in two sections of the first four riffles/runs within a reach (Heitke, et al., 2010).

The MMI is organized based on different bioregions within Montana (i.e. Mountain, Low Valley, and Plains), and the Little Blackfoot River watershed falls within the Mountain and Low Valley MMI regions; in these regions, the macroinvertebrate community shift point that indicates impairment is an MMI score less than 63 and 48, respectively. These values are established as sediment targets in the Little Blackfoot TPA. The O/E model compares the taxa that are expected at a site under a variety of environmental conditions with the actual taxa that were found when the site was sampled and is expressed as a ratio of the Observed/Expected taxa (O/E value). The O/E community shift point that indicates impairment for all Montana streams is any O/E value <0.80. Therefore, an O/E score of ≥0.80 is established as a sediment target in the Little Blackfoot TPA.

Because the indices evaluate different aspects of the macroinvertebrate community, the MMI and O/E scores for a single site are evaluated independently. For both metrics, an index score greater than the threshold value is desirable, and the result of each sampling event is evaluated separately. Because index scores may be affected by other pollutants or forms of pollution such as habitat disturbance, they will be evaluated in consideration of more direct indicators of excess sediment. Additionally, because the macroinvertebrate sample frequency and spatial coverage is typically low for each watershed and because of the extent of research showing the harm of excess sediment to aquatic life, meeting both biological targets does not necessarily indicate a waterbody is fully supporting its aquatic life beneficial use. For these reasons, measures that indicate an imbalance in sediment supply and/or transport capacity will also be used for TMDL development determinations.

## 5.5 EXISTING CONDITION AND COMPARISON TO WATER QUALITY TARGETS

This section includes a comparison of existing data to water quality targets along with a TMDL development determination for each stream segment of concern in the Little Blackfoot watershed

(**Section 5.2**). Most waterbodies reviewed within this section are listed for sediment impairment on the 2010 303(d) List, and although placement onto the 303(d) list indicates impaired water quality, a comparison of water quality targets to existing data helps define the level of impairment and establishes a benchmark to help evaluate the effectiveness of restoration efforts. For the three streams evaluated within this section not on the 2010 303(d) List, the data review is not a formal beneficial use assessment but provides information about the likelihood of impairment and justification for TMDL development (Note: a stream does not have to be on the 303(d) list to have a TMDL developed).

## 5.5.1 Dog Creek, upper segment (MT76G004_071)

The upper segment of Dog Creek (MT76G004_071) is listed for sedimentation/siltation on the 2010 303(d) List. In addition, this segment is also listed for alteration in stream-side or littoral vegetative covers, which is non-pollutant commonly linked to sediment impairment. Dog Creek is listed for sediment impairment based on sedimentation attributed to livestock trampling of banks, channelization from the road and railroad, and logging that included timber harvest up to the stream. Dredge dams and streamside tailings from historical mining in the drainage are also cited in the assessment file as potential sediment sources. The upper segment of Dog Creek flows 4.3 miles from the headwaters to its confluence with Meadow Creek.

### Physical Condition and Sediment Sources

No data were collected in this segment by DEQ in 2009. During DEQ field assessments conducted in 1990 and 1998, field observations were similar; some sections of the stream and riparian habitat looked good but other sections were heavily trampled by livestock, accelerating bank erosion and increasing fine sediment in the channel. The largest grazing issues were observed within the Helena National Forest. Also, there were mine tailings within the channel in the vicinity of the Bald Butte Millsite, which is currently being remediated (see **Section 7.5.5**), but at the time had four instream impoundments that had been breached. In a pebble count conducted in 1998, the stream particles exhibited a bimodal distribution, with a large amount of silt/clay and very fine sand and a large amount of medium to coarse gravel. Beaver ponds were observed within the drainage and noted to be acting as sediment traps.

FWP evaluated a reach on USFS land (RM 13.8) within this segment in 2007 (**Figure 5-1**). Extensive beaver activity was present upstream and downstream of the reach in addition to throughout the reach itself. The reach was classified as a B channel and scored high in the geomorphology portion of the assessment. Pool habitat and riparian vegetation rated poorly, and cattle use in the riparian zone and hoof shear along the streambanks were observed. Evidence of historic logging within the riparian zone and placer mining were also noted. Fish habitat, riparian vegetation, and beaver activity were all more abundant upstream and downstream of the assessed reach, but mining and recreational activities were noted as common within the riparian area farther upstream from the site.

### Summary and TMDL Development Determination

There are no macroinvertebrate samples and no recent DEQ data to compare to water quality targets but the 2007 assessment by FWP is consistent with DEQ assessments from the 1990s. Despite portions of the segment having beaver dams to retain sediment, healthy riparian vegetation, and fish habitat, bank erosion and channel sedimentation continue to be accelerated by grazing within the riparian area and legacy effects from historical logging and mining. Therefore, based on the listing status and remaining sediment sources, a sediment TMDL will be developed for upper Dog Creek.

### 5.5.2 Dog Creek, lower segment (MT76G004_072)

The lower segment of Dog Creek (MT76G004_072) is listed for sedimentation/siltation on the 2010 303(d) List. In addition, this segment is also listed for alteration in stream-side or littoral vegetative covers, which is non-pollutant commonly linked to sediment impairment. Lower Dog Creek is listed for sediment impairment based on overutilization of the riparian area by livestock, bank erosion associated with channelization from the railroad, and sediment inputs from the road. The lower segment of Dog Creek flows 12.4 miles from its confluence with Meadow Creek to the mouth at the Little Blackfoot River.

**Physical Condition and Sediment Sources**

In 2007, FWP performed assessments at three sites in lower Dog Creek (**Figure 5-1**). The uppermost site (RM 10.4) was on USFS land in an area that transitioned from abundant willows and beavers to a section with no beavers or woody vegetation. Bank erosion was observed on outside bends lacking woody vegetation and more extensive lateral and vertical erosion were observed upstream of the reach near the confluence with Hope Creek. Grazing in the reach was light during an August visit but much more noticeable during a visit in October. A small riparian exclosure was observed and noted to be part of a grazing allotment agreement. Fish habitat was marginal. The middle reach (RM 5.1) was a C channel with extensive beaver activity. Grazing pressure appeared to be managed appropriately as there was a healthy riparian community of mostly willows and sedges, and pools depth and fish habitat rated highly. At both this site and the lowermost site (RM 1.3), the railroad was encroaching on the channel and restricting the floodplain. The channel at the lowermost site was also confined by an access road. Within this reach, there was a good amount of mature cottonwoods, willows, and dogwoods, but limited recruitment of cottonwoods. Woody debris was limited within the channel, pools were shallow, and fine sediment accumulation was observed throughout the reach.

DEQ performed sediment and habitat assessments at three monitoring sites on lower Dog Creek in 2009 (**Figure 5-1**). The uppermost site (DOG11-09) was in a meandering section of stream with extensive beaver complexes observed upstream and downstream of the reach. The assessment length was reduced from five to two cells due to a property boundary in the middle of the reach. Portions of the reach had either slumping banks falling into the channel or the stream was eroding into the hillslope, but other parts of the reach had undercut banks stabilized by wetland vegetation and willows. Upstream of the assessed portion, one section of stream had riparian fencing to exclude grazing along the channel and was associated with dense riparian vegetation and stable banks, whereas another section that was being actively grazed had extensive bank erosion and some channel overwidening. The middle site (DOG12-04) was in a section of the creek confined by the railroad. Some dense wetland vegetation was observed, but generally the streambanks were tall and eroding along the side abutting the railroad that lacked riprap and actively retreating along the opposite bank from channelization and shifts in energy caused by the riprap. The lowermost site (DOG13-03) was in an irrigated field and was channelized with return flows seeping back into the stream from both banks. Bank erosion was attributed to areas where return flows had oversaturated the banks and also potentially to historic grazing practices.

**Comparison to Water Quality Targets**

The existing data in comparison to the targets for lower Dog Creek are summarized in **Table 5-11** and the macroinvertebrate bioassessment data are located in **Table 5-12**. All bolded cells are above target thresholds.

**Table 5-11. Existing sediment-related data for lower Dog Creek relative to targets. Values that do not meet the target are in bold.**

| Reach ID | Assessment Year | Mean BFW (ft) | Existing Stream Type | Potential Stream Type | Riffle Pebble Count (mean) | | Grid Toss (mean) | | Channel Form (median) | | Instream Habitat | | | Greenline % Shrub Cover |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % <6mm | % <2mm | Riffle % <6mm | Pool % <6mm | W/D Ratio | Entrenchment Ratio | Residual Pool Depth (ft) | Pools / Mile | LWD / Mile | |
| DOG11-09 | 2009 | 15.0 | E4 | E3/4 | 13 | 5 | 3 | ND | 9.4 | 8.8 | 1.5 | 40 | 26 | 24 |
| DOG12-04 | 2009 | 23.4 | B4c/C4/E4/F4 | C4 | 7 | 3 | 4 | 4 | 16.4 | 6.4 | 1.7 | 32 | 11 | 45 |
| DOG13-03 | 2009 | 28.7 | B4/F4b | C4 | 6 | 2 | 5 | 7 | 20.6 | 1.3 | 0.8 | 11 | 5 | 32 |

**Table 5-12. Macroinvertebrate bioassessment data for lower Dog Creek. Values that do not meet the target threshold are in bold.**

| Station ID | Location | Collection Date | Collection Method | Site Type | MMI | O/E |
|---|---|---|---|---|---|---|
| C01DOGC01 | 1.1 miles d/s of Hope Creek | 8/12/2004 | EMAP - Reach | Mountain | **55.9** | **0.47** |

**Summary and TMDL Development Determination**

All sites met the fine sediment targets. Given the amount of beaver activity observed at all reaches, this is likely a result of the beaver ponds acting as sediment traps. In areas where beaver activity was observed, pool habitat and woody debris counts were greater, and streambanks were stabilized by healthy riparian vegetation communities. However, effects from confinement by the railroad and roads, as well as current and historical grazing practices, are evident in the habitat measures. Reach DOG11-09 was overwidened and DOG13-03 was entrenched, and all DEQ reaches failed to meet targets for pools and LWD frequency. Additionally, the residual pool depth at DOG13-03 was much less than the other two reaches and failed to meet the target, and two of the reaches were below the target for riparian shrub cover. The macroinvertebrate sample, which was collected near FWP site RM 10.4, failed to meet both metrics. Although all fine sediment targets were met, extensive bank erosion was noted in this area, and impairment of the macroinvertebrate community is likely associated with excess sediment. Several portions of the segment appear to be recovering from historical land management practices, however, overgrazing, removal of riparian vegetation, and channelization are accelerating bank erosion and likely limiting support of fish and aquatic life. This information supports the 303(d) listing and a sediment TMDL will be developed for lower Dog Creek.

## 5.5.3 Elliston Creek (MT76G004_040)

Elliston Creek (MT76G004_040) is listed for alteration in stream-side or littoral vegetative covers on the 2010 303(d) List, which is a non-pollutant form of impairment commonly linked to sediment impairment. The habitat listing is based on channelization, riprap, and riparian habitat removal near Elliston. Based on a cursory source assessment review during project scoping, Elliston Creek was included in the 2009 DEQ data collection and will be evaluated relative to the sediment targets. Elliston Creek flows 5 miles from its headwaters to the mouth at the Little Blackfoot River.

**Physical Condition and Sediment Sources**

In 2008, FWP performed assessments at two sites on USFS land on Elliston Creek (**Figure 5-1**). The upper site (RM 3.7) was in an intermittent stretch near the headwaters within a grazing allotment and appeared to be part of a historical beaver pond complex. The channel was classified as a Bc, and some small eroding banks were observed on bends without deep-rooted vegetation but the channel appeared fairly stable. Evidence of grazing was observed, noxious weeds were common, and overhead cover for fish was low. There were some decent pools but naturally low flow was identified as a limiting factor for fish within this reach. Downstream of the reach, the channel was noted as highly unstable, predominantly dry, and containing several headcuts 3-4 feet high with extensive lateral erosion. The other site was closer to the mouth (RM 1.0) within a fenced livestock exclosure. The channel was slightly entrenched and classified as a B channel. There were some actively eroding banks lacking deep-rooted vegetation but it appeared to be recovering. Historical livestock access points were also still recovering but woody shrub density was rated as good and young plant recruitment was observed. Fish habitat was noted to be limited by a lack of deep pools and woody debris but overall got a good score because of the improving riparian habitat and abundance of spawning habitat.

DEQ performed sediment and habitat assessments at two monitoring sites on Elliston Creek in 2009 (**Figure 5-1**). The upper site (ELLI08-01) was a meandering section of the stream with pugging and hummocking along the valley bottom and channel margins resulting from grazing and evidence of historic timber harvest along the channel. Riparian vegetation was a mix of willows, grass, and wetland vegetation. Pool habitat was extensive but spawning potential was noted as being potentially limited by fines and embeddedness in the pool tails. Despite evidence of overgrazing in the riparian, the riparian grasses were dense and limiting bank erosion. The other site (ELLI08-02) was in a small valley bottom between fairly steep valley walls and had riparian fencing to limit grazing pressure along the stream. Spawning gravels were observed in pool tails and streambanks were densely vegetated with wetland grasses, willow, and alder. Bank erosion was limited to sharp bends where the channel was cutting into the hillslope and was attributed to natural sources. This reach was noted as achieving its potential. These observations are consistent with the mixed management practices observed during a 1998 DEQ assessment.

**Comparison to Water Quality Targets**

The existing data in comparison to the targets for Elliston Creek are summarized in **Table 5-13**. The macroinvertebrate bioassessment data for Elliston Creek is located in **Table 5-14**. All bolded cells are above target thresholds.

**Table 5-13. Existing sediment-related data for Elliston Creek relative to targets. Values that do not meet the target are in bold.**

| Reach ID | Assessment Year | Mean BFW (ft) | Existing Stream Type | Potential Stream Type | Riffle Pebble Count (mean) | | Grid Toss (mean) | | Channel Form (median) | | Instream Habitat | | | Greenline % Shrub Cover |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % <6mm | % <2mm | Riffle % <6mm | Pool % <6mm | W/D Ratio | Entrenchment Ratio | Residual Pool Depth (ft) | Pools / Mile | LWD / Mile | |
| **ELLI08-01** | 2009 | 7.9 | E4 | E4 | 38 | 20 | 35 | 17 | 9.2 | 5.2 | 0.8 | 169 | 370 | 21 |
| **ELLI08-02** | 2009 | 8.8 | E4/C4/B4c | B/E4 | 23 | 9 | 33 | 8 | 11.9 | 4.9 | 0.8 | 116 | 201 | 38 |
| **231 (PIBO)** | 2002 | 8.1 | -- | -- | -- | -- | -- | -- | 8.6 | -- | 0.8 | 114 | 0 | -- |
| | 2007 | 9.0 | -- | -- | 28 | 27 | -- | 28 | 9.7 | -- | 0.7 | 117 | 156 | -- |

**Table 5-14. Macroinvertebrate Bioassessment Data for Elliston Creek.**

Values that do not meet the target threshold are in bold.

| Station ID | Location | Collection Date | Collection Method | Site Type | MMI | O/E |
|---|---|---|---|---|---|---|
| 231 (PIBO) | 0.8 miles upstream of mouth | 2002 | KICK - PIBO | Low Valley | **45.2** | **0.79** |
| | | 2007 | | | **41.7** | **0.65** |

**Summary and TMDL Development Determination**

There were several exceedances of fine sediment targets in riffles and one exceedance of the pool tail target. The macroinvertebrate sample, which was collected at the PIBO site with elevated fine sediment, failed to meet both metric targets in 2002 and in 2007. All sites were slightly below the residual pool depth target, which agrees with the FWP observation at the lower site regarding a lack of deep pools. One reach was slightly overwidened but with the exception of observations near FWP site RM 3.7, the channel morphology was fairly stable. The PIBO site and lowermost FWP site are closer to the town of Elliston and lacking LWD. Field notes indicate riparian shrub cover was meeting its potential at site ELLI08-02 but shrub cover at the upper DEQ site has been limited by overgrazing within the riparian zone. Collectively, the field measurements and observations indicate management changes are improving instream and riparian habitat in portions of the stream but the impairment of the riparian habitat caused by historical activities and current overgrazing remains and is linked to excess sediment loading to the stream that is likely limiting its ability to support fish and aquatic life. Therefore, a sediment TMDL will be prepared for Elliston Creek.

## 5.5.4 Little Blackfoot River, upper segment (MT76G004_020)

The upper segment of the Little Blackfoot River (MT76G004_020) is listed for sedimentation/siltation on the 2010 303(d) List. In addition, this segment is also listed for alteration in stream-side or littoral vegetative covers, which is a non-pollutant commonly linked to sediment impairment. The upper Little Blackfoot River is listed based on sedimentation attributed to channelization by the road and railroad, road erosion, channel modifications, historic mine disturbances and waste rock/tailings, logging, removal of riparian vegetation, and livestock grazing. The upper segment of the Little Blackfoot River flows 21.6 miles from its headwaters to its confluence with Dog Creek.

### Physical Condition and Sediment Sources

As part of the Physical Features Inventory (Land & Water Consulting, 2002), the 5 mile section of the upper Little Blackfoot from the USFS boundary to Dog Creek was evaluated in 2001. Upstream of Telegraph Creek, stream banks, riparian health, and aquatic habitat were predominantly in good condition and there were no signs of excessive sedimentation in the channel. In this upper portion of the reach, there was evidence of historical riparian logging, beaver activity, and two large naturally eroding banks where the river was cutting into the hillslope. Channel morphology was stable within most of the upper reach but overutilization by livestock was noted within the vicinity of Telegraph Creek. Downstream of Telegraph Creek, streambank trampling and increasing effects from grazing within the riparian zone were observed; only about half of stream banks had deep-rooted vegetation, the frequency and severity of bank erosion increased, width/depth ratios increased, and fine sediment accumulation was observed in pools and on point bars.

In 2007 and 2008, FWP performed assessments on five sites in the upper segment of the Little Blackfoot River (**Figure 5-1**). The uppermost site (RM 40.1) transitioned from a B to a meandering C channel and had an optimal riparian zone with a coniferous overstory and willow/alder understory in some sections and wetland grasses in areas with fewer conifers. Fish habitat was rated as excellent as the reach contained deep pools, undercut banks, and frequent large woody debris. The next site (RM 36.9) was a B channel in a narrow, high-gradient canyon. The riparian zone was narrow but largely intact and noxious weeds were primarily associated with a road cut along part of the reach. The substrate was large boulders and fish habitat was mostly pocket pools but rated highly. Large woody debris was limited but recruitment potential was rated as high because of beetle-killed timber near the channel. The next site (RM 34.9) was a fairly high gradient B channel with a coniferous overstory and a sparse understory of alder and willow dominated by noxious weeds. Pool habitat was mostly pocket pools and large woody debris was low but identified as having high potential recruitment. Human disturbances to the reach included a rock check dam, confinement by recreational roads, and a frequently-used ford. The next site (RM 31.1) was in a narrow canyon near the mouth of Slate Creek. It was classified as a C channel with a high width-depth ratio with fish habitat limited by a lack of deep pools, and woody debris. The channel was slightly incised in sections and riparian buffer width was noted to be limited from the reduced access to the floodplain. Small rock check dams were noted to be potential barriers to upstream fish movement had been constructed in the channel near a campsite along the reach.

The lowermost site (RM 26.7) was just upstream of the Dog Creek confluence and classified as an overwidened C channel with some incisement and significant bank erosion. This site was the only one that overlapped with the reach evaluated as part of the 2001 Physical Features Inventory (Land & Water Consulting, 2002). Riparian vegetation was mostly willows but density was limited by noxious weeds and grasses associated with disturbance. Grazing pressure was light and young willow recruitment was noted as improving. Fine sediment deposition was noted in pools throughout the segment and fish habitat was rated as fair due to shallow pools, limited large woody debris, and cover. Although grazing management practices seem to have improved since the 2001 assessment, the prevalence of disturbance-induced grasses within the riparian zone, numerous eroding banks, and accumulation of fine sediment in pools indicates recovery is occurring very slowly and likely limited by remaining sediment sources.

DEQ performed one sediment and habitat assessment in the upper segment of the Little Blackfoot River in 2009 (**Figure 5-1**). The site (LBR24-03) was in a semi-confined valley section on USFS land. The area appeared to have been altered historically by placer mining or some other large scale disturbance. The reach was predominantly a riffle with large gravel bar deposits; few pools and no potential spawning gravels were observed. The road and historical channel disturbances were noted as bank erosion sources but erosion was predominantly attributed to natural sources.

### Comparison to Water Quality Targets

The existing data in comparison to the targets for upper Little Blackfoot River are summarized in **Table 5-15**. The macroinvertebrate bioassessment data for upper Little Blackfoot River is located in **Table 5-16.** All bolded cells are above target thresholds.

**Table 5-15. Existing sediment-related data for upper Little Blackfoot River relative to targets. Values that do not meet the target are in bold.**

| Reach ID | Assessment Year | Mean BFW (ft) | Existing Stream Type | Potential Stream Type | Riffle Pebble Count (mean) | | Grid Toss (mean) | | Channel Form (median) | | Instream Habitat | | | Greenline % Shrub Cover |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % <6mm | % <2mm | Riffle % <6mm | Pool % <6mm | W/D Ratio | Entrenchment Ratio | Residual Pool Depth (ft) | Pools / Mile | LWD / Mile | |
| **LBR24-03** | 2009 | 38.6 | C3b | C3b | 6 | 4 | 14 | 1 | 20.0 | 7.4 | 1.7 | 8 | 58 | 63 |
| **233 (PIBO)** | 2002 | 23.1 | -- | -- | -- | -- | -- | 18 | 18.0 | -- | 1.9 | 39 | 266 | -- |
| **233 (PIBO)** | 2007 | 22.6 | -- | -- | 8 | 4 | -- | 3 | 19.9 | -- | 0.9 | 27 | 222 | -- |
| **2799 (PIBO)** | 2009 | 45.6 | -- | -- | 11 | 15 | -- | 6 | 34.6 | -- | 2.4 | 25 | 115 | -- |

**Table 5-16. Macroinvertebrate bioassessment data for upper Little Blackfoot River. Values that do not meet the target threshold are in bold.**

| Station ID | Location | Collection Date | Collection Method | Site Type | MMI | O/E |
|---|---|---|---|---|---|---|
| C01LTBRLR02 | Just upsteam of Ontario Cr confluence | 08/09/2004 | EMAP Reach | Low Valley | 64.6 | 1.02 |
| 233 (PIBO) | 7.5 miles downstream from the headwaters | 2002 | KICK - PIBO | Mountain | 74.2 | 0.93 |
| | | 2007 | KICK - PIBO | | 75.8 | **0.73** |

### Summary and TMDL Development Determination

All fine sediment targets were met except for the riffle grid toss at LBR24-03. None of the fine sediment data in **Table 5-15** were collected downstream of Telegraph Creek, however, which is where excess sedimentation was observed in pools in both 2001 and 2007. One of the six macroinvertebrate indices did not meet target values, but similarly to the fine sediment values, they were not collected in the areas most affected by excess sediment. All channel morphology targets were met, which also corresponds to observations from the 2001 assessment indicating channel dimensions are within the expected range until downstream of Telegraph Creek. One site failed to meet the target for residual pool depth, and the DEQ site failed to meet the targets for pool and large woody debris frequency. The PIBO and DEQ reach data correlate well with the observations from the 2001 Physical Features Inventory; controllable human sources were observed and there are some localized areas where habitat measures are not achieving potential or fine sediment is elevated, but overall there are minimal indicators of increased sediment loading from human sources upstream of Telegraph Creek. Although the recent FWP assessment indicates conditions downstream of Telegraph Creek have improved since 2001, high width/depth ratios, human caused bank erosion, and fine sediment accumulation in pools continue to be problems. This information supports the 303(d) listing and a sediment TMDL will be developed for the upper segment of the Little Blackfoot River.

### 5.5.5 Little Blackfoot River, lower segment (MT76G004_010)

The lower segment of the Little Blackfoot River (MT76G004_010) is listed for sedimentation/siltation on the 2010 303(d) List. In addition, the lower segment of the Little Blackfoot River is also listed for alteration in stream-side or littoral vegetative covers, which is a non-pollutant commonly linked to sediment impairment. The lower Little Blackfoot River is listed based on sedimentation attributed to channelization by the road and railroad, channel modifications, haying near the channel, removal of riparian vegetation, and livestock grazing. The lower segment of the Little Blackfoot River flows 26.2 miles from its confluence with Dog Creek to its mouth at the Clark Fork River.

**Physical Condition and Sediment Sources**

As part of the Physical Features Inventory (Land & Water Consulting, 2002), the entire lower segment of the Little Blackfoot River was assessed in 2001. Within the vicinity of Elliston, streambanks, riparian vegetation, and fish habitat were rated highly (i.e., scored well). Between Elliston and North Trout Creek, overgrazing of riparian vegetation was apparent and the portions of the channel were incised and isolated from the floodplain. Historical channel movement and erosion, as well as periodic riprap, were observed along the railroad bed, but large woody debris was common and pools were fairly deep. Between North Trout Creek and Snowshoe Creek Road, there were some localized issues associated with riprap along the railroad but habitat and grazing management were highly rated. From Snowshoe Creek Road to Homestead Gulch (which is downstream of Threemile Creek), some portions of the channel had minimal sediment sources, but overall poor quality riparian vegetation, actively eroding banks, and limited pool habitat were commonplace. Additionally, much of the channel had been historically altered or straightened and contained riprap and gravel dikes; the railroad, Highway 12, the irrigation network, and management of private land were all cited as sources. Several small tributaries had silt deposits near their mouth, and near Spotted Dog Creek, there was evidence that downcutting of the river had caused a headcut and some incisement of the creek.

From Homestead Gulch to Beck Hill Road (~4.5 miles upstream of the mouth), the river ranged from near-optimal riparian and channel habitat conditions to severely degraded and channelized conditions. Riprap and actively eroding banks were fairly common, as was confinement of the channel by the railroad, highway, or both. The last several miles of the river had minimal riprap and the most extensive active bank erosion of any reach; this section was noted as being a substantial sediment source to the Clark Fork River, and sedimentation within the channel was common, particularly downstream of the most significant eroding streambanks. Within the entire assessed segment, streambank erosion worsened downstream of Avon and the section from there to Homestead Gulch had the highest frequency of streambank alterations. In a comparison of conditions in 2001 relative to 1979, the frequency of streambank alterations, gravel dikes, and eroding banks was much lower and signs of recovery were observed throughout the river corridor; riprap and irrigation diversions had increased slightly; no new channelization was noted; and despite some localized recovery and lengthening, the overall river length did not change.

In 2007, FWP performed assessments at three sites on the lower segment of the Little Blackfoot River (**Figure 5-1**). The upper site (RM 21.3) was upstream of North Trout Creek and was a C channel with active erosion on several meander bends and evidence of historical erosion. Riprap was common, particularly along the railroad. Woody plant density was inconsistent, cottonwood recruitment was limited, and noxious weeds and grasses associated with disturbance were common in the riparian zone. A riparian exclosure was observed and cattle had entered it, however, riparian grazing pressure was still light in the area. There were numerous deep pools and large woody debris accumulations, but fish habitat was limited in several areas where cover was lacking and the channel was shallow and braided. The next site (RM 9.6) was a meandering C channel. The site had limited erosion where riparian vegetation was lacking but most bank erosion was associated with the riprap and the channel abutting Highway 12. The density of woody vegetation in the riparian zone was limited by noxious weeds and disturbance-induced grasses. Pool habitat was limited by constriction of the channel from the highway and railroad but was rated highly and noted to be at its “practical potential.” The lowermost site (RM 4.0) was a C channel with significant bank erosion associated with banks lacking vegetation with deep roots. There was a substantial amount of riprap along the railroad within the reach and on meander bends along hay fields upstream of the reach. Similar to the other reaches, woody riparian vegetation was sparse and noxious weeds and shallow-rooted grasses were common. Livestock overwinter in the pasture adjacent to the reach but browse pressure and effects along the channel were minimal. There were several deep scour pools but the habitat potential was limited by a low amount of large woody debris.

DEQ performed three sediment and habitat assessments in the lower segment of the Little Blackfoot River in 2009 (**Figure 5-1**). Both the upper (LBR 26-06) and middle (LBR 27-06) sites were in meandering sections of river lined by cottonwoods and reed canary grass that were slightly encroached upon by the railroad, and both sites had deep pools and LWD aggregates. The upper site was near FWP site RM 21.3 and channelization from the railroad appeared to be altering channel migration by cutting off meander bends and contributing to the formation of transverse riffles. Some fine sediment accumulations were observed in slow water areas. The middle site was about one mile downstream of FWP site RM 9.6 and flowed through an area used for hay production; several large eroding banks were observed on meander bends that were also documented in the 2001 study. The lowest site (LBR 30-05) was 5 miles upstream from the mouth near the confluence with McDonald Creek in a channelized section that paralleled the railroad. The reach had some pocket pools but was predominantly riffle habitat. Riparian vegetation consisted of periodic shrubs, mature cottonwoods, and herbaceous groundcover. Most of the active streambank erosion was observed in the straight portion of the reach and was attributed to livestock access.

### Comparison to Water Quality Targets

The existing data in comparison to the targets for the lower segment of the Little Blackfoot River are summarized in **Table 5-17**. The macroinvertebrate bioassessment data for the lower Little Blackfoot River is located in **Table 5-18.** All bolded cells are above target thresholds.

**Table 5-17. Existing sediment-related data for lower Little Blackfoot River relative to targets. Values that do not meet the target are in bold.**

| Reach ID | Assessment Year | Mean BFW (ft) | Existing Stream Type | Potential Stream Type | Riffle Pebble Count (mean) |  | Grid Toss (mean) |  | Channel Form (median) |  | Instream Habitat |  |  | Greenline % Shrub Cover |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | % <6mm | % <2mm | Riffle % <6mm | Pool % <6mm | W/D Ratio | Entrenchment Ratio | Residual Pool Depth (ft) | Pools / Mile | LWD / Mile |  |
| **LBR26-06** | 2009 | 69.9 | C3/C4 | C4 | 4 | 2 | 4 | 5 | 36.5 | 4.9 | 2.5 | 26 | 211 | 52 |
| **LBR27-06** | 2009 | 83.9 | C3/C4 | C4 | 2 | 2 | 6 | 1 | 45.1 | 6.5 | 3.2 | 24 | 92 | 41 |
| **LBR30-05** | 2009 | 76.2 | B3/B4c/C3 | C4 | 3 | 1 | 2 | ND | 35.9 | 2.0 | 2.4 | 16 | 40 | 27 |

**Table 5-18. Macroinvertebrate bioassessment data for lower Little Blackfoot River. Values that do not meet the target threshold are in bold.**

| Station ID | Location | Collection Date | Collection Method | Site Type | MMI | O/E |
|---|---|---|---|---|---|---|
| CFR10.2 | USGS gage | 08/17/2000 | Hess | Low Valley | 50.8 | 1.00 |
| CFR10.2 |  | 08/04/2001 |  |  | 76.6 | 0.82 |
| C01LTBLR01 |  | 08/21/2001 | Unknown |  | 60.9 | 1.00 |
|  |  | 06/28/2002 | Hess |  | 59.1 | 1.00 |
|  |  | 06/18/2003 | Hess |  | 57.2 | 1.14 |
|  |  | 06/30/2004 | Kick |  | 56.7 | 1.29 |
|  |  | 07/21/2005 | Unknown |  | 57.5 | 1.00 |

### Summary and TMDL Development Determination

In general, recent data indicate conditions in the lower segment have vastly improved since the 1970s, and even since the 2001 assessment. All fine sediment, macroinvertebrate, residual pool depth, and pool frequency targets were met. These measurements combined with documented observations indicate that much of the river has limited accumulations of fine sediment, deep pool habitat, and adequate amounts of large woody debris. However, in 2001 and in recent FWP and DEQ assessments, large actively eroding banks and riparian vegetation lacking deep roots were noted throughout the segment, particularly downstream of Avon. Accelerated bank erosion was attributed to a combination of human sources including the highway and railroad, cropland, grazing, channelization and bank alterations, and removal of riparian vegetation.

Although excess fine sediment was not reflected in the measurements at the three DEQ sites, indications of the sediment supply exceeding the river's transport capacity were observed within the channel at numerous locations; accumulations were observed in slow water areas at the uppermost DEQ site (LBR26-06), areas of shallow water and channel braiding at the nearby FWP site RM 21.3 was noted to be limiting habitat, and sedimentation at tributary outlets and within the last several miles of the segment were observed during the 2001 assessment. The effects of extensive bank erosion are also apparent in the channel morphology; all three assessment sites were overwidened and exceeded the target for width/depth ratio. The uppermost site met the target for LWD, but the middle site failed to meet the LWD target, and the most downstream site failed to meet both the LWD and riparian shrub targets. This downstream decrease in riparian shrub cover is consistent with observations from 2001. Although changes in management practices have resulted in improvement throughout the segment and meeting potential in some sections, based on significant controllable sediment sources and the listing status, a sediment TMDL will be developed for the lower segment of the Little Blackfoot River.

## 5.5.6 Snowshoe Creek (MT76G004_080)

Snowshoe Creek (MT76G004_080) is listed for sedimentation/siltation on the 2010 303(d) List. In addition, this segment is also listed for alteration in stream-side or littoral vegetative covers and low flow alterations, which are non-pollutants commonly linked to sediment impairment. Snowshoe Creek is listed based on sedimentation attributed to logging, road construction, mining, grazing, and hay production. Snowshoe Creek extends 10.7 miles from the headwaters its mouth at the Little Blackfoot River.

### Physical Condition and Sediment Sources

In 2007, FWP performed assessments at two sites on Snowshoe Creek (**Figure 5-1**). The uppermost site (RM 9.2) was an E channel on USFS land in a canyon area upstream of Lois Lake with substantial historical mining activity. The site was noted as having altered channel morphology and a variable gradient because of mining, but the riparian vegetation has recovered well and consisted of dense wetland vegetation and willows. Two riparian exclosures were present at the site but had been compromised due to inadequate maintenance. Also, a water gap between the enclosures was not functioning as designed and was identified as a significant sediment source. The channel was deep and there were several high quality pools but there was a lack of large woody debris. The lower site (RM 2.1) was downstream of Lois Lake. The reach was an incised G channel that was establishing a new lower floodplain. There were some willows along the channel, but most meander bends without woody vegetation were eroding, and hay meadows and disturbance-induced grasses were dominant in the reach. Fish habitat was rated as good, but fine sediment accumulation was noted throughout the reach and the absence of willows was cited as a limiting factor. There was some beaver activity along the reach. There are two non-reference PIBO sites on Snowshoe Creek that are located within 0.1 miles downstream of FWP site RM 9.2 (**Figure 5-1**). The closer site (2261) was sampled in 2007 and the other site (230) was sampled in 2002 and 2007.

DEQ performed sediment and habitat assessments at two sites on Snowshoe Creek in 2009 (**Figure 5-1**). The upper site (SNOW08-01) was on USFS land upstream of all FWP and PIBO sites in a narrow valley section downstream of a section that was formerly impounded. A road parallels much of the stream, including this reach, and the hillslope on the opposite bank had been previously harvested. Pugging and hummocking was observed at the site from grazing but conifers and shrubs lined most of the channel and bank erosion was minimal. LWD created small pools and potential spawning gravels were observed. The lower site (SNOW18-05) was approximately 1.5 miles upstream of the mouth, and the stream was quite sinuous and flowed through a hayed meadow with a substantial buffer. The substrate was predominantly fine in this reach, and the stream had wetland vegetation along its margins and frequent pools and deep undercut on meander bends. Streambank erosion at SNOW18-05 was minimal and attributed to natural sources.

### Comparison to Water Quality Targets

The existing data in comparison to the targets for the Snowshoe Creek are summarized in **Table 5-19**. The macroinvertebrate bioassessment data for the Snowshoe Creek is located in T**able 5-20**. All bolded cells are above target thresholds.

**Table 5-19. Existing sediment-related data for Snowshoe Creek relative to targets. Values that do not meet the target are in bold.**

| Reach ID | Assessment Year | Mean BFW (ft) | Existing Stream Type | Potential Stream Type | Riffle Pebble Count (mean) | | Grid Toss (mean) | | Channel Form (median) | | Instream Habitat | | | Greenline % Shrub Cover |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % <6mm | % <2mm | Riffle % <6mm | Pool % <6mm | W/D Ratio | Entrenchment Ratio | Residual Pool Depth (ft) | Pools / Mile | LWD / Mile | |
| **SNOW08-01** | 2009 | 6.2 | E4b | E4b | 9 | 5 | 10 | 16 | 5.6 | 3.6 | 0.6 | 79 | 290 | 54 |
| **SNOW18-05** | 2009 | 11.2 | E4 | E4 | 19 | 11 | 19 | 14 | 9.0 | 5.0 | 1.5 | 111 | 37 | 24 |
| **230 (PIBO)** | 2002 | 9.0 | -- | -- | -- | -- | -- | 40 | 8.7 | -- | 0.5 | 76 | 172 | -- |
| **230 (PIBO)** | 2007 | 10.4 | -- | -- | 74 | 67 | -- | 69 | 15.0 | -- | 0.7 | 75 | 166 | -- |
| **2261 (PIBO)** | 2007 | 17.7 | -- | -- | -- | -- | -- | -- | 20.8 | -- | 0.8 | 64 | -- | -- |

**Table 5-20. Macroinvertebrate bioassessment data for Snowshoe Creek. Values that do not meet the target threshold are in bold.**

| Station ID | Location | Collection Date | Collection Method | Site Type | MMI | O/E |
|---|---|---|---|---|---|---|
| C01SNOWC10 | 1.5 miles from headwaters | 08/19/2004 | Kick | Mountain | **50.3** | **0.60** |
| 230 (PIBO) | | 2002 | PIBO - Kick | Mountain | 71.2 | **0.53** |
| 230 (PIBO) | | 2007 | PIBO - Kick | Mountain | 77.8 | **0.53** |

**Summary and TMDL Development Determination**

Fine sediment targets were met at the DEQ sites but PIBO 230 exceeded pebble count targets in 2007 and pool tail grid toss targets in 2002 and 2007. The PIBO site with elevated fines is just downstream of FWP site RM 9.2, where riparian exclosures were not functioning properly and a water gap was noted as a significant sediment source in 2007. The DEQ sites were meeting the entrenchment ratio target but the lower site was slightly exceeding the target for width/depth ratio. No Rosgen channel type was recorded for the PIBO sites but given their proximity to the FWP site, they are likely E channels; all sites exceeded the width/depth ratio target for E channels. Also, in 2007, PIBO 230 had a much higher percentage of pool fines and almost twice the width/depth ratio than in 2002. All sites upstream of Lois Lake did not meet the targets for residual pool depth and pool frequency, which could associated with the mining-related changes to channel morphology noted by FWP. Consistent with FWP observations, LWD and riparian shrub cover were lacking near the PIBO sites and RM 9.2, as well as closer to the mouth (i.e., RM 2.1 and SNOW18-05). Macroinvertebrate samples were all collected at the same location upstream of Lois Lake (near PIBO 230 and RM 9.2); one sample failed to meet the MMI target and all failed to meet the O/E target, which indicates impairment. Although fine sediment accumulations closer to the mouth observed by FWP may be associated with the channel type and beaver activity, excess sediment sources and high fines in the upper watershed, as well as low macroinvertebrate index scores, residual pool depths, LWD frequency, and riparian shrub cover all support the listing and a sediment TMDL will be developed for Snowshoe Creek.

## 5.5.7 Spotted Dog Creek, lower segment (MT76G004_032)

Lower Spotted Dog Creek (MT76G004_032) is listed for sedimentation/siltation on the 2010 303(d) List. In addition, this segment is also listed for alteration in stream-side or littoral vegetative covers, which is a non-pollutant commonly linked to sediment impairment. Lower Spotted Dog is listed for sediment impairment based on sedimentation attributed to agriculture and livestock grazing. The lower segment of Spotted Dog Creek extends 10.7 miles from the US Forest Service boundary to its mouth at the Little Blackfoot River.

**Physical Condition and Sediment Sources**

Recent data collection occurred at several sites either within or upstream of the upper segment of Spotted Dog Creek (**Figure 5-1**). Although only the lower segment is listed for sediment impairment, the sites are discussed here because they are within the watershed for the lower segment and the TMDL must evaluate all sediment sources to an impaired segment. In 2007, FWP performed an assessment at RM 11.3, which is on USFS land near the headwaters of Spotted Dog Creek, which is upstream of both Spotted Dog Creek segments. Evidence of cattle grazing was observed but the riparian vegetation, LWD, pool habitat, and fish cover were all rated as excellent. Riparian vegetation was primarily alders with a coniferous overstory. Flow appeared naturally low and substantial deposition of fine sediment was noted. In 2009, DEQ performed an assessment at the downstream end of the upper segment of Spotted Dog Creek on USFS property (SPOT01-01). The upstream end of the site appeared to represent reference conditions for upper elevation streams flowing through conifer dominated valley bottoms. Evidence of historic timber harvest was observed along the downstream end. Extensive LWD spanned the channel and led to localized LWD aggregates; the LWD as well as root wads from fallen trees were the cause for many of the observed pools and also provided fish cover. Some fine sediment was observed in slow water areas. Streambank erosion was minimal, with one eroding bank associated with the historic land uses. Riparian shrub density was naturally limited along this reach due to the dense coniferous overstory. In 2007, one non-reference PIBO site was sampled in the upper segment of Spotted Dog Creek just downstream of SPOT01-01.

In 2007, FWP performed assessments at two sites within the lower segment of Spotted Dog Creek (**Figure 5-1**). The upper site (RM 4.6) was a B channel within a canyon. A recent timber harvest had occurred near the left side of the channel and cattle were observed throughout the reach. Fish habitat was rated as fair because pools were mostly shallow pocket water, and LWD and fish cover were sparse within the reach. Riparian vegetation was mostly grasses, some alders, and a coniferous overstory. The downstream site (RM 1.2) was a C channel in a hay meadow. The riparian vegetation was primarily disturbance-induced grasses and the occasional mature willow, but no recruitment of young willows was observed. Lateral erosion of the streambanks was observed throughout the reach and the channel appeared to have downcut historically. Fine sediment accumulations were observed throughout the reach and flow was limited. The fish habitat rated highly but could be improved by more LWD/rootwads and streambank vegetation to improve shading and fish cover.

DEQ performed one sediment and habitat assessment (SPOT12-02) on the lower segment of Spotted Dog Creek in 2009 (**Figure 5-1**). The site was in close proximity to RM 1.2 and was a meandering channel in a meadow. Bank erosion was observed at the outsides of meander bends and the channel appeared to be actively downcutting. Field notes indicated bank erosion and downcutting may be related to streambed degradation along the Little Blackfoot mainstem, which corresponds to observations made along the Little Blackfoot Physical Features Inventory in 2001 (see discussion in **Section 5.5**). Compound pools were formed by channel meanders and overhanging shrubs and included some potential spawning gravel. Management pressure appeared to be light within this meadow. Riparian vegetation was primarily reed canary grass with occasional willows; however, wetland vegetation was colonizing the insides of meander bends, which is indicative of channel recovery. Extensive streambank erosion of tall (4-5 feet) banks and active retreat was observed.

**Comparison to Water Quality Targets**

The existing data in comparison to the targets for Spotted Dog Creek are summarized in **Table 5-21** (Note: only SPOT12-02 is within the lower segment). No macroinvertebrate bioassessment data are available for lower Spotted Dog Creek. All bolded cells fail to meet (exceed) target thresholds.

**Table 5-21. Existing sediment-related data for lower Spotted Dog Creek relative to targets. Values that do not meet the target are in bold.**

| Reach ID | Assessment Year | Mean BFW (ft) | Existing Stream Type | Potential Stream Type | Riffle Pebble Count (mean) | | Grid Toss (mean) | | Channel Form (median) | | Instream Habitat | | | Greenline % Shrub Cover |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % <6mm | % <2mm | Riffle % <6mm | Pool % <6mm | W/D Ratio | Entrenchment Ratio | Residual Pool Depth (ft) | Pools / Mile | LWD / Mile | |
| **SPOT01-01** | 2009 | 15.7 | B4/C4/E4 | B4 | 18 | 11 | 6 | 7 | 18.5 | 3.1 | 1.0 | 106 | 449 | 12 |
| **SPOT12-02** | 2009 | 22.2 | B4/C4b | C4 | 4 | 1 | 5 | 7 | 16.0 | 6.5 | 1.7 | 42 | 26 | 7 |
| **PIBO (2274)** | 2007 | 13.7 | -- | -- | 26 | 22 | -- | 17 | 13.4 | -- | 0.95 | 144 | 1067 | -- |

**Summary and TMDL Development Determination**

Both the PIBO site and DEQ site in the upper segment failed to meet one or more fine sediment targets, which corresponds to the DEQ and FWP observations of fine sediment deposition within that part of the watershed. Fine sediment accumulations could be natural, related to the low flow in the upper watershed, or could also be associated with historical or existing land uses. Although SPOT01-01 also failed to meet the target for W/D ratio and percent riparian shrub cover, the coniferous overstory at that site precludes dense riparian shrub cover, and bank erosion observations as well as other sediment and habitat parameters in that portion of the watershed indicate it is providing excellent habitat for fish and other aquatic life.

SPOT12-02 met all targets for fine sediment and channel form but failed to meet the habitat related targets of pool and LWD frequency and riparian shrub cover. This corresponds to observations at RM 1.2 and RM 4.6, and shows the extent of habitat alterations that have occurred along the lower segment. Although fine sediment targets were met at this site, excess sediment deposition was noted by FWP at RM 1.2, and both DEQ and FWP noted channel downcutting and active streambank erosion. Improvements in management practices have resulted in some channel recovery, but the channel instability and actively eroding banks associated with a lack of woody riparian vegetation and channel downcutting supports the listing and a sediment TMDL will be prepared for the lower segment of Spotted Dog Creek.

## 5.5.8 Telegraph Creek, upper segment (MT76G004_051)

Upper Telegraph Creek (MT76G004_051) is listed for sedimentation/siltation on the 2010 303(d) List. In addition, this segment is also listed for physical substrate habitat alterations. Upper Telegraph Creek is listed based on sedimentation attributed to roads, tailings and channel disturbances associated with mining, and logging. The upper segment of Telegraph Creek extends 5.4 miles from its headwaters to its confluence with Hahn Creek.

### Physical Condition and Sediment Sources

In 2007, FWP performed assessments at three sites on upper Telegraph Creek (**Figure 5-1**). All sites (i.e., RM 3.6, RM 4.9, and RM 6.7) were classified B channels and showed evidence of historic placer mining; the channel was slightly incised at each site and the substrate was dominated by large cobbles and boulders. The riparian vegetation scored highly at all sites but spawning habitat was noted to be limited by a lack of deep pools and LWD.

DEQ performed a sediment and habitat assessment at one site on upper Telegraph Creek (TELE04-01) in 2009 (**Figure 5-1**). The site was approximately 0.3 miles upstream of FWP site RM 3.6, and site visit notes contained observations similar to RM 3.6 associated with historical mining such as an entrenched channel and large substrate. Additionally, large berms, which are also likely remnants from placer mining, were observed along the channel corridor at TELE04-01. The field notes also mentioned potential effects from historic logging and roads but did not cite any sources within the reach associated with existing land uses. However, in an assessment of unpaved roads within the entire Little Blackfoot watershed (discussed in **Section 5.7.3** and **Appendix E**), upper Telegraph Creek had the highest unpaved road density per mile (i.e., 3.31), and four of six assessed crossings had a contributing length greater than 200 feet, indicating roads may still potentially be a significant source of sediment within the drainage. Pool habitat was predominantly pocket pools, but spawning sized gravels were observed. Streambank erosion was typically limited due to armoring by the cobble substrate but one berm along the left bank was eroding near the downstream end of the reach.

### Comparison to Water Quality Targets

The existing data in comparison to the targets for upper Telegraph Creek are summarized in **Table 5-22**. The macroinvertebrate bioassessment data for upper Telegraph Creek is located in **Table 5-23**. All bolded cells are above target thresholds.

**Table 5-22. Existing sediment-related data for upper Telegraph Creek relative to targets. Values that do not meet the target are in bold.**

| Reach ID | Assessment Year | Mean BFW (ft) | Existing Stream Type | Potential Stream Type | Riffle Pebble Count (mean) | | Grid Toss (mean) | | Channel Form (median) | | Instream Habitat | | | Greenline % Shrub Cover |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % <6mm | % <2mm | Riffle % <6mm | Pool % <6mm | W/D Ratio | Entrenchment Ratio | Residual Pool Depth (ft) | Pools / Mile | LWD / Mile | |
| **TELE04-01** | 2009 | 22.1 | B3/F3b | B3 | 5 | 2 | 5 | 1 | 15.1 | 2.0 | 1.4 | 53 | 132 | 36 |

**Table 5-23. Macroinvertebrate Bioassessment Data for upper Telegraph Creek. Values that do not meet the target threshold are in bold.**

| Station ID | Location | Collection Date | Collection Method | Site Type | MMI | O/E |
|---|---|---|---|---|---|---|
| C01TGRPC01 | 1.8 miles downstream of headwaters | 08/09/2004 | EMAP - Reach | Mountain | 63.4 | **0.61** |

### Summary and TMDL Development Determination

All targets were met at the DEQ site except for LWD and greenline cover, which is likely associated with historic logging and mining-related disturbances to the riparian area. This assessment reach indicates most habitat parameters have recovered from historical disturbances to the channel, but observations at the DEQ and FWP sites indicate the particle size distribution in the channel still has not recovered (i.e., it is lacking gravel and small cobbles). Inadequate smaller cobbles and gravel can reduce the habitat for macroinvertebrates, which is the primary food source for fish. The macroinvertebrate sample indicates impairment, as it was barely meeting the MMI target of 63 and was well below the O/E target. In addition to unpaved roads remaining a potential sediment source, data discussed for the metals TMDLs (**Section 7.5.3**) indicate there are still a significant amount of tailings and waste rock along the stream and its tributaries in the upper watershed, which could also be a substantial source of sediment. This information supports the listing and a sediment TMDL will be developed for upper Telegraph Creek.

## 5.5.9 Threemile Creek, lower segment (MT76G004_112)

Lower Threemile Creek (MT76G004_112) is listed for alteration in stream-side or littoral vegetative covers and low flow alterations on the 2010 303(d) List, which are non-pollutant forms of impairment commonly linked to sediment impairment. The habitat listings based on livestock trampling of the banks and channel and partial to complete dewatering of sections of the stream. Based on a cursory source assessment review during project scoping, lower Threemile Creek was included in the 2009 DEQ data collection and will be evaluated relative to the sediment targets. Lower Threemile Creek flows 7 miles from Quigley Ranch Reservoir to the mouth at the Little Blackfoot River.

### Physical Condition and Sediment Sources

DEQ performed sediment and habitat assessments at two sites on lower Threemile Creek in 2009 (**Figure 5-1**). Due to access issues, both assessment sites were within the lower mile of the segment. The upper site (THRE16-01) was upstream of the confluence with Sixmile Creek in a meandering section. Pools were associated with meander bends with woody shrubs and bank erosion was observed on meander bends lacking deep rooted vegetation. Some pugging and hummocking was observed but grazing pressure appeared light. Riparian vegetation was grass and wetland plants with occasional woody shrubs. The lower site (THRE17-01) was downstream of Sixmile Creek near the mouth at the Little Blackfoot River and contained a rock irrigation dam at the downstream end. The site was similar to the upper site in that it was used for grazing but only light effects were observed. The reach was an almost continuous riffle and only contained three pools. Subsurface fines were observed during pool grid toss measurements. Riparian vegetation was mostly grasses and wetland plants.

### Comparison to Water Quality Targets

The existing data in comparison to the targets for lower Threemile Creek are summarized in **Table 5-24**. No macroinvertebrate bioassessment data are available for lower Threemile Creek. All bolded cells are above target thresholds.

**Table 5-24. Existing sediment-related data for lower Threemile Creek relative to targets. Values that do not meet the target are in bold and shaded gray.**

| Reach ID | Assessment Year | Mean BFW (ft) | Existing Stream Type | Potential Stream Type | Riffle Pebble Count (mean) |  | Grid Toss (mean) |  | Channel Form (median) |  | Instream Habitat |  |  | Greenline % Shrub Cover |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  |  |  | % <6mm | % <2mm | Riffle % <6mm | Pool % <6mm | W/D Ratio | Entrenchment Ratio | Residual Pool Depth (ft) | Pools / Mile | LWD / Mile |  |
| **THRE16-01** | 2009 | 16.1 | C4/E4 | C4 | 16 | 12 | 2 | 2 | 19.6 | 11.1 | 1.0 | 100 | 69 | 39 |
| **THRE17-01** | 2009 | 24.2 | C3/C4 | C3 | 9 | 5 | 1 | 6 | 19.0 | 10.1 | 3.1 | 18 | 9 | 7 |

**Summary and TMDL Development Determination**

The lower site exceeded the pebble count target for fine sediment less than 2mm and upper site exceeded the pebble count target for fine sediment less than 6mm. Although all grid tosses met the target values, elevated fine sediment was noted in the subsurface layer of pool tails at site THRE17-01. Channel form targets were within the expected range at both sites. The upper site failed to meet the residual pool depth target and the lower site, which was mostly a riffle, failed to meet the pool frequency target. Both sites failed to meet the LWD and riparian greenline targets, although values were much lower at the downstream site. Based on recent data indicating excess sediment as well as field observations of numerous human sediment sources associated with upland land management and bank erosion in the upper watershed, a sediment TMDL will be developed for lower Threemile Creek.

## 5.5.10 Trout Creek (MT76G004_120)

Trout Creek (MT76G004_120) has never been formally assessed for beneficial use support but was assessed along with the sediment impaired streams based on stakeholder concerns regarding fish and aquatic life use support and potentially significant sediment sources identified during project scoping. Trout Creek flows 11.5 miles from its headwaters to the mouth at the Little Blackfoot River.

**Physical Condition and Sediment Sources**

In 2008, FWP performed assessments at two sites on Trout Creek (**Figure 5-1**). The upper site (RM 8.3) was a Bc channel on USFS land in a confined canyon that was a steeper A channel upstream and downstream. Woody vegetation in the riparian zone was limited and attributed to upland grasses and weeds being common. Bank trampling and overutilization by livestock was also noted to have increased bank erosion and resulted in an overwidened and shallow channel. Fish habitat was rated as fair and most pools were shallow and filled with fine sediment. Most fish found during electrofishing were contained within the few deeper pools. Flow appeared naturally low within the reach. Effects from livestock were also observed on private land downstream of the reach; the channel appeared unstable, and was actively widening and downcutting in sections. The lower site (RM 3.5) was a Bc channel that was surrounded by two small hay meadows. There was evidence the channel had downcut in the past but is recovering and had established a new floodplain. The riparian zone contained a narrow strip of woody shrubs and cottonwoods and bank erosion was limited to sections with shallow-rooted grasses. Pools, woody debris, and vegetative cover rated highly but excess fine sediment accumulation was noted to be reducing habitat quality by limiting pool depth and altering spawning gravel composition.

DEQ performed sediment and habitat assessments at two sites on Trout Creek in 2009 (**Figure 5-1**). The upper site (TROU15-4) was located on USFS land approximately 0.5 miles downstream of RM 8.3. The site was in an area heavily impacted by historic and ongoing land uses, including logging in the upper watershed, grazing, and potentially some sort of mining. It appeared to be an area of restoration or recent shifts in grazing management, as there was a riparian exclosure fence and areas that seemed to be former cattle access sites were filled with angular cobbles. The channel was a relatively straight and nearly continuous riffle that was deeply entrenched and lined with alders. Spawning potential was limited and the substrate was noted as embedded. The lower site (TROU17-04) was located in grazed section of valley bottom approximately 0.7 miles downstream of RM 3.5 and near the confluence with the Little Blackfoot River. Pugging and hummocking was observed and dewatering was identified as a potential concern. The meandering channel had frequent pools and brook trout were observed clustered in a couple of the pools. Pool tails-outs contained relatively fine sediment, which may limit spawning potential for certain species. Undercut banks were identified at the outsides of meander bends but likely contribute relatively little sediment due to the low stream power. The channel was overwidened in places that were used for cattle access, though some of these spots appeared to be recovering. The riparian vegetation consisted of willows with grass and wetland plants. Downstream of the reach, irrigation diversions ran along the base of the valley wall the valley appeared to contain relatively dense willows.

### Comparison to Water Quality Targets

The existing data in comparison to the targets for Trout Creek are summarized in **Table 5-25**. No macroinvertebrate bioassessment data are available for Trout Creek. All bolded cells are above target thresholds.

**Table 5-25. Existing sediment-related data for Trout Creek relative to targets. Values that do not meet the target are in bold.**

| Reach ID | Assessment Year | Mean BFW (ft) | Existing Stream Type | Potential Stream Type | Riffle Pebble Count (mean) | | Grid Toss (mean) | | Channel Form (median) | | Instream Habitat | | | Greenline % Shrub Cover |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | % <6mm | % <2mm | Riffle % <6mm | Pool % <6mm | W/D Ratio | Entrenchment Ratio | Residual Pool Depth (ft) | Pools / Mile | LWD / Mile | |
| **TROU15-01** | 2009 | 11.6 | B4/C4b/F4b | B4 | 11 | 6 | 5 | 10 | 14.6 | 2.2 | 0.8 | 48 | 53 | 59 |
| **TROU17-04** | 2009 | 10.5 | C4/E4 | C4/E4 | 15 | 9 | 7 | 36 | 11.1 | 17.7 | 0.9 | 127 | 21 | 20 |

### Summary and TMDL Development Determination

Both sites met the riffle fine sediment targets, however, both sites exceeded the pool tail grid toss target. The upper DEQ site also failed to meet the target for residual pool depth and pool frequency. This combined with FWP observations that fine sediment was filling pools, most pools were shallow, and fish were predominantly found in deeper pools are all indications that excess fine sediment is limiting the stream's ability to fully support fish. Both sites met the channel form targets, however, localized channel widening was observed by DEQ at the lower site and more widespread channel overwidening was observed by FWP at the upper site as a result of livestock stream access and overgrazing in the riparian zone. Neither site was meeting the LWD target, and the lower site was not meeting the target for riparian shrub cover. Although riparian habitat and eroding streambanks appear to be recovering in some portions of the stream as a result of land management changes, overall, recent data indicate that human sediment sources combined with a limited transport capacity are resulting in excess sediment within Trout Creek that is diminishing the quantity and quality of fish habitat and likely impairing its ability to fully support fish and other aquatic life. Therefore, a sediment TMDL will be prepared for Trout Creek.

## 5.6 SEDIMENT TMDL DEVELOPMENT SUMMARY

Based on the comparison of existing conditions to water quality targets, 10 sediment TMDLs will be developed in the Little Blackfoot TPA. **Table 5-26** summarizes the sediment TMDL development determinations and corresponds to the waterbodies of concern identified in **Section 5.3**.

**Table 5-26 Summary of Sediment TMDL Development Determinations**

| Stream Segment | Waterbody # | TMDL Development Determination (Y/N) |
|---|---|---|
| DOG CREEK, headwaters to Meadow Creek | MT76G004_071 | Y |
| DOG CREEK, Meadow Creek to the mouth (Little Blackfoot River) | MT76G004_072 | Y |
| ELLISTON CREEK, headwaters to the mouth (Little Blackfoot River) | MT76G004_040* | Y |
| LITTLE BLACKFOOT RIVER, the headwaters to Dog Creek | MT76G004_020 | Y |
| LITTLE BLACKFOOT RIVER, Dog Creek to the mouth (Clark Fork River) | MT76G004_010 | Y |
| SNOWSHOE CREEK, headwaters to the mouth (Little Blackfoot River) | MT76G004_080 | Y |
| SPOTTED DOG CREEK, forest boundary to the mouth (Little Blackfoot River) | MT76G004_032 | Y |
| TELEGRAPH CREEK, headwaters to Hahn Creek | MT76G004_051 | Y |
| THREEMILE CREEK, Quigley Reservoir to the mouth (Little Blackfoot River) | MT76G004_112* | Y |
| TROUT CREEK, headwaters to the mouth (Little Blackfoot River) | MT76G004_120* | Y |

* Not on Montana's 2010 303(d) List

## 5.7 SEDIMENT SOURCE ASSESSMENT AND QUANTIFICATION

This section summarizes the assessment approach, current sediment load estimates, and the rationale for load reductions and allocations within the Little Blackfoot TPA. The focus is on the following four potentially significant sediment source categories and associated controllable human loading associated with each of these sediment source categories.

- streambank erosion
- upland erosion and riparian health
- unpaved roads
- permitted point sources

EPA sediment TMDL development guidance for source assessments states that the basic source assessment procedure includes compiling an inventory of all sources of sediment to the waterbody and using one or more methods to determine the relative magnitude of source loading, focusing on the primary and controllable sources of loading (U.S. Environmental Protection Agency, 1999b). Additionally, regulations allow that loadings "may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (Water quality planning and management, 40 CFR § 130.2(G)). The source assessments evaluated loading from the primary sediment sources using standard DEQ methods, but the sediment loads presented herein represent relative loading estimates within each source category, and should not be considered as actual loading values. Rather, relative estimates provide the basis for percent reductions in loads that can be accomplished via improved land management practices for each source category. These estimates of percent reduction provide a basis for setting load or wasteload allocations. As better information becomes available and the linkages between loading and instream conditions improve, the loading estimates presented here can be further refined in the future through adaptive management.

For each impaired waterbody segment, sediment loads from each source category were estimated based on field surveys, watershed modeling, and load extrapolation techniques (described below). The results include a mix of sediment sizes, particularly for bank erosion that involves both fine and coarse sediment loading to the receiving water, whereas loads from roads, upland erosion, and permitted point source discharges are predominately fine sediment.

The complete methods and results for source assessments for streambank erosion, upland erosion, and roads are located in **Appendices C, D,** and **E.** The following sections provide a summary of the load assessment results along with the basis for load reductions via improved land management practices. This load reduction basis provides the rationale for the TMDL load and wasteload allocations defined in **Section 5.8**.

## 5.7.1 Eroding Streambank Sediment Assessment

Streambank erosion was assessed in 2009 at the 19 full assessment reaches discussed in **Section 5.3**. At each site, eroding streambanks were classified as either actively or slowly eroding, the susceptibility to erosion was assessed by performing Bank Erosion Hazard Index (BEHI) measurements, and the erosive force was determined by evaluating the Near Bank Stress (NBS) (Rosgen, 1996; 2004). BEHI scores were determined at each eroding streambank based on the following parameters: bank height, bankfull height, root depth, root density, bank angle, and surface protection. In addition to BEHI data collection, the source of streambank erosion was evaluated based on observed human-caused disturbances and the surrounding land-use practices based on the following near-stream source categories:

- transportation
- riparian grazing
- cropland
- mining
- silviculture
- irrigation-shifts in stream energy
- natural sources
- other

Based on the aerial assessment process (described in **Section 5.3**) in which each 303(d) listed waterbody segment is divided into different reaches, streambank erosion data from each 2009 monitoring site was used to extrapolate to the reach scale. Then, the average value for each unique reach category was applied to unmonitored reaches within the corresponding category to estimate loading associated with bank erosion at the listed stream segment and watershed scales.

The potential for sediment load reduction via riparian BMPs was estimated based on the ratio of actively to slowly eroding banks from five reaches with greater than 75% natural erosion sources. That ratio (i.e., 70% active vs. 30% slowly) was applied to each reach category and extrapolated to all similar reach types for reaches with predominantly human sources. The most appropriate BMPs will vary by site, but streambank stability and erosion rates are largely a factor of the health of vegetation near the stream, and the application of riparian BMPs are anticipated to lower the amount of actively eroding banks and result in the estimated reductions. Although the reduction may not be achievable in all areas, greater reductions will likely be achievable in some areas. Because channel parameters and other variables must be altered within the SWAT model (see **Section 5.7.3** and **Appendix D**) to reduce loading associated with bank erosion and it is difficult to get a certain percentage for each impaired watershed, loading reductions achievable via the implementation of riparian BMPs were applied to the existing loads from the SWAT model based on reductions identified in the *Sediment and Habitat Assessment* (**Appendix C**). Additionally, the percentage of streambank erosion from natural versus human sources is based on the streambank assessment (**Appendix C**).

**Assessment Summary**

Because the SWAT model used to estimate loading from upland erosion (see **Section 5.7.3** and **Appendix D**) is calibrated to flow at the USGS gage near Garrison and to a sediment rating curve based on data at the gage, bank erosion loads summarized here and used in the TMDL are from the model, but the allocations and percent reductions are based on the bank erosion source assessment (**Table 5-27**). Based on the model output, streambank erosion contributes an estimated 2,187 tons of sediment per year to the Little Blackfoot TPA. Sediment loads due to streambank erosion range from 0.9 tons/year in the upper Dog Creek watershed to 261 tons per year in the upper Little Blackfoot River watershed. Implementation of riparian BMPs could decrease annual bank erosion 20% within the Little Blackfoot River watershed. Significant sources of streambank erosion include riparian grazing, riparian clearing, hay production, and transportation. **Appendix C** contains additional information about sediment loads from eroding streambanks in the Little Blackfoot TPA by subwatershed.

**Table 5-27. Existing and Reduced Sediment Load from Eroding Streambanks within the Little Blackfoot TPA.**

| Subbasin | Existing Sediment Load (tons/year) | Allowable Sediment Load with Riparian BMPs (tons/year) | Percent Reduction |
|---|---|---|---|
| Dog Creek, upper segment | 0.9 | 0.8 | 7% |
| Dog Creek, lower segment | 234 | 197 | 16% |
| Elliston Creek | 3.3 | 2.8 | 16% |
| Little Blackfoot River, upper segment | 261 | 235 | 10% |
| Little Blackfoot River, lower segment | 2,654 | 2,123 | 20% |
| Snowshoe Creek | 34 | 27 | 21% |
| Spotted Dog Creek, lower segment | 84 | 46 | 45% |
| Telegraph Creek, upper segment | 24 | 22 | 8% |
| Threemile Creek, lower segment | 41 | 39 | 8% |
| Trout Creek | 112 | 84 | 25% |

### 5.7.1.1 Streambank Assessment Assumptions

The following is a summary of the significant assumptions used during the eroding streambank assessment:

- Because the SWAT model integrates all sediment sources and loading is based on a sediment rating curve developed using data from the USGS gage on the Little Blackfoot River near Garrison, it is assumed that the streambank erosion load from the model is a better estimate of the existing load than that from the field assessment
- The ratio of actively to slowly eroding streambanks at sites with predominantly natural sources is an appropriate and achievable rate in reaches where all reasonable land, soil, and water conservation practices are applied.

- The average annual load per Reach Type is applicable to other reaches within the same category.
- Sources of bank erosion at the assessed stream segment scale are representative of sources for that watershed.
- The annual streambank erosion rates used to develop the sediment loading numbers were based on Rosgen BEHI studies along the Lamar River in Yellowstone National Park. While the predominant geologies differ between the Wyoming research sites and the Little Blackfoot watershed, the rates are applicable to the Little Blackfoot and suitable for helping estimate the percentage in streambank associated loading reductions achievable with the implementation of riparian BMPs.

### 5.7.2 Upland Erosion and Riparian Buffering Capacity Assessment

The hydrologic simulation model known as SWAT (Soil and Water Assessment Tool) was used to determine the existing sediment loads and potential reductions from upland sources in the Little Blackfoot TPA. SWAT is a river basin scale model developed to quantify the impact of land management practices in large, complex watersheds. It incorporates hydrologic, climactic, and water chemistry data with detailed land cover/land use and topography information to predict pollutant loading for seasonal and annual time frames.

To simulate pollutant loading at the watershed scale, SWAT first partitions a watershed into a number of subbasins. Each subbasin delineated within the model is simulated as a homogeneous area in terms of climatic conditions, but with additional subdivisions within each subbasin to represent various soils and land use types. Each of these subdivisions is referred to as a hydrologic response unit (HRU) and is assumed to be spatially uniform in terms of soils, land use, topographic and climatic data. Once the HRU categories have been defined, the model then introduces the hydrologic and land management information in order to generate the sediment loads from the landscape. Data over a four year period of record (2002 through 2005) from the USGS gage on the Little Blackfoot River near Garrison (#12324590) was used to calibrate the hydrology for this model.

SWAT uses a complicated approach but is built around the widely used Universal Soil Loss Equation (USLE). USLE uses five main factors by which to estimate soil erosion: R * K* LS * C * P, where:

R = rainfall/intensity
K = erodibility
LS = length/slope
C = vegetation cover
P = field practices

Values for these factors applied to each of the HRUs in each of the subbasins. All values except "P" and "C" are environmental factors; therefore, they are not management factors and are not modified for the existing or desired condition scenarios. Per the NRCS state agronomist, the P value was set at 1 for all HRUs for both scenarios. The C-factor, which represents the amount of ground cover, was set per HRU category for the existing condition and for an improved conditions scenario associated with the implementation of upland BMPs. C-factors for both scenarios were based on literature values, estimates of existing field conditions in the watershed determined through site visits, communication with local stakeholders, and comparisons to previous SWAT model efforts in the Upper Clark Fork and Bitterroot River watersheds.

HRU categories and C-factors used in the Little Blackfoot River SWAT model for both scenarios are listed in **Table 5-28**. The land use categories that were modified are range-brush and pasture. C-factor changes equate to roughly a 10% improvement in ground cover per category. A C-factor slightly higher than a deciduous/evergreen forest was used for logged areas within the forested category because logging intensity within the watershed is generally low and because practices, such as riparian clearcutting, that tend to produce high sediment yields have not been used since at least 1991, when the MT Streamside Management Zone (SMZ) law was enacted. Additionally, the USLE model is intended to reflect long-term average sediment yield, and while a sediment pulse typically occurs in the first year after logging, sediment production after the first year rapidly declines (Elliot, 2006; Elliot.W.J. and Robichaud, 2001; Rice, et al., 1972). The logging C-factor, which is incorporated into the forest category, is the same for both management scenarios to indicate that logging will continue sporadically on public and private land within the watershed and will produce sediment at a rate slightly higher than an undisturbed forest. This is not intended to imply that additional best management practices beyond those in the SMZ law should not be used for logging activities. Additional details about the SWAT model and the upland erosion assessment are in **Appendix D**.

**Table 5-28. SWAT HRU Categories and C-factors for the existing and improved condition scenarios**

| SWAT Code | Land Cover/Land Use Description | Percent Watershed Area | Existing C-factor | Improved Condition C-factor |
|---|---|---|---|---|
| SWRN | Southwestern US (Arid) Range | 0.01% | 0.310 | 0.310 |
| FRSE | Forest-Evergreen | 55.42% | 0.005 | 0.005 |
| RNGB | Range-Brush | 38.94% | 0.034 | 0.031 |
| PAST | Pasture | 4.45% | 0.013 | 0.008 |
| WETF | Wetlands-Forested | 0.50% | 0.002 | 0.002 |
| URBN | Residential | 0.55% | 0.018 | 0.018 |

**Assessment Summary**

From the model output, an average annual sediment load delivered to the stream is determined for each listed stream's watershed. The average annual upland sediment load is the sum of the average annual loads from each land cover/land use type (HRU category). This sediment load represents the best estimation of current loading from upland sources. **Table 5-29** presents the modeled existing sediment load as well as the loading reductions achievable with improvement of upland management practices. Additional details about the SWAT model and the achievable reductions by land cover category for each listed stream's watershed are in **Appendix D**.

**Table 5-29. Existing and Reduced Sediment Load from Upland Sources within the Little Blackfoot TPA**

| Subbasin | Existing Delivered Sediment Load (tons/year) | Normalized Existing Load (tons/mile$^2$/year) | Improved Upland Conditions Sediment Load (tons/year) | Normalized Improved Upland Condition Load (tons/mile$^2$/year) | Percent Reduction |
|---|---|---|---|---|---|
| Dog Creek, upper segment | 130 | 17.8 | 114 | 15.6 | 12.1% |
| Dog Creek, lower segment | 2,183 | 37.3 | 2,044 | 35.0 | 6.4% |
| Elliston Creek | 117 | 19.1 | 102 | 16.7 | 12.3% |
| Little Blackfoot River, upper segment | 4,056 | 40.6 | 3,828 | 38.3 | 5.6% |
| Little Blackfoot River, lower segment | 12,046 | 29.2 | 10,999 | 26.7 | 8.7% |
| Snowshoe Creek | 348 | 19.3 | 300 | 15.1 | 13.8% |

**Table 5-29. Existing and Reduced Sediment Load from Upland Sources within the Little Blackfoot TPA**

| Subbasin | Existing Delivered Sediment Load (tons/year) | Normalized Existing Load (tons/mile$^2$/year) | Improved Upland Conditions Sediment Load (tons/year) | Normalized Improved Upland Condition Load (tons/mile$^2$/year) | Percent Reduction |
|---|---|---|---|---|---|
| Spotted Dog Creek, lower segment | 1,686 | 38.0 | 1,549 | 34.9 | 8.1% |
| Telegraph Creek, upper segment | 151 | 9.4 | 148 | 9.2 | 2.4% |
| Threemile Creek, lower segment | 691 | 13.5 | 538 | 10.5 | 22.1% |
| Trout Creek | 422 | 24.2 | 388 | 22.2 | 8.2% |

### 5.7.1.1 Improved Riparian Condition Scenario

The SWAT model scenario for existing conditions and loading associated with upland sources incorporates the current capacity of riparian buffers within the Little Blackfoot TPA to filter sediment and prevent it from entering streams. However, riparian vegetation can greatly alter sediment loading to streams, and based on a riparian assessment performed by DEQ in 2009, there is significant opportunity for improved riparian health in the Little Blackfoot watershed. Therefore, in conjunction with the upland loading reductions achievable via implementing BMPs to improve ground cover, a scenario of improved riparian health was incorporated in the SWAT model to estimate the additional upland reductions achievable via the implementation of riparian BMPs.

NRCS recommends a minimum buffer width of 30 feet (Natural Resource Conservation Service, 2011b; 2011a), and the ability of riparian buffers to effectively filter sediment increases with increasing buffer width. For instance, a 100 foot wide, well-vegetated riparian buffer is a common recommended buffer width(Mayer, et al., 2005; Cappiella, et al.,2006) and has been found to filter 75-90% of incoming sediment from reaching the stream channel (Wegner, 1999; Knutson and Naef, 1997). Although sediment removal efficiency is affected by factors such as ground slope, buffer health, and buffer composition, the literature values were used as the basis for applying filter strips of varying widths (i.e., 30, 50, and 100 feet) to estimate additional sediment upland loading reductions that could be achieved with improved riparian conditions.

Different buffer widths were used based on a riparian health classification performed by DEQ during the stratification process described in **Section 5.3.2**. Using aerial photos, delineated reaches were given a riparian condition category of good, fair, or poor based on land use adjacent to the stream, riparian vegetation type and density, and the presence or absence of human related activities near the stream corridor. Based on this, each stream investigated was given corresponding percentages of condition based on the total length of stream assessed. The desired condition is 75% good/25 % fair buffer and because each watershed was estimated to already be at least 25% fair, a ratio of buffer widths was applied within SWAT to HRUs within each impaired stream's watershed depending on the existing amount of poor/fair/good buffers. Given that poor buffers need the most improvement, under the improved condition scenario, buffer widths classified as poor were assigned a width of 100 feet, fair buffers were assigned a width of 50 feet, and good buffers were assigned a width of 30 feet. Because SWAT groups areas of similar soils, land use, and slope into HRUs, single HRUs are often spread throughout a subwatershed. Since a riparian buffer is applied by HRU, it is difficult to only apply the buffer along the extent of each stream. Therefore, the distribution of HRUs was evaluated for each watershed in need of a TMDL and filter strips were added to land types that tend to occur along streams and will benefit the most from improved riparian vegetation. This was typically pasture but also included rangeland, especially in areas with heavy grazing. In areas such as upper Telegraph Creek, where there is a substantial amount of forest but the effects of logging or presence of mine tailings in the riparian area represent a potential sediment source, filter strips were added to the forest category as a surrogate for reductions that could occur from improving the riparian vegetation and/or stabilizing tailings. It is assumed that additional reductions could occur within all land cover categories by improvement of the riparian vegetation. Additional information about the improved riparian condition scenario is provided in **Appendix D**.

**Assessment Summary**

Based on improvements in riparian health, the model indicated that additional reductions in sediment loading ranging from 6 to 24% are achievable. **Table 5-30** shows the difference between the existing upland load and the allowable load with improved upland and riparian conditions.

**Table 5-30. Sediment Load from Upland Sources with Improved Upland and Riparian Conditions**

| Subbasin | Existing Delivered Sediment Load (tons/year) | Normalized Existing Load (tons/mile$^2$/year) | Allowable Delivered Sediment Load with Improved Upland and Riparian Conditions (tons/year) | Normalized Allowable Load (tons/mile$^2$/year) | Percent Reduction |
|---|---|---|---|---|---|
| Dog Creek, upper segment | 130 | 17.8 | 100 | 13.6 | 23.2% |
| Dog Creek, lower segment | 2,183 | 37.3 | 1,876 | 32.1 | 14.1% |
| Elliston Creek | 117 | 19.1 | 85 | 13.8 | 27.5% |
| Little Blackfoot River, upper segment | 4,056 | 40.6 | 3,575 | 35.8 | 11.8% |
| Little Blackfoot River, lower segment | 12,046 | 29.2 | 9,891 | 24.0 | 17.9% |
| Snowshoe Creek | 348 | 19.3 | 267 | 14.7 | 23.1% |
| Spotted Dog Creek, lower segment | 1,686 | 38.0 | 1,336 | 30.1 | 20.7% |
| Telegraph Creek, upper segment | 151 | 9.4 | 128 | 7.9 | 15.6% |
| Threemile Creek, lower segment | 691 | 13.5 | 373 | 7.3 | 46.0% |
| Trout Creek | 422 | 24.2 | 325 | 18.6 | 23.1% |

### *5.7.1.2 Upland Assessment Assumptions*

As with any modeling effort, and especially when modeling at a watershed scale, there are a number of assumptions that must be accepted. For upland erosion source assessment, here are the major assumptions:

- The input variables used in the USLE calculations are representative of their respective land use conditions.

- The land management practices (grazing duration, hay cutting, etc) for certain land use categories that define the vegetative cover throughout the year are relatively consistent and representative of practices throughout the watershed.
- The application of riparian filtering is applicable only to the improved conditions and the current model inherently incorporates existing conditions across the landscape.
- The riparian condition as estimated through the aerial assessment is representative of on-the-ground conditions.
- Applying filter strips within SWAT is an acceptable surrogate for improved riparian condition. Filter strips were applied to the land cover categories where they will be most effective, but estimated reductions may not be achievable in all areas and additional reductions may be achievable in some areas where filter strips were not applied.
- The improvement scenarios to riparian condition and land management are reasonable and achievable.
- A substantial portion of upland load after improvements in management practices for each land use category is a component of the "natural upland load." The assessment methodology did not differentiate between sediment loads with all reasonable BMPs and "natural" loads.

## 5.7.3 Road Sediment Assessment

### *5.7.3.1 Unpaved Roads*

Sediment loading from unpaved roads was assessed using GIS, field data collection, and sediment modeling. The results of the roads assessment was then incorporated into the SWAT model. Each identified unpaved road crossing and near-stream parallel road segment was assigned attributes for road name, surface type, road ownership, stream name, subwatershed, and landscape type (i.e., mountain, foothill, or valley). Twenty two crossings and five near-stream parallel segments representing the range of conditions within the watershed were field assessed in 2009, and sediment loading was estimated using the Water Erosion Prediction Project Methodology (WEPP:Road). The average sediment contribution from unpaved road crossings and near-stream road segments were extrapolated to all unpaved roads in the watershed based on landscape setting (i.e., mountain, foothill, and valley). To address sediment from unpaved roads in the TMDLs and allocations that follow in **Section 5.6**, the WEPP:Roads analysis was also run using BMPs to reduce the road contributing length to 200 feet. The 200-foot BMP scenario is used in this document as a general approximation of an achievable modeled loading reduction to help develop the road crossing allocations. The intent is to ensure that all road crossings have the appropriate BMPs in place to protect water quality via reduced sediment loading. Other potential BMPs include the installation of full structural BMPs at existing road crossings (drive through dips, culvert drains, settling basins, silt fence, etc), road surface improvement, reduction in road traffic levels (seasonal or permanent road closures), and timely road maintenance to reduce surface rutting. Because parallel segments contributed less than 0.1% of the loading associated with unpaved roads, and well-maintained culvert drains were observed on parallel segments in several drainages (i.e., Snowshoe, Telegraph, and Elliston), no BMP reduction scenarios were applied to the load from near-stream parallel segments. A more detailed description of this assessment can be found in *Road Sediment Assessment and Modeling (Water & Environmental Technologies, P.C., 2010)* (**Appendix E**).

The existing road conditions and sediment loadings from the assessment were introduced into the SWAT model through use of a point source. Since roads are not a separate land use in this model (i.e., they are not explicitly modeled), each sub-basin had a sediment point source added to simulate the road loadings. These loads were reported on an annual basis in the assessment but are distributed within SWAT based on monthly rainfall totals, so that the sediment loading is greater in high rainfall months.

**Assessment Summary**

Based on the source assessment, unpaved roads are estimated to contribute 38 tons of sediment per year to the Little Blackfoot River watershed. Sediment loads due to unpaved roads range from <1 ton/year in the Elliston Creek watershed to 5.2 tons/year in the Dog Creek watershed. Thirty six percent of the private crossings already have a contributing length less than 200 feet and 27% of federal crossings are already meeting the goal; however, private crossings averaged a greater contributing length (561 feet versus 401) and a greater load (0.085 tons versus 0.07 tons), indicating how a few crossings with inadequate BMPs can influence loading to streams.

Out of the 22 crossings evaluated in the field, 12 had at least one BMP installed. Observed BMPs were graveled surface, water bars, culverts drains, and drive through dips. Factors influencing sediment loads from unpaved roads at the watershed scale include the overall road density within the watershed and the configuration of the road network, along with factors related to road construction and maintenance. **Table 5-31** contains annual sediment loads from unpaved roads in the watersheds where TMDLs are developed within this document as well as the reduced load and percent reduction based on the BMP conditions described above. **Appendix E** contains additional information about sediment loads from unpaved roads in the Little Blackfoot TPA. Note: The USFS may have decommissioned some unpaved roads since the road network information was obtained (spring 2009) and those changes are not reflected in the source assessment.

**Table 5-31. Annual Sediment Load (tons/year) from Unpaved Roads within the Little Blackfoot River Watershed.**

| Watershed | Total Load (tons/year) | Percent Load Reduction After BMP Application | Total Sediment Load After BMP Application |
|---|---|---|---|
| Dog Creek, upper segment | 1.4 | 70% | 0.4 |
| Dog Creek, lower segment | 5.2 | 71% | 1.5 |
| Elliston Creek | 0.5 | 70% | 0.1 |
| Little Blackfoot River, upper segment | 9.8 | 71% | 2.9 |
| Little Blackfoot River, lower segment | 38.4 | 75% | 9.7 |
| Snowshoe Creek | 2.3 | 74% | 0.6 |
| Spotted Dog Creek, lower segment | 4.0 | 79% | 0.8 |
| Telegraph Creek, upper segment | 3.8 | 71% | 1.1 |
| Threemile Creek, lower segment | 2.2 | 79% | 0.5 |
| Trout Creek | 0.8 | 76% | 0.2 |

*Due to rounding, differences in loads presented in this table may not correspond to the percent reduction.

### *5.7.3.2 Traction Sand*

Traction sand applied to paved roads in the winter can be a significant source of sediment loading to streams. A study by the Montana Department of Transportation (MDT) (Staples, et al., 2004) found that traction sand predominantly contains particles less than 6mm and 2mm, which are size fractions that can be detrimental to fish and other aquatic life as in-stream concentrations increase(Irving and Bjorn, 1984; Mebane, 2001; Weaver and Fraley, 1991; Shepard, et al., 1984; Suttle, et al., 2004; Zweig and Rabeni, 2001).

Sediment loading associated with traction sand was estimated based on application rates multiplied by contributing distances and a delivery ratio. Annual application rates were provided by MDT for Highway

12 and 141 and the Powell County Roads Department for secondary roads. Contributing lengths were identified by querying the GIS database for paved roads within 100 feet of streams. The Powell County Road Department applies traction sand to a few steep gravel roads but these were excluded from the traction sand estimate. Based on a range of delivery ratios in the Prospect Creek TMDL and literature values for the effectiveness of vegetated buffers (Asmussen, et al., 1976; Hall, et al., 1983; Han, et al., 2005; Mickelson, et al., 2003; Montana Department of Environmental Quality, 2009), a 15% delivery rate was assumed. The delivery rate equates to a buffer length of 50 to 100 feet with 50% vegetative cover.

The loading reduction potential was estimated by assuming that BMPs could reduce the annual delivery rate to 10% (which equates to 60% vegetative cover). This could be achieved by a combination of BMPs, which may include a lower application rate, street sweeping, improving maintenance of existing BMPs, altering plowing speed at crossings, and structural control measures. It is acknowledged that public safety is a primary factor in the usage of traction sand, and the reduction in loading from traction sand is anticipated to be achieved by improving BMPs without sacrificing public safety. Additional details regarding the traction sand assessment are provided in **Appendix E**.

**Assessment Summary**

Based on the source assessment, traction sand was identified as a potentially significant source in three tributaries to the Little Blackfoot River and contributes approximately 39 tons of sediment per year to the Little Blackfoot TPA (**Table 5-32**). Additional BMPs are estimated to reduce traction sand loading by 33% to all affected waterbodies.

**Table 5-32. Annual Sediment Load (tons/year) from Traction Sand within the Little Blackfoot River Watershed.**

| Watershed | Total Load (tons/year) | Percent Load Reduction After BMP Application | Total Sediment Load After BMP Application |
|---|---|---|---|
| Elliston Creek | 0.4 | 33% | 0.3 |
| Little Blackfoot River, lower segment | 39.0 | 33% | 26.0 |
| Threemile Creek, lower segment | 7.0 | 33% | 4.6 |
| Trout Creek | 9.8 | 33% | 6.5 |

*Due to rounding, differences in loads presented in this table may not correspond to a 33 percent reduction.

### *5.7.3.3 Culvert Failure and Fish Passage*

Undersized or improperly installed culverts may be a chronic source of sediment to streams or a large acute source during failure, and they may also be passage barriers to fish. Therefore, during the roads assessment, the flow capacity and potential to be a fish passage barrier was evaluated for each culvert. Due to fords at four road crossings and conditions preventing full measurements at four crossings, the culvert analysis was performed at 14 of the 22 road crossings. The assessment incorporated bankfull width measurements taken upstream of each culvert to determine the stream discharge associated with different flood frequencies (e.g. 2, 5, 10, 25, 50, and 100 year) as well as measurements to estimate the capacity and amount of fill material of each culvert. It is assumed that fill above an undersized culvert will periodically erode into the channel but the culvert will not completely fail; therefore, the annual amount of sediment at-risk was set at a 25% probability for the loading analysis.

A common BMP for culverts is designing them to accommodate the 25-year storm event; this capacity is specified as a minimum in Water Quality BMPs for Montana Forests (Montana State University, Extension Service, 2001), and it is typically the minimum used by the USFS. Therefore, fill was only assumed to be at-risk in culverts that cannot convey a 25-year event. However, other considerations such as fish passage, the potential for large debris loads, and the level of development and road density upstream of the culvert should also be taken into consideration during culvert installation and replacement, and may necessitate the need for a larger culvert. For instance, the USFS typically designs culverts to pass the 100-year event and be suitable for fish and aquatic organism passage on fish bearing streams (U.S. Department of Agriculture, Forest Service, 1995). Therefore, the BMP scenario for culverts is no loading from culverts as a result of being undersized, improperly installed, or inadequately maintained. At a minimum, culverts should meet the 25-year event, but for fish-bearing streams or those with a high level of road development upstream, meeting the 100-year event is recommended.

Fish passage assessments were performed on 15 culverts; bridges and sites where all measurements could not be collected were excluded. The assessment was based on the methodology defined in **Appendix E**, which is geared toward assessing passage for juvenile salmonids. Considerations for the assessment include stream flow, the culvert slope, culvert perch/outlet drop, culvert blockage, and constriction ratio (i.e. culvert width to bankfull width). The assessment is intended to be a coarse level evaluation of fish passage that quickly identifies culverts that are likely fish passage barriers and those that need a more in-depth analysis. The culvert assessment in **Appendix E** contains information that may help land managers focus restoration efforts on those culverts that were concluded as being fish barriers and/or undersized per this analysis.

**Assessment Summary**

Out of the 14 culverts assessed for failure risk, 11 (79%) were estimated to pass a 25-year event and 6 (43%) were estimated to pass the 100-year event. All culverts evaluated on USFS land were estimated to pass at least a 25-year event but only two of seven were estimated to be designed for Q100. On private lands, culvert capacity was quite varied with half being estimated to pass a 100-year event and the other half estimated to only be built for a two-year event. Assuming a 25% probability of failure annually (for culverts meeting less than Q25), it was estimated that 196 tons of sediment are at-risk; this load is presented to give an estimate of the potential loading associated with undersized culverts in the Little Blackfoot Watershed but because of the sporadic natural and uncertainty regarding timing of culvert failures, the estimated load at-risk is not including in the existing loads estimates for each impaired stream. For the fish passage assessment, all 15 assessed culverts were determined to pose a significant passage risk to juvenile fish at all flows. The predominant reason cited as a barrier to fish passage was a steep culvert gradient.

### *5.7.3.4 Road Assessment Assumptions*

The following is a summary of the significant assumptions used during the roads assessment:

- The road crossings and parallel segments assessed in the field are representative of conditions throughout the watershed.
- Although ownership may affect the level of BMP implementation, landscape setting was assumed to be the largest determinant of loading per crossing. Field sites were selected to have a representative number per ownership type, but the loads were extrapolated based on landscape setting (i.e., mountain, foothill, and valley).
- Using a modeling scenario that focuses on reducing the contributing length near road crossings will effectively reduce the majority of the sediment load from roads and is an effective way to represent loading reductions associated with the implementation of all reasonable, land, soil, and water conservation practices.

- BMPs may have already have been implemented on many roads and therefore the reductions necessary in some locations may be less than described in this document.

## 5.7.4 Permitted Point Sources

As of September 14, 2011, there were four Montana Pollutant Discharge Elimination System (MPDES) permitted point sources within the Little Blackfoot Watershed (**Figure A-16**). Three of the permits are general permits (MTR100000) for construction stormwater and the fourth is a general permit for suction dredging (MTG370000). To provide the required wasteload allocation for permitted point sources, a source assessment was performed for these point sources. However, because of the nature of sediment loading associated with these permits and because effluent limits are not contained within the existing permits, the WLAs are not intended to add load limits to the permits; it is assumed that the WLAs will be met by adherence to the General Permit requirements (MTR100000 and MTG370000).

### *5.7.4.1 Construction Stormwater Permits*

Since construction activities at a site are relatively temporary and short term in nature, the number of construction sites covered by the general permit at any given time varies. Collectively, these areas of severe ground disturbance have the potential to be significant sediment sources if proper BMPs are not implemented and maintained. Each construction stormwater permittee is required to develop a SWPPP that identifies the stormwater BMPs that will be in place during construction. Prior to permit termination, disturbed areas are required to have a vegetative density equal to or greater than 70% of the pre-disturbed level (or an equivalent permanent method of erosion prevention). Inspection and maintenance of BMPs is required, and although Montana stormwater regulations provide the authority to require stormwater monitoring, water quality sampling is typically not required (Heckenberger, Brian, personal communication 2009).

To estimate the disturbed acreage associated with construction stormwater permits, the permit files were reviewed for anticipated acres to be disturbed. One permit for construction stormwater is for a 3 acre gravel borrow pit in the Dog Creek watershed and the others are for bridge replacements over the Little Blackfoot River at Highway 12 (33 acres) and at Beck Hill Road (<1 acre). Due to similarities in the amount of ground cover, potential sediment loading for the construction sites if adequate BMPs are not followed were calculated using annual erosion rate for the Southwestern US range category from the SWAT model (**Appendix H**). That land use category represents barren lands in the NLCD and is defined as areas of bedrock as well as glacial debris, strip mines, gravel pits, and other accumulations of earthen material that generally have less than 15% of total cover. The average erosion rate from this category (which only represents 23 acres within the watershed) was multiplied by the amount of disturbed area due to construction for each permit. To estimate the reduction in loading associated with following proper BMPs and adhering to permit requirements, a 65% reduction was applied based on studies from the U.S. EPA and the International Stormwater Best Management Practices Database (Geosyntec Consultants and Wright Water Engineers, Inc., 2008; EPA, 2009b). The reduced loads will be the used to set the wasteload allocations for construction stormwater permits. Because following permit conditions meets the intent of the WLA for construction stormwater, any future permits will meet the TMDL by following all permit conditions, including the SWPPP.

**Assessment Summary**

Based on the source assessment, construction stormwater permits in the Little Blackfoot watershed have the potential to contribute up to 50.7 tons of sediment per year (**Table 5-33**). That load can be reduced to 17.7 tons by adhering to permit conditions and following all necessary BMPs.

**Table 5-33. Sediment Loading and Reductions from Permitted Construction Sites**

| Watershed | Loading rate based on SWAT (T/Acre/ Year) | Annual Disturbed Acres | Estimated Load Without Adequate BMPs (T/Year) | BMP Sediment Load (T/Year) | Percent Reduction |
|---|---|---|---|---|---|
| **Dog Creek** | 1.37 | 3 | 4.1 | 1.4 | 65% |
| **Little Blackfoot** | 1.37 | 37 | 50.7 | 17.7 | 65% |

### *5.7.4.2 Suction Dredge Permit*

The suction dredge permit (MTG370318) is in the Carpenter Creek drainage. Because no sediment TMDL is being presented for Carpenter Creek, the WLA for the suction dredge permit will be part of the TMDL for the lower segment of the Little Blackfoot River. The general permit has special conditions to minimize harmful conditions caused by elevated suspended sediment concentrations including no disturbance of streambanks, dredging only within the wetted channel, no wheeled equipment in the stream while dredging, and avoiding dredging areas where silt and clay are concentrated. Additionally, no visual increase in turbidity is allowed at the end of the mixing zone (i.e., 10 stream widths downstream), and the permittee must keep a daily log to demonstrate compliance with this condition.

**Assessment Summary**

Because only sediment within the wetted channel is permitted and no visual increase is allowed beyond the mixing zone, if the permit conditions are followed, no sediment loading is anticipated from this permit and a WLA of 0 will be provided.

### 5.7.5 Source Assessment Summary

The estimated annual sediment load from all identified sources throughout the Little Blackfoot River watershed is 14,828 tons. Each source category has different seasonal loading rates, and the relative percentage of the total load from each source category does not necessarily indicate its importance as a loading source. Instead, due to the coarse nature of the source assessment work and the unique uncertainties involved with each source assessment category, the intention is to separately evaluate source impacts within each assessment category (e.g., bank erosion, upland erosion, roads). Results for each source assessment category provide an adequate tool to focus waters quality restoration activities in the Little Blackfoot TPA by indicating the relative contribution of different subwatersheds or landcover types for that source category and the percent loading reductions that can be achieved with the implementation of improved management practices (**Appendices C, D,** and **E**).

## 5.8 TMDL AND ALLOCATIONS

### 5.8.1 Application of Percent Reduction and Yearly Load Approaches

The sediment TMDLs for the Little Blackfoot TPA will be based on a percent reduction approach as discussed in **Section 4.0.** This approach will apply to the loading allocated among sources as well as to the TMDL for each waterbody. An implicit margin of safety will be applied as further discussed in **Section 5.9**. (Cover, et al., 2008) observed a correlation between sediment supply and instream measurements of fine sediment in riffles and pools; it is assumed that a decrease in sediment supply, particularly fine sediment, will correspond to a decrease in the percent fine sediment deposition within the streams of interest and result in attainment of the sediment related water quality standards. A percent-reduction approach is preferable because there is no numeric standard for sediment to calculate the allowable load and because of the uncertainty associated with the loads derived from the source assessment (which are used to establish the TMDL), particularly when comparing different load categories such as road crossings to bank erosion. Additionally, the percent-reduction TMDL approach is more applicable for restoration planning and sediment TMDL implementation because this approach helps focus on implementing water quality improvement practices (i.e., BMPs), versus focusing on uncertain loading values.

An annual expression of the TMDLs was determined as the most appropriate timescale because sediment generally has a cumulative effect on aquatic life and other designated uses, and all sources in the watershed are associated with periodic loading. Each sediment TMDL is stated as an overall percent reduction of the average annual sediment load that can be achieved after summing the individual annual source allocations and dividing them by the existing annual total load. EPA encourages TMDLs to be expressed in the most applicable timescale but also requires TMDLs to be presented as daily loads (Grumbles, B., personal communication 2006). Daily loads are provided in **Appendix D**.

## 5.8.2 Development of Sediment Allocations by Source Categories

The percent-reduction allocations are based on the modeled BMP scenarios for each major source type (e.g., streambank erosion, upland erosion, roads and permitted point sources). These BMP scenarios are discussed within **Section 5.7** and associated appendices, and reflect reasonable reductions as determined from literature, agency and industry documentation of BMP effectiveness, and field assessments. Sediment loading reductions can be achieved through a combination of BMPs, and the most appropriate BMPs will vary by site. Sediment loading was evaluated at the watershed scale and associated sediment reductions are also applied at the watershed scale based on the fact that many sources deliver sediment to tributaries that then deliver the sediment load to the impaired waterbodies.

It is important to recognize that the first critical step toward meeting the sediment allocations involves applying and/or maintaining the land management practices or BMPs that will reduce sediment loading. Once these actions have been completed at a given location, the landowner or land manager will have taken action consistent with the intent of the sediment allocation for that location. For many nonpoint source activities, it can take several years to achieve the full load reduction at the location of concern, even though full BMP implementation is in effect. For example, it may take several years for riparian areas to fully recover after implementing grazing BMPs or allowing re-growth in areas of historic riparian harvest. It is also important to apply proper BMPs and other water quality protection practices for all new or changing land management activities to limit any potential increased sediment loading.

Progress towards TMDL and individual allocation achievement can be gauged by adherence to point source permits, BMP implementation for nonpoint sources, and improvement in or attainment of water quality targets defined in **Section 5.4**. Any effort to calculate loads and percent reductions for purposes of comparison to TMDLs and allocations in this document should be accomplished via the same methodology and/or models used to develop the loads and percent reductions presented within this document.

The following subsections present additional allocation details for each sediment source category.

### *5.8.2.1 Streambank Erosion*

Sediment loads associated with bank erosion were identified by separate source categories (e.g., transportation, grazing, natural) in **Appendix C**. Because of the inherent uncertainty in extrapolating this level of detail to the watershed scale, and also because of uncertainty regarding impacts from historical land management activity, all human caused sources of bank erosion were combined for the purpose of expressing the TMDL and allocations. Streambank stability and erosion rates are very closely linked to the health of the riparian zone; reductions in sediment loading from bank erosion are expected to be achieved by applying BMPs within the riparian zone.

### *5.8.2.2 Upland Erosion*

No reductions were allocated to natural sources, which are a significant portion of all upland land use categories. The allocation to upland sources includes application of BMPs to present land use activities as well as recovery from past land use influences such as riparian harvest. For all upland sources, the largest percent reduction will be achieved via riparian improvements.

### *5.8.2.3 Roads*

The unpaved road allocation can be met by incorporating and documenting that all road crossings and parallel segments with potential sediment delivery to streams have the appropriate BMPs in place. Routine maintenance of the BMPs is also necessary to ensure that sediment loading remains consistent with the intent of the allocations. At some locations, road closure or abandonment alone may be appropriate and, due to very low erosion potential linked to native vegetation growth on the road surface, additional BMPs may not be necessary.

### *5.8.2.4 Permitted Point Sources*

Due to the limited number of permitted point sources within the watershed, WLAs are only presented in the TMDLs for lower Dog Creek and the lower segment of the Little Blackfoot River. WLAs are expected to be met by adherence to permit conditions.

## 5.8.3 Allocations and TMDL for Each Stream

The following subsections present of the existing quantified sediment loads, allocations and TMDL for each waterbody.

### *5.8.3.1 Dog Creek, upper segment (MT76G004_071)*

**Table 5-34. Sediment Source Assessment, Allocations and TMDL for upper Dog Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | **Unpaved Roads Total** | **1.4** | **0.4** | **70%**** |
| **Streambank Erosion** | Human Caused | 0.8 | 0.7 | 8% |
| | Natural Background | 0.1 | 0.1 | 0% |
| | **Total** | **0.9** | **0.8** | **7%** |
| **Upland Sediment Sources** | Forest | 10 | 10 | 0% |
| | Range | 120 | 90 | 25% |
| | **Total** | **130** | **100** | **23%** |
| **Total Sediment Load** | | **132** | **101** | **23%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

### *5.8.3.2 Dog Creek, lower segment (MT76G004_072)*

Note: Because TMDLS are presented on a watershed basis, the TMDL for Lower Dog Creek also includes all loading to the upper segment.

**Table 5-35. Sediment Source Assessment, Allocations and TMDL for lower Dog Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | **Unpaved Roads Total** | **5.2** | **1.5** | **71%**** |
| **Streambank Erosion** | Human Caused | 212 | 175 | 18% |
| | Natural Background | 22 | 22 | 0% |
| | **Total** | **234** | **197** | **16%** |
| **Upland Sediment Sources** | Forest | 504 | 504 | 0% |
| | Range | 1,579 | 1,299 | 18% |
| | Pasture | 31 | 4 | 87% |
| | Developed | 68 | 68 | 0% |
| | **Total** | **2,182** | **1,876** | **14%** |
| **Point Sources** | **Construction Stormwater Permit (MTR103849)** | **4.1** | **1.4** | **65%** |
| **Total Sediment Load** | | **2,426** | **2,076** | **14%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

### *5.8.3.3 Elliston Creek (MT76G004_040)*

**Table 5-36. Sediment Source Assessment, Allocations and TMDL for Elliston Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | Unpaved Roads | 0.5 | 0.1 | 70% |
| | Traction Sand | 0.4 | 0.3 | 33% |
| | **Total** | **0.9** | **0.4** | **56%**** |
| **Streambank Erosion** | Human Caused | 2.4 | 1.9 | 22% |
| | Natural Background | 0.9 | 0.9 | 0% |
| | **Total** | **3.3** | **2.8** | **16%** |
| **Upland Sediment Sources** | Forest | 41 | 41 | 0% |
| | Range | 49 | 38 | 22% |
| | Pasture | 25 | 5 | 80% |
| | Developed | 2 | 2 | 0% |
| | **Total** | **117** | **85** | **27%** |
| **Total Sediment Load** | | **121** | **88** | **27%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

### *5.8.3.4 Little Blackfoot River, upper segment (MT76G004_020)*

**Table 5-37. Sediment Source Assessment, Allocations and TMDL for the upper Little Blackfoot River**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | **Unpaved Roads Total** | **9.8** | **2.9** | **71%**** |
| **Streambank Erosion** | Human Caused | 207 | 181 | 13% |
| | Natural Background | 54 | 54 | 0% |
| | **Total** | **261** | **235** | **13%** |
| **Upland Sediment Sources** | Forest | 857 | 836 | 2% |
| | Range | 3,179 | 2,735 | 14% |
| | Pasture | 18 | 2 | 89% |
| | Developed | 1 | 1 | 0% |
| | **Total** | **4,056** | **3,575** | **12%** |
| **Total Sediment Load** | | **4,326** | **3,813** | **12%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

### *5.8.3.5 Little Blackfoot River, lower segment (MT76G004_010)*

Note: Because TMDLS are presented on a watershed basis, the TMDL for the Lower Little Blackfoot River also includes all loading to the upper segment.

**Table 5-38. Sediment Source Assessment, Allocations and TMDL for the lower Little Blackfoot River**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | Unpaved Roads | 38 | 10 | 75% |
| | Traction Sand | 39 | 26 | 33% |
| | **Total** | **77** | **36** | **54%**** |
| **Streambank Erosion** | Human Caused | 2,420 | 1,890 | 22% |
| | Natural Background | 234 | 234 | 0% |
| | **Total** | **2,654** | **2,123** | **21%** |
| **Upland Sediment Sources** | Forest | 1,832 | 1,811 | 1% |
| | Range | 9,117 | 7,721 | 15% |
| | Pasture | 894 | 156 | 83% |
| | Developed | 204 | 204 | 0% |
| | **Total** | **12,046** | **9,891** | **18%** |
| **Point Sources** | **Construction Stormwater Permits (MTR100000)** | **51** | **18** | **65%** |
| | **Suction Dredge Permit (MTG370318)** | **0** | **0** | **0%** |
| **Total Sediment Load** | | **14,828** | **12,068** | **19%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

### *5.8.3.6 Snowshoe Creek (MT76G004_080)*

**Table 5-39. Sediment Source Assessment, Allocations and TMDL for Snowshoe Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | **Unpaved Roads Total** | **2.3** | **0.6** | **74%**** |
| **Streambank Erosion** | Human Caused | 32 | 25 | 23% |
| | Natural Background | 2 | 2 | 0% |
| | **Total** | **34** | **27** | **20%** |
| **Upland Sediment Sources** | Forest | 26 | 26 | 0% |
| | Range | 241 | 208 | 14% |
| | Pasture | 80 | 33 | 59% |
| | **Total** | **348** | **267** | **23%** |
| **Total Sediment Load** | | **384** | **295** | **23%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

### *5.8.3.7 Spotted Dog Creek, lower segment (MT76G004_032)*

Note: Because TMDLS are presented on a watershed basis, the TMDL for Lower Spotted Dog Creek also includes all loading to the upper segment.

**Table 5-40. Sediment Source Assessment, Allocations and TMDL for lower Spotted Dog Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | **Unpaved Roads Total** | **4.0** | **0.8** | **79%**** |
| **Streambank Erosion** | Human Caused | 81 | 43 | 47% |
| | Natural Background | 3 | 3 | 0% |
| | **Total** | **84** | **46** | **45%** |
| **Upland Sediment Sources** | Forest | 203 | 203 | 0% |
| | Range | 1,395 | 1,118 | 20% |
| | Pasture | 88 | 15 | 83% |
| | **Total** | **1,686** | **1,336** | **21%** |
| **Total Sediment Load** | | **1,774** | **1,383** | **22%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

### *5.8.3.8 Telegraph Creek, upper segment (MT76G004_051)*

**Table 5-41. Sediment Source Assessment, Allocations and TMDL for upper Telegraph Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | **Unpaved Roads Total** | **3.8** | **1.1** | **71%** |
| **Streambank Erosion** | Human Caused | 17 | 15 | 11% |
| | Natural Background | 7 | 7 | 0% |
| | **Total** | **24** | **22** | **8%** |
| **Upland Sediment Sources** | Forest | 113 | 95 | 16% |
| | Range | 35 | 33 | 6% |
| | Pasture | 3 | 0.4 | 87% |
| | **Total** | **151** | **128** | **15%** |
| **Total Sediment Load** | | **179** | **151** | **16%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

### *5.8.3.9 Threemile Creek, lower segment (MT76G004_112)*

Note: Because TMDLS are presented on a watershed basis, the TMDL for Lower Threemile Creek includes all loading to the upper segment.

**Table 5-42. Sediment Source Assessment, Allocations and TMDL for lower Threemile Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | Unpaved Roads | 2.2 | 0.5 | 79% |
| | Traction Sand | 7.0 | 4.6 | 33% |
| | **Total** | **9.2** | **5.1** | **45%**** |
| **Streambank Erosion** | Human Caused | 43 | 39 | 8% |
| | Natural Background | 1 | 1 | 0% |
| | **Total** | **44** | **40** | **8%** |
| **Upland Sediment Sources** | Forest | 45 | 44 | 2% |
| | Range | 303 | 283 | 7% |
| | Pasture | 334 | 37 | 89% |
| | **Total** | **691** | **373** | **46%** |
| **Total Sediment Load** | | **744** | **418** | **44%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

### *5.8.3.10 Trout Creek (MT76G004_120)*

**Table 5-43. Sediment Source Assessment, Allocations and TMDL for Trout Creek**

| Sediment Sources | | Current Estimated Load (Tons/Year) | Total Allowable Load (Tons/Year) | Load Allocations (% reduction) |
|---|---|---|---|---|
| **Roads** | Unpaved Roads | 0.8 | 0.2 | 76% |
| | Traction Sand | 9.8 | 6.5 | 33% |
| | **Total** | **11** | **6.7** | **37%**** |
| **Streambank Erosion** | Human Caused | 105 | 77 | 27% |
| | Natural Background | 7 | 7 | 0% |
| | **Total** | **112** | **84** | **28%** |
| **Upland Sediment Sources** | Forest | 46 | 46 | 0% |
| | Range | 322 | 267 | 17% |
| | Pasture | 47 | 5 | 89% |
| | Developed | 7 | 7 | 0% |
| | **Total** | **422** | **325** | **23%** |
| **Total Sediment Load** | | **545** | **416** | **24%** |

*Sediment loads and percent reductions were rounded and may not exactly match the loads presented in the appendices.

**The allocation to roads also includes no loading from undersized, improperly installed, or inadequately maintained culvert. The 25-year event is considered the minimum but the 100-year event is recommended for fish-bearing streams.

## 5.9 SEASONALITY AND MARGIN OF SAFETY

Seasonality and margin of safety are both required elements of TMDL development. This section describes how seasonality and margin of safety were applied during development of the Little Blackfoot TPA sediment TMDLs.

### 5.9.1 Seasonality

All TMDL documents must consider the seasonal applicability of water quality standards as well as the seasonal variability of pollutant loads to a stream. Seasonality was addressed in several ways as described below.

- The applicable narrative water quality standards (**Appendix B**) are not seasonally dependent, although low flow conditions provide the best ability to measure harm to use based on the selected target parameters. The low flow or base flow condition represents the most practical time period for assessing substrate and habitat conditions, and also represents a time period when high fine sediment in riffles or pool tails will likely influence fish and aquatic life. Therefore, meeting targets during this time frame represents an adequate approach for determining standards attainment.
- The substrate and habitat target parameters within each stream are measured during summer or autumn low flow conditions consistent with the time of year when reference stream measurements are conducted. This time period also represents an opportunity to assess effects of the annual snow runoff and early spring rains, which is the typical time frame for sediment loading to occur.
- The DEQ sampling protocol for macroinvertebrates identifies a specific time period for collecting samples based on macroinvertebrate life cycles. This time period coincides with the low flow or base flow condition.

- All assessment modeling approaches are standard approaches that specifically incorporate the yearly hydrologic cycle specific to the Little Blackfoot watershed. The resulting loads are expressed as average yearly loading rates to fully assess loading throughout the year.
- Allocations are based on average yearly loading and the preferred TMDL expression is as an average yearly load reduction, consistent with the assessment methods.

### 5.9.2 Margin of Safety

Natural systems are inherently complex. Any approach used to quantify or define the relationship between pollutant loading rates and the resultant water quality impacts, no matter how rigorous, will include some level of uncertainty or error. To compensate for this uncertainty and ensure water quality standards are attained, a margin of safety is required as a component of each TMDL. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. Environmental Protection Agency, 1999b). This plan incorporates an implicit MOS in a variety of ways:

- By using multiple targets to assess a broad range of physical and biological parameters known to illustrate the effects of sediment in streams and rivers. These targets serve as indicators of potential impairment from sediment and also help signal recovery, and eventual standards attainment, after TMDL implementation. Conservative assumptions were used during development of these targets.
- TMDL development was pursued for all streams evaluated, even though some streams were close to meeting all target values. This approach addresses some of the uncertainty associated with sampling variability and site representativeness, and recognizes that sediment source reduction capabilities exist throughout the watershed.
- By using standards, targets, and TMDLs that address both coarse and fine sediment delivery.
- By properly incorporating seasonality into target development, source assessments, and TMDL allocations.
- By using an adaptive management approach to evaluate target attainment and allow for refinement of load allocation, targets, modeling assumptions, and restoration strategies to further reduce uncertainties associated with TMDL development (discussed below in **Section 5.10** and in **Sections 9.0** and **10.0**).
- By using naturally occurring sediment loads as described in ARM 17.30.602(17) (see **Appendix B**) to establish the TMDLs and allocations based on reasonably achievable load reductions for each source category. Specifically, each major source category must meet percent reductions to satisfy the TMDL because of the relative loading uncertainties between assessment methodologies.
- TMDLs are developed at the watershed scale addressing all potentially significant human related sources beyond just the impaired waterbody segment scale. This approach should also reduce loading and improve water quality conditions within other tributary waterbodies throughout the watershed.

## 5.10 TMDL DEVELOPMENT UNCERTAINTIES AND ADAPTIVE MANAGEMENT

A degree of uncertainty is inherent in any study of watershed processes. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainty through adaptive management is a key component of TMDL implementation. The process of adaptive management is predicated on the premise that TMDLs, allocations and their supporting analyses are not static, but are processes that can be subject to periodic modification or adjustment as new information and relationships are better understood. Within the Little Blackfoot TPA, adaptive management for sediment TMDLs relies on continued monitoring of water quality and stream habitat conditions, continued assessment of impacts from human activities and natural conditions, and continued assessment of how aquatic life and coldwater fish respond to changes in water quality and stream habitat conditions.

As noted in **Section 5.9.2**, adaptive management represents an important component of the implicit margin of safety. This document provides a framework to satisfy the MOS by including sections focused on TMDL implementation, monitoring and adaptive management (**Sections 9.0** and **10.0**). Furthermore, state law (ARM 75-5-703), requires monitoring to gauge progress toward meeting water quality standards and satisfying TMDL requirements. These TMDL implementation monitoring reviews represent an important component of adaptive management in Montana.

Perhaps the most significant uncertainties within this document involve the accuracy and representativeness of 1) field data and target development and 2) the accuracy and representativeness of the source assessments and associated load reductions. These uncertainties and approaches used to reduce uncertainty are discussed in following subsections.

### 5.10.1 Sediment and Habitat Data Collection and Target Development

Some of the uncertainties regarding accuracy and representativeness of the data and information used to characterize existing water quality conditions and develop water quality targets are discussed below.

Data Collection

The stream sampling approach used to characterize water quality is described within **Appendix C**. To control sampling variability and improve accuracy, the sampling was done by trained environmental professionals using a standard DEQ procedure developed for the purpose of sediment TMDL development (Montana Department of Environmental Quality, 2010b). This procedure defines specific methods for each parameter, including sampling location and frequency to ensure proper representation and applicability of results. Prior to any sampling, a sampling and analysis plan (SAP) was developed to ensure that all activity was consistent with applicable quality control and quality assurance requirements. Site selection was a major component of the SAP, and was based on a stratification process described in **Appendix C**. The stratification work ensured that each stream included one or more sample sites representing a location where excess sediment loading or altered stream habitat could affect fish or aquatic life.

Even with the applied quality controls, a level of uncertainty regarding overall accuracy of collected data will exist. There is uncertainty regarding whether or not the appropriate sites were assessed and whether or not an adequate number of sites were evaluated for each stream. Also, there is the uncertainty of the representativeness of collecting data from one sampling season. These uncertainties are difficult to quantify and even more difficult to eliminate given resource limitations and occasional stream access problems.

Target Development

DEQ evaluated several data sets to ensure that the most representative information and most representative statistic was used to develop each target parameter consistent with the reference approach framework outlined in **Appendix B**. Using reference data is the preferred approach for target setting, however, some uncertainty is introduced because of differing protocols between the available reference data and DEQ data for the Little Blackfoot TPA. These differences were acknowledged within the target development discussion and taken into consideration during target setting. For each target parameter, DEQ stratified the Little Blackfoot sample results and target data into similar categories, such as stream width or Rosgen stream type, to ensure that the target exceedance evaluations were based on appropriate comparison characteristics.

The established targets are meant to apply under median conditions of natural background and natural disturbance. It is recognized that under some natural conditions such as a large fire or flood event, it may be impossible to satisfy one or more of the targets until the stream and/or watershed recovers from the natural event. The goal, under these conditions, is to ensure that management activities are undertaken in a way that the achievement of targets is not significantly delayed in comparison to the natural recovery time. Also, human activity should not significantly increase the extent of water quality impacts from natural events. For example, extreme flood events can cause a naturally high level of sediment loading that could be significantly increased from a large number of road crossing or culvert failures.

Because sediment target values are based on statistical data percentiles, DEQ recognizes that it may be impossible to meet all targets for some streams even under normal levels of disturbance. On the other hand, some target values may underestimate the potential of a given stream and it may be appropriate to apply more protective targets upon further evaluation during adaptive management. It is important to recognize that the adaptive management approach provides the flexibility to refine targets as necessary to ensure protection of the resource and to adapt to new information concerning target achievability.

### 5.10.2 Source Assessments and Load Reduction Analyses

Each assessment method introduces uncertainties regarding the accuracy and representativeness of the sediment load estimates and percent load reduction analyses. For each source assessment, assumptions must be made to evaluate sediment loading and potential reductions at the watershed scale, and because of these uncertainties, conclusions may not be representative of existing conditions and achievable reductions at all locations within the watershed. Uncertainties are discussed independently for the three major source categories of bank erosion, upland erosion, and unpaved road crossings.

Bank Erosion

Bank erosion loads were initially quantified using the DEQ protocols (Montana Department of Environmental Quality, 2010b) and the standard BEHI methodology as defined within **Appendix C**. Prior to any sampling, a SAP was developed to ensure that all activity was consistent with applicable quality control and quality assurance requirements. Site selection was a major component of the SAP, and was based on a stratification process described in **Appendix C**. The results were then extrapolated across the Little Blackfoot watershed as defined in **Appendix C** to provide an estimate of the relative bank erosion loading from various streams and associated stream reaches. Based on this process, the relative contribution from human versus natural sources as well as the potential for reduction with the implementation of riparian BMPs was estimated and used for TMDL allocations. Stratifying and assessing each unique reach type was not practical, therefore adding to uncertainty associated with the load extrapolation results.

The final quantification of bank erosion loads was derived from the SWAT model; because the model integrates all sediment sources, it was assumed that load estimates from the model are more accurate than the field estimates. There is some uncertainty with the bank erosion loads from the model because insufficient data were available to truly calibrate the model and the calibration period was run using a sediment rating curve developed from available data. Additional uncertainty comes from the model because streambank erosion is not directly estimated but is calculated based on the difference between the load at the outlet for each stream and the sum of upland and in-channel loading.

There is additional uncertainty regarding the amount of bank erosion linked to human activities and the specific human sources, as well as the ability to reduce the human related bank erosion levels. This uncertainty is largely associated with historic disturbances, which are extremely difficult to identify the level to which they are still affecting streambank erosion, how much is associated with human sources, and what the dominant human sources are. Even if difficult to quantify, the linkages between human activity such as riparian clearing and bank erosion, are well established and these linkages clearly exist at different locations throughout the Little Blackfoot watershed. Evaluating bank erosion levels, particularly where best management practices have been applied along streams, is an important part of adaptive management that can help define the level of human-caused bank erosion as well as the relative impact that bank erosion has on water quality throughout the Little Blackfoot watershed.

Upland Erosion

A professional modeler determined upland erosion loads by applying a landscape soil loss equation (USLE) within the SWAT model as defined in **Appendix D**. As with any model, there will be uncertainty in the model input parameters including uncertainties regarding land use, land cover and assumptions regarding existing levels of BMP application. For example, only one vegetative condition was assigned per land cover type (i.e., cannot reflect land management practices that change vegetative cover from one season to another), so an average condition is used for each scenario in the model. However, the model uses factors such as plant growth and surface residue to alter the cover slightly on a daily basis. Although limited land use changes occurred over the model simulation period (or since) and it is believed that the model is representative of conditions within the watershed, the recent change in land ownership the Spotted Dog Creek drainage (see FWP land in **Figure A-14**) was not incorporated into the model.

The upland erosion model integrates sediment delivery based on riparian health, with riparian health evaluations linked to the stream stratification work discussed above. The potential to reduce sediment loading was based on modest land cover improvements to reduce the generation of eroded sediment particles in combination with riparian improvements. The uncertainty regarding existing erosion prevention BMPs and ability to reduce erosion with additional BMPs represents a level of uncertainty. Also, because model is not spatial, the riparian health improvement was simulated with the use of filter strips, which are applied by unique land category (HRU) and include both riparian and upland areas. An attempt was made to minimize uncertainty by looking at the HRU distribution and applying filter strips to HRUs with a substantial amount of riparian area. Additionally, filter strips were primarily applied to HRUs where grazing is most abundant or those where field observations indicate sediment loading could be decreased through improved riparian vegetation. Although some uncertainty is introduced by simulating riparian improvements in this manner, the exercise was performed within the model so that the pollutant removal capacity of the filters could be simulated and because the filter strips were used as a BMP for both sediment and nutrient TMDLs. Even with these uncertainties, the ability to reduce upland sediment erosion and delivery to nearby waterbodies is well documented in literature, the filter strips widths used are based on literature values, and the estimated reductions are consistent with literature values for riparian buffers.

Roads

The most significant road sediment load was linked to unpaved road crossings. As described in **Appendix E**, the road crossings sediment load was estimated via a standardized simple yearly model developed by the U.S. Forest Service. This model relies on a few basic input parameters that are easily measured in the field, as well as inclusion of precipitation data from local weather stations. A total of 22 sites were randomly selected for evaluation, representing about 5% of the total population of roads. The results from these 22 sites were extrapolated to the whole population of roads stratified by landscape type. The reduction potential for all roads was also based on data collected from the 22 sites taking into consideration existing BMP conditions. Random selection of the stratified sites was intended to capture a representative subset of the road crossings for existing conditions and level of BMP implementation, but some uncertainty is introduced because of the small sample size relative to the total number of road crossings. There is some uncertainty about if the needed reductions are comparable across ownership categories; as discussed in **Section 5.7.3.1**, the USFS roads typically had a shorter contributing length and lower load than the private crossings. Although this suggests lower reductions may be needed on federal roads, because of the distribution of federal roads across the landscape and extrapolation of loads by landscape setting, it is believed that the load estimates and reductions are reasonable. There is a high potential for loading from unpaved roads throughout the watershed and ultimately, the needed reductions will vary by road, regardless of ownership.

# 6.0 NUTRIENT TMDL COMPONENTS

This portion of the document focuses on nutrients (nitrogen and phosphorus forms) as a cause of water quality impairments in the Little Blackfoot River TPA. It includes: 1) the mechanisms by which nutrients can impair beneficial uses, 2) the specific stream segments of concern, 3) the presently available data pertaining to nutrients impairment characterization in the watershed, including target development and a comparison of existing water quality to targets, 4) quantification of the various contributing sources of nutrients based on recent studies, and 5) identification of and justification for the nutrients TMDLs and the TMDL allocations.

## 6.1 NUTRIENT IMPACTS TO BENEFICIAL USES

Nitrogen and phosphorus are naturally occurring chemical elements required for the healthy and stable functioning of aquatic ecosystems. Streams in particular are dynamic systems that are dependent on a balance between nutrient additions, consumption by autotrophic organisms, cycling of biologically fixed nitrogen and phosphorus into higher trophic levels, and cycling of organically fixed nutrients into inorganic forms with biological decomposition. Nutrient additions to streams from natural landscape erosion, groundwater discharge and in-stream biological decomposition maintain a balance between organic and inorganic nutrient forms. Human influences may alter nutrient cycling pathways causing damage to biological stream function and water quality degradation.

Excess nitrogen in the form of dissolved ammonia (which is typically associated with wastewater) can be toxic to fish and other aquatic life, and elevated nitrate in drinking water can inhibit normal hemoglobin function in infants. The current drinking water nitrate limit is 10 mg/L (Montana Department of Environmental Quality, 2010a). Beside the direct effects of excess nitrogen, elevated inputs of nitrogen and phosphorus from human sources can accelerate aquatic algal growth to nuisance levels. Respiration and decomposition of excessive algal biomass depletes the supply of dissolved oxygen, which can cause mortality of fish and other forms of aquatic life. Nutrient concentrations in surface water are considered controlling factors in formation of blue-green algae blooms (Priscu, 1987), which can produce toxins that can be lethal to aquatic life, wildlife, livestock and humans. Aside from the toxicity effects, nuisance algae tend to be less palatable and can cause shifts in the macroinvertebrate community structure, which may also affect fish, who feed on macroinvertebrates (U.S. Environmental Protection Agency, 2010). Additionally, changes in water clarity, fish community structure, and aesthetics can detract from recreational uses such as fishing, swimming, and boating (Suplee, et al., 2009). Nuisance algae can also increase treatment costs of drinking water or pose health risks if ingested in drinking water (World Health Organization, 2003).

## 6.2 STREAM SEGMENTS OF CONCERN

A total of four waterbody segments in the Little Blackfoot TPA appeared on the 2010 Montana 303(d) List due to phosphorus and/or nitrogen impairments (**Table 6-1**): Dog Creek (lower segment), Little Blackfoot River (lower segment), Snowshoe Creek, and Spotted Dog Creek (lower segment). Stream segments of concern in the Little Blackfoot River watershed are those streams listed as impaired for phosphorus and/or nitrogen on the 2010 303(d) List and include:

**Table 6-1. Waterbody segments in the Little Blackfoot TPA with nutrient listings on the 2010 303(d) List**

| Stream Segment | Waterbody ID | Nutrient Pollutant Listing |
|---|---|---|
| DOG CREEK, Meadow Creek to the mouth (Little Blackfoot River) | MT76G004_072 | Nitrate+Nitrite |
| LITTLE BLACKFOOT RIVER, Dog Creek to the mouth (Clark Fork River) | MT76G004_010 | Nitrate+Nitrite |
| SNOWSHOE CREEK, headwaters to the mouth (Little Blackfoot River) | MT76G004_080 | Nitrate+Nitrite |
| SPOTTED DOG CREEK, forest boundary to the mouth (Little Blackfoot River) | MT76G004_032 | Total Phosphorus |

Two additional waterbody segments were also identified as streams of concern based on data collected to assist with the source assessment for the lower Little Blackfoot River and were evaluated as part of the nutrient TMDL development process. They include the lower segment of Carpenter Creek (MT76G004_092) and the lower segment of Threemile Creek (MT76G004_112).

## 6.3 WATER QUALITY DATA SOURCES

To characterize nutrient conditions for TMDL development purposes, a nutrient data compilation was completed and additional monitoring was performed by DEQ. The following data sources represent the primary information used to characterize water quality.

1) **DEQ TMDL Sampling**: DEQ conducted water quality sampling from 2008 through 2010 in support of nutrient TMDL development. Water samples were collected and analyzed for nutrients at 22 sites during 1 high flow and 2 growing season (i.e., July-September) events in 2008 and at 23 sites during 1 growing season event in 2009. To provide additional supporting information regarding summer nutrient concentrations and potential sources, 27 sites were sampled during 3 growing season events in 2010 (**Figure 6-1**).

   Sample locations bracketed tributaries and changes in land use type or management. In addition to water quality samples, algal samples were collected during growing season sampling in 2008 through 2010 and analyzed for chlorophyll-*a* concentration and ash free dry weight (AFDW). AFDW is a measurement that captures living and dead algal biomass, and is particularly helpful for streams where some or all of the algae are dead (because chlorophyll-*a* only measures the living algae).
2) **DEQ Assessment Files**: The files contain information used to make the existing nutrient impairment determinations. This includes water quality and algal data collected between 1998 and 2005, as well as other historical information collected or obtained by DEQ. Macroinvertebrate data were collected on some streams in 2004 (**Figure 6-1**).
3) **USGS gage on the Little Blackfoot River near Garrison**: Nutrient samples were collected throughout the year by USGS and the Tri-State Water Quality Council (to evaluate loading to the Clark Fork River), primarily between 1998 and 2002 (**Figure 6-1**).
4) **Watershed Health Clinic at University of Montana**: Nutrient samples were collected at four locations monthly along the Little Blackfoot River between May and September from 1999 to 2002 for the Missoula Water Quality District.

Growing season nutrient data used for the data review and TMDL development are included in **Appendix G**. Other nutrient data from the watershed is publicly available through EPA's STORET water quality database and the DEQ's EQuIS water quality database.

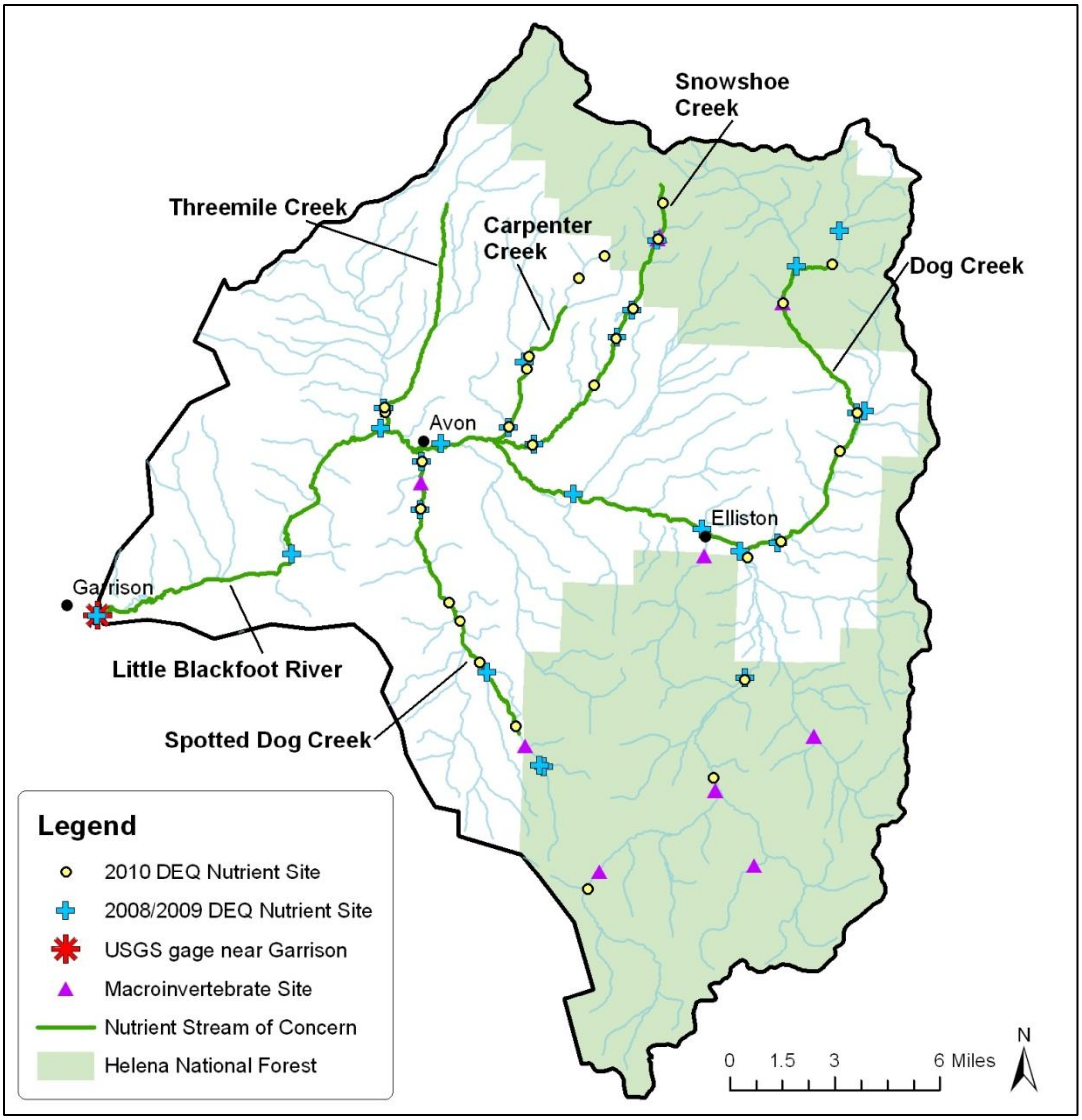

**Figure 6-1. Nutrient sampling sites on the streams of concern.**

## 6.4 NUTRIENT WATER QUALITY TARGETS AND COMPARISON TO EXISTING CONDITIONS

TMDL water quality targets are numeric indicator values used to evaluate attainment of water quality standards, and are discussed conceptually in **Section 4.0**. The following section presents nutrient water quality targets, and compares those target values to recently collected nutrient data in the Little Blackfoot River watershed following DEQ's draft assessment methodology *(Suplee and Sada de Suplee, 2011)*. To be consistent with DEQ's draft assessment methodology and because of improvements in analytical methods, only data from the past 10 years (2001-2011) are included in the review of existing data. Additionally, many of the nutrient samples collected prior to 2005 were analyzed for Total Kjeldahl

Nitrogen (TKN), which has since been replaced by DEQ with Total Persulfate Nitrogen as the preferred analytical method for total nitrogen; samples analyzed for TKN may have a bias and are excluded from the data review.

### 6.4.1 Nutrient Water Quality Targets

Although Montana's water quality standards for nutrients are currently narrative, draft numeric nutrient criteria have been developed by the DEQ, and are the basis of the nutrient water quality targets for the Little Blackfoot TPA. The draft nutrient criteria are the result of research initiated by DEQ in 2001 and are based on 1) the results of a public perception survey regarding what level of algae was perceived as 'undesirable' (Suplee, et al., 2009), 2) stressor-response studies performed by DEQ to determine the maximum nutrient concentrations that will maintain algal growth below undesirable levels, 3) a literature review of stressor-response studies, and 4) a comparison of nutrient stressor-response thresholds to eco-regionally stratified reference data from Montana (Suplee, et al., 2008).

Nutrient targets for nitrate+nitrite ($NO_3$+$NO_2$), total nitrogen (TN), total phosphorus (TP), and chlorophyll-*a* are presented in **Table 6-2** and based on the draft nutrient criteria for the Middle Rockies level 3 ecoregion, which encompasses the Little Blackfoot River watershed. Both the nutrient criteria and the nutrient targets within this document apply during the summer growing season from July 1st through Sept 30th, when algal growth has the highest potential to affect beneficial uses.

**Table 6-2. Nutrient Targets for the Little Blackfoot TPA**

| Parameter | Target Value |
|---|---|
| Nitrate+Nitrite ($NO_3$+$NO_2$) | ≤ 0.100 mg/L |
| Total Nitrogen (TN) | ≤ 0.300 mg/L |
| Total Phosphorus (TP) | ≤ 0.030 mg/L |
| Chlorophyll-*a* (or Ash Free Dry Weight) | ≤ 120 mg/m² (≤35 g AFDW/$m^2$) |

### 6.4.2 Existing Conditions and Comparison to Water Quality Targets

Evaluation of nutrient target attainment is conducted by comparing existing water quality conditions to the water quality targets in **Table 6-2** following the methodology in the DEQ draft guidance document, *2011 Assessment Methodology for Determining Wadeable Stream Impairment due to Excess Nitrogen and Phosphorus Levels (Suplee and Sada de Suplee, 2011)*. For each waterbody segment, a data summary will be presented along with a comparison of existing data to targets using the assessment methodology and a TMDL development determination. Because most of the impairment listings are based on older data or were listed prior to development of numeric criteria, each stream segment will be evaluated for impairment from $NO_3$+$NO_2$, TN, and TP. Although the data review in this section does not constitute an official impairment determination, data were evaluated following the assessment methodology and TMDL development determinations will be dependent on the outcome of the data evaluation.

The assessment methodology utilizes two statistical tests (Exact Binomial Test and the One-Sample Student's T-test for the Mean) to evaluate water quality data for compliance with established target values. In general, compliance with water quality targets is <u>not</u> attained when nutrient chemistry data demonstrates a target exceedance rate of >20% (Exact Binomial Test), when mean water quality nutrient chemistry results exceed target values (Student T-test), or when a single chlorophyll-*a* result exceeds benthic algal target concentrations (120 mg/$m^2$ or 35 g AFDW/$m^2$). Where water chemistry and algae data do not provide a clear determination of impairment status, or other limitations exist, macroinvertebrate biometrics (HBI >4.0) are considered in further evaluating compliance with nutrient targets, as directed by the assessment methodology. Lastly, inherent to any impairment determination is the existence of human sources of pollutant loading anthropogenic sources of nutrients must be present for a stream to be considered impaired. Note: to ensure a higher degree of certainty for removing an impairment determination and making any new impairment determination, the statistical tests are configured differently for an unlisted nutrient form versus a listed nutrient form, which may result in a different number of allowable exceedances for nutrients within a single stream segment. This helps assure that assessment reaches do not vacillate between listed and delisted status by the change in results from a single additional sample.

### *6.4.2.1 Carpenter Creek, lower segment (MT76G004_092)*

Lower Carpenter Creek is not listed on the 2010 303(d) List for nutrient impairment but is included in this review because data collected to assist with TMDL development for the Little Blackfoot River indicated elevated nutrient concentrations. The lower segment of Carpenter Creek extends 4.9 miles from the confluence with Basin Creek to the mouth at the Little Blackfoot River. Prior to recent monitoring, nutrient data had not been collected on Carpenter Creek since 1983.

Between 2008 and 2010, nine growing season nutrient samples were collected on lower Carpenter Creek (**Figure 6-1**). Algal samples were analyzed for chlorophyll-*a* and AFDW between 2008 and 2010, but no recent macroinvertebrate data are available for this segment. Summary nutrient data statistics and assessment method evaluation results for lower Carpenter Creek are provided in **Tables 6-3** and **6-4**, respectively. Of the samples, $NO_3$+$NO_2$ and TN passed both statistical tests, but TP failed both statistical tests and all TP samples exceeded the target value. Although the chlorophyll samples met the target value, TP failing both statistical tests indicates impairment and a TP TMDL will be developed.

**Table 6-3. Nutrient Data Summary for Lower Carpenter Creek**

| Nutrient Parameter | Sample Timeframe | n | min | max | mean | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 2008-2010 | 9 | 0.005 | 0.01 | 0.007 | 0.01 |
| TN | 2008-2010 | 9 | 0.10 | 0.31 | 0.24 | 0.28 |
| TP | 2008-2010 | 9 | 0.039 | 0.061 | 0.049 | 0.055 |
| Chlorophyll-*a* | 2008-2010 | 2 | 8 | 16 | 12 | NA |
| AFDW | 2008-2010 | 1 | NA | 18 | NA | NA |

**Table 6-4. Assessment Method Evaluation Results for Lower Carpenter Creek**

| Nutrient Parameter | n | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-a Test Result | Indicates Impairment? |
|---|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 9 | 0.100 | 0 | Pass | Pass | Pass | No |
| TN | 9 | 0.300 | 1 | Pass | Pass | Pass | No |
| TP | 9 | 0.030 | 9 | Fail | Fail | Pass | Yes |

### *6.4.2.2 Dog Creek, lower segment (MT76G004_072)*

Lower Dog Creek is listed on the 2010 303(d) List for $NO_3$+$NO_2$ nutrient impairment. The lower segment of Dog Creek flows 12.4 miles from its confluence with Meadow Creek to the mouth at the Little Blackfoot River. Lower Dog Creek is listed for $NO_3$+$NO_2$ based on nutrient, chlorophyll-*a*, and macroinvertebrate samples from 1998 and attributed to grazing and other agricultural sources.

Between 2007 and 2010, 17 growing season nutrient samples were collected on lower Dog Creek (**Figure 6-1**). Algal samples were analyzed for chlorophyll-*a* and AFDW in between 2007 and 2010, and one macroinvertebrate sample was collected in 2004. Summary nutrient data statistics and assessment method evaluation results for lower Dog Creek are provided in **Tables 6-5** and **6-6**, respectively. The data for all nutrient forms passed both statistical tests; neither nitrogen form ($NO_3$+$NO_2$ nor TN) had a single sample that exceeded the target value but four TP samples exceeded the target value. One algal sample exceeded the AFDW target, which indicates excess algae are impairing beneficial uses. Additionally, a macroinvertebrate sample from 2004 had a HBI score greater than 4, which also indicates nutrient impairment. This situation is typically the result of excess algae taking up nutrients at a high rate and causing low instream nutrient concentrations. Based on there being no target exceedances for nitrogen but four target exceedances for TP, this indicates that the impairment is due to TP instead of $NO_3$+$NO_2$ and a TP TMDL will be developed for lower Dog Creek.

**Table 6-5. Nutrient Data Summary for Lower Dog Creek**

| Nutrient Parameter | Sample Timeframe | n | min | max | mean | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 2007-2010 | 17 | 0.005 | 0.010 | 0.006 | 0.010 |
| TN | 2007-2010 | 17 | 0.025 | 0.290 | 0.142 | 0.198 |
| TP | 2007-2010 | 17 | 0.011 | 0.038 | 0.025 | 0.031 |
| Chlorophyll-*a* | 2007-2010 | 9 | 6 | 37 | 19 | NA |
| AFDW | 2010 | 4 | 8 | 145 | 46 | NA |
| Macroinvertebrate HBI | 2004 | 1 | NA | 4.16 | NA | NA |

**Table 6-6. Assessment Method Evaluation Results for Lower Dog Creek**

| Nutrient Parameter | n | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-a Test Result | Indicates Impairment? |
|---|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 17 | 0.100 | 0 | Pass | Pass | Fail | No |
| TN | 17 | 0.300 | 0 | Pass | Pass | Fail | No |
| TP | 17 | 0.030 | 4 | Pass | Pass | Fail | Yes |

### *6.4.2.3 Little Blackfoot River, lower segment (MT76G004_010)*

The lower segment of the Little Blackfoot River is listed on the 2010 303(d) List for $NO_3$+$NO_2$ nutrient impairment. The lower segment of the Little Blackfoot River flows 26.2 miles from its confluence with Dog Creek to its mouth at the Clark Fork River. The lower Little Blackfoot River was originally listed based on data from the late 1970s and remained listed based on elevated algal and $NO_3$+$NO_2$ concentrations in the 1990s and early 2000s, particularly downstream of Avon. The impairment is attributed to grazing and other agricultural sources.

Between 2001 and 2010, 40 growing season nutrient samples were collected on the lower segment of the Little Blackfoot River (**Figure 6-1**). Algal samples were analyzed for chlorophyll-*a* and AFDW in 2008 and 2009, but no recent macroinvertebrate data are available for this segment. Summary nutrient data statistics and assessment method evaluation results for the lower Little Blackfoot River are provided in **Tables 6-7** and **6-8**, respectively. The $NO_3$+$NO_2$ and TN data passed both statistical tests and had no samples exceed the target value, but the TP data failed the binomial test and 14 samples exceeded the target value. One algal sample exceeded the AFDW target, which indicates excess algae are impairing beneficial uses. Based the elevated AFDW value, TP failing the binomial test, and the 14 target exceedances for TP, this indicates that the impairment is due to TP instead of $NO_3$+$NO_2$, and a TP TMDL will be developed for the lower segment of the Little Blackfoot River.

**Table 6-7. Nutrient Data Summary for the Lower Segment of the Little Blackfoot River**

| Nutrient Parameter | Sample Timeframe | n | min | max | mean | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 2001-2010 | 40 | 0.003 | 0.050 | 0.010 | 0.010 |
| TN | 2001-2010 | 15 | 0.050 | 0.160 | 0.103 | 0.150 |
| TP | 2001-2010 | 40 | 0.010 | 0.044 | 0.026 | 0.034 |
| Chlorophyll-*a* | 2008-2009 | 10 | 0.1 | 40 | 15 | NA |
| AFDW | 2009 | 1 | NA | 81 | NA | NA |

**Table 6-8. Assessment Method Evaluation Results for the Lower Segment of the Little Blackfoot River**

| Nutrient Parameter | n | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-a Test Result | Indicates Impairment? |
|---|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 40 | 0.100 | 0 | Pass | Pass | Fail | No |
| TN | 15 | 0.300 | 0 | Pass | Pass | Fail | No |
| TP | 40 | 0.030 | 14 | Fail | Pass | Fail | Yes |

### *6.4.2.4 Snowshoe Creek (MT76G004_080)*

Snowshoe Creek is listed on the 2010 303(d) List for $NO_3$+$NO_2$ nutrient impairment. Snowshoe Creek extends 10.7 miles from the headwaters to its mouth at the Little Blackfoot River. The $NO_3$+$NO_2$ listing is based on nutrient, algal, and macroinvertebrate data from a 2004 DEQ assessment and is attributed to riparian grazing and unknown sources.

Between 2004 and 2010, 29 growing season nutrient samples were collected on Snowshoe Creek (**Figure 6-1**). Algal samples were analyzed for chlorophyll-*a* and AFDW between 2008 and 2010, and one macroinvertebrate sample was collected in 2004. Summary nutrient data statistics and assessment method evaluation results for Snowshoe Creek are provided in **Tables 6-9** and **6-10**, respectively. The $NO_3$+$NO_2$ data failed the binomial test and seven samples exceeded the target value. The TN data passed both statistical tests and had zero exeedances of the target value, and the TP data passed both statistical tests but had seven exceedances of the target value. One algal sample exceeded the AFDW target and another sample exceeded the chlorophyll-*a* target value, which indicates excess algae are impairing beneficial uses. The macroinvertebrate sample from 2004 was meeting the target and had a HBI score less than 4. Although seven samples exceeded the TP target value, because it passed both statistical tests and Snowshoe Creek is currently listed for $NO_3$+$NO_2$ (but not TP), this indicates the excess algal growth is associated with $NO_3$+$NO_2$. Therefore, the data support the existing listing and a $NO_3$+$NO_2$ TMDL will be developed for Snowshoe Creek. Note, a TN TMDL would typically be written to address a $NO_3$+$NO_2$ problem, but because the excess $NO_3$+$NO_2$ in the stream is not reflected in the TN data, the TMDL will be for $NO_3$+$NO_2$.

**Table 6-9. Nutrient Data Summary for Snowshoe Creek**

| Nutrient Parameter | Sample Timeframe | n | min | max | mean | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 2004-2010 | 29 | 0.005 | 0.140 | 0.056 | 0.110 |
| TN | 2004-2010 | 28 | 0.080 | 0.230 | 0.150 | 0.206 |
| TP | 2004-2010 | 29 | 0.002 | 0.064 | 0.018 | 0.031 |
| Chlorophyll-*a* | 2008-2010 | 9 | 1 | 486 | 89 | NA |
| AFDW | 2010 | 4 | 5 | 64 | 26 | NA |
| Macroinvertebrate HBI | 2004 | 1 | NA | 3.00 | NA | NA |

**Table 6-10. Assessment Method Evaluation Results for Snowshoe Creek**

| Nutrient Parameter | n | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-a Test Result | Indicates Impairment? |
|---|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 29 | 0.100 | 7 | Fail | Pass | Fail | Yes |
| TN | 28 | 0.300 | 0 | Pass | Pass | Fail | No |
| TP | 29 | 0.030 | 7 | Pass | Pass | Fail | No |

### *6.4.2.5 Spotted Dog Creek, lower segment (MT76G004_032)*

Lower Spotted Dog Creek is listed on the 2010 303(d) List for TP nutrient impairment. The lower segment of Spotted Dog Creek extends 10.7 miles from the US Forest Service boundary to its mouth at the Little Blackfoot River. The TP listing is based on nutrient, algal, and macroinvertebrate data from a 2005 DEQ assessment and is attributed to riparian grazing.

Between 2005 and 2010, 28 growing season nutrient samples were collected on lower Spotted Dog Creek (**Figure 6-1**). Algal samples were analyzed for chlorophyll-*a* and AFDW in between 2008 and 2010, and one macroinvertebrate sample was collected in 2004. Summary nutrient data statistics and assessment method evaluation results for lower Spotted Dog Creek are provided in **Tables 6-11** and **6-12**, respectively. The TP data failed both statistical tests and 20 of the 28 samples exceeded the target value. The data for both nitrogen forms ($NO_3$+$NO_2$ and TN) passed both statistical tests; no $NO_3$+$NO_2$ samples exceeded the target value and only one TN sample exceeded the target value. Two algal samples exceeded the AFDW target, which indicates excess algae are impairing beneficial uses. The macroinvertebrate sample from 2004 was meeting the target and had a HBI score less than 4. Based on the data review, excess algal growth is a result of excess TP and not nitrogen. The data support the current listing and a TP TMDL will be developed for lower Spotted Dog Creek.

**Table 6-11. Nutrient Data Summary for Lower Spotted Dog Creek**

| Nutrient Parameter | Sample Timeframe | n | min | max | mean | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 2005-2010 | 28 | 0.005 | 0.01 | 0.006 | 0.009 |
| TN | 2005-2010 | 28 | 0.025 | 0.320 | 0.167 | 0.248 |
| TP | 2005-2010 | 28 | 0.017 | 0.061 | 0.036 | 0.043 |
| Chlorophyll-*a* | 2008-2010 | 11 | 0.1 | 31 | 14 | NA |
| AFDW | 2010 | 6 | 18 | 634 | 133 | NA |
| Macroinvertebrate HBI | 2004 | 1 | NA | 2.59 | NA | NA |

**Table 6-12. Assessment Method Evaluation Results for Lower Spotted Dog Creek**

| Nutrient Parameter | n | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-a Test Result | Indicates Impairment? |
|---|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 28 | 0.100 | 0 | Pass | Pass | Fail | No |
| TN | 28 | 0.300 | 1 | Pass | Pass | Fail | No |
| TP | 28 | 0.030 | 20 | Fail | Fail | Fail | Yes |

### *6.4.2.6 Threemile Creek, lower segment (MT76G004_112)*

Lower Threemile Creek is not listed on the 2010 303(d) List for nutrient impairment but is included in this review because data collected to assist with TMDL development for the Little Blackfoot River indicated elevated nutrient concentrations. Lower Threemile Creek flows 7 miles from Quigley Ranch Reservoir to the mouth at the Little Blackfoot River. The DEQ assessment file mentions excess algae observed during a 1991 assessment but contains no nutrient data.

Between 2008 and 2010, nine growing season nutrient samples were collected on lower Threemile Creek (**Figure 6-1**). Algal samples were analyzed for chlorophyll-*a* and AFDW between 2008 and 2010, but no recent macroinvertebrate data are available for this segment. Summary nutrient data statistics and assessment method evaluation results for lower Threemile Creek are provided in **Tables 6-13** and **6-14**, respectively. The data for TP and TN failed both statistical tests; all TP samples exceeded the target value and 8 of the 9 TN samples exceeded the target value. The $NO_3$+$NO_2$ data passed both statistical tests and two of the samples exceeded the target value. One of the algal samples exceeded the AFDW target, which indicates excess algae are impairing beneficial uses. Therefore, the recent data indicate excess nutrients are limiting beneficial uses in lower Threemile Creek and nutrient TMDLs will be developed for TP and TN.

**Table 6-13. Nutrient Data Summary for Lower Threemile Creek**

| Nutrient Parameter | Sample Timeframe | n | min | max | mean | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 2008-2010 | 9 | 0.005 | 0.17 | 0.058 | 0.094 |
| TN | 2008-2010 | 9 | 0.22 | 0.94 | 0.541 | 0.612 |
| TP | 2008-2010 | 9 | 0.050 | 0.077 | 0.067 | 0.074 |
| Chlorophyll-*a* | 2008-2010 | 5 | 9 | 47 | 19 | NA |
| AFDW | 2010 | 3 | 7 | 161 | 65 | NA |

**Table 6-14. Assessment Method Evaluation Results for Lower Threemile Creek**

| Nutrient Parameter | n | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-a Test Result | Indicates Impairment? |
|---|---|---|---|---|---|---|---|
| Nitrate+Nitrite | 9 | 0.100 | 2 | Pass | Pass | Fail | No |
| TN | 9 | 0.300 | 8 | Fail | Fail | Fail | Yes |
| TP | 9 | 0.030 | 9 | Fail | Fail | Fail | Yes |

## 6.4.3 Nutrient TMDL Development Summary

Although most of the 2010 303(d) listings in the Little Blackfoot TPA are for $NO_3$+$NO_2$, recent data indicate excess phosphorus is the primary cause of nutrient impairment. The only $NO_3$+$NO_2$ listing supported by recent data is for Snowshoe Creek. However, five TP TMDLs will be developed, including two for unlisted segments. Additionally, a TN TMDL will be developed for a currently unlisted segment. Overall, these changes are the result of limited data at the time the waterbody segments were listed and different criteria that were used as the listing basis. **Table 6-15** summarizes the 2010 nutrient 303(d) listings for the Little Blackfoot TPA and TMDL development determinations for the waterbodies of concern identified in **Section 6.3**.

**Table 6-15. Summary of Nutrient TMDL Development Determinations**

| Stream Segment | Waterbody ID | 2010 303(d) Nutrient Impairments | TMDLs Prepared |
|---|---|---|---|
| CARPENTER CREEK, Basin Creek to the mouth (Little Blackfoot River) | MT76G004_092 | none | TP |
| DOG CREEK, Meadow Creek to the mouth (Little Blackfoot River) | MT76G004_072 | $NO_3$+$NO_2$ | TP |
| LITTLE BLACKFOOT RIVER, Dog Creek to the mouth (Clark Fork River) | MT76G004_010 | $NO_3$+$NO_2$ | TP |
| SNOWSHOE CREEK, headwaters to the mouth (Little Blackfoot River) | MT76G004_080 | $NO_3$+$NO_2$ | $NO_3$+$NO_2$ |
| SPOTTED DOG CREEK, forest boundary to the mouth (Little Blackfoot River) | MT76G004_032 | TP | TP |
| THREEMILE CREEK, Quigley Reservoir to the mouth (Little Blackfoot River) | MT76G004_112 | none | TP, TN |

## 6.5 NUTRIENT SOURCE ASSESSMENT AND QUANTIFICATION

This section summarizes the assessment approach, current nutrient load estimates, and the rationale for load reductions and allocations within the Little Blackfoot TPA. The nutrient data discussed in **Section 6.3** were used to identify whether nitrogen and/or phosphorus are causing impairment, however, the primary tool for evaluating loading contributions from different sources was the Soil and Water Assessment Tool (SWAT), which is a watershed scale model. An overview of the model is provided below followed by a discussion of each source category.

### 6.5.1 SWAT Model

SWAT is a physically based watershed-scale loading model and was used to model the Little Blackfoot watershed. SWAT models the nitrogen and phosphorus cycles in soil. Precipitation dissolves mineral nitrogen and phosphorus from the soil surface and transports it in surface runoff. Water percolates through the soil and dissolves mineral nitrogen and phosphorus, which is then carried into streams via lateral (soil) flow and shallow groundwater flow. Rainfall deposits nitrogen (but not phosphorus) on the land surface due to atmospheric deposition. Dead and dying biomass is picked up by surface runoff and carried into receiving streams as well. Additionally, other nutrient sources such as cattle manure and fertilizer application are present within the watershed. These processes affect each land-use type to differing degrees based on the amount of biomass, infiltration capacity, soil types, and size of each land-use type, as well as the external loading applied.

SWAT also models a number of in-stream processes, including algal growth and uptake, the nitrogen and phosphorus cycles, organic settling, and carbonaceous biological oxygen demand, to name a few. These processes depend on many variables such as water quality, climatic data, point sources, and sub-basin specific loading rates.

#### *6.5.1.1 Model Setup Overview*

The Little Blackfoot watershed was divided into sub-basins within the model, with a sub-basin for each stream segment requiring a TMDL. Each sub-basin was further divided into areas with unique land use, management, slope, and soil attributes called hydrologic response units (HRUs). HRUs are not spatially connected within each sub-basin, and all HRUs route directly into the stream reach. The model hydrology was calibrated to the USGS gage near Garrison using discharge and climatic data. Because sediment and nutrient data were limited at the gage, rating curves were developed using discharge measurements and the available sediment/nutrient data in lieu of calibration as a predictive tool for sediment/nutrient concentrations across various flows. The model uses daily inputs and can generate outputs on timescales ranging from daily to annual. Because the nutrient targets apply from July 1 through September 30, model outputs summarized in this section are for that time frame only.

## 6.5.2 Source Categories

No nutrient point sources exist in the watershed and agriculture is the primary source category in the Little Blackfoot TPA. The model evaluated loading from the following sources:

- Agriculture (pasture and rangeland)
- Forest (and wetlands)
- Residential Development
- Septic

Source assessment information for natural background as well as all sources evaluated within the SWAT model is described in detail within this section. Note: Although road-related sediment was incorporated into the model for the sediment TMDLs, it is not discussed within this section because it is not a significant nutrient source; only a small fraction of phosphorus is bound to the sediment and overall the road-related sediment was a small fraction of the total sediment load.

### *6.5.2.1 Natural Background*

The natural background component of nutrient loading was not explicitly evaluated by the model, but a significant component of the forest category and portions of all other categories are associated with background loading.

**Geology**

Portions of the watershed near the mouth of the Little Blackfoot River and near Elliston, Gimlet Creek in the Sixmile Creek portion of the Threemile Creek drainage, and the lower half of Dog Creek are underlain by the Phosphoria Formation (Swanson, 1973) (denoted in pink in **Figures A-17** and **A-18**). This formation has the potential to cause elevated phosphorus concentrations in groundwater and surface water, and it was historically mined for phosphate in the Dog and Threemile creek watersheds. Dissolved phosphorus concentrations from GWIC monitoring wells are available for 27 locations within the watershed, including lower Dog Creek, upper Threemile Creek, and along the mainstem Little Blackfoot River (**Figure A-8**). All samples were below the detection limit (0.05mg/L) except for a single sample on lower Snowshoe Creek. Well depths ranged from 35 to 500 feet (averaging 113 feet), indicating the formation is not likely influencing groundwater in these locations, even at shallow depths.

A study of the geologic contribution of the Phosphoria Formation to Gold Creek in the nearby Upper Clark Fork drainage found a significant geologic influence (Carey, 1991). In that study as well as in research by Pringle and Triska (1991), dissolved phosphorus concentrations increased during the summer as flow decreased. In a review of nutrient data collected by the University of Montana between 1999 and 2002 on the mainstem Little Blackfoot River near Elliston and the mouth, dissolved phosphorus concentrations did not tend to increase during low flow. Additionally, dissolved and total phosphorus concentrations in Gold Creek were typically more than triple the concentration in the Little Blackfoot River and Dog Creek. Both of these differences between Gold Creek and the Little Blackfoot watershed indicate that although geologic phosphorus may be elevating the background phosphorus concentration in Dog Creek and portions of the Little Blackfoot River relative to other streams in the watershed, human sources are the main factor in phosphorus water quality target exceedances in those areas.

It is more difficult to determine the influence of the Phosphoria Formation on phosphorus concentrations within Threemile Creek because no dissolved phosphorus data is available for Threemile Creek and due to access issues, the most upstream water samples were near the outlet of Sixmile Creek (approximately 0.8 miles upstream where Threemile Creek flows into the Little Blackfoot River). Total phosphorus concentrations at the mouth of Threemile Creek were greater during high flow sampling in 2008 than during low flow sampling that year but the particulate fraction of total phosphorus tends to be greater during high flow, making it difficult to draw conclusions from the 2008 data. In a comparison of low flow total phosphorus data from 2009 and 2010 at the mouth of Sixmile Creek and in Threemile Creek just upstream of its confluence with Sixmile Creek, all concentrations were greater than the target but values were similar and there was no consistent trend of higher concentrations in Sixmile Creek. Because the Phosphoria Formation is only present in the upper portion of the Sixmile Creek drainage and controllable human phosphorus sources are present in the Sixmile Creek drainage and the Threemile Creek drainage upstream of Sixmile Creek, it is assumed that geology alone is not causing the water quality target exceedances. Future monitoring of total and dissolved phosphorus is recommended during the growing and non-growing season in multiple locations within the Threemile Creek watershed to better evaluate phosphorus sources and the geologic contribution.

It is important to note that mining increased the exposure of the formation to the environment, which could also increase loading of phosphorus (and other associated minerals) to surface and groundwater. Due to access issues and sampling limitations, the effect of mining was not evaluated and is recommended to be addressed in the sampling scheme for future monitoring.

**Wildlife**

The effect of wildlife grazing and waste on nutrient loading is considered part of the natural background load. The contribution of wildlife was not evaluated during this project and may be greater in more heavily used areas of the watershed, however, in a multi-state study with varying densities of wildlife and livestock, wildlife were estimated to contribute a minimal nutrient load relative to livestock (Moffitt, 2009).

### *6.5.2.2 Forest*

The forested areas in the Little Blackfoot watershed are heavily timbered. Additionally, coniferous forests do not lose a large percentage of their biomass each fall (as a deciduous forest does). Therefore, overall runoff values are low for forested areas due to their capacity to infiltrate, transpire, and otherwise capture rainfall. Additionally, the amount of soil exposed to erosion for forested areas, which is referred to as the C factor, is low. However, some of the forested areas in the Little Blackfoot watershed are grazed, and a few have a legacy of mining in the form of tailings piles and unvegetated areas near streams. To account for these, the c factor for forested areas was near the higher end of a typical undisturbed forested area.

To simulate the forest grazing that occurs between June and October, grazed forested areas have daily biomass removals due to eating and trampling, and daily manure deposits for these time periods based on cattle densities listed on the grazing permits. Both of these affect runoff and nutrient deposition. Grazing had to be applied at the HRU scale and was applied on HRUs that were predominantly within grazing allotments on the Helena National Forest. It was assumed that the same number of cow/calf pairs grazing in forest or rangeland over the summer were moved to pasture during the rest of the year (October – May).

**Wetlands**

Wetlands have high biomass quantities (and thus high transpiration capacities), but low infiltration rates. Although they are mixed in with the forested areas, it was assumed they are not grazed. Therefore, natural nutrient processes are the only contributors in the wetland areas. Because wetlands make up such a small percentage of the loading and are considered a natural sources of nutrients, modeled loads from this source were aggregated into the load for forests.

### *6.5.2.3 Agriculture*

Although the majority of cattle are typically not grazing along the valley bottoms during the growing season, there are several possible mechanisms for the transport of nutrients from agricultural land to surface water during the growing season. The potential pathways include: the effect of winter grazing on vegetative health and its ability to uptake and nutrients and minimize erosion in upland and riparian areas, breakdown of excrement and loading via surface and subsurface pathways, delivery from grazed forest and rangeland during the growing season, transport of fertilizer applied in late spring via overland flow and groundwater, and the increased mobility of phosphorus caused by irrigation-related saturation of soils in pastures (Green and Kauffman, 1989).

**Pasture**

Pasture is managed for hay production during the summer, and for grazing feed during the fall and spring. Hay pastures are fairly thickly vegetated in the summer, less so in the fall through spring. The winter grazing period is long (October – May) and through trampling and consumption reduces biomass at a time of the year when it is already low. Commercial fertilizers are used infrequently in the watershed, but cattle manure is applied naturally from October through May in larger quantities (higher cattle density) than on the range and forested areas. Livestock manure and consumption input values were based on literature values.

**Rangeland**

Rangeland has much less biomass than other land uses, and therefore contributes fewer nutrients from biomass decay. However, grazing impacts (manure deposition) do factor in. Similar to the forest areas, rangeland is grazed during the summer months in the watershed. This grazing is handled similar to the grazing in the forest areas.

### *6.5.2.4 Development*

Developed areas contribute nutrients to the watershed by runoff from impervious surfaces, deposition by machines/automobiles, application of fertilizers, and increased irrigation on lawns. Although developed areas often have the highest nutrient loading rates, in the Little Blackfoot River watershed developed areas make up a very small percentage of the overall area.

### *6.5.2.5 Septic*

Septic systems in the Little Blackfoot watershed model were represented as point sources. The number of septic systems in the watershed was estimated based on land uses and cadastral data. The daily load from each system was based on literature values and conservative assumptions used during permitting for subdivisions in Montana (Montana Department of Environmental Quality, 2009). Because a complete system failure is typically addressed very quickly, conservative assumptions were used for the load estimates (i.e. low nutrient removal efficiency), and no site-specific septic data were available, it was assumed that all septic tanks are conventional systems that are working properly (i.e. 0% failure rate). The typical loading rate to stream was estimated based on the soils and geology and then added to the model as daily point sources. These point sources were calculated independently for each sub-basin based on the number of septic tanks assigned to the specific sub-basin.

### 6.5.3 Modeled Existing Nutrient Load Summary

Based on the SWAT model, existing total summer nutrient loading is presented by watershed in **Table 6-16** and source assessment results by land use category are presented for each watershed in **Figures 6-2** and **6-3**. The presented load represents the summer season average for a typical year.

**Table 6-16. Modeled Summer Nutrient Loads by Watershed (July 1 – September 30)**

| | **Summer Nutrient Load (lbs)** | |
|---|---|---|
| **Watershed** | **TP** | **N** |
| Carpenter Creek | 35 | NA |
| Dog Creek, lower segment | 145 | NA |
| Little Blackfoot River, lower segment | 524 | NA |
| Snowshoe Creek | NA | 703 ($NO_{3/2}$) |
| Spotted Dog Creek, lower segment | 104 | NA |
| Threemile Creek, lower segment | 41 | 1,103 (TN) |

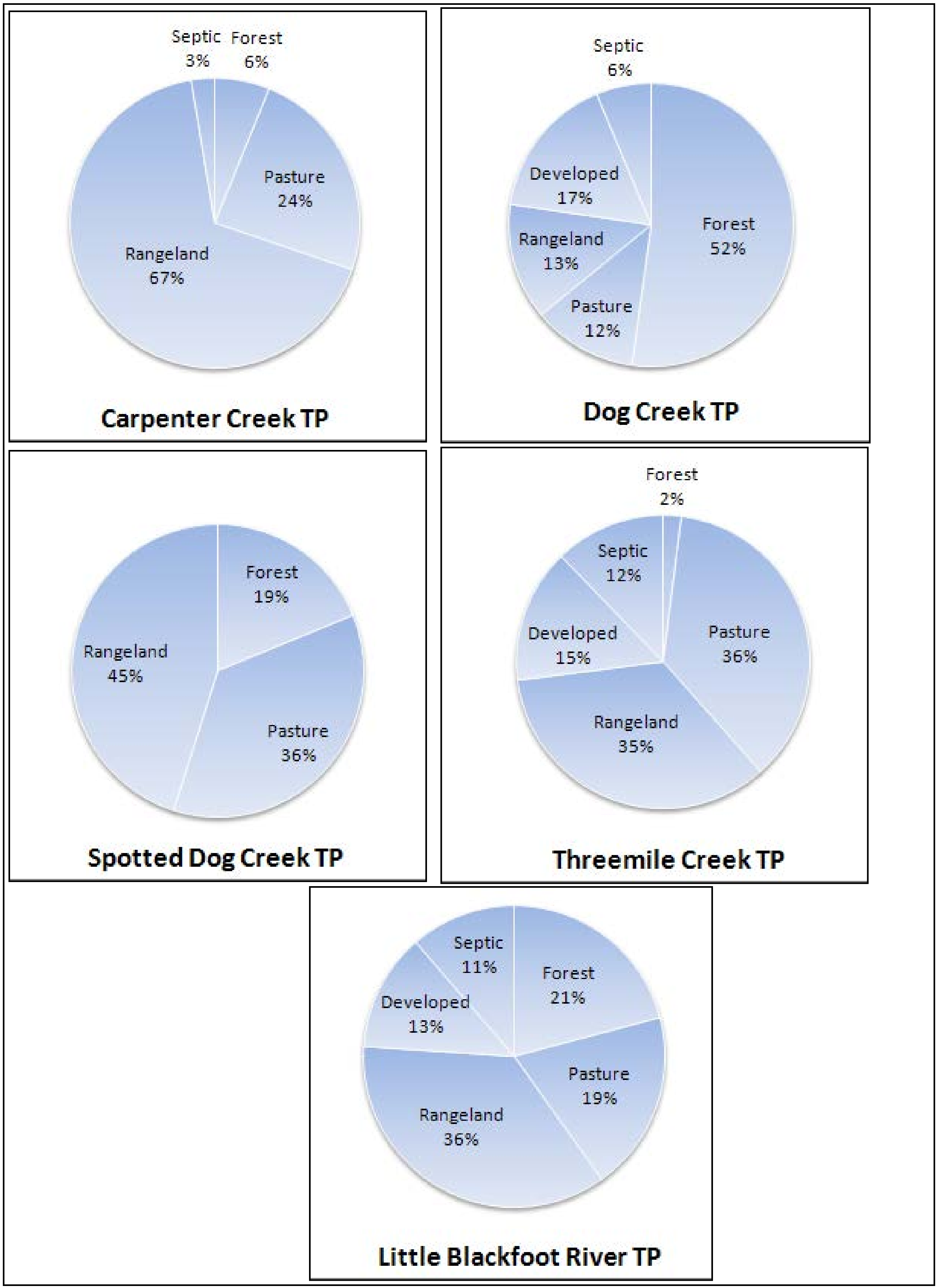

**Figure 6-2. Source Assessment Result Summary by Watershed for TP.**

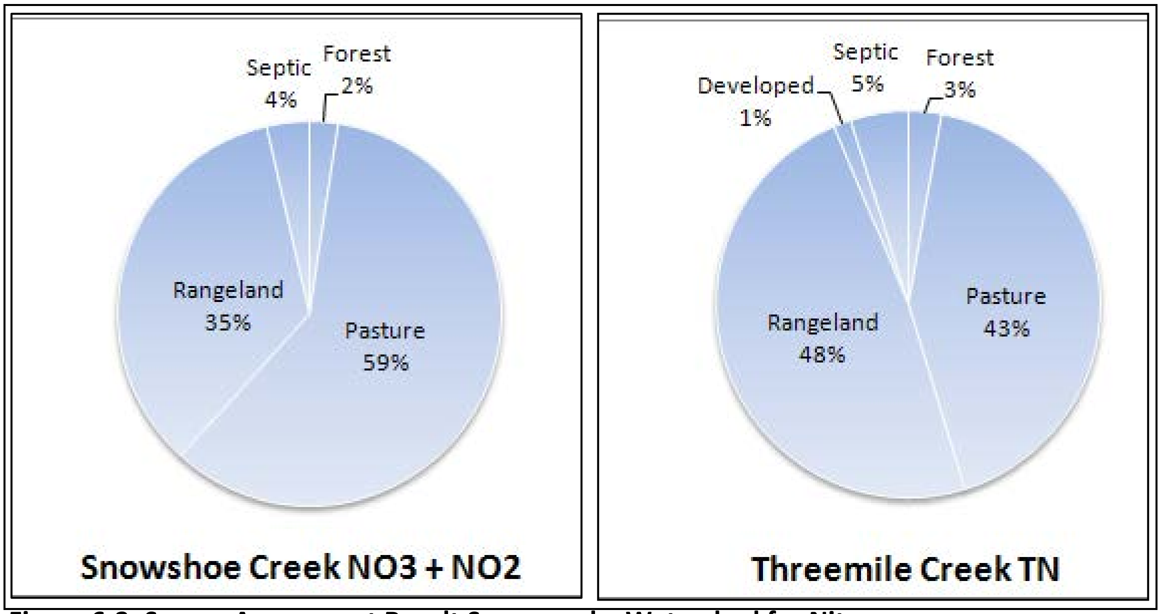

**Figure 6-3. Source Assessment Result Summary by Watershed for Nitrogen.**

The source assessment results (**Figures 6-2** and **6-3**) indicate that most TP is coming from rangeland and pasture; the existing load ranges from 55% to 91% in all watersheds except Dog Creek (25%). In Dog Creek, forest is the dominant TP source category at 52% of the current load; in that watershed, however, concentrations were typically just over the water quality target and limited reductions are needed to meet the TMDL. In other watersheds, the TP loading contribution from forests ranges from 2% to 21%. Septic and developed lands contribute little to no TP to Carpenter and Spotted Dog creeks and are close to 25% of the load in the other watersheds. For TN, the contribution from septic, developed lands, and forests is much smaller than for TP; the combined load from rangeland and pasture is greater than 90% for both Snowshoe and Threemile creek. Overall, the source assessment results are consistent with the land use patterns in the watershed and indicate that the majority of nutrient loading is coming from agricultural sources.

## 6.5.4 SWAT Model Scenarios and Result Summary

Because nutrient loading reductions are necessary to meet the TMDLs and water quality standards, the SWAT model was also used to evaluate loading reductions that can be achieved by improving land management practices. Changes in land management practices were simulated by running scenarios within the model to see how much implementing different BMPs will reduce nutrient loading relative to the reductions needed to meet the TMDLs.

The four scenarios that were simulated in SWAT are: 1) riparian buffer improvements, 2) increasing channel protection, 3) rotational grazing, and 4) improvements in irrigation efficiency. Each scenario is briefly described below. More detailed explanations of each scenario and the model inputs are provided in the SWAT Modeling Report, **Appendix D**.

### *6.5.4.1 Riparian Buffer Improvements*

Riparian buffers are important zones for filtering and taking up nutrients from surface and groundwater but also function to slow surface runoff, disperse channelized runoff, improve streambank stability, and act as a barrier against flood flows. As described in **Section 5.7.2** and **Appendix D**, vegetative filter strips were applied as a surrogate for riparian buffers. This was done because single HRUs are often spread throughout a subwatershed, making it difficult to only apply the buffer along the extent of each stream. Therefore, the distribution of HRUs was evaluated for each watershed in need of a TMDL and filter strips were added to land types that tend to occur along streams and will benefit the most from improved riparian vegetation. The filter strip width applied within the scenario varied for each sub-basin depending on the existing condition of the riparian zone (as classified in the riparian health assessment described in **Section 5.3.2**).

#### *6.5.4.2 Increased Channel Protection*

Increased channel protection means improved streambank stability. This scenario was used because streambank stability is strongly tied to riparian health and because phosphorus loading associated with streambank erosion will likely be reduced via reducing streambank erosion. Within SWAT, however, modifying this parameter resulted in sediment reductions ranging from 0.1% to 9.8% but did not alter nutrient loading. Because the model balances inputs from all sources and includes in-stream nutrient processing when calibrating to nutrient concentrations at the gage station, streambank erosion reductions applied externally to the model for sediment TMDLs were not used for nutrients. Therefore, although improved streambank stability was not explicitly incorporated into the scenarios, improving the riparian buffer will also enhance streambank stability and likely result in greater phosphorus reductions than those estimated in the riparian buffer scenario.

#### *6.5.4.3 Rotational Grazing*

Rotational grazing should result in improved vegetative cover and plant vigor in currently overgrazed areas as well as providing a better environment for manure to breakdown in-place and improving the forage utilization efficiency for livestock. Rotational grazing was simulated in SWAT by adjusting the vegetative cover, C factor, on grazed land cover types (i.e., pasture and rangeland), which was also done for the sediment TMDLs and is described in **Section 5.7.2**. The adjustment in C factor values equates to a 10% improvement in ground cover per category and the values were set based on literature values, estimates of existing field conditions in the watershed determined through site visits, communication with local stakeholders, and comparisons to previous SWAT model efforts in the Upper Clark Fork and Bitterroot River watersheds.

#### *6.5.4.4 Improved Irrigation Efficiency*

Surface runoff as well as subsurface flow associated with the irrigation network may increase the transport of nutrients to streams, and improvements to irrigation efficiency may reduce nutrient (and sediment) inputs to surface water (Ciotti, et al., 2010). Irrigation studies in other watersheds in western Montana have found that up to a 15% improvement in efficiency in the diverted water can be made with small adjustments and upgrades to ditches (Van Mullen, 2006; Kron, et al., 2009); although these findings indicate a similar reduction may be achievable in the Little Blackfoot watershed, a conservative irrigation improvement scenario was run by improving irrigation efficiency by 5%. Likely because the scenario altered subsurface flow and TP is typically transported in surface runoff, irrigation changes did not reduce TP loads. However, because nitrogen is more mobile in groundwater, irrigation improvements resulted in a 8% reduction in TN in Snowshoe Creek and a 2% reduction in Threemile Creek. However, because no irrigation study has been conducted to determine reasonable improvement efficiencies within the Little Blackfoot and because reductions associated with riparian buffer improvements and rotational grazing are anticipated to achieve greater than necessary reductions in most cases, this scenario is included primarily for informational purposes.

### *6.5.4.5 Model Scenario Results and Comparison to Existing Loads*

Because the draft numeric nutrient criteria include a 20 percent exceedance rate, the sample data were used to calculate a load that corresponds to the 80th percentile of the growing season sample dataset. The 80th percentile represents a concentration that incorporates the 20% exceedance rate. Although the needed reductions vary from day to day depending on streamflow and nutrient concentrations, it was assumed the implementing BMPs that will achieve loading reductions corresponding to the 80th percentile of the sample dataset will result in TMDL attainment over the growing season. Also, because the necessary reduction does vary from day to day, the 80th percentile reduction served as a comparison tool when running the model scenarios to see how the estimated scenario reductions compare to the needed reductions, to help gauge if the scenarios needed to be modified, and as an indicator of the achievability of meeting the water quality targets.

A summary of the needed growing season reduction range as well as the 80th percentile reduction based on sample data is provided in **Table 6-17** along with the estimated achievable reductions associated with the two main scenarios and the scenarios combined. Typically a single scenario will not be sufficient to achieve the necessary reductions and combining the scenarios should achieve more than the necessary reductions. This indicates that the TMDLs should be attainable and that the appropriate solution will likely be a combination of these scenarios. Also, given that all scenarios combined results in reductions well over the needed reduction for most streams, this provides a margin of safety that implementing the scenarios will result in attainment of water quality targets and the TMDL.

In a few instances, the modeled scenarios fall short of the reduction goal. All of these instances were on tributaries, and this could be because the model was calibrated to the gauge and has a lesser degree of certainty on the tributaries, the existing condition or scenarios are not accurately reflected in the model, or the sample data are not representative of typical growing season conditions. Model uncertainty is described in more detail in **Appendix D**. Based on the estimated reductions for scenarios in most streams and the well known ability of improvements in grazing management and riparian buffers to decrease nutrient loading to streams, it is assumed that the necessary reduction can be achieved in all waterbody segments. The scenarios were set up at the watershed scale and it is acknowledged that each scenario is not necessary and applicable in all locations.

**Table 6-17. Needed loading reductions relative to SWAT modeling scenario reductions.**

| Waterbody Segment | Needed Reduction Range | 80th Percentile Reduction (Scenario Goal) | Riparian Buffers | Rotational Grazing | Riparian Buffers and Rotational Grazing |
|---|---|---|---|---|---|
| | Total Phosphorus | | | | |
| Carpenter Creek | 25-51% | 46% | 29% | 10% | 34% |
| Dog Creek, lower segment | 0-21% | 2% | 28% | 9% | 37% |
| Little Blackfoot River, lower segment | 0-14% | 9% | 30% | 11% | 38% |
| Spotted Dog Creek, lower segment | 0-51% | 30% | 46% | 13% | 50% |
| Threemile Creek, lower segment | 39-72% | 59% | 48% | 9% | 49% |
| | Total Nitrogen | | | | |
| Snowshoe Creek* | 0-29% | 9% | 12% | 18% | 25% |
| Threemile Creek, lower segment | 0-68% | 51% | 39% | 8% | 43% |

*Because reducing TN will reduce $NO_{3+2}$ loading and there is a higher level of uncertainty pertaining to dissolved fractions within the model because it was calibrated to total fractions, TN reductions were evaluated even though the TMDL is for $NO_{3+2}$

## 6.6 TMDLS AND ALLOCATIONS

Nutrient TMDLs will be developed for the nutrient pollutant causes identified for each waterbody in **Table 6-15**. The TMDL equation for each nutrient form is based on flow and the nutrient targets and provided in **Equation 6-1** through **Equation 6-3**. The target values are based on the most sensitive uses; therefore, the nutrient TMDLs are protective of all designated beneficial uses. Future conditions will be considered meeting the TMDL if there is less than a 20 percent exceedance rate as long as exceedances are spatially and temporally random during the summer months. This exceedance rate allows for natural variability yet should protect against nutrient conditions that impact any use of the water. The TMDLs are applied only to the summer growing season (July 1st through Sept 30th).

**Equation 6-1.**
Total Nitrogen TMDL (lbs/day) = CFS*1.62
Where: CFS = Average daily discharge in cubic feet per second
1.62 = Conversion factors combined with total nitrogen target from **Table 6-2**

**Equation 6-2.**
Nitrate + Nitrite TMDL (lbs/day) = CFS*0.54
Where: CFS = Average daily discharge in cubic feet per second
0.54 = Conversion factors combined with total nitrogen target from **Table 6-2**

**Equation 6-3.**
Total Phosphorus TMDL (lbs/day) = CFS*0.162
Where: CFS = Average daily discharge in cubic feet per second
0.162 = Conversion factors combined with total phosphorus target from **Table 6-2**

TMDL examples are provided for each waterbody segment using growing season sample data; the examples show the maximum and minimum measured existing load based on the sample data, as well as the load based on the 80$^{th}$ percentile of the data. The TMDL can be displayed as a line graph of allowable loading with increasing flow. **Figure 6-4** is the graph of a TN TMDL for the range of mean daily flows from zero to 48 cfs. The vertical dotted lines intersect the graph at the points corresponding to the three stream flow values of 10, 25 and 45 cfs. The horizontal dotted lines, extending from the diagonal TMDL graph to the y-axis, identify the maximum TN load allowed for these three discharge rates.

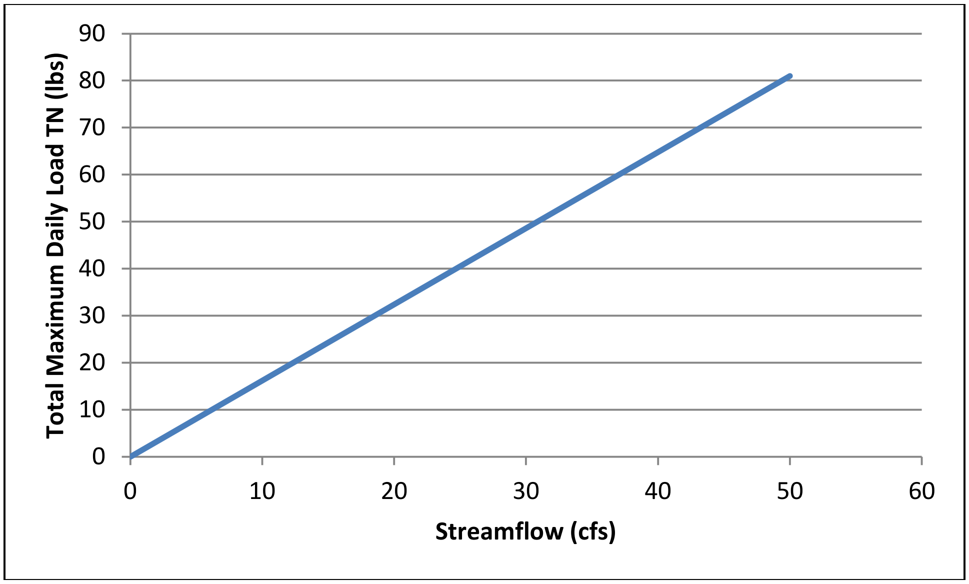

**Figure 6-4. Graph of the TN TMDLs for mean daily flows from zero to 50 cfs.**

Flow duration curves express stream flows in terms of the percentage of time that flows are equaled or exceeded. **Figure 6-5** is the flow duration curve for mean daily discharge in the Little Blackfoot River at USGS station 12324590 and is grouped by prevailing hydrologic condition (U.S. Environmental Protection Agency, 2007).

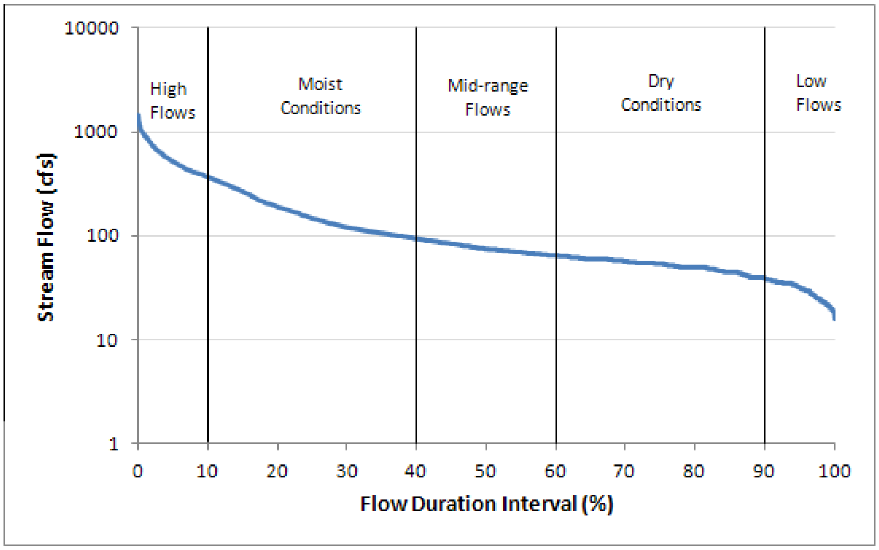

**Figure 6-5. Flow duration curve based on a period of record from 2001-2010 for the Little Blackfoot River at USGS Station #12324590, partitioned by annual hydrologic condition.**

The relationship between flow and loading can be used to illustrate the seasonal loading distribution so that loading controls can be developed and implemented to target the most critical loading periods. A flow duration curve can be converted to a load duration curve showing the TMDL by replacing values for mean daily flow on the y-axis with the allowable daily load derived by using **Equations 6-1** through **6-3**. A load duration curve illustrating the TMDL along with loads determined from field measurements is a useful tool for correlating existing loads with hydrologic conditions, and will be used to graphically display the TMDL and existing loading conditions for each waterbody segment. Although there is only one USGS gage in the watershed with mean daily flows, flow durations curves were developed within the SWAT model for each waterbody with a nutrient TMDL. Based on the flow duration curves, load duration curves were developed and will be used to display the TMDL(s) for each waterbody segment as well as exceedances based on the sample data summarized in **Section 6.4**. All load duration curves only contain water quality data collected during the summer growing season.

## 6.6.1 Allocation Approach

Because agriculture is the predominant source category and all sources are nonpoint, the TMDL allocations are composited into a single load allocation to all nonpoint sources, including natural background sources. Therefore, the equation for all nutrient TMDLs is as follows: TMDL = LA. Because there are no point sources, the wasteload allocation (WLA) is 0. All nutrient TMDLs include an implicit margin of safety, which is based on conservative assumptions as described in **Section 6.6.8.3**.

Allocations are intended to be met by implementation of additional BMPs. In recent years, some improvements have been made such as the installation of riparian fencing and changes in grazing management, but additional and more widespread improvements are needed to decrease nutrient loading and meet TMDLs. Necessary BMPs may include but are not limited to those used in the model scenarios, which were improved riparian buffers and rotational grazing. The scenarios did not alter the current livestock density, but instead focused on the distribution, usage, and timing on the landscape. For instance, limiting livestock access to streams via fencing, providing alternate water sources, and/or installation of hardened crossings will reduce direct nutrient inputs to streams, increase streambank stability, and improve the riparian buffer health, which are factors that will be essential to meeting both the nutrient and sediment TMDLs. Although the modeled BMP scenarios discussed within **Section 6.5** and **Appendix D** reflect reasonable reductions as determined from literature, agency and industry documentation of BMP effectiveness, and field assessments, nutrient loading reductions can be achieved through a combination of BMPs, and the most appropriate BMPs will vary by site. Septic loading is typically a fairly small portion of existing nutrient loading (**Figures 6-2** and **6-3**) and because no failure rate was assumed for the existing condition, no loading reductions are anticipated from septic sources; however, the allocation to septic, which addresses both current and future loading, is expected to be met by proper placement, maintenance, and cleaning of septic systems.

Although the needed reductions (based on sample data) and the estimated reductions from the model shown in **Table 6-17** only apply to the growing season, because all sources are nonpoint, it is anticipated that TMDL implementation will result in reductions in nutrient loading year-round. This will address sources of nutrients that tend to be introduced to streams during runoff but stored in channel and become available during the summer growing season. As shown in **Appendix D,** typical annual reductions in nutrient loading from implementation of the modeling scenarios is expected to result in greater reduction percentages than those shown for the growing season. **Appendix D** includes the anticipated summer and annual loading reductions associated with BMP implementation.

### *6.6.1.1 Meeting Allocations*

It is important to recognize that the first critical step toward meeting the nutrient allocations involves applying and/or maintaining the land management practices or BMPs that will reduce nutrient loading. Once these actions have been completed at a given location, the landowner or land manager will have taken action consistent with the intent of the nutrient allocation for that location. For many nonpoint source activities, it can take several years to achieve the full load reduction at the location of concern, even though full BMP implementation is in effect. For example, it may take several years for riparian areas to fully recover and decrease nutrient loading after implementing grazing BMPs. It is also important to apply proper BMPs and other water quality protection practices for all new or changing land management activities to limit any potential increased nutrient loading.

Progress towards TMDL and individual allocation achievement can be gauged by BMP implementation and improvement in or attainment of water quality targets defined in **Section 6.4.1**. Any effort to calculate loads and percent reductions for purposes of comparison to TMDLs and allocations in this document should be accomplished via the same methodology and/or models used to develop the loads and percent reductions presented within this document.

TMDLs are shown graphically using load duration curves in **Figures 6-6** through **6-12** and example TMDLs using sample data to show the range of needed loading reductions are provided by waterbody segment in **Tables 6-18** through **6-24**.

## 6.6.2 Carpenter Creek, lower segment (MT76G004_092)

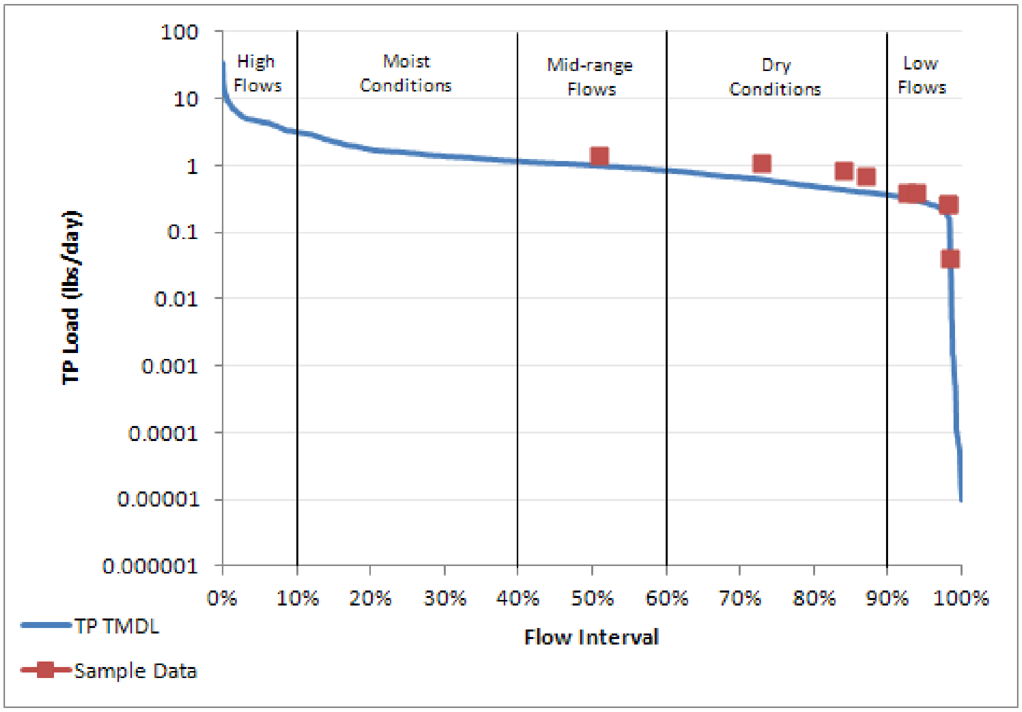

**Figure 6-6. Load duration curve showing TP TMDL and sample data for Carpenter Creek.**

**Table 6-18. Total Phosphorus Allocations and TMDL for Carpenter Creek.**

| Sample Data | TP Concentration | Existing Load (lbs/day) | TMDL (lbs/day) | % Reduction |
|---|---|---|---|---|
| Minimum | 0.039 | 0.40 | 0.31 | 23% |
| Maximum | 0.061 | 0.86 | 0.42 | 51% |
| 80th Percentile | 0.055 | 0.91 | 0.49 | 46% |

## 6.6.3 Dog Creek, lower segment (MT76G004_072)

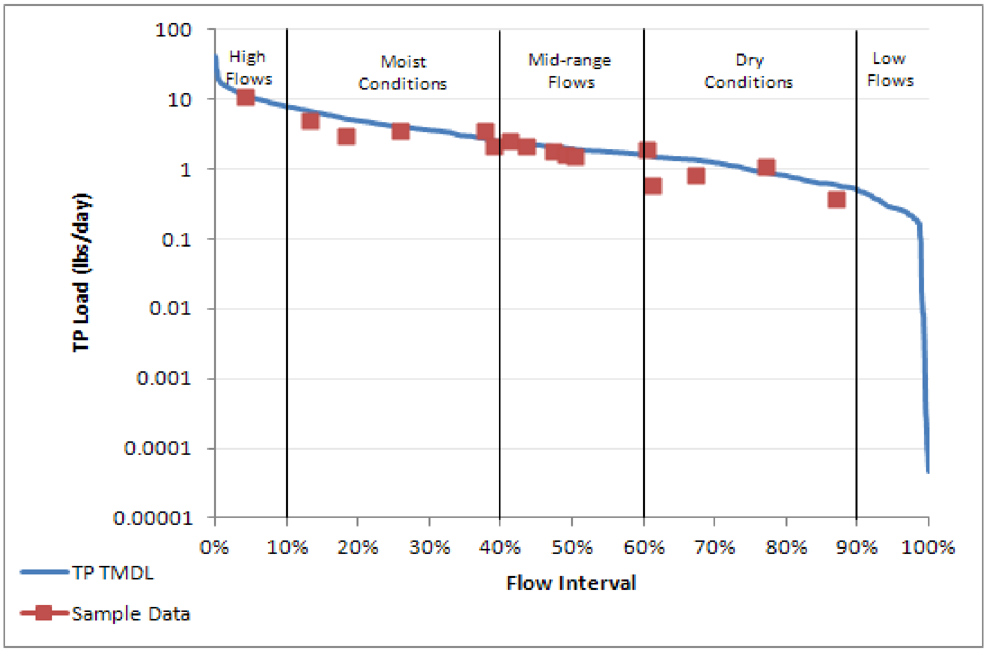

Figure 6-7. Load duration curve showing TP TMDL and sample data for Dog Creek.

Table 6-19. Total Phosphorus Allocations and TMDL for Dog Creek.

| Sample Data | TP Concentration | Existing Load (lbs/day) | TMDL (lbs/day) | % Reduction |
|---|---|---|---|---|
| Minimum | 0.011 | 0.58 | 1.57 | 0% |
| Maximum | 0.038 | 3.56 | 2.81 | 21% |
| 80th Percentile | 0.031 | 4.27 | 4.19 | 2% |

## 6.6.4 Little Blackfoot River, lower segment (MT76G004_010)

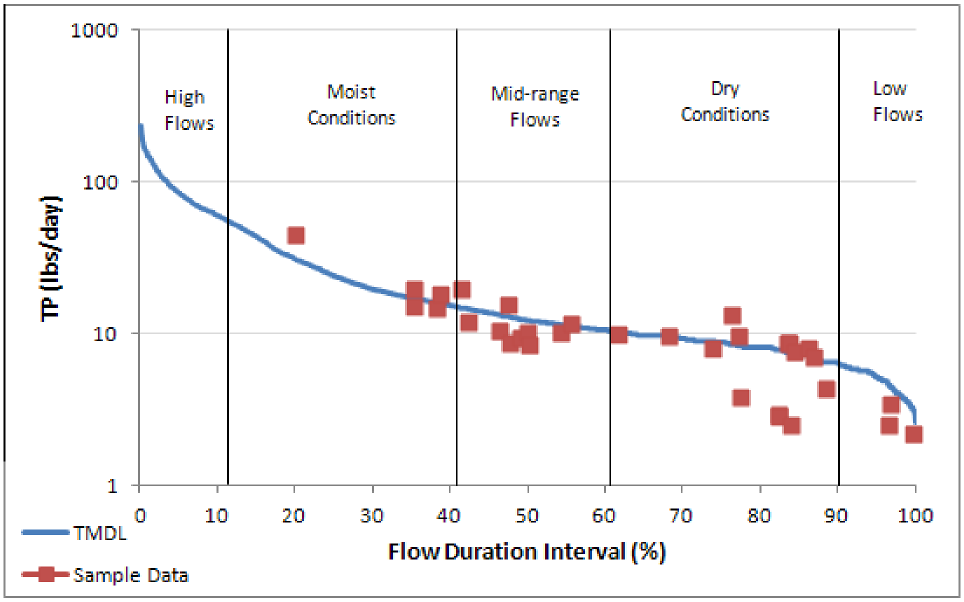

Figure 6-8. Load duration curve showing TP TMDL and sample data for the Little Blackfoot River.

**Table 6-20. Total Phosphorus Allocations and TMDL for the lower Little Blackfoot River.**

| Sample Data | TP Concentration | Existing Load (lbs/day) | TMDL (lbs/day) | % Reduction |
|---|---|---|---|---|
| Minimum | 0.011 | 2.90 | 7.92 | 0% |
| Maximum | 0.035 | 18.4 | 15.77 | 14% |
| 80th Percentile | 0.033 | 15.25 | 13.95 | 9% |

## 6.6.5 Snowshoe Creek (MT76G004_080)

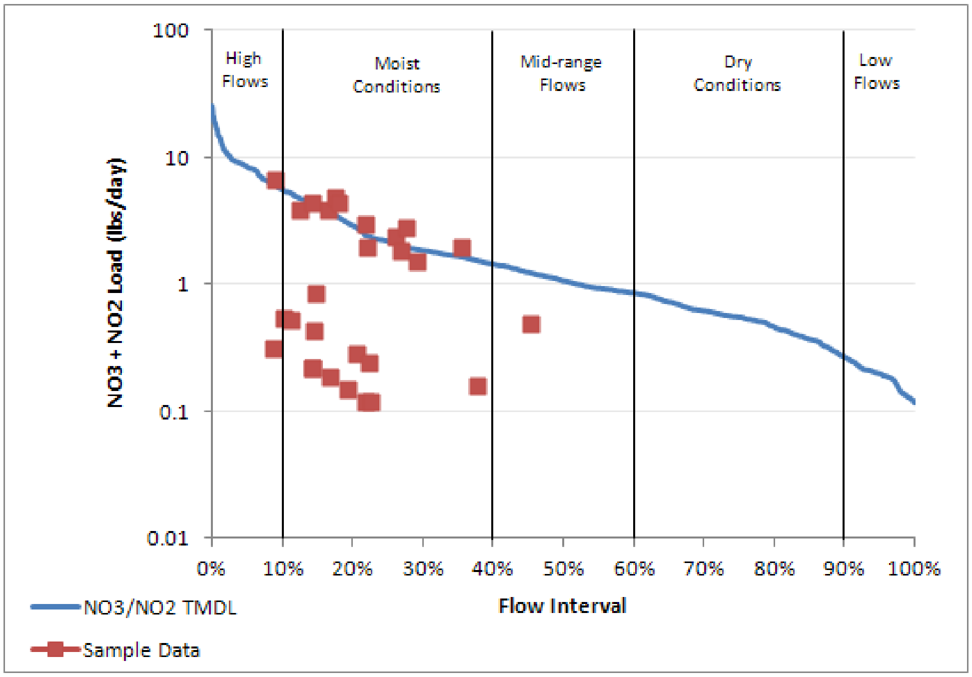

**Figure 6-9. Load duration curve showing NO3 + NO2 TMDL and sample data for Snowshoe Creek.**

**Table 6-21. Nitrate + Nitrate Allocations and TMDL for Snowshoe Creek.**

| Sample Data | NO3+2 Concentration | Existing Load (lbs/day) | TMDL (lbs/day) | % Reduction |
|---|---|---|---|---|
| Minimum | 0.005 | 0.22 | 4.38 | 0% |
| Maximum | 0.14 | 4.89 | 3.49 | 29% |
| 80th Percentile | 0.11 | 4.82 | 4.38 | 9% |

## 6.6.6 Spotted Dog Creek, lower segment (MT76G004_032)

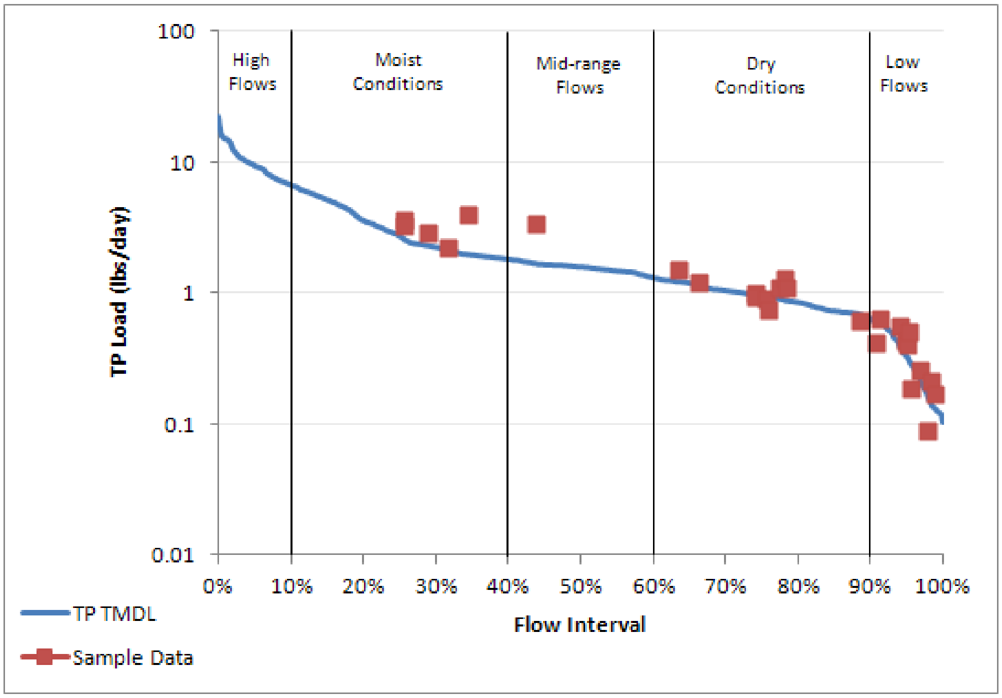

**Figure 6-10. Load duration curve showing TP TMDL and sample data for Spotted Dog Creek.**

**Table 6-22. Total Phosphorus Allocations and TMDL for Spotted Dog Creek.**

| Sample Data | TP Concentration | Existing Load (lbs/day) | TMDL (lbs/day) | % Reduction |
|---|---|---|---|---|
| Minimum | 0.017 | 0.09 | 0.16 | 0% |
| Maximum | 0.061 | 4.00 | 1.97 | 51% |
| 80th Percentile | 0.043 | 2.27 | 1.59 | 30% |

### 6.6.7 Threemile Creek, lower segment (MT76G004_112)

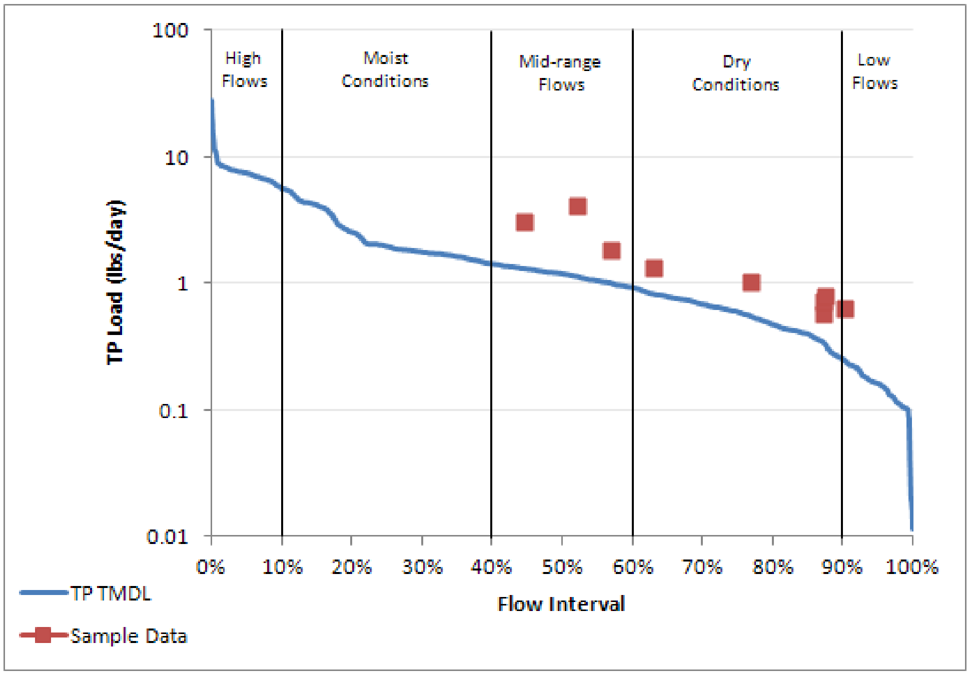

Figure 6-11. Load duration curve showing TP TMDL and sample data for Threemile Creek.

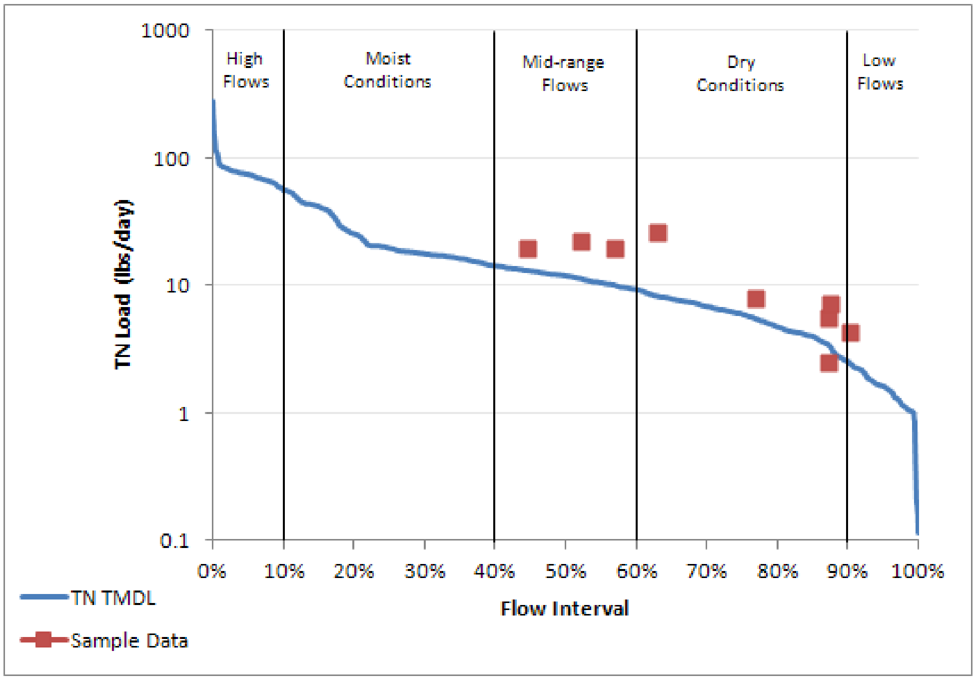

Figure 6-12. Load duration curve showing TN TMDL and sample data for Threemile Creek.

Table 6-23. Total Phosphorus Allocations and TMDL for Threemile Creek.

| Sample Data | TP Concentration | Existing Load (lbs/day) | TMDL (lbs/day) | % Reduction |
|---|---|---|---|---|
| Minimum | 0.049 | 1.35 | 0.82 | 39% |
| Maximum | 0.109 | 4.14 | 1.14 | 72% |
| 80th Percentile | 0.074 | 2.61 | 1.06 | 59% |

**Table 6-24. Total Nitrogen Allocations and TMDL for Threemile Creek.**

| Sample Data | TN Concentration | Existing Load (lbs/day) | TMDL (lbs/day) | % Reduction |
|---|---|---|---|---|
| Minimum | 0.22 | 2.49 | 3.40 | 0% |
| Maximum | 0.94 | 25.84 | 8.25 | 68% |
| 80th Percentile | 0.61 | 21.61 | 10.59 | 51% |

## 6.6.8 Seasonality, Margin of Safety and Uncertainty

TMDL documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin of safety to account for uncertainties between pollutant sources and the quality of the receiving waterbody, and to ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. This section describes seasonality and margin of safety in the Little Blackfoot watershed nutrient TMDL development process.

### *6.6.8.1 Seasonality*

Addressing seasonal variations is an important and required component of TMDL development and throughout this plan seasonality is an integral consideration. Water quality and particularly nitrogen concentrations are recognized to have seasonal cycles. Specific examples of how seasonality has been addressed within this document include:

- Water quality targets and subsequent allocations are applicable for the summer-time growing season (July1st – Sept 30th), to coincide with seasonal algal growth targets.
- Nutrient data used to determine compliance with targets and to establish allowable loads was collected during the summertime period to coincide with applicable nutrient targets
- Load duration curves were developed to demonstrate the typical seasonal flow regimes when nutrients become a problem.

### *6.6.8.2 Margin of Safety*

A margin of safety is a required component of TMDL development. The margin of safety (MOS) accounts for the uncertainty about the pollutant loads and the quality of the receiving water and is intended to protect beneficial uses in the face of this uncertainty. The MOS may be applied implicitly by using conservative assumptions in the TMDL development process or explicitly by setting aside a portion of the allowable loading (U.S. Environmental Protection Agency, 1999a). This plan addresses MOS implicitly in a variety of ways:

- Static nutrient target values (0.030 mg/L TP, 0.100 mg/L $NO_3$+$NO_2$, 0.300 mg/L TN) were used to calculate allowable loads (TMDLs). Allowable exceedances of nutrient targets (see **Section 6.4.3**) were not incorporated into the calculation of allowable loads, thereby adding a MOS to established allocations.
- Target values were developed to err on the conservative side of protecting beneficial uses.
- By considering seasonality (discussed above) and variability in nutrient loading.
- Model scenarios were developed to be reasonable and achievable, and the scenarios estimate greater than necessary reductions for nutrients in most streams.
- Modeled loading reductions are shown for the growing season when nutrient targets apply but practices will be implemented year round, resulting in even greater reductions in nutrient loading.

- By using an adaptive management approach to evaluate target attainment and allow for refinement of load allocation, assumptions, and restoration strategies to further reduce uncertainties associated with TMDL development.

### *6.6.8.3 Uncertainty and Adaptive Management*

Uncertainties in the accuracy of field data, nutrient targets, source assessments, loading calculations, and other considerations are inherent when assessing and evaluating environmental variables for TMDL development. However, mitigation and reduction of uncertainties through adaptive management approaches is a key component of ongoing TMDL implementation and evaluation. The process of adaptive management is predicated on the premise that TMDL targets, allocations, and the analyses supporting them are not static, but are processes subject to modification and adjustment as new information and relationships are understood. Uncertainty is inherent in both the water quality-based and model-based modes of assessing nutrient sources and needed reductions. The main sources of uncertainty are summarized below.

**Water Quality Conditions**

It was assumed that sampling data for each waterbody segment is representative of conditions in each segment. Most segments have more than the desired 12 samples but Carpenter and Dog creeks but have a smaller dataset, which increases the uncertainty of the representativeness of the data. Additionally, macroinvertebrate data are a supplementary indicator, and most waterbody segments have little to no macroinvertebrate data. Particularly in situations where nutrient and algal data indicate borderline impairment, additional macroinvertebrate data may help decrease the uncertainty. Data for all waterbody segments with a nutrient TMDL clearly indicate the targets are not being attained, however, future monitoring as discussed in **Section 10.0** should help reduce the uncertainty regarding data representativeness, improve the understanding of the effectiveness of BMP implementation, and increase the understanding of the loading reductions needed to meet the TMDLs.

It was assumed that background concentrations are less than the target values, and based on sample data upstream of known sources, this appears to be true. However, it is possible that target values are naturally exceeded during certain times or at certain locations in the watershed. There is a greater level of uncertainty in areas underlain by the Phosphoria Formation; available data were reviewed to assess the geologic phosphorus contribution and indicated it is not the primary cause of target exceedances. However, based on the limited amount of dissolved phosphorus data, additional monitoring is recommended (particularly in the Threemile Creek watershed) to further evaluate the geologic contribution to phosphorus concentrations in surface water. Additionally, phosphate was mined in the Dog Creek and Threemile Creek watershed, which could accelerate the background loading rate in these drainages and should be investigated during future monitoring.

**Source Assessment and SWAT Model**

Much of the uncertainty associated with the nutrient TMDLs relates to the SWAT model and how existing conditions were represented. A detailed description of the model inputs, assumptions, and uncertainty is contained in **Appendix D**; this section provides an overview of the assumptions made and aspects of the model inputs with the greatest uncertainty.

Efforts were made to work with agency representatives familiar with the watershed as well as landowners to make the model inputs as realistic as possible. Based on this, general trends in the timing of the irrigation season and haying as well as fertilizer usage were obtained. There is some uncertainty regarding the typical total number of cow/calf pairs in the watershed as livestock numbers were based on limits for grazing allotments within the Helena National Forest and assumed to represent the numbers for the watershed; the Agricultural Statistics Service provides numbers summarized by county but they could not be parsed to the watershed scale to verify the assumption of livestock numbers. As discussed in **Appendix D**, several windshield surveys were conducted during the winter to count cattle; while a very coarse estimate, this effort indicated the assumption for the watershed is reasonable. For livestock with stream access, there is potential for increased nutrient loading from direct input of excrement. This is a nutrient source that was not accounted for in the model and has the likelihood of increasing nutrient concentrations quite a bit, particularly during the growing season when runoff events are sporadic.

DEQ conducted a limited field assessment of vegetative cover in different areas of the watershed to assist with the C factor values used to represent existing conditions and also to identify to potential change in C factor with improved management practices. This reduced some of the uncertainty associated with characterizing existing conditions; however, it is important to acknowledge that for each cover type, the same condition was applied throughout the watershed. Because the source assessment was performed at this watershed scale, livestock density and vegetative conditions were not adjusted to account for field scale variability.

Riparian vegetation is well known to be an important factor in maintaining streambank stability and filtering nutrients and other pollutants from runoff and groundwater as it migrates to surface water; because land cover units within SWAT are not spatially related, a true riparian buffer scenario could not be simulated. Vegetative cover strips were used as a surrogate and the estimated reductions are in line with literature values for buffers, but because of the spatial limitations of the model there is some uncertainty regarding the total reduction potential per sub-basin. Also, additional reductions may be possible in some areas where filter strips were not applied.

The model was calibrated for hydrology, sediment, and nutrients. The hydrologic calibration includes some irrigation components as well as reservoirs on Threemile, Spotted Dog, and Snowshoe creeks. Limited knowledge of the irrigation network and reservoir operation introduces some uncertainty into the hydrologic calibration, which may affect the nutrient routing and the source assessment. Some uncertainty is also associated with the sediment and nutrient calibrations because they were completed with rating curves because of the limited amount of water quality at the gage near Garrison. This uncertainty as well as the fact that the calibration was done to a point near the mouth and applied to tributaries as well as the mainstem Little Blackfoot most likely affected existing nutrient concentrations predicted within the model. However, this does not detract from the model results because it was primarily used to identify achievable reductions in nutrient loading via the implementation of BMPs.

One other area of uncertainty is the contribution from septic systems. Based on the age of septic systems within the watershed, there are probably some failing systems, and depending on their proximity or connectivity to surface water, they could be point sources of nutrient loading. However, a completely failing system has obvious symptoms and will be addressed quickly, and a partially failing system will likely result in similar loading as a functioning system, unless it’s in close proximity to surface water. This source could be investigated further, particularly in segments with nearby septic systems and elevated nutrient concentrations that cannot be explained by other sources; however, based on the low septic density within the watershed and conservative loading estimates used, even with this uncertainty, septic systems will typically be a minor source of nutrient loading.

Despite the uncertainty associated with the loading contributions from the various nonpoint sources in the watershed, based on the modeling, literature, and field observations there is a fairly high level of certainty that improvements in land management practices discussed in this document will reduce nutrient loading sufficiently to meet the TMDLs.

# 7.0 METALS TMDL COMPONENTS

This portion of the document focuses on metals as an identified cause of water quality impairments in the Little Blackfoot TPA. It describes: 1) the mechanisms by which metals impair beneficial uses of those streams, 2) the specific stream segments of concern, 3) the presently available data pertaining to metals impairments in the watershed, 4) the various contributing sources of metals based on recent data and studies, and 5) the metals TMDLs and allocations.

## 7.1 MECHANISM OF EFFECTS OF EXCESS METALS TO BENEFICIAL USES

Waterbodies with metals concentrations exceeding the aquatic life and/or human health standards can impair support of numerous beneficial uses including aquatic life, cold water fisheries, drinking water, and agriculture. Within aquatic ecosystems, elevated concentrations of heavy metals can have a toxic, carcinogenic, or bioconcentrating effect on biota. Humans and wildlife can suffer acute and chronic effects from consuming drinking water or fish with elevated metals concentrations. Because elevated metals concentrations can be toxic to plants and animals, high metals concentrations in irrigation or stock water may affect agricultural uses.

## 7.2 STREAM SEGMENTS OF CONCERN

A total of seven waterbody segments in the Little Blackfoot TPA were listed as impaired due to metals-related causes on the 2010 Montana 303(d) List (**Table 7-1**). Sampling performed as part of TMDL development found five additional waterbody segments impaired by metals not currently on the 303(d) List. All 2010 303(d) listings are included in **Table 1-1** and the beneficial use support status of listed segments is presented in **Table 3-1**. Metals-related listings include arsenic, beryllium, cadmium, copper, cyanide, iron, lead, mercury, pH, selenium, and zinc. Cyanide is not a metal but the 303(d) listing is addressed within this document because it is frequently associated with metals and mining sources.

**Table 7-1. Waterbody segments in the Little Blackfoot TPA with metals listings on the 2010 303(d) List.**

| Stream Segment | Waterbody Segment ID | Probable Causes of Impairment |
|---|---|---|
| DOG CREEK, headwaters to Meadow Creek | MT76G004_071 | Arsenic, Lead, Zinc |
| LITTLE BLACKFOOT RIVER, the headwaters to Dog Creek | MT76G004_020 | Arsenic, Cyanide |
| LITTLE BLACKFOOT RIVER, Dog Creek to the mouth (Clark Fork River) | MT76G004_010 | Copper, Lead |
| MONARCH CREEK, headwaters to the mouth (Ontario Creek) | MT76G004_060 | Arsenic, Copper, Lead, Mercury, Selenium; pH |
| TELEGRAPH CREEK, headwaters to Hahn Creek | MT76G004_051 | Arsenic, Beryllium, Cadmium, Copper, Iron, Zinc |
| TELEGRAPH CREEK, Hahn Creek to the mouth (Little Blackfoot River) | MT76G004_052 | Lead, Mercury |
| UN-NAMED CREEK, headwaters to mouth (Ontario Creek)* | MT76G006_010* | Arsenic, Cadmium, Copper, Lead, Mercury, Zinc; pH |

*Formerly identified on the 303(d) List as the Ontario Mine Wetland.

## 7.3 INFORMATION SOURCES AND ASSESSMENT METHODS

The total metals load entering a waterbody is equal to the sum of all contributing source areas. In general, this means that headwater areas will have fewer potential source areas (although they frequently have a high concentration of abandoned mines), whereas locations lower in the watershed will have numerous potential source areas. To determine the location and magnitude of general sources, GIS layers, historical water quality data, and aerial photos were used.

GIS data included the DEQ High Priority Abandoned Hardrock Mine sites, the DEQ Abandoned Hardrock Mines database, the DEQ Active Hardrock Mine sites, the Montana Bureau of Mines and Geology (MBMG) Abandoned and Inactive Mines database, and permitted point sources (i.e. Montana Pollutant Discharge Elimination System permits) (**Appendix A, Figure A-16).** A query of applicable databases showed there are no active hardrock mines in the Little Blackfoot TPA. The only permitted point source is a general permit for suction dredging (MTG370000) on Carpenter Creek, a tributary to the lower segment of Little Blackfoot River. The permit conditions specify an effluent limit for turbidity but do not explicitly set limitations for metals. This permit is discussed further in **Section 7.5.12**. DEQ abandoned mine assessment files were also reviewed for notes about potential sources including discharging adits, unstable tailings, and mining wastes in the floodplain. Additionally, the potential for mines in the MBMG database to affect surface water quality in metals-listed streams within the Little Blackfoot TPA was assessed by reviewing the MBMG assessment of abandoned mines in the Helena National Forest (Hargrave, et al., 1998). Because geology and soil can influence water quality, geologic data from the USGS General Surficial Geology of Montana 1:500,000 scale map and soils data from the State Soil Geographic (STATSGO) database was also examined.

Conditions of many mine sites in the TPA and their continued effects on surface water were investigated as part of a risk assessment and reclamation prioritization by DEQ's Abandoned Mine Lands (AML) Program and MBMG in the early 1990s. Many of the 303(d) listings are based on water column and sediment metals data from either the 1970s or the 1990s. Data collected earlier than 10 years ago (i.e. 2001) were used to aid in the initial coarse level source assessment, to help determine sampling locations for additional data collection, and to provide background concentrations, but are not used within this document in the existing data review due to potential data quality and reliability issues (e.g. reporting limits higher than water quality standards and uncertainty regarding collection, analysis and recording methods) and because conditions may have changed substantially since data collection. For certain waterbodies, reclamation activities have occurred since 2001, and only data collected post-reclamation will be evaluated as part of the data review characterizing existing conditions. If the timeframe for the data review is shorter than the previous 10 years, that will be indicated in the waterbody-specific discussion.

Information used for the data review and TMDL development includes DEQ's assessment data collected since 2001, samples collected at the USGS gaging station on the Little Blackfoot River near Garrison, and samples collected by the USFS. Information DEQ AML collected evaluating conditions before and after reclaiming abandoned mines will also be use. To add to the historical dataset and document seasonal variability, DEQ conducted metals water quality and sediment monitoring in 2008 and 2009 in the listed watersheds during spring runoff and base flow conditions. Sediment metals data was collected during base flow to aid in the source assessment. Metals-rich sediment can be a source of metals at mine sites as it is carried downstream and deposited in the stream channel or floodplain. Field and analytical protocols for the samples collected in 2008/2009 are described in the Little Blackfoot TMDL Planning Area Chemistry and Chlorophyll Monitoring Sampling and Analysis Plan (Hydrosolutions Inc., 2009;

Hydrosolutions Inc., 2010), and raw data is contained in **Appendix G**. For all data reviewed, samples collected between April 15th and June 30th are assumed to represent high flow and all other samples are low flow (unless otherwise specified in a sampling report).

The effect of runoff on metals concentrations can vary, as spring runoff may dilute metals sources that enter the stream through groundwater or may increase erosion and erode soils/tailings containing metals. Mining areas may contribute metals through groundwater discharge, which occurs year-round, but tend to be more apparent during low flow when surface water inputs are minimal. Examining water quality data under various hydrologic conditions is necessary to characterize water chemistry metal conditions.

Based on the review of GIS and water quality data, potential sources of metals loading in the Little Blackfoot TPA include:

- 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
- Permitted point sources

## 7.3.1 Natural Background Loading

Natural background loading of metals occurs as a result of geologic conditions. Therefore, the degree of loading can vary considerably among subwatersheds in the planning area, as geologic conditions vary throughout (**Figure A-4**). When possible, background loading will be accounted for separately from human-caused sources. However, because mining has affected all of the streams that are listed for metals impairment to some extent, the natural background loading may not be expressed separately from other loading. The underlying assumption is that natural background sources alone would not result in the exceedance of TMDL target concentrations of metals in the water column, or in sediments. If future monitoring proves this to be incorrect, these TMDLs may need to be revised in accordance with the Adaptive Management strategy provided in **Section 7.9**.

## 7.3.2 Abandoned Mines and Associated Wastes

Due to intensive historic mining, there are an estimated 250 abandoned mines within the Little Blackfoot TPA according to the DEQ and MBMG databases (**Figure A-16**). Fifteen have been ranked by DEQ as high priority abandoned mines, most of which are located in the southeast portion of the TPA (**Figure A-16**). As of September 2011, reclamation work has been conducted at six of the 15 priority sites. Abandoned mine types included in the databases are placer, hard rock/lode, mineral deposits, and quarries. Because of the different mine types in the databases, abandoned mine sites may range from small ground disturbances to areas with adits (which can be dry or discharging) and/or tailings and waste rock piles of different sizes. Waste rock dumps and tailings may be in upland areas, in the floodplain or streamside, or in the stream channel. Depending on the parent geology, stability and level of re-vegetation, and capacity to leach metals and/or generate acid mine drainage, the effects of mining wastes on stream water quality can vary greatly.

There is typically not enough data near individual mining sources to allocate a specific percentage of the TMDL to an individual site relative to other abandoned mine sources. In instances where there is adequate data, loading from abandoned mines, adits, and tailings will be evaluated as separate unpermitted point sources and provided distinct wasteload allocations (WLA). Otherwise, the contribution from all abandoned mine sources (e.g. adits, waste rock, tailings) in a contributing area or entire watershed is grouped into a composite WLA from abandoned mines. This approach is based on the assumption that reductions in metals loading can be achieved through the remediation of these abandoned mines and associated waste rock/tailings.

## 7.4 WATER QUALITY TARGETS AND SUPPLEMENTAL INDICATORS

### 7.4.1 Targets

**Water Column Metals Concentrations**

For pollutants with numeric standards, such as metals, the established state numeric water quality standard, as defined in Circular DEQ-7 (Montana Department of Environmental Quality, 2010a), is typically adopted as the water quality target. DEQ-7 (Montana Department of Environmental Quality, 2010a) contains numeric water quality standards for Montana's surface and ground waters that are set at concentrations necessary to protect the beneficial uses of the waters. Acute and chronic toxicity aquatic life standards are designed to protect aquatic life uses, while the human health standard is designed to protect drinking water uses. As defined in DEQ-7, compliance with chronic water quality standards is based on an average water quality metals concentration over a 96 hour period and the acute water quality standard is based on a one hour average concentration, and both are not to be exceeded more than once in a three year period.

Water quality standards (acute and chronic aquatic life, human health) for each parameter of concern in the Little Blackfoot TPA at a water hardness of 25 and mg/L are shown in **Appendix B, Table B2-5**. The numeric aquatic life standards for many metals are dependent upon water hardness values, and as the hardness increases, the water quality standards for a specific metal also increases (i.e. becomes less stringent). Consequently, where the aquatic life numeric standards are used as the target, the water quality target values for specific metals will vary with water hardness. The acute and chronic aquatic life standards for cadmium, copper, lead, and zinc are hardness-dependent.

Water quality targets for metals are the State of Montana human health and acute and chronic aquatic life standards as defined in Circular DEQ-7. Based on DEQ's draft assessment methodology (Montana Department of Environmental Quality, 2011), a pollutant waterbody combination will be considered not in compliance with the metals target if any of these circumstances are met:

- The exceedance rate of chronic aquatic life standards is > 10%. Note: the desired minimum sample size for this evaluation is 8; if there are less than 8 samples, at least 2 samples must exceed the chronic aquatic life standard to be considered not meeting the target.
- ≥ 1 sample exceeds twice the acute aquatic life water quality standard
- ≥ 1 sample exceeds the human health water quality standard

As discussed in **Section 3.0**, the aquatic life numeric standards will be used as a target for iron, because the human health standard is a secondary maximum contaminant level based on aesthetic properties and would likely be removed via conventional treatment. If the data indicate that the human health guidance values for iron would be consistently exceeded after conventional treatment, use of the waterbody for drinking water is considered impaired for this constituent.

**pH**

As discussed in **Section 3.0** and detailed in **Appendix B**, both narrative and numeric standards apply to pH. The numeric standard for B-1 waters, which allows for a pH variation of 0.5 within the range of 6.5

to 8.5 and maintaining a pH of greater than 7.0 for waterbodies naturally above 7.0, will be applied as the water quality target. An additional component of the numeric standard that will apply as the target is that waterbodies with a natural pH outside this range (6.5-8.5) must be maintained without change. For waterbodies that do not meet this target and the cause is attributable to metals sources, no pH TMDL will be written. Instead, metals TMDLs will be written as surrogates to address the address the pH impairment because acid mine drainage associated with metals sources should be addressed in conjunction with reclamation activities needed to meet metals TMDLs.

## 7.4.2 Supplemental Indicators

### Sediment Metals Concentrations

As discussed in **Section 3.0**, narrative standards found in Montana's general water quality prohibitions apply to metals concentrations that are found in stream bottom sediments. Stream sediment data may also be indicative of beneficial use impairment caused by elevated metals and are used as supplementary indicators of impairment. In addition to directly impairing aquatic life that interacts with the elevated metals in the sediment, the elevated sediment values can also be an indicator of elevated concentrations of metals during runoff conditions. This can be a particularly important supplemental indicator when high flow data is lacking or limited.

The National Oceanic and Atmospheric Administration (NOAA) has developed Screening Quick Reference Tables that contain metals concentration guidelines for freshwater sediments (National Oceanic and Atmospheric Administration, 2008). Screening criteria concentrations come from a variety of toxicity studies and are expressed in Probable Effects Levels (PELs) (**Table 7-2**). PELs represent the sediment concentration above which toxic effects frequently occur, and are calculated as the geometric mean of the 50th percentile concentration of the toxic effects dataset and the 85th percentile of the no-effect dataset. Although the State of Montana does not currently have criteria that define impairment condition based on sediment quality data, PELs provide a screening tool to evaluate the potential for impacts to aquatic life and will be used as a supplemental indicator to assist in impairment determinations where water chemistry data are limited. Because numeric standards exist for metals in water and sediment standards are narrative, sediment metals information will be used as a supplemental indicator to water column data.

**Table 7-2. Screening level criteria for sediment metals concentrations that will be used as supplemental indicators in the Little Blackfoot TPA.**

| Metal of Concern | PEL (µg/g dry weight) |
|---|---|
| Arsenic | 17 |
| Cadmium | 3.53 |
| Copper | 197 |
| Lead | 91.3 |
| Mercury | 0.486 |
| Selenium* | 2.0 |
| Zinc | 315 |

*The screening value for selenium is based on the BC Ministry of Environment sediment standard ( British Columbia Ministry of Water, Land and Air Protection, 2001)

### Human Metals Sources

The presence of human metals sources does not always result in impairment of a beneficial use. When there are no significant identified human sources of metals within the watershed of a 303(d) listed stream, no TMDL will be prepared since Montana's narrative standards for metals relate to human causes. Human and natural sources will be evaluated using recently collected data, field observations and watershed scale source assessment information obtained using aerial imagery, GIS data layers, and other relevant information sources.

### 7.4.3 Metals TMDL Development Framework

The metals targets and supplemental indicators are summarized in **Table 7-3**. TMDL determination is based on the following assumptions:

- Unless background data are available to show otherwise, natural levels of metals are below the water quality standards for aquatic life under all flow conditions.
- Single water quality samples represent a 96-hour average water quality condition.

Whether or not a TMDL is developed depends on target and supplemental indicator compliance, human sources, pollutant waterbody listing status, and dataset size as follows:

- For a currently listed pollutant waterbody combination:
    - A TMDL will be developed if all water quality targets and sediment supplemental indicator values are met and the sample size is less than eight but the source assessment indicates human sources.
    - A TMDL will not be developed if all water quality targets and sediment supplemental indicator values are met and the sample size is at least eight.
    - A TMDL will be developed if data are not in compliance with water quality targets and human sources are identified. This also applies if human sources are identified but data indicate natural background conditions may exceed water quality targets under certain flow conditions. Additional monitoring may be recommended in lieu of TMDL development if background conditions exceed water quality targets and human sources are not identified.
- For an unlisted pollutant waterbody combination:
    - A TMDL will be developed if there are at least eight recent samples, human sources are identified, and water quality samples are not in compliance with targets.
    - If there are at least eight recent water quality samples and data are in compliance with targets but sediment samples exceed supplemental indicator values, TMDL development will be determined on a case by case basis depending on human sources and the severity and extent of elevated sediment metals concentrations.
    - Monitoring may be recommended in lieu of TMDL development if water quality targets or sediment supplemental indicators are not met but the sample size is less than eight.

**Table 7-3. Targets and Supplemental Indicators for Metals in the Little Blackfoot TPA.**

| **Water Quality Targets** | **Proposed Criterion** |
|---|---|
| Montana's numeric water quality standards | As described in Circular DEQ-7 |
| **Supplemental Indicators** | **Proposed Criterion** |
| Sediment metal concentrations (µg/g dry weight) | Not impeding aquatic life use support: Comparable to PEL guidance values (see **Section 7.4.2**) |
| Human metals sources | No significant human sources |

## 7.5 EXISTING CONDITION AND COMPARISON TO WATER QUALITY TARGETS

For each waterbody segment with available data human sources will be reviewed first, after which recent water quality and sediment data will be evaluated relative to the water quality targets and supplemental indicators to make a TMDL development determination. Segments will be discussed relative to their location in the TPA, with segments higher in the watershed discussed first.

## 7.5.1 Un-named Creek (MT76G006_010)

Prior to the 2010 303(d) List, this waterbody ID was associated with a wetland that surrounds the un-named creek. However, based on historical sampling locations, the fact that the creek flows through the wetland, and the creek's relation to metals sources, the ID and impairment listings were transferred to Un-named creek. Un-named Creek was listed for arsenic, cadmium, copper, lead, mercury, pH, and zinc on the 2010 303(d) List. The segment extends 0.8 miles from the headwaters to the mouth at Ontario Creek (**Figure 7-1**.)

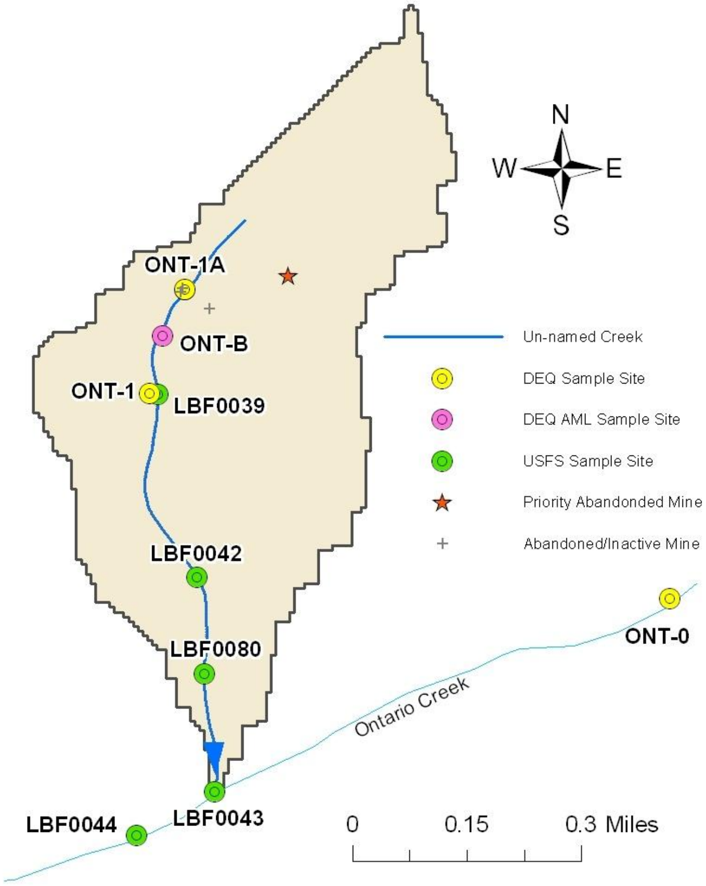

**Figure 7-1. Un-named Creek Sample Sites**

### Sources and Available Data

The Un-named Creek basin contains a few prospect mines and two abandoned hardrock mines in the upper watershed (**Figure 7-1**). Major mining activity spanned the early to mid-20th century. One of the abandoned mines, the Amanda Mine, lacks description in any of the references and like the prospects, it is suspected to be an insignificant source of metals impairment. The other mine in the watershed, the Ontario Mine and Millsite, is the most probable impairment source. Ontario Mine is on DEQ's priority abandoned mine list and has been the subject of two reclamation projects and two university studies.

Prior to reclamation, the Ontario Mine site consisted of multiple discharging adits, waste rock piles and tailings extending a distance down Ontario Creek. In 2003, the USFS removed tailings on Forest Service property and two years later the DEQ AML program addressed waste rock on private property (Tetra Tech, 2006). DEQ's reclamation activities included removing bare tailings piles and armoring the adit drainage channel with rock, but it did not stop or treat the adit discharge and tailings that had naturally re-vegetated were left in place (Olsen, 2004).

Sources of metals impairment have been investigated in numerous reports and sampling studies. The waterbody was first listed as impaired by metals and pH in 2000 based on data collected in the 1990s. A master's thesis by Elizabeth Milodragovich investigated the site before reclamation in an attempt to determine if the wetland was improving surface water quality. The wetland's influence was shown to vary by metal constituent and season. Overall, only three metals were shown to consistently decrease in both load and concentration; lead concentrations actually increased significantly in the wetland. Groundwater was also investigated but it was found to have very little influence on surface water due to the low permeability of wetland soils (Milodragovich, 2003). The USFS also collected samples in 2001 and 2002 prior to reclamation, note however, that only data collected after the conclusion of both reclamation efforts (i.e. >2005) will be used for Un-named Creek's TMDL determinations and calculations. This distinction assures that the conditions described in this document are current and reflect any modifications to Un-named Creek caused by reclamation. Another master's thesis investigated the interaction of metals and plant uptake at the Ontario Mine site following initial remediation performed by the USFS but before the 2005 DEQ reclamation (Olsen, 2004). This research found that plants accumulated significantly more aluminum, cadmium, copper and zinc following remediation. The Olsen study reiterated that abandoned mine land reclamation is a complex process, and that in some cases it may be more economically and environmentally advantageous to leave tailings in place and allow natural revegetation to occur.

Post-reclamation sampling includes a site established in 2008 by DEQ AML, ONT-B (**Figure 7-1**), located directly below the rock lined channel and considered the first site on Un-named Creek. This site often had the highest metals concentrations because it was closest to the adit discharge. More recent sediment samples and high and low flow water samples were collected by DEQ in 2008 and 2009 at one Un-named Creek site, ONT-1, to aid with TMDL development. DEQ also tested the adit discharge at site ONT-1A on one occasion. The most recent samples were collected by the USFS from four sites on Un-named Creek in 2008 and 2010. A more comprehensive description of abandoned mines found in this watershed is provided in **Section F.1** of **Appendix F**.

### Comparison to Water Quality Targets and TMDL Development Determination

The rationale for deciding if a TMDL was developed for each Un-named Creek pollutant depended on a combination of factors displayed in **Table 7-4** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only listed metals or those with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, TMDLs were developed for all six of the metals-related pollutants on the 2010 303(d) List as well as one metal not previously listed (iron). Numerous recent mercury samples could not be used for target comparisons because they were not analyzed using a detection limit below the human health standard and unless detection limits are below water quality standards, exceedances cannot be determined. Even though no samples detected mercury, because it is a listed pollutant with less than eight samples, a mercury TMDL was written. Additionally, recent data support the pH listing; the metals TMDLs will be used as a surrogate for a pH TMDL because reclamation activities needed to meet the metals TMDLs will address sources of acid mine drainage causing the pH impairment.

**Table 7-4. Un-named Creek TMDL Decision Factors**

| Parameter | Arsenic | Cadmium | Copper | Iron | Lead | Mercury | Zinc |
|---|---|---|---|---|---|---|---|
| Number of samples | 9 | 9 | 9 | 9 | 9 | 1 | 9 |
| Chronic AL exceedance rate > 10% | Yes | Yes | Yes | Yes | Yes | No | Yes |
| Greater than twice the acute AL exceeded | No | Yes | Yes | NA | Yes | No | Yes |
| Human health criterion exceeded | Yes | Yes | No | NA | Yes | No | Yes |
| NOAA sediment PELs exceeded | Yes | No | No | NA | Yes | Not tested | No |
| Human-caused sources present | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 2010 303(d) listing status | Listed | Listed | Listed | Not listed | Listed | Listed | Listed |
| **TMDL Developed?** | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

## 7.5.2 Monarch Creek (MT76G004_060)

Monarch Creek was listed for arsenic, copper, lead, mercury, selenium and pH on the 2010 303(d) List. The segment extends 4.7 miles from the headwaters to the mouth at Ontario Creek (**Figure 7-2**).

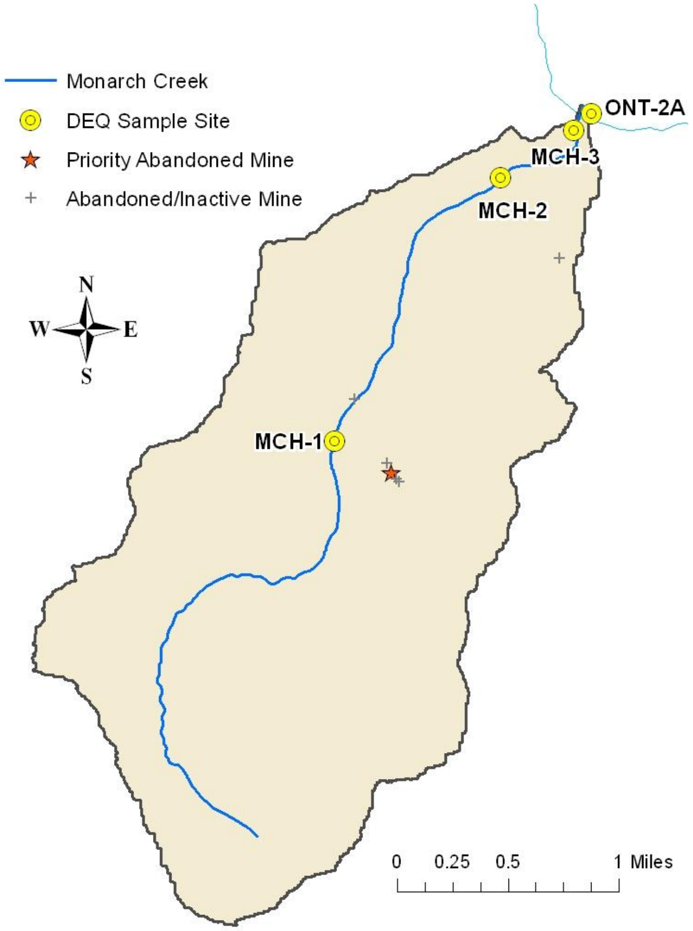

**Figure 7-2. Monarch Creek Sample Sites**

### Sources and Available Data

The Monarch Creek basin contains a few prospect mines but only one abandoned hardrock mine, the Monarch Mine (**Figure 7-2**). The Monarch Mine appears on DEQ's priority abandoned mines list and was most active at the turn of the 20th century although sporadic mining activity occurred as recently 1995 (Hargrave, et al., 1998). Monarch Mine is the likely source of metals impairment in Monarch Creek as the mine site consists of discharging adits, tailing piles in the floodplain and ferric-hydroxide-stained pools between the mill and creek (Hargrave, et al., 1998). A more comprehensive description of abandoned mines found in this watershed is located in **Section F.2** of **Appendix F**.

Sources of metals impairment to Monarch Creek have been investigated in numerous reports and sampling studies. Monarch Creek was first listed as impaired by metals and pH in 1988 based on data collected in the 1970s. Environmental impacts from the Monarch Mine were later investigated in 1995 by MBMG while inventorying abandoned mines in the area. DEQ subsequently collected surface water and benthic sediment data in 2004 as part of a reassessment of Monarch Creek. More recent sediment samples and high and low flow water samples were collected by DEQ in 2008 and 2009 at two Monarch Creek sites (**Figure 7-2**) to aid with TMDL development. A third site, MCH-3, was created in 2009 when the previously established sites were inaccessible due to early season conditions.

### Comparison to Water Quality Targets and TMDL Development Determination

The rationale for deciding if a TMDL was developed for each Monarch Creek pollutant depended on a combination of factors displayed in **Table 7-5** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only listed metals or those with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, TMDLs were developed for three of the five metals-related pollutants on the 2010 303(d) List. Numerous recent mercury samples could not be used for target comparisons because they were not analyzed using a detection limit below the human health standard and unless detection limits are below water quality standards, exceedances cannot be determined. Even though no samples detected mercury, because it is a listed pollutant with less than eight samples, a mercury TMDL was written. Because no recent samples exceeded arsenic or selenium water quality targets, no TMDLs were developed for arsenic or selenium. The 303(d) listing status for these metals will be formally reevaluated by DEQ in the future. Additionally, recent data support the pH listing; the metals TMDLs will be used as a surrogate for a pH TMDL because reclamation activities needed to meet the metals TMDLs will address sources of acid mine drainage causing the pH impairment.

**Table 7-5. Monarch Creek TMDL Decision Factors**

| Parameter | Arsenic | Copper | Lead | Mercury | Selenium |
|---|---|---|---|---|---|
| Number of samples | 8 | 8 | 8 | 1 | 8 |
| Chronic AL exceedance rate > 10% | No | Yes | Yes | No | No |
| Greater than twice the acute AL exceeded | No | No | No | No | No |
| Human health criterion exceeded | No | No | No | No | No |
| NOAA sediment PELs exceeded | Yes | No | Yes | No | Yes |
| Human-caused sources present | Yes | Yes | Yes | Yes | Yes |
| 2010 303(d) listing status | Listed | Listed | Listed | Listed | Listed |
| **TMDL Developed?** | No | Yes | Yes | Yes | No |

## 7.5.3 Ontario Creek (MT76G004_130)

Ontario Creek was not included on the2010 303(d) List as impaired by metals but synoptic sampling as part of TMDL development for other streams in the TPA found elevated concentrations of cadmium, copper and lead. The segment extends 6.0 miles from the headwaters to the mouth at the Little Blackfoot River (**Figure 7-3**).

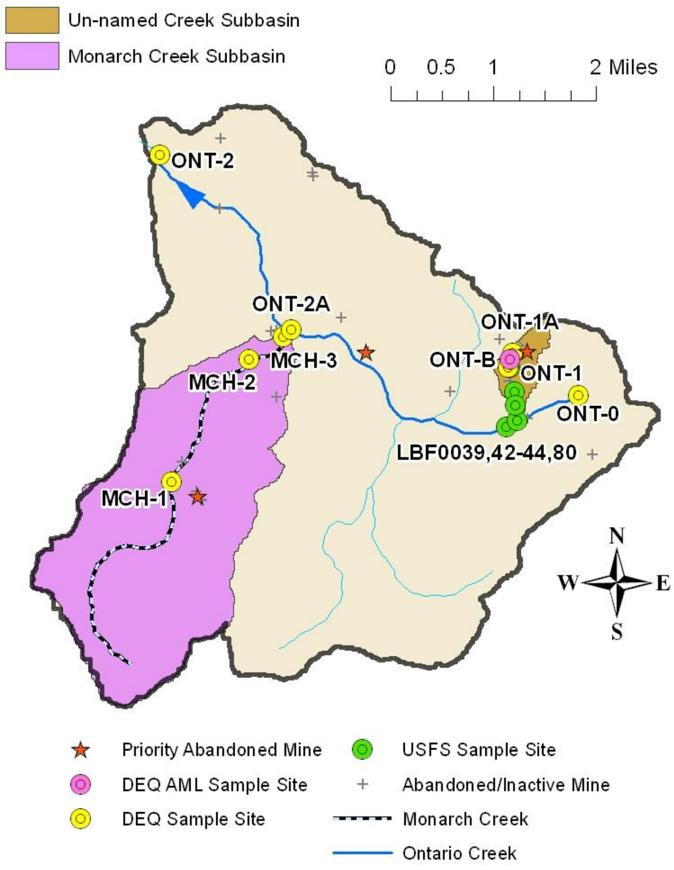

**Figure 7-3. Ontario Creek Sample Sites**

### Sources and Available Data

The Ontario Creek basin contains approximately 20 abandoned mines including three that appear on DEQ's priority abandoned mines list. A description of metal sources and available data for two tributaries, Un-named Creek and Monarch Creek, is provided in **Sections 7.5.1** and **7.5.2**. Additional metals sources in the basin include the Hard Luck Mine, which potentially contributes metals to the mainstem Ontario Creek. This priority abandoned mine is located within 1,000 feet of Ontario Creek and is comprised of three waste rock piles and two discharging adits (Pioneer Technical Services, Inc., 1993). Operation and production dates are unknown. When visited in 1993, the adit discharge was being piped around the waste rock dump but no surface water samples were collected. A review of abandoned mine land records housed at DEQ identified three additional non-priority mines (SW NW Section 20, SW NW Section 26 and West Ontario) where water had been observed flowing out of mine adits and could potentially impact water quality in Ontario Creek. A more comprehensive description of abandoned mines found in this watershed is located in **Section F.3** of **Appendix F**.

Sources of metals impairment to Ontario Creek had not been intensely sampled before the start of this TMDL process. While the USFS collected samples with elevated metals concentrations on Ontario Creek in an effort that focused near the Un-named Creek confluence in the early 1990s and the early 2000s, the stream remained unlisted. More recent sediment samples and high and low flow water samples were collected by DEQ in 2008 and 2009 at one Ontario Creek site, ONT-2 (**Figure 7-3**), to aid with TMDL development. Another site in the headwaters region, ONT-0, was sampled during one low event and a third site, ONT-2A, was sampled during both flow conditions in 2009. The most recent samples were collected by the USFS from one site, LBF0044, on Ontario Creek in 2008 and 2010.

**Comparison to Water Quality Targets and TMDL Development Determination**

The rationale for deciding if a TMDL was developed for each Ontario Creek pollutant depended on a combination of factors displayed in **Table 7-6** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only metals with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, TMDLs were developed for three metals-related pollutants not included on the 2010 303(d) List.

**Table 7-6. Ontario Creek TMDL Decision Factors**

| Parameter | Cadmium | Copper | Lead |
|---|---|---|---|
| Number of samples | 9 | 9 | 9 |
| Chronic AL exceedance rate > 10% | Yes | Yes | Yes |
| Greater than twice the acute AL exceeded | Yes | No | No |
| Human health criterion exceeded | No | No | No |
| NOAA sediment PELs exceeded | Yes | No | Yes |
| Human-caused sources present | Yes | Yes | Yes |
| 2010 303(d) listing status | Not listed | Not listed | Not listed |
| **TMDL Developed?** | **Yes** | **Yes** | **Yes** |

## 7.5.4 Sally Ann Creek (MT76G004_055)

Sally Ann Creek was not included on the2010 303(d) List as impaired by metals but synoptic sampling as part of TMDL development for other streams in the TPA found elevated concentrations of cadmium, copper and zinc. The segment extends 1.6 miles from the headwaters to the mouth at O'Keefe Creek (**Figure 7-4**).

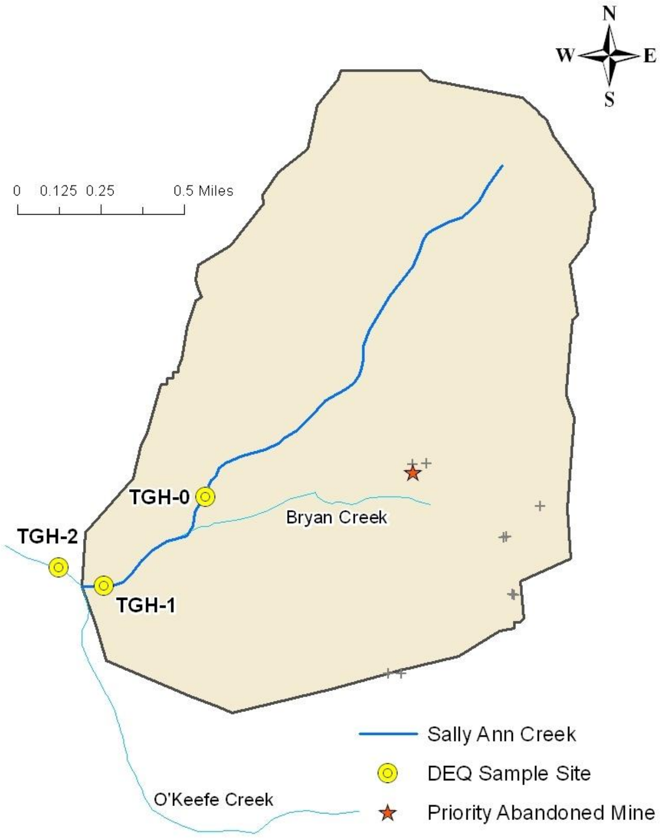

**Figure 7-4. Sally Ann Creek Sample Sites**

**Sources and Available Data**

The Sally Ann Creek basin contains approximately five abandoned mines, including the Telegraph Mine which appears on DEQ's priority abandoned mines list. Additionally, placer mining is known to have occurred in a tributary to Sally Ann Creek. Major mining activity occurred in the 1920s and 1930s. One of the abandoned mines, the Bullion Mine, was visited by MBMG in 1993 and noted as having no visible impacts (Hargrave, et al., 1998). A review of abandoned mine land records housed at DEQ identified two additional non-priority mines (Home Stake and Excelsior) in the basin with waste rock piles or standing water in mine shafts which could also potentially impact water quality in Sally Ann Creek. In 1995 the Telegraph Mine had a discharging adit and water flowing through waste rock and tailings that tested very acidic and high in metals concentrations (Hargrave, et al., 1998). Some mine waste was removed from the Telegraph Mine in 2005 by the USFS (Ihle, Beth, personal communication 2008). A more comprehensive description of abandoned mines found in this watershed is located in **Section F.4** of **Appendix F**.

Sources of metals impairment to Sally Ann Creek had not been intensely investigated before the start of this TMDL process. The only available data is sediment samples and high and low flow water samples collected by DEQ in 2008 and 2009 at one Sally Ann Creek site, TGH-1 (**Figure 7-4**). Another site, TGH-0, was established in 2009.

**Comparison to Water Quality Targets and TMDL Development Determination**

The rationale for deciding if a TMDL was developed for each Sally Ann Creek pollutant depended on a combination of factors displayed in **Table 7-7** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only metals with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, TMDLs were developed for three metals-related pollutants not included on the 2010 303(d) List.

**Table 7-7. Sally Ann Creek TMDL Decision Factors**

| Parameter | Cadmium | Copper | Zinc |
|---|---|---|---|
| Number of samples | 6 | 6 | 6 |
| Chronic AL exceedance rate > 10% | Yes | Yes | Yes |
| Greater than twice the acute AL exceeded | Yes | No | No |
| Human health criterion exceeded | No | No | No |
| NOAA sediment PELs exceeded | Yes | No | Yes |
| Human-caused sources present | Yes | Yes | Yes |
| 2010 303(d) listing status | Not listed | Not listed | Not listed |
| **TMDL Developed?** | **Yes** | **Yes** | **Yes** |

## 7.5.5 O'Keefe Creek (MT76G004_054)

O'Keefe Creek was not included on the2010 303(d) List as impaired by metals but synoptic sampling as part of TMDL development for other streams in the TPA found elevated concentrations of cadmium, copper and zinc. The segment extends 2.0 miles from the headwaters to the mouth at Telegraph Creek (**Figure 7-5**).

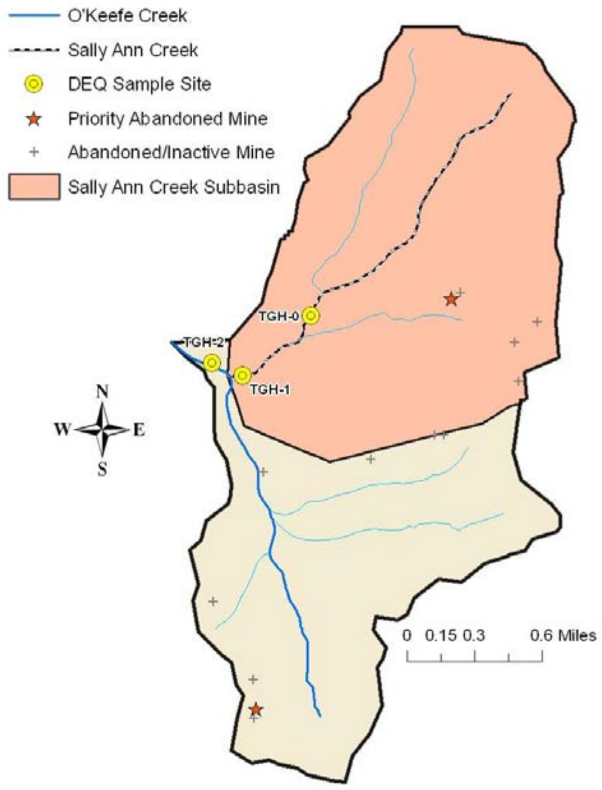

**Figure 7-5. O'Keefe Creek Sample Sites**

### Sources and Available Data

The O'Keefe Creek basin contains approximately 15 abandoned mines. A description of metal sources and available data from Sally Ann Creek, a tributary to O'Keefe Creek, is provided in **Section 7.5.4**. Additional sources include the Sure Thing Mine which appears on DEQ's priority abandoned mines list and was the site of major mining activity throughout the first half of the 20th century. The Sure Thing Mine site has a discharging adit that flows through tailings and waste rock that exceeded many metal human health standards (Pioneer Technical Services, Inc., 1993). Starting in 2001, the Sure Thing Mine was the site of a four year field demonstration investigating the effectiveness of using sulfate-reducing bacteria to mitigate the impacts of acid mine drainage. The study found metals concentrations in the adit discharge were reduced and pH increased, but after the study period the treatment system was removed (Nordwick, 2008a). Another potential source of metals in the basin is the O'Keefe Creek/Copper King Mine, which is adjacent to O'Keefe Creek and has mine wastes in contact with the stream and several impoundments (Hargrave, et al., 1998). A more comprehensive description of abandoned mines found in this watershed is located in **Section F.5** of **Appendix F**.

Sources of metals impairment to O'Keefe Creek had not been intensely sampled before the start of this TMDL process. The only available data is one stream sediment sample and high and low flow water samples collected by DEQ in 2008 and 2009 at a single O'Keefe Creek site, TGH-2 (**Figure 7-5**). Note all data used for TMDL determinations was collected after the temporary treatment system at the Sure Thing Mine site was removed.

### Comparison to Water Quality Targets and TMDL Development Determination

The rationale for deciding if a TMDL was developed for each O'Keefe Creek pollutant depended on a combination of factors displayed in **Table 7-8** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only metals with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, TMDLs were developed for three metals-related pollutants not included on the 2010 303(d) List.

**Table 7-8. O'Keefe Creek TMDL Decision Factors**

| Parameter | Cadmium | Copper | Zinc |
|---|---|---|---|
| Number of samples | 4 | 4 | 4 |
| Chronic AL exceedance rate > 10% | Yes | Yes | Yes |
| Greater than twice the acute AL exceeded | Yes | No | No |
| Human health criterion exceeded | No | No | No |
| NOAA sediment PELs exceeded | Yes | No | Yes |
| Human-caused sources present | Yes | Yes | Yes |
| 2010 303(d) listing status | Not listed | Not listed | Not listed |
| **TMDL Developed?** | **Yes** | **Yes** | **Yes** |

## 7.5.6 Upper Telegraph Creek (MT76G004_051)

The upper segment of Telegraph Creek was listed for arsenic, beryllium, cadmium, copper, iron, and zinc on the 2010 303(d) List. It extends 5.4 miles from the headwaters to the mouth at Hahn Creek (**Figure 7-6**).

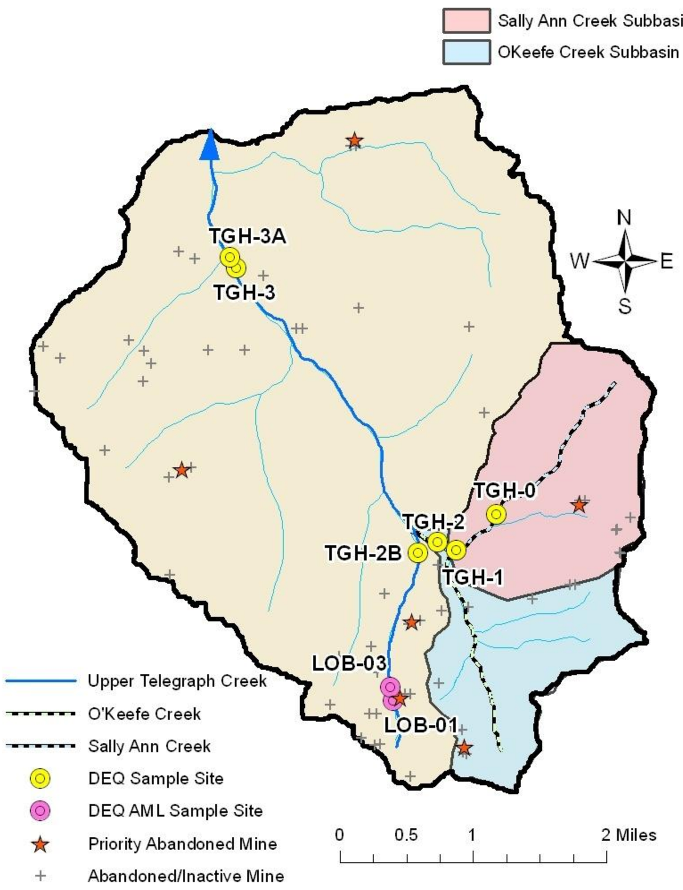

**Figure 7-6. Upper Telegraph Creek Sample Sites**

### Sources and Available Data

The upper Telegraph Creek basin contains approximately 50 abandoned mines, half of which are located in the tributary basins of Sally Ann Creek and O'Keefe Creek. Descriptions of metal sources and available data for Sally Ann Creek and O'Keefe Creek are provided in **Sections 7.5.4** and **7.5.5**.

Metals sources exclusive to the upper Telegraph basin include four mines that appear on DEQ's priority abandoned mines list. A review of abandoned mine land records housed at DEQ identified three additional non-priority mines (SW SE Section 10, Champion, and Moonlight Cabin Mine) in the basin with waste rock piles or standing water in mine shafts which could impact water quality in upper Telegraph Creek. One of the priority abandoned mines, the Third Term Mine, had an adit tunnel backfilled and the surrounding land re-sloped in 1993 by DEQ AML (Clark, P., personal communication 2010). However, two years later the adit had subsided and the reclaimed area still lacked soils or vegetation (Hargrave, et al., 1998). The USFS removed some mine waste from the Third Term and Viking, Hub Camp and Hope mines in 2005 (Ihle, Beth, personal communication 2008). Another priority site, the Lily/Orphan Boy Mine, has discharging adits and waste rock spanning Telegraph Creek (Tetra Tech, 2009b). Starting in 1994 the Lily/Orphan Boy Mine was the site of a ten year field demonstration investigating the effectiveness of using sulfate-reducing bacteria to mitigate the impacts of acid mine drainage. The study found metals concentrations in the adit discharge were reduced and pH increased, but after the study period the treatment system was removed (Nordwick, 2008b). DEQ's AML Program recently completed a reclamation investigation assessing conditions and detailing the site's potential for reclamation (Tetra Tech, 2009a). Phase II of the report, in which a detailed engineering and cost analysis is performed, is forthcoming (Clark, P., personal communication 2010). Other potential sources of metals in the basin are the Julia, Anna R/Hattie M, Hub Camp and Viking Mines with their associated adits and mine waste piles as close as 500 feet from Telegraph Creek (Hargrave, et al., 1998; Pioneer Technical Services, Inc., 1993). A more comprehensive description of abandoned mines found in this watershed is located in **Section F.6** of **Appendix F**.

Sources of metals impairment to upper Telegraph Creek have been investigated in numerous reports and sampling studies. Telegraph Creek was first listed for metals impairment in 1988 based on data collected by DEQ in the late 1970s. A number of water and sediment samples were collected near abandoned mines in 1993 and 1995 by MBMG and DEQ AML (Hargrave, et al., 1998; Pioneer Technical Services, Inc., 1993).DEQ AML collected samples in 2008 at LOB-01 and LOB-03 (**Figure 7-6**) near the Lily/Orphan Boy Mine site for the reclamation investigation report. The most recent sediment samples and high and low flow water samples were collected by DEQ in 2008 and 2009 to aid with TMDL development. Three sites, TGH-2B, TGH-3 and TGH-3A (**Figure 7-6**), were sampled during both flow conditions for one year. Note: all data used for TMDL determinations was collected after the temporary treatment system at the Lily/Orphan Boy Mine site was removed.

**Comparison to Water Quality Targets and TMDL Development Determination**
The rationale for deciding if a TMDL was developed for each upper Telegraph Creek pollutant depended on a combination of factors displayed in **Table 7-9** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only listed metals or those with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, TMDLs were developed for five of the six metals-related pollutants on the 2010 303(d) List in addition to one metal not previously listed (lead). Even though beryllium was not detected in any samples, because it is a listed pollutant with less than eight samples, a beryllium TMDL was written. Because no recent samples exceeded iron water quality targets, no TMDL was developed and the 303(d) listing status for iron will be formally reevaluated by DEQ in the future.

**Table 7-9. Upper Telegraph Creek TMDL Decision Factors**

| Parameter | Arsenic | Beryllium | Cadmium | Copper | Iron | Lead | Zinc |
|---|---|---|---|---|---|---|---|
| Number of samples | 8 | 4 | 8 | 8 | 8 | 6 | 8 |
| Chronic AL exceedance rate > 10% | No | No | Yes | Yes | No | Yes | Yes |
| Greater than twice the acute AL exceeded | No | No | Yes | No | NA | No | Yes |
| Human health criterion exceeded | Yes | No | No | No | NA | No | No |
| NOAA sediment PELs exceeded | Yes | NA | Yes | No | NA | Yes | Yes |
| Human-caused sources present | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 2010 303(d) listing status | Listed | Listed | Listed | Listed | Listed | Not listed | Listed |
| **TMDL Developed?** | **Yes** | **Yes** | **Yes** | **Yes** | **No** | **Yes** | **Yes** |

## 7.5.7 Lower Telegraph Creek (MT76G004_052)

The lower segment of Telegraph Creek was listed for lead and mercury on the 2010 303(d) List and extends 2.5 miles from the bottom of the upper segment (confluence with Hahn Creek) to the mouth at the Little Blackfoot River (**Figure 7-7**).

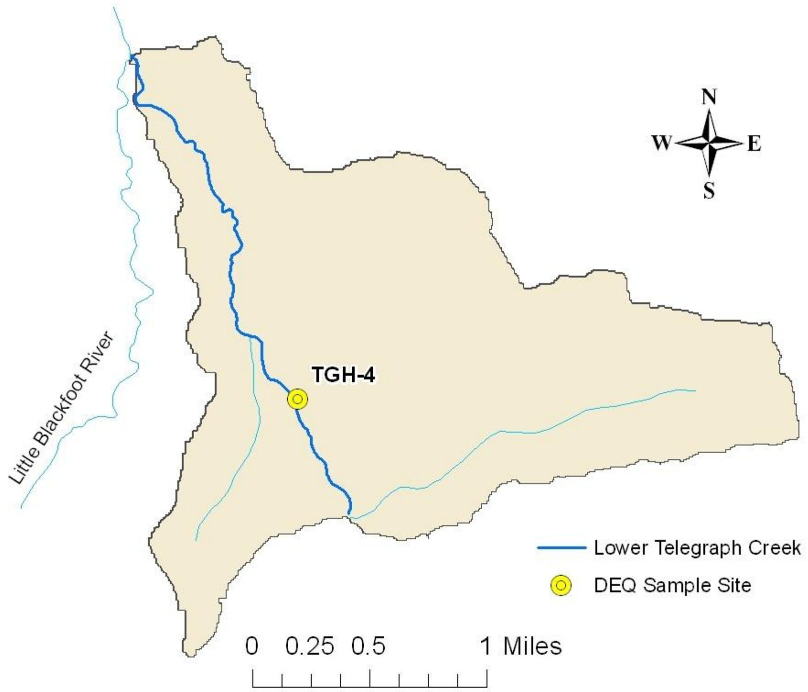

**Figure 7-7. Lower Telegraph Creek Sample Sites**

**Sources and Available Data**

The lower Telegraph Creek basin contains no abandoned mines. The sources of human-related metals inputs to lower Telegraph Creek are abandoned mines in the upper Telegraph Creek basin described separately in **Section 7.5.6** and **Appendix F**.

Sources of metals impairment to lower Telegraph Creek have been investigated in numerous sampling studies. Telegraph Creek was first listed for metals on the 1988 303(d) List based on data collected by DEQ in 1977. Until 1999, the two Telegraph Creek segments were combined as one (MT76G004-20). Historic data from the Third Term Mine in the upper Telegraph Creek basin indicate elevated mercury levels, which could be the source of the mercury listing for lower Telegraph Creek. The most recent sediment samples and high and low flow water samples were collected by DEQ in 2008 and 2009 at one site, TGH-4 (**Figure 7-7**), to aid with TMDL development.

**Comparison to Water Quality Targets and TMDL Development Determination**

The rationale for deciding if a TMDL will be developed for each lower Telegraph Creek pollutant depends on a combination of factors displayed in **Table 7-10** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only listed metals or those with target/supplemental indicator exceedances are presented. Based on the data review described in **Section F.7** of **Appendix F**, TMDLs were developed for the two metals-related pollutants on the 2010 303(d) List as well as three metals not previously listed (cadmium, copper and zinc). Numerous recent mercury samples could not be used for target comparisons because they were not analyzed using a detection limit below the human health standard and unless detection limits are below water quality standards, exceedances cannot be determined. Even though mercury was not detected in any samples, because it is a listed pollutant with less than eight samples, a mercury TMDL was written.

**Table 7-10. Lower Telegraph Creek TMDL Decision Factors**

| Parameter | Cadmium | Copper | Lead | Mercury | Zinc |
|---|---|---|---|---|---|
| Number of samples | 4 | 4 | 4 | 1 | 4 |
| Chronic AL exceedance rate > 10% | Yes | Yes | Yes | No | Yes |
| Greater than twice the acute AL exceeded | No | No | No | No | No |
| Human health criterion exceeded | No | No | No | No | No |
| NOAA sediment PELs exceeded | Yes | No | No | Not tested | Yes |
| Human-caused sources present | Yes | Yes | Yes | Yes | Yes |
| 2010 303(d) listing status | Not listed | Not listed | Listed | Listed | Not listed |
| **TMDL Developed?** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |

## 7.5.8 American Gulch Creek (MT76G004_079)

American Gulch Creek was not included on the2010 303(d) List as impaired by metals but synoptic sampling as part of TMDL development for other streams in the TPA found elevated concentrations of arsenic. The segment extends 2.7 miles from the headwaters to the mouth at Dog Creek (**Figure 7-8**).

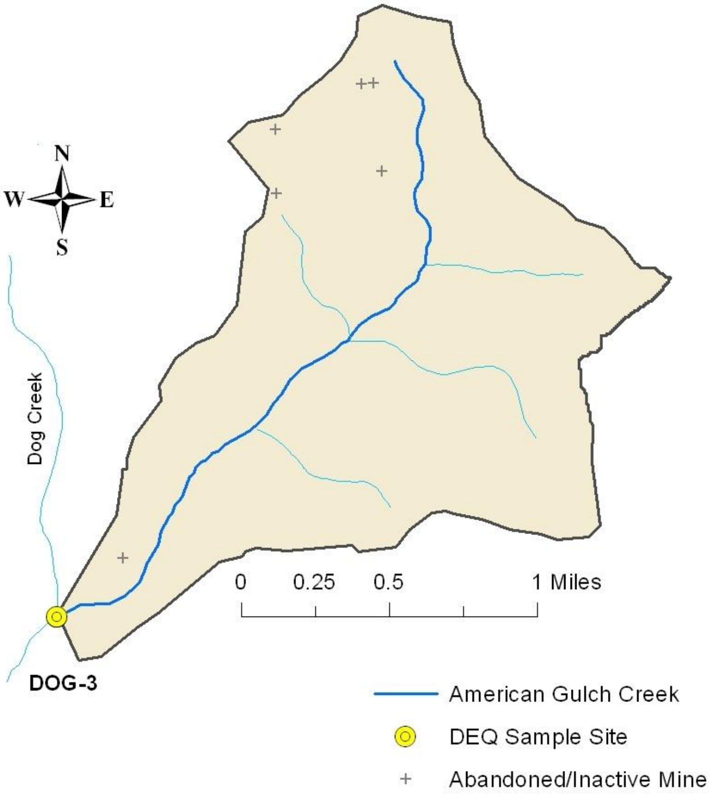

**Figure 7-8. American Gulch Creek Sample Sites**

### Sources and Available Data

The American Gulch Creek basin contains approximately six abandoned lode and prospect mines, none of which appear on DEQ's priority abandoned mines list. A review of abandoned mine land records housed at DEQ identified two additional non-priority mines (Neenan and NE SE Section 10) in the basin with associated tailings that could impact water quality in American Gulch Creek. The abandoned mine databases lacked descriptive information on the remaining mines. Additionally, DEQ AML (Pioneer

Technical Services, Inc., 1993) and MBMG (Hargrave, et al., 1998) sampling efforts that investigated abandoned mines in the region failed to study mines specific to American Gulch Creek.

Sources of metals impairment to American Gulch Creek had not been intensely sampled before the start of this TMDL process. The only available data is one stream sediment sample and high and low flow water samples collected by DEQ in 2008 and 2009 at a single American Gulch Creek site, DOG-3 (**Figure 7-8**).

**Comparison to Water Quality Targets and TMDL Development Determination**
The rationale for deciding if a TMDL was developed for each American Gulch Creek pollutant depended on a combination of factors displayed in **Table 7-11** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only metals with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, TMDLs were developed for one metals-related pollutant not included on the 2010 303(d) List.

**Table 7-11. American Gulch Creek TMDL Decision Factors**

| Parameter | Arsenic |
|---|---|
| Number of samples | 4 |
| Chronic AL exceedance rate > 10% | No |
| Greater than twice the acute AL exceeded | No |
| Human health criterion exceeded | Yes |
| NOAA sediment PELs exceeded | Yes |
| Human-caused sources present | Yes |
| 2010 303(d) listing status | Not listed |
| **TMDL Developed?** | **Yes** |

## 7.5.9 Upper Dog Creek (MT76G004_071)

The upper segment of Dog Creek was listed for arsenic, lead and zinc on the 2010 303(d) List and extends 4.3 miles from the headwaters to the confluence with Meadow Creek (**Figure 7-9**).

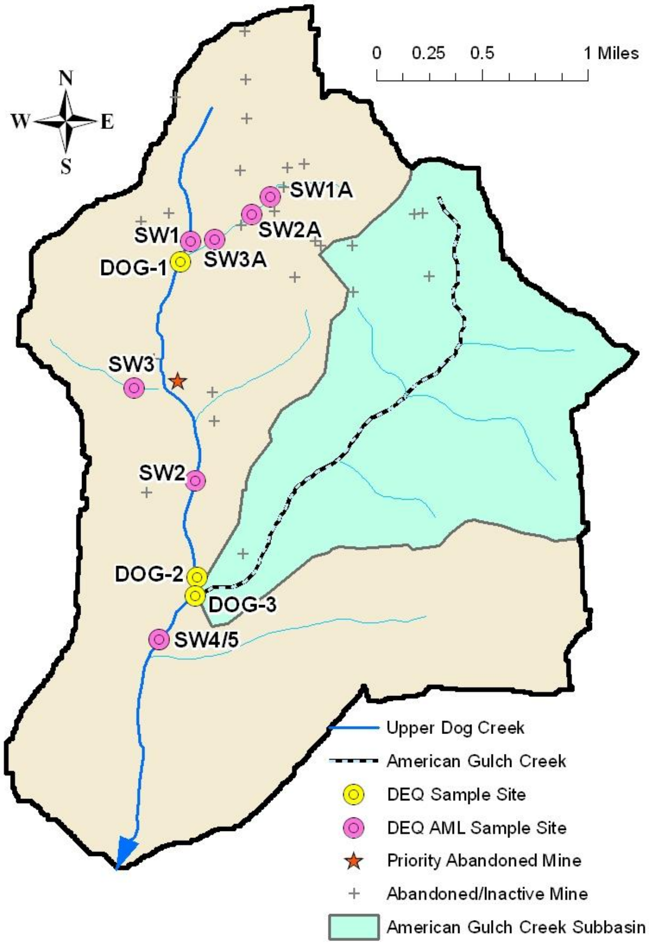

**Figure 7-9. Upper Dog Creek Sample Sites**

### Sources and Available Data

The upper Dog Creek basin contains approximately 25 abandoned mines including one (Bald Butte) that appears on DEQ's priority abandoned mines list. A review of abandoned mine land records housed at DEQ identified six additional non-priority mines (Black Hawk Janette, Black Douglas, Kenawa, Larson, Rose Bud, and Rose Densmore) in the basin with waste rock piles or standing water in mine shafts which could impact water quality in upper Dog Creek. Major mining activity took place from the early to mid-20th century. A description of metal sources and available data for a tributary to Dog Creek, American Gulch Creek, is provided in **Section 7.5.8**. In 2010, DEQ AML started a three year reclamation project on the Bald Butte Mine to limit the mobility of contaminants. The project will also remove mine waste from two other mines in the area (Devon/Sterling and Albion) and place all of the material in a secure repository (Olympus Technical Services, Inc., 2004). Currently, waste rock and tailings are present in the floodplain of Dog Creek and its tributaries. In addition, numerous abandoned and inactive mines in the area are discharging metal-laden water into nearby streams either directly or through groundwater flow (Hargrave, et al., 1998; Pioneer Technical Services, Inc., 1993). A more comprehensive description of abandoned mines found in this watershed is located in **Section F.9** of **Appendix F**.

Sources of metals impairment to upper Dog Creek have been investigated in numerous reports and sampling studies. Dog Creek's upper segment was originally included on the 303(d) List in 2000 based on data collected in 1998. DEQ AML collected more than 50 stream sediment samples of Dog Creek in 2003, many of them more than double the PEL value, making it unique among streams in the Little Blackfoot TPA for its abundance of sediment samples. At the same time, water quality data were collected to help evaluate the reclamation potential of Bald Butte Mine and the surrounding area. The most recent metals data was collected by DEQ in 2008 and 2009 at two sample sites, DOG-1 and DOG-2, to aid with TMDL development (**Figure 7-9**). A third site, DOG-3, was established on American Gulch, a tributary to Dog Creek's upper segment. Note all Dog Creek data was collected before the start of reclamation on Bald Butte Mine. Water quality conditions could change from what is presented in this document as a result.

#### Comparison to Water Quality Targets and TMDL Development Determination

The rationale for deciding if a TMDL was developed for each upper segment Dog Creek pollutant depended on a combination of factors displayed in **Table 7-12** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only listed metals or those with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, TMDLs will be developed for the three metals-related pollutants on the 2010 303(d) List as well as two metals not previously listed (cadmium and copper). Supplemental indicator values for mercury were exceeded in all sediment samples, with 89% being more than twice the PEL, but no surface water samples have been collected; future water quality monitoring is recommended to determine if mercury is causing metals impairment.

**Table 7-12. Upper Dog Creek TMDL Decision Factors**

| Parameter | Arsenic | Cadmium | Copper | Lead | Zinc |
|---|---|---|---|---|---|
| Number of samples | 12 | 12 | 9 | 12 | 12 |
| Chronic AL exceedance rate > 10% | No | Yes | Yes | Yes | Yes |
| Greater than twice the acute AL exceeded | No | No | No | No | Yes |
| Human health criterion exceeded | Yes | No | No | Yes | No |
| NOAA sediment PELs exceeded | Yes | Yes | Yes | Yes | Yes |
| Human-caused sources present | Yes | Yes | Yes | Yes | Yes |
| 2010 303(d) listing status | Listed | Not listed | Not listed | Listed | Listed |
| **TMDL Developed?** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |

## 7.5.10 Lower Dog Creek (MT76G004_072)

Lower Dog Creek Creek was not included on the 2010 303(d) List as impaired by metals but synoptic sampling as part of TMDL development for other streams in the TPA found elevated concentrations of copper and lead. The segment extends 13.6 miles from Meadow Creek to the mouth at the Little Blackfoot River (**Figure 7-10**).

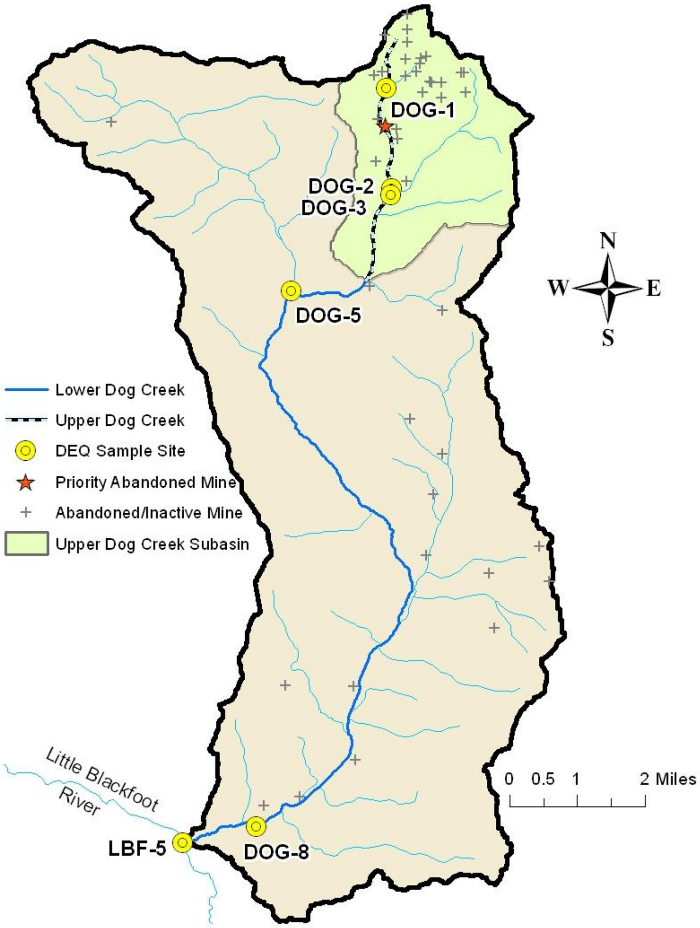

**Figure 7-10. Lower Dog Creek Sample Sites**

### Sources and Available Data

The Dog Creek basin contains approximately 45 abandoned mines, 30 of which are located in the upper Dog Creek basin. A description of metal sources and available data from upper Dog Creek is provided in **Section 7.5.9** and **Appendix F**. The remaining 15 mines lacked description in abandoned mine databases besides listing copper, gold and silver as commodities produced (Hargrave, et al., 1998). Additionally, DEQ AML (Pioneer Technical Services, Inc., 1993) and MBMG (Hargrave, et al., 1998) sampling efforts that investigated abandoned mines in the region failed to study mines specific to lower Dog Creek.

Sources of metals impairment to lower Dog Creek had not been intensely sampled before the start of this TMDL process. The only available data is one stream sediment sample and high and low flow water samples collected by DEQ in 2008 and 2009 at a single lower Dog Creek site, DOG-8 (**Figure 7-10**). A second site (DOG-5) was established on Hope Creek, a tributary to lower Dog Creek.

### Comparison to Water Quality Targets and TMDL Development Determination

The rationale for deciding if a TMDL was developed for each lower Dog Creek pollutant depended on a combination of factors displayed in **Table 7-13** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only metals with target/supplemental indicator exceedances are presented. Based on the data review described in **Section F.10** of **Appendix F**, TMDLs were developed for two metals-related pollutants not included on the 2010 303(d) List.

**Table 7-13. Lower Dog Creek TMDL Decision Factors**

| Parameter | Copper | Lead |
|---|---|---|
| Number of samples | 4 | 4 |
| Chronic AL exceedance rate > 10% | Yes | Yes |
| Greater than twice the acute AL exceeded | No | No |
| Human health criterion exceeded | No | No |
| NOAA sediment PELs exceeded | No | Yes |
| Human-caused sources present | Yes | Yes |
| 2010 303(d) listing status | Not listed | Not listed |
| **TMDL Developed?** | **Yes** | **Yes** |

## 7.5.11 Upper Little Blackfoot River (MT76G004_020)

The upper segment of the Little Blackfoot River was listed for arsenic and cyanide on the 2010 303(d) List and extends 22.5 miles from the headwaters to the confluence with Dog Creek (**Figure 7-11**).

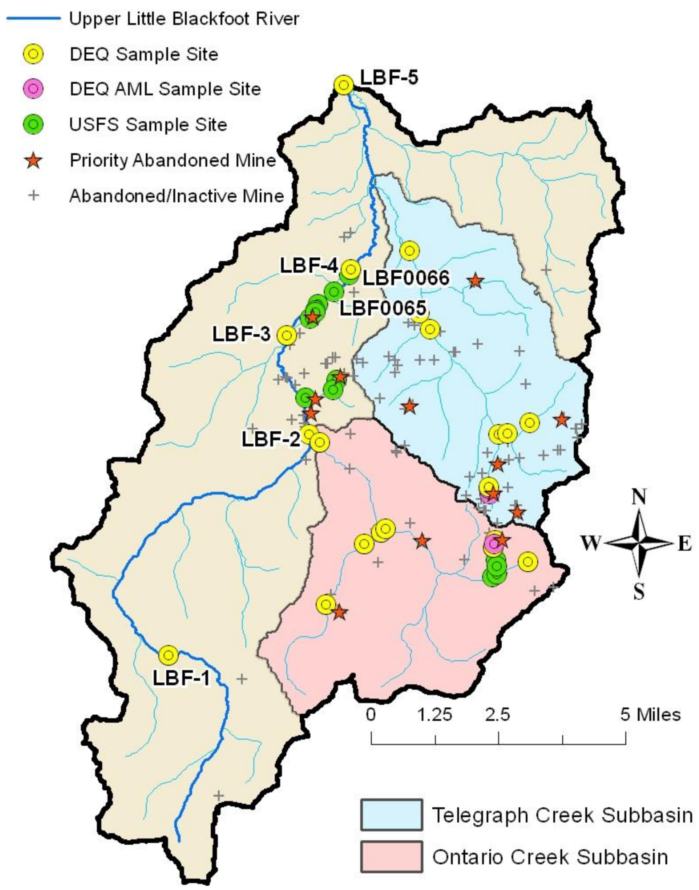

Figure 7-11. Upper Little Blackfoot River Sample Sites

### Sources and Available Data

The upper Little Blackfoot River basin contains an estimated 110 abandoned mines, approximately 70 of which are located in the tributary basins of Ontario and Telegraph Creek. Descriptions of metal sources and available data for Ontario and Telegraph Creek are provided in **Sections 7.5.3** and **7.5.7** and

**Appendix F**. The upper Little Blackfoot basin contains a majority (13/15) of the priority abandoned mines in the TPA; four are located in the upper Little Blackfoot watershed outside the Ontario and Telegraph Creek subbasins. A review of abandoned mine land records housed at DEQ identified five additional non-priority mines (Negroes, NE NW Section 12, SE NW Section 12, SW NE Section 12 and SW SE Section 1) in the basin with associated adits (one observed discharging) that could impact water quality in the Little Blackfoot River. Major mining activity took place from the early to mid-20th century.

The four priority abandoned mines located outside of the Ontario and Telegraph creek watersheds are the Charter Oak, Kimball, Mountain View and Golden Anchor Mines. In 1996/1998 the USFS removed waste material and conducted adit treatment at the Charter Oak Mine: it is now listed on the National Register of Historic Places and open for interpretative tours (USDA Forest Service, 2007). Even though recent data has not detected cyanide, the Charter Oak Mine is potential source because empty barrels of sodium cyanide and sprayer equipment used for cyanide application were found at the site. After reclamation, in 2009 and 2010, the Forest Service collected water samples from three wells downstream of the mine site, two discharging adits and two beaver pond sites that all had metals exceedances, thus Charter Oak Mine is still introducing metals into the Little Blackfoot River. The Kimball, Mountain View, and Golden Anchor Mines are within a mile of each other and all have mine wastes near surface waters. These three remaining priority abandoned mines are potential sources of metals to the Little Blackfoot River even though the USFS removed mine wastes from these sites in 2006 (Ihle, Beth, personal communication 2008). Five additional mines in the basin have adits possibly impacting water quality. In November 2008, the formerly plugged Golden Anchor Mine adit blew-out, sending forth a large volume of orange-colored water into Tramway Creek, a tributary to the Little Blackfoot River (Byron, 12/4/2008). After the blow-out, both DEQ and USFS collected water quality data. No fish-kills were documented (Byron, 1/17/2009), and based on the data, the incident only resulted in a temporary spike in metals concentrations in the Little Blackfoot River. A more comprehensive description of abandoned mines found in this watershed is located in **Section F.11** of **Appendix F**.

Sources of metals impairment to the upper Little Blackfoot River have been investigated in numerous reports and sampling studies. The Little Blackfoot River's upper segment was first listed for metals impairment in 1990 based on data collected by DEQ in the late 1970s. A number of water and sediment samples were collected near abandoned mines in 1993 and 1995 by MBMG and DEQ AML (Hargrave, et al., 1998; Pioneer Technical Services, Inc., 1993). In 2008, the USFS collected metals data on two Little Blackfoot River sites, LBF0065 and LBF0066 (**Figure 7-11**). The most recent sediment samples and high and low flow water samples were collected at five sites by DEQ in 2008 and 2009 to aid with TMDL development (**Figure 7-11**). Note data collected immediately following the Golden Anchor Mine blowout was not used for TMDL determinations because it was deemed non-representative of current conditions.

### Comparison to Water Quality Targets and TMDL Development Determination

The rationale for deciding if a TMDL was developed for each Little Blackfoot River (upper segment) pollutant depended on a combination of factors displayed in **Table 7-14** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only listed metals or those with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, TMDLs will be developed for the two metals-related pollutants on the 2010 303(d) List as well as three metals not previously listed (cadmium, copper, and lead).

**Table 7-14. Upper Little Blackfoot River TMDL Decision Factors**

| Parameter | Arsenic | Cadmium | Copper | Cyanide | Lead |
|---|---|---|---|---|---|
| Number of samples | 20 | 20 | 20 | 8 | 20 |
| Chronic AL exceedance rate > 10% | No | Yes | Yes | Yes | Yes |
| Greater than twice the acute AL exceeded | No | Yes | No | No | No |
| Human health criterion exceeded | Yes | No | No | No | Yes |
| NOAA sediment PELs exceeded | Yes | No | No | NA | Yes |
| Human-caused sources present | Yes | Yes | Yes | Yes | Yes |
| 2010 303(d) listing status | Listed | Not listed | Not listed | Listed | Not listed |
| **TMDL Developed?** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |

## 7.5.12 Lower Little Blackfoot River (MT76G004_010)

The lower segment of Little Blackfoot River was listed for copper and lead on the 2010 303(d) List and extends 26.5 miles from the bottom of the upper segment (confluence of Dog Creek) to the mouth at the Clark Fork River (**Figure 7-12**).

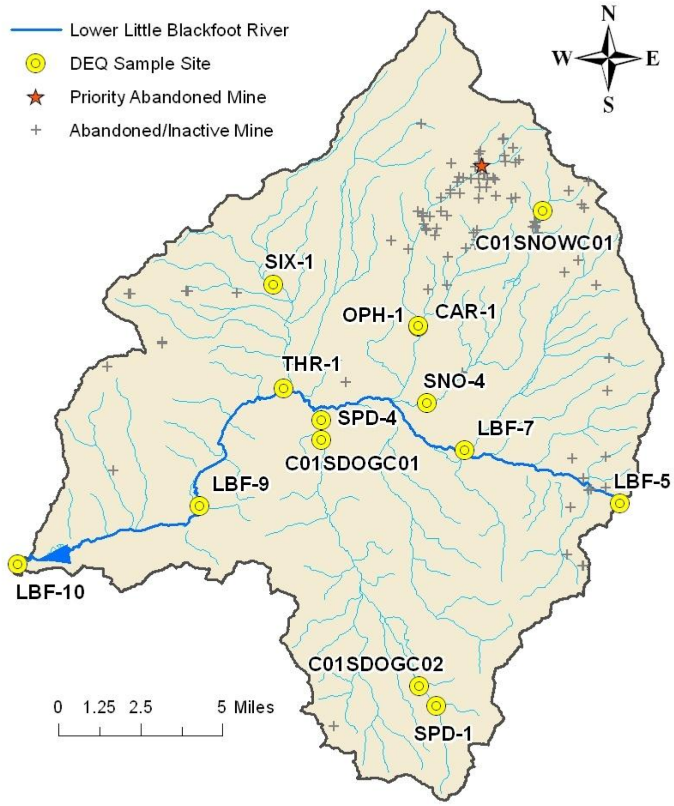

**Figure 7-12. Lower Little Blackfoot River Sample Sites**

### Sources and Available Data

The lower Little Blackfoot River basin contains an estimated 100 abandoned mines, including the Victory/Evening Star Mine which appears on DEQ's priority abandoned mines list. Another factor influencing water quality in the lower segment is approximately 110 abandoned mines and thirteen priority abandoned mines located in the upper Little Blackfoot River basin. A description of metal sources and available data for the Little Blackfoot River's upper segment is provided in **Section 7.5.11** and **Appendix F**. Major mining activity took place from the early to mid-20th century. Like most mining in the lower Little Blackfoot River basin, the Victory/Evening Star Mine is located in the Ophir Creek drainage. When MBMG visited the mine site in 1995 there were tailings in the Ophir Creek floodplain but they did not appear to be actively eroding (Hargrave, et al., 1998). A review of abandoned mine land records housed at DEQ identified nine additional non-priority mines (Blue Speckled Adit, Cow Spring Cabin, Esmeralda Hill, Gimlet, NE NE Section 19, NE NW Section 29, Ophir Cabin, SE NW Section 20 and Upsetti) in the basin with waste rock piles or standing water in mine shafts which could impact water quality in the Little Blackfoot River. A more detailed description of abandoned mines found in this watershed is located in **Section F.12** of **Appendix F**.

As of October 2011, there was an active general permit for suction dredging (MTG370318) on Carpenter Creek. The general permit has special conditions to minimize harmful conditions caused by elevated suspended sediment concentrations, however metals loading is not specifically addressed; DEQ sampled stream sediments at CAR-1 (**Figure 7-12**) and found all metal concentrations to be below secondary targets. Based on permit conditions that limit suspended sediment and low metals concentrations in the stream sediment, the suction dredging operation is not expected to result in the exceedance of metals water quality targets.

Sources of metals impairment to the lower Little Blackfoot River have been investigated in numerous reports and sampling studies. The lower segment of the Little Blackfoot River was first listed for metals in 2000 based on data collected in the 1970s and 1980s. Additionally, a USGS gage on the Little Blackfoot River near the town of Garrison has collected discharge data since 1972 and intermittent water quality data since 1982. More recent sediment samples and high and low flow water samples were collected by DEQ in 2008 and 2009 at three sites on the Little Blackfoot River, LBF-7, LBF-9 and LBF-10 (**Figure 7-12**), to aid with TMDL development. A fourth site, LBF-5, was established on the upper segment directly before the start of the lower segment. DEQ also established sample sites in six tributary streams.

### Comparison to Water Quality Targets and TMDL Development Determination

The rationale for deciding if a TMDL was developed for each Little Blackfoot River (lower segment) pollutant depended on a combination of factors displayed in **Table 7-15** in accordance with the process explained in **Section 7.4**. Note, although an entire suite of metals was sampled, only listed metals or those with target/supplemental indicator exceedances are presented. Based on the data review described in **Appendix F**, a TMDL will be developed for one of the two metals-related pollutants on the 2010 303(d) List as well as one metal not previously listed (arsenic). Because no recent samples exceeded copper water quality targets, no TMDL was developed and the 303(d) listing status for copper will be formally reevaluated by DEQ in the future.

**Table 7-15. Lower Little Blackfoot River TMDL Decision Factors**

| Parameter | Arsenic | Copper | Lead |
|---|---|---|---|
| Number of samples | 34 | 34 | 34 |
| Chronic AL exceedance rate > 10% | No | No | Yes |
| Greater than twice the acute AL exceeded | No | No | No |
| Human health criterion exceeded | Yes | No | No |
| NOAA sediment PELs exceeded | Yes | No | Yes |
| Human-caused sources present | Yes | Yes | Yes |
| 2010 303(d) listing status | Not listed | Listed | Listed |
| **TMDL Developed?** | **Yes** | **No** | **Yes** |

### 7.5.13 TMDL Development Determination Summary

Twelve individual stream segments were found to have metals-related impairments in the Little Blackfoot River TMDL Planning Area. A review of metals target exceedances verified most metals impairments on the 2010 303(d) List, however, four listings were shown not to be representative of current conditions and TMDLs were not developed in these cases. Additionally, recent sampling identified elevated concentrations for 23 metals not identified on the 2010 303(d) List. Included in **Table 7-16** is a summary of existing metals impairment causes and an overview of which TMDLs were prepared based on observed target exceedances. A total of 45 metals TMDLs are required as well as two pH impairments that will be addressed via surrogate metals TMDLs. TMDLs and allocations for these parameters are given in the following section.

**Table 7-16. Summary of Streams Requiring Metals TMDLs**

| Stream Segment | Waterbody Segment ID | Metals-related 2010 303(d) Listings | Metals TMDLs Prepared |
|---|---|---|---|
| AMERICAN GULCH CREEK, headwaters to mouth (Dog Creek) | MT76G004_079 | - | Arsenic |
| DOG CREEK, headwaters to Meadow Creek | MT76G004_071 | Arsenic, Lead, Zinc | Arsenic, Cadmium, Copper, Lead, Zinc |
| DOG CREEK, Meadow Creek to mouth (Little Blackfoot River) | MT76G004_072 | - | Copper, Lead |
| LITTLE BLACKFOOT RIVER, headwaters to Dog Creek | MT76G004_020 | Arsenic, Cyanide | Arsenic, Cadmium, Copper, Cyanide, Lead |
| LITTLE BLACKFOOT RIVER, Dog Creek to mouth (Clark Fork River) | MT76G004_010 | ***Copper***, Lead | Arsenic, Lead |
| MONARCH CREEK, headwaters to mouth (Ontario Creek) | MT76G004_060 | ***Arsenic***, Copper, Lead, Mercury, pH, ***Selenium*** | Copper, Lead, Mercury, pH* |
| O'KEEFE CREEK, headwaters to mouth (Telegraph Creek) | MT76G004_054 | - | Cadmium, Copper, Zinc |
| ONTARIO CREEK, headwaters to mouth (Little Blackfoot River) | MT76G004_130 | - | Cadmium, Copper, Lead |
| SALLY ANN CREEK, headwaters to mouth (O'Keefe Creek) | MT76G004_055 | - | Cadmium, Copper, Zinc |
| TELEGRAPH CREEK, headwaters to Hahn Creek | MT76G004_051 | Arsenic, Beryllium, Cadmium, Copper, ***Iron***, Zinc | Arsenic, Beryllium, Cadmium, Copper, Lead, Zinc |
| TELEGRAPH CREEK, Hahn Creek to mouth (Little Blackfoot River) | MT76G004_052 | Lead, Mercury | Cadmium, Copper, Lead, Mercury, Zinc |
| UN-NAMED CREEK, headwaters to mouth (Ontario Creek) | MT76G006_010 | Arsenic, Cadmium, Copper, Lead, Mercury, pH, Zinc | Arsenic, Cadmium, Copper, Iron, Lead, Mercury, pH*, Zinc |

*pH listings are addressed via surrogate metals TMDLs

***Bold Italics***: recent data does not support listing. Listing status will be reevaluated.

## 7.6 METALS TMDLS APPROACH

TMDLs for metals represent the maximum amount (lbs/day) of each metal that a stream can receive while maintaining water quality standards. A stream's ability to assimilate metal pollutants is based on stream discharge (i.e. its ability to dilute metal concentration), and for many metals, the water hardness (which can effect toxicity and determines the numeric water quality standard). Because both of these variables (streamflow and hardness) vary seasonally, the TMDL for a metal must be established so that it maintains protection of beneficial uses for the anticipated range of flow and hardness conditions. Metals TMDLs are calculated using the equation below:

**TMDL = (X) (Y) (k)**

TMDL = Total Maximum Daily Load in lbs/day
X = lowest applicable metals water quality target in µg/L for a specific hardness value
Y = streamflow in cubic feet per second (cfs)
k = conversion factor of 0.0054

All metals TMDLs are calculated using the most stringent target value, which ensures that the TMDLs are protective off all designated beneficial uses. Note that the more stringent chronic aquatic life standards are used to calculate most TMDLs. Using the chronic standard to calculate an allowable daily load, rather than a 96-hour load limit (see **Section 7.4.1**), affords an implicit margin of safety in calculating the TMDL and also establishes a daily load limit expression. For some metals the human health standard is used in calculating TMDL because it is more stringent than the chronic aquatic life standard. This is the case for lead (under high water hardness conditions) and arsenic and mercury (under all conditions). Although the TMDL is often derived from the chronic standards, acute aquatic life standards are also established as water quality targets, and are applied as an instantaneous in-stream pollutant concentration that shall not be exceeded (see **Section 7.4.1**). Remediation will be needed to address the sources of metals loading that contribute to the exceedance of water quality targets and to meet the allocations defined in **Section 7.7**.

**Figures 7-13** through **7-22** show TMDLs for arsenic, beryllium, cadmium, copper, cyanide, iron, lead, mercury, selenium and zinc under various flow conditions. These curves are applicable to all metals TMDLs in this document. Where aquatic life criteria are variable based on water hardness, TMDLs at a hardness of 25 mg/L and 400 mg/L are shown. TMDLs based on human health criteria are also shown where appropriate. Example TMDLs are shown in **Table 7-17** for the 12 waterbody segments in the Little Blackfoot TPA requiring metals TMDLs.

Where data is available, TMDLs are calculated based on high and low flow sampling events. High flows are assumed to be between April 15th and June 30th while low flow samples are those collected at all other times. The existing loads, percent reductions and TMDL components displayed in this document should not be considered rigid numbers; rather, they should be seen as best approximations portraying the existing variability inherent to these calculations. Existing loads for each waterbody segment are calculated using sample data from sites with the greatest exceedance of the applicable water quality target for most metals unless otherwise stated because it is assumed that addressing the sources needed to meet the TMDL at the location with the greatest exceedance will result in attainment of water quality standards throughout the waterbody. However, in some instances where a portion of the TMDL is allocated to an upstream segment, the upstream segment's TMDL will be calculated at the site lowest in the basin. Also, non-detect samples are considered to be ½ the detection limit when used in calculations.

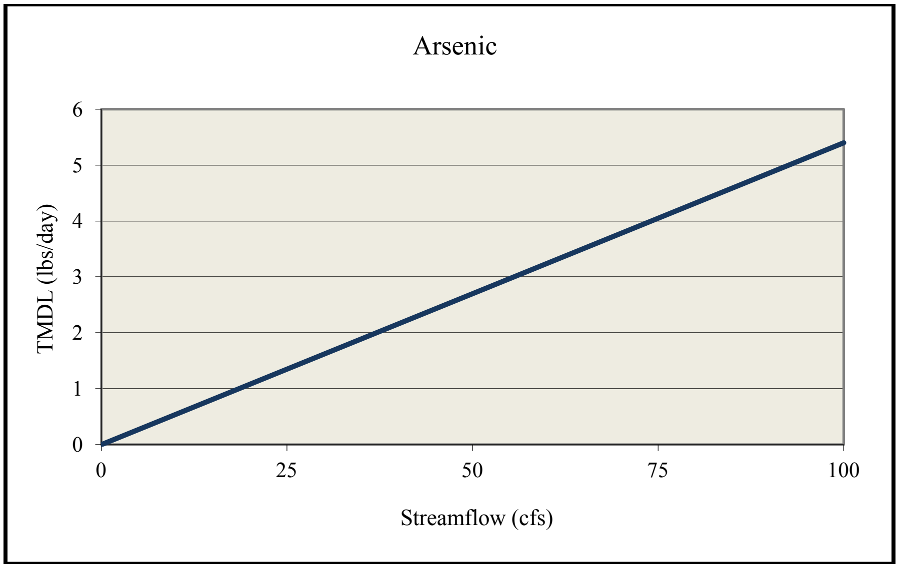

Figure 7-13. Arsenic TMDL as a function of flow

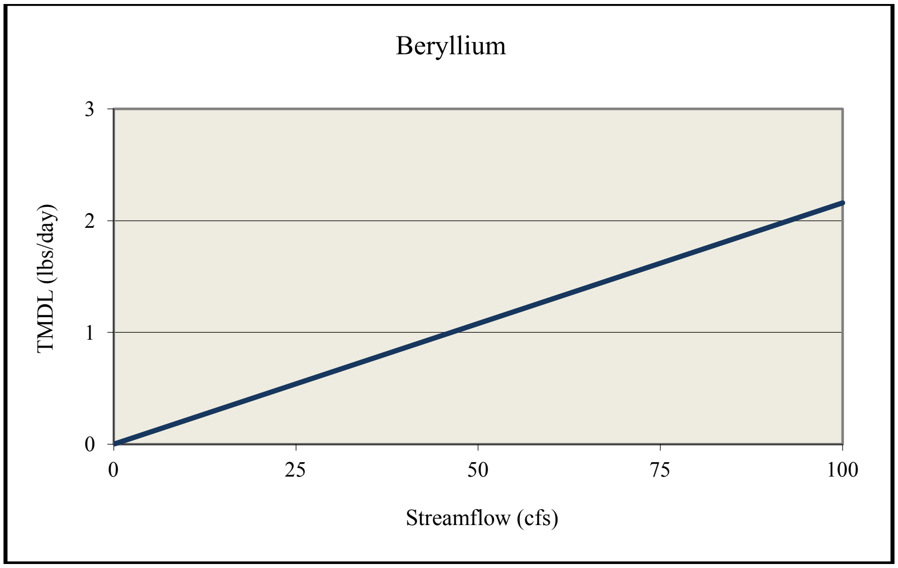

Figure 7-14. Beryllium TMDL as a function of flow

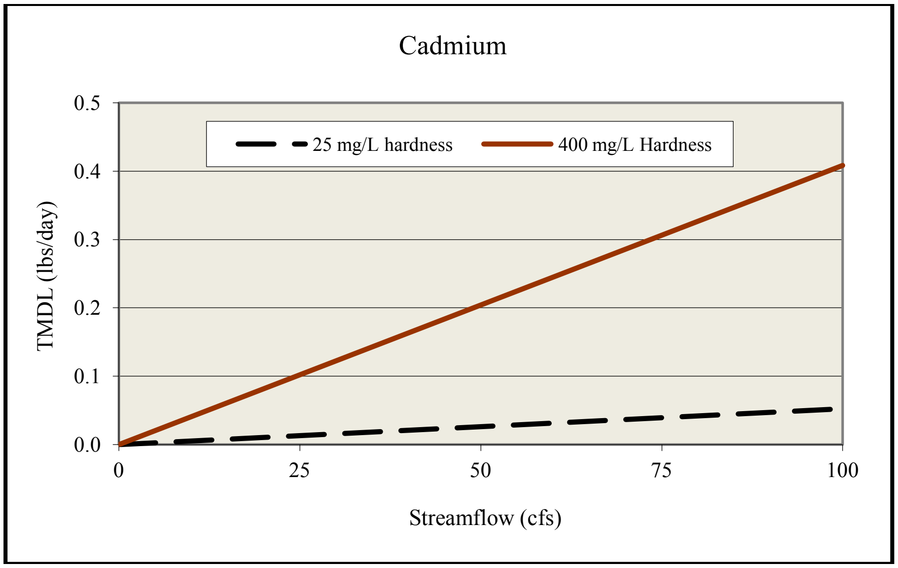

Figure 7-15. Cadmium TMDL as a function of flow

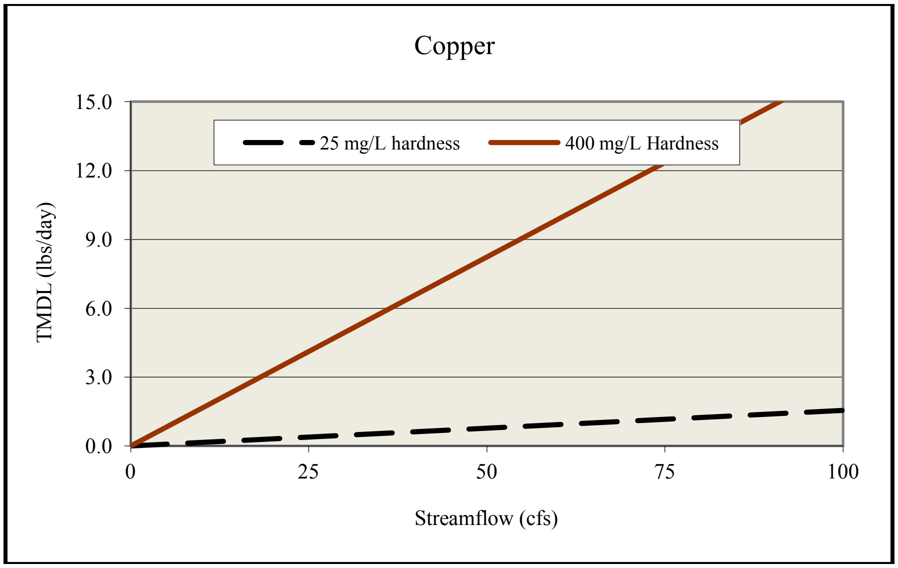

Figure 7-16. Copper TMDL as a function of flow

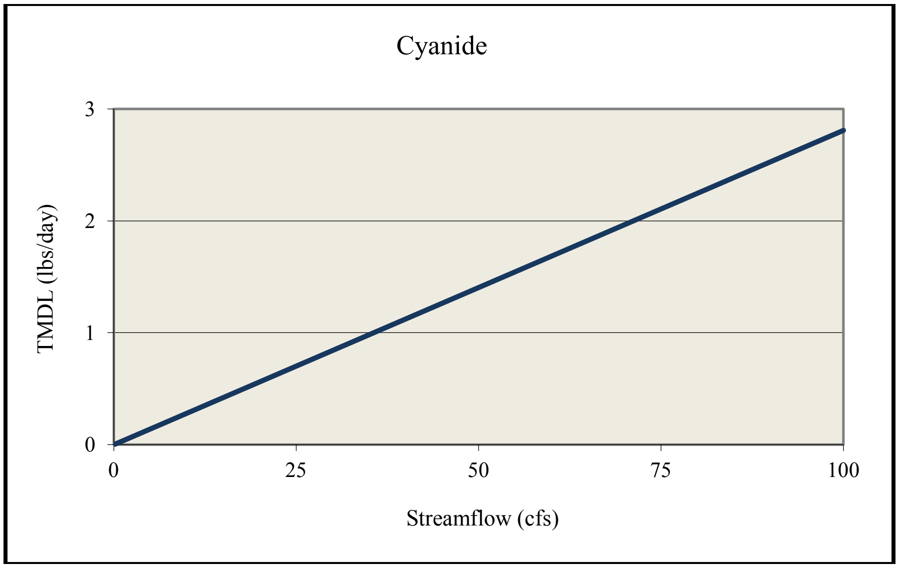

Figure 7-17. Cyanide TMDL as a function of flow

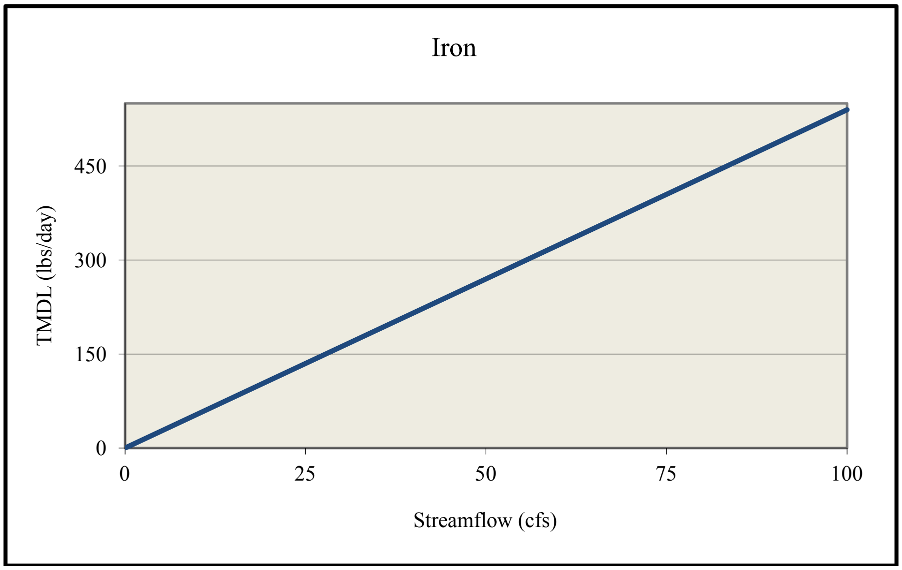

Figure 7-18. Iron TMDL as a function of flow

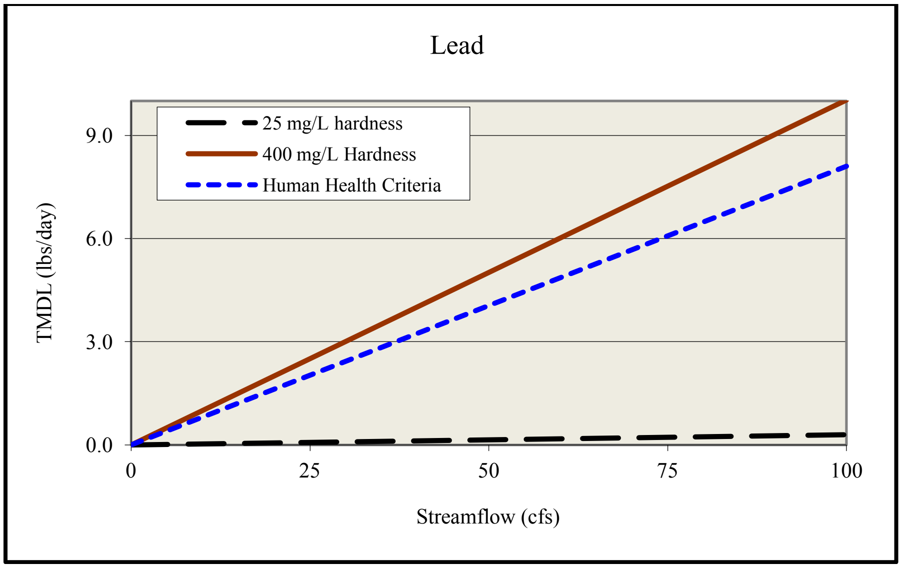

Figure 7-19 Lead TMDL as a function of flow

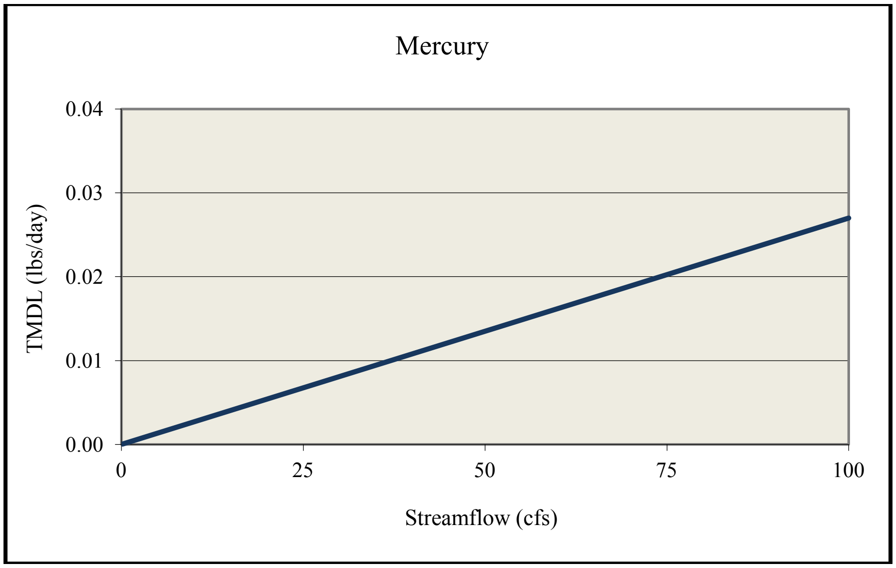

Figure 7-20 Mercury TMDL as a function of flow

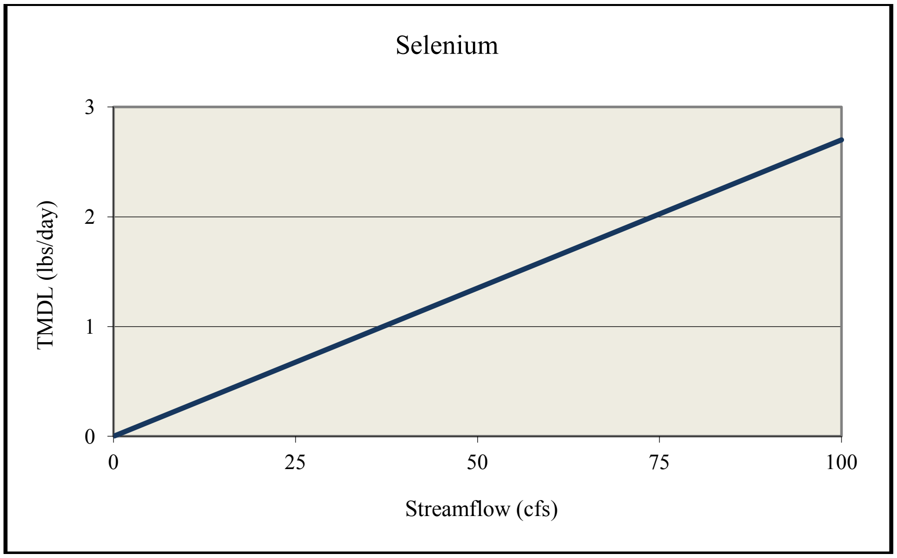

Figure 7-21 Selenium TMDL as a function of flow

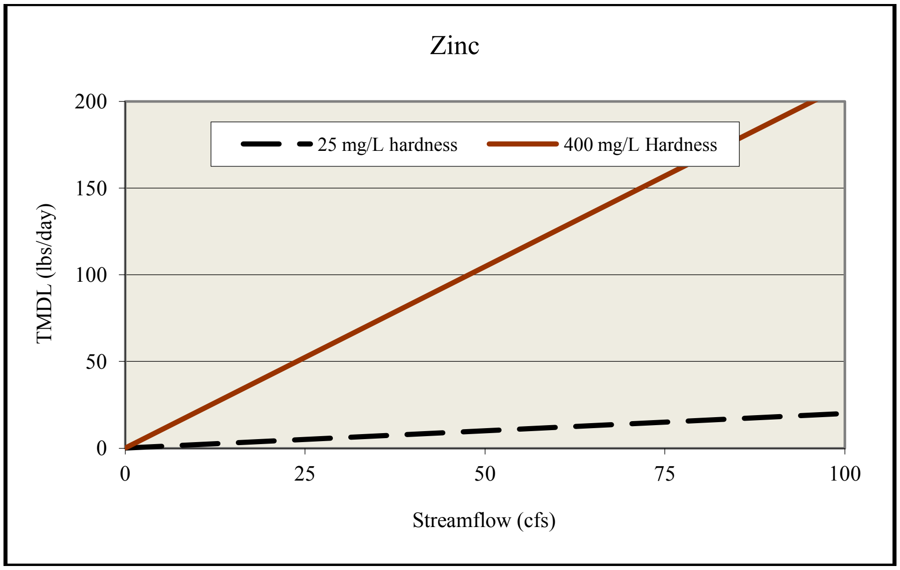

Figure 7-22. Zinc TMDL as a function of flow

**Table 7-17. Detailed inputs for example TMDLs in the Little Blackfoot TPA**

| Stream Segment | Station | Discharge (cfs) | | Hardness | | Metal | Target Conc. (µg/L) | | TMDL (lbs/day) | | % Reduction Based on Sample Target Exceedances | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | High Flow | Low Flow | High Flow | Low Flow | | High Flow | Low Flow | High Flow | Low Flow | High Flow | Low Flow |
| American Gulch Creek(MT76G004_079) | DOG-3 | 13.37 | 0.85 | 99 | 149 | Arsenic | 10 | 10 | 0.722 | 0.046 | 23% | 38% |
| Dog Creek, Upper (MT76G004_071) | * | 26.65 | 1.8 | 99 | 156.5 | Arsenic | 10 | 10 | 1.439 | 0.097 | 23% | 62% |
| | | | | | | Cadmium | 0.27 | 0.38 | 0.039 | 0.004 | 62% | 0% |
| | | | | | | Copper | 9.25 | 13.68 | 1.331 | 0.133 | 0% | 0% |
| | | | | | | Lead | 3.14 | 5.63 | 0.452 | 0.055 | 68% | 30% |
| | | | | | | Zinc | 118.8 | 175.12 | 17.097 | 1.702 | 0% | 0% |
| Dog Creek, Lower (MT76G004_072) | DOG-8 | 247.6 | 12.17 | 49 | 134 | Copper | 5.07 | 11.98 | 6.779 | 0.787 | 28% | 0% |
| | | | | | | Lead | 1.28 | 4.62 | 1.711 | 0.304 | 80% | 0% |
| Little Blackfoot River, Upper (MT76G004_020) | LBF-5 | 908.13 | 35.9 | 33 | 65 | Arsenic | 10 | 10 | 49.039 | 1.930 | 38% | 0% |
| | | | | | | Cadmium | 0.12 | 0.2 | 0.588 | 0.039 | 25% | 0% |
| | | | | | | Copper | 3.62 | 6.46 | 17.752 | 1.252 | 48% | 0% |
| | | | | | | Cyanide | 5.2 | 5.2 | 25.500 | 1.008 | 77% | 0% |
| | | | | | | Lead | 0.78 | 1.84 | 3.825 | 0.357 | 92% | 0% |
| Little Blackfoot River, Lower (MT76G004_010) | LBF-10 | 1555.5 | 58.2 | 67 | 138 | Arsenic | 10 | 10 | 83.997 | 3.143 | 29% | 0% |
| | | | | | | Lead | 1.91 | 4.79 | 16.043 | 1.505 | 79% | 0% |
| Monarch Creek (MT76G004_060) | MCH-2 | 13.79 | 1.49 | 9 | 15 | Copper | 2.85 | 2.85 | 0.212 | 0.023 | 5% | 0% |
| | | | | | | Lead | 0.54 | 0.54 | 0.04 | 0.004 | 33% | 0% |
| | | | | | | Mercury | 0.05 | 0.05 | 0.004 | 0.0004 | 0% | 0% |
| O'Keefe Creek (MT76G004_054) | TGH-2 | 40.21 | 0.8 | 10 | 28 | Cadmium | 0.1 | 0.11 | 0.022 | 0.001 | 95% | 0% |
| | | | | | | Copper | 2.85 | 3.14 | 0.619 | 0.014 | 43% | 0% |
| | | | | | | Zinc | 37.02 | 40.75 | 8.038 | 0.176 | 47% | 0% |
| Ontario Creek (MT76G004_130) | ONT-2 | 238.09 | 5.39 | 9 | 15 | Cadmium | 0.1 | 0.1 | 0.129 | 0.003 | 55% | 0% |
| | | | | | | Copper | 2.85 | 2.85 | 3.664 | 0.083 | 29% | 0% |
| | | | | | | Lead | 0.54 | 0.54 | 0.694 | 0.016 | 89% | 0% |
| Sally Ann Creek (MT76G004_055) | TGH-1 | 33.43 | 0.49 | 10 | 31 | Cadmium | 0.1 | 0.11 | 0.018 | 0.0003 | 93% | 0% |
| | | | | | | Copper | 2.85 | 3.43 | 0.514 | 0.009 | 29% | 0% |
| | | | | | | Zinc | 37.02 | 44.42 | 6.683 | 0.118 | 26% | 0% |

**Table 7-17. Detailed inputs for example TMDLs in the Little Blackfoot TPA**

| Stream Segment | Station | Discharge (cfs) |  | Hardness |  | Metal | Target Conc. (µg/L) |  | TMDL (lbs/day) |  | % Reduction Based on Sample Target Exceedances |  |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | High Flow | Low Flow | High Flow | Low Flow |  | High Flow | Low Flow | High Flow | Low Flow | High Flow | Low Flow |
| Telegraph Creek, Upper (MT76G004_051) | TGH-3A | 90.16 | 1.91 | 13 | 38 | Arsenic | 10 | 10 | 4.869 | 0.103 | 0% | 0% |
|  |  |  |  |  |  | Beryllium | 4 | 4 | 1.947 | 0.041 | 0% | 0% |
|  |  |  |  |  |  | Cadmium | 0.1 | 0.13 | 0.049 | 0.001 | 17% | 0% |
|  |  |  |  |  |  | Copper | 2.85 | 4.08 | 1.388 | 0.042 | 43% | 0% |
|  |  |  |  |  |  | Lead | 0.54 | 0.93 | 0.263 | 0.010 | 61% | 0% |
|  |  |  |  |  |  | Zinc | 37.02 | 52.87 | 18.024 | 0.544 | 26% | 0% |
| Telegraph Creek, Lower (MT76G004_052) | TGH-4 | 93.5 | 4.36 | 16 | 42 | Cadmium | 0.1 | 0.14 | 0.050 | 0.003 | 9% | 0% |
|  |  |  |  |  |  | Copper | 2.85 | 4.45 | 1.439 | 0.105 | 43% | 0% |
|  |  |  |  |  |  | Lead | 0.54 | 1.05 | 0.273 | 0.025 | 61% | 0% |
|  |  |  |  |  |  | Mercury | 0.05 | 0.05 | 0.025 | 0.0012 | 0% | 0% |
|  |  |  |  |  |  | Zinc | 32.07 | 57.45 | 18.691 | 0.506 | 26% | 0% |
| Un-named Creek (MT76G006_010) | ONT-1 | - | 0.07 | - | 43 | Arsenic | - | 10 | - | 0.004 | - | 82% |
|  |  |  |  |  |  | Cadmium | - | 0.14 | - | 0.0001 | - | 94% |
|  |  |  |  |  |  | Copper | - | 4.54 | - | 0.002 | - | 82% |
|  |  |  |  |  |  | Iron | - | 1000 | - | 0.378 | - | 36% |
|  |  |  |  |  |  | Lead | - | 1.09 | - | 0.004 | - | 88% |
|  |  |  |  |  |  | Mercury | - | 0.05 | - | 0.00002 | - | 0% |
|  |  |  |  |  |  | Zinc | - | 58.61 | - | 0.022 | - | 84% |

*TMDL calculated for Dog Creek below confluence with American Gulch Creek

## 7.7 METALS LOADING SUMMARY, TMDLS AND ALLOCATIONS

Proceeding from the upper watershed to the lower, loading summaries and source allocations are provided for each waterbody-pollutant combination with a TMDL in the sections that follow. Metals TMDLs are allocated to point (wasteload) and nonpoint (load) sources. The TMDL is comprised of the sum of all significant point and nonpoint metals sources (natural and human-caused), plus a margin of safety (MOS) that accounts for uncertainties in loading and receiving water analyses. In addition to metals load allocations, the TMDL must also take into account the seasonal variability of metals loads and adaptive management strategies in order to address uncertainties inherent in environmental analysis. The aim of the loading summaries is to discuss seasonal loading trends and significant loading sources and pathways.

These elements are combined in the following equation:

**TMDL = ∑WLA + ∑LA + MOS**

WLA = Wasteload Allocation or the portion of the TMDL allocated to metals point sources
LA = Load Allocation or the portion of the TMDL allocated to nonpoint metals sources and natural background
MOS = Margin of Safety or an accounting of uncertainty about the relationship between metals loads and receiving water quality

WLAs are allowable pollutant loads that are assigned to point sources (permitted and non-permitted). The only permitted point source with a potential to affect metals loading in the basin is a general suction dredge permit (MTG3700000) on Carpenter Creek addressed in the lower segment Little Blackfoot River TMDL (**Section 7.7.12**). Waste sources associated with historic mining such as adit discharges, tailings, and waste rock piles are considered non-permitted point sources (and subject to a WLA). Where adequate data is available to evaluate loading from individual mining sources, these non-permitted point sources will be given separate WLAs. Otherwise, the contribution from all abandoned mines (e.g. adits, waste rock, tailings) in a contributing area or entire watershed is grouped into a composite WLA from abandoned mines. LAs are allowable pollutant loads assigned to nonpoint sources and may include the cumulative pollutant load from naturally occurring and human-caused sources. As defined in ARM 17.30.602, naturally occurring sources also include *"those sources from developed areas where all reasonable land, soil and water conservation practices have been applied."* Within the Little Blackfoot TMDL planning area, naturally-occurring metals concentrations are established by using data upstream of mining sources. An attempt is made to find such sites within each listed segment's basin, but if a basin is heavily impacted by human related metals sources or no site was established upstream of mining activity, LAs to background sources will be calculated using other sites in the planning area deemed representative.

### 7.7.1 Un-named Creek (MT76G006_010)

**Loading Summary**

The Ontario Mine is the primary source of metals loading to Un-named Creek. Because deep snow prevented access to the 1st order stream during recent DEQ sampling, only low flow metals data (i.e., July-October) were reviewed for the loading analysis. It is difficult to evaluate spatial or year-to-year loading trends in the basin because only one flow measurement (an estimate) is contained in the available dataset. Metal concentrations were elevated at all sites but did not have a consistent downstream trend; site ONT-B (**Figure 7-1**), located directly downstream of the rock-lined adit channel, had the highest exceedances for all metals of concern except arsenic.

In general, the two reclamation projects on Ontario Mine have not reduced metals concentrations in the creek; the highest observed concentrations of many metals occurred post reclamation. This is likely because mining activities altered the headwaters of the drainage, and the adit discharge, which was left untreated, is now the source water of the creek (Pioneer Technical Services, Inc., 1993). The only modification made to the adit discharge was armoring the channel to mitigate headcutting. Because the lined channel is somewhat of a treatment area, all samples collected downstream of the armored channel are considered Un-named Creek sample sites within this document.

### TMDLs and Allocations

Because all human-related metals loading to Un-named Creek is associated with the Ontario Mine, a single wasteload allocation to the mine is provided, **$WLA_{Ontario}$**. Metals concentrations found at ONT-0, located upstream of mining activity and above Un-named Creek's confluence with Ontario Creek (**Figure 7-10**), were used to calculate the natural background load allocation, **$LA_{Nat}$**. The average annual precipitation and underlying geology at ONT-0 is comparable to that of Un-named Creek's basin (**Figures A-4 and A-9**). Although concentrations at ONT-B were usually the highest, since there was no corresponding flow data, data from ONT-1 were used to calculate existing loads and example TMDLs. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-18** summarizes TMDL components and shows example TMDLs and allocations for low flow conditions for Un-named Creek. No reduction is shown in the example for mercury because no exceedances were observed during recent sampling, however, reductions may be necessary under certain flow conditions. Metals TMDLs will act as a surrogate for a pH TMDL because setting loads for pH is not practical and reclamation activities needed to meet the metals TMDLs will address sources of acid mine drainage causing the pH impairment.

$$TMDL_{Un\text{-}named} = WLA_{Ontario} + LA_{Nat}$$
**MOS = Implicit**

**Table 7-18. Un-named Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{Ontario}$ (lbs/day) |
|---|---|---|---|---|---|---|
| Arsenic | Low flow | 0.004 | 0.021 | 82% | 0.001 | 0.003 |
| Cadmium | Low flow | 0.0001 | 0.0008 | 94% | 0.0000 | 0.0001 |
| Copper | Low flow | 0.002 | 0.009 | 82% | 0.001 | 0.001 |
| Iron | Low flow | 0.378 | 0.590 | 36% | 0.053 | 0.325 |
| Lead | Low flow | 0.0004 | 0.0035 | 88% | 0.0001 | 0.0003 |
| Mercury | Low flow | 0.00002 | 0.00000 | 0% | 0.00001 | 0.00001 |
| Zinc | Low flow | 0.022 | 0.136 | 84% | 0.002 | 0.020 |

Low flow: 0.07 cfs, 43 mg/L hardness

## 7.7.2 Monarch Creek (MT76G004_060)

### Loading Summary

The Monarch Mine is the primary source of metals loading to Monarch Creek. Concentrations of metals in Monarch Creek only exceeded water quality targets during high flow conditions. During spring runoff, copper and lead loads increased three to four times from the site upstream of the Monarch Mine (MCH1) to the site below (MCH2) (**Figure 7-2**). Further downstream at MCH-2 and MCH-3, copper and mercury concentrations were the same but lead was more elevated at MCH-3. While most loading is occurring between the upper two sites, additional lead loading is occurring between MCH-2 and MCH-3, possibly related to the high concentrations of lead observed in stream sediments observed at MCH-2. Water samples collected from the discharging adit were at the detection limit for copper and below the detection limit for lead and mercury, and all stream water samples were below detection limits during low flow events. The tendency of high flow exceedances indicate that metals loading to Monarch Creek is associated with surface runoff over the tailings within the floodplain and/or mobilization of sediments within the channel.

### TMDLs and Allocations

Because all human-related metals loading to Monarch Creek is associated with the Monarch Mine, a single wasteload allocation to the mine is provided, $\mathbf{WLA_{Monarch}}$. Metal concentrations found at MCH-1, located upstream of mining activity, were used to calculate the natural background load allocation, $\mathbf{LA_{Nat}}$. All samples at this site were below the detection limit for the three metals of concern, except for a high flow copper sample that was at the detection limit. Metal concentrations were slightly more elevated at MCH-3 yet since there was no low flow data at this site, data from MCH-2 were used to calculate existing loads and example TMDLs. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-19** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for Monarch Creek. No reduction is shown in the example for mercury because no exceedances were observed during recent sampling, however, reductions may be necessary under certain flow conditions. While TMDLs are currently being met during low flow conditions, reductions are necessary during high flow. Metals TMDLs will act as a surrogate for a pH TMDL because setting loads for pH is not practical and reclamation activities needed to meet the metals TMDLs will address sources of acid mine drainage causing the pH impairment.

$$\mathbf{TMDL_{Monarch} = WLA_{Monarch} + LA_{Nat}}$$

**MOS = Implicit**

**Table 7-19. Monarch Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{Monarch}$ (lbs/day) |
|---|---|---|---|---|---|---|
| Copper | High flow | 0.212 | 0.223 | 5% | 0.074 | 0.138 |
| | Low flow | 0.023 | 0.004 | 0% | 0.004 | 0.019 |
| Lead | High flow | 0.040 | 0.060 | 33% | 0.019 | 0.022 |
| | Low flow | 0.004 | 0.002 | 0% | 0.002 | 0.002 |
| Mercury | High flow | 0.004 | 0.002 | 0% | 0.002 | 0.002 |
| | Low flow | 0.0004 | 0.0002 | 0% | 0.0002 | 0.0002 |

High flow: 13.79 cfs, 9 mg/L hardness
Low flow: 1.49 cfs, 15 mg/L hardness

## 7.7.3 Ontario Creek (MT76G004_130)

### Loading Summary

Due to extensive historic mining in the basin, there are numerous sources of metals loading to Ontario Creek, including two tributaries, Un-named and Monarch creeks (described separately in **Sections 7.7.1** and **7.7.2**). Concentrations of metals in Ontario Creek only exceeded water quality targets during high flow conditions. There is no available high flow data at ONT-0 (**Figure 7-3**), but from ONT-2A to ONT-2 flows increased nearly three-fold and while concentrations of copper and lead remained constant or increased downstream, the concentration of cadmium was reduced by 84%. Because of this reduction in cadmium concentrations, even though flows were much higher, the cadmium load decreased from ONT-2A to ONT-2 while loads of copper and lead significantly increased. Even if loading inputs from Un-named Creek and Monarch Creek were reduced to meet TMDLs, water quality targets would still be exceeded at ONT-2. Therefore, reductions are required throughout the watershed such as near the Hard Luck Mine that has discharging adits and waste rock piles near Ontario Creek. The tendency of high flow exceedances plus high metal concentrations in stream sediments indicate that metal loading to Ontario Creek is associated with surface runoff over mine waste and/or mobilization of sediments within the channel.

### TMDLs and Allocations

Because human-related metals loading to Ontario Creek is associated with numerous sources, the wasteload has been broken into three allocations: one representing Un-named Creek's contribution ($\mathbf{WLA_{Un\text{-}named}}$), another for Monarch Creek ($\mathbf{WLA_{Monarch}}$) and a third assigned to Ontario Creek ($\mathbf{WLA_{Ontario}}$). The $\mathbf{WLA_{Un\text{-}named}}$ is equivalent to the low flow Un-named Creek TMDL provided in **Section 7.7.1**, which was also applied to the high flow $\mathbf{WLA_{Un\text{-}named}}$ because no high flow data is available. Although having high flow data is preferable, this was determined to be reasonable because Un-named Creek is a $1^{st}$ order stream dominated by groundwater inputs (Hargrave, et al., 1998; Pioneer Technical Services, Inc., 1993) and conditions are assumed to be relatively constant throughout the year. $\mathbf{WLA_{Monarch}}$ is conceptually the same as the Monarch Creek TMDL provided in **Section 7.7.2**, but differs slightly because sample data from the same sampling event were used for all WLAs within the Ontario Creek TMDL and flow and hardness conditions differed some from that used for the Monarch Creek TMDL. $\mathbf{WLA_{Ontario}}$ was calculated by subtracting the **WLA**s and $\mathbf{LA_{Nat}}$ from the TMDL. Metals concentrations from site ONT-0, located upstream of mining activity, were used to calculate the natural background load allocation, $\mathbf{LA_{Nat}}$. However, because ONT-0 was only sampled during low flow, data from LBF-1 on the Little Blackfoot River were used to calculate the $\mathbf{LA_{Nat}}$ for high flows. The average annual precipitation and underlying geology at LBF-1 is comparable to that of Ontario Creek's basin (**Figures A-4** and **A-9**). Data from ONT-2 were used to calculate existing loads and example TMDLs for Ontario Creek. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-20** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for Ontario Creek. While TMDLs are currently being met during low flow conditions, reductions are necessary during high flow.

$$\mathbf{TMDL_{Ontario} = WLA_{Un\text{-}named} + WLA_{Monarch} + WLA_{Ontario} + LA_{Nat}}$$

**MOS = Implicit**

**Table 7-20. Ontario Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{Un\text{-}named}$ (lbs/day) | $WLA_{Monarch}$ (lbs/day) | $WLA_{Ontario}$ (lbs/day) |
|---|---|---|---|---|---|---|---|---|
| Cadmium | High flow | 0.129 | 0.283 | 55% | 0.043 | 0.0001 | 0.008 | 0.077 |
| | Low flow | 0.003 | 0.001 | 0% | 0.0009 | 0.0001 | 0.0002 | 0.0017 |
| Copper | High flow | 3.664 | 5.143 | 29% | 2.159 | 0.002 | 0.586 | 0.917 |
| | Low flow | 0.083 | 0.029 | 0% | 0.047 | 0.002 | 0.015 | 0.019 |
| Lead | High flow | 0.694 | 6.300 | 89% | 0.270 | 0.0004 | 0.111 | 0.313 |
| | Low flow | 0.016 | 0.007 | 0% | 0.006 | 0.0004 | 0.003 | 0.007 |

High flow: 238.09 cfs, 9 mg/L hardness
Low flow: 5.39 cfs, 15 mg/L hardness

## 7.7.4 Sally Ann Creek (MT76G004_055)

### Loading Summary

The Telegraph Mine is the primary source of metals loading to Sally Ann Creek. Concentrations of metals in Sally Ann Creek only exceeded water quality targets during high flow conditions. Placer and hardrock mining occurred in the watershed near Bryan Creek, an intermittent tributary to Sally Ann Creek. Bryan Creek contributed flows during 2008/2009 DEQ sampling but 1995 MBMG records noted the creek ran dry late in the year (Hargrave, et al., 1998). DEQ established sites on Sally Ann Creek above (TGH-0) and below Bryan Creek's confluence (TGH-1) (**Figure 7-4**). Concentrations of zinc at the upper site were always below detection, but cadmium and copper exceeded targets during high flow, indicating some loading is occurring in the headwaters; however, larger inputs of cadmium and copper must be occurring between the two sample sites because concentrations remained uniform even as flows doubled or tripled. For zinc, Telegraph Mine is assumed to be the sole source of human-related loading because zinc was not detected at TGH-0 yet exceeded targets downstream at TGH-1. The tendency of high flow exceedances indicate that metal loading to Sally Ann Creek is dependent upon inputs from Bryan Creek and associated to a lesser degree with surface runoff over mine wastes in the headwaters. Another potential loading mechanism is the mobilization of sediments within the channel since metal concentrations in stream sediments exceeded secondary targets at TGH-1 but not TGH-0.

### TMDLs and Allocations

Because most human-related metals loading to Sally Ann Creek is associated with the Telegraph Mine, one wasteload allocation is provided for the mine, **$WLA_{TeleMine}$**, and a separate wasteload allocation is established for the Sally Ann Creek mainstem, **$WLA_{Mainstem}$**. As shown in **Table 7-21**, flows were used to derive wasteload allocations. The increase in discharge observed between TGH-0 and TGH-1 (**Figure 7-4**) was attributed to Bryan Creek and the percentage of total flow contributed by Bryan Creek was calculated as the difference in flows divided by the flow at TGH-1. Flow weighted wasteload allocations were then identified as the flow contribution percentage multiplied by the difference between the TMDL and the **$LA_{Nat}$**.

**Table 7-21. Flow Weighted WLA Calculations for Sally Ann Creek**

| Stream Segment | % of Total High Flow | High Flow WLA Calculation | % of Total Low Flow | Low Flow WLA Calculation |
|---|---|---|---|---|
| Sally Ann Mainstem | 33% | $WLA_{Mainstem}$ = 0.33 * ($TMDL_{SallyAnn}$ - $LA_{Nat}$) | 45% | $WLA_{Mainstem}$ = 0.45 * ($TMDL_{SallyAnn}$ - $LA_{Nat}$) |
| Bryan Creek | 67% | $WLA_{TeleMine}$= 0.67 * ($TMDL_{SallyAnn}$ - $LA_{Nat}$) | 55% | $WLA_{TeleMine}$ = 0.55 * ($TMDL_{SallyAnn}$ - $LA_{Nat}$) |

Due to historic mining in the basin, no Sally Ann site accurately depicts natural background levels of metals. Thus, concentrations from a site on the Little Blackfoot River located upstream of mining activity, LBF-1 (**Figure 7-11**), were used to calculate the natural background load allocation, **$LA_{Nat}$**. The average annual precipitation and underlying geology at LBF-1 is comparable to that of Sally Ann Creek's basin (**Figures A-4** and **A-9**). Data from TGH-1 were used to calculate existing loads and example TMDLs for Sally Ann Creek. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-22** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for Sally Ann Creek. While TMDLs are currently being met during low flow conditions, reductions are necessary during high flow.

**$TMDL_{SallyAnn} = WLA_{Mainstem} + WLA_{TeleMine} + LA_{Nat}$**
**MOS = Implicit**

**Table 7-22. Sally Ann Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{Mainstem}$ (lbs/day) | $WLA_{TeleMine}$ (lbs/day) |
|---|---|---|---|---|---|---|---|
| Cadmium | High flow | 0.018 | 0.244 | 93% | 0.007 | 0.004 | 0.007 |
| | Low flow | 0.0003 | 0.0001 | 0% | 0.0001 | 0.0001 | 0.0001 |
| Copper | High flow | 0.514 | 0.722 | 29% | 0.361 | 0.051 | 0.103 |
| | Low flow | 0.009 | 0.003 | 0% | 0.001 | 0.003 | 0.004 |
| Zinc | High flow | 6.683 | 9.026 | 26% | 0.903 | 1.908 | 3.873 |
| | Low flow | 0.118 | 0.053 | 0% | 0.013 | 0.047 | 0.057 |

High flow: 33.43 cfs, 10 mg/L hardness
Low flow: 0.49 cfs, 31 mg/L hardness

## 7.7.5 O'Keefe Creek (MT76G004_054)

### Loading Summary

The primary sources of metals loading to O'Keefe Creek are the Sure Thing Mine and Sally Ann Creek, which is described separately in **Sections 7.7.4**. Cadmium and copper water quality targets in O'Keefe Creek were only exceeded during high flow conditions; zinc targets were exceeded in both high flow samples and in one of two low flow samples. At certain times of the year, Sally Ann Creek contributed over 80% of the flow to O'Keefe Creek. Flows increased between the lowest Sally Ann Creek site and TGH-2 (**Figure 7-5**) and metals concentrations were similar or slightly higher at TGH-2, resulting in consistently larger loads at TGH-2. Even if loading inputs from Sally Ann Creek were reduced to meet TMDLs, water quality targets would still be exceeded at TGH-2; thus, a significant load of metals is coming from the Sure Thing and O'Keefe Creek/Copper King Mines and reductions are required throughout the entire watershed. Zinc concentrations were extremely elevated in adit samples of the Sure Thing Mine (82 times the acute aquatic life standard) which could be the source of the low flow zinc exceedance observed in O'Keefe Creek. The tendency of high flow exceedances plus high metal concentrations in stream sediments indicate that metals loading to O'Keefe Creek is primarily associated with surface runoff over mine waste and/or mobilization of sediments within the channel, however, the Sure Thing Mine adit is likely a source of loading during low flow conditions.

### TMDLs and Allocations

Because human-related metals loading to O'Keefe Creek is associated with multiple sources, the wasteload has been broken into two allocations: one representing Sally Ann Creek's contribution (**$WLA_{SallyAnn}$**) and another for the mainstem O'Keefe Creek (**$WLA_{O'Keefe}$**). The **$WLA_{SallyAnn}$** is equivalent to the TMDL calculated for Sally Ann Creek and **$WLA_{O'Keefe}$** was calculated by subtracting **$WLA_{SallyAnn}$** and **$LA_{Nat}$** from the TMDL. Due to historic mining in the basin, no O'Keefe Creek site accurately depicts natural background levels of metals, thus concentrations from a site on the Little Blackfoot River located upstream of mining activity, LBF-1 (**Figure 7-11**), were used to calculate the natural background load allocation, **$LA_{Nat}$**. The average annual precipitation and underlying geology at LBF-1 is comparable to that of O'Keefe Creek's basin (**Figures A-4** and **A-9**). Data from TGH-2 were used to calculate existing loads and example TMDLs for O'Keefe Creek. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-23** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for O'Keefe Creek. While TMDLs are currently being met during low flow conditions, reductions are necessary during high flow.

$$\mathbf{TMDL_{O'Keefe} = WLA_{SallyAnn} + WLA_{O'Keefe} + LA_{Nat}}$$
**MOS = Implicit**

**Table 7-23. O'Keefe Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{SallyAnn}$ (lbs/day) | $WLA_{O'Keefe}$ (lbs/day) |
|---|---|---|---|---|---|---|---|
| Cadmium | High flow | 0.022 | 0.417 | 95% | 0.001 | 0.018 | 0.002 |
| | Low flow | 0.0005 | 0.0004 | 0% | 0.0001 | 0.0003 | 0.0001 |
| Copper | High flow | 0.619 | 1.086 | 43% | 0.073 | 0.514 | 0.031 |
| | Low flow | 0.014 | 0.004 | 0% | 0.001 | 0.009 | 0.004 |
| Zinc | High flow | 8.038 | 15.199 | 47% | 0.183 | 6.683 | 1.172 |
| | Low flow | 0.176 | 0.130 | 0% | 0.008 | 0.118 | 0.050 |

High flow: 40.21 cfs, 10 mg/L hardness
Low flow: 0.8 cfs, 28 mg/L hardness

## 7.7.6 Telegraph Creek, Upper Segment (MT76G004_051)

### Loading Summary

Due to extensive historic mining in the basin, there are numerous sources of metals loading to upper Telegraph Creek. A review of the data shows that O'Keefe Creek, described separately in **Sections 7.7.5** and **Appendix F**, transports a larger metals load than Telegraph Creek above their confluence. This is due primarily to the fact that O'Keefe Creek's flows were five to eight times greater. Metals water quality targets were exceeded in O'Keefe Creek but only during high flow, whereas Telegraph Creek's headwaters had low flow exceedances for cadmium and zinc and had high flow exceedances that were greater than those observed in O'Keefe Creek. Arsenic concentrations were highest in Telegraph Creek's headwaters near the Lily Orphan Boy Mine, which has mine wastes spanning the active stream channel.

Metal loads generally increased downstream during high flows. Numerous tributaries affected by historical mining join the mainstem between TGH-2B and TGH-3A (**Figure 7-6**) resulting in additional loading; while concentrations remained similar across the two sites, flows doubled. Even if loading inputs from O'Keefe Creek and Telegraph Creek's headwaters were reduced to meet TMDLs, cadmium, copper and lead would still exceed targets at TGH-3A; thus, reductions are required throughout the entire watershed. While low flow exceedances were observed in the headwaters, no metals exceeded water quality targets during these times at the downstream sites TGH-3 or TGH-3A. The tendency of high flow exceedances plus high metal concentrations in stream sediments indicate that metal loading to upper Telegraph Creek is primarily associated with surface runoff over mine waste and/or mobilization of sediments within the channel, however, low flow exceedances indicate there is also likely a discrete metals source in the upper watershed (i.e. upstream of TGH-2B) .

### TMDLs and Allocations

Because human-related metals loading to upper Telegraph Creek is associated with numerous sources, the wasteload has been broken into three allocations: one for the headwaters region above Telegraph Creek's confluence with O'Keefe Creek ($\mathbf{WLA_{Headwaters}}$), one capturing the inputs below the confluence ($\mathbf{WLA_{Mid}}$) and a third representing metals loading from O'Keefe Creek, which includes loads from Sally Ann Creek ($\mathbf{WLA_{O'Keefe}}$). The $\mathbf{WLA_{O'Keefe}}$ is equivalent to the TMDL calculated for O'Keefe Creek. As shown in **Table 7-24**, flows were used to derive the other wasteload allocations. $\mathbf{WLA_{Headwaters}}$ and $\mathbf{WLA_{Mid}}$ are the product of that stream segment's percent contribution to the remaining discharge at TGH-3A after removing O'Keefe Creek flows, multiplied by the difference between the TMDL and the $\mathbf{LA_{Nat}}$.

**Table 7-24. Flow Weighted WLA Calculations for Upper Telegraph Creek**

| Stream Segment | % of Total High Flow | High Flow WLA Calculation | % of Total Low Flow | Low Flow WLA Calculation |
|---|---|---|---|---|
| Telegraph Creek Headwaters | 15.5% | $WLA_{Headwaters} = 0.155 * (TMDL_{UpTele} - LA_{Nat} - WLA_{O'Keefe})$ | 9% | $WLA_{Headwaters} = 0.09 * (TMDL_{UpTele} - LA_{Nat} - WLA_{O'Keefe})$ |
| Telegraph Creek Mid | 84.5% | $WLA_{Mid} = 0.845 * (TMDL_{UpTele} - LA_{Nat} - WLA_{O'Keefe})$ | 91% | $WLA_{Mid} = 0.91 * (TMDL_{UpTele} - LA_{Nat} - WLA_{O'Keefe})$ |

Due to extensive historic mining in the Telegraph Creek basin, no Telegraph site accurately depicts natural background levels of metals; thus, concentrations from a site on the Little Blackfoot River located upstream of mining activity, LBF-1 (**Figure 7-11**), were used to calculate the natural background load allocation for upper Telegraph Creek, **$LA_{Nat}$**. The average annual precipitation and underlying geology at LBF-1 is comparable to that of Telegraph Creek's basin (**Figures A-4** and **A-9**). Data from TGH-3A were used to calculate existing loads and example TMDLs for Telegraph Creek's upper segment. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-25** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for the upper segment of Telegraph Creek. No reduction is shown in the example for arsenic or beryllium because no exceedances were observed during recent sampling, however, reductions may be necessary under certain flow conditions. While TMDLs are currently being met during low flow conditions, reductions are necessary during high flow.

$$TMDL_{UpTele} = WLA_{Headwaters} + WLA_{Mid} + WLA_{O'Keefe} + LA_{Nat}$$

**MOS = Implicit**

**Table 7-25. Upper Telegraph Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{Headwaters}$ (lbs/day) | $WLA_{Mid}$ (lbs/day) | $WLA_{O'Keefe}$ (lbs/day) |
|---|---|---|---|---|---|---|---|---|
| Arsenic | High flow | 4.869 | 1.461 | 0% | 0.342 | 0.365 | 1.990 | 2.171 |
| | Low flow | 0.103 | 0.015 | 0% | 0.008 | 0.005 | 0.047 | 0.043 |
| Beryllium | High flow | 1.947 | 0.243 | 0% | 0.114 | 0.150 | 0.815 | 0.869 |
| | Low flow | 0.041 | 0.005 | 0% | 0.003 | 0.002 | 0.019 | 0.017 |
| Cadmium | High flow | 0.049 | 0.058 | 17% | 0.009 | 0.003 | 0.015 | 0.022 |
| | Low flow | 0.001 | 0.000 | 0% | 0.000 | 0.000 | 0.001 | 0.000 |
| Copper | High flow | 1.388 | 2.434 | 43% | 0.456 | 0.049 | 0.265 | 0.619 |
| | Low flow | 0.042 | 0.021 | 0% | 0.003 | 0.002 | 0.023 | 0.014 |
| Lead | High flow | 0.263 | 0.682 | 61% | 0.057 | 0.014 | 0.075 | 0.117 |
| | Low flow | 0.010 | 0.003 | 0% | 0.001 | 0.000 | 0.005 | 0.003 |
| Zinc | High flow | 18.024 | 24.343 | 26% | 1.139 | 1.371 | 7.475 | 8.038 |
| | Low flow | 0.544 | 0.206 | 0% | 0.027 | 0.031 | 0.310 | 0.176 |

High flow: 90.16 cfs, 13 mg/L hardness
Low flow: 1.91 cfs, 38 mg/L hardness

## 7.7.7 Telegraph Creek, Lower Segment (MT76G004_052)

### Loading Summary

The primary source of metals loading to lower Telegraph Creek is the load transported from sources in the upper Telegraph Creek watershed (**Section 7.7.6**). The abandoned mine databases indicate that there are no human sources of metals in the lower Telegraph Creek watershed, however, the upper

Telegraph Creek watershed has numerous abandoned mines as described in **Section 7.5.6**. Concentrations of metals in lower Telegraph Creek only exceeded water quality targets during high flow conditions, which differs slightly from the upper segment (which also had low flow exceedances); this is likely due to dilution occurring as the distance increases from metals sources along the upper segment. During the May 2009 sampling event, over 90% of the loading for all metals of concern observed at TCH-4 (**Figure 7-7**) were present in the upper segment site TGH-3A (**Figure 7-6**). The upper segment's influence is likely even higher because TGH-3A is upstream from some of the abandoned mines in the upper watershed (**Figure 7-6**). For example, a tributary potentially impacted by the Third Term Mine (a priority abandoned mine) enters upper Telegraph Creek below TGH-3A. Surface water samples of the tributary, although over ten years old, had target exceedances for all metals of concern including mercury. Thus, the Third Term Mine could be a source of mercury to lower Telegraphs Creek and should be investigated further. Because metal concentrations and flows remain relatively constant between TGH-3A and TGH-4, over all flow conditions, the resulting loads were similar and there is no significant downstream loading trend. Addressing the human-caused metals sources in the upper Telegraph Creek basin will result in the loading reductions necessary to meet the TMDLs and water quality targets in the lower segment.

### TMDLs and Allocations

Because there are no known point sources of metals in lower Telegraph Creek, a **$\mathbf{WLA}_{\mathbf{LwrTele}}$** was not established. Instead, the TMDL was broken into two allocations: one corresponding to the TMDL attributed to upper Telegraph Creek (**$\mathbf{WLA}_{\mathbf{UpTele}}$**), and another representing the combined load from naturally occurring and historic mining-related nonpoint sources in the lower Telegraph basin (**$\mathbf{LA}_{\mathbf{LwrTele}}$**). The **$\mathbf{LA}_{\mathbf{LwrTele}}$** was identified as the load remaining after subtracting the **$\mathbf{WLA}_{\mathbf{UpTele}}$** from the TMDL. Data from TGH-4 in 2009 had the highest target exceedances and were used to calculate existing loads and example TMDLs for Telegraph Creek's lower segment. However, high flow data from 2009 showed a slight reduction between the last upper Telegraph site and TGH-4 (1.91 cfs vs. 1.63 cfs) that was not present in the 2008 data (1.96 cfs vs. 4.47 cfs). It is assumed this reduction is human induced (e.g. irrigation withdrawal or measurement error), and a corrected TGH-4 flow for May 2009 was estimated to be 4.36 cfs by applying the same percent increase that was observed in 2008. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-26** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for the lower segment of Telegraph Creek. No reduction is shown in the example for mercury because no exceedances were observed during recent sampling, however, reductions may be necessary under certain flow conditions. While TMDLs are currently being met during low flow conditions, reductions are necessary during high flow.

$$\mathbf{TMDL_{LwrTele} = WLA_{UpTele} + LA_{LwrTele}}$$

**MOS = Implicit**

**Table 7-26. Lower Telegraph Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{LwrTele}$ (lbs/day) | $WLA_{UpTele}$ (lbs/day) |
|---|---|---|---|---|---|---|
| Cadmium | High flow | 0.050 | 0.056 | 9% | 0.002 | 0.049 |
| | Low flow | 0.003 | 0.001 | 0% | 0.002 | 0.001 |
| Copper | High flow | 1.439 | 2.525 | 43% | 0.051 | 1.388 |
| | Low flow | 0.105 | 0.047 | 0% | 0.063 | 0.042 |
| Lead | High flow | 0.273 | 0.707 | 61% | 0.010 | 0.263 |
| | Low flow | 0.025 | 0.006 | 0% | 0.015 | 0.010 |

**Table 7-26. Lower Telegraph Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{LwrTele}$ (lbs/day) | $WLA_{UpTele}$ (lbs/day) |
|---|---|---|---|---|---|---|
| Mercury | High flow | 0.025 | 0.013 | 0% | 0.001 | 0.024 |
| | Low flow | 0.0012 | 0.000 | 0% | 0.001 | 0.0005 |
| Zinc | High flow | 18.691 | 25.245 | 26% | 0.668 | 18.024 |
| | Low flow | 1.353 | 0.471 | 0% | 0.808 | 0.544 |

High flow: 93.5 cfs, 16 mg/L hardness
Low flow: 4.36 cfs, 42 mg/L hardness

## 7.7.8 American Gulch Creek (MT76G004_079)

### Loading Summary

The primary source of metals loading to American Gulch Creek is a cluster of abandoned mines in the headwaters region. The single American Gulch Creek sample site, DOG-3 (**Figure 7-8**), does not allow downstream loading along the segment to be analyzed but all four samples collected over both flow conditions at DOG-3 had arsenic concentrations that exceeded water quality targets. Between May and July 2008, arsenic concentrations remained the same (14 µg/L); in the second year of sampling the concentration of arsenic was higher during low flow (16 µg/L vs. 13 µg/L). Unlike most stream segments in the Little Blackfoot TPA, metals target exceedances were consistently observed in American Gulch Creek during both flow conditions. In addition, water hardness values, which are strongly influenced by groundwater inputs, were higher as a consequence of the unique geology underlying the greater Dog Creek Watershed (**Figure A-4**). However, hardness did fluctuate between flow conditions indicating that the creek is not entirely controlled by groundwater. Recent sampling did not involve testing for the dissolved fraction of arsenic, which could help identify the arsenic source. Loading to American Gulch Creek includes a discrete source such as groundwater or an adit in addition to the loading associated with surface runoff over mine waste. Another likely source of arsenic loading is the mobilization of sediments within the channel which greatly exceeded secondary targets.

### TMDLs and Allocations

Because all human-related metals loading to American Gulch Creek is associated with mines whose influence cannot be separated, a single wasteload allocation is provided to abandoned mining sources, **$WLA_{American}$**. The **$WLA_{American}$** was calculated by subtracting **$LA_{Nat}$** from the TMDL. Concentrations from DOG-5 (**Figure 7-10**), a site on Hope Creek located upstream of mining activity in a tributary basin to lower Dog Creek, were used to calculate the natural background load allocation, **$LA_{Nat}$**. Data from DOG-3 were used to calculate existing loads and example TMDLs for American Gulch Creek. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-27** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for American Gulch Creek. Existing loads are not meeting TMDLs during low or high flow conditions, thus reductions are necessary during both scenarios.

**$TMDL_{American} = WLA_{American} + LA_{Nat}$**
**MOS = Implicit**

**Table 7-27. American Gulch Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{American}$ (lbs/day) |
|---|---|---|---|---|---|---|
| Arsenic | High flow | 0.722 | 0.939 | 23% | 0.108 | 0.614 |
| | Low flow | 0.046 | 0.073 | 38% | 0.007 | 0.039 |

High flow: 13.37 cfs, 99 mg/L hardness
Low flow: 0.85 cfs, 149 mg/L hardness

## 7.7.9 Dog Creek, Upper Segment (MT76G004_071)

### Loading Summary

Due to extensive historic mining in the basin, there are numerous sources of metals loading to upper Dog Creek. A review of the data shows that in addition to loading along the mainstem, metals sources also exist on two tributaries, an un-named stream and American Gulch Creek (**Figure 7-9**). DEQ AML collected samples of the un-named tributary and Dog Creek above their confluence in September 2003 that found target exceedances in both streams, but overall load inputs were small due to low flows values. The lowest un-named tributary site, SW3A (**Figure 7-9**), had the highest cadmium and zinc exceedances of any site in the upper Dog Creek basin, but a TMDL for the tributary was not developed due to a lack of samples and spatial/temporal independence; however it is assumed sources in the tributary basin will need to be addressed in order for upper Dog Creek's TMDLs to be met. Although American Gulch Creek discharged more water, had greater arsenic exceedances and supplied a larger load of metals when compared to the un-named tributary, it still did not match Dog Creek's load or target exceedances before their union.

Sites along Dog Creek had arsenic, cadmium, copper, lead and zinc water quality target exceedances during high flow conditions and arsenic, cadmium and lead exceedances during low flow. Between sample sites DOG-1 and DOG-2 (**Figure 7-9**) the concentrations of metals varied but individual metals trended the same regardless of flow conditions; arsenic and lead concentrations increased significantly downstream (indicating the Bald Butte Mine as the primary source of these metals) while cadmium, copper and zinc decrease but remained elevated (indicating the un-named tributary as the primary source of these three metals). Cadmium, copper and zinc also greatly exceeded water quality targets in the Devon/Sterling Mine's adit discharge; zinc was nearly 15 times over the human health standard and nearly all of the zinc recovered in Dog Creek was the dissolved fraction. These exceedances in the adit water discharging into the un-named tributary support the identification of the un-named tributary as the principal source of cadmium, copper and zinc. Discharging adits are likely a source of loading during low flow conditions as well as leaching of metals into the groundwater from Bald Butte Mine wastes located in the Dog Creek floodplain (Olympus Technical Services, Inc., 2004). These floodplain materials can also contribute to loading when they are inundated during high flows, at which time mobilization of metals in stream channel sediments (which were extensively sampled and consistently tested high) likely occurs. Note all Dog Creek data used for example TMDL calculations were collected before the start of reclamation on the Bald Butte and Devon/Sterling Mine sites. Water quality conditions could change from what is presented in this document as a result.

### TMDLs and Allocations

Because human-related metals loading to upper Dog Creek is associated with numerous sources, the wasteload has been broken into two allocations: one for contributions from American Gulch Creek (**$WLA_{American}$**) and a second representing metals loading from the upper Dog Creek mainstem (**$WLA_{UpDog}$**). The **$WLA_{American}$** is equivalent to the American Gulch Creek TMDL provided in **Section 7.7.8** and **$WLA_{UpDog}$**

was calculated by subtracting **$WLA_{American}$** and **$LA_{Nat}$** from the TMDL. Concentrations from DOG-5 (**Figure 7-10**), a site on Hope Creek located upstream of mining activity in a tributary basin to lower Dog Creek, were used to calculate the natural background load allocation, **$LA_{Nat}$**. Data from DOG-2 and DOG-3 were combined to estimate existing loads and example TMDLs below the confluence of American Gulch Creek and upper Dog Creek. No reductions are shown in the example for copper or zinc because of restrictions applied on data collection dates as a result of calculating TMDLs below American Gulch Creek, however, exceedances of these metals were observed at other times during recent sampling and reductions may be necessary under certain conditions. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-28** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for upper Dog Creek. Existing loads are not meeting TMDLs during low or high flow conditions, thus reductions are necessary during both scenarios.

$$TMDL_{UpDog} = WLA_{UpDog} + WLA_{American} + LA_{Nat}$$
**MOS = Implicit**

**Table 7-28. Upper Dog Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{UpDog}$ (lbs/day) | $WLA_{American}$ (lbs/day) |
|---|---|---|---|---|---|---|---|
| Arsenic | High flow | 1.439 | 1.871 | 23% | 0.108 | 0.610 | 0.722 |
| | Low flow | 0.097 | 0.253 | 62% | 0.008 | 0.044 | 0.046 |
| Cadmium | High flow | 0.039 | 0.103 | 62% | 0.003 | 0.016 | 0.019 |
| | Low flow | 0.004 | 0.002 | 0% | 0.000 | 0.002 | 0.002 |
| Copper | High flow | 1.331 | 1.079 | 0% | 0.143 | 0.520 | 0.668 |
| | Low flow | 0.133 | 0.043 | 0% | 0.003 | 0.070 | 0.060 |
| Lead | High flow | 0.452 | 1.430 | 68% | 0.036 | 0.189 | 0.227 |
| | Low flow | 0.055 | 0.079 | 30% | 0.001 | 0.029 | 0.024 |
| Zinc | High flow | 17.097 | 10.791 | 0% | 0.359 | 8.161 | 8.577 |
| | Low flow | 1.702 | 0.228 | 0% | 0.026 | 0.905 | 0.771 |

High flow: 26.65 cfs, 99 mg/L hardness
Low flow: 1.8 cfs, 156.5 mg/L hardness

## 7.7.10 Dog Creek, Lower Segment (MT76G004_072)

### Loading Summary

While there are abandoned mines in the lower Dog Creek basin, the primary source of metals loading is the load transported from upper Dog Creek (**Section 7.7.9**). During low flow conditions, copper and lead concentrations in lower Dog Creek were above natural background levels but did not exceed targets; the only time exceedances occurred was during spring runoff. Between DOG-2 (**Figure 7-10**), the lowest site on the upper segment, and DOG-8, metal concentrations decreased in all scenarios; over this same reach loads increased because flows increased by an average factor of nine for low flows and 14 for high flows. Although most of the loading is coming from the upper segment, even if loading inputs from upper Dog Creek were reduced to meet TMDLs, water quality targets would still be exceeded at DOG-8; thus, reductions are also required within the lower watershed. The tendency of high flow exceedances plus high lead concentrations in stream sediments indicate that metal loading to Dog Creek is associated with surface runoff over mine waste and/or mobilization of sediments within the channel.

### TMDLs and Allocations

Because human-related metals loading to lower Dog Creek is associated with multiple sources, the wasteload has been broken into two allocations: one for contributions from upper Dog Creek (**$WLA_{UpDog}$**)

and a second for lower Dog Creek (**$WLA_{LwrDog}$**). The **$WLA_{UpDog}$** is equivalent to the upper Dog Creek TMDL provided in **Section 7.7.9** and **$WLA_{LwrDog}$** was calculated by subtracting **$WLA_{UpDog}$** and **$LA_{Nat}$** from the TMDL. Concentrations from DOG-5 (**Figure 7-10**), a site on Hope Creek located upstream of mining activity, were used to calculate the natural background load allocation, **$LA_{Nat}$**. Data from DOG-8 were used to calculate existing loads and example TMDLs for lower Dog Creek. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-29** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for lower Dog Creek. While TMDLs are currently being met during low flow conditions, reductions are necessary during high flow.

**$TMDL_{LwrDog} = WLA_{LwrDog} + WLA_{UpDog} + LA_{Nat}$**
**MOS = Implicit**

**Table 7-29. Lower Dog Creek Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{LwrDog}$ (lbs/day) | $WLA_{UpDog}$ (lbs/day) |
|---|---|---|---|---|---|---|---|
| Copper | High flow | 6.779 | 9.359 | 28% | 2.386 | 3.061 | 1.331 |
| | Low flow | 0.787 | 0.197 | 0% | 0.028 | 0.626 | 0.133 |
| Lead | High flow | 1.711 | 8.557 | 80% | 0.597 | 0.663 | 0.452 |
| | Low flow | 0.304 | 0.112 | 0% | 0.014 | 0.235 | 0.055 |

High flow: 247.6 cfs, 49 mg/L hardness
Low flow: 12.17 cfs, 134 mg/L hardness

## 7.7.11 Little Blackfoot River, Upper Segment (MT76G004_020)

### Loading Summary

Due to extensive historic mining in the basin, there are numerous sources of metals loading to the Little Blackfoot River's upper segment. A review of the data shows that among other sources, Ontario Creek (**Section 7.7.3**) and Telegraph Creek (**Section 7.7.7**) contribute significant loading. Water quality standards in the upper Little Blackfoot River were only exceeded during high flows, except for two arsenic samples collected below the Charter Oak Mine that exceeded standards during low flow. No metal water quality targets were exceeded at LBF-1 (**Figure 7-11**) above Ontario Creek's confluence but concentrations and loads increased downstream. The highest exceedances were observed at LBF-4, below the Kimball and Golden Anchor Mines, which have piles of fine-grain waste rock in the floodplain (Hargrave, et al., 1998). During the 2008 high flow sampling event, flows between sites LBF-3 and LBF-4 decreased. This anomaly can be explained by a combination of factors including errors in using the float method to estimate velocity when streams were deemed unsafe to wade (Hydrosolutions Inc., 2010), effects of irrigation withdrawals and/or naturally loosing reaches. A study investigating groundwater-surface water interactions between Elliston and Avon on the Little Blackfoot River's lower segment found the mainstem had sections of both seasonally loosing and gaining reaches; similar variation is expected on the upper segment (PBS&J, 2009).

The temporary spike in metals delivered to the Little Blackfoot River associated with the Golden Anchor Mine blowout cannot be converted into loads for further analysis because flow measurements were not collected, and metals concentrations collected by the USFS in the three months following the November 2008 blowout were not used to calculate example TMDLs. Although DEQ samples following the blowout exceeded targets for arsenic, cadmium and copper not seen in the previous spring, 2009 low flow concentrations were much reduced and similar to 2008 low flow concentrations. Primarily because of greater flows, Ontario Creek contributes more loading than Telegraph Creek but the metals concentrations were higher in Telegraph Creek for all metals of concern besides lead. As with the Little

Blackfoot River, metals loading from these tributaries is predominantly occurring during high flow conditions. Even if loading inputs from these two tributaries were reduced to meet TMDLs, water quality targets would still be exceeded at LBF-5 (near Dog Creek); thus, additional metals loading is coming from mining sources along the Little Blackfoot mainstem and reductions are required throughout the entire watershed. The largest metals load input occurred between sites LBF-2 and LBF-4 on the mainstem, over which distance the stream receives contributions from the Charter Oak, Golden Anchor, Kimball, and Mountain View Mines. This source area requires major reductions. The tendency of high flow exceedances plus high metal concentrations in stream sediments and waste rock in the floodplain indicate that metals loading to upper Little Blackfoot River is associated with surface runoff over mine waste and/or mobilization of sediments within the channel.

### TMDLs and Allocations

Because human-related metals loading to the upper Little Blackfoot River is associated with numerous sources, the wasteload has been broken into three allocations: one for Ontario Creek ($\mathbf{WLA_{Ontario}}$), one representing inputs from Telegraph Creek ($\mathbf{WLA_{Tele}}$) and a third capturing metals loading from remaining sources ($\mathbf{WLA_{UpLBF}}$). The $\mathbf{WLA_{Ontario}}$ and $\mathbf{WLA_{Tele}}$ are equivalent to the TMDL calculated for those streams (**Sections 7.7.3** and **7.7.7**). $\mathbf{WLA_{UpLBF}}$ was calculated by subtracting the **WLA**s and $\mathbf{LA_{Nat}}$ from the TMDL. Metals concentrations from site LBF-1, located upstream of mining activity, were used to calculate the natural background load allocation, $\mathbf{LA_{Nat}}$. While concentrations at LBF-4 were slightly higher, data from LBF-5 were used to calculate existing loads and example TMDLs for the upper Little Blackfoot River in order to incorporate loading for the entire basin. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-30** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for the Little Blackfoot River's upper segment. While TMDLs are currently being met during low flow conditions, reductions are necessary during high flow.

$$\mathbf{TMDL_{UpLBF} = WLA_{Ontario} + WLA_{Tele} + WLA_{UpLBF} + LA_{Nat}}$$

**MOS = Implicit**

**Table 7-30. Upper Little Blackfoot River Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{Ontario}$ (lbs/day) | $WLA_{Tele}$ (lbs/day) | $WLA_{UpLBF}$ (lbs/day) |
|---|---|---|---|---|---|---|---|---|
| Arsenic | High flow | 49.039 | 78.462 | 38% | 4.670 | 12.857 | 2.020 | 29.493 |
| | Low flow | 1.939 | 1.551 | 0% | 0.212 | 0.291 | 0.035 | 1.400 |
| Cadmium | High flow | 0.588 | 0.785 | 25% | 0.125 | 0.129 | 0.050 | 0.285 |
| | Low flow | 0.039 | 0.008 | 0% | 0.006 | 0.003 | 0.003 | 0.027 |
| Copper | High flow | 17.752 | 34.327 | 48% | 6.227 | 3.664 | 1.439 | 6.422 |
| | Low flow | 1.252 | 0.388 | 0% | 0.071 | 0.083 | 0.105 | 0.994 |
| Cyanide | High flow | 25.500 | 112.790 | 77% | 7.783 | 3.214 | 1.262 | 13.241 |
| | Low flow | 1.008 | 0.485 | 0% | 0.353 | 0.073 | 0.059 | 0.523 |
| Lead | High flow | 3.825 | 47.077 | 92% | 0.778 | 0.694 | 0.273 | 2.080 |
| | Low flow | 0.357 | 0.048 | 0% | 0.035 | 0.016 | 0.025 | 0.281 |

High flow: 908.13 cfs, 33 mg/L hardness
Low flow: 35.9 cfs, 65 mg/L hardness

## 7.7.12 Little Blackfoot River, Lower Segment (MT76G004_010)

### Loading Summary

While there are abandoned mines in the lower Little Blackfoot River basin, the primary source of metals loading to the lower segment is the load transported from the upper segment (**Section 7.7.11**). All arsenic and lead standard exceedances in the mainstem occurred during high flow conditions except for one lead exceedance in July 2008. Within the lower Little Blackfoot River basin, mining was concentrated in the Carpenter and Ophir Creek drainages; however, recent surface water data collected in that area at CAR-1 and OPH-1 (**Figure 7-12**) did not exceed targets.

Arsenic and lead concentrations generally decrease in the downstream direction. Dissolved lead was identified as a minor portion of the total recoverable concentration, indicating that lead loading is primarily associated with particulates. Samples on six tributaries were also collected to help identify sources and while lead was generally not detected, three out of four arsenic samples on Threemile Creek at THR-1 (**Figure 7-12**) had concentrations equivalent to, but not in excess of the human health standard. Since no target exceedances were observed in these tributaries and because the site highest in the watershed (LBF-7) had the most elevated metal concentrations, it is assumed the upper segment is the primary contributor of metals loading to the Little Blackfoot River's lower segment. That said, even if loading inputs from the upper segment were reduced to meet TMDLs, water quality would still slightly exceeded targets near the mouth of the Little Blackfoot River at LBF-10; thus reductions are required throughout the entire watershed. While abandoned mine databases do not indicate an obvious source, during the high flow 2009 event, metal concentrations increased between LBF-9 and LBF-10. Additional monitoring in the area could help distinguish where the remaining loading is coming from. Similar to the upper segment, flows downstream did not consistently increase or decrease likely due to a combination of factors including errors in using the float method to estimate velocity when streams were deemed unsafe to wade (Hydrosolutions Inc., 2010), effects of irrigation withdrawals and/or naturally losing reaches. A study investigating groundwater-surface water interactions between Elliston and Avon found the Little Blackfoot River had sections of both seasonally losing and gaining reaches (PBS&J, 2009). The tendency of high flow exceedances plus high metal concentrations in stream sediments indicate that metal loading to lower Little Blackfoot River is associated with surface runoff over mine waste and/or mobilization of sediments within the channel. As of October 2011 there was an active general permit for suction dredging (MTG370318) on Carpenter Creek. As discussed in the data review in **Section 7.5.12**, this activity is not anticipated to be a source of metals loading, and it is provided a WLA of 0. This WLA is anticipated to be met by adherence to permit conditions.

### TMDLs and Allocations

Because human-related metals loading to the lower Little Blackfoot River is associated with multiple sources, the wasteload has been broken into three allocations: one for contributions from the upper segment of the Little Blackfoot River ($\mathbf{WLA_{UpLBF}}$), a second representing loads associated with the suction dredge permit on Carpenter Creek ($\mathbf{WLA_{Suction}}$) and a third capturing metals loading from other sources within the lower Little Blackfoot River ($\mathbf{WLA_{LwrLBF}}$). The $\mathbf{WLA_{UpLBF}}$ is equivalent to the upper Little Blackfoot River TMDL provided in **Section 7.7.11** and $\mathbf{WLA_{LwrLBF}}$ was calculated by subtracting $\mathbf{WLA_{UpLBF}}$ and $\mathbf{LA_{Nat}}$ from the TMDL. Concentrations from SPD-1 (**Figure 7-12**), a site on Spotted Dog Creek, were used to calculate the natural background load allocation, $\mathbf{LA_{Nat}}$. While concentrations at LBF-7 were slightly higher, data from LBF-10 were used to calculate existing loads and example TMDLs for the lower Little Blackfoot River in order to incorporate loading for the entire basin. A **MOS** is addressed through implicit considerations (**Section 7.8**). **Table 7-31** summarizes TMDL components and shows example TMDLs and allocations for high and low flow conditions for the lower Little Blackfoot River. While TMDLs are currently being met during low flow conditions, reductions are necessary during high flow.

$$\mathbf{TMDL_{Lwr\ LBF} = WLA_{UpLBF} + WLA_{Suction} + WLA_{LwrLBF} + LA_{Nat}}$$

**MOS = Implicit**

**Table 7-31. Lower Little Blackfoot River Metals TMDLs and Allocation Examples**

| Metal | Flow | TMDL (lbs/day) | Existing Load (lbs/day) | Percent Reduction | $LA_{Nat}$ (lbs/day) | $WLA_{UpLBF}$ (lbs/day) | $WLA_{Suction}$ (lbs/day) MTG370318 | $WLA_{LwrLBF}$ (lbs/day) |
|---|---|---|---|---|---|---|---|---|
| Arsenic | High flow | 83.997 | 117.596 | 29% | 13.983 | 49.039 | 0.000 | 20.975 |
| | Low flow | 3.143 | 1.571 | 0% | 0.361 | 1.939 | 0.000 | 0.843 |
| Lead | High flow | 16.043 | 77.277 | 79% | 0.874 | 3.825 | 0.000 | 11.344 |
| | Low flow | 1.505 | 0.079 | 0% | 0.030 | 0.357 | 0.000 | 1.118 |

High flow: 1555.5 cfs, 67 mg/L hardness
Low flow: 58.2 cfs, 138 mg/L hardness

## 7.8 SEASONALITY AND MARGIN OF SAFETY

All TMDL documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin of safety into the load allocation process to account for uncertainties in pollutant sources and other watershed conditions, and ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. This section describes the considerations of seasonality and a margin of safety in the Little Blackfoot TPA metal TMDL development process.

### Seasonality

Seasonality addresses the need to ensure year round beneficial use support. Seasonality was considered for assessing loading conditions and for developing water quality targets, TMDLs, and allocation schemes. For metals TMDLs, seasonality is critical due to varying metals loading pathways and varying water hardness during high and low flow conditions. Loading pathways associated with overland flow and erosion of metals-contaminated soils and wastes tend to be the major cause of elevated metals concentrations during high flows, with the highest concentrations and metals loading typically occurring during the rising limb of the hydrograph. Loading pathways associated with groundwater transport and/or adit discharges tend to be the major cause of elevated metals concentrations during low or base flow conditions. Hardness tends to be lower during higher flow conditions, thus leading to lower water quality standards for some metals during the runoff season. Seasonality is addressed in this document as follows:

- Metals concentrations and loading conditions are evaluated for both high flow and low flow conditions.
- Metals TMDLs incorporate streamflow as part of the TMDL equation.
- Metals targets apply year round, with monitoring criteria for target attainment developed to address seasonal water quality extremes associated with loading and hardness variations.
- TMDLs and load reduction needs are developed for high and low flow conditions.

### Margin of Safety (MOS)

The margin of safety is to ensure that TMDLs and allocations are sufficient to sustain conditions that will support beneficial uses. All metals TMDLs incorporate an implicit MOS in several ways. The implicit margin of safety is applied by using conservative assumptions throughout the TMDL development process and is addressed by the following:

- Target attainment, refinement of load allocations, and, in some cases, impairment validations and TMDL-development decisions are all based on an adaptive management approach that relies on future monitoring and assessment for updating planning and implementation efforts.

- Chronic standards were used to calculate a daily load limit rather than a 96-hour load limit
- Load allocations to background sources were set using sample data from the same sampling event/hydrologic period as the example TMDL, often resulting in a greater allocation to background sources under high flow conditions.
- Sediment metals concentration criteria were used as secondary indicators.

## 7.9 UNCERTAINTY AND ADAPTIVE MANAGEMENT

Uncertainties in the accuracy of field data, applicable target values, source assessments, loading calculations, modeling assumptions, and other considerations are inherent when assessing and evaluating environmental variables for TMDL development. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainties through adaptive management approaches is a key component of ongoing TMDL implementation and evaluation. Uncertainties, assumptions, and considerations are addressed throughout this document and point to the need to refine analysis, conduct further monitoring, and address unknowns in order to develop better understanding of impairment conditions and the processes that affect impairment. This process of adaptive management is predicated on the premise that targets, TMDLs, allocations, and the analyses supporting them are not static, but are processes subject to modification and adjustment as new information and relationships are understood.

The adaptive management process allows for continual feedback on the progress of restoration activities and status of beneficial uses. It provides the flexibility to refine targets as necessary to ensure protection of the resource or to adapt to new information concerning target achievability. For instance, as a result of additional monitoring and source refinement discussed in the **Section 10.0**, additional WLAs may be necessary for abandoned mines that are found to be discrete sources and the allocations and margin of safety may be modified. Components may be changed to improve ways of achieving and measuring success. A restoration and monitoring plan is closely linked to the adaptive management process and is described in detail in **Sections 10.1**.

The water quality restoration targets and associated metals TMDLs developed for the Little Blackfoot TPA are based on future attainment of the B-1 classification water quality standards. In order to achieve attainment, all significant sources of metal loading must be addressed via all reasonable land, soil, and water conservation practices. It is recognized however, that in spite of all reasonable efforts, attainment of restoration targets may not be possible due to the potential presence of unalterable human-caused sources and/or natural background sources of metals loading. For this reason, an adaptive management approach is adopted for all metals targets described within this document. Under this adaptive management approach, all metals identified in this plan as requiring TMDLs will ultimately fall into one of the three categories identified below:

- Implementation of restoration activities resulting in full attainment of restoration targets for all parameters;
- Implementation of restoration activities fails to result in target attainment due to underperformance or ineffectiveness of restoration actions. Under this scenario the waterbody remains impaired and will require further restoration efforts associated with the pollutants of concern. The target may or may not be modified based on additional information, but conditions still exist that require additional pollutant load reductions to support beneficial uses and meet applicable water quality standards. This scenario would require some form of additional, refocused restoration work.

- Implementation of restoration activities fails to result in target attainment, but target attainment is deemed unachievable even though all applicable monitoring and restoration activities have been completed. Under this scenario, site-specific water quality standards and/or the reclassification of the waterbody may be necessary. This would then lead to a new target (and TMDL) for the pollutant(s) of concern, and the new target could either reflect the existing conditions at the time or the anticipated future conditions associated with the restoration work that has been performed.

The DEQ Remediation Division and/or DEQ Standards Program personnel will lead this effort within DEQ to make determinations concerning the appropriateness of specific mine cleanup activities relative to expectations for mining cleanup efforts for any impairment condition associated with mining impacts. This includes consideration of appropriate evaluation of cleanup options, actual cleanup planning and design, as well as the appropriate performance and maintenance of the cleanup activities. Where NPDES permitted point sources are involved, the DEQ Permitting Program will also be involved. Determinations on the performance of all aspects of restoration activities, or lack thereof, will then be used along with available in-stream data to evaluate the appropriateness of any given target and beneficial use support. Reclamation activities and monitoring conducted by other parties, including but not limited to the USFS, should be incorporated into the process as well. The information will also help determine any further cleanup/load reduction needs for any applicable waterbody and will ultimately help determine the success of water quality restoration.

It is acknowledged that construction or maintenance activities related to restoration, construction/maintenance, and future development may result in short term increase in surface water metals concentrations. For any activities that occur within the stream or floodplain, all appropriate permits should be obtained before commencement of the activity. Federal and State permits necessary to conduct work within a stream or stream corridor are intended to protect the resource and reduce, if not completely eliminate, pollutant loading or degradation from the permitted activity. The permit requirements typically have mechanisms that allow for some short term impacts to the resource, as long as all appropriate measures are taken to reduce impact to the least amount possible.

# 8.0 OTHER IDENTIFIED ISSUES OR CONCERNS

## 8.1 POLLUTION LISTINGS

Water quality issues are not limited simply to those streams where TMDLs are developed. In some cases, streams have not yet been reviewed through the assessment process and do not appear on the 303(d) List. In other cases, streams in the Little Blackfoot TPA may appear on the 303(d) List but may not always require TMDL development for a pollutant, but do have pollution listings such as “alteration in stream-side or littoral vegetation covers” that could be linked to a pollutant. These habitat related pollution causes are often associated with sediment issues, may be associated with nutrient or temperature issues, or may be having a deleterious effect on a beneficial use without a clearly defined quantitative measurement or direct linkage to a pollutant to describe that impact. Nevertheless, the issues associated with these streams are still important to consider when working to improve water quality conditions in individual streams, and the Little Blackfoot River watershed as a whole. In some cases, pollutant and *pollution* causes are listed for waterbody, and the management strategies as incorporated through the TMDL development for the pollutant, inherently address some or all of the pollution listings. **Table 8-1** presents the *pollution* listings in the Little Blackfoot TPA, and notes those streams listed that either do not have any associated pollutant listings or a TMDL in this document.

**Table 8-1. Waterbody segments with pollution listings on the 2010 303(d) List**

| Waterbody ID | Stream Segment | 2010 Probable Causes of Impairment |
|---|---|---|
| MT76G004_010 | LITTLE BLACKFOOT RIVER, Dog Creek to the mouth (Clark Fork River) | Alteration in stream side or littoral vegetation covers; Low flow alterations |
| MT76G004_020 | LITTLE BLACKFOOT RIVER, the headwaters to Dog Creek | Alteration in stream side or littoral vegetation covers |
| MT76G004_032 | SPOTTED DOG CREEK, forest boundary to the mouth (Little Blackfoot River) | Alteration in stream side or littoral vegetation covers |
| MT76G004_040 | ELLISTON CREEK, headwaters to the mouth (Little Blackfoot River) | Alteration in stream side or littoral vegetation covers |
| MT76G004_051 | TELEGRAPH CREEK, headwaters to Hahn Creek | Alteration in stream side or littoral vegetation covers |
| MT76G004_071 | DOG CREEK, headwaters to Meadow Creek | Alteration in stream side or littoral vegetation covers |
| MT76G004_072 | DOG CREEK, Meadow Creek to the mouth (Little Blackfoot River) | Alteration in stream side or littoral vegetation covers |
| MT76G004_080 | SNOWSHOE CREEK, headwaters to the mouth (Little Blackfoot River) | Alteration in stream side or littoral vegetation covers; Low flow alterations |
| MT76G004_091 | CARPENTER CREEK, headwaters to Basin Creek* | Alteration in stream side or littoral vegetation covers; Physical substrate habitat alterations; Other anthropogenic substrate alterations |
| MT76G004_092 | CARPENTER CREEK, Basin Creek to the mouth (Little Blackfoot River) | Physical substrate habitat alterations |
| MT76G004_100 | WOODSON GULCH, Trib to Carpenter Creek T11N, R7W, Sec 29* | Physical substrate habitat alterations |
| MT76G004_112 | THREEMILE CREEK, Quigley Ranch Res. to mouth (Little Blackfoot River) | Alteration in stream side or littoral vegetation covers |

* Streams listed for *pollution* only, with no pollutant listings or no TMDL in this document.

### 8.1.2 Pollution Causes of Impairment Descriptions

Pollution listings are often used as a probable cause of impairment when available data at the time of assessment does not necessarily provide a direct quantifiable linkage to a specific pollutant, however non-pollutant sources or indicators do indicate impairment. In some cases the pollutant and pollution categories are linked and appear together in the cause listings, however a pollution category may appear independent of a pollutant listing. The following discussion provides some rationale for the application of the identified pollution causes to a waterbody, and thereby provides additional insight into possible factors in need of additional investigation or remediation.

**Alteration in Stream-side or Littoral Vegetation Covers**

Alteration in stream-side or littoral vegetation covers refers to circumstances where practices along the stream channel have altered or removed riparian vegetation and subsequently affected channel geomorphology and/or stream temperature. Such instances may be riparian vegetation removal for a road or utility corridor, or overgrazing by livestock along the stream. As a result of altering the stream-side vegetation, destabilized banks from loss of vegetative root mass could lead to overwidened stream channel conditions, elevated sediment and/or nutrient loads, and the resultant lack of canopy cover can lead to increased water temperatures.

**Physical Substrate Habitat Alterations**

Physical substrate habitat alterations generally describe cases where the stream channel has been physically altered or manipulated, such as through the straightening of the channel or from human-influenced channel downcutting, resulting in a reduction of morphological complexity and loss of habitat (riffles and pools) for fish and aquatic life. For example, this may occur when a stream channel has been straightened to accommodate roads, agricultural fields, or through placer mine operations.

**Other Anthropogenic Substrate Alterations**

Streams may be listed for other anthropogenic substrate alterations when data indicates impacts to the stream channel have resulted from apparent anthropogenic activities, but parameters related to substrate (pebble counts) do not appear high, and morphological characteristics such as width/depth or entrenchment are also within expected values. For example, this would take place in a system where the reduction or historic reduction of vegetation capable of producing large woody debris has occurred, in a system where large woody debris is integral to pool development (quality and quantity) and channel function.

**Low Flow Alterations**

Streams are typically listed for low flow alterations when irrigation withdrawal management leads to base flows that are too low to support the beneficial uses designated for that system. This could result in dry channels or extreme low flow conditions unsupportive of fish and aquatic life. It could also result in lower flow conditions which absorb thermal radiation more readily and increase stream temperatures, which in turn creates dissolved oxygen conditions too low to support some species of fish.

It should be noted that while Montana law states that TMDLs cannot impact Montana water rights and thereby affect the allowable flows at various times of the year, the identification of low flow alterations as a probable source of impairment does not violate any state or federal regulations or guidance related to stream assessment and beneficial use determination. Subsequent to the identification of this as a probable cause of impairment, it is up to local users, agencies, and entities to improve flows through water and land management.

### 8.1.3 Monitoring and BMPs for Pollution Affected Streams

Streams listed for *pollution* as opposed to a pollutant should not be overlooked when developing watershed management plans. Attempts should be made to collect sediment, nutrient, and temperature information where data is minimal and the linkage between probable cause, pollution listing, and effects to the beneficial uses are not well defined. The monitoring and restoration strategies that follow in **Sections 9.0** and **10.0** are presented to address both pollutant and non-pollutant issues for streams in the Little Blackfoot TPA with TMDLs in this document, and they are equally applicable to streams listed for the above pollution categories.

## 8.2 POTENTIAL POLLUTANT ISSUES NOT ADDRESSED

Although this document addresses all pollutant listings on the 2010 303(d) List, there are a couple issues where additional investigation is recommended that may warrant TMDL development in the future.

### 8.2.1 Temperature

Although Snowshoe Creek and the lower segment of the Little Blackfoot River are listed for low flow alterations, which is commonly associated with temperature impairment, no temperature data evaluation or TMDLs were included within this document because no waterbodies are listed for temperature impairment. However, temperature data collected in 2007 by DEQ, in 2007/2008 by FWP (Lindstrom, et al., 2008; Liermann, et al., 2009), and over several years at the USGS gage near Garrison indicate temperatures in the Little Blackfoot River may be elevated above temperatures that are harmful to fish at certain times during the summer. It is recommended 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.

### 8.2.2 Aluminum

Metals sampling for TMDL development revealed dissolved aluminum concentrations during runoff conditions that were occasionally slightly above the chronic aquatic life standard. This occurred only during runoff and in drainages with a known history of mining and those without, indicating concentrations may naturally be elevated. Any stream with a history of mining in its watershed that had elevated dissolved aluminum concentrations has numerous metals TMDLs within this document, so if human sources exist, associated loading should be addressed during implementation of those TMDLs. It is recommended that additional monitoring and source characterization be conducted for dissolved aluminum.

# 9.0 RESTORATION OBJECTIVES AND IMPLEMENTATION STRATEGY

While certain land uses and human activities are identified as sources and causes of water quality impairment during TMDL development, the management of these activities is of more concern than the activities themselves. This document does not advocate for the removal of land and water uses to achieve water quality restoration objectives, but instead for making changes to current and future land management practices that will help improve and maintain water quality. This section describes an overall strategy and specific on-the-ground measures designed to restore beneficial water uses and attain water quality standards in Little Blackfoot TPA streams. The strategy includes general measures for reducing loading from each significant identified pollutant source.

## 9.1 WATER QUALITY RESTORATION OBJECTIVES

The following are general water quality goals provided in this TMDL document:

- Provide technical guidance for full recovery of aquatic life beneficial uses to all impaired streams within the Little Blackfoot TPA by improving sediment, nutrient, and metal water quality conditions. This technical guidance is provided by the TMDL components in the document which include:
    - water quality targets,
    - pollutant source assessments, and
    - a restoration and TMDL implementation strategy.

A watershed restoration plan (WRP) can provide a framework strategy for water quality restoration and monitoring in the Little Blackfoot TPA, focusing on how to meet conditions that will likely achieve the TMDLs presented in this document, as well as other water quality issues of interest to local communities and stakeholders. Watershed restoration plans identify considerations that should be addressed during TMDL implementation and should assist stakeholders in developing a more detailed adaptive plan in the future. A locally developed WRP will likely provide more detailed information about restoration goals and spatial considerations but may also encompass more broad goals than this framework includes. A WRP would serve as a locally organized “road map” for watershed activities, sequences of projects, prioritizing of projects, and funding sources for achieving local watershed goals, including water quality improvements. The WRP is intended to be a living document that can be revised based on new information related to restoration effectiveness, monitoring results, and stakeholder priorities. The following are key elements suggested for the WRP:

- Support for implementing restoration projects to protect water conditions so that all streams in the watershed maintain good water quality, with an emphasis on waters with TMDLs completed.
- Detailed cost/benefit analysis and spatial considerations for water quality improvement projects.
- Develop an approach for future BMP installment and efficiency results tracking.
- Provide information and education components to assist with stakeholder outreach about restoration approaches, benefits, and funding assistance.
- Other various watershed health goals, such as weed control initiatives.
- Other local watershed based issues.

## 9.2 AGENCY AND STAKEHOLDER COORDINATION

Successful implementation requires collaboration among private landowners, land management agencies, and other stakeholders. The DEQ does not implement TMDL pollutant reduction projects for nonpoint source activities, but can provide technical and financial assistance for stakeholders interested in improving their water quality. The DEQ will work with participants to use the TMDLs as a basis for developing locally-driven WRPs, administer funding specifically to help fund water quality improvement and pollution prevention projects, and can help identify other sources of funding.

Because most nonpoint source reductions rely on voluntary measures, it is important that local landowners, watershed organizations, and resource managers continue to work collaboratively with local and state agencies to achieve water quality restoration which will progress toward meeting water TMDL targets and load reductions. Specific stakeholders and agencies that have been, and will likely continue to be, vital to restoration efforts include the Little Blackfoot Watershed Group, Watershed Restoration Coalition of the Upper Clark Fork, Clark Fork Coalition, Deer Lodge Conservation District, USFS, NRCS, DNRC, FWP, NRDP, EPA and DEQ. Other organizations and non-profits that may provide assistance through technical expertise, funding, educational outreach, or other means include Montana Water Center, University of Montana Watershed Health Clinic, and MSU Extension Water Quality Program.

## 9.3 RESTORATION STRATEGY BY POLLUTANT

This section summarizes the primary restoration strategy for each pollutant with TMDLs in this document as well as some general information on restoration of non-pollutant impairments.

### 9.3.1 Sediment Restoration Strategy

The goal of the sediment restoration strategy is to prevent the availability, transport, and delivery of sediment by a combination of minimizing sediment delivery, reducing the rate of runoff, and intercepting sediment transport. Streamside riparian vegetation restoration and long term riparian area management are vital restoration practices that must be implemented across the watershed to achieve the sediment TMDLs. Vigorous native streamside riparian vegetation filters sediment from upland runoff and improves streambank stability and slows bank erosion. Sediment is also deposited more heavily in healthy riparian zones during flooding because water velocities slow in these areas enough for excess sediment to settle out.

Improved grazing management is another major component of the sediment restoration approach. This may include adjusting the timing and duration of grazing, the development of multi-pasture systems that include riparian pastures, and the development of off-site watering areas. Additionally, grazing management, combined with some additional fencing costs in many riparian areas, would promote natural recovery. Active vegetation planting along with bank sloping may increase costs, but still remains within a reasonable and relatively cost effective restoration approach. When stream channel restoration work is needed because of altered stream channels, costs increase and projects should be assessed on a case by case basis. In general, these are sustainable agricultural practices that promote attainment of conservation objectives while meeting agricultural production goals. The appropriate BMPs will differ by landowner and are recommended to be part of a comprehensive farm/ranch plan.

Although roads may be a small source of sediment at the watershed scale, sediment derived from roads may cause significant localized impact in some stream reaches. Restoration approaches for unpaved roads near streams should be to divert water off of roads and ditches before it enters the stream. The diverted water should be routed through natural healthy vegetation, which will act as filter zones for the sediment laden runoff before it enters streams. Sediment loads from culvert failure and culvert caused scour were not assessed by the TMDL source assessment, but should be considered in road sediment restoration approaches.

Historic placer mining activities may have very localized impacts that affect sediment production within the watershed. If found, mining caused sediment sources that can be restored at reasonable costs could be prioritized into the WRP. Any other unknown sediment sources could also be incorporated into the WRP while considering cost and sediment reduction benefits.

All of these best management practices are considered reasonable restoration approaches due to their benefit and generally low costs. Riparian restoration and road erosion control are standard best management practices identified by NRCS, and are not overly expensive to our society. Although the appropriate BMP will vary by waterbody and site, controllable sources and BMP types can be prioritized by watershed to reduce sediment loads in individual streams.

## 9.3.2 Nutrient Restoration Strategy

The goal of the nutrient restoration strategy is to reduce nutrient input to stream channels by increasing the filtering and uptake capacity of riparian vegetation areas, decreasing the amount of bare ground, and limiting the transport of nutrients from rangeland and cropland. Cropland filter strip extension, vegetative restoration, and long-term filter area maintenance are vital BMPs for achieving nutrient TMDLs in predominantly agricultural watersheds. Grazing systems with the explicit goal of increased vegetative post-grazing ground cover are needed to address the same nutrient loading from rangelands. Grazing prescriptions that enhance the filtering capacity of riparian filter areas offer a second tier of controls on the sediment content of upland runoff. Grazing and pasture management adjustments should consider:

1. The timing and duration of near-stream grazing,
2. The spacing and exposure duration of on-stream watering locations,
3. Provision of off-stream site watering areas to minimize near-stream damage and allow impoundment operations that minimize salt accumulations,
4. Active reseeding and rest rotation of locally damaged vegetation stands,
5. Improved management of irrigation systems and fertilizer applications, and
6. Incorporation of streamside vegetation buffer to irrigated croplands and confined feeding areas

Seasonal livestock confinement areas have a historic precedent for placement near or adjacent to flowing streams. Stream channels were the only available livestock water sources prior to the extension of rural electicity. Although limited in size, their repeated use generates high nutrient concentrations in close proximity to surface waters. Episodic runoff with high nutrient concentrations generates large loads that can settle in pools of intermittent streams and remain bio-available through the growing season. Diversion and routing of confinement runoff to harvestable nutrient uptake areas outside of active water courses are effective controls.

In addition to the agricultural related BMPs, a reduction of sediment delivery from roads and eroding streambanks is another component of the nutrient reduction restoration plan. Additional sediment related BMPs are presented in **Section 9.3.1**.

In general, these are sustainable grazing and cropping practices that can reduce nutrient inputs while meeting production goals. The appropriate combination of BMPs will differ according to landowner preferences and equipment but are recommended as components of comprehensive plan for farm and ranch operators. Sound planning combined with effective conservation BMPs should be sought whenever possible and applied to croplands, pastures and livestock handling facilities. Assistance from resource professionals from various local, state, and federal agencies or non-profit groups is widely available in Montana. The local USDA Service Center and county conservation district offices are geared to offer both planning and implementation assistance.

### 9.3.3 Metals Restoration Strategy

The restoration strategy for metals focuses on regulatory mechanisms and/or programs applicable to the controllable source types present within the watershed; which, for the most part, are associated with historic mining and mining legacy issues. Potential metals loading sources associated with abandoned mines include discharging mine adits and mine waste materials on-site and in-channel. The goal of the metals restoration strategy is to limit the input of metals to stream channels from priority abandoned mine sites and other identified sources of metals impairments. For most of the mining-related sources, additional analysis will likely be required to identify site-specific metals delivery pathways and to develop mitigation plans.

Goals and objectives for future restoration work include the following:

- 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.

### 9.3.4 Pollution Restoration Strategy

Although TMDL development is not required for pollution listings, they are frequently linked to pollutants, and addressing pollution sources is an important component of TMDL implementation. Pollution listings within the Little Blackfoot TPA include alteration in stream-side or littoral vegetative covers, physical substrate habitat alterations, other anthropogenic substrate alterations, and low flow alterations. Typically, habitat impairments are addressed during implementation of associated pollutant TMDLs. Although flow alterations have the most direct link with temperature, adequate flow is also critical for downstream sediment transport and improving the assimilative capacity of streams for sediment, nutrient, and metals inputs. Therefore, if restoration goals within the Little Blackfoot TPA are not also addressing pollution impairments, additional pollution-related BMP implementation should be considered. Habitat and flow BMPs are discussed below in **Section 9.4**.

## 9.4 RESTORATION APPROACHES BY SOURCE CATEGORY

For each major source of human-caused pollutant loads in the Little Blackfoot TPA, general management recommendations are outlined below. The effect of different sources can change seasonally and be dependent on the magnitude of storm/high flow events. Therefore, restoration activities within the Little Blackfoot TPA should focus on all major sources for each pollutant category. Yet, restoration should begin with addressing significant sources where large load reductions can be obtained within each source category. For each major source, BMPs will be most effective as part of a management strategy that focuses on critical areas within the watershed, which are those areas contributing the largest pollutant loads or are especially susceptible to disturbance. The source assessment results provided within **Appendices C - G** and summarized in **Section 5.7, 6.5, and 7.7** provide information that should be used to help determine priorities for each major source type in the watershed and for each of the general management recommendations discussed.

Applying BMPs for existing activities where they are currently needed is the core of TMDL implementation but only forms a part of the restoration strategy. Also important are efforts to avoid future load increases by ensuring that new activities within the watershed incorporate all appropriate BMPs, and ensuring continued implementation and maintenance of those BMPs currently in place or in practice. Restoration might also address other current pollution-causing uses and management practices. In some cases, efforts beyond implementing new BMPs may be required to address key pollutant sources. In these cases, BMPs are usually identified as a first effort followed by an adaptive management approach to determine if further restoration activities are necessary to achieve water quality standards. Monitoring is also an important part of the restoration process; recommendations are outlined in **Section 10.0**.

### 9.4.1 Grazing

Development of riparian grazing management plans should be a goal for landowners in the watershed who are not currently using a plan. Private land owners may be assisted by state, county federal, and local conservation groups to establish and implement appropriate grazing management plans. The goal of riparian grazing management is not to eliminate all grazing in these areas. Nevertheless, in some areas, a more restrictive management strategy may be necessary for a period in order to accelerate re-establishment of a riparian community with the most desirable species composition and structure. Grazing should be managed to provide filtering capacity via adequate groundcover, streambank stability via mature riparian vegetation communities, and shading from mature riparian climax communities.

Grazing management includes the timing and duration of grazing, the development of multi-pasture systems, including riparian pastures, and the development of off-site watering areas. The key strategy of the recommended grazing BMPs is to develop and maintain healthy riparian vegetation and minimize disturbance of the streambank and channel. The primary recommended BMPs for the Little Blackfoot TPA are providing off-site watering sources, limiting livestock access to streams, providing “water gaps” where livestock access to a stream is necessary, planting woody vegetation along streambanks, and establishing riparian buffers. Although passive restoration via new grazing plans or limited bank revegetation are a preferred BMPs, in some instances, bank stabilization may be necessary prior to planting vegetation. Other general grazing management recommendations and BMPs to address grazing sources of pollutants and pollution can be obtained in Appendix A of Montana’s NPS Management Plan (Montana Department of Environmental Quality, 2007).

### 9.4.2 Small Acreages

Small acreages are growing rapidly, and many small acreage owners own horses or cattle. Animals grazing on small acreages can lead to overgrazing and a shortage of grass cover, leaving the soil subject to erosion and runoff to surface waters. General BMP recommendations for small acreage lots with animals include creating drylots, developing a rotational grazing system, and maintaining healthy riparian buffers. Small acreage owners should collaborate with MSU Extension Service, NRCS, conservation districts and agriculture organizations to develop management plans for their lots. Further information may be obtained from the Montana Nonpoint Source Management Plan (Montana Department of Environmental Quality, 2007) or the MSU extension website at: http://www.msuextension.org/ruralliving/Index.html.

### 9.4.3 Animal Feeding Operations

Animal feeding operations (AFOs) can pose a number of risks to water quality. To minimize water quality effects from AFOs, the USDA and EPA released the Unified National Strategy for AFOs in 1999 (U.S. Department of Agriculture and U.S. Environmental Protection Agency, 1999). This plan is a written document detailing manure storage and handling systems, surface runoff control measures, mortality management, chemical handling, manure application rates, schedules to meet crop nutrient needs, land management practices, and other options for manure disposal. An AFO that meets certain specified criteria is referred to as a Concentrated Animal Feeding Operation (CAFO), and in addition may be required to obtain a Montana Pollution Discharge Elimination System (MPDES) permit as a point source. Montana's AFO compliance strategy is based on federal law and has voluntary, as well as, regulatory components. If voluntary efforts can eliminate discharges to state waters, in some cases no direct regulation is necessary through a permit. Operators of AFOs may take advantage of effective, low cost practices to reduce potential runoff to state waters, which additionally increase property values and operation productivity. Properly installed vegetative filter strips, in conjunction with other practices to reduce wasteloads and runoff volume, are very effective at trapping and detaining sediment and reducing transport of nutrients and pathogens to surface waters, with removal rates approaching 90 percent (U.S. Department of Agriculture and U.S. Environmental Protection Agency, 1999). Other options may include clean water diversions, roof gutters, berms, sediment traps, fencing, structures for temporary manure storage, shaping, and grading. Animal health and productivity also benefit when clean, alternative water sources are installed to prevent contamination of surface water.

Opportunities for financial and technical assistance (including comprehensive nutrient management plan development) in achieving voluntary AFO and CAFO compliance are available from conservation districts and NRCS field offices. Voluntary participation may aide in preventing a more rigid regulatory program from being implemented for Montana livestock operators in the future.

Further information may be obtained from the DEQ website at: http://www.deq.mt.gov/wqinfo/mpdes/cafo.asp.

Montana's NPS pollution control strategies for addressing AFOs are summarized in the bullets below:

- Work with producers to prevent NPS pollution from AFOs.
- Promote use of State Revolving Fund for implementing AFO BMPs.
- Collaborate with MSU Extension Service, NRCS, and agriculture organizations in providing resources and training in whole farm planning to farmers, ranchers, conservation districts, watershed groups and other resource agencies.
- Encourage inspectors to refer farmers and ranchers with potential nonpoint source discharges to DEQ watershed protection staff for assistance with locating funding sources and grant opportunities for BMPs that meet their needs. (This is in addition to funds available through NRCS and the Farm Bill).
- Develop early intervention of education & outreach programs for small farms and ranches that have potential to discharge nonpoint source pollutants from animal management activities. This includes assistance from the DEQ Permitting Division, as well as external entities such as DNRC, local watershed groups, conservation districts, and MSU Extension.

### 9.4.4 Cropland

The primary strategy of the recommended cropland BMPs is to reduce sediment and nutrient inputs. The major factors involved in decreasing sediment loads are reducing the amount of erodible soil, reducing the rate of runoff, and intercepting eroding soil before it enters waterbodies. The main BMP recommendations for the Little Blackfoot TPA are vegetated filter strips (VFS) and riparian buffers. Both of these methods reduce the rate of runoff, promote infiltration of the soil (instead of delivering runoff directly to the stream), and intercept sediment. Effectiveness is typically about 70 percent for filter strips and 50 percent for buffers (Montana Department of Environmental Quality, 2007). Filter strips and buffers are most effective when used in conjunction with agricultural BMPs that reduce the availability of erodible soil such as conservation tillage, crop rotation, strip cropping, and precision farming. Filter strips along streams should be composed of natural vegetative communities which will also supply shade to reduce instream temperatures. Filter strips widths along streams should be at least double the average mature canopy height to assist in providing stream shade. Additional BMPs and details on the suggested BMPs can be obtained from NRCS and in Appendix A of Montana's NPS Management Plan (Montana Department of Environmental Quality, 2007).

### 9.4.5 Irrigation

Flow alteration and dewatering are commonly considered water quantity rather than water quality issues. However, changes to stream flow can have a profound effect on the ability of a stream to attenuate pollutants, especially nutrients, metals and heat. Flow reduction may increase water temperature, allow pollutants to accumulate in stream channels, reduce available habitat for fish and other aquatic life, and may cause the channel to respond by changing in size, morphology, meander pattern, rate of migration, bed elevation, bed material composition, floodplain morphology, and streamside vegetation if flood flows are reduced (Andrews and Nankervis, 1995; Schmidt and Potyondy, 2004). Local coordination and planning are especially important for flow management because State law indicates that legally obtained water rights cannot be divested, impaired, or diminished by Montana's water quality law (MCA 75-5-705).

The SWAT model indicated that improving irrigation efficiency will reduce nitrogen loading to streams in the Little Blackfoot River watershed. Improvements should focus on how to reduce the amount of stream water diverted during July and August, while still growing crops on traditional cropland. It may be desirable to investigate irrigation practices earlier in the year that promote groundwater return during July and August. Understanding irrigation water, groundwater and surface water interactions is an important part of understanding how irrigation practices will affect stream flow during specific seasons. Although additional investigation of inefficiencies in the irrigation network is needed to obtain the most improvement, potential changes are as follows:

- Install upgraded head gates for more exact control of water diversions and to minimize leakage when not in operation.
- Develop more efficient means to supply water to livestock.
- Determine necessary amounts of water to divert that would reduce over watering and improve forage quality and production.
- Redesign irrigation systems.
- Upgrade ditches (including possible lining) to increase ditch conveyance efficiency.

### 9.4.6 Riparian Areas and Floodplains

Riparian areas and floodplains are critical for wildlife habitat, groundwater recharge, reducing the severity of floods and upland and streambank erosion, and filtering pollutants from runoff. Therefore, enhancing and protecting riparian areas and floodplains within the watershed should be a priority of TMDL implementation in the Little Blackfoot TPA.

Initiatives to protect riparian areas and floodplains will help protect property, increase channel stability, and buffer waterbodies from pollutants. However, in areas with a much smaller buffer or where historical vegetation removal and development have shifted the riparian vegetation community and limited its functionality, a tiered approach for restoring stream channels and adjacent riparian vegetation should be considered that prioritizes areas for restoration based on the existing condition and potential for improvement. In non-conifer dominated areas, the restoration goals should focus on restoring natural shrub cover on streambanks to riparian vegetation target levels associated with the sediment and nutrient TMDLs. Passive riparian restoration is preferable, but in areas where stream channels are unnaturally stable or streambanks are eroding excessively, active restoration approaches, such as channel design, woody debris and log vanes, bank sloping, seeding, and shrub planting may be needed. Factors influencing appropriate riparian restoration would include the severity of degradation, site-potential for various species, and the availability of local sources as transplant materials. In general, riparian plantings would promote the establishment of functioning stands of native riparian species. Weed management should also be a dynamic component of managing riparian areas.

The use of riprap or other “hard” approaches is not recommended and is not consistent with water quality protection or implementation of this plan. Although they may be absolutely necessary in some instances, these “hard” approaches generally redirect channel energy and exacerbate erosion in other places. Bank armoring should be limited to areas with a demonstrated infrastructure threat. Where deemed necessary, apply bioengineered bank treatments to induce vegetative reinforcement of the upper bank, reduce stream scouring energy, and provide shading and cover habitat.

### 9.4.7 Unpaved Roads

The road sediment reductions in this document represent an estimation of the sediment load that would remain once appropriate road BMPs were applied at all locations. Achieving this reduction in sediment loading from roads may occur through a variety of methods at the discretion of local land managers and restoration specialists. Road BMPs can be found on the Montana DEQ or DNRC websites and within Montana’s Nonpoint Source Management Plan (Montana Department of Environmental Quality, 2007). Examples include:

- Providing adequate ditch relief up-grade of stream crossings.
- Constructing waterbars, where appropriate, and up-grade of stream crossings.
- Instead of cross pipes, using rolling dips on downhill grades with an embankment on one side to direct flow to the ditch. When installing rolling dips, ensure proper fillslope stability and sediment filtration between the road and nearby streams.
- Insloping roads along steep banks with the use of cross slopes and cross culverts.
- Outsloping low traffic roads on gently sloping terrain with the use of a cross slope.
- Using ditch turnouts and vegetative filter strips to decrease water velocity and sediment carrying capacity in ditches.
- For maintenance, grade materials to the center of the road and avoid removing the toe of the cutslope.
- Preventing disturbance to vulnerable slopes.

- Using topography to filter sediments; flat, vegetated areas are more effective sediment filters.
- Where possible, limit road access during wet periods when drainage features could be damaged.
- Limit new road stream crossings and the length of near-stream parallel segments to the extent practicable.

### 9.4.7.1 Culverts and Fish Passage

Although there are a lot of factors associated with culvert failure and it is difficult to estimate the true at-risk load, the culvert analysis found that approximately 79% of the culverts were designed to accommodate a 25-year storm event. The allocation strategy for culverts is no loading from culverts as a result of being undersized, improperly installed, or inadequately maintained. The culvert assessment included 15 culverts in the watershed, which is a small percentage of the total culverts, and it is recommended that the remaining culverts be assessed so that a priority list may be developed for culvert replacement. As culverts fail, they should be replaced by culverts that pass a 100 year flood on fish bearing streams and at least 25 year events on non fish bearing streams. Some road crossings may not pose a feasible situation for upgrades to these sizes because of road bed configuration; in those circumstances, the largest size culvert feasible should be used. If funding is available, culverts should be prioritized and replaced prior to failure.

Another consideration for culvert upgrades should be fish and aquatic organism passage. In a coarse assessment of fish passage, all culverts were determined to pose a significant passage risk to juvenile fish at all flows; this suggests that a large percentage of culverts in the watershed are barriers to fish passage. Each fish barrier should be assessed individually to determine if it functions as an invasive species and/or native species barrier. These two functions should be weighed against each other to determine if each culvert acting as a fish passage barrier should be mitigated. Montana FWP can aid in determining if a fish passage barrier should be mitigated, and, if so, can aid in culvert design.

### 9.4.7.2 Traction Sand

Severe winter weather and mountainous roads in the Little Blackfoot River watershed will require the continued use of relatively large quantities of traction sand. Nevertheless, closer evaluation of and adjustments to existing practices should be done to reduce traction sand loading to streams to the extent practicable. The necessary BMPs may vary throughout the watershed and particularly between state and private roads but may include the following:

- Utilize a snow blower to directionally place snow and traction sand on cut/fill slopes away from sensitive environments.
- Increase the use of chemical deicers and decrease the use of road sand, as long as doing so does not create a safety hazard or cause undue degradation to vegetation and water quality.
- Improve maintenance records to better estimate the use of road sand and chemicals, as well as to estimate the amount of sand recovered in sensitive areas.
- Continue to fund MDT research projects that will identify the best designs and procedures for minimizing road sand impacts to adjacent bodies of water and incorporate those findings into additional BMPs.
- Street sweeping and sand reclamation.
- Identify areas where the buffer could be improved or structural control measures may be needed.
- Improved maintenance of existing BMPs.
- Increase availability of traction sand BMP training to both permanent and seasonal MDT employees as well as private contractors.

### 9.4.8 Stormwater Construction Permitting and BMPs

Construction activities disturb the soil, and if not managed properly, they can be substantial sources of sediment. Construction activity disturbing one acre or greater is required to obtain permit coverage through DEQ under the Stormwater General Permit for Construction Activities. A Stormwater Pollution Prevention Plan (SWPPP) must be developed and submitted to obtain a permit. A SWPPP identifies pollutants of concern, which is most commonly sediment, construction related sources of those pollutants, any nearby waterbodies that could be affected by construction activities, and BMPs that will be implemented to minimize erosion and discharge of pollutants to waterbodies. The SWPPP must be implemented for the duration of the project, including final stabilization of disturbed areas, which is a vegetative cover of at least 70% of the pre-disturbance level or an equivalent permanent stabilization measure. Development and implementation of a thorough SWPPP should ensure WLAs within this document are met.

Land disturbance activities that are smaller than an acre (and exempt from permitting requirements) also have the potential to be substantial pollutant sources, and BMPs should be used to prevent and control erosion consistent with the upland erosion allocations. Potential BMPs for all construction activities include construction sequencing, permanent seeding with the aid of mulches or geotextiles, check dams, retaining walls, drain inlet protection, rock outlet protection, drainage swales, sediment basin/traps, earth dikes, erosion control structures, grassed waterways, infiltration basins, terraced slopes, tree/shrub planting, and vegetative buffer strips. An EPA support document for the construction permits has extensive information about construction related BMPs, including limitations, costs, and effectiveness (EPA 2009a).

### 9.4.9 Urban Area Stormwater BMPs

Even though Avon and Elliston do not have a large enough population to require a municipal stormwater permit, activities to reduce pollutant loading from new development or redevelopment should be pursued consistent with the upland erosion allocations and efforts to avoid future water quality problems. Any BMPs which promote onsite or after collection infiltration, evaporation, transpiration or reuse of the initial flush stormwater should be implemented as practicable on all new or redevelopment projects. EPA provides more comprehensive information about stormwater best management practices on their website at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm

### 9.4.10 Beaver Populations and Sediment Yields

Historic heavy trapping of beavers has likely had an effect on sediment yields in the watershed. Before the removal of beavers, many streams had a series of catchments that moderated flow, with smaller unincised multiple channels and frequent flooding. Now some stream segments have incised channels and are no longer connected to the floodplain. This results in more bank erosion because high flows scour streambanks to a greater extent instead of flowing onto the floodplain. Beaver ponds also capture and store sediment and there can be large reductions in total suspended solids (TSS) concentrations below a beaver impoundment in comparison to TSS concentrations above the beaver impoundment (Bason, 2004).

Management of headwaters areas should include consideration of beaver habitat. Long-term management could include maintenance of beaver habitat in headwaters protection areas and even allowing for increased beaver populations in areas currently lacking the beaver complexes that can trap sediment, reduce peak flows, and increase summer low flows. Allowing for existing and even increased beaver habitat is considered consistent with the sediment TMDL water quality goals.

### 9.4.11 Forestry and Timber Harvest

Timber harvest activities should be conducted by all landowners according to Forestry BMPs for Montana (Montana State University, Extension Service, 2001) and the Montana Streamside Management Zone (SMZ) Law (77-5-301 through 307 MCA). The Montana Forestry BMPs cover timber harvesting and site preparation, road building including culvert design, harvest design, other harvesting activities, slash treatment and site preparation, winter logging, and hazardous substances. While the SMZ Law is intended to guide commercial timber harvesting activities in streamside areas (i.e., within 50 feet of a waterbody), the riparian protection principles behind the law should be applied to numerous land management activities (i.e., timber harvest for personal use, agriculture, development). Prior to harvesting on private land, landowners or operators are required to notify the Montana DNRC. DNRC is responsible for assisting landowners with BMPs and monitoring their effectiveness. The Montana Logging Association and DNRC offer regular Forestry BMP training sessions for private landowners. .

The SMZ Law protects against excessive erosion and therefore is appropriate for helping meet sediment load allocations. USFS INFISH Riparian Habitat Conservation Area guidelines provide significant sediment protection as well as protection from elevated thermal loading (i.e., elevated temperature) by providing adequate shade. This guidance improves upon Montana’s SMZ law and includes an undisturbed 300 foot buffer on each side of fish bearing streams and 150 foot buffer on each side of non-fish bearing streams with limited exclusions and BMP guidance for timber harvest, roads, grazing, recreation and other human sources (U.S. Department of Agriculture, Forest Service, 1995).

In addition to the BMPs identified above, effects that timber harvest may have on yearly streamflow levels, such as peak flow, should be considered. Water yield and peak flow increases should be modeled in areas of continued timber harvest and potential effects should be evaluated. Furthermore, noxious weed control should be actively pursued in all harvest areas and along all forest roads.

### 9.4.12 Mining

Because restoration of metals sources that are not also associated with sediment and nutrients are typically implemented under state and federal programs, this section will discuss general restoration programs and funding mechanisms that may be applicable to the metals sources instead of specific BMPs. The need for further characterization of impairment conditions and loading sources is addressed through the framework monitoring plan in **Section 10.0**. A number of state and federal regulatory programs have been developed over the years to address water quality problems stemming from historic mines, associated disturbances, and metal refining impacts. Some regulatory programs and approaches considered most applicable to the Little Blackfoot River watershed include:

- The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA),
- The State of Montana Mine Waste Cleanup Bureau’s Abandoned Mine Lands (AML) Reclamation Program,
- The Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA), which incorporates additional cleanup options under the Controlled Allocation of Liability Act (CALA) and the Voluntary Cleanup and Redevelopment Act (VCRA).

### Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)

CERCLA, which is also common referred to as Superfund, is a Federal law that addresses cleanup on sites, such as historic mining areas, where there has been a hazardous substance release or threat of release. Sites are prioritized on the National Priority List (NPL) using a hazard ranking system with significant focus on human health. Under CERCLA, the potentially responsible party or parties must pay for all remediation efforts based upon a liability approach whereby any existing or historical land owner can be held liable for restoration costs. Where viable landowners are not available to fund cleanup, funding can be provided under Superfund authority. Federal agencies can be delegated Superfund authority, but cannot access funding from Superfund.

Cleanup actions under CERCLA must be based on professionally developed plans and can be categorized as either Removal or Remedial. Removal actions can be used to address the immediate need to stabilize or remove a threat where an emergency exists. Removal actions can also be non-time critical.

Once removal activities are completed, a site can then undergo Remedial Actions or may end up being scored low enough from a risk perspective that it no longer qualifies to be on the NPL for Remedial Action. Under these conditions the site is released back to the state for a "no further action" determination. At this point there may still be a need for additional cleanup since there may still be significant environmental threats or impacts, although the threats or impacts are not significant enough to justify Remedial Action under CERCLA. Any remaining threats or impacts would tend to be associated with wildlife, aquatic life, or aesthetic impacts to the environment or aesthetic impacts to drinking water supplies versus threats or impacts to human health. A site could, therefore, still be a concern from a water quality restoration perspective, even after CERCLA removal activities have been completed.

Remedial actions may or may not be associated with or subsequent to removal activities. A remedial action involves cleanup efforts whereby Applicable or Relevant and Appropriate Requirements and Standards (ARARS), which include state water quality standards, are satisfied. Once ARARS are satisfied, then a site can receive a "no further action" determination.

### Montana Mine Waste Cleanup Bureau Abandoned Mine Reclamation Program (AML)

The Mine Waste Cleanup Bureau (MWCB), which is part of the DEQ Remediation Division, is responsible for reclamation of historical mining disturbances associated with abandoned mines in Montana.

The MWCB abandoned mine reclamation program is funded through the Surface Mining Control and Reclamation Act of 1977 (SMCRA) with SMCRA funds distributed to states by the federal government. In order to be eligible for SMCRA funding, a site must have been mined or affected by mining processes, and abandoned or inadequately reclaimed, prior to August 3, 1977 for private lands, August 28, 1974 for Forest Service administered lands, and prior to 1980 for lands administered by the U.S. Bureau of Reclamation. Furthermore, there must be no party (owner, operator, other) who may be responsible for reclamation requirements, and the site must not be located within an area designated for remedial action under the federal Superfund program or certain other programs. The DEQ reclamation priority number or responsible agency for the priority abandoned mines in the Little Blackfoot TPA are listed in **Table 9-1.**

Note: The USFS has removed some mine waste from Charter Oak, Golden Anchor, Hope, Hub Camp, Kimball, Mountain View, Ontario, Third Term and Viking Mines.

**Table 9-1. Priority Abandoned Mine Sites Identified as Potential Sources of Metals Impairments.**

| Priority Abandoned Mine | Watershed | DEQ Priority # or Responsible Agency |
|---|---|---|
| Bald Butte Millsite* | Upper Dog Creek | #3 |
| Lilly/Orphan Boy | Upper Telegraph Creek | #12 |
| Sure Thing | Upper Telegraph Creek | #22 |
| Julia | Upper Telegraph Creek | #42 |
| Anna P./Hattie M. | Upper Telegraph Creek | #48 |
| Golden Anchor | Upper Little Blackfoot | #63 |
| Mountain View | Upper Little Blackfoot | #69 |
| Kimball | Upper Little Blackfoot | #81 |
| Monarch | Monarch Creek | #82 |
| Hard Luck Mine | Ontario Creek | #100 |
| Victory/Evening Star | Ophir Creek (Lower Little Blackfoot River) | #122 |
| Telegraph | Sally Ann Creek | #123 |
| Third Term | Upper Telegraph Creek | #131 |
| Ontario Millsite | Un-named/Ontario Creek | Reclaimed by MWCB |
| Charter Oak | Upper Little Blackfoot | Reclaimed by USFS |

*Currently undergoing reclamation activities

**Montana Comprehensive Environmental Cleanup and Responsibility Act (CECRA)**

Reclamation of historic mining-related disturbances administered by the State of Montana and not addressed under SMCRA, are typically addressed through the DEQ State Superfund or CECRA program. The CECRA program maintains a list of facilities potentially requiring response actions based on the confirmed release or substantial threat of a release of a hazardous or deleterious substance that may pose an imminent and substantial threat to public health, safety or welfare or the environment (ARM 17.55.108). Listed facilities are prioritized as maximum, high, medium, or low priority or in operation and maintenance status based on the potential threat posed. Currently, there are no active sites on the CECRA priority list in the Little Blackfoot River watershed.

CECRA also encourages the implementation of voluntary cleanup activities under the VCRA and CALA. It is possible that any historic mining-related metals loading sources identified in the watershed in the future could be added to the CECRA list and addressed through CECRA, with or without the VCRA and/or CALA process. A site can be added to the CECRA list at DEQ's initiative, or in response to a written request made by any person to the department containing the required information.

## 9.5 POTENTIAL FUNDING SOURCES

Funding and prioritization of restoration or water quality improvement project is integral to maintaining restoration activity and monitoring successes and failures. Several government agencies fund watershed or water quality improvement projects. Below is a brief summary of potential funding sources to assist with TMDL implementation.

### 9.5.1 Section 319 Nonpoint Source Grant Program

Section 319 grant funds are typically used to help identify, prioritize, and implement water quality protection projects with focus on TMDL development and implementation of nonpoint source projects. Individual contracts under the yearly grant typically range from $20,000 to $150,000, with a 25 percent or more match requirement. 319 projects typically need to be administered through a non-profit or local government such as a conservation district, a watershed planning group, or a county.

### 9.5.2 Future Fisheries Improvement Program

The Future Fisheries grant program is administered by FWP and offers funding for on-the-ground projects that focus on habitat restoration to benefit wild and native fish. Anyone ranging from a landowner or community-based group to a state or local agency is eligible to apply. Applications are reviewed annually in December and June. Projects that may be applicable to the Little Blackfoot River watershed include restoring streambanks, improving fish passage, and restoring/protecting spawning habitats.

### 9.5.3 Watershed Planning and Assistance Grants

The MT DNRC administers Watershed Planning and Assistance Grants to watershed groups that are sponsored by a Conservation District. Funding is capped at $10,000 per project and the application cycle is quarterly. The grant focuses on locally developed watershed planning activities; eligible activities include developing a watershed plan, group coordination costs, data collection, and educational activities.

Numerous other funding opportunities exist for addressing nonpoint source pollution. Additional information regarding funding opportunities from state agencies is contained in Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, 2007) and information regarding additional funding opportunities can be found at http://www.epa.gov/nps/funding.html.

### 9.5.4 Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is administered by NRCS and offers financial (i.e., incentive payments and cost-share grants) and technical assistance to farmers and ranchers to help plan and implement conservation practices that improve soil, water, air and other natural resources on their land. The program is based on the concept of balancing agricultural production and forest management with environmental quality, and is also used to help producers meet environmental regulations. EQIP offers contracts with a minimum length of one year after project implementation to a maximum of 10 years. Each county receives an annual EQIP allocation and applications are accepted continually during the year; payments may not exceed $300,000 within a six-year period.

### 9.5.5 Resource Indemnity Trust/Reclamation and Development Grants Program

The Resource Indemnity Trust/Reclamation and Development Grants Program (RIT/RDG) is an annual program administered by MT DNRC that can provide up to $300,000 to address environmental related issues. This money can be applied to sites included on the AML priority list, but of low enough priority where cleanup under AML is uncertain. RIT/RDG program funds can also be used for conducting site assessment/ characterization activities such as identifying specific sources of water quality impairment. RIT/RDG projects typically need to be administered through a non-profit or local government such as a conservation district, a watershed planning group, or a county.

### 9.5.6 Upper Clark Fork River Basin Restoration Fund

The State of Montana has received monies through a series settlement agreements occurring between 1999 and 2008 with the Atlantic Richfield Company (ARCO) as a result of the release of mining-related waste that caused injuries to the natural resources within the Upper Clark Fork watershed. The Natural

Resource Damage Program (NRDP), which is part of the Montana Department of Justice, filed the suit on behalf of the State of Montana and currently manages the over-site of the funds.

Previously, a grants process was in place to disperse some of the settlement money from the 1999 Upper Clark Fork River Basin Restoration Fund. That process has been discontinued and a different process by which the remaining funds will be spent is currently being assessed as part of a long range plan. The main emphasis of the long range plan is to determine how the remaining funds will be distributed among aquatic, terrestrial, and groundwater resources. The plan will base funding of future projects on State's aquatic priority plan (Montana Department of Fish, Wildlife and Parks and Natural Resource Damage Program, 2011). The aquatic priorities indicate that some funding will likely be available for restoring and protecting fisheries habitat in the Little Blackfoot River watershed. The following waterbodies in the Little Blackfoot TPA were identified as priorities for fisheries habitat restoration and protection: the lower segment of the Little Blackfoot River (Priority 1), the upper segment of the Little Blackfoot River (Priority 2), both Dog Creek segments (Priority 2), part of Snowshoe Creek (Priority 2), and part of Spotted Dog Creek (Priority 2) (Montana Department of Fish, Wildlife and Parks and Natural Resource Damage Program, 2011). An outline describing how priority aquatic resource funding would occur is currently being evaluated and will likely be formalized by the end of 2011. And by the end of 2012, the formal process that will determine the funding of priority aquatic resource restoration will be finalized.

# 10.0 MONITORING STRATEGY

The monitoring framework discussed in this section is an important component of watershed restoration, a requirement of TMDL development under Montana's TMDL law, and the foundation of the adaptive management approach. While targets and allocations are calculated using the best available data, the data are only an estimate of a complex ecological system. The margin of safety is put in place to reflect some of this uncertainty, but other issues only become apparent when restoration strategies are underway. Having a monitoring strategy in place allows for feedback on the effectiveness of restoration activities (whether TMDL targets are being met), if all significant sources have been identified, and whether attainment of TMDL targets is feasible. Data from long-term monitoring programs also provide technical justifications to modify restoration strategies, targets, or allocations where appropriate.

The monitoring framework presented in this section provides a starting point for the development of more detailed and specific planning efforts regarding monitoring needs; it does not assign monitoring responsibility. Monitoring recommendations provided are intended to assist local land managers, stakeholder groups, and federal and state agencies in developing appropriate monitoring plans to meet aforementioned goals. Funding for future monitoring is uncertain and can vary with economic and political changes. Prioritizing monitoring activities depends on stakeholder priorities for restoration and funding opportunities.

The objectives for future monitoring in the Little Blackfoot TPA include: 1) tracking and monitoring restoration activities and evaluating the effectiveness of individual and cumulative restoration activities, 2) baseline and impairment status monitoring to assess attainment of water quality targets and identify long-term trends in water quality and 3) refining the source assessments. Each of these objectives is discussed below.

## 10.1 ADAPTIVE MANAGEMENT AND UNCERTAINTY

An adaptive management approach is used to manage resource commitments as well as achieve success in meeting the water quality standards and supporting all beneficial uses. This approach works in cooperation with the monitoring strategy and allows for adjustments to the restoration goals or pollutant targets, TMDLs, and/or allocations, as necessary. These adjustments would take into account new information as it arises.

The adaptive management approach is outlined below:

- <u>TMDLs and Allocations</u>: The analysis presented in this document assumes that the load reductions proposed for each of the listed streams will enable the streams to meet target conditions and that meeting target conditions will ensure full support of all beneficial uses. Much of the monitoring proposed in this section of the document is intended to validate this assumption. If it looks like greater reductions in loading or improved performance is necessary to meet targets, then updated TMDL and/or allocations will be developed based on achievable reductions via application of reasonable land, soil, and water conservations practices.
- <u>Water Quality Status</u>: As new stressors are added to the watershed and additional data are collected, new water quality targets may need to be developed or existing targets/allocations may need to be modified.

## 10.2 TRACKING AND MONITORING RESTORATION ACTIVITIES AND EFFECTIVENESS

Monitoring should be conducted prior to and after project implementation to help evaluate the effectiveness of specific practices or projects. This approach will help track the recovery of the system and the effects, or lack of effects, from ongoing management activities in the watershed. At a minimum, effectiveness monitoring should address the pollutants that are targeted for each project. Information about specific locations, spatial extent, designs, contact information, and any effectiveness evaluation should be compiled about each project. Information about all restoration projects along with tracking overall extent of BMP implementation should be compiled into one location for the entire watershed.

For nutrients and metals, loading reductions and BMP effectiveness can be evaluated with water quality samples and comparing them to the targets. For sediment, which has no numeric standard, loading reductions and BMP effectiveness may be estimated using the approaches used within this document. However, tracking BMP implementation and project-related measurements will likely be most practical for sediment. For instance, for road improvements, it is not anticipated that post-project sediment loads will be measured. Instead, documentation of the BMP, reduced contributing length, and before/after photos documenting the presence and effectiveness of the BMP will be most appropriate. For installation of riparian fencing, before/after photo documentation of riparian vegetation and streambank and a measurement such as greenline that documents the percentage of bare ground and shrub cover may be most appropriate. Evaluating instream parameters used for sediment targets will be one of the tools used to gage the success of implementation when DEQ conducts a formal assessment but may not be practical for most projects since the sediment effects within a stream represent cumulative effects from many watershed scale activities and because there is typically a lag time between project implementation and instream improvements (Meals, et al., 2010).

If sufficient implementation progress is made within a watershed, DEQ will conduct a TMDL Implementation Evaluation (TIE). During this process, recent data are compiled, monitoring is conducted (if necessary), data are compared to water quality targets (typically a subset for sediment), BMP implementation since TMDL development is summarized, and data are evaluated to determine if the TMDL is being achieved or if conditions are trending one way or another. If conditions indicate the TMDL is being achieved, the waterbody will be recommended for reassessment and may be delisted. If conditions indicate the TMDL is not being achieved, according to Montana State Law (75-5-703(9)), the evaluation must determine if:

- The implementation of a new or improved phase of voluntary reasonable land, soil, and water conservation practices is necessary,
- Water quality is improving, but more time is needed for compliance with water quality standards, or
- Revisions to the TMDL are necessary to achieve applicable water quality standards and full support of beneficial uses.

## 10.3 BASELINE AND IMPAIRMENT STATUS MONITORING

In addition to effectiveness monitoring, watershed scale monitoring should be conducted to expand knowledge of existing conditions and to provide data that can be used during the TIE. Although DEQ is the lead agency for conducting impairment status monitoring, other agencies or entities may collect and provide compatible data. Wherever possible, it is recommended that the type of data and methodologies used to collect and analyze the information be consistent with DEQ methodology so as to allow for comparison to TMDL targets and track progress toward meeting TMDL goals. The information in this section provides general guidance for future impairment status monitoring.

### 10.3.1 Sediment

Each of the sediment streams of interest was stratified into unique reaches based on physical characteristics and anthropogenic influence. The assessed sites represent only a percentage of the total number of stratified reaches. Sampling additional monitoring locations could provide additional data to assess existing conditions, and provide more specific information on a per stream basis as well as the TPA as a whole.

It is acknowledged that various agencies and entities have differing objectives, as well as time and resources available to achieve those objectives. However, when possible, it is recommended that at a minimum the following parameters be collected to allow for comparison to TMDL targets:

- Riffle pebble count (using Wolman Pebble Count methodology and/or 49-point grid tosses)
- Residual pool depth and pool frequency measurements
- Greenline assessment

Additional information will undoubtedly be useful and assist impairment status evaluations in the future and may include total suspended solids, identifying percentage of eroding banks, human sediment sources, areas with a high background sediment load, macroinvertebrate studies, McNeil core sediment samples, and fish population surveys and redd counts. The Helena National Forest has collected McNeil core data, which was not incorporated into this document, but as it is a direct sediment measurement, it may be useful as a target or implementation evaluation tool in the future.

An important part of impairment determination and adaptive management is determining when a stream has fully recovered from past management practices where recovery is still occurring from historical improvements in management but recent BMPs were not applied. Particularly within the Helena National Forest, ongoing PIBO monitoring can provide critical insight into the extent of recovery from past practices via comparisons between reference and managed sites.

### 10.3.2 Nutrients

Although extensive nutrient samples were collected to assist with TMDL development, less data were collected for both segments of Carpenter Creek and Threemile Creek because they were initially included to aid in the source assessment for the lower segment of the Little Blackfoot River. Therefore, when watershed scale monitoring is conducted to assist with future impairment determinations, particular attention should be given to collecting additional nutrient data on Carpenter and Threemile creeks. Future sampling should also include algal sampling for chlorophyll-*a* and AFDW. Additionally, macroinvertebrates are part of a second tier assessment if nutrient and/or algae concentrations do not clearly indicate impairment or non-impairment; macroinvertebrate data is currently sparse in the watershed and additional sampling is recommended on all waterbodies with TMDLs in this document.

### 10.3.3 Metals

Although extensive metals samples were collected to assist with TMDL development, for some metals, insufficient data were collected to fully verify the existing listing. For other metals that are not on the 2010 303(d) List, available data indicate they may be causing impairment but the sample size is too small to make a conclusion. Continued sampling at a subset of the recent sites displayed in **Table 10-1** is recommended for consistency to characterize watershed conditions during future impairment determinations.

**Table 10-1. Waterbody-Pollutant Combinations Where More Sampling is Needed**

| Stream Segment | Waterbody Segment ID | Pollutant |
|---|---|---|
| American Gulch Creek | MT76G004_079 | Cadmium, Iron, Lead |
| Dog Creek (lower segment) | MT76G004_072 | Cadmium |
| Dog Creek (upper segment) | MT76G004_071 | Cyanide, Mercury |
| Little Blackfoot River (upper segment) | MT76G004_020 | Cyanide |
| Monarch Creek | MT76G004_060 | Mercury |
| O'Keefe Creek | MT76G004_054 | Lead |
| Sally Ann Creek | MT76G004_055 | Iron, Lead |
| Telegraph Creek (lower segment) | MT76G004_052 | Mercury |
| Telegraph Creek (upper segment) | MT76G004_051 | Beryllium |
| Un-named Creek | MT76G006_010 | Mercury |

## 10.4 SOURCE ASSESSMENT REFINEMENT

In many cases, the level of detail provided by the source assessments only provides broad source categories or areas that need to reduce pollutant loads and additional source inventory and load estimate work may be desirable. Strategies for strengthening source assessments for each of the pollutants may include more thorough sampling or field surveys of source categories and are described by pollutant in this section. Although additional suspended sediment and nutrient data at the USGS gage near Garrison may refine the SWAT model, most of the impairments are in tributaries, and thus resources could be used more efficiently by focusing on identifying the most significant source areas within each impaired stream’s watershed to determine where implementation will be most effective. Recommendations for source assessment refinement are described below by pollutant.

### 10.4.1 Sediment

Sediment-related information that could help strengthen the source assessments is as follows:

- a refined bank erosion retreat rate for Little Blackfoot River watershed streams,
- a better understanding of bank erosion impacts from historical land management activities,
- improved modeling for upland erosion delivery in forested watersheds where riparian zones have recovered from SMZ law implementation,
- improved modeling for concentrated flow through riparian areas,
- evaluation of seasonal loading aspects for the major sources and potential implications regarding TMDL target parameters,
- a review of land management practices specific to subwatersheds of concern to determine where the greatest potential for improvement can occur for the major land use categories,
- additional sampling in streams with less data such as Dog, Spotted Dog, Telegraph, and Threemile creeks to get a better idea of the reductions needed and to identify source areas
- evaluation of “hot spots” that the model may not have adequately addressed, such as a confined animal operation adjacent to a stream, and
- additional field surveys of culverts, roads, and road crossings to help prioritize the road segments/crossings of most concern.

### 10.4.2 Nutrients

Nutrient-related information that could help strengthen the source assessment is as follows:

- more data to characterize background conditions, particularly in areas underlain by the Phosphoria Formation
- a better understanding of septic contributions,
- a better understanding of nutrient concentrations in groundwater and spatial variability
- a better understanding of the irrigation network and its effect on hydrology and nutrient concentrations
- a more detailed understanding of fertilization practices within the watershed
- a review of land management practices specific to subwatersheds of concern to determine where the greatest potential for improvement can occur for the major land use categories,
- evaluation of “hot spots” that the model may not have adequately addressed, such as a confined animal operation adjacent to a stream, and
- additional sampling in streams with less data such as Threemile and Carpenter creeks to get a better idea of the reductions needed and to identify source areas

### 10.4.3 Metals

Because of both limited data and the complexity of sources, many of the TMDL allocations to mining sources are clumped into composite allocations. In watersheds with composite WLAs to unpermitted point sources and in watersheds with composite LAs to diffuse mining-related sources that also include some abandoned mines or mining wastes, follow up monitoring should focus on defining the contribution from abandoned mines and other discrete mining sources. Although many of the mines in the DEQ and/or MBMG databases have been visited to determine the location and condition of abandoned mines, in most cases the contribution from individual abandoned mines is unknown. Additionally, there may be discrete abandoned mine sources that are contributing to exceedances of metals targets that are not identified in either of the State databases. As additional information becomes available regarding contributions from abandoned mines, TMDLs may be modified via adaptive management to split composite WLAs into separate WLAs and/or to develop WLAs for discrete mining sources in watersheds dominated by nonpoint source loading that currently have a composite LA.

Several of the priority abandoned mines were last assessed in the early 1990s, and conditions and source areas at those mines may have changed since then; additional monitoring is recommended to determine the nature of reclamation work required to meet TMDLs.

Metals-related information that could help strengthen the source assessments is as follows:

- Additional cyanide sampling around the Charter Oak Mine (upper Little Blackfoot basin) and Bald Butte Mine (upper Dog basin) where cyanide is known to have been used as part of historic mining processes
- Water quality data from sites nearer to historic mines to better identify and separate source areas, especially for O’Keefe, American Gulch and lower Dog Creeks
- High flow data from Un-named Creek to better recognize transmission pathways and investigate loading trends seasonally
- Additional sampling in stream segments with less data such as Sally Ann, O’Keefe, lower Telegraph, American Gulch, and lower Dog creeks to get a more specific idea of source areas

# 11.0 PUBLIC PARTICIPATION

Stakeholder and public involvement is a component of TMDL planning supported by EPA guidelines and required by Montana state law (MCA 75-5-703, 75-5-704) which directs DEQ to consult with watershed advisory groups and local conservation districts during the TMDL development process. Technical advisors, stakeholders and interested parties, state and federal agencies, interest groups, and the public were solicited to participate in differing capacities throughout the TMDL development process in the Little Blackfoot TMDL Planning Area (TPA).

## 11.1 PARTICIPANTS AND ROLES

Throughout completion of the Little Blackfoot TPA TMDLs, DEQ worked with stakeholders to keep them apprised of project status and solicited input from a TMDL advisory group. A description of the participants in the development of the TMDLs in the Little Blackfoot TPA and their roles is contained below.

**Montana Department of Environmental Quality**
Montana state law (MCA 75-5-703) directs DEQ to develop all necessary TMDLs. DEQ has provided resources toward completion of theses TMDLs in terms of staff, funding, internal planning, data collection, technical assessments, document development, and stakeholder communication and coordination. DEQ has worked with other state and federal agencies to gather data and conduct technical assessments. DEQ has also partnered with watershed organizations to collect data and coordinate local outreach activities for this project.

**United States Environmental Protection Agency**
EPA is the federal agency responsible for administering and coordinating requirements of the Clean Water Act (CWA). Section 303(d) of the CWA directs states to develop TMDLs (see **Section 1.1**), and EPA has developed guidance and programs to assist states in that regard. EPA has provided funding and technical assistance to Montana's overall TMDL program and is responsible for final TMDL approval. Project management was primarily provided by the EPA Regional Office in Helena, MT.

**Conservation Districts**
The majority of the Little Blackfoot TPA falls within Powell County; however a small portion in the northeastern section of the watershed is located in Lewis and Clark County. Therefore, DEQ provided both the Deer Lodge Valley Conservation District and the North Powell Conservation District with consultation opportunity during development of TMDLs. This included opportunities to provide comment during the various stages of TMDL development, and an opportunity for participation in the advisory group discussed below.

**TMDL Advisory Group**
The Little Blackfoot TMDL Advisory Group consisted of selected resource professionals who possess a familiarity with water quality issues and processes in the Little Blackfoot River watershed, and also representatives of applicable interest groups. All members were solicited to participate in an advisory capacity per Montana state law (75-5-703 and 704). DEQ requested participation from the interest groups defined in MCA 75-5-704 and included local city and county representatives, livestock-oriented and farming-oriented agriculture representatives, conservation groups, watershed groups, state and federal land management agencies, and representatives of recreation and tourism interests. The

advisory group also included additional stakeholders and landowners with an interest in maintaining and improving water quality and riparian resources.

Advisory group involvement was voluntary and the level of involvement was at the discretion of the individual members. Members had the opportunity to provide comment and review of technical TMDL assessments and reports and to attend meetings organized by DEQ for the purpose of soliciting feedback on project planning. Typically, draft documents were released to the advisory group for review under a limited timeframe, and their comments were then compiled and evaluated. Final technical decisions regarding document modifications resided with DEQ.

Communications with the group members was typically conducted through email and draft documents were made available through DEQ's wiki for TMDL projects (http://montanatmdlflathead.pbworks.com). Opportunities for review and comment were provided for participants at varying stages of TMDL development, including opportunity for review of the draft TMDL document prior to the public comment period.

**Area Landowners**

Since 56 percent of the planning area is in private ownership, local landowner cooperation in the TMDL process has been critical. Their contribution has included access for stream sampling and field assessments and personal descriptions of seasonal water quality and stream flow characteristics. The DEQ sincerely thanks the planning area landowners for their logistical support and informative participation in impromptu water resource and land management discussions with our field staff and consultants.

## 11.2 RESPONSE TO PUBLIC COMMENTS

Upon completion of the draft TMDL document, and prior to submittal to EPA, DEQ issues a press release and enters into a public comment period. During this timeframe, the draft TMDL document is made available for general public comment, and DEQ addresses and responds to all formal public comments.

The formal public comment period was initiated on November 22, 2011 and closed on December 21, 2011. Electronic copies of the draft document were made available at the Deer Lodge Valley Conservation District in Deer Lodge, MT and at the State Library in Helena, MT. A public informational meeting and open house was held in Avon, MT on December 7, 2011. EPA and DEQ provided an overview of the document, answered questions, and solicited public input and comment on the TMDLs. The announcement for the meeting was distributed to the Watershed Restoration Coalition (which now includes the Little Blackfoot Watershed Group), Deer Lodge Valley and North Powell conservation districts, the Little Blackfoot TMDL Advisory Group, the Statewide TMDL Advisory Group, and other identified interested parties via email. Notice of the meeting was posted on the DEQ webpage and DEQ wiki, at the Elliston Post Office, Elliston store, and Avon Café, and also advertised in the following newspapers: Independent Record (Helena) and Silver State Post (Deer Lodge/Powell County).

Numerous informal comments were made at the public meeting regarding the evaluation of nutrient loading from geology, wildlife, and agricultural sources during the growing season; although no formal comments of this nature were submitted during the public comment period, additional clarifying text was added to the nutrient source assessment discussion in **Section 6.5.2**. The comments received during the public comment period and DEQ responses to these comments are presented within **Appendix H**.

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