# LOWER BLACKFOOT NUTRIENTS TMDLS AND WATER QUALITY IMPROVEMENT PLAN

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Various versions of sections of this document were sent to stakeholders for review and input. The involvement of all reviewers led to improvements in this document and is greatly appreciated. DEQ would like to thank the Technical Advisory Group and the Watershed Advisory Group members and members of the general public for their comments and contributions.

Katie Makarowski, a monitoring coordinator with DEQ, collected much of the data for these TMDLs and performed the assessments required for this project to proceed. 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.

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# ACRONYM LIST

| Acronym | Definition |
|---|---|
| AFDM | Ash Free Dry Mass |
| AFO | Animal Feeding Operation |
| AML | Abandoned Mine Lands |
| ARARS | Applicable or Relevant and Appropriate Requirements and Standards |
| ARM | Administrative Rules of Montana |
| AUMS | Animal Unit Months |
| BLM | Bureau of Land Management (Federal) |
| BMP | Best Management Practices |
| CAFO | Concentrated (or Confined) Animal Feeding 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 |
| CWA | Clean Water Act |
| DEQ | Department of Environmental Quality (Montana) |
| DNRC | Department of Natural Resources & Conservation (Montana) |
| ECHO | Enforcement Compliance History Online |
| EPA | Environmental Protection Agency (U.S.) |
| EQIP | Environmental Quality Initiatives Program |
| FWP | Fish, Wildlife & Parks (Montana) |
| GIS | Geographic Information System |
| GWIC | Groundwater Information Center |
| HBI | Hilsenhoff’s Biotic Index |
| HUC | Hydrologic Unit Code |
| INFISH | Inland Native Fish Strategy |
| IR | Integrated Report |
| LA | Load Allocation |
| MCA | Montana Code Annotated |
| MDT | Montana Department of Transportation |
| MEANSS | Method for Estimating Attenuation from Septic Systems |
| MOS | Margin of Safety |
| MPDES | Montana Pollutant Discharge Elimination System |
| MSU | Montana State University |
| MWCB | Mine Waste Cleanup Bureau (DEQ) |
| NHD | National Hydrography Dataset |
| NLCD | National Land Cover Dataset |
| NOAA | National Oceanographic and Atmospheric Administration |
| NPL | National Priorities List |
| NPS | Nonpoint Source |
| NRCS | National Resources Conservation Service |
| OU | Operational Units |
| PCB | PolyChlorinated Biphenyls |
| PRISM | Parameter-Elevation Regressions on Independent Slopes Model |
| QA | Quality Assurance |

| | |
|---|---|
| QC | Quality Control |
| RAWS | Remote Automatic Weather Stations |
| RIT/RDG | Resource Indemnity Trust/Reclamation and Development Grants Program |
| SMCRA | Surface Mining Control & Reclamation Act |
| SMZ | Streamside Management Zone |
| SSURGO | Soil Survey Geographic database |
| STORET | EPA STOrage and RETrieval database |
| TIE | TMDL Implementation Evaluation |
| TMDL | Total Maximum Daily Load |
| TN | Total Nitrogen |
| TP | Total Phosphorus |
| TPA | TMDL Planning Area |
| USDA | United States Department of Agriculture |
| 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 |
| WLA | Wasteload Allocation |
| WRP | Watershed Restoration Plan |

# DOCUMENT SUMMARY

This document presents a total maximum daily load (TMDL) and water quality improvement plan for five impaired tributaries to the Blackfoot River, including Elk Creek, Washoe Creek, West Fork Ashby Creek, Camas Creek, and Union Creek (see **Figure 5-1**).

The Montana Department of Environmental Quality (DEQ) develops TMDLs and submits them to the U.S. Environmental Protection Agency (EPA) for approval. The Montana Water Quality Act requires DEQ to develop TMDLs 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 Lower Blackfoot TMDL Planning Area (TPA) is located in Missoula, Granite, and Powell counties and includes the Blackfoot River and its tributaries, from the confluence with the Clearwater River to its mouth at the Clark Fork River near Bonner. The tributaries originate in the Rattlesnake Mountains to the North of the watershed and Garnet Mountains to the south. The watershed drainage area encompasses about 241,052 acres, with federal, state, and private land ownership.

DEQ determined that five waterbody segments do not meet the applicable water quality standards. The scope of this document addresses problems with nutrients (**Table DS-1**). Nine TMDLs were written to address 10 pollutant impairments and one non-pollutant impairment in the five waterbody segments (**Table 1-1**). Although DEQ recognizes that there are other pollutant listings for this TPA, this document addresses only nutrients. Non-pollutant impairments as well as impairments due to temperature, sediment, and metals were addressed in the 2009 Lower Blackfoot TPA TMDL document (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009).

DEQ identified nutrients as impairing aquatic life in Elk, Washoe, West Fork Ashby, Camas, and Union creeks and impairing primary contact recreation in Washoe Creek. Nutrients affect designated uses in these streams by enabling excess algal growth and altering aquatic insect communities. Water quality restoration goals for nutrients were established on the basis of DEQ's draft numeric nutrient criteria (Suplee et al., 2008; Suplee and Watson, 2013). DEQ believes that once these water quality goals are met, water uses will no longer be affected by nutrients in these streams.

DEQ quantified nutrient loads for natural background conditions and for septic systems and livestock grazing. The Lower Blackfoot TPA TMDLs indicate that when reductions are needed, they range from 29% to 85%.

In this document, DEQ recommends strategies for achieving nutrient reductions. They include best management practices (BMPs) for building and maintaining roads, for harvesting timber, grazing livestock, and for developing subdivisions. In addition, they include BMPs for expanding riparian buffer areas and using other land, soil, and water conservation practices that improve stream channel conditions and associated riparian vegetation.

Implementation of most water quality improvement measures described in this document is based on voluntary actions of watershed stakeholders. Ideally, local watershed groups and/or other watershed stakeholders will use this TMDL document 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 document includes a monitoring strategy designed to track progress in meeting TMDL objectives and goals and to help refine the plan during its implementation.

Although most water quality improvement measures are based on voluntary actions, federal law specifies permit requirements developed to protect narrative and/or numeric water quality criteria, be consistent with the assumptions and requirements of wasteload allocations (WLAs) on streams where TMDLs have been developed and approved by EPA. The Lower Blackfoot waterbody segments discussed in this document do not have any permitted dischargers requiring the incorporation of WLAs into permit conditions.

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

| Waterbody & Location Description | TMDL Prepared | Impaired Use(s) |
|---|---|---|
| **Camas Creek**, 1 mile above mouth to mouth (Union Creek) | Total Nitrogen,<br>Total Phosphorus | Aquatic Life, Primary Contact Recreation |
| **Elk Creek**, headwaters to Stinkwater Creek | Nitrate,<br>Total Phosphorus | Aquatic Life, Primary Contact Recreation |
| **Union Creek**, headwaters to mouth (Blackfoot River) | Total Nitrogen,<br>Total Phosphorus | Aquatic Life, Primary Contact Recreation |
| **Washoe Creek**, headwaters to mouth (Union Creek) | Total Nitrogen,<br>Total Phosphorus | Aquatic Life, Primary Contact Recreation |
| **West Fork Ashby Creek**, headwaters to mouth (East Fork Ashby Creek) | Total Phosphorus | Aquatic Life, Primary Contact Recreation |

# 1.0 INTRODUCTION

This document presents an analysis of water quality information and establishes total maximum daily loads (TMDLs) for nutrient problems in the Lower Blackfoot TMDL Planning Area (TPA). This document also presents a general framework for resolving these problems. **Figures A2-A16** in **Appendix A** show the waterbodies in the Lower Blackfoot TPA with nutrients 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.

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

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

Each waterbody in Montana has a set of designated uses from the list above. Montana has established water quality standards to protect these uses, and a waterbody that does not meet one or more standards is called an impaired water. Each state must monitor their waters to track if they are supporting their designated uses, and every two years DEQ prepares 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. The 303(d) list portion of the IR includes all of those waterbody segments impaired by a pollutant, which require a TMDL, whereas TMDLs are not required for non-pollutant causes of impairments. **Table B-1** in **Appendix B** identifies all impaired waters for the Lower Blackfoot TPA from Montana's 2012 303(d) List, and includes non-pollutant impairment causes included in Montana's "2012 Water Quality Integrated Report." **Table B-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 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 impairment causes from the “2012 Water Quality Integrated Report” that are addressed in this document. Each pollutant impairment falls within the nutrients TMDL pollutant category.

New data assessed during this project identified three new nutrient impairment causes for waterbodies in the Lower Blackfoot TPA. These impairment causes are identified in **Table 1-1** and noted as not being on the 2012 303(d) List (within the integrated report). Instead, these waters will be documented within DEQ assessment files and incorporated into the 2014 IR.

TMDLs are completed for each waterbody – pollutant combination, and this document contains nine TMDLs (**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 6.0**. **Section 6.0** also provides some basic water quality solutions to address those non-pollutant causes not specifically addressed by TMDLs in this document.

Although DEQ recognizes that there are other pollutant listings for the Lower Blackfoot TPA without completed TMDLs (**Table B-1** in **Appendix B**), this document only addresses those identified in **Table 1-1**. This is because DEQ sometimes develops TMDLs in a watershed at varying phases, with a focus on one or more specific pollutant types. Sediment, temperature, and metals TMDLs were previously completed for the Lower Blackfoot TPA in 2009 (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009). **Table B-1** in **Appendix B** includes impairment causes with completed TMDLs, as well as non-pollutant impairment causes that were addressed by those TMDLs.

**Table 1-1. Nutrients Water Quality Impairment Causes for the Lower Blackfoot TPA Addressed within this Document**

| Waterbody & Location Description[1] | Waterbody ID | Impairment Cause | Impairment Cause Status | Included in 2012 Integrated Report[2] |
|---|---|---|---|---|
| **BLACKFOOT RIVER**, Belmont Creek to mouth (Clark Fork) | MT76F001_033 | Ammonia (Un-ionized) | Not impaired based on updated assessment | Yes |
| **CAMAS CREEK**, 1 mile above mouth to mouth (Union Creek) | MT76F006_060 | Nitrogen (Total) | TN TMDL in this document | No |
| | | Phosphorus (Total) | TP TMDL in this document | Yes |
| **EAST FORK ASHBY CREEK,** headwaters to mouth (Ashby Creek) | MT76F006_050 | Nitrate/Nitrite (Nitrite + Nitrate as N) | Not impaired based on updated assessment | Yes |
| | | Phosphorus (Total) | Not impaired based on updated assessment | Yes |
| **ELK CREEK,** headwaters to Stinkwater Creek | MT76F006_031 | Nitrogen (Nitrate) | Nitrate TMDL in this document | Yes |
| | | Phosphorus (Total) | TP TMDL in this document | No |
| **UNION CREEK,** headwaters to mouth (Blackfoot River) | MT76F006_010 | Nitrogen (Total) | TN TMDL in this document | No |
| | | Phosphorus (Total) | TP TMDL in this document | Yes |
| **WASHOE CREEK,** headwaters to mouth (Union Creek) | MT76F006_090 | Nitrate/Nitrite (Nitrite + Nitrate as N) | Addressed by TN TMDL in this document | Yes |
| | | Nitrogen (Total) | TN TMDL in this document | Yes |
| | | Phosphorus (Total) | TP TMDL in this document | Yes |
| | | Chlorophyll-*a*[3] | Addressed by TP and TN TMDLs in this document | Yes |
| **WEST FORK ASHBY CREEK,** headwaters to mouth (East Fork Ashby Creek) | MT76F006_020 | Phosphorus (Total) | TP TMDL in this document | Yes |

[1] All waterbody segments within Montana's Water Quality Integrated Report are indexed to the National Hydrography Dataset (NHD)

[2] Impairment causes not in the "2012 Water Quality Integrated Report" were recently identified and will be included in the 2014 Integrated Report.

[3] Non-pollutant

## 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 nutrients (i.e., chlorophyll-*a*. 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** Lower Blackfoot 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 Lower Blackfoot watershed.

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

**Sections 5.0** Nutrients TMDL Components:
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 6.0** Other Identified Issues or Concerns:
Describes other problems that could potentially be contributing to water quality impairment and how the TMDLs in this plan and the 2009 plan (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009) might address some of these concerns. This section also provides recommendations for combating these problems.

**Section 7.0** Restoration Objectives and Implementation Plan:
Discusses water quality restoration objectives and presents a framework for implementing a strategy to meet the identified objectives and TMDLs.

**Section 8.0** Monitoring for Effectiveness:
Describes a water quality monitoring plan for evaluating the long-term effectiveness of the "Lower Blackfoot Nutrients TMDLs and Water Quality Improvement Plan".

**Section 9.0** Stakeholder and Public Participation:
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 LOWER BLACKFOOT WATERSHED DESCRIPTION

This section includes a summary of the physical, ecological, and demographic profile of the Lower Blackfoot watershed and is intended to provide background information to support total maximum daily load (TMDL) development.

## 2.1 PHYSICAL CHARACTERISTICS

The following information describes the physical characteristics of the Lower Blackfoot TMDL Planning Area (TPA).

### 2.1.1 Location

The Blackfoot River watershed lies in west central Montana, extending from approximately 30 miles northwest of Helena to seven miles east of Missoula (**Figure A-1**). For TMDL planning purposes, the Blackfoot Watershed was divided into four planning areas (from upstream to downstream): the Blackfoot Headwaters, Nevada Creek, the Middle Blackfoot, and the Lower Blackfoot.

The Lower Blackfoot planning area covers approximately 377 square miles (241,052 acres) from Blackfoot River's confluence with Clearwater River to its mouth at the Clark Fork River near Bonner, Montana. The drainage area of listed tributaries in the Lower Blackfoot planning area is given in **Table 2-1**. Almost the entire Lower Blackfoot TPA resides in Missoula County, although a small southeast portion falls within the jurisdictions of Granite and Powell Counties. The watershed is bounded to the south by the Garnet Mountain Range and the Rattlesnake Creek drainage to the west.

**Table 2-1. Drainage Area of Listed Tributaries in the Lower Blackfoot TPA**

| Streams Name | Square Miles | Acres |
|---|---|---|
| West Fork Ashby Creek | 4.5 | 2,866 |
| East Fork Ashby Creek | 6.0 | 3,781 |
| Camas Creek | 21.6 | 13,829 |
| Elk Creek (upper) | 28 | 18,063 |
| Union Creek | 100.5 | 64,301 |
| Washoe Creek | 8.5 | 5,422 |

### 2.1.2 Topography

Elevations in the Lower Blackfoot Project Area range from approximately 3,280 feet above sea level at the mouth of the Blackfoot River to 7,646 feet at the summit of Sheep Mountain. The landscape is dominated by the broad Blackfoot River valley with steeper slopes along the drainage divide. The Blackfoot River flows through a narrower canyon section upstream of Bonner. The Union Creek Valley is referred to locally as the Potomac Valley and is a large, gently sloping tributary basin feeding into the larger Blackfoot River Valley. Elevation is mapped on **Figure A-2**.

### 2.1.3 Geology

Exposed rocks in the planning area range in age from the Precambrian (1.5 billion years old) to the Quaternary (15,000 years old) (Alt and Hyndman, 1986). The Precambrian shale, siltstone, quartzite, and carbonate formations belong to a grouping of rocks called "Belt Series" rocks. Belt Series rocks formed through the process of sediment deposition over 500 million years into a large inland sea called the Belt Basin. These sedimentary deposits are remarkably consistent over large distances and are over 40,000 feet thick locally. During the formation of the Rocky Mountains from 75 to 60 million years ago, Belt rocks in the area of the Blackfoot watershed were uplifted, folded and thrust eastward over younger sedimentary rocks. Granite intruded into the Belt rocks both before and after thrusting and resulted in the formation of several mineral deposits. Large portions of the watershed were subsequently covered with volcanic rocks during the middle Tertiary period (approximately 40 million years ago). Remnants of these rocks are found primarily in the southern portion of the watershed as are sedimentary deposits derived from these volcanic rocks. More recently, the Blackfoot River watershed area was subjected to two major periods of glaciation, the Bull Lake glaciation about 70,000 years ago and the Pinedale glaciation of 15,000 years ago. Glaciation strongly influences the current landscape as evidenced by numerous moraines and associated hummocky topography, kettle lakes, and broad expanses of flat glacial outwash.

The geology of the Lower Blackfoot planning area consists mostly of the metasedimentary rock quartzite, which comprises nearly 60% of the watershed. Quaternary alluvium is the next most prevalent and comprises 14% of the planning area. Six other rock types, including volcanic, glacial, sedimentary, and intrusive formations cover the remaining 28 percent of the planning area (**Table 2-2**). Intrusive rocks (monzonite and diorite) are located in the headwater portions of Elk Creek and Ashby Creek and easily erode into sand sized particles. Phosphoria formations have a potential to impact background loading rates of phosphorus, however the Montana Bureau of Mines and Geology map for the Missoula East 30’ x 60’ Quadrangle indicates no phosphoria formations exist in the TPA (Lonn et al., 2010). This controls the natural substrate of these streams. Geologic units and rock types are mapped in **Figures A-3** and **A-4** based on a 1:500,000 scale geologic map of the state digitized by Raines and Johnson (1995).

**Table 2-2. Geology of the Lower Blackfoot TPA**

| Generalized Rock Type | Acres | Percentage of TPA |
|---|---|---|
| Quartzite (metamorphic) | 138,820 | 57.5% |
| Alluvium | 33,516 | 13.9% |
| Carbonate (sedimentary) | 23,427 | 9.7% |
| Mixed clastic (sedimentary) | 21,189 | 8.8% |
| Quartz monzonite (intrusive igneous) | 13,778 | 5.7% |
| Glacial drift | 8,666 | 3.6% |
| Volcanic | 1,031 | 0.4% |
| Diorite (intrusive igneous) | 1,005 | 0.4% |

### 2.1.4 Soil

The U.S. General Soil Map developed by the National Cooperative Soil Survey and based on the STATSGO2 dataset was used to evaluate soil properties in the Lower Blackfoot planning area. The STATSGO2 dataset is intended for watershed or larger-scale mapping and provides information on chemical and physical properties of soils. Soil analysis requiring more detail than this watershed characterization should consult the Natural Resource Conservation Service’s (NRCS) Soil Survey Geographic (SSURGO) dataset. **Figure A-5** depicts coverage of the four soil orders that exist within the project area. Soil orders, the broadest level of soil taxonomy, combine soils into units with similar attributes. Soils of the same order typically share properties because they were formed under similar scenarios. Investigating the distribution of soil orders in the project area can help better explain soil behavior and potential effects to water quality.

Inceptisols cover 80% of the TPA and are known for having only a slight degree of weathering and soil development. This is because they are considered geologically young, having only been exposed after the most recent glaciation. Less common, at 12% of the total planning area, are alfisols. These are moderately leached yet productive soils that can be susceptible to erosion if their surface litter is removed (Brady and Weil, 2002). The alfisol soil units in the Garnet Mountains are composed of less clay than those in the center of the TPA at lower elevations because the colder-mountainous environment leads to less leaching and slower soil formation. Mollisols are considered agriculturally productive soils and typically form under grasslands with humus-rich surface horizons; mollisol coverage closely follows the cultivated crops and pasture land uses shown on **Figure A-16**. Entisols are the least developed soils and can be found in the Blackfoot River valley near the Clark Fork River confluence in alluvium dominated geology.

A soil's susceptibility to erosion is a property especially relevant to TMDLs when reviewing upland loading sources. Erodibility is mapped in **Figure A-6** using the K-factor from the Universal Soil Loss Equation (USLE) (Wischmeier and Smith, 1978). The K-factor is an inherent property of the soil that is independent of rainfall, slope, vegetation cover and management differences. Values range from 0 to 1, with a greater value corresponding to a greater potential for erosion. Soil erodibility is assigned to the following ranges: low (0.0-0.2), moderate-low (0.21-0.30) and moderate-high (0.31-0.40). Values of > 0.4 are considered highly susceptible to erosion, although no soils in the TPA fall within this range. The majority of the project area has low susceptibility soils (87%). The next rating, moderate-low susceptibility, nearly covers the remaining area (12%). The most erosion-susceptible soils in the watershed have a K-factor of 0.32 which classifies as moderate-high. These soils are found near the mouth of the Blackfoot River in alluvium under the entisol soil order but make up less than 1% of the total planning area.

Slope is another soil property that affects erosion and thus warrants consideration during the TMDL process. **Figure A-7** shows slopes calculated from the 30-meter National Elevation Dataset. Slopes in the planning area vary from 0° in the flat valley bottoms to over 85° in the steepest mountains and ravines.

### 2.1.5 Surface Water

The geographic scope of this document is the southwest portion of the Blackfoot River watershed (HUC 1702030). Precipitation falling on the north aspect of the Garnet Mountain Range and south aspect of the Rattlesnake Mountain Range joins the mainstem Blackfoot River within the planning area. The Blackfoot River entering the TPA carries water from as far away as Lincoln, MT and the Seeley-Swan Valley. The sole pour point of the basin is where the Blackfoot flows into the Clark Fork River. As such, the TPA is part of the larger Columbia River Basin which eventually flows into the Pacific Ocean. No stream sections in the planning area have been given National Wild and Scenic River status or associated protections.

The streams of the Lower Blackfoot planning area typically originate in terrain that exceeds 5,500 feet in elevation. In their headwaters areas, most streams flow through steep, narrow valley bottoms that are laterally confined and support narrow riparian corridors (A/B channel types, (Rosgen, 1996)).

Both Elk Creek and Union Creek, two major tributaries to the Blackfoot River, flow through broad alluvial valleys prior to descending to the entrenched Blackfoot River corridor. These valleys include an area near Ninemile Prairie (Elk Creek) and the Potomac Valley (Union Creek). Both of these valleys were inundated by Glacial Lake Missoula, one of the largest lakes ever impounded behind an ice dam (Alt, 2001). The Glacial Lake Missoula ice dam formed when glaciers of the most recent ice age reached their maximum southerly extent around 15,000 years ago. The ice dam failed several dozen times, and each time, catastrophic flooding occurred in eastern Washington through the Columbia River corridor. Age dates of ash contained within flood deposits demonstrate that the last flooding occurred approximately 13,000 years ago (Alt, 2001). Glacial Lake Missoula flooded all of the mountain valleys of the Clark Fork drainage, including the Blackfoot River valley above Clearwater Junction. Lake deposits extend into the Middle Blackfoot and Nevada Creek TMDL planning areas, and up the Clark Fork River as far as Drummond (Alt, 2001).

Within the Lower Blackfoot planning area, the mainstem Blackfoot River is entrenched within a well-defined river valley with a moderate slope and steep valley walls. The valley wall geology is mostly Precambrian Belt Series rocks. Due to the low erodability of these rocks, the tributary streams that enter the lower Blackfoot River (Belmont Creek, Union Creek, and Elk Creek) all have steep reaches at their mouths where they abruptly enter the Blackfoot River stream corridor. These reaches tend to be stable, coarse grained, moderately confined channels characterized by step-pool habitat.

The USGS has established six gaging stations and water quality sites in the TPA; **Figure A-8** indicates which sites are actively recording continuous data and which have been retired. Information on all stations is listed in **Table 2-3**. The only active gage is located six miles upstream from the town of Bonner. Discharge was measured sporadically from 1898 to 1905. Since 1940, when collection became regular, the largest discharge ever recorded was 19,200 cfs on June 10, 1964. The average peak flow over the 81 years with recorded data is 9,107 cfs.

**Table 2-3. USGS Stations in the Lower Blackfoot TPA**

| Site Name | Site Number | Period of Record |
|---|---|---|
| Blackfoot River at Clearwater MT | 12339000 | 1921-1970 |
| Clearwater River at Clearwater MT | 12339500 | 1921-2005 |
| Blackfoot River near Potomac MT | 12339800 | 1956-1975 |
| West Twin Creek near Bonner MT | 12339900 | 1959-1991 |
| Blackfoot River near Bonner MT | 12340000 | 1898-2012 (active) |
| Blackfoot River at Milltown, MT | 465224113525501 | 2005 |

Data from the Blackfoot River near Bonner indicate flows most often peak during May and reach a minimum in January. This pattern is typical of snowmelt dominated systems in Montana. The average monthly discharge for this site is displayed in **Figure 2-1**.

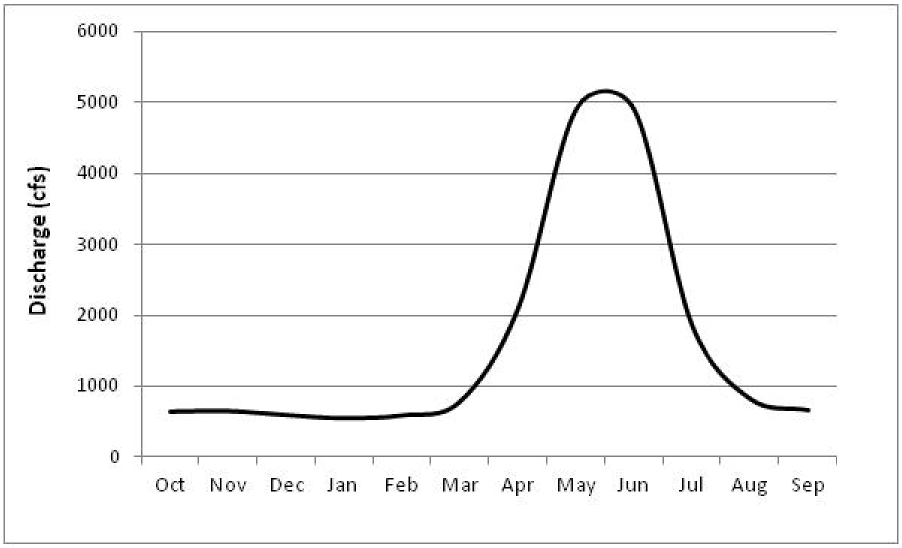


**Figure 2-1. Average Monthly Discharge at USGS Site #12340000 (1898-2012)**

## 2.1.6 Groundwater

The groundwater surrounding the town of Milltown has been extensively studied for arsenic contamination caused by the Milltown Dam's collection of mine wastes originating upstream in the Clark Fork River (Berthelote and Woessner, 2009; Moore and Woessnerr, 2003). The aquifer at the mouth of the Blackfoot River is situated in 8-55 meters of Quaternary alluvium and is an extension of the larger sole source Missoula Valley aquifer west of Hellgate Canyon. In the 1980s samples from domestic wells in Milltown first identified a problem: an arsenic plume with concentrations ranging from 220 to 510 ug/l, much greater than the human health standard of 10 ug/l (Moore and Woessnerr, 2003). Concern for the health of Milltown residents was the impetus for removing Milltown Dam and other related superfund work discussed in **Section 2.3.5**.

The Montana Bureau of Mines and Geology's Ground Water Information Center (GWIC) database has recorded 508 groundwater wells throughout the Lower Blackfoot TPA. The Lower Blackfoot Valley and the Potomac Valley along Highway 200 have the highest concentrations of groundwater wells. The locations of these wells are displayed in **Figure A-9** with the 11 wells noted that have water quality information available in GWIC. Wells range in depth from 10-820 feet and water is found anywhere between 1.1 and 400 feet below the ground surface.

## 2.1.7 Climate

Average annual precipitation isolines for the time period 1981-2010 are mapped on **Figure A-10** using data provided by Oregon State University's Parameter-Elevation Regressions on Independent Slopes Model (PRISM). PRISM uses point measurements of climate data and a digital elevation model to extrapolate climatic conditions across the landscape. Precipitation in the Lower Blackfoot varies from 15 inches a year in the Potomac Valley up to 59 inches in the headwaters region of Belmont Creek. Precipitation trends follow elevation with most moisture falling in the mountains and the quantity gradually decreasing downhill. The mean annual precipitation over the whole TPA is 37 inches.

Five weather stations (**Table 2-4**) have collected continuous climate data in the planning area recently. These stations are plotted in **Figure A-10** and symbolized according their associated monitoring network. Remote automatic weather stations or RAWS, is a multi-agency collaboration that focuses on conditions related to wildland fires. SNOTEL, short for snowpack telemetry, is an automated system of snowpack and related climate sensors used to develop water supply forecasts and operated by the (NRCS). The National Oceanic and Atmospheric Administration (NOAA) manages another climate station and finally, the Montana Department of Transportation (MDT) collects weather data for road conditions at one additional site in the TPA. Data collected at each station varies depending upon which network it belongs to.

**Table 2-4. Weather Stations in the Lower Blackfoot Planning Area**

| Location | Network | Elevation (ft) | Period of Record |
|---|---|---|---|
| Potomac | NOAA | 3,635 | 1964 - present |
| Greenough | MDT | 3,799 | 1998 - present |
| Stinkwater Creek | RAWS | 5,443 | 1998 - present |
| Lubrecht Flume | SNOTEL | 4,680 | 1978 - present |
| N Fk Elk Creek | SNOTEL | 6,250 | 1978 - present |

In an attempt to show the range of observations, average monthly climate statistics are presented in **Tables 2-5** and **2-6** for the two stations with the greatest variation in elevation, since elevation is one of the most influential factors of climate. **Table 2-5** summarizes the North Fork Elk Creek SNOTEL station. Data at this site from 1989 through 2012 indicate maximum temperatures in the low-70s most often occur in July and temperatures reach a minimum in the three month period from December to February. While slightly more extreme, this same general temperature pattern holds true for the weather station in the town of Potomac as shown in **Table 2-6**. The lower elevation Potomac site receives much less annual precipitation (14.6 vs. 26.4 inches). Records dating back to 1964 indicate snowfall has been observed in Potomac every month of the year besides June, July and August.

**Table 2-5. Average Monthly Climate Statistics at the N Fk Elk Creek SNOTEL (1989-2012)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Min Temp (°F)** | 16 | 16 | 20 | 26 | 33 | 39 | 46 | 46 | 39 | 30 | 21 | 15 |
| **Max Temp (°F)** | 28 | 30 | 37 | 45 | 54 | 62 | 73 | 71 | 61 | 46 | 33 | 27 |
| **Total Precip (in)** | 2.5 | 1.9 | 2.4 | 2.7 | 3.2 | 3.3 | 0.9 | 1.3 | 1.3 | 1.8 | 2.6 | 2.5 |

**Table 2-6. Average Monthly Climate Statistics at the Potomac Weather Station (1964-2010)**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Min Temp (°F)** | 9 | 12 | 19 | 25 | 32 | 39 | 41 | 39 | 32 | 25 | 18 | 9 |
| **Mean Temp (°F)** | 20 | 25 | 33 | 41 | 49 | 56 | 62 | 61 | 52 | 41 | 29 | 19 |
| **Max Temp (°F)** | 31 | 38 | 46 | 56 | 66 | 73 | 83 | 83 | 72 | 58 | 40 | 30 |
| **Total Precip (in)** | 1.4 | 1.0 | 0.8 | 1.0 | 1.7 | 1.9 | 0.9 | 1.0 | 1.1 | 1.1 | 1.4 | 1.5 |
| **Snowfall (in)** | 15.8 | 8.5 | 6.0 | 1.6 | 0.2 | 0.0 | 0.0 | 0.0 | 0.1 | 0.6 | 7.6 | 14.8 |
| **Snowdepth (in)** | 13.6 | 11.4 | 6.7 | 0.8 | 0.2 | 0.0 | 0.0 | 0.0 | 0.0 | 0.6 | 4.9 | 10.8 |

A third SNOTEL site, also shown on **Figure A-10**, lies five miles northwest of the planning area in the Rattlesnake National Recreation Area. At an elevation of 7,400 feet, the Stuart Peak SNOTEL is over 1,000 feet higher than any of the five stations previously discussed and could be used to better approximate the climate in the northwest section of the TPA. This station been recording data since 1994 and receives on average 47 inches of precipitation a year.

## 2.2 ECOLOGICAL CHARACTERISTICS

The following information describes the ecological characteristics of the Lower Blackfoot TPA.

### 2.2.1 Ecoregion

Ecoregions denote areas where the type, quality and quantity of environmental resources are similar. The classification incorporates a wide array of disciplines including geology, physiography, vegetation, climate, soils, land use, wildlife and hydrology. Ecoregions are organized into four hierarchical levels. Level I is the coarsest, dividing North American into 15 regions; level IV is the most refined, dividing Montana into 76 regions. **Table 2-7** contains information on the distribution of level III and IV ecoregions in the Lower Blackfoot TPA.

**Table 2-7. Ecoregion Distribution in the Lower Blackfoot Planning Area**

| Level III Ecoregion | Level IV Ecoregion | Acres | Square Miles | % Total |
|---|---|---|---|---|
| Middle Rockies | Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains | 208,440 | 325.7 | 86.3% |
| | Southern Garnet Sedimentary-Volcanic Mountains | 22,618 | 35.3 | 9.4% |
| | Foothill Potholes | 10,194 | 15.9 | 4.2% |
| | Deer Lodge-Philipsburg-Avon Grassy Intermontane Hills and Valleys | 263 | 0.4 | 0.1% |

**Figure A-11** displays the spatial extent of level IV ecoregions. The entire TPA falls within the Middle Rockies level III ecoregion and over 85% is classified as the Rattlesnake-Blackfoot-South Swan-Northern Garnet-Sapphire Mountains level IV ecoregion. This area is characterized as drier than ecoregions to the northwest and west but wetter than those east of the Continental Divide. The land is forested with climax vegetation listed as subalpine fir, Douglas-fir and ponderosa pine and underlain by a heterogeneous mixture of Precambrian Belt formations and Tertiary-Cretaceous igneous rocks. The Southern Garnet Sedimentary-Volcanic Mountains level IV ecoregion is mapped in the headwaters of Ashby, Union and Elk Creek and has similar vegetation communities as the above mentioned ecoregion although carbonate-rich sedimentary formations are more common which affects the soils, water quality and aquatic biota. The Foothill Potholes level IV ecoregion covers 4% of the TPA and is concentrated around the town of Greenough. This ecoregion is more prevalent in the Upper Blackfoot watershed and is a product of glaciation. The landscape in the Foothill Potholes unit is dominated by hills, hummocky moraines, outwash plains, terraces and fans that contain an abundant amount of depressional wetlands and pothole lakes providing a rich diversity of wildlife habitat.

### 2.2.2 Aquatic Life

There are two native fish species of concern in the Lower Blackfoot planning area: bull trout and westslope cutthroat trout. Distributions of these species are displayed in **Figure A-12** based on data provided by Montana Fish, Wildlife and Parks (FWP) from 2010.

Bull trout have been listed under the federal Endangered Species Act as threatened by extinction since 1998 due to habitat loss and degradation, introduction of non-native fish, fragmentation from dams and other barriers and historical overharvesting. The species is acutely sensitive to environmental degradation and spawn only in cobble/boulder substrate with sufficient groundwater upwelling to aerate eggs and low levels of silt to prevent smothering (Montana Department of Fish, Wildlife and Parks, 2012). Additionally, bull trout often migrate great distances to spawn and the upstream journeys of many fish have been cut short by irrigation structures, dams and similar instream obstructions. In

1998 Montana Fish Wildlife and Parks estimated the Milltown Dam, then located at the confluence of the Blackfoot and Clark Fork Rivers, stopped roughly 200,000 fish a year attempting to migrate upstream, including an unknown number of bull trout (Dickson, 2003). The Milltown Dam was removed in 2008 (see **Section 2.3.5**) however many smaller obstacles still exist throughout the watershed. The reservoir behind the dam also provided prime habitat for introduced northern pike which are well known to consume other fish. Westslope cutthroat trout have been given a less severe prognosis of species health than bull trout. The state of Montana places Westslope cutthroats under the category "species of concern." The rationale for this designation is declining populations caused by similar reasons as those harming bull trout. Both of these native fish species are further threatened by their ability to hybridize with introduced trout. Yellowstone cutthroat trout are another Montana fish species of concern present in the planning area, although they are not native to the Lower Blackfoot drainage.

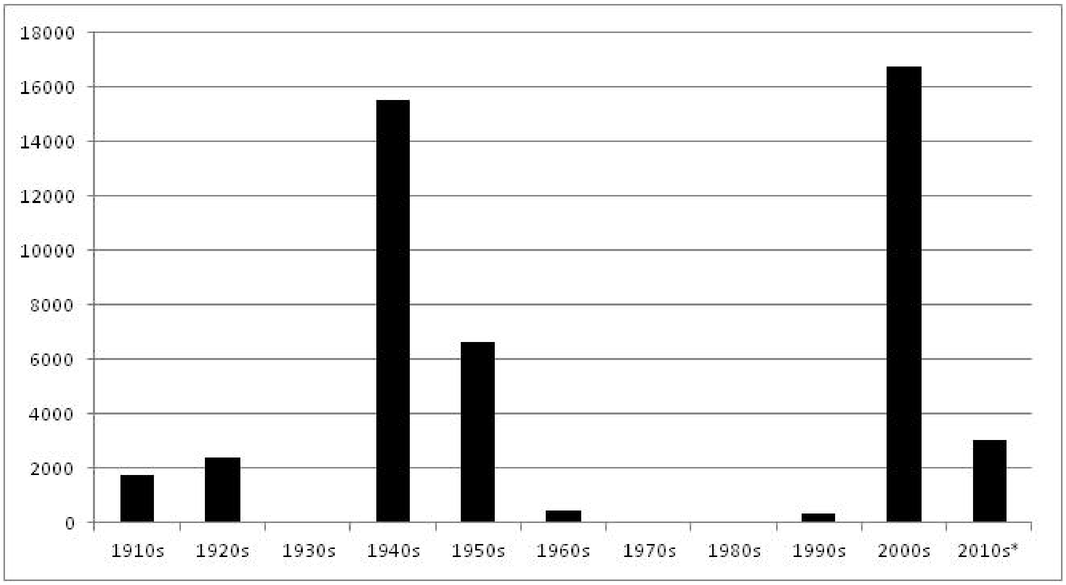
Since 1990, the Big Blackfoot Chapter of Trout Unlimited; Montana Fish, Wildlife and Parks; the U.S. Fish and Wildlife Service; the Blackfoot Challenge and many other cooperators have engaged in an aggressive native fish recovery effort in the Blackfoot watershed. Over 200 fisheries related restoration projects have been completed on 41 tributaries as part of this effort that continues today. Native species restoration efforts focus on adopting protective regulations, screening irrigation ditches, protecting critical spawning habitat, altering riparian management practices, removing seasonal migration barriers, instream habitat restoration, increasing instream flows and enlisting landowners in perpetual conservation easements. Monitoring restored stream reaches indicate increases in population density and spawning redds, (Pierce and Podner, 2000; Pierce, 2002). Increased bull trout and westslope cutthroat trout densities at lower Blackfoot River sampling locations (Johnsrud and Scotty Brown Sections) suggest tributary restoration efforts in the lower portions of the watershed are improving native mainstem populations. While these efforts have been successful, issues such as extended drought, the emergence of whirling disease, and habitat degradation continue to threaten the health of Blackfoot fisheries and aquatic life.

### 2.2.3 Terrestrial Life

The Lower Blackfoot TPA also encompasses the range of several terrestrial species of concern. Two mammals have been listed as federally threatened under the Endangered Species Act: grizzly bears since 1975 and Canada lynx in 2000. The US Fish and Wildlife Service (USFWS) also identify the wolverine, whitebark pine and yellow-billed cuckoo as candidate species for protection under the Endangered Species Act (U.S. Department of Interior, Fish and Wildlife Service, 2012).

### 2.2.4 Fires

Fire is a natural part of the Lower Blackfoot ecosystem and many species have evolved to exist with the disturbance. For example, lodgepole pine developed serotinous cones that require heat from fires to open and disperse their seeds. It is well documented that fire suppression during the first half of the 20th century altered the natural fire regime in the western United States (National Wildfire Coordinating Group, 2012). Fire perimeters in the project area from 1889-2011 are shown in **Figure A-13**, however the impacts of fire suppression cannot be clearly distinguished at his scale. The trend in acreage burned over the last century is displayed in **Figure 2-2**. Since 2000, 19,780 acres or 8% of the total project area burned. The largest fire on record was the 2003 Mineral-Primm Fire that burned in the West Fork Gold Creek drainage. The most recent wildlife occurred in 2011 when the West Riverside fire burned 3,045 acres on the hillslope north of Bonner, MT.



*The category “2010s” is an incomplete decade and only has data for years 2010-2011.

**Figure 2-2. Estimated Acreage Burned in the Lower Blackfoot TPA Per Decade**

## 2.3 CULTURAL CHARACTERISTICS

The following information describes the cultural characteristics of the Lower Blackfoot TPA.

### 2.3.1 Population

The Lower Blackfoot planning area is mostly rural with populations concentrated in the Potomac Valley, near the mouth of Elk Creek and near the mouth of the Blackfoot River. Using densities of 2010 census blocks, an estimated 1,950 people live in the TPA. There are no cities or incorporated places within the project area. Milltown, Bonner, Potomac and Greenough are all designated as “other places” by the US Census Bureau. The most populous of these four towns is Bonner, which had a population of 1,663 in 2010. The nearest regional population center is Missoula (population 66,800) located only five miles east of Milltown. The population density of the planning area is mapped on **Figure A-14**.

### 2.3.2 Transportation Networks

Montana Highway 200 is the chief transportation route in the Lower Blackfoot TPA. It bisects the planning area east to west connecting Milltown and Interstate 90 to cities outside the TPA such as Ovando and Lincoln to the northeast. Clearwater Junction is a significant intersection of Montana Highway 200 and Highway 83. The latter connects the Town of Seeley Lake and the Swan Valley to Missoula. An extensive network of unpaved roads in various stages of maintenance crisscrosses the TPA; many were built to access timber stands.

An abandoned railroad line runs along the length of the Blackfoot River for its entire reach within the TPA. The line was previously used by the Chicago, Milwaukee, St. Paul and Pacific Railroad Company. A private, unpaved airport is located along Camas Creek.

### 2.3.3 Land Ownership

The largest landholder in the Lower Blackfoot TPA is the Plum Creek Timber Company. In 2008, the Nature Conservancy and the Trust for Public Land entered into an agreement with Plum Creek to purchase over 310,000 acres of land in western Montana. Known as the Montana Legacy Project, the intent of the purchase was to preserve wildlife habitat and water resources, sustain the economy of local communities and prevent large tracts of land from being sold and fragmented into smaller, private ownership which would have restricted recreational access and increased ad hoc development. The second phase of this project is currently ongoing and involves transferring possession of the land to public ownership. Approximately 39,000 acres of the Lower Blackfoot TPA falls within the Montana Legacy Project boundaries and as of December 2012, 4,000 acres have been transferred to the US Forest Service and 30,000 acres have been transferred to the state of Montana. This significant land sale reduced Plum Creek's holdings in the TPA from 45% of the total area in 2008 to 26% in 2012.

Ownership boundaries are shown in **Figure A-15** and detailed in **Table 2-8**. Public land ownership information was provided by the Montana Natural Heritage Program ( 2011) and the extent of private timber lands was identified using the 2009 Montana Cadastral. Ownership is closely split between public (53%) and private (47%). Montana State Trust lands were greatly expanded as a result of the Montana Legacy Project and now comprise 19% of the TPA. The state government, specifically the Montana University System, also owns and operates the Lubrecht Experiment Forest near Greenough as an educational research area. The Bureau of Land Management is the fourth largest landholder, owning 12,000 acres in the center of the planning area adjacent to the Blackfoot River and additional acreage in the Garnet Mountains. The Lolo National Forest extends into the northeast corner of the TPA accounting for 10% of the total area. Lastly, Montana Fish, Wildlife and Parks manages five fishing and stream access sites along the Blackfoot River totaling 171 acres.

**Table 2-8. Land Ownership in the Lower Blackfoot Planning Area**

| Owner | Acres | Square Miles | Percentage of TPA |
|---|---|---|---|
| Private Timber Lands | 63,970 | 100 | 26.5% |
| Other Private | 49,770 | 78 | 20.6% |
| Montana State Trust Lands | 45,216 | 71 | 18.8% |
| Bureau of Land Management | 26,659 | 42 | 11.1% |
| US Forest Service | 24,159 | 38 | 10.0% |
| Montana University System | 20,282 | 32 | 8.4% |
| The Nature Conservancy | 10,826 | 17 | 4.5% |
| Montana Fish, Wildlife and Parks | 171 | 0 | 0.1% |

## 2.3.4 Land Cover and Use

Land cover within the planning area is dominated by evergreen forests as indicated in **Table 2-9**. Subalpine fir, Douglas-fir and ponderosa pine are the climax vegetation species in these forests. The second most common land cover is shrub/scrub. These two categories account for over 87% of the total area. The shrub/scrub land cover class is marked by vegetation less than five meters high including true shrubs, early successional trees or trees stunted by environmental conditions. The third most widespread land cover, accounting for roughly 8% of the landscape, is herbaceous. Herbaceous land cover is characterized by natural or semi-natural plants that die down at the end of each growing season. These areas are not intensively managed or tilled but can be used for grazing purposes. More intense agriculture occurs on only 3% of the TPA under the cultivated crops and hay/pasture land cover classes. Agriculture is concentrated in the Potomoc Valley and the Blackfoot River Valley surrounding Greenough. The other nine land cover categories are rare and each account for less than 1% of the TPA. Developed areas are clustered around the towns of Milltown, Bonner and Greenough but overall, the planning area is largely rural and undeveloped. Land cover is mapped on **Figure A-16** using the most recent National Land Cover Database (NLCD) (Homer et al., 2007).

**Table 2-9. Land Cover Distribution in the Lower Blackfoot Planning Area.**

| Land Cover | Acres | Square Miles | Percentage of TPA |
|---|---|---|---|
| Evergreen Forest | 174,578 | 272.8 | 72.2% |
| Shrub/Scrub | 35,779 | 55.9 | 14.8% |
| Herbaceous | 18,638 | 29.1 | 7.7% |
| Cultivated Crops | 4,735 | 7.4 | 2.0% |
| Hay/Pasture | 2,769 | 4.3 | 1.1% |
| Developed, Open Space | 1,618 | 2.5 | 0.7% |
| Woody Wetlands | 1,007 | 1.6 | 0.4% |
| Developed, Low Intensity | 803 | 1.3 | 0.3% |
| Mixed Forest | 767 | 1.2 | 0.3% |
| Open Water | 402 | 0.6 | 0.2% |
| Deciduous Forest | 366 | 0.6 | 0.2% |
| Barren Land | 198 | 0.3 | 0.1% |
| Developed, Medium Intensity | 108 | 0.2 | 0.04% |
| Developed, High Intensity | 6 | 0.0 | 0.002% |

The slopes of many stream valleys in the upper watersheds were historically logged. In some areas, such as on Keno Creek, the valley bottom riparian areas were harvested for timber as well. Some mining has occurred in these headwaters areas, such as on Union Creek and Day Gulch. Mining in Day Gulch resulted in extensive re-grading of the valley bottom. As streams flow into lower gradient lowland areas, several traverse broad alluvial valleys prior to entering the mainstem Blackfoot River. On several streams, the transitional areas at the upstream ends of these valleys are extensively placer mined. Elk Creek has a rich history of placer mining near the Yreka mining camp. Currently in this area, the channel flows through a heavily placer mined valley bottom with dredge ponds and tailings piles that confine the channel. Some restoration has occurred in this area to mitigate the impacts of placer mining (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009).

The broad alluvial valleys of Elk Creek and Union Creek exhibit significant impacts from recent agricultural land uses. Stream corridor grazing is common, and the channels are commonly entrenched and/or overwidened due to bank trampling or channel straightening efforts. In the Potomac Valley, recent residential development with stream corridor grazing on relatively small land parcels has further affected stream geomorphology. Woody riparian vegetation density in these valleys tends to be low, and bank stability is variable (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009).

## 2.3.5 Milltown Dam

Following decades of environmental degradation resulting from mining, milling, and smelting in the upper Clark Fork River watershed, the U.S. Environmental Protection Agency (EPA) designated the river from Warm Springs Creek to the Milltown Dam as a federal superfund site in 1992. Due to its size and complexity, the site was divided into several operational units (OUs). Of one of these OUs is the Milltown Reservoir Sediments OU (see **Figure 2-3**).

The Milltown Dam was built in 1907, just below the confluence of the Blackfoot and Clark Fork Rivers to provide hydroelectric power to local timber mills. Over that time, approximately 6.6 million cubic yards of contaminated sediment had been transported downstream from Butte in the Clark Fork River and accumulated behind the dam (**EPA, 2011**). Arsenic had polluted local drinking water aquifers and other metals threatened aquatic life communities. After years of planning and research, EPA and the Montana Department of Environmental Quality (DEQ) in combination with numerous other crucial stakeholders decided to remove the dam, create a temporary bypass channel for the Clark Fork River and draw down the reservoir so that toxic sediments, the contamination source, could be removed and transported to a permanent offsite repository. On March 28, 2008 the Milltown Dam was breached and the work excavating and removing sediments continued for the next two years.

The removal of Milltown Dam dropped the stage of the Blackfoot River at its mouth, reduced sediment deposition that used to occur in the slow moving waters of the reservoir and allowed the river to flow unimpeded into the Clark Fork River. The state of Montana is currently designing a park at the two rivers' confluence and monitoring the arsenic groundwater plume remains a priority.

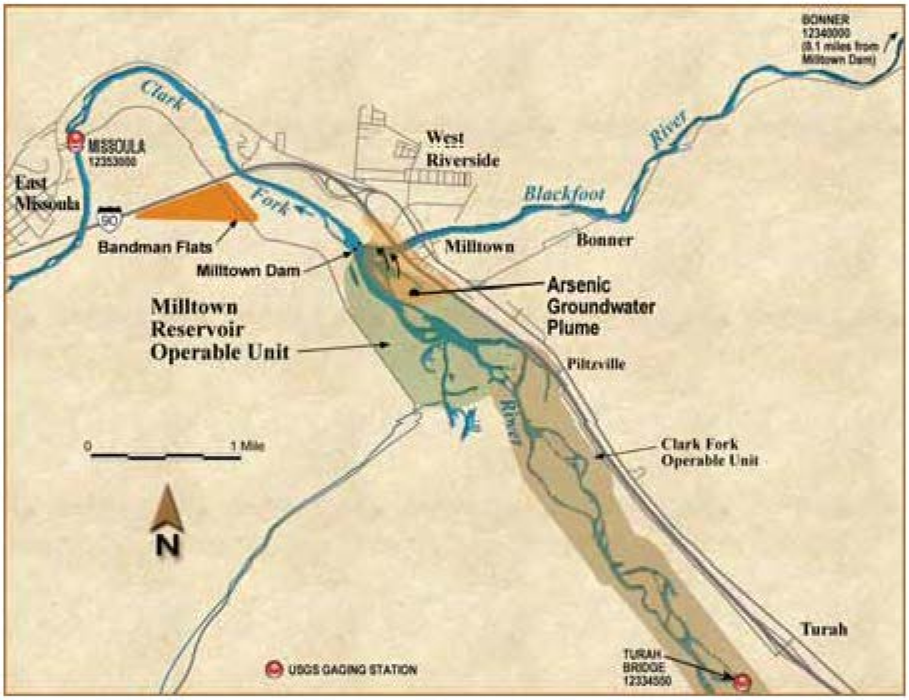


**Figure 2-3. Image Depicting the Milltown Reservoir Operable Unit and Arsenic Plume (U.S. Environmental Protection Agency, 2004)**

## 2.3.6 Permitted Point Sources

According to EPA's Enforcement and Compliance History Online (ECHO) database, there are two point sources permitted under the Montana Pollution Discharge Elimination System (MPDES) within the Lower Blackfoot planning area. One is located on the old Stimson Lumber Company millsite, which closed operations in 2008. The Stimson Lumber Company previously had a permit to discharge water from a cooling pond into the Blackfoot River, which expired in 2011. During transfer of ownership, soils under the cooling pond and nearby buildings were discovered to contain extremely high levels of toxic polychlorinated biphenyls (PCBs) (Associated Press, 2012; Chaney, 2011). Stimson Lumber Company and DEQ worked cooperatively to place contaminated sediment into an on-site repository and continue to monitor the situation with additional well tests (Montana Department of Environmental Quality, 2012b). At this time, PCBs do not appear to be threatening the Blackfoot River. The new owners of the millsite, Bonner Property Development LLC, hold MPDES permit MT0000205 for sewerage systems and continue to lease the industrial site to numerous smaller business operations.

The second permitted point source is a suction dredge mining operation (permit MTG370281) located on the 303(d) listed segment of Elk Creek, however information from the ECHO database lists this permit as inactive. The locations of these two MPDES permits are shown on **Figure A-8**. No concentrated animal feeding operations (CAFOs) are reported within the TPA.

### 2.3.7 Wastewater

There are no sewered areas within the Lower Blackfoot planning area; wastewater treatment is provided by on-site septic tanks and drainfields. The City of Missoula sanitary sewer system extends nearly to Bonner but ends at the Canyon River Golf Club subdivision just north of the Interstate 90-Clark Fork River Bridge. Roughly 780 septic systems are estimated in the project area – a number based on the assumption of one septic tank for each 2.5 persons using 2010 census block data. Because most of the project area is uninhabited, septic system densities are much lower than other parts of the state.

# 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 total maximum daily loads (TMDL) 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 Lower Blackfoot TMDL Planning Area (TPA) can be found in **Appendix C**.

## 3.1 LOWER 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 Lower Blackfoot watershed are classified as B-1, which specifies that the water must be maintained suitable to support all of the following uses (Administrative Rules of Montana (ARM) (17.30.623(1)):

- 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
- Agriculture 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 C.** DEQ's water quality assessment method for nutrients is designed to evaluate the most sensitive use for that pollutant group, thus ensuring protection of all designated uses (Suplee and Sada de Suplee, 2011). For streams in Western Montana, the most sensitive uses assessed for nutrients are aquatic life and primary contact recreation. DEQ determined that five waterbody segments in the Lower Blackfoot TMDL Planning Area (TPA) do not meet the nutrients water quality standards (**Table 3-1**).

**Table 3-1. List of Nutrients Impaired Waterbodies and their Impaired Uses in the Lower Blackfoot TPA with Completed Nutrient TMDLs Contained in this Document**

| Waterbody & Location Description | Waterbody ID | TMDL Prepared | Impaired Use(s) |
|---|---|---|---|
| **Camas Creek**, 1 mile above mouth to mouth (Union Creek) | MT76F006_060 | Total Nitrogen, Total Phosphorus | Aquatic Life, Primary Contact Recreation |
| **Elk Creek**, headwaters to Stinkwater Creek | MT76F006_031 | Nitrate, Total Phosphorus | Aquatic Life, Primary Contact Recreation |

**Table 3-1. List of Nutrients Impaired Waterbodies and their Impaired Uses in the Lower Blackfoot TPA with Completed Nutrient TMDLs Contained in this Document**

| Waterbody & Location Description | Waterbody ID | TMDL Prepared | Impaired Use(s) |
|---|---|---|---|
| **Union Creek**, headwaters to mouth (Blackfoot River) | MT76F006_010 | Total Nitrogen, Total Phosphorus | Aquatic Life, Primary Contact Recreation |
| **Washoe Creek**, headwaters to mouth (Union Creek) | MT76F006_090 | Total Nitrogen, Total Phosphorus | Aquatic Life, Primary Contact Recreation |
| **West Fork Ashby Creek**, headwaters to mouth (East Fork Ashby Creek) | MT76F006_020 | Total Phosphorus | Aquatic Life, Primary Contact Recreation |

## 3.2 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 standards are developed when there is insufficient information to develop specific numeric standards and/or the natural variability makes it impractical to develop numeric standards. Narrative standards describe the allowable or desired condition. This condition is often defined as an allowable increase above “naturally occurring.” DEQ often uses the naturally occurring condition, called a “reference condition,” to help determine whether or not narrative standards are being met (see **Appendix C**). Although narrative standards currently apply to nutrients in the Lower Blackfoot TPA, DEQ is pursuing numeric standards for nutrients (i.e., total nitrogen and total phosphorus) throughout the state (see **Appendix C**).

# 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: $\text{TMDL} = \Sigma\text{WLA} + \Sigma\text{LA}$, 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 loads to their sources

Although the way a TMDL is expressed can vary by pollutant, these four components are common to all TMDLs. 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.

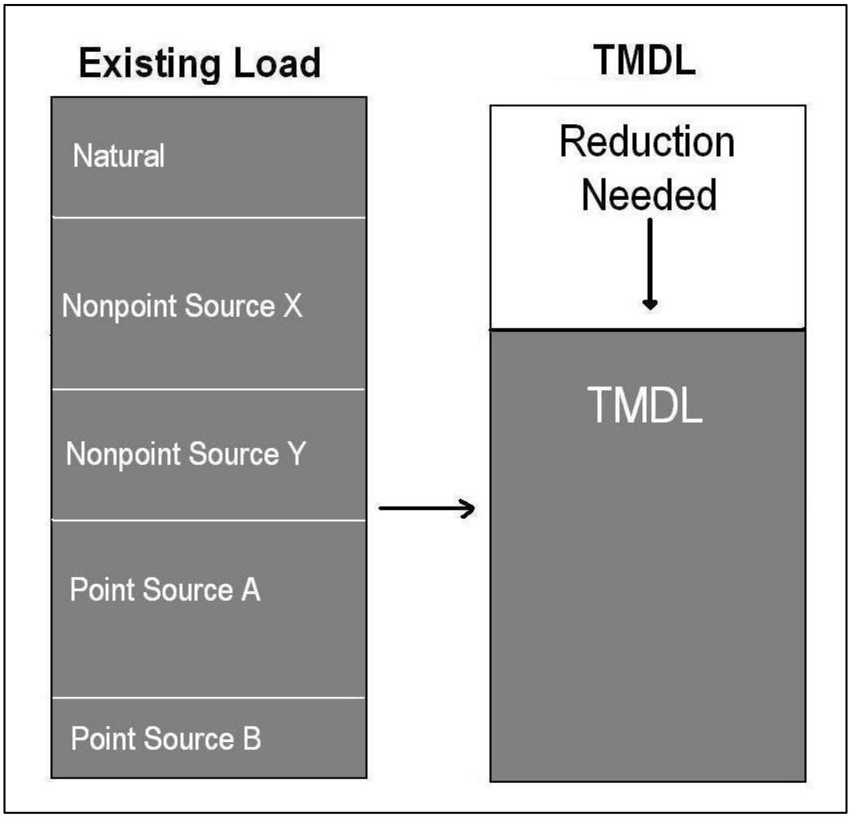


**Figure 4-1. Schematic Example of TMDL Development**

## 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., agriculture) 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. 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.

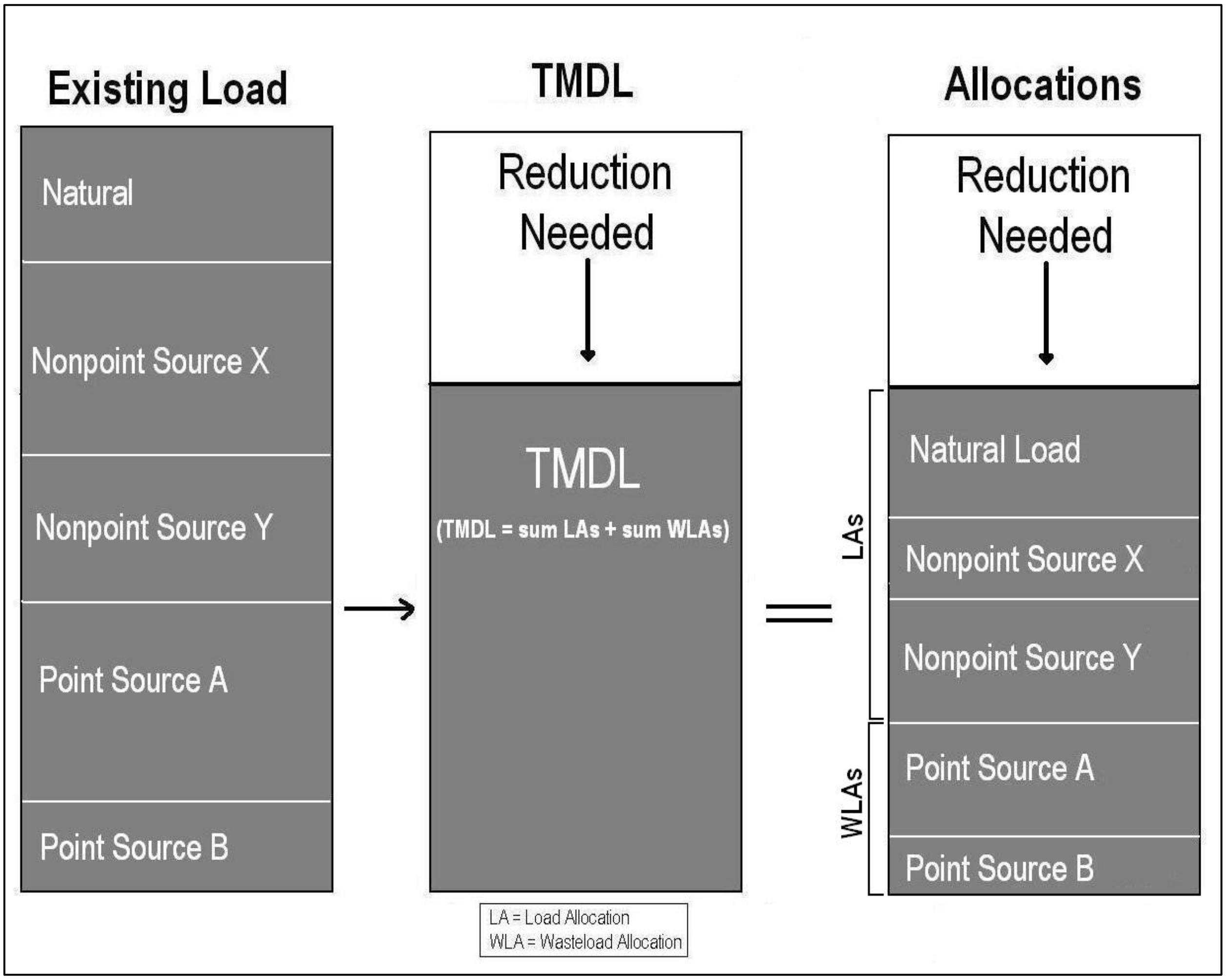


**Figure 4-2. Schematic Diagram of a TMDL and its Allocations**

TMDLs must also incorporate a margin of safety. The margin of safety accounts for the uncertainty, or any lack of knowledge, about the relationship between the pollutant loads and the quality of the receiving waterbody. The margin of safety may be applied implicitly by using conservative assumptions in the TMDL development process, or explicitly by setting aside a portion of the allowable loading (i.e., a TMDL = WLA + LA + MOS) (U.S. Environmental Protection Agency, 1999). The margin of safety is a required component to help ensure that water quality standards will be met when all allocations are achieved. In Montana, TMDLs typically incorporate implicit margins of safety.

## 4.5 IMPLEMENTING TMDL ALLOCATIONS

The Clean Water Act (CWA) and Montana state law (Section 75-5-703 of the Montana Water Quality Act) require wasteload allocations to be incorporated into appropriate discharge permits, thereby providing a regulatory mechanism to achieve load reductions from point sources. Nonpoint source reductions linked to load allocations are not required by the CWA or Montana statute, and are primarily implemented through voluntary measures. This document contains several key components to assist stakeholders in implementing nonpoint source controls. **Section 7.0** discusses a restoration and implementation strategy by pollutant group and source category, and provides recommended best management practices (BMPs) per source category (e.g., grazing, septic, etc.). **Section 7.5** discusses potential funding sources that stakeholders can use to implement BMPs for nonpoint sources. The Watershed Protection Section at the Montana Department of Environmental Quality (DEQ)helps to coordinate nonpoint source pollution prevention activities implementation throughout the state and provides resources to stakeholders to assist in nonpoint source BMPs. Montana's Nonpoint Source Management Plan (available at http://www.deq.mt.gov/wqinfo/nonpoint/NonpointSourceProgram.mcpx) further discusses nonpoint source implementation strategies at the state level.

DEQ uses an adaptive management approach to implementing TMDLs to ensure that water quality standards are met over time (outlined in **Section 8.1**). This includes a monitoring strategy and an implementation review that is required by Montana statute (see **Section 8.2**). TMDLs may be refined as new data become available, land uses change, or as new sources are identified.

# 5.0 NUTRIENTS TMDL COMPONENTS

This section focuses on nutrients (nitrogen and phosphorus forms) as a cause of water quality impairment in the Lower Blackfoot Total Maximum Daily Load (TMDL) Planning Area (TPA). It describes 1) nutrient impairment of beneficial uses; 2) specific stream segments of concern; 3) currently available data on nutrient impairment assessment in the watershed, including target development and a comparison of existing water quality to targets; 4) quantification of nutrient sources based on recent studies; and 5) identification and justification for nutrient TMDLs and TMDL allocations.

## 5.1 EFFECTS OF EXCESS NUTRIENTS ON BENEFICIAL USES

Nitrogen and phosphorus are natural background chemical elements required for the healthy and stable functioning of aquatic ecosystems. Streams in particular are dynamic systems that depend on a balance of nutrients, which is affected by 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. Additions from natural landscape erosion, groundwater discharge, and instream 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 human sources) can be toxic to aquatic life. Elevated nitrates in drinking water can inhibit normal hemoglobin function in infants. Besides 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 dissolved oxygen, which can kill fish and other forms of aquatic life. Nutrient concentrations in surface water can lead to blue-green algae blooms (Priscu, 1987), which can produce toxins lethal to aquatic life, wildlife, livestock, and humans.

Aside from toxicity, nuisance algae can shift the macroinvertebrate community structure, which also may affect fish that feed on macroinvertebrates (U.S. Environmental Protection Agency, 2010). Additionally, changes in water clarity, fish community structure, and aesthetics can harm recreational uses, such as fishing, swimming, and boating (Suplee et al., 2009). Nuisance algae can increase treatment costs of drinking water or pose health risks if ingested in drinking water (World Health Organization, 2003).

## 5.2 STREAM SEGMENTS OF CONCERN

There are seven waterbody segments In the Lower Blackfoot TPA that are present on the 2012 Montana 303(d) List for phosphorus and/or nitrogen impairments. These impairments occur on the Blackfoot River, Camas Creek, East Fork Ashby Creek, Elk Creek, Union Creek, Washoe Creek, and West Fork Ashby Creek (**Table 5-1**). Although the Blackfoot River and East Fork Ashby Creek are on the 2012 Montana 303(d) List, the Montana Department of Environmental Quality (DEQ) has concluded that they are no longer impaired for nutrients. These changes in impairment status are the result of the assessment process and will be updated on the 2014 Montana 303(d) List. There are 11 waterbody-pollutant combinations that are addressed in this portion of the document (**Table 5-1**).

**Table 5-1. Waterbody Segments in the Lower Blackfoot TPA with Nutrient Probable Causes on the 2012 303(d) List and Probable Causes that are Addressed in this Section**

| Stream Segment | Waterbody ID | Nutrient Probable Causes | Nutrient Probable Causes that are Addressed |
|---|---|---|---|
| BLACKFOOT RIVER, Belmont Creek to mouth (Clark Fork) | MT76F001_033 | Ammonia (Un-ionized) | None |
| EAST FORK ASHBY CREEK | MT76F006_050 | Nitrate/Nitrite[1], Total Phosphorus | None |
| ELK CREEK, headwaters to Stinkwater Creek | MT76F006_031 | Nitrate | Nitrate, Total Phosphorus |
| WASHOE CREEK, headwaters to mouth (Union Creek) | MT76F006_090 | Nitrate/Nitrite[1], Total Nitrogen, Total Phosphorus, Chlorophyll-*a*[2] | Nitrate, Total Nitrogen, Total Phosphorus, Chlorophyll-*a*[2] |
| WEST FORK ASHBY CREEK | MT76F006_020 | Total Phosphorus | Total Phosphorus |
| CAMAS CREEK, 1 mile above mouth to mouth (Union Creek) | MT76F006_060 | Total Phosphorus | Total Nitrogen, Total Phosphorus |
| UNION CREEK, headwaters to mouth (Blackfoot River) | MT76F006_010 | Total Phosphorus | Total Nitrogen, Total Phosphorus |

[1] Nitrate/Nitrite will be referred to as Nitrate throughout this document.

[2] Non-pollutant; addressed via nutrient TMDLs

## 5.3 INFORMATION SOURCES AND WATER QUALITY ASSESSMENT METHODS

To assess nutrient conditions for TMDL development, DEQ compiled nutrient data and undertook additional monitoring. The following data sources represent the primary information used to characterize water quality.

1) **DEQ TMDL Sampling:** DEQ conducted water quality sampling from 2004 through 2012 to update impairment determinations and assist with the development of nutrient TMDLs. Most of the data was collected during 2009, 2011, and 2012 with fewer samples collected in 2004 and 2006. All waterbody segments where sampled over a minimum of three years.

Sample locations were generally such that they provided a comprehensive upstream to downstream view of nutrient levels (**Figure 5-1**). The location of sample collection also allowed for analysis of potential source impacts (e.g., mine presence, changes in land use, septic influence). All data used in TMDL development was collected during the growing season for the Middle Rockies Level III Ecoregion (July 1 – September 30). Benthic algae samples were collected from 2009 through 2012. Each stream segment had at least three samples collected. These samples were analyzed for chlorophyll-*a* concentration and ash free dry mass (AFDM). AFDM is a measurement that captures both living and dead algal biomass and is particularly helpful for streams where some or all of the algae are dead (because chlorophyll-*a* measures only living algae). At least two macroinvertebrate samples were collected from each stream between 2004 and 2011.

2) **DEQ Assessment Files:** These files contain information used to make the existing nutrient impairment determinations.

Growing season nutrient data used for impairment assessment purposes and TMDL development are included in **Appendix D**. Other nutrient data from the watershed is publicly available through U.S. Environmental Protection Agency's (EPA) STORET and DEQ's EQuIS water quality databases.

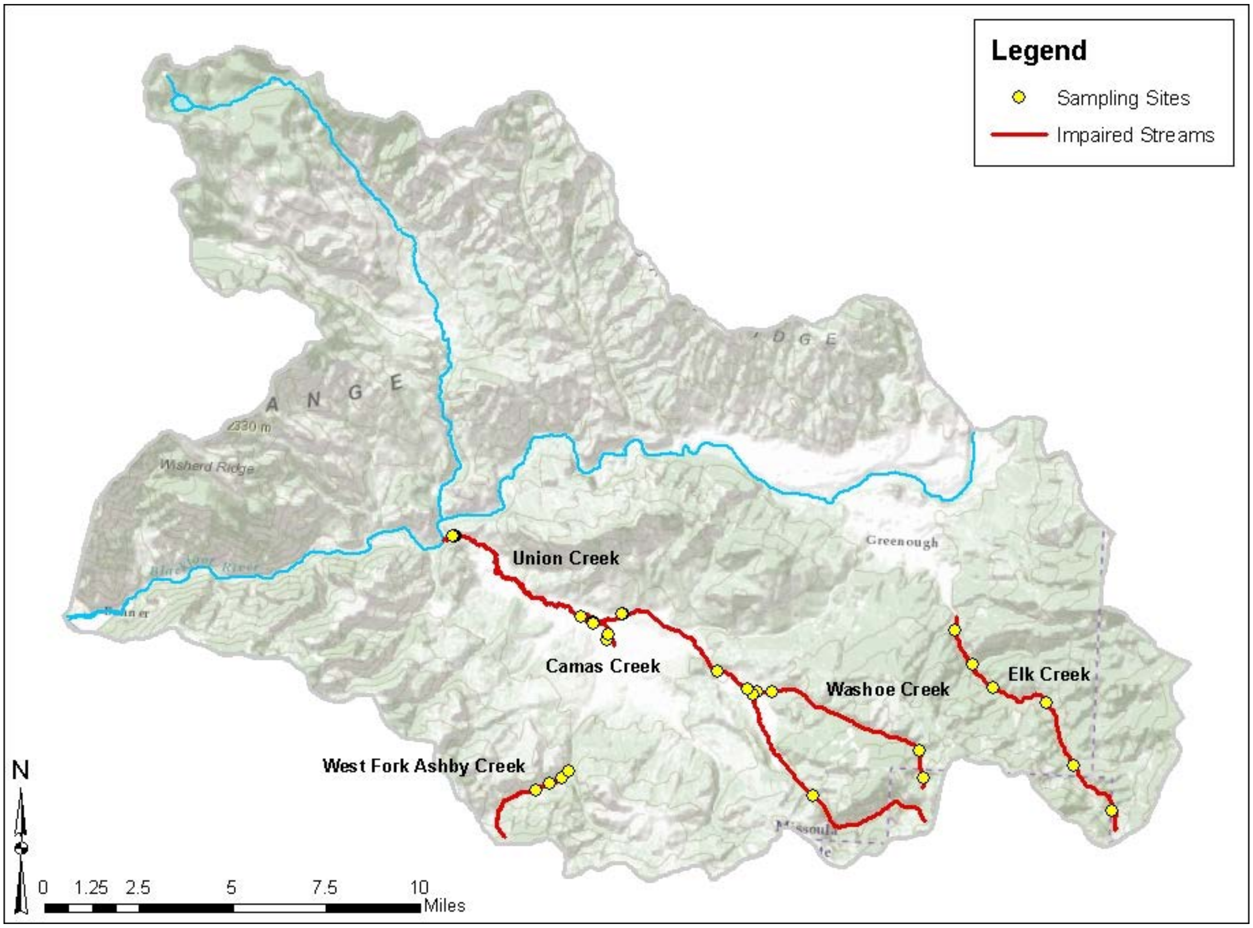


**Figure 5-1. Nutrient impaired streams in the Lower Blackfoot TPA for which TMDLs will be written and associated sampling locations**

Additional sources of information used to develop TMDL components (**Section 4.0**) include the following:

- Streamflow data
- GIS data layers
- Outside agency and university websites and documentation
- Land-use information

The above information and water quality data are used to compare existing conditions to waterbody restoration goals (targets), to assess nutrient pollutant sources, and to help determine TMDL allocations. Field data sheets were reviewed to rule out irregularities in collection methods or sample QA/QC. Laboratory methods and QA/QC criteria were also reviewed to ensure these values were accurate. There was no indication that any results were anomalous.

## 5.4 WATER QUALITY TARGETS

TMDL water quality targets are numeric indicator values used to evaluate whether water quality standards have been met. These are discussed further in **Section 4.0**. This section presents nutrient water quality targets and compares them with recently collected nutrient data in the Lower Blackfoot TPA following DEQ's assessment methodology (Suplee and Sada de Suplee, 2011). To be consistent with DEQ's assessment methodology, and because of improvements in analytical methods, only data from the past 10 years are included in the review of existing data.

### 5.4.1 Nutrient Water Quality Standards

Montana's water quality standards for nutrients (nitrogen and phosphorous) are narrative and are addressed via narrative criteria. Narrative criteria require state surface waters to be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will: 1) produce conditions that create concentrations or combinations of material toxic or harmful to aquatic life, and 2) create conditions that produce undesirable aquatic life (ARM 17.30.637 (1) (d-e)). DEQ is currently developing numeric nutrient criteria that will be established at levels consistent with narrative criteria requirements. These draft numeric criteria are the basis for the nutrient TMDL targets and are consistent with EPA's guidance on TMDL development and federal regulations.

### 5.4.2 Nutrient Target Values

Nutrient water quality targets include nutrient concentrations in surface waters and measures of benthic algae (a form of aquatic life that at elevated concentrations is undesirable) chlorophyll-*a* concentrations and AFDM. The target concentrations for nitrogen and phosphorus are established at levels believed to prevent excess growth and proliferation of algae which can cause harm to aquatic life, fishes, and contact recreation. Since 2002, DEQ has conducted studies in order to develop numeric criteria for nutrients (N and P forms). DEQ is developing draft numeric nutrient standards for total nitrogen (TN) and total phosphorus (TP) based on 1) public surveys defining what level of algae was perceived as "undesirable" (Suplee et al., 2009)and 2) the outcome of nutrient stressor-response studies that determine nutrient concentrations that will maintain algal growth below undesirable and harmful levels (Suplee et al., 2008; Suplee and Watson, 2013).

Nutrient targets for TN and TP (which are also draft numeric criteria), chlorophyll-*a*, and AFDM are based on Suplee and Watson (2013) and can be found in **Table 5-2**. The nitrate target is based on research by Suplee et al. (2008) and can also be found in **Table 5-2**. DEQ has determined that the values for nitrate, TN, and TP provide an appropriate numeric translation of the applicable narrative nutrient water quality standards based on existing water quality data in the Lower Blackfoot TPA and on the type of typical coldwater wadeable streams addressed by nutrient TMDL development in this document. These targets are appropriate for the Level IV Ecoregions that comprise the Lower Blackfoot TPA (Rattlesnake-Blackfoot-South Swan-Northern Garnet- Sapphire Mountain and Southern Garnet Sedimentary-Volcanic Mountains). The target values are based on the most sensitive uses; therefore, the nutrient TMDLs are protective of all designated uses. When the draft criteria for TN and TP become numeric standards they will be in DEQ's DEQ-12 circular.

A macroinvertebrate biometric (Hilsenhoff's biotic index (HBI) score) is also considered in further evaluation of compliance with nutrient targets **Table 5-2**. An HBI score of greater than 4.0 may be used along with nutrient, chlorophyll-*a*, and AFDM data to indicate nutrient impairment.

Because numeric nutrient chemistry is established to maintain algal levels below target chlorophyll-*a* concentrations and AFDM, target attainment applies and is evaluated during the summer growing season (July 1–September 30 for the Middle Rockies Level III Ecoregion) when algal growth will most likely affect beneficial uses. Targets listed here have been established specifically for nutrient TMDL development in the Lower Blackfoot TPA and may or may not be applicable to streams in other TMDL project areas. The target values for nitrate, TN, and TP will be used to develop TMDLs. See **Section 8-1** for the adaptive management strategy as it relates to nutrient water quality targets.

**Table 5-2. Nutrient Targets for the Lower Blackfoot TPA**

| Parameter | Target Value |
|---|---|
| Nitrate | ≤ 0.100 mg/L(1) |
| Total Nitrogen | ≤ 0.300 mg/L(2) |
| Total Phosphorus | ≤ 0.030 mg/L(2) |
| Chlorophyll-*a* | ≤ 125 mg/m$^2$(2) |
| Ash Free Dry Mass | ≤ 35 g /m$^2$(2) |
| Hilsenhoff's Biotic Index | < 4.0 |

(1) Value is from Suplee et al. (2008).
(2) Value is from Suplee and Watson (2013).

## 5.4.3 Existing Conditions and Comparison to Targets

To evaluate whether attainment of nutrient targets has been met, the existing water quality conditions in each waterbody segment are compared to the water quality targets in **Table 5-2** using the methodology in the DEQ guidance document "2011 Assessment Methodology for Determining Wadeable Stream Impairment due to Excess Nitrogen and Phosphorus Levels" (Suplee and Sada de Suplee, 2011). This approach provides DEQ with updated impairment determinations used for TMDL development. Because the original impairment listings are based on old data or were listed before developing the numeric criteria, each stream segment will be evaluated for impairment from nitrate, TN, and TP using data collected within the past 10 years. As mentioned in **Section 5.2** the Lower Blackfoot River (Belmont Creek to mouth)and East Fork Ashby Creek showed no nutrient impairment, and therefore TMDLs are not being developed for them and assessment information is not included in this document.

The assessment methodology uses 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 not attained when nutrient chemistry data shows a target exceedance rate of >20% (Exact Binomial Test), when mean water quality nutrient chemistry exceeds target values (Student T-test), or when a single chlorophyll-*a* exceeds benthic algal target concentrations (125 mg/m$^2$ or 35 g AFDM/m$^2$). Where water chemistry and algae data do not provide a clear determination of impairment, or where other limitations exist, a macroinvertebrate biometric (HBI) is considered in further evaluating compliance with nutrient targets. Lastly, inherent to any impairment determination is the existence of human sources of pollutant loading. Human-caused 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 than for a listed nutrient form. This can result in a different number of allowable exceedances for nutrients within a single stream segment. Such tests help assure that assessment reaches do not vacillate between listed and delisted status by the change in results from a single additional sample. When applying the T-test for assessment and sample values were below detection limits, one-half the detection limit was used.

### *5.4.3.1 Elk Creek*

Elk Creek is on the 2012 303(d) List as impaired for nitrate. The impaired segment of Elk Creek begins at the headwaters in the Garnet Mountains and flows from southeast to northwest 8.5 miles until its termination at the confluence with Stinkwater Creek. The watershed surrounding the impaired segment is about 18,063 acres. Land ownership in this area consists of about 51% Bureau of Land Management (BLM), 13% Montana State Trust Lands, 34% Montana University System, and 2% private. Potential nutrient sources within the impaired segment include natural, agriculture, septic systems, silviculture, and mining.

Summary nutrient data statistics and assessment method evaluation results for Elk Creek are provided in **Tables 5-3 and 5-4**, respectively. Twenty-one nitrate samples were collected between 2006 and 2012; values ranged from < 0.005 to 0.106 mg/L with one sample exceeding the nitrate target of 0.100 mg/L. Nineteen TN samples were collected between 2009 and 2012; values ranged from < 0.050 to 0.130 mg/L with zero samples exceeding the TN target of 0.300 mg/L. Twenty-one TP samples were collected between 2006 and 2012; values ranged from 0.014 to 0.048 mg/L with fifteen samples exceeding the TP target of 0.030 mg/L.

Four chlorophyll-*a* and three AFDM samples were collected from Elk Creek between 2009 and 2012. Chlorophyll-*a* values ranged from 6.9 to 188.7 mg/m² with one exceeding the target of 125 mg/m². AFDM values ranged from 19.4 to 87.4 g/m² with two exceeding the target of 35 g/m². There were two macroinvertebrate samples collected from Elk Creek in 2011. HBI values ranged from 3.3 to 3.8 with zero exceeding the target of 4.0.

Assessment results shown in **Table 5-4** indicate that Elk Creek is impaired for nitrate and TP. Although nitrate passed both statistical tests, the previous listing for nitrate, the failure of both the chlorophyll-*a* and AFDM tests, and uncertainty in nutrient uptake led DEQ to retain the nitrate impairment. TMDLs will be written for nitrate and TP.

**Table 5-3. Nutrient Data Summary for Elk Creek**

| Nutrient Parameter | Sample Timeframe | Sample Size | Min[1] | Max | Median | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate, mg/L | 2006-2012 | 21 | < 0.005 | 0.106 | 0.010 | 0.020 |
| TN, mg/L | 2009-2012 | 19 | < 0.050 | 0.130 | 0.074 | 0.101 |
| TP, mg/L | 2006-2012 | 21 | 0.014 | 0.048 | 0.033 | 0.042 |
| Chlorophyll-*a*, mg/m$^2$ | 2009-2012 | 4 | 6.9 | 188.7 | 46.8 | 108.8 |
| AFDM, g/m$^2$ | 2011-2012 | 3 | 19.4 | 87.4 | 56.8 | 75.2 |
| Macroinvertebrate HBI | 2011 | 2 | 3.3 | 3.8 | 3.6 | 3.7 |

[1] Values preceded by a "<" symbol are detection limits for that parameter. The actual sample value was below the detection limit.

**Table 5-4. Assessment Method Evaluation Results for Elk Creek**

| Nutrient Parameter | Sample Size | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-*a* Test Result | AFDM Test Result | TMDL Required? |
|---|---|---|---|---|---|---|---|---|
| Nitrate | 21 | 0.100 | 1 | PASS | PASS | FAIL | FAIL | YES |
| TN | 19 | 0.300 | 0 | PASS | PASS |  |  | NO |
| TP | 21 | 0.030 | 15 | FAIL | FAIL |  |  | YES |

### *5.4.3.2 Washoe Creek*

Washoe Creek is on the 2012 303(d) List as impaired for nitrate, TN, TP, and chlorophyll-*a*. The impaired segment of Washoe Creek begins at the headwaters in the Garnet Mountains and flows from southeast to northwest 6.1 miles until its termination at the confluence with Union Creek. The Washoe Creek watershed encompasses about 5,422 acres. Land ownership in this area consists of about 26% BLM, 13% Montana State Trust Lands, 16% Montana University System, and 45% private. Potential nutrient sources within the impaired segment include natural, agriculture, septic systems, silviculture, and mining.

Summary nutrient data statistics and assessment method evaluation results for Washoe Creek are provided in **Tables 5-5 and 5-6**, respectively. Ten nitrate samples were collected between 2004 and 2012; values ranged from < 0.005 to 0.040 mg/L with zero samples exceeding the nitrate target of 0.100 mg/L. Seven TN samples were collected between 2009 and 2011; values ranged from 0.020 to 0.290 mg/L with zero samples exceeding the TN target of 0.300 mg/L. Ten TP samples were collected between 2004 and 2012; values ranged from 0.017 to 0.090 mg/L with seven samples exceeding the TP target of 0.030 mg/L.

Three chlorophyll-*a* and three AFDM samples were collected from Washoe Creek between 2009 and 2011. Chlorophyll-*a* values ranged from 4.1 to 17.0 mg/m² with zero exceeding the target of 125 mg/m². AFDM values ranged from 3.9 to 60.4 g/m² with one exceeding the target of 35 g/m². There were four macroinvertebrate samples collected from Washoe Creek from 2004 to 2011. HBI values ranged from 2.0 to 4.4 with two exceeding the target of 4.0.

Assessment results shown in **Table 5-6** indicate that Washoe Creek is impaired for nitrate, TN, and TP. Although there were zero nitrate and zero TN exceedances, the previous listings for nitrate and TN, a lack of data, and the exceedance of the AFDM target led DEQ to retain these impairments. Both the lack of data and the exceedance of AFDM create uncertainty in the impairment decision. The lack of data results in insufficient evidence to determine that Washoe Creek is either impaired or not impaired as indicated by DEQ's nutrient assessment method (Suplee and Sada de Suplee, 2011). The exceedance of AFDM introduces uncertainty because it is possible that nutrient values, including nitrate and TN, are below target values due to uptake by algae. DEQ will take the approach of addressing this nitrate listing with a TN TMDL. TMDLs will be written for TN and TP. The Chlorophyll-*a* impairment cause will be retained for Washoe Creek. Since chlorophyll-*a* is not a pollutant, but instead considered and observed effect, it will be by addressed by the nutrient TMDLs.

**Table 5-5. Nutrient Data Summary for Washoe Creek**

| Nutrient Parameter | Sample Timeframe | Sample Size | Min[1] | Max | Median | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate, mg/L | 2004-2012 | 10 | < 0.005 | 0.040 | 0.010 | 0.014 |
| TN, mg/L | 2009-2012 | 7 | 0.020 | 0.290 | 0.050 | 0.189 |
| TP, mg/L | 2004-2012 | 10 | 0.017 | 0.090 | 0.037 | 0.078 |
| Chlorophyll-*a*, mg/m$^2$ | 2009-2011 | 3 | 4.1 | 17.0 | 9.9 | 14.2 |
| AFDM, g/m$^2$ | 2009-2011 | 3 | 3.9 | 60.4 | 13.0 | 41.4 |
| Macroinvertebrate HBI | 2004-2011 | 4 | 2.0 | 4.4 | 3.5 | 4.3 |

[1] Values preceded by a "<" symbol are detection limits for that parameter. The actual sample value was below the detection limit.

**Table 5-6. Assessment Method Evaluation Results for Washoe Creek**

| Nutrient Parameter | Sample Size | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-*a* Test Result | AFDM Test Result | TMDL Required? |
|---|---|---|---|---|---|---|---|---|
| Nitrate | 10 | 0.100 | 0 | NOT ENOUGH DATA | NOT ENOUGH DATA | PASS | FAIL | YES |
| TN | 7 | 0.300 | 0 | NOT ENOUGH DATA | NOT ENOUGH DATA | | | YES |
| TP | 10 | 0.030 | 7 | FAIL | FAIL | | | YES |

### *5.4.3.3 West Fork Ashby Creek*

West Fork Ashby Creek is on the 2012 303(d) List as impaired for TP. The impaired segment of West Fork Ashby Creek begins at the headwaters in the Garnet Mountains and flows southwest to northeast 3.1 miles until its termination at the confluence with East Fork Ashby Creek. The West Fork Ashby Creek watershed encompasses about 2,866 acres. Land ownership in this area consists of about 2% BLM, 54% Montana State Trust Lands, and 44% private. Potential nutrient sources within the impaired segment include natural, agriculture, septic systems, silviculture, and mining.

Summary nutrient data statistics and assessment method evaluation results for West Fork Ashby Creek are provided in **Tables 5-7 and 5-8**, respectively. Fourteen nitrate samples were collected between 2004 and 2012; values ranged from 0.007 to 0.040 mg/L with zero samples exceeding the nitrate target of 0.100 mg/L. Twelve TN samples were collected between 2009 and 2012; values ranged from 0.050 to 0.086 mg/L with zero samples exceeding the TN target of 0.300 mg/L. Fourteen TP samples were collected between 2004 and 2012; values ranged from 0.005 to 0.044 mg/L with eleven samples exceeding the TP target of 0.030 mg/L.

Three chlorophyll-*a* and three AFDM samples were collected from West Fork Ashby Creek between 2011 and 2012. Chlorophyll-*a* values ranged from 2.4 to 18.0 mg/m$^2$ with zero exceeding the target of 125 mg/m$^2$. AFDM values ranged from 2.5 to 4.6 g/m$^2$ with zero exceeding the target of 35 g/m$^2$. There were three macroinvertebrate samples collected from West Fork Ashby Creek from 2004 to 2011. HBI values ranged from 2.0 to 3.3 with zero exceeding the target of 4.0.

Assessment results shown in **Table 5-8** indicate that West Fork Ashby Creek is impaired for TP. Although algae and macroinvertebrate samples did not indicate harm to these uses, both the binomial and t-test failed to meet the target for TP. Nutrient concentrations provided by Suplee et al. (2008) and Suplee and Watson (2013) are selected to prevent the growth of algae most years under naturally varying conditions. The target values developed by Suplee et al. (2008) and Suplee and Watson (2013) for the Middle Rockies Level III ecoregion represent values that, when exceeded, tend to increase algal growth to nuisance levels and adversely affect macroinvertebrate populations. The total phosphorus targets were consistently exceeded in this stream and may support conditions that periodically produce nuisance levels of algae, especially if physical conditions such as shade change along the stream. In light of this information and the previous listing for TP, DEQ decided to retain the TP listing for West Fork Ashby Creek. A TMDL will be written for the TP nutrient probable cause.

**Table 5-7. Nutrient Data Summary for West Fork Ashby Creek**

| Nutrient Parameter | Sample Timeframe | Sample Size | Min | Max | Median | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate, mg/L | 2004-2012 | 14 | 0.007 | 0.040 | 0.010 | 0.011 |
| TN, mg/L | 2009-2012 | 12 | 0.050 | 0.086 | 0.050 | 0.077 |
| TP, mg/L | 2004-2012 | 14 | 0.005 | 0.044 | 0.037 | 0.042 |
| Chlorophyll-*a*, mg/m$^2$ | 2011-2012 | 3 | 2.4 | 18.0 | 3.5 | 12.2 |
| AFDM, g/m$^2$ | 2011-2012 | 3 | 2.5 | 4.6 | 3.3 | 4.1 |
| Macroinvertebrate HBI | 2004-2011 | 3 | 2.0 | 3.3 | 3.1 | 3.2 |

**Table 5-8. Assessment Method Evaluation Results for West Fork Ashby Creek**

| Nutrient Parameter | Sample Size | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-*a* Test Result | AFDM Test Result | Macro Test Result | TMDL Required? |
|---|---|---|---|---|---|---|---|---|---|
| Nitrate | 14 | 0.100 | 0 | PASS | PASS | PASS | PASS | PASS | NO |
| TN | 12 | 0.300 | 0 | PASS | PASS | | | | NO |
| TP | 14 | 0.030 | 11 | FAIL | FAIL | | | | YES |

### *5.4.3.4 Camas Creek*

Camas Creek is on the 2012 303(d) List as impaired for TP. The impaired segment of Camas Creek begins about 1 mile upstream from its confluence with Union Creek and ends at this confluence to the west of Potomac, MT. Camas Creek flows from southeast to northwest. The entire Camas Creek watershed encompasses about 13,829 acres. Land ownership in this area consists of about 1% BLM, 50% Montana State Trust Lands, and 49% private. Potential nutrient sources within the impaired segment include agriculture and septic systems. Ashby Creek, which is fed by West Fork Ashby and East Fork Ashby creeks, was historically a tributary to Camas Creek, but due to channelization near the mouth now flows directly into Union Creek. Upstream of the impaired segment, potential nutrient sources include natural, agriculture, septic systems, silviculture, and mining.

Summary nutrient data statistics and assessment method evaluation results for Camas Creek are provided in **Tables 5-9 and 5-10**, respectively. Eleven nitrate samples were collected between 2004 and 2012; values ranged from 0.020 to 0.404 mg/L with four samples exceeding the nitrate target of 0.100 mg/L. Nine TN samples were collected between 2009 and 2012; values ranged from 0.190 to 0.756 mg/L with five samples exceeding the TN target of 0.300 mg/L. Eleven TP samples were collected between 2004 and 2012; values ranged from 0.024 to 0.204 mg/L with nine samples exceeding the TP target of 0.030 mg/L.

Four chlorophyll-*a* and four AFDM samples were collected from Camas Creek between 2009 and 2011. Chlorophyll-*a* values ranged from 16.0 to 44.1 mg/m$^2$ with zero exceeding the target of 125 mg/m$^2$. AFDM values ranged from 9.2 to 150.7 g/m$^2$ with two exceeding the target of 35 g/m$^2$. There were four macroinvertebrate samples collected from Camas Creek from 2004 to 2011. All HBI values exceeded the target of 4.0.

Assessment results shown in **Table 5-10** indicate that Camas Creek is impaired for TN and TP. As a result a TMDL will be written for each of these nutrient probable causes. Results also show a potential nitrate problem that will be addressed via the TN impairment and resulting TMDL.

**Table 5-9. Nutrient Data Summary for Camas Creek**

| Nutrient Parameter | Sample Timeframe | Sample Size | Min | Max | Median | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate, mg/L | 2004-2012 | 11 | 0.020 | 0.404 | 0.080 | 0.323 |
| TN, mg/L | 2009-2012 | 9 | 0.190 | 0.756 | 0.390 | 0.587 |
| TP, mg/L | 2004-2012 | 11 | 0.024 | 0.204 | 0.036 | 0.053 |
| Chlorophyll-*a*, mg/m$^2$ | 2009-2011 | 4 | 16.9 | 44.1 | 31.4 | 42.9 |
| AFDM, g/m$^2$ | 2009-2011 | 4 | 9.2 | 150.7 | 46.2 | 100.1 |
| Macroinvertebrate HBI | 2004-2011 | 4 | 4.4 | 6.0 | 5.0 | 5.5 |

**Table 5-10. Assessment Method Evaluation Results for Camas Creek**

| Nutrient Parameter | Sample Size | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-*a* Test Result | AFDM Test Result | TMDL Required? |
|---|---|---|---|---|---|---|---|---|
| Nitrate | 11 | 0.100 | 4 | PASS | FAIL | PASS | FAIL | NO |
| TN | 9 | 0.300 | 5 | FAIL | FAIL | | | YES |
| TP | 11 | 0.030 | 9 | FAIL | FAIL | | | YES |

## *5.4.3.5 Union Creek*

Union Creek is on the 2012 303(d) List as impaired for TP. The impaired segment of Union Creek begins at the headwaters in the Garnet Mountains and flows southeast to northwest 21.6 miles until its termination at the confluence with the Blackfoot River. The Union Creek watershed encompasses about 64,301 acres. Land ownership in this area consists of about 7% BLM, 40% Montana State Trust Lands, 4% Montana University System, and 49% private. Camas, Washoe, and Ashby creeks are tributaries to Union Creek. Potential nutrient sources within the impaired segment include natural, agriculture, septic systems, silviculture, and mining.

Summary nutrient data statistics and assessment method evaluation results for Union Creek are provided in **Tables 5-11 and 5-12**, respectively. Thirty-two nitrate samples were collected between 2006 and 2011; values ranged from 0.005 to 0.450 mg/L with four samples exceeding the nitrate target of 0.100 mg/L. Twenty-eight TN samples were collected between 2009 and 2011; values ranged from 0.060 to 0.760 mg/L with fourteen samples exceeding the TN target of 0.300 mg/L. Thirty-two TP samples were collected between 2006 and 2011; values ranged from 0.018 to 0.132 mg/L with twenty-six samples exceeding the TP target of 0.030 mg/L.

Five chlorophyll-*a* and five AFDM samples were collected from Union Creek between 2009 and 2011. Chlorophyll-*a* values ranged from 8.1 to 37.0 mg/m$^2$ with zero exceeding the target of 125 mg/m$^2$. AFDM values ranged from 14.3 to 68.9 g/m$^2$ with two exceeding the target of 35 g/m$^2$. There were three macroinvertebrate samples collected from Union Creek from 2004 to 2011. All HBI values exceeded the target of 4.0.

Assessment results shown in **Table 5-12** indicate that Union Creek is impaired for TN and TP. As a result a TMDL will be written for each of these nutrient probable causes.

**Table 5-11. Nutrient Data Summary for Union Creek**

| Nutrient Parameter | Sample Timeframe | Sample Size | Min | Max | Median | 80th percentile |
|---|---|---|---|---|---|---|
| Nitrate, mg/L | 2006-2011 | 32 | 0.005 | 0.450 | 0.011 | 0.040 |
| TN, mg/L | 2009-2011 | 28 | 0.060 | 0.760 | 0.296 | 0.455 |

**Table 5-11. Nutrient Data Summary for Union Creek**

| Nutrient Parameter | Sample Timeframe | Sample Size | Min | Max | Median | 80th percentile |
|---|---|---|---|---|---|---|
| TP, mg/L | 2006-2011 | 32 | 0.018 | 0.132 | 0.063 | 0.082 |
| Chlorophyll-*a*, mg/m$^2$ | 2009-2011 | 5 | 8.1 | 37.0 | 25.5 | 36.0 |
| AFDM, g/m$^2$ | 2009-2011 | 5 | 14.3 | 68.9 | 33.0 | 51.6 |
| Macroinvertebrate HBI | 2004-2011 | 3 | 4.9 | 5.5 | 5.3 | 5.4 |

**Table 5-12. Assessment Method Evaluation Results for Union Creek**

| Nutrient Parameter | Sample Size | Target Value (mg/l) | Target Exceedances | Binomial Test Result | T-test Result | Chl-*a* Test Result | AFDM Test Result | TMDL Required? |
|---|---|---|---|---|---|---|---|---|
| Nitrate | 32 | 0.100 | 4 | PASS | PASS | PASS | FAIL | NO |
| TN | 28 | 0.300 | 14 | FAIL | FAIL | | | YES |
| TP | 32 | 0.030 | 26 | FAIL | FAIL | | | YES |

### 5.4.4 Nutrient TMDL Development Summary

**Table 5-13** summarizes the nutrient impairment determinations for the Lower Blackfoot TPA, along with the summary of the nutrient pollutants for which TMDLs will be prepared based on DEQ's updated assessments for these streams. The changes from the 2012 303(d) List (**Table 5-1**) are because of limited data collection at the time the waterbody segments were initially listed and the improved assessment method along with significant data collection since original impairment determinations. The updated impairment determinations will be reflected in the 2014 Water Quality Integrated Report. Note that as per **Table 5-13** a total of nine separate nutrient TMDLs will be developed for five stream segments. These nine TMDLs address ten nutrient impairment causes and one chlorophyll-*a* (non-pollutant) impairment cause.

**Table 5-13. Summary of Nutrient TMDL Development Determinations**

| Stream Segment | Waterbody ID | Updated 303(d) Nutrient Impairment(s) | TMDLs Prepared |
|---|---|---|---|
| BLACKFOOT RIVER, Belmont Creek to mouth (Clark Fork) | MT76F001_033 | No Nutrient Impairments | None |
| EAST FORK ASHBY CREEK | MT76F006_050 | No Nutrient Impairments | None |
| ELK CREEK, headwaters to Stinkwater Creek | MT76F006_031 | Nitrate, Total Phoshorus | Nitrate, Total Phosphorus |
| WASHOE CREEK, headwaters to mouth (Union Creek) | MT76F006_090 | Nitrate, Total Nitrogen, Total Phosphorus, Chlorophyll-*a*[1] | Total Nitrogen[2], Total Phosphorus |
| WEST FORK ASHBY CREEK | MT76F006_020 | Total Phosphorus | Total Phosphorus |
| CAMAS CREEK, 1 mile above mouth to mouth (Union Creek) | MT76F006_060 | Total Phosphorus | Total Nitrogen, Total Phosphorus |
| UNION CREEK, headwaters to mouth (Blackfoot River) | MT76F006_010 | Total Phosphorus | Total Nitrogen, Total Phosphorus |

[1] Non-pollutant; remains an impairment cause and is addressed via nutrient TMDLs

[2] Nitrate remains a nutrient impairment for Washoe Creek. The TN TMDL will address both TN and nitrate.

## 5.5 SOURCE ASSESSMENT, TMDL, AND ALLOCATION APPROACHES

This section provides the overall approach used for source assessment, TMDL development, and allocations. This approach is then applied to each of the five stream segments.

### 5.5.1 Source Assessment Approach

Assessment of existing nutrient (i.e., nitrate, nitrogen and phosphorus) sources is needed to develop load allocations to specific source categories. Water quality sampling data collected from 2004 through 2012 represents the most recent data for determining existing nutrient water quality conditions. This data was collected with the objectives of 1) evaluating attainment of water quality targets and 2) assessing load contributions from nutrient sources within the Lower Blackfoot TPA. These data form the primary dataset from which existing water quality conditions were evaluated and from which nitrate, TN and TP loading estimates are derived. Data used to conduct these analyses is publicly available at: http://www.epa.gov/storet/dw_home.html.

This section characterizes the type, magnitude, and distribution of sources contributing to nutrient loading to impaired streams, provides loading estimates for significant source types, and establishes the approach applied toward establishing the TMDLs for each stream and allocations to specific source categories. Source types include natural, septic, and other human-caused sources and are described in further detail for each stream. Source characterization links nutrient sources, nutrient loading to streams, and water quality response, and supports the formulation of the load allocation portion of the TMDL. As described in **Section 5.4.2**, nitrate, TN, and TP water quality targets are applicable during the summer growing season (i.e., July 1 – September 30) and as a result TMDLs will as well. Consequently, source characterizations are focused mainly on sources and mechanisms that influence nutrient contributions during this period. Total loading estimates are established for the summer growing season time period and are based on observed water quality data and flow conditions measured during this time period. Load allocation estimates for natural, septic, and other human-caused sources are also established for the summer growing season time period and are based on literature values and simple models.

Source characterization and assessment was conducted by using monitoring data collected from the TPA from 2004 through 2012 and simple modeling. To display nutrient values measured from the impaired streams and determine spatial patterns in nutrient concentrations, box plots are used. In descriptive statistics, box plots area a convenient way of graphically depicting groups of numerical date through their five number summaries. Box plots depict the smallest observation (sample minimum), 25th percentile, median, 75th percentile, and the largest observation (sample maximum). Box plots display differences between the data without making any assumptions of the underlying statistical distribution of the data. The spacing between the different parts of the box indicates the degree of dispersion and skewness in data and identifies outliers. When sample data used in boxplots was below detection limits the detection limit was used.

Land use in the Lower Blackfoot TPA primarily consists of agriculture (livestock grazing), silviculture (timber harvest), and historical mining. None of the nutrient impaired waterbodies in the Lower Blackfoot TPA has contributing sources from sites with MPDES surface water point source permits. Nutrient sources therefore consist primarily of 1) natural sources derived from airborne deposition, vegetation, soils, and geologic weathering; and 2) human-caused sources (agriculture, septic, silviculture, and mining). These sources may include a variety of discrete and diffuse pollutant inputs that have differing pathways to a waterbody.

There are several possible mechanisms for the transport of nutrients from agricultural land to surface water during the growing season. The potential pathways include 1) direct loading via the breakdown of excrement and fertilizer, 2) delivery from grazed forest and rangeland during the growing season via surface and subsurface pathways, and 3) the effect of grazing on vegetative health and its ability to uptake nutrients and minimize erosion in upland and riparian areas. Grazing on forest and in pastures is common in the Lower Blackfoot TPA. Cattle are allowed to roam and are not deliberately concentrated along the valley bottoms during the growing season. Horses may also be allowed to roam and graze though they have been observed on small acreage lots that are fenced.

#### *5.5.1.1 Agricultural (Livestock) Loading Estimate*

A coarse approach was used to estimate what may be the most significant pathway (i.e., direct loading from the breakdown of livestock (cattle and horse) excrement) for nutrients to enter the five impaired streams. Although this approach uses cattle grazing permits as the basis for estimating nutrient loading from livestock, this estimate is meant to address all livestock grazing (e.g., horses) that may occur in the impaired watersheds. This approach is based on a specific set of assumptions and because it is coarse only accounts for a few of the many variables that can have an effect on nutrient loading from livestock. As a result, there is uncertainty in the values generated from this approach. Regardless of the accuracy of this approach, reducing nutrient inputs from direct loading will reduce nutrient loads in impaired waterbodies. Reducing direct loading from livestock entails using BMPs that reduce the amount of time that livestock spend in direct contact with streams and adjacent banks. Reducing nutrient loading from livestock does not necessarily mean reducing the number of animals being grazed.

To estimate nutrient loading from livestock, first the cattle density on Lubrecht, Montana Department of Natural Resources and Conservation (DNRC), and BLM lands in the watershed of interest was estimated. This was done using the total number of permitted Animal Unit Months (AUMs) for allotments that were at least partially contained within a watershed, number of months open for grazing, and area of grazing allotments from the applicable permits. The following equation demonstrates how cattle density of permitted lands (by ownership) was calculated.

**Equation 1:**

***Cattle density = (# AUMs / # Months) * # Permitted acres***

To calculate the number of livestock throughout the watershed, the density for a given ownership was multiplied by the number of total acres owned within the watershed (the calculated DNRC cattle density was used as a conservative estimate for private lands):

**Equation 2:**

***# cattle in watershed = Cattle density * # acres in watershed***

The number of cattle present was then multiplied by the amount of manure produced by a cow, the percentage of either nitrogen or phosphorus in cow manure, and the percentage of time a cow spends next to the water:

**Equation 3:**

***Daily nutrient load = # cattle in watershed * lbs manure produced by a cow each day* % nutrient in manure * Time spent near a stream***

The resulting loads from each applicable landownership type were then added to get the final load for the watershed:

**Equation 4:**

***Livestock total daily nutrient load = DNRC daily load + BLM daily load + Lubrecht daily load + Private daily load***

Key assumptions for this method are as follows:

- Allotments are grazed to full AUM value (i.e., does not account for drought years when fewer AUMs are used)
- All cattle graze during the entire four month open grazing season (e.g., June 1 to September 30)
- All acreage within a watershed has the potential to be grazed unless located in inactive allotments
- Cattle density on private land is the same on DNRC land within a watershed
- Cattle spend 1% of their time near a stream (Porath et al., 2002; Sheffield et al., 1997) and thus 1% of their manure reaches the stream
- A cow produces 159 lbs of wet-weight manure per day (mean of American Society of Agricultural Engineers standard s for Dairy Cattle and Beef Cattle; (Wilkerson et al., 1997))
- Nitrogen is 1.9% of wet-weight cow manure (Texas Cattle Feeders Association, 2008)
- Phosphorus is 1% of wet-weight cow manure (Van Horn et al., 1994)

This method estimates the nutrient load from livestock just prior to entering a stream. It does not account for uptake that occurs in the riparian zone (Groffman et al., 1992; Peterjohn and Correll, 1984) or uptake once the nutrients enter a stream (Ensign and Doyle, 2006; Valett et al., 2002).

The method used incorporates many assumptions and as a result there is uncertainty in the loading estimates. It is meant to develop coarse estimates of nutrient loading from livestock in the Lower Blackfoot TPA. As part of the implementation of a watershed restoration plan (**Section 7-1**), more refined models could be used to reduce uncertainty in estimates of nutrient loading from livestock.

### *5.5.1.2 Septic Loading Estimate*

Septic systems, even when operating as designed can contribute nutrients to surface water through subsurface pathways. The amount of nutrients that a given septic system contributes to a waterbody is dependent upon its discharge, soils, and distance from the waterbody. A simple model, the Method for Estimating Attenuation from Septic Systems (MEANSS), was used to incorporate the previously mentioned variables and provide coarse estimates of the nitrate and TP loads to each waterbody (see **Appendix F**).

Key assumptions for this method are as follows:

- All septic systems in a watershed are conventional and functioning properly
- The loading rate before attenuation for nitrate from conventional systems is 30.5 lbs/yr
- The loading rate before attenuation for phosphorus from conventional systems is 6.44 lbs/yr
- Load reductions are dependent on soil type and distance from water as described in **Appendix F**.

MEANSS was used to determine septic loading based on a 0% failure rate. As a result, for a TMDL to be achieved it is assumed that any failing septic systems would be identified and repaired. Similar to the method used for estimating nutrient loads from livestock, this method estimates the load from septic systems just prior to entering a stream. It does not account for uptake that occurs in the riparian zone (Groffman et al., 1992; Peterjohn and Correll, 1984) or uptake once the nutrients enter a stream (Ensign and Doyle, 2006; Valett et al., 2002).

The MEANSS model incorporates many assumptions and as a result there is uncertainty in the loading estimates. It is meant to develop coarse estimates of nutrient loading from septic systems in the Lower Blackfoot TPA. As part of the implementation of a watershed restoration plan (**Section 7-1**), more refined models could be used to reduce uncertainty in estimates of nutrient loading from septic systems.

### *5.5.1.3 Silviculture (Timber Harvest) Loading Estimate*

Silviculture practices inevitably cause some measure of downstream effects that may or may not be significant over time. Changes in land cover will change the rate at which water evapotranspires and thus the water balance, in that the distribution of water between base flow and runoff will change. Disturbances of the ground surface will also disrupt the hydrological cycle. The combination of these changes can alter water yield, peak flows and water quality (Jacobson, 2004). Changes in biomass uptake and soil conditions will affect the nutrient cycle. Elevated nitrate concentrations result from increased leaching from the soil as mineralization is enhanced. This increase generally only lasts up to two or three years before returning to pre-harvest levels (Feller and Kimmins, 1984; Likens et al., 1978; Martin and Harr, 1989). Nutrient uptake by biomass is also greatly reduced after timber harvest, leaving more nutrients available for runoff. Loading from silviculture is not estimated in this document because unlike grazing, timber harvest does not occur throughout the watersheds but in specific locations that differ from one year to the next. In addition, the effect of timber harvest on instream nutrient levels is short term and would be difficult to model as a general effect. In lieu of loading estimates, water quality data was examined in relationship to harvest records to determine if timber harvest is having an identifiable effect.

### *5.5.1.4 Mining Loading Estimate*

Surface water quality can be degraded by releases of contaminants from mine waste material or from co-mingling with acid mine drainage from mine adits. Nutrients impacts from mining can be the result of the use of blasting (e.g., TNT) which introduces nitrate and the use of cyanide which introduces TN. Concentration of potential contaminants depends on whether or not these methods were used, the timing of when mining has taken place, mechanism of chemical release, streamflow, and water chemistry. Like timber harvest, mining has taken place at specific locations within the Lower Blackfoot TPA. In addition, much of the mining in the area ceased during or before the mid-1900's. As a result, loading from mining was not estimated; instead, water quality data was examined in relationship to specific mine locations to determine if mining was having an identifiable effect on nutrient loading.

### *5.5.1.5 Natural Background Loading Estimate*

Load allocations for natural background sources in all applicable impaired segments are based on median concentration values from reference sites in the Middle Rockies Level III Ecoregion during the July 1 – September 30 growing season (nitrate = 0.02 mg/L (Suplee et al., 2008), TN = 0.095 mg/L, and TP = 0.01 mg/L (Suplee and Watson, 2013). Reference sites were chosen to represent stream conditions where human activities may be present but do not negatively harm the waterbody's uses. The effects of natural events such as flooding, fire, and beetle kill may be captured at these sites. Natural background loads are calculated by multiplying the median reference concentration by the measured median growing season streamflow.

## 5.5.2 Approach to TMDL Development and Allocations

### *5.5.2.1 TMDL Equation*

TMDL calculations for nitrate, TN and TP are based on the following formula:

Equation 5: TMDL = (X) (Y) (5.4)

*TMDL= Total Maximum Daily Load in lbs/day*
*X = water quality target in mg/L (nitrate = 0.100 mg/L, TN = 0.30 mg/L, or TP = 0.030 mg/L)*
*Y = streamflow in cubic feet per second*
*5.4 = conversion factor*

Note that the TMDL is not static, as flow increases the allowable (TMDL) load increases as shown by the total phosphorus example in **Figure 5-2**.

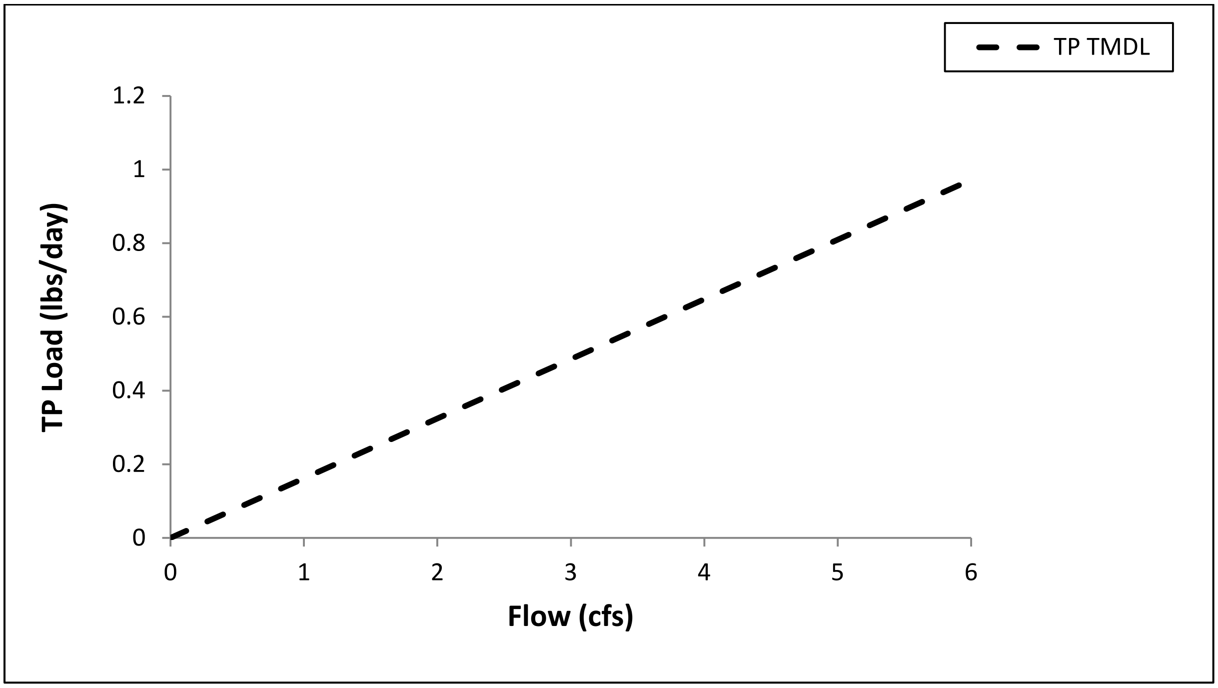


**Figure 5-2. Example TMDL for total phosphorus from 0 to 6 cfs**

**Approach to TMDL Allocations**

As discussed in **Section 4.0**, the nitrate, TN, and TP TMDLs for applicable impaired waterbodies consists of the sum of load allocations to individual source categories (**Tables 5-14 and 5-15**). Load allocations will be calculated for the following source categories: 1) Natural background, 2) Septic and 3) Other Human-caused (agriculture, silviculture, and mining). In the absence of individual WLAs and an explicit margin of safety (MOS), the TMDLs for nitrate, TN, and TP in each waterbody are equal to the sum of the individual loads as follows:

**Equation 6**: $\text{TMDL} = \text{LA}_{\text{NB}} + \text{LA}_{\text{SE}} + \text{LA}_{\text{H}}$

$LA_{NB}$ = *Load Allocation to natural background sources*
$LA_{SE}$ = *Load Allocation to septic sources*
$LA_{H}$ = *Load Allocation to agriculture, silviculture, and mining sources*

**Table 5-14. Nitrate and TN load allocation source categories and descriptions for the Lower Blackfoot TPA**

| Source Category | Load Allocation Descriptions |
|---|---|
| Natural Background | • soils and local geology<br>• natural vegetative decay<br>• wet and dry airborne deposition<br>• wild animal waste<br>• natural biochemical processes that contribute nitrogen to nearby waterbodies |
| Septic | • human waste |
| Other Human-Caused (Agricultural, Silviculture, and Mining) | • domestic animal waste<br>• fertilizer<br>• loss of riparian and wetland vegetation along streambanks<br>• limited nutrient uptake due to loss of overstory<br>• cyanide breakdown from leaching<br>• runoff from exposed rock containing natural background nitrate<br>• residual chemicals left over from mining practices |

**Table 5-15. TP load allocation source categories and descriptions for the Lower Blackfoot TPA**

| Source Category | Load Allocation Descriptions |
|---|---|
| Natural Background | • soils and local geology<br>• natural vegetative decay<br>• wet and dry airborne deposition<br>• wild animal waste<br>• natural biochemical processes that contribute phosphorus to nearby waterbodies |
| Septic | • human waste |
| Other Human-Caused (Agricultural, Silviculture, and Mining) | • domestic animal waste<br>• fertilizer<br>• loss of riparian and wetland vegetation along streambanks<br>• limited nutrient uptake due to loss of overstory<br>• runoff from exposed rock containing natural background phosphorus |

### Natural background Allocation

Natural background loading is discussed in **Section 5.5.1.5**. The natural background load is calculated as follows:

**Equation 7**: LANB = (X) (Y) (5.4)

$LA_{NB}$ = *Load Allocated to natural background sources*
*X = natural background concentration in mg/L (nitrate = 0.02 mg/L, TN = 0.095 mg/L, or TP = 0.01 mg/L)*
*Y = streamflow in cubic feet per second (median from the applicable stream)*
*5.4 = conversion factor*

### Allocations for Septic and Other Human-Caused Sources

The load allocation to septic and other human-caused sources is calculated as the difference between the allowable daily load (TMDL) and the natural background load:

**Equation 8**: $LA_{SE} + LA_{H} = TMDL - LA_{NB}$

$LA_{SE}$ = *Load Allocation to septic sources*
$LA_{H}$ = *Load Allocation to agriculture, silviculture, and mining sources*

Results from modeling septic and livestock loading will be used to determine loading specific to the septic and other human-caused sources allocations. These results, along with information regarding existing load and load reductions necessary to satisfy the TMDL, will provide the basis for determining values for the load allocations.

### *5.5.2.2 Total Existing Load*

To estimate the total existing loading for the purpose of estimating a required load reduction, the following equation will be used:

**Equation 9**: Total Existing Load = (X) (Y) (5.4)

*X = measured concentration in mg/L (80th percentile[1] from the applicable stream)*
*Y = streamflow in cubic feet per second (median from the applicable stream)*
*5.4 = conversion factor*

[1] The 80th percentile will be used because it corresponds to the exceedance rate allowed by the Exact Binomial Test used for water quality assessment described in **Section 5.4.3**.

## 5.6 SOURCE ASSESSMENTS, TMDLS, ALLOCATIONS, AND REDUCTIONS FOR EACH STREAM

The below sections describe the most significant natural and human-caused sources in more detail, establish TMDLs and load allocations to specific source categories, provide nutrient loading estimates for natural, septic, and human-caused source categories to nutrient-impaired stream segments, and estimate reductions necessary to meet water quality targets for the following streams:

- Elk Creek
- Washoe Creek
- West Fork Ashby Creek
- Camas Creek
- Union Creek

The existing loads are used to estimate load reductions by comparing them to the allowable (TMDL) load and computing a required percent reduction to meet the TMDL. These load reduction estimates can be complicated by nutrient uptake within the stream. Nitrate, TN, and/or TP target exceedances, or the extent by which they exceed a target, can be masked by nutrient uptake.

No load reductions are given for natural background allocations. Septic load allocations have no reductions because BMPs are part of the installation and proper functioning of a septic system. To reduce the impacts of adding septic systems in the future, Type II systems may be installed to decrease nitrogen loading and/or systems may be installed further away from streams to allow for more nutrients attenuation.

## 5.6.1 Elk Creek

### *5.6.1.1 Assessment of Water Quality Results*

The source assessment for Elk Creek consists of an evaluation of nitrate and TP concentrations and exceedances of chlorophyll-*a* and/or AFDM within the impaired segment of Elk Creek. This is followed by the quantification of the most significant human caused sources of nutrients.

DEQ collected water quality samples from Elk Creek during the growing season over the time period of 2006-2012 (**Section 5.4.3.1**, **Table 5-3**). **Figure 5-3** presents summary statistics for nitrate concentrations at sampling sites in Elk Creek. With the exception of the site near the headwaters, Nitrate values in this segment were always less than half the target of 0.10 mg/L. A decline in nitrate values occurs from the headwaters to Yreka with the lowermost four sites having similar nitrate values.

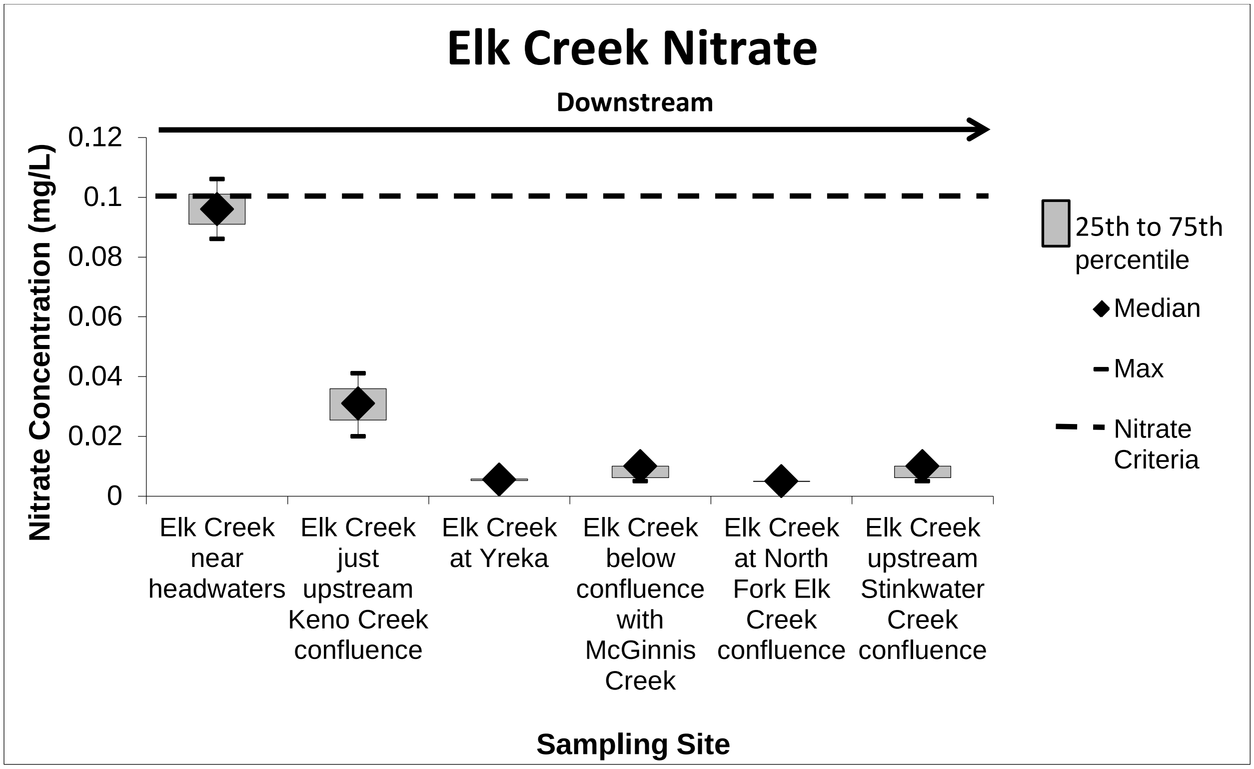


**Figure 5-3. Nitrate Box Plots for Elk Creek**

**Figure 5-4** presents summary statistics for TP concentrations at sampling sites in Elk Creek. TP values in this segment were always below the target of 0.03 mg/L at the two most upstream sites. Samples from the lowermost three sites always exceeded the TP target. Overall, TP values increased moving in the downstream direction.

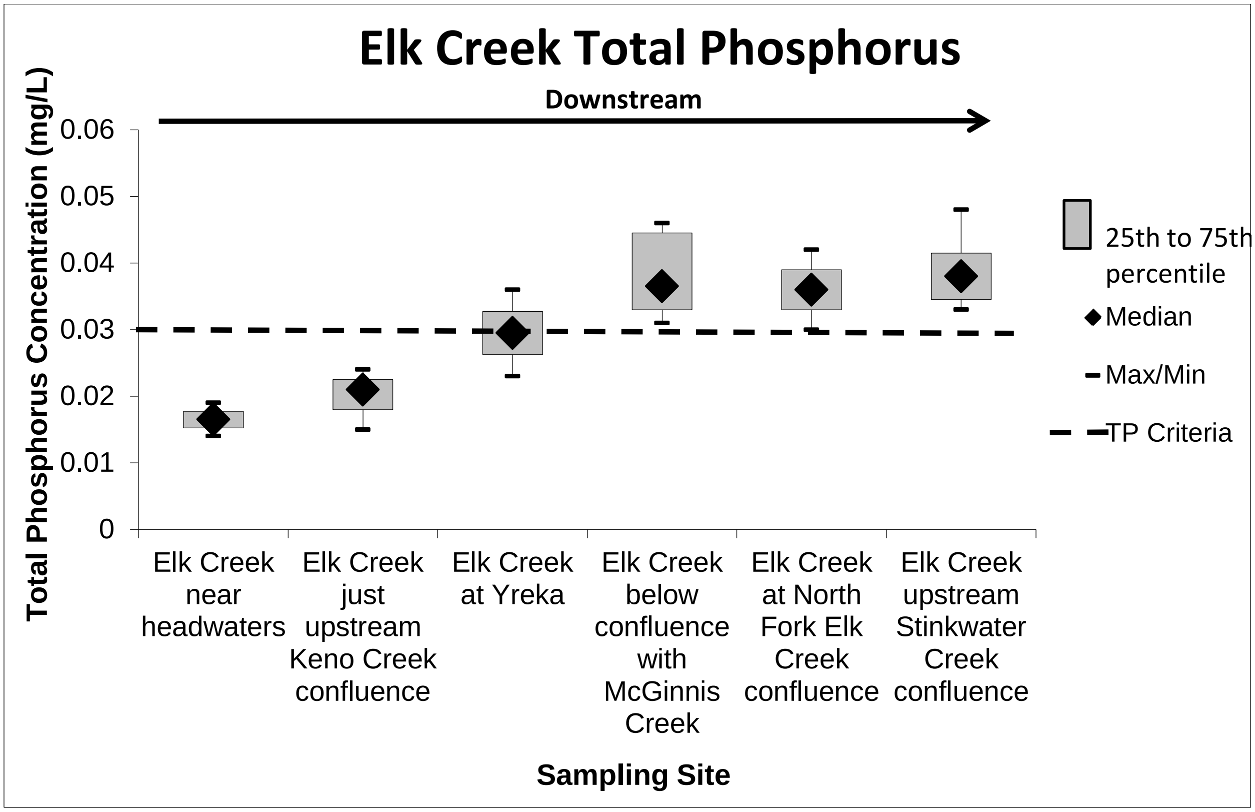


**Figure 5-4. TP Box Plots for Elk Creek**

All exceedances of algal measures (1 chlorophyll-*a* and 2 AFDM) occurred at the site just upstream from the Keno Creek confluence. It is possible that nutrient uptake by algae is responsible for measured values of nitrate and TP being below their respective target at this site.

### *5.6.1.2 Assessment of Loading by Source Categories*

**Agricultural (Livestock) Nutrient Loading**

Cattle are seasonally grazed in this portion of the Elk Creek watershed. There are two BLM allotments (Coloma and Mulkey West), no DNRC grazing allotments, and one Lubrecht Experimental Forest allotment (Camp Unit) within the watershed. BLM lands within the Coloma allotment are permitted for 0.034 AUMS per acre between June 15 and October 15. The Mulkey West allotment is not active and has not been since 1999, although grazing is known to occur on it. Lubrecht lands within the Camp Unit allotment are permitted for 0.100 AUMs per acre between June 1 and September 30. Only portions of the allotments (Coloma – 593 BLM acres; Mulkey West – 1,682 BLM acres, Camp Unit – 976 Lubrecht acres) actually overlap the watershed. Estimated nutrient loading from livestock in the Elk Creek watershed is 0.89 lb/day nitrogen and 0.47 lb/day phosphorus (**Equation 4**; **Section 5.5.1.1**). Although only 8% of the Elk Creek watershed is explicitly used for grazing, effects from cattle grazing have been observed outside of active allotments along the stream channel and its tributaries. Livestock grazing is likely a substantial source of nutrients in Elk Creek.

**Septic Nutrient Loading**

DEQ estimates that there are 10 single family dwellings in the Elk Creek watershed with septic systems. The MEANSS analysis indicates that septic systems contribute up to 0.23 lb/day nitrate and 0 lbs/day phosphorus. All septic locations are about ¼ mile or more from the Elk Creek stream channel and are spread throughout the western side of the drainage. Four likely drain into Day Gulch which enters Elk Creek just downstream of the headwaters sampling site. Four water quality samples were collected from Day Gulch in 2011 and 2012; none of these samples exceeded targets for nitrate, TN, or TP. The location of these dwellings when considered in combination with the sampling locations in **Figures 5-3** and **5-4** indicates that the nitrogen contribution from septic to Elk Creek is not causing targets to be exceeded. Nevertheless, based on the MEANSS Model, septic loading of nitrogen, in the form of nitrate, is about 20.5% of the combined loading from both septic and from livestock grazing and represents a potentially substantial source to Elk Creek.

**Silvicultural Nutrient Loading**

Timber was harvested from BLM lands in the Elk Creek watershed from 1988-1990 and again from 2001-2004. During 1988-1990, 318 acres were harvested resulting in 6,033 million board feet of product. During 2001-2004, 784 acres were harvested resulting in 2,075 million board feet of product. Since 2004 there have been no other BLM timber sales in the watershed. Timber harvest on DNRC lands consisted of about 233 acres from 2003-2005. Harvest on Lubrecht Experimental Forest lands over the last 10 years consisted of 875 acres (about 5% of the watershed) for about 8.5 million board feet of product. Much of this harvest was to remove beetle killed trees. Any nutrient loading from tree die-off is a component of what is considered natural versus being attributed to harvest. Due to the limited acreage harvested in the last 10 years and because the harvest was primarily to remove already dead trees, any potential nutrients contribution to Elk Creek from silviculture is likely insignificant.

**Mining Nutrient Loading**

There are 26 abandoned mines upslope from the impaired segment of Elk Creek. The majority of these mines are located at the upper elevations on the south side of the watershed. **Figure 5-3** indicates that the only nitrate value above the target occurs at the headwaters site which is downstream of only the Haparanda mine which was opened in 1886 and has not produced since 1904 (Montana Department of Environmental Quality, 2013b). The Day Gulch watershed contains six abandoned mines and enters Elk Creek directly downstream of the headwaters site. Day Gulch was sampled four times during 2011 and 2012 and all nitrate values were below the detection limit (i.e., all were below 0.01 mg/L). Groundwater data collected downslope of mines in the Elk Creek/Day Gulch headwaters indicated that nitrate values are low (≤ 0.05 mg/L; see **Appendix D**, **Table D-4**). Any potential nitrogen contribution to Elk Creek from mining is likely insignificant as measured nitrate values in Elk Creek are generally less than half the target, a tributary to Elk Creek containing multiple mines shows no indication of elevated nitrate values, and groundwater downslope of historical mines contains low levels of nitrate.

### *5.6.1.3 Nitrate TMDL, Allocations, and Current Loading*

The TMDL for nitrate is based on **Equation 5** and the TMDL allocations are based on **Equation 6**. The value of the nitrate TMDL is a function of the flow; an increase in flow results in an increase in the TMDL. The following example nitrate TMDL for Elk Creek uses **Equation 5** with the median measured flow from all sites during 2006-2012 sampling (5.06 cfs):

$$\boldsymbol{TMDL = (0.10\ mg/L)\ (5.06\ cfs)\ (5.4) = 2.73\ lbs/day}$$

**Equation 7** is the basis for the natural background load allocation for nitrate. To continue with the example at a flow of 5.06 cfs, this allocation is as follows:

$$\boldsymbol{LA_{NB} = (0.02\ mg/L)\ (5.06\ cfs\ )\ (5.4) = 0.55\ lb/day}$$

Using **Equation 8**, the combined septic and other human-caused nitrate load allocation at 5.06 cfs can be calculated:

**$LA_{SE} + LA_{H}$ = 2.73 lbs/day – 0.55 lb/day = 2.18 lbs/day**

The example nitrate TMDL and load allocations are summarized in **Table 5-16**.

An example total existing load is calculated as follows using **Equation 9,** the 80th percentile of nitrate values measured from Elk Creek from 2006-2012 (0.02 mg/L) and the median measured flow of 5.06 cfs:

***Total Existing Load* = (0.02 mg/L) (5.06 cfs) (5.4) = 0.55 lb/day**

The existing load does not reflect a need for reduction to meet the TMDL value. This is not surprising given the minimal number of nitrate target exceedances. If it were not for the complications of nutrient uptake, one could conclude that nitrate is not a problem. Nevertheless, the potential for nitrate target exceedances masked by nutrient uptake makes it difficult to accurately estimate load reduction requirements for most nutrient TMDLs.

The example nitrate TMDL and load allocations are summarized in **Table 5-16**. Because the existing load is less than the TMDL, the combined septic and livestock allocation of 2.18 lbs/day can be parsed out based on the relative loading contributions from each. As discussed above, 79.5% of the combined load can be attributed to livestock grazing and 20.5% to septic. For the above example TMDL, this equates to an $LA_{SE}$ of 0.45 lb/day for the septic loading allocation and an $LA_{H}$ of 1.73 lbs/day for the other human-caused sources (mostly livestock) loading allocation. This partitioning approach to the load allocations, after subtraction of the natural background allocation, applies to all flows and associated TMDLs.

Implementation of grazing BMPs is expected to reduce both nitrate and phosphorus loading and thus reduce algae levels as well.

**Table 5-16. Elk Creek Nitrate Example TMDL and Load Allocations**

| Source Category | Allocation & TMDL (lbs/day)[1] |
|---|---|
| Natural Background | 0.55 |
| Septic | 0.45[2] |
| Other Human-caused (primarily livestock grazing) | 1.73[2] |
| | **TMDL = 2.73** |

*[1] Based on a median growing season flow of 5.06 cfs*
*[2] Based on existing loading estimate ratio*

### 5.6.1.4 TP TMDL, Allocations, Current Loading, and Reductions

The TMDL for TP is based on **Equation 5** and the TMDL allocations are based on **Equation 6**. The value of the TP TMDL is a function of the flow; an increase in flow results in an increase in the TMDL. The following example TP TMDL for Elk Creek uses **Equation 5** with the median measured flow from all sites during 2006-2012 sampling (5.06 cfs):

***TMDL* = (0.03 mg/L) (5.06 cfs) (5.4) = 0.82 lb/day**

**Equation 7** is the basis for the natural background load allocation for TP. To continue with the example at a flow of 5.06 cfs, this allocation is as follows:

**$LA_{NB}$ = (0.01 mg/L) (5.06 cfs ) (5.4) = 0.27 lb/day**

Using **Equation 8**, the combined septic and other human-caused TP load allocation at 5.06 cfs can be calculated:

**$LA_{SE}$ + $LA_{H}$ = 0.82 lb/day – 0.27 lb/day = 0.55 lb/day**

Because the existing septic load is estimated at 0 lbs/day for phosphorus, then **$LA_{SE}$** will always be equal to 0 lbs/day in **Equation 8** and the **$LA_{H}$** will always be equal to the TMDL value minus **$LA_{NB}$**, or 0.55 lb/day per the above example conditions.

An example total existing load is calculated as follows using **Equation 9,** the 80th percentile of TP values measured from Elk Creek from 2006-2012 (0.042 mg/L) and the median measured flow of 5.06 cfs:

***Total Existing Load* = (0.042 mg/L) (5.06 cfs) (5.4) = 1.15 lbs/day**

**Table 5-17** contains the results for the example TP TMDL, load allocations, and current loading. In addition, it contains the percent reduction to the other human-caused load allocation required to meet the water quality target for TP. The percent reductions to the natural background and septic load allocations are assumed to be 0%. At the median growing season flow of 5.06 cfs and the 80th percentile of measured TP values, the current loading in Elk Creek is greater than the TMDL. Under these example conditions a 38% reduction of other human-caused sources and an overall 29% reduction of TP in Elk Creek would result in the TMDL being met. The source assessment of the Elk Creek watershed indicates that livestock grazing is the most likely source of TP in Elk Creek; load reductions should focus on limiting and controlling TP loading from this source. Meeting load allocations for Elk Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

**Table 5-17. Elk Creek TP Example TMDL, Load Allocations, Current Loading, and Reductions**

| Source Category | Allocation & TMDL (lbs/day)[1] | Existing Load (lbs/day)[1] | Percent Reduction |
|---|---|---|---|
| Natural Background | 0.27 | 0.27 | 0% |
| Septic | 0.00 | 0.00[2] | 0% |
| Other Human-caused (primarily livestock grazing) | 0.55 | 0.88[2] | 38% |
| | **TMDL = 0.82** | **Total = 1.15** | **Total = 29%** |

*[1] Based on a median growing season flow of 5.06 cfs*
*[2] Based on existing loading estimate ratio*

## 5.6.2 Washoe Creek

### *5.6.2.1 Assessment of Water Quality Results*

The source assessment for Washoe Creek consists of an evaluation of TN and TP concentrations and exceedances of chlorophyll-*a* and/or AFDM. This is followed by the quantification of the most significant human caused sources of nutrients.

DEQ collected water quality samples from Washoe Creek during the growing season over the time period of 2004-2012 (**Section 5.4.3.2, Table 5-5**). **Figure 5-5** presents summary statistics for TN concentrations at sampling sites in Washoe Creek. TN values in Washoe Creek were always below the target of 0.30 mg/L. There is a trend toward higher TN values at the downstream site.

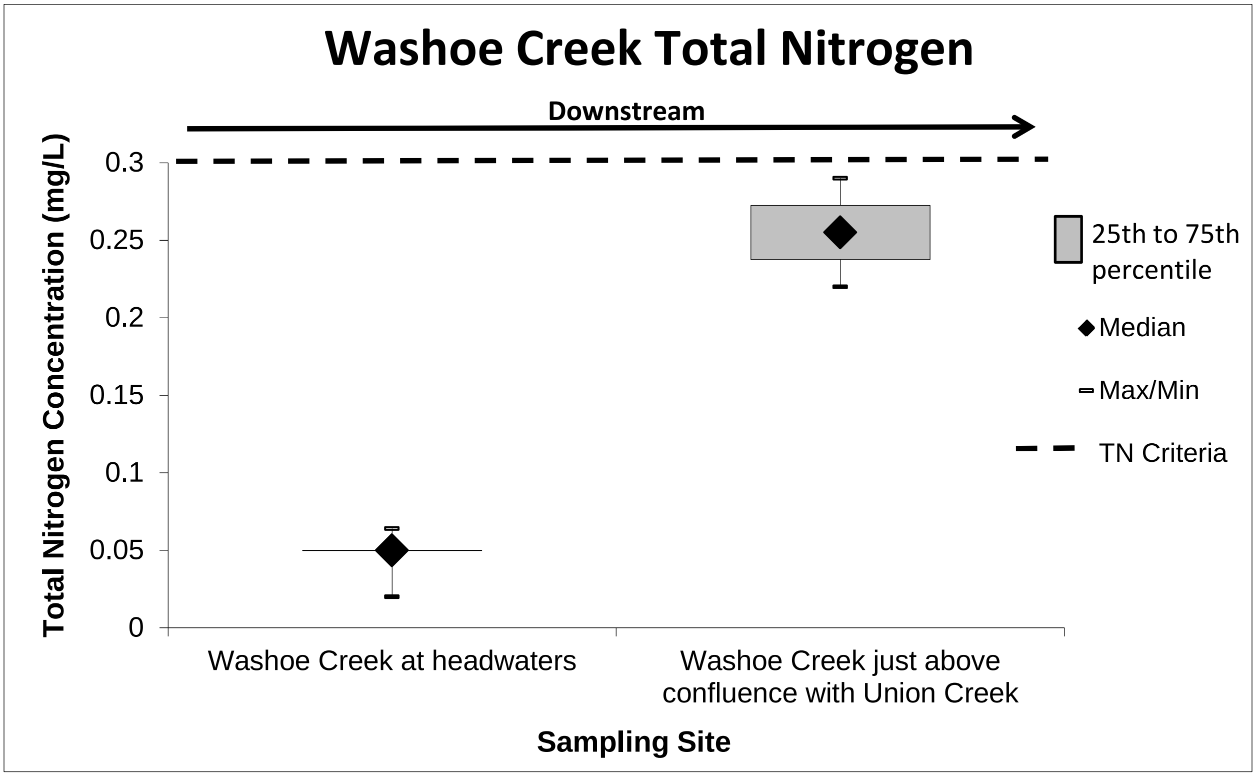


Figure 5-5. TN Box Plots for Washoe Creek

**Figure 5-6** presents summary statistics for TP concentrations at sampling sites in Washoe Creek. TP values in this segment were generally above the target of 0.03 mg/L. There is a trend toward higher TP values when moving in the downstream direction.

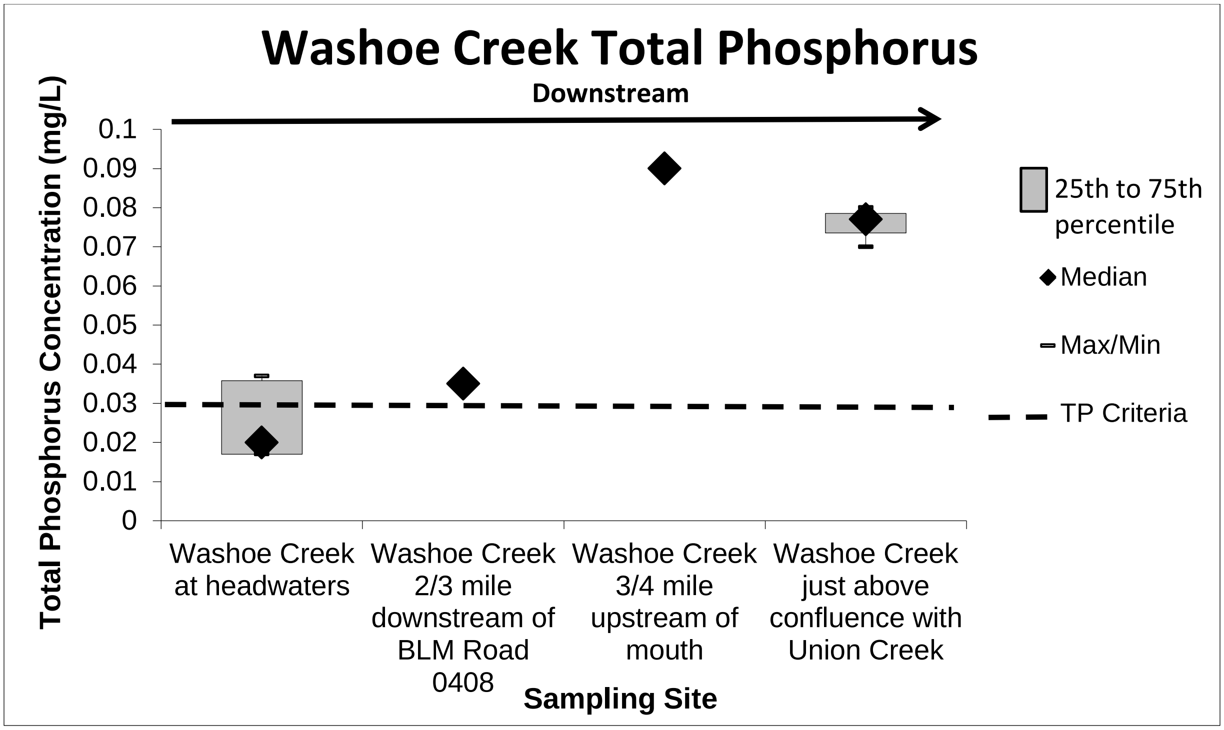


**Figure 5-6. TP Box Plots for Washoe Creek**

The single exceedance of algal measurement was AFDM at the headwaters site. It is possible that nutrient uptake by algae is responsible for measured TN values being below their target at this site. Despite the high measurement for AFDM at this site on August 11, 2011, the measured TP value (0.036 mg/L) was still above the target of 0.030 mg/L.

### *5.6.2.2 Assessment of Loading by Source Categories*

**Agricultural (Livestock) Nutrient Loading**

Cattle and horses are grazed in the Washoe Creek watershed. There are two BLM allotments (Coloma and Bonita-Clinton), multiple DNRC grazing allotments, and one Lubrecht Experimental Forest allotment (Camp Unit) within the watershed. BLM lands within the Coloma allotment are permitted for 0.034 AUMs per acre between June 15 and October 15. BLM lands within the Bonita-Clinton allotment are permitted for 0.055 AUMs per acre between June 1 and September 30. Lubrecht lands within the Camp Unit allotment are permitted for 0.100 AUMs per acre between June 1 and September 30. Only portions of the allotments (Coloma – 1,310 BLM acres; Bonita-Clinton – 0 BLM acres, Camp Unit – 193 Lubrecht acres) actually overlap the watershed. DNRC allotments within the Washoe Creek watershed consist of about 667 acres and are permitted for 0.12 AUMs per acre between June 1 and September 30. Estimated nutrient loading from livestock in the Washoe Creek watershed is 3.62 lbs/day nitrogen and 1.9 lbs/day phosphorus (**Equation 4**; **Section 5.5.1.1**). Livestock grazing is likely a significant nutrient source in Washoe Creek.

**Septic Nutrient Loading**

DEQ estimates that there are eight single family dwellings in the Washoe Creek watershed with septic systems. The MEANSS analysis indicates that these dwellings could contribute up to 0.25 lb/day nitrate and 0.016 lb/day phosphorus. Five of these septic locations are in the headwaters downstream of the upper two sites shown in **Figure 5-6** and are at least 0.25 miles from Washoe Creek. The remaining three are located near the confluence with Union Creek upstream of the lowermost sampling site and are located less than 400 ft from the stream channel. Because all TN values are below targets and TP values are elevated upstream of any septic locations, it is likely that septic represents a minimal potential nutrient contribution to Washoe Creek. Nevertheless, based on the MEANSS model, septic loading is about 6.5% of the combined TN loading from both septic and livestock and about 0.8% of the combined TP load.

**Silvicultural Nutrient Loading**

Timber was harvested from BLM lands in the Washoe Creek watershed from 1984-1987. During this time 407 acres were harvested resulting in 3,500 million board feet of product. Since 1987, there have been no other BLM timber sales in the watershed. Timber harvest on DNRC lands consisted of 136 acres during the 1980's, 23 acres during the 1990's, and 17 acres from 2000-2005. Due to the limited acreage harvested in the last 10 years (< 1%), any potential nutrients contribution to Washoe Creek from silviculture is likely insignificant.

**Mining Nutrient Loading**

There are three abandoned mines within the Washoe Creek watershed. This area was part of the Coloma mining district (Montana Department of Environmental Quality, 2013b) and has not been mined since the mid-1900's. Because all nitrate and TN values were below their respective targets and a substantial amount of time has passed since active mining occurred, any potential nitrogen contribution to Washoe Creek from mining is likely insignificant.

### 5.6.2.3 TN TMDL, Allocations, and Current Loading

The TMDL for TN is based on **Equation 5** and the TMDL allocations are based on **Equation 6**. The value of the TN TMDL is a function of the flow; an increase in flow results in an increase in the TMDL. The following example TN TMDL for Washoe Creek uses **Equation 5** with the median measured flow from all sites during 2006-2012 sampling (0.065 cfs):

***TMDL* = (0.30 mg/L) (0.065 cfs) (5.4) = 0.11 lb/day**

**Equation 7** is the basis for the natural background load allocation for TN. To continue with the example at a flow of 0.065 cfs, this allocation is as follows:

**$LA_{NB}$ = (0.095 mg/L) (0.065 cfs ) (5.4) = 0.03 lb/day**

Using **Equation 8**, the combined septic and other human-caused TN load allocation at 0.065 cfs can be calculated:

**$LA_{SE} + LA_{H}$ = 0.11 lb/day – 0.03 lb/day = 0.08 lb/day**

An example total existing load is calculated as follows using **Equation 9,** the 80th percentile of TN values measured from Washoe Creek from 2004-2012 (0.189 mg/L) and the median measured flow of 0.065 cfs:

***Total Existing Load* = (0.189 mg/L) (0.065 cfs) (5.4) = 0.066 lb/day**

The existing load does not reflect a need for a reduction to meet the TMDL value. This is not surprising given that there were no measured TN target exceedances. If it were not for the complications of nutrient uptake, one could conclude that TN is not a problem. Nevertheless, the potential for TN target exceedances masked by nutrient uptake makes it difficult to accurately estimate load reduction requirements for most nutrient TMDLs.

The example TN TMDL and load allocations are summarized in **Table 5-18.** Because the existing load is less than the TMDL, the combined septic and livestock grazing allocation of 0.08 lb/day can be parsed out based on the relative loading contributions from each. As discussed in **Section 5.6.2.2** above, 93.5% of the combined load can be attributed to livestock grazing and 6.5% to septic. For the above example TMDL, this equates to an $LA_{SE}$ of 0.005 lb/day for the septic loading allocation and an $LA_H$ of 0.075 lb/day for the other human-caused sources (mostly livestock) loading allocation. This partitioning approach to the load allocations, after subtraction of the natural background allocation, applies to all flows and associated TMDLs.

This TMDL along with the TMDL for TP serve to address the chlorophyll-*a* impairment for Washoe Creek. By reducing nutrient loads in Washoe Creek, it is expected that algae growth and thus chlorophyll-*a* levels will be reduced. The nutrient issues causing high algae levels are the likely the result of the high phosphorus in Washoe Creek. By controlling the input of phosphorus sources, which are often the same as those contributing nitrate and TN, it is expected that overall nutrient and thus algae levels will be reduced.

**Table 5-18. Washoe Creek TN Example TMDL and Load Allocations**

| Source Category | Allocation & TMDL (lbs/day)[1] |
|---|---|
| Natural Background | 0.03 |
| Septic | 0.005[2] |
| Other Human-caused (primarily livestock grazing) | 0.075[2] |
| | **TMDL = 0.11** |

[1] *Based on a median growing season flow of 0.065 cfs*

[2] *Based on existing loading estimate ratio*

### 5.6.2.4 Nitrate TMDL Surrogate

Because nitrate is a component of TN, and because the loading sources and methods to reduce loading sources of nitrate and TN are essentially the same, the above TMDL for TN provides a surrogate TMDL for nitrate in Washoe Creek. All nitrate values measured from Washoe Creek were below the target of 0.10 mg/L (**Tables 5-5 and 5-6**). As a result, existing nitrate loading would result in 0% load reduction requirement consistent with the TN TMDL and allocations would apply to the same source categories consistent with the TN allocations.

### 5.6.2.5 TP TMDL, Allocations, Current Loading, and Reductions

The TMDL for TP is based on **Equation 5** and the TMDL allocations are based on **Equation 6**. The value of the TP TMDL is a function of the flow; an increase in flow results in an increase in the TMDL. The following example TP TMDL for Washoe Creek uses **Equation 5** with the median measured flow from all sites during 2006-2012 sampling (0.065 cfs):

$$TMDL = (0.03 \text{ mg/L})(0.065 \text{ cfs})(5.4) = 0.011 \text{ lb/day}$$

**Equation 7** is the basis for the natural background load allocation for TP. To continue with the example at a flow of 0.065 cfs, this allocation is as follows:

**$LA_{NB}$ = (0.01 mg/L ) (0.065 cfs ) (5.4) = 0.004 lb/day**

Using **Equation 8**, the combined septic and other human-caused TP load allocation at 0.065 cfs can be calculated:

**$LA_{SE} + LA_{H}$ = 0.011 lb/day – 0.004 lb/day = 0.007 lb/day**

An example total existing load is calculated as follows using **Equation 9,** the 80th percentile of TP values measured from Washoe Creek from 2004-2012 (0.078 mg/L) and the median measured flow of 0.065 cfs:

***Total Existing Load* = (0.078 mg/L) (0.065 cfs) (5.4) = 0.027 lb/day**

The portion of the existing load attributed to septic and other human sources is 0.023 lb/day, which is determined by subtracting out the 0.004 lb/day background load. This 0.023 lb/day value represents the load measured within the stream after potential nutrient uptake, versus the significantly higher value of 1.916 lbs/day (**Section 5.6.2.2**), which represents the estimated combined loading to the stream from both septic and livestock, with septic representing an estimated 0.8% of the total loading to the stream. This information is used to parse out the existing load of 0.023 lb/day based on the relative loading contributions from each source category; resulting in 0.0002 lb/day for septic and 0.0228 lb/day for other human-caused sources (primarily livestock). Because background loading is based on measured instream reference concentrations, no adjustment to background loading is necessary.

**Table 5-19** contains the results for the example TP TMDL, load allocations, and current loading. In addition, it contains the percent reduction to the other human-caused load allocation required to meet the water quality target for TP. The percent reductions to the natural background and septic load allocations are assumed to be 0%. At the median growing season flow of 0.065 cfs and the 80th percentile of measured TP values, the current loading in Washoe Creek is greater than the TMDL. Under these example conditions a 70% reduction of other human-caused sources and an overall 59% reduction of TP in Washoe Creek would result in the TMDL being met. This TMDL along with the TMDL for TN serve to address the chlorophyll-*a* impairment for Washoe Creek. By reducing nutrient loads in Washoe Creek, it is expected that algae growth and thus chlorophyll-*a* levels will be reduced. The source assessment of Washoe Creek indicates that livestock grazing is the most likely source of TP in Washoe Creek; load reductions should focus on limiting and controlling TP loading from this source. Meeting load allocations for Washoe Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

**Table 5-19. Washoe Creek TP Example TMDL, Load Allocations, Current Loading, and Reductions**

| Source Category | Allocation & TMDL (lbs/day)[1] | Existing Load (lbs/day)[1] | Percent Reduction |
|---|---|---|---|
| Natural Background | 0.004 | 0.004 | 0% |
| Septic | 0.0002 | 0.0002[2] | 0% |
| Other Human-caused (primarily livestock grazing) | 0.0068 | 0.0228[2] | 70% |
| | **TMDL = 0.011** | **Total = 0.027** | **Total = 59%** |

[1] *Based on a median growing season flow of 0.065 cfs*

[2] *Based on existing loading estimate ratio*

## 5.6.3 West Fork Ashby Creek

### *5.6.3.1 Assessment of Water Quality Results*

The source assessment for West Fork Ashby Creek consists of an evaluation of TP concentrations and exceedances of chlorophyll-*a* and/or AFDM. This is followed by the quantification of the most significant human caused sources of nutrients.

DEQ collected water quality samples from West Fork Ashby Creek during the growing season over the time period of 2004-2012 (**Section 5.4.3.3, Table 5-7**). **Figure 5-7** presents summary statistics for TP concentrations at sampling sites in West Fork Ashby Creek. TP values in this segment were generally above the target of 0.03 mg/L. There is a slight trend toward higher TP values when moving in the downstream direction.

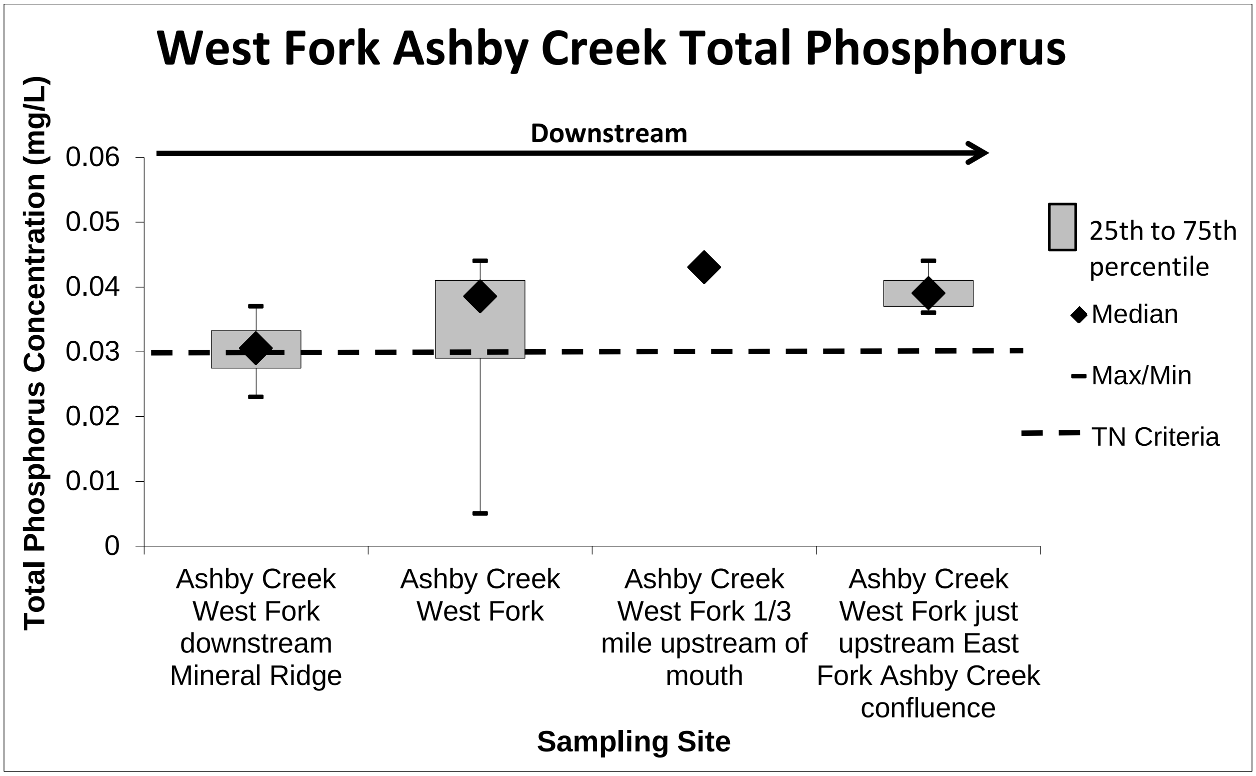


**Figure 5-7. TP Box Plots for West Fork Ashby Creek**

The targets for chlorophyll-*a* and AFDM were not exceeded in West Fork Ashby Creek.

### *5.6.3.2 Assessment of Loading by Source Categories*

**Agricultural (Livestock) Nutrient Loading**

Cattle are grazed in the West Fork Ashby Creek watershed. The entire watershed is contained within the Bonita-Clinton grazing allotment, of which about 36 acres are BLM property. BLM lands on the entire Bonita-Clinton allotment are permitted for 0.055 AUMs per acre between June 1 and September 30. There are multiple DNRC allotments within the West Fork Ashby Creek watershed that combined consist of about 1,627 acres and are permitted for 0.053 AUMs per acre between June 1 and September 30. Estimated nutrient loading from livestock in the West Fork Ashby Creek watershed is 0.65 lb/day phosphorus (**Equation 4**; **Section 5.5.1.1**). Livestock grazing is likely a significant nutrient source in West Fork Ashby Creek.

**Septic Nutrient Loading**
DEQ estimates that there is one single family dwelling in the West Fork Ashby Creek watershed with septic systems. It is located upstream of all four sampling sites. The MEANSS analysis indicates that this dwelling is contributing 0 lbs/day phosphorus. Any potential phosphorus contribution to West Fork Ashby Creek from properly designed and functioning septic systems is likely insignificant.

**Silvicultural Nutrient Loading**
There has not been any timber harvest on BLM lands in the West Fork Ashby Creek watershed in the past 30 years. Timber harvest on DNRC lands consisted of about 327 acres during the 1980’s, 576 acres during the 1990’s, and 366 acres from 2000-2005. Visual observation of aerial images indicates that most of the watershed has been historically logged and is in varying stages of regeneration. The adjacent East Fork Ashby Creek watershed (about 3,781 acres) is similar in size to the West Fork Ashby Creek watershed (about 2,866 acres) and also looks similar in aerial images. Timber harvest in the East Fork Ashby Creek watershed consisted of about 938 acres in the 1980’s, 1,566 acres in the 1990’s, and 193 in the 2000’s. Despite the history of logging in this watershed, it is not impaired for nutrients (see **Section 5.2**). Due to the time that has lapsed since most of the harvest took place, the limited acreage harvested in the last 10 years (about 12%), and observation of an adjacent watershed with a similar silviculture history and no nutrient impairments, any potential nutrients contribution to West Fork Ashby Creek from silviculture is likely insignificant.

**Mining Nutrient Loading**
There is a single abandoned mine within the West Fork Ashby Creek watershed. This mine, called the Sumpter (or Blackhawk) mine appears to have been inactive since the 1930s (Montana Department of Environmental Quality, 2013a). All nitrate and TN values were below their respective targets. Any potential nitrogen contribution to West Fork Ashby Creek from mining is likely insignificant.

### *5.6.3.3 TP TMDL, Allocations, Current Loading, and Reductions*

The TMDL for TP is based on **Equations 5** and the TMDL allocations are based on **Equation 6**. The value of the TP TMDL is a function of the flow; an increase in flow results in an increase in the TMDL. The following example TP TMDL for West Fork Ashby Creek uses **Equation 5** with the median measured flow from all sites during 2009-2012 sampling (0.42 cfs):

$$\boldsymbol{TMDL = (0.03\ mg/L)\ (0.42\ cfs)\ (5.4) = 0.068\ lb/day}$$

**Equation 7** is the basis for the natural background load allocation for TP. To continue with the example at a flow of 0.42 cfs, this allocation is as follows:

$$\boldsymbol{LA_{NB} = (0.01\ mg/L)\ (0.42\ cfs)\ (5.4) = 0.023\ lb/day}$$

Using **Equation 8**, the combined septic and other human-caused TP load allocation at 0.42 cfs can be calculated:

$$\boldsymbol{LA_{SE} + LA_{H} = 0.068\ lb/day - 0.023\ lb/day = 0.045\ lb/day}$$

Because the existing septic load is estimated at 0 lbs/day for phosphorus, then the $\boldsymbol{LA_{SE}}$ will always equal 0 lbs/day in **Equation 8** and the $\boldsymbol{LA_{H}}$ will always then be equal to the TMDL value minus $\boldsymbol{LA_{NB}}$, or 0.045 lb/day per the above equations.

An example total existing load is calculated as follows using **Equation 9,** the 80th percentile of TP values measured from West Fork Ashby Creek from 2004-2012 (0.042 mg/L) and the median measured flow of 0.42 cfs:

**Total Existing Load = (0.042 mg/L) (0.42 cfs) (5.4) = 0.095 lb/day**

**Table 5-20** contains the results for the example TP TMDL, load allocations, and current loading. In addition, it contains the percent reduction to the other human-caused load allocation required to meet the water quality target for TP. The percent reductions to the natural background and septic load allocations are assumed to be 0%. At the median growing season flow of 0.42 cfs and the 80th percentile of measured TP values, the current loading in West Fork Ashby Creek is greater than the TMDL. Under these example conditions a 38% reduction of other human-caused sources and an overall 28% reduction of TP in West Fork Ashby Creek would result in the TMDL being met. The source assessment of the West Fork Ashby Creek watershed indicates that livestock grazing is the most likely source of TP in West Fork Ashby Creek; load reductions should focus on limiting and controlling TP loading from this source. Meeting load allocations for West Fork Ashby Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

**Table 5-20. West Fork Ashby Creek TP Example TMDL, Load Allocations, Current Loading, and Reductions**

| Source Category | Allocation & TMDL (lbs/day)[1] | Existing Load (lbs/day)[1] | Percent Reduction |
|---|---|---|---|
| Natural Background | 0.023 | 0.023 | 0% |
| Septic | 0.00 | 0.00[2] | 0% |
| Other Human-caused (primarily livestock grazing) | 0.045 | 0.072[2] | 38% |
| | **TMDL = 0.068** | **Total = 0.095** | **Total = 28%** |

[1] *Based on a median growing season flow of 0.42 cfs*
[2] *Based on existing loading estimate ratio*

## 5.6.4 Camas Creek

### *5.6.4.1 Assessment of Water Quality Results*

The source assessment for Camas Creek consists of an evaluation of TN and TP concentrations and exceedances of chlorophyll-*a* and/or AFDM within the impaired segment of Camas Creek . This is followed by the quantification of the most significant human caused sources of nutrients.

DEQ collected water quality samples from Camas Creek during the growing season over the time period of 2004-2012 (**Section 5.4.3.4, Table 5-9**). **Figure 5-8** presents summary statistics for TN concentrations at sampling sites in Camas Creek. TN values in this segment were generally greater than the target of 0.30 mg/L. Although the median value decreases in the downstream direction, the maximum value is greatest at the most downstream site.

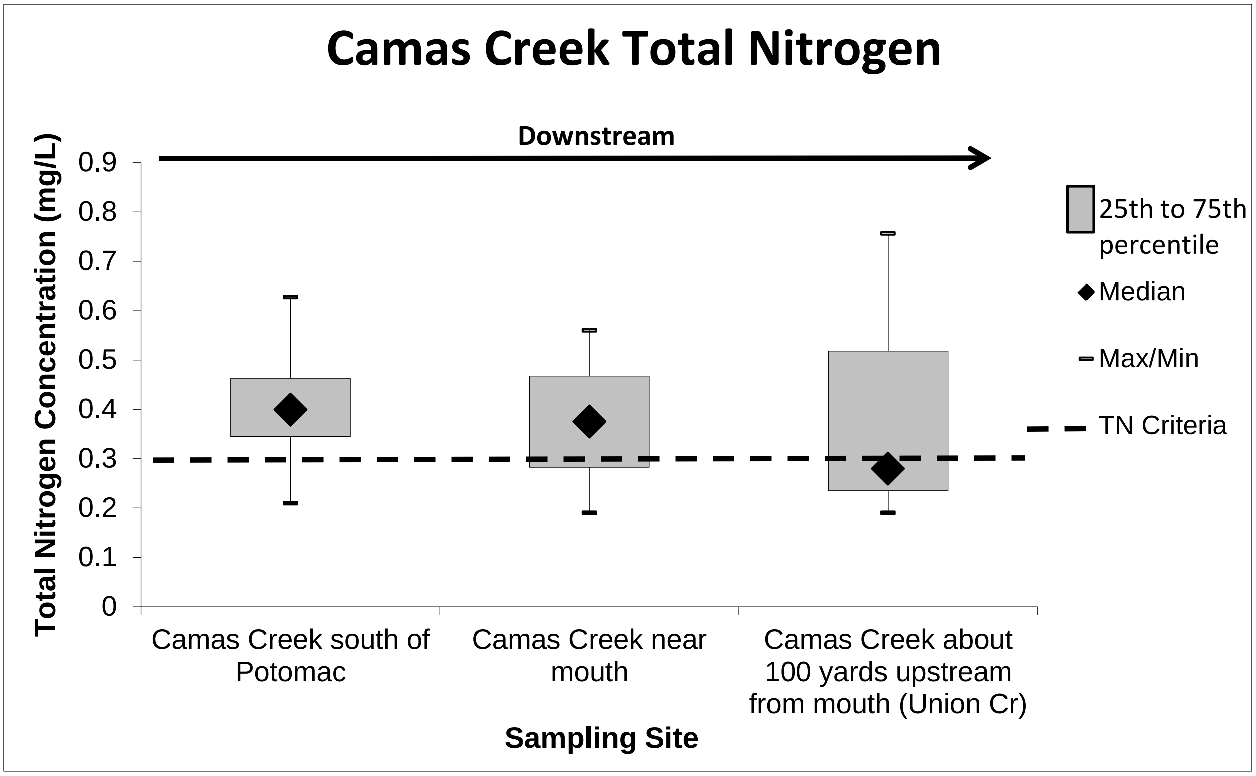


**Figure 5-8. TN Box Plots for Camas Creek**

**Figure 5-9** presents summary statistics for TP concentrations at sampling sites in Camas Creek. TP values in this segment were nearly always above the target of 0.03 mg/L. The distribution of TP values was very similar at the two most upstream sites. The lowermost site had the greatest median, 75th percentile, and maximum as well as the greatest variability in measured values.

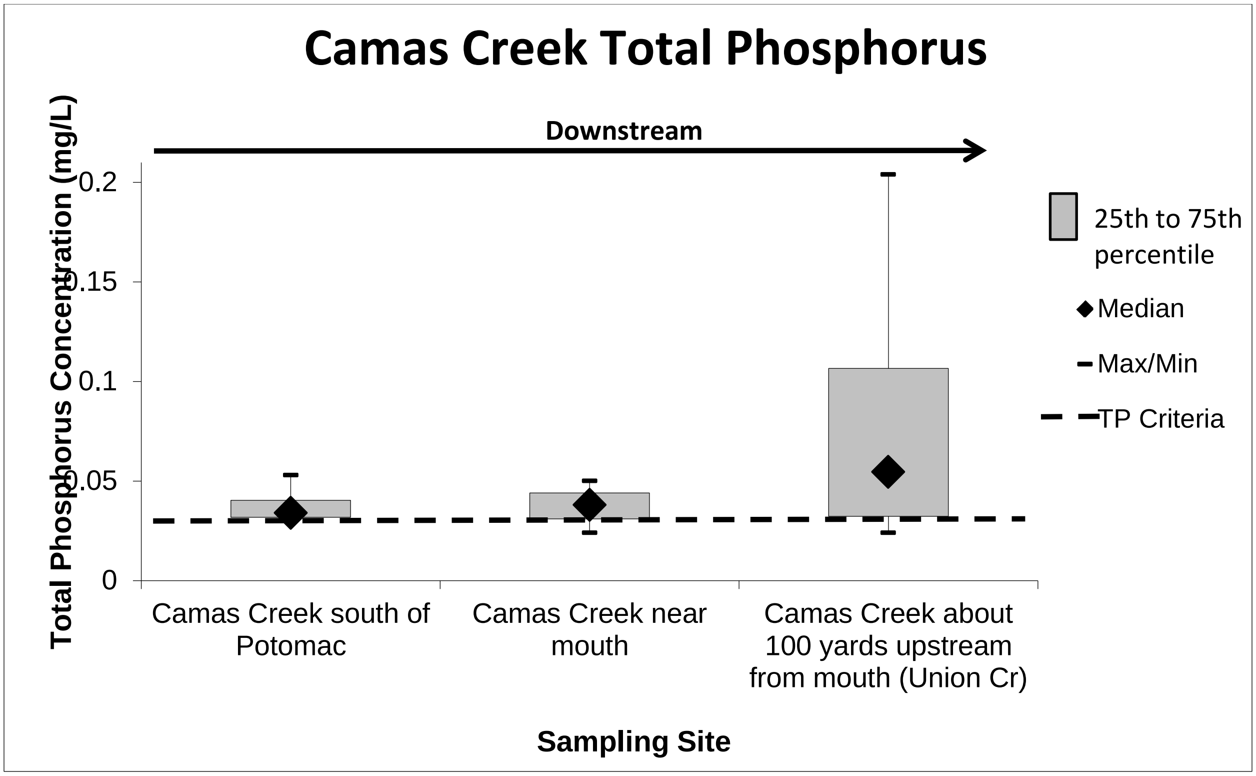


**Figure 5-9. TP Box Plots for Camas Creek**

There was a single exceedance of AFDM at each of the two lowermost sites. Despite evidence that algae is taking up nutrients at these sites, TN and TP values are generally above target values.

### *5.6.4.2 Assessment of Loading by Source Categories*

**Agricultural (Livestock) Nutrient Loading**

The impaired portion of the Camas Creek watershed is all privately owned and consists of predominantly pasture and hay fields. Cattle and horses are grazed upstream of and along the impaired segment of Camas Creek. There is one BLM allotment (Bonita-Clinton) and multiple DNRC grazing allotments in the entire Camas Creek watershed. BLM lands within the Bonita-Clinton allotment are permitted for 0.055 AUMs between June 1 and September 30. Only a portion of the Bonita-Clinton allotment (88 BLM acres) actually overlaps the watershed. DNRC allotments within the Camas Creek watershed consist of about 8,704 acres that are permitted for 0.049 AUMs per acre between June 1 and September 30. Estimated nutrient loading from livestock in the Camas Creek watershed is 5.08 lbs/day nitrogen and 2.67 lbs/day phosphorus (**Equation 4**; **Section 5.5.1.1**). Livestock grazing is likely a significant nutrient source in Camas Creek.

**Septic Nutrient Loading**

DEQ estimates that there are 118 single family dwellings in the Camas Creek watershed with septic systems. The MEANSS analysis indicates that these dwellings could contribute up to 3.08 lbs/day nitrate and 0.004 lb/day phosphorus. Most of these are located on or adjacent to the Potomac Valley. There are seven single family dwellings along the impaired segment of Camas Creek. Data for nitrate (3 samples), TN (4 samples), and TP (4 samples) was collected from a site on Camas Creek upstream of all but three septic sites in 2006 and 2009. At this location 1 nitrate, 1 TN, and 1 TP sample exceeded targets. Groundwater data collected from a well in Potomac had elevated nitrate levels relative to the surface water target used in our analysis (see **Appendix D**, **Table D-4**). This indicates that although septic represents a potentially substantial nutrient source to Camas Creek, it is not the only source contributing to high nutrient values. Nevertheless, based on the MEANSS model, septic loading is about 38% of the combined TN loading from both septic and livestock and about 0.15% of the combined TP load.

**Silvicultural Nutrient Loading**

Although timber harvest in not a potential nutrient source within the impaired portion of the watershed, it does exist upstream. Timber harvest on DNRC lands consisted of about 1,315 acres during the 1980's, 3,786 acres during the 1990's, and 2,401 acres from 2000-2010. Water quality samples were collected from three sites on Camas Creek upstream of the impaired segment from 2006-2009. These samples consisted of 11 nitrate, 9 TN, and 11 TP samples; of these, 3 nitrate, 1 TN, and 2 TP exceeded targets. Water samples did not link silviculture to instream nutrient values and as a result, although about 17% of the watershed was harvested since 2000, it is believed that timber harvest is not a significant nutrient source to Camas Creek.

**Mining Nutrient Loading**

There are no mines upstream of Camas Creek as it flows today. There are 10 mines in the Ashby Creek watershed which historically was a tributary of Camas Creek. Channelization has moved the Ashby Creek channel such that it enters Union Creek downstream of the confluence of Camas and Union Creeks. As a result, mining is not considered to be a source of nutrients to Camas Creek.

### 5.6.4.3 TN TMDL, Allocations, Current Loading, and Reductions

The TMDL for TN is based on **Equations 5** and the TMDL allocations are based on **Equation 6**. The value of the TN TMDL is a function of the flow; an increase in flow results in an increase in the TMDL. The following example TN TMDL for Camas Creek uses **Equation 5** with the median measured flow from all sites during 2006-2012 sampling (3.66 cfs):

$$TMDL = (0.30\ \text{mg/L})\ (3.66\ \text{cfs})\ (5.4) = 5.93\ \text{lbs/day}$$

**Equation 7** is the basis for the natural background load allocation for TN. To continue with the example at a flow of 3.66 cfs, this allocation is as follows:

$$LA_{NB} = (0.095\ \text{mg/L})\ (3.66\ \text{cfs})\ (5.4) = 1.88\ \text{lbs/day}$$

Using **Equation 8**, the combined septic and other human-caused TN load allocation at 3.66 cfs can be calculated:

$$LA_{SE} + LA_{H} = 5.93\ \text{lbs/day} - 1.88\ \text{lbs/day} = 4.05\ \text{lbs/day}$$

An example total existing load is calculated as follows using **Equation 9,** the 80th percentile of TN values measured from Camas Creek from 2009-2012 (0.587 mg/L) and the median measured flow of 3.66 cfs:

$$\textit{Total Existing Load} = (0.587\ \text{mg/L})\ (3.66\ \text{cfs})\ (5.4) = 11.6\ \text{lbs/day}$$

The portion of the existing load attributed to septic and other human sources is 9.72 lbs/day, which is determined by subtracting out the background load. This 9.72 lbs/day value is only slightly higher than the value of 8.16 lbs/day (**Section 5.6.4.2**), which represents the estimated combined loading to the stream from both septic (3.08 lbs/day) and livestock (5.08 lbs/day). Because the existing load value is close to the calculated value from **Section 5.6.4.2**, and because there are other agricultural sources within Camas Creek watershed including at least one livestock confinement area and multiple hay fields, the septic load will be set equal to the calculated load of 3.08 lbs/day for existing load and subsequent example load allocation development purposes.

**Table 5-21** contains the results for the example TN TMDL, load allocations, and current loading. In addition, it contains the percent reduction to the other human-caused load allocation required to meet the water quality target for TN. The percent reductions to the natural background load and septic allocations are assumed to be 0%. At the median growing season flow of 3.66 cfs and the 80th percentile of measured TN values, the current loading in Camas Creek is greater than the TMDL. Under these example conditions an 85% reduction of other human-caused sources and an overall 49% reduction of TN in Camas Creek would result in the TMDL being met. The source assessment of the Camas Creek watershed indicates that livestock grazing is the most likely source of TN in Camas Creek; load reductions should focus on limiting and controlling TN loading from this source. Meeting load allocations for Camas Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

**Table 5-21. Camas Creek TN Example TMDL, Load Allocations, Current Loading, and Reductions**

| Source Category | Allocation & TMDL (lbs/day)[1] | Existing Load (lbs/day)[1] | Percent Reduction |
|---|---|---|---|
| Natural Background | 1.88 | 1.88 | 0% |
| Septic | 3.08 | 3.08[2] | 0% |
| Other Human-caused (primarily livestock grazing) | 0.97 | 6.64[2] | 85% |
| | **TMDL = 5.93** | **Total = 11.6** | **Total = 49%** |

*[1] Based on a median growing season flow of 3.66 cfs*

*[2] Based on existing load estimates with modification to the other human-caused loading to account for the difference between existing and calculated loads.*

### 5.6.4.4 TP TMDL, Allocations, Current Loading, and Reductions

The TMDL for TP is based on **Equations 5** and the TMDL allocations are based on **Equation 6**. The value of the TP TMDL is a function of the flow; an increase in flow results in an increase in the TMDL. The following example TP TMDL for Camas Creek uses **Equation 5** with the median measured flow from all sites during 2006-2012 sampling (3.66 cfs):

$$TMDL = (0.03 \text{ mg/L}) (3.66 \text{ cfs}) (5.4) = 0.59 \text{ lb/day}$$

**Equation 7** is the basis for the natural background load allocation for TP. To continue with the example at a flow of 3.66 cfs, this allocation is as follows:

$$LA_{NB} = (0.01 \text{ mg/L}) (3.66 \text{ cfs}) (5.4) = 0.20 \text{ lb/day}$$

Using **Equation 8**, the combined septic and other human-caused TP load allocation at 3.66 cfs can be calculated:

$$LA_{SE} + LA_{H} = 0.59 \text{ lb/day} - 0.20 \text{ lb/day} = 0.39 \text{ lb/day}$$

An example total existing load is calculated as follows using **Equation 9,** the 80th percentile of TP values measured from Camas Creek from 2009-2012 (0.053 mg/L) and the median measured flow of 3.66 cfs:

**Total Existing Load = (0.053 mg/L) (3.66 cfs) (5.4) = 1.05 lbs/day**

The portion of the existing load attributed to septic and other human sources is 0.85 lb/day, which is determined by subtracting out the 0.20 lb/day background load. This 0.85 lb/day value represents the load measured within the stream after potential nutrient uptake, versus the higher value of 2.674 lbs/day (**Section 5.6.4.2**) representing the estimated combined loading to the stream from both septic and livestock, with septic representing an estimated 0.15% of the total loading to the stream. This information is used to parse out the existing load of 0.80 lb/day based on the relative loading contributions from each source category; resulting in 0.001 lb/day for septic and 0.849 lb/day for other human-caused sources (primarily livestock). Because background loading is based on measured instream reference concentrations, no adjustment to background loading is necessary.

**Table 5-22** contains the results for the example TP TMDL, load allocations, and current loading. In addition, it contains the percent reduction to the other human-caused load allocation required to meet the water quality target for TP. The percent reductions to the natural background and septic load allocations are assumed to be 0%. At the median growing season flow of 3.66 cfs and the 80th percentile of measured TP values, the current loading in Camas Creek is greater than the TMDL. Under these example conditions a 54% reduction of other human-caused sources and an overall 44% reduction of TP in Camas Creek would result in the TMDL being met. The source assessment of the Camas Creek watershed indicates that livestock grazing is the most likely source of TP in Camas Creek; load reductions should focus on limiting and controlling TP loading from this source. Meeting load allocations for Camas Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

**Table 5-22. Camas Creek TP Example TMDL, Load Allocations, Current Loading, and Reductions**

| Source Category | Allocation & TMDL (lbs/day)[1] | Existing Load (lbs/day)[1] | Percent Reduction |
|---|---|---|---|
| Natural Background | 0.20 | 0.20 | 0% |
| Septic | 0.001 | 0.001[2] | 0% |
| Other Human-caused (primarily livestock grazing) | 0.389 | 0.849[2] | 54% |
| | **TMDL = 0.59** | **Total = 1.05** | **Total = 44%** |

[1] *Based on a median growing season flow of 3.66 cfs*
[2] *Based on existing loading estimate ratio*

## 5.6.5 Union Creek

### *5.6.5.1 Assessment of Water Quality Results*

The source assessment for Union Creek consists of an evaluation of TN and TP concentrations and exceedances of chlorophyll-*a* and/or AFDM. This is followed by the quantification of the most significant human caused sources of nutrients.

DEQ collected water quality samples from Union Creek during the growing season over the time period of 2006-2011 (**Section 5.4.3.5, Table 5-11**). **Figure 5-10** presents summary statistics for TN concentrations at sampling sites in Union Creek. TN values in Union Creek were generally below the target of 0.30 mg/L from highway 200 upstream whereas they were generally above the target downstream of this point. There is a trend toward higher TN values when moving in the downstream direction.

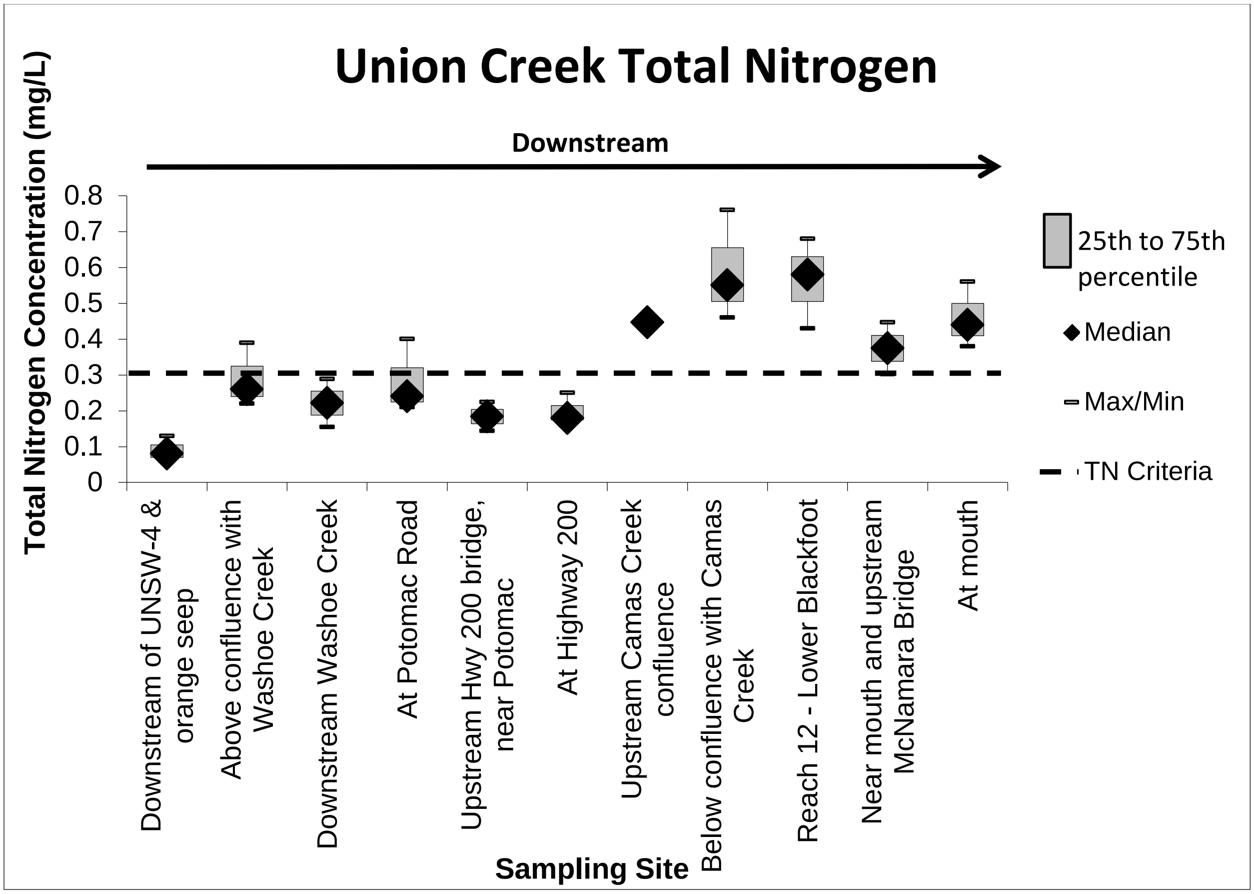


Figure 5-10. TN Box Plots for Union Creek

**Figure 5-11** presents summary statistics for TP concentrations at sampling sites in Union Creek. TP values in this segment were generally above the target of 0.03 mg/L. There is a trend toward higher TP values when moving in the downstream direction.

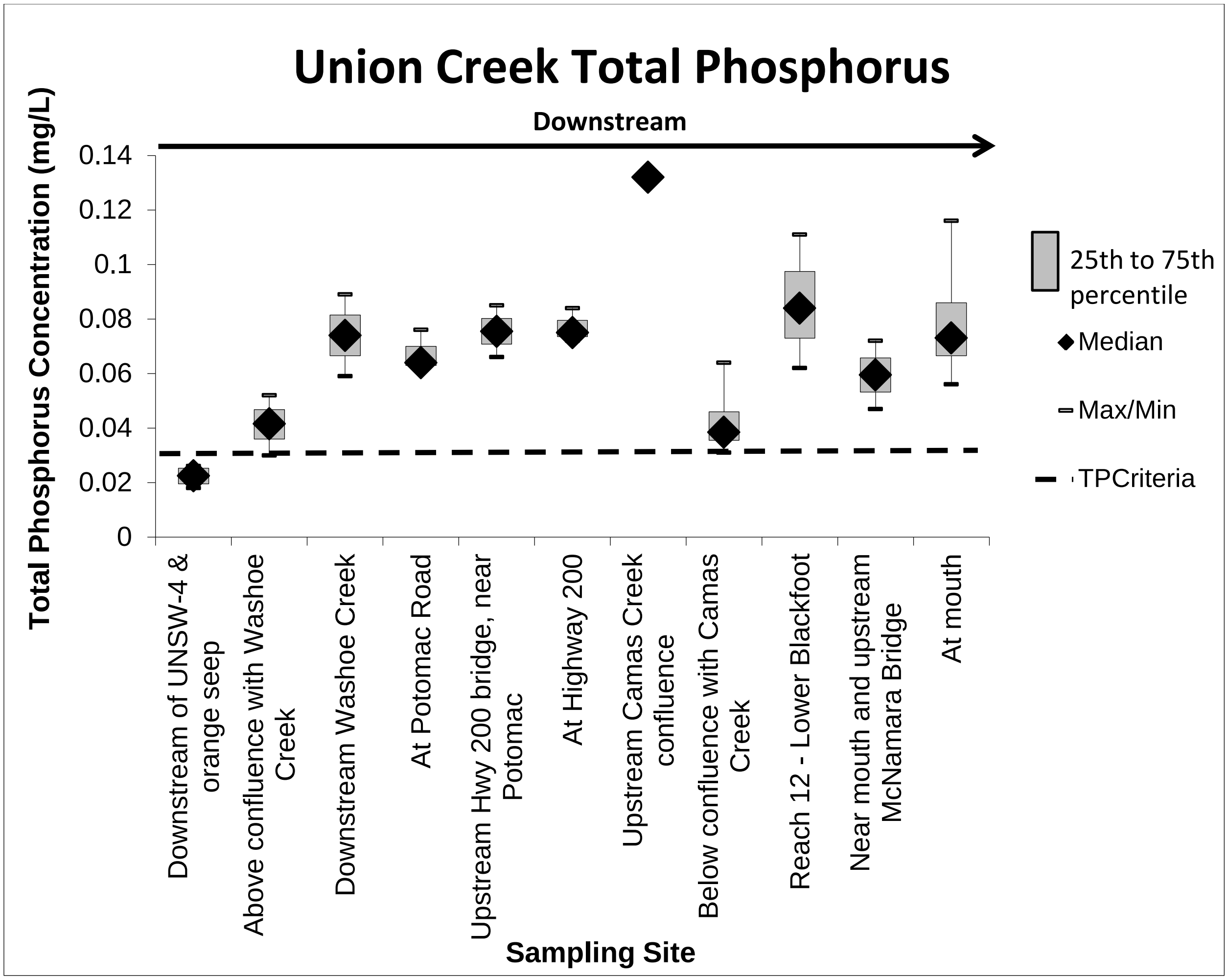


**Figure 5-11. TP Box Plots for Union Creek**

There were two exceedances of AFDM; both were upstream of the highway 200 sampling site. It is possible that nutrient uptake by algae is responsible for measured TN values being below their target at these sites. Despite this potential uptake, measured TP values were always above the target at these sites.

### *5.6.5.2 Assessment of Loading by Source Categories*

**Agricultural (Livestock) Nutrient Loading**

Cattle and horses are grazed in the Union Creek watershed. There are two BLM allotments (Coloma and Bonita-Clinton), multiple DNRC, and two Lubrecht Experimental Forest (Potomac West and Potomac East units) grazing allotments in the Union Creek watershed. BLM lands within the Coloma allotment are permitted for 0.034 AUMs per acre between June 15 and October 15. BLM lands within the Bonita-Clinton allotment are permitted for 0.055 AUMs per acre between June 1 and September 30. Portions of the Coloma (1,694 BLM acres) and Bonita-Clinton (2,286 BLM acres) grazing allotments are found in the Union Creek headwaters. DNRC allotments within the Union Creek watershed consist of about 25,522 acres and are permitted for 0.051 AUMs per acre between June 1 and September 30. Lubrecht lands within the Potomac West Unit (1,041 acres) are permitted for 0.12 AUMs per acre and within the Potomac East Unit (1,649 acres) are permitted for 0.101 AUMs per acre between June 1 and September 30. Estimated nutrient loading from livestock in the Union Creek watershed is 26.25 lbs/day nitrogen and 13.82 lbs/day phosphorus (**Equation 4**; **Section 5.5.1.1**). Livestock grazing is likely a significant nutrient source in Union Creek.

**Septic Nutrient Loading**

DEQ estimates that there are 355 single family dwellings in the Union Creek watershed with septic systems. The MEANSS analysis indicates that these dwellings could contribute up to 8.81 lbs/day nitrate and 0.031 lb/day phosphorus. Most of the septic sites are located on or adjacent to Union Creek and the Potomac Valley. Groundwater data collected from wells along Union Creek are consistent with the results of the MEANSS model as some locations have elevated nitrate values and low ortho-phosphate values (see **Appendix D**, **Table D-4**). Septic represents a potentially substantial nitrogen (nitrate) contribution to Union Creek, calculated at 25% of the combined TN loading from both septic and livestock and about 0.22% of the combined TP load.

**Silvicultural Nutrient Loading**

Timber was harvested from BLM lands in the Union Creek watershed from 1987-1989. During this time 251 acres were harvested resulting in 2,007 million board feet of product. Since 1987, there have been no other BLM timber sales in the watershed. Timber harvest on DNRC lands consisted of 4,828 acres during the 1980's, 11,719 acres during the 1990's, and 7,997 acres from 2000-2010. About 12% of the Union Creek watershed was harvested from 2000-2010. Based on the Camas Creek watershed where 17% of the watershed was harvested during the same time period and water quality data did not link silviculture to instream nutrient issues, any potential nutrient contribution to Union Creek from silviculture is likely minimal.

**Mining Nutrient Loading**

There are twenty-five abandoned mines within the Union Creek watershed. All but four of these mines are located in the Camas, Washoe, East Fork Ashby, and West Fork Ashby watersheds. Nearly all nitrate (one exceedance) and all TN values from these streams were below their respective targets. Any potential nitrogen contribution to Union Creek from mining is likely insignificant.

### 5.6.5.3 TN TMDL, Allocations, Current Loading, and Reductions

The TMDL for TN is based on **Equations 5** and the TMDL allocations are based on **Equation 6**. The value of the TN TMDL is a function of the flow; an increase in flow results in an increase in the TMDL. The following example TN TMDL for Union Creek uses **Equation 5** with the median measured flow from all sites during 2006-2011 sampling (1.55 cfs):

$$TMDL = (0.30 \text{ mg/L})\ (1.55 \text{ cfs})\ (5.4) = 2.51 \text{ lbs/day}$$

**Equation 7** is the basis for the natural background load allocation for TN. To continue with the example at a flow of 1.55 cfs, this allocation is as follows:

$$LA_{NB} = (0.095 \text{ mg/L})\ (1.55 \text{ cfs})\ (5.4) = 0.80 \text{ lb/day}$$

Using **Equation 8**, the combined septic and other human-caused TN load allocation at 1.55 cfs can be calculated:

$$LA_{SE} + LA_{H} = 2.51 \text{ lbs/day} - 0.80 \text{ lb/day} = 1.71 \text{ lbs/day}$$

An example total existing load is calculated as follows using **Equation 9,** the 80th percentile of TN values measured from Union Creek from 2009-2011 (0.455 mg/L) and the median measured flow of 1.55 cfs:

***Total Existing Load* = (0.455 mg/L) (1.55 cfs) (5.4) = 3.81 lbs/day**

The portion of the existing load attributed to septic and other human sources is 3.01 lbs/day, which is determined by subtracting out the 0.80 lb/day background load. This 3.01 lbs/day value represents the load measured within the stream after potential nutrient uptake, versus the higher value of 35.06 lbs/day (**Section 5.6.4.2**) representing the estimated combined loading to the stream from both septic and livestock, with septic representing an estimated 25% of the total loading to the stream. This information is used to parse out the existing load of 3.01 lbs/day based on the relative loading contributions from each source category; resulting in 0.75 lb/day for septic and 2.26 lbs/day for other human-caused sources (primarily livestock). Because background loading is based on measured instream reference concentrations, no adjustment to background loading is necessary.

**Table 5-23** contains the results for the example TN TMDL, load allocations, and current loading. In addition, it contains the percent reduction to the other human-caused load allocation required to meet the water quality target for TN. The percent reductions to the natural background and septic load allocations are assumed to be 0%. At the median growing season flow of 1.55 cfs and the 80th percentile of measured TN values, the current loading in Union Creek is greater than the TMDL. Under these example conditions a 58% reduction of other human-caused sources and an overall 34% reduction of TN in Union Creek would result in the TMDL being met. The source assessment of the Union Creek watershed indicates that livestock grazing is the most likely source of TN in Union Creek; load reductions should focus on limiting and controlling TN loading from this source. Meeting load allocations for Union Creek may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

**Table 5-23. Union Creek TN Example TMDL, Load Allocations, Current Loading, and Reductions**

| Source Category | Allocation & TMDL (lbs/day)[1] | Existing Load (lbs/day)[1] | Percent Reduction |
|---|---|---|---|
| Natural Background | 0.80 | 0.80 | 0% |
| Septic | 0.75 | 0.75[2] | 0% |
| Other Human-caused (primarily livestock grazing) | 0.96 | 2.26[2] | 58% |
| | **TMDL = 2.51** | **Total = 3.81** | **Total = 34%** |

*[1] Based on a median growing season flow of 1.55 cfs*

*[2] Based on existing loading estimate ratio*

### 5.6.5.4 TP TMDL, Allocations, Current Loading, and Reductions

The TMDL for TP is based on **Equations 5** and the TMDL allocations are based on **Equation 6**. The value of the TP TMDL is a function of the flow; an increase in flow results in an increase in the TMDL. The following example TP TMDL for Union Creek uses **Equation 5** with the median measured flow from all sites during 2006-2011 sampling (1.55 cfs):

***TMDL* = (0.03 mg/L) (1.55 cfs) (5.4) = 0.25 lb/day**

**Equation 7** is the basis for the natural background load allocation for TP. To continue with the example at a flow of 1.55 cfs, this allocation is as follows:

$\boldsymbol{LA_{NB}}$ **= (0.01 mg/L ) (1.55 cfs ) (5.4) = 0.084 lb/day**

Using **Equation 8**, the combined septic and other human-caused TP load allocation at 1.55 cfs can be calculated:

$\boldsymbol{LA_{SE} + LA_{H}}$ **= 0.25 lb/day – 0.084 lb/day = 0.166 lb/day**

An example total existing load is calculated as follows using **Equation 9**, the 80th percentile of TP values measured from Union Creek from 2006-2011 (0.082 mg/L) and the median measured flow of 1.55 cfs:

***Total Existing Load*** **= (0.082 mg/L) (1.55 cfs) (5.4) = 0.69 lb/day**

The portion of the existing load attributed to septic and other human sources is 0.606 lb/day, which is determined by subtracting out the 0.084 lb/day background load. This 0.606 lb/day value represents the load measured within the stream after potential nutrient uptake, versus the significantly higher value of 13.851 lbs/day (**Section 5.6.4.2**) representing the estimated combined loading to the stream from both septic and livestock, with septic representing an estimated 0.22% of the total loading to the stream. This information is used to parse out the existing load of 0.606 lb/day based on the relative loading contributions from each source category; resulting in 0.0013 lb/day for septic and 0.6047 lb/day for other human-caused sources (primarily livestock). Because background loading is based on measured instream reference concentrations, no adjustment to background loading is necessary.

**Table 5-24** contains the results for the example TP TMDL, load allocations, and current loading. In addition, it contains the percent reduction to the other human-caused load allocation required to meet the water quality target for TP. The percent reductions to the natural background and septic load allocations are assumed to be 0%. At the median growing season flow of 1.55 cfs and the 80th percentile of measured TP values, the current loading in Union Creek is greater than the TMDL. Under these example conditions a 73% reduction of other human-caused sources and an overall 64% reduction of TP in Union Creek would result in the TMDL being met. The source assessment of the Union Creek watershed indicates that livestock grazing is the most likely source of TP in Union Creek; load reductions should focus on limiting and controlling TP loading from this source. Meeting load allocations for Union Creek may be achieved through a variety of water quality planning and implementation actions and is addressed **Section 7.0**.

**Table 5-24. Union Creek TP Example TMDL, Load Allocations, Current Loading, and Reductions**

| Source Category | Allocation & TMDL (lbs/day)[1] | Existing Load (lbs/day)[1] | Percent Reduction |
|---|---|---|---|
| Natural Background | 0.084 | 0.084 | 0% |
| Septic | 0.0013 | 0.0013[2] | 0% |
| Human-caused (primarily livestock grazing) | 0.1647 | 0.6047[2] | 73% |
| | **TMDL = 0.25** | **Total = 0.69** | **Total = 64%** |

[1] *Based on a median growing season flow of 1.55 cfs*
[2] *Based on existing loading estimate ratio*

## 5.7 SEASONALITY AND MARGIN OF SAFETY

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 Lower Blackfoot TPA nutrient TMDL development process.

### 5.7.1 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 (July 1st – 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 summer-time period to coincide with applicable nutrient targets.

### 5.7.2 Margin of Safety

A margin of safety is a required component of TMDL development. The margin of safety 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, 1999). 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 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.

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.

## 5.8 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 Washoe Creek had fewer samples and because of sample results there was much uncertainty of the representativeness of the data. This led DEQ to retain impairment determinations for TN and nitrate in this waterbody segment. Additionally, there were situations where data for a specific nutrient indicated that values were below targets, but because of previous impairment determinations and the uncertainty in nutrient limitation and uptake within the streams the impairment determinations were retained. As a result, data for some waterbody segments with a nutrient TMDL indicate that targets are being attained. Future monitoring as discussed in **Section 8.0** should help reduce the uncertainty regarding data representativeness, clarify whether or not nutrient forms that have a TMDL but are meeting targets have a role in causing excess algal growth, 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 and from other, streams within the Lower Blackfoot TPA that are not impaired for nutrients, 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. Future monitoring should help reduce uncertainty regarding background nutrients concentrations.

### Livestock and Septic Loading Models

Much of the uncertainty associated with the livestock and septic loading models is related to how well they represent existing conditions. 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. Assumptions for these models are provided in **Section 5.5**.

Based on the age of some 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.

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.

# 6.0 OTHER IDENTIFIED ISSUES OR CONCERNS

## 6.1 POLLUTANT IMPAIRMENTS

There are many other pollutant impairments in the Lower Blackfoot total maximum daily load (TMDL) Planning Area (TPA) (see **Table B-1** in **Appendix B**). These impairments were addressed in the 2009 TMDL document for the Lower Blackfoot TPA (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009).

## 6.2 NON-POLLUTANT IMPAIRMENTS

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 Lower Blackfoot TPA may appear on the 303(d) list but may not always require TMDL development for a pollutant, but do have non-pollutant listings such as "chlorophyll-*a*" that could be linked to a nutrient pollutant. Many non-pollutant causes are habitat issues often associated with sediment, but may be associated with nutrient or temperature, 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 Lower Blackfoot TPA as a whole. In some cases, pollutant and non-pollutant 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 non-pollutant listings. Washoe Creek has the only non-pollutant impairment (chlorophyll-*a*) in the Lower Blackfoot TPA that was not addressed by the 2009 TMDL document for the Lower Blackfoot TPA (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009). This impairment was addressed via TN and TP TMDLs (see **Section 5.5.2**). BMPs described in **Section 7.0** of this document and in **Section 9.2.6.3** of Lower Blackfoot TPA (2009) will help address the chlorophyll-*a* listing in Washoe Creek. As BMPs are put into place and nutrient values are reduced, DEQ expects that algal growth will decrease and chlorophyll-*a* values will be reduced as well.

### 6.1.2 Monitoring and Best Management Practices for Non-Pollutant-Affected Streams

Streams impaired for a non-pollutant 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 are minimal and the linkage between probable cause, non-pollutant listing, and effects to the beneficial uses are not well defined. The monitoring and restoration strategies that follow in **Sections 7.0** and **8.0** are presented to address both pollutant and non-pollutant issues for streams in the Lower Blackfoot TPA with TMDLs in this document.

# 7.0 WATER QUALITY IMPROVEMENT PLAN

While certain land uses and human activities are identified as sources and causes of water quality impairment during total maximum daily load (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 nutrients water quality standards in Elk, Washoe, West Fork Ashby, Camas, and Union creeks. The strategy includes general measures for reducing loading from each significant identified pollutant source.

## 7.1 WATER QUALITY RESTORATION OBJECTIVE

The following is the general water quality objective provided in this TMDL document:

- Provide technical guidance for full recovery of aquatic life beneficial uses to all impaired streams within the Lower Blackfoot TMDL Planning Area (TPA) by improving nutrients 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.

This TMDL document is a step in restoring water quality in the Lower Blackfoot TPA. A watershed restoration plan (WRP) can provide a framework strategy for water quality restoration and monitoring in the Lower 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. WRPs contain detailed adaptive management plans and identify considerations that should be addressed during TMDL implementation. 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 the nine minimum elements for the WRP:

- Identification of causes of impairment and pollutant sources or groups of similar sources that need to be controlled to achieve needed load reductions, and any other goals identified in the watershed plan. Sources that need to be controlled should be identified at the significant subcategory level, along with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).
- An estimate of the load reductions expected from management measures.
- A description of the nonpoint source management measures that will need to be implemented to achieve load reductions in paragraph 2, and a description of the critical areas in which those measures will be needed to implement this plan.

- Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.
- An information and education component used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.
- Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.
- A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.
- A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made toward attaining water quality standards.
- A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item 8 immediately above.

## 7.2 IMPLEMENTATION OF THE PLAN

The implementation plan discussed in this report is based on an adaptive management approach that includes a monitoring program and feedback loop. Successful implementation requires collaboration among private landowners, land management agencies, and other stakeholders.

### 7.2.1 DEQ and Stakeholder Roles

Successful implementation requires collaboration among private landowners, land management agencies, and other stakeholders. The Montana Department of Environmental Quality (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. DEQ will work with participants to use the TMDLs as a basis for developing locally-driven WRPs, administering funding specifically to help fund water quality improvement and pollution prevention projects, and identifying 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 Blackfoot Challenge, Bonita-Clinton-Potomac Grazing Association, Lubrecht Experimental Forest, Trout Unlimited, Plum Creek Timber, Natural Resources Conservation Service (NRCS), Montana Department of Natural Resources and Conservation (DNRC), Bureau of Land Management, Montana Fish Wildlife and Parks (FWP), U.S. Environmental Protection Agency 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.

### 7.2.2 Nutrients 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 post-grazing vegetative 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
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 historically been placed near or adjacent to flowing streams. Stream channels were the only available livestock water sources prior to the extension of rural electricity. 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 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 a 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.

In addition to the agricultural related BMPs, reducing sediment delivery from roads and eroding streambanks is another component of the nutrient reduction restoration plan. Sediment issues in the Lower Blackfoot TPA were addressed in a 2009 TMDL document (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2009). It is expected that the sediment and temperature related BMPs presented in **Section 9.0** of that plan will also help reduce nutrient loading in Elk, Washoe, West Fork Ashby, Camas, and Union creeks.

### 7.2.3 Non-Pollutant Restoration Strategy

Although TMDL development is not required for non-pollutant listings, they are frequently linked to pollutants, and addressing non-pollutant sources is an important component of TMDL implementation. There is one nutrient related non-pollutant listing in the Lower Blackfoot TPA (chlorophyll-*a* on Washoe Creek). This impairment will be addressed during implementation of associated TN and TP TMDLs for Washoe Creek. BMPs related to nutrients are discussed below in **Section 7.3**.

## 7.3 RESTORATION APPROACHES BY SOURCE CATEGORY

For each potential source of human-caused pollutant loads in the Lower Blackfoot TPA, general management recommendations are outlined below. Septic and livestock grazing are considered to be the two major nutrient contributors to the Lower Blackfoot TPA and are given the most in depth consideration and discussion in **Section 5.0**. The other sources described in this section may represent a substantial contribution of nutrients locally or when combined. The effect of different sources can change seasonally and be dependent on the magnitude of storm/high flow events. Therefore, restoration activities within the Lower Blackfoot TPA should focus on all major sources for each pollutant category. Restoration should begin with addressing significant sources where large load reductions can be obtained within each source category. The source assessment results in **Sections 5.6.1-5.6.5** provide information that should be used to help determine priorities for each major source type in the watershed.

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 implementing appropriate BMPs for new activities and continuing implementation and maintenance of those BMPs currently in place or practice. Restoration might also address current non-pollutant -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 the determination of whether 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 8.0**.

In recognition that noxious weeds are a problem throughout Montana and may be associated with any of the following source categories, noxious weed control should be actively pursued whenever BMPs are being implemented.

### 7.3.1 Grazing

A riparian grazing management plan such as that developed by the Bonita-Clinton -Potomac Grazing Association(2013) 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 Lower 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 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 non-pollutant can be obtained in Appendix A of Montana’s NPS Management Plan (Montana Department of Environmental Quality, 2012a) and in (Harmon, 1999).

### 7.3.2 Small Acreages

The number of small acreages is 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, 2012a) or by contacting the MSU extension (http://www.msuextension.org/).

### 7.3.3 Septic

BMPs for septic systems include regular inspection and cleaning and repair of leaking or otherwise malfunctioning systems. As large acreages are subdivided into smaller lots, the number of septic systems in the watershed increases. Plans for development of lands within the Lower Blackfoot TPA should consider the effects of additional septic systems to watersheds and consider ways of minimizing septic impacts to water quality such as installing type II systems to decrease nitrogen loading, installing systems further away from streams to allow for more nutrients attenuation, and/or constructing a wastewater treatment plant to connect multiple wastewater systems.

### 7.3.4 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 (United States 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 alternate 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, 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 (United States 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.

Financial and technical assistance (including comprehensive nutrient management plan development) in achieving voluntary AFO and CAFO compliance may be 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://deq.mt.gov/wqinfo/mpdes/cafo.mcpx

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 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 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 and Compliance Division, as well as external entities such as DNRC, local watershed groups, conservation districts, and MSU Extension.

## 7.3.5 Cropland

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 recommendation for the Lower Blackfoot TPA is the use of riparian buffers. Buffers reduce the rate of runoff, promote infiltration into the soil (instead of delivering runoff directly to the stream), and intercept sediment. 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. Buffers along streams should be composed of natural vegetative communities which will also supply shade to reduce instream temperatures. Buffer widths along streams should be at least double the average mature canopy height to assist in providing stream shade. Reducing the amount of fertilizer applied to cropland (such as the hay fields in the Union and Camas watersheds) can also reduce nutrients loading. 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, 2012a).

## 7.3.6 Irrigation

Union and Camas creeks are affected by irrigation primarily in their lower reaches. Flow alteration and dewatering are commonly considered water quantity rather than water quality issues. However, changes to streamflow 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). In addition to the BMPs recommended in Appendix A of Montana's NPS Management Plan (Montana Department of Environmental Quality, 2012a), 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).

### 7.3.7 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. Enhancing and protecting riparian areas and floodplains within the watershed should be a priority of TMDL implementation in the Lower 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. Passive riparian restoration is preferable, but in areas where stream channels are unnaturally unstable 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 desired to speed up the rate of recovery. 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 should be designed to 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.

### 7.3.8 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.

Buffers of about 50 ft can substantially reduce the amount of sediment and nutrients entering a stream (Lakel et al., 2010; Lee et al., 2003). The SMZ Law protects against excessive erosion within 50 ft of a stream and therefore is an appropriate starting point for helping meet nutrient (especially forms bound to sediments) load allocations. Buffers of greater than 50 ft provide additional protection against sediment and nutrients (Mayer et al., 2005; Wegner, 1999). On USFS Lands, 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.

In addition to the BMPs identified above, effects that timber harvest may have on yearly streamflow levels, such as peak flow, should be considered. Timber harvest plans should evaluate the potential for cumulative effects on water yield and peak flow increases and implement BMPs to reduce sediment and nutrients loading.

## 7.3.9 Mining

Because restoration of mining impacts are typically implemented under state and federal programs, this section will discuss general restoration programs and funding mechanisms that may be applicable to mines as nutrients sources instead of specific BMPs. The need for further characterization of impairment conditions and loading sources is addressed through the monitoring plan in **Section 8.0**. 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 that may be applicable to the Lower Blackfoot TPA 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. There are currently no priority abandoned mines in the Lower Blackfoot TPA.

**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 Lower Blackfoot TPA.

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.

## 7.5 POTENTIAL FUNDING SOURCES

Funding and prioritization of restoration or water quality improvement projects 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.

### 7.5.1 Section 319 Nonpoint Source Grant Program

Section 319 grant funds are typically used to implement water quality restoration projects that focus on implementing a Watershed Restoration Plan. Individual contracts under the yearly award process typically range from $10,000 to $300,000, with a 40 percent of total project cost match requirement. 319 project funds are awarded to non-profit or governmental entities such as a conservation district, a watershed group, or a county.

### 7.5.2 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 semiannually in December and June. Projects that may be applicable to the Lower Blackfoot River watershed include restoring streambanks, improving fish passage, and restoring/protecting spawning habitats.

### 7.5.3 Watershed Planning and Assistance Grants

The MT DNRC administers Watershed Planning and Assistance Grants to conservation districts and watershed groups that are sponsored by a conservation district. Funding is capped at $11,000 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 is contained in Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, 2012a) and online at: http://www.epa.gov/nps/funding.html.

### 7.5.4 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.

### 7.5.5 Resource Indemnity Trust/Reclamation and Development Grants Program

The Resource Indemnity Trust/Reclamation and Development Grants Program (RIT/RDG) is a biennial program administered by MT DNRC that can provide up to $300,000 to address environmental 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 need to be administered through a local government such as a conservation district, city board, or county.

# 8.0 MONITORING FOR EFFECTIVENESS

The monitoring framework discussed in this section is an important component of watershed restoration, a requirement of total maximum daily load (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 local land managers, stakeholder groups, and federal and state agencies to develop more detailed and specific planning efforts regarding monitoring needs; it does not assign monitoring responsibility. 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 Lower Blackfoot TMDL Planning Area (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.

## 8.1 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:

- TMDLs and Allocations: 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.

- The models used to develop the allocations for septic and livestock grazing are coarse models that were used to estimate the relative contribution of each source type to the impaired streams. The models were based on specific sets of assumptions described in **Sections 5.5.1.1** and **5.5.1.2** and account for a limited number of variables that can affect nutrient loading. As a result there is uncertainty in the accuracy of the values developed. If there is future interest in answering specific questions regarding nutrients loading or in calculating more accurate loading estimates, more detailed models will need to be used.

Water Quality Status: 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.

## 8.2 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, contacts, 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 in one location for the entire watershed.

Loading reductions and BMP effectiveness can be evaluated with water quality samples and comparing them to the targets. In cases where BMPs targeting other probable causes such as sediment are being implemented, BMP effectiveness may be evaluated by documenting the length of streambank repaired and/or taking before and after photos of the project area.

If sufficient implementation progress is made within a watershed, the Montana Department of Environmental Quality (DEQ) will conduct a TMDL Implementation Evaluation (TIE). During this process, DEQ compiles recent data, conducts monitoring (if necessary), may be compare data to water quality targets (typically a subset for sediment), summarizes BMP implementation since TMDL development , and evaluates data 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 removed from the 303(d) list. 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.

## 8.3 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.

### 8.3.1 Nutrients

Although extensive nutrient data were collected to assist with TMDL development, fewer samples were collected from Washoe Creek due to a lack of access during the sampling time period. When watershed scale monitoring is conducted to assist with future impairment determinations, particular attention should be given to collecting additional nutrient data on Washoe Creek. Future sampling should also include algal sampling for chlorophyll-*a* and ash free dry mass. Additionally, macroinvertebrates are part of a second tier assessment if nutrient and/or algae concentrations do not clearly indicate impairment and therefore should be collected. Data collection that includes water quality, algal, and macroinvertebrate samples ensures that all aspects of nutrients and their effects on aquatic life can be evaluated.

## 8.4 SOURCE ASSESSMENT REFINEMENT

In many cases, the level of detail provided by the source assessments only provides broad source categories need reduced pollutant loads. Strengthening source assessments for each of the pollutants may include more thorough sampling or field surveys of source categories and are described in this section. To refine source assessment of nutrient impaired waterbodies in the Lower Blackfoot TPA resources could be used to focus on identifying the most significant source areas within each impaired stream's watershed to determine where implementation will be most effective.

### 8.4.1 Nutrients

The following could help strengthen the source assessment:

- more data to characterize background conditions,
- a better understanding of septic contributions,
- a better understanding of nutrient concentrations in groundwater and spatial variability
- a 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,
- additional sampling in streams with less data such as Washoe Creek to get a better idea of the reductions needed and to identify source areas

# 9.0 STAKEHOLDER AND PUBLIC PARTICIPATION

Stakeholder and public involvement is a component of total maximum daily load (TMDL) planning supported by the U.S. Environmental Protection Agency's (EPA) guidelines and required by Montana state law (MCA 75-5-703, 75-5-704) which directs the Montana Department of Environmental Quality (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 Lower Blackfoot TMDL Planning Area (TPA).

## 9.1 PARTICIPANTS AND ROLES

Throughout completion of the Lower Blackfoot TPA nutrient 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 Lower 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 these 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.

**TMDL Advisory Group**
The Lower Blackfoot TPA TMDL Advisory Group consisted of selected resource professionals who possess a familiarity with water quality issues and processes in the Lower Blackfoot TPA, 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 e-mail 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 47 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 streamflow 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.

## 9.2 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. This public review period was initiated on July 3, 2013 and ended on August 6, 2013. At a public meeting on July 18, 2013 in Potomac, MT, DEQ provided an overview of the TMDLs for nutrients in the Lower Blackfoot TMDL Planning Area, made copies of the document available to the public, answered questions, and solicited public input and comment on the plan. The announcement for that meeting was distributed among the Watershed Advisory Group, posted on the DEQ webpage, at the Blackfoot Challenge Ovando Office, at the Potomac Post Office, and advertised in the following newspapers: Seeley Swan Pathfinder, Helena Independent Record, and Missoulian. This section includes DEQ's response to all public comments received during the public comment period.

One comment letter was received during the public comment period. Comments were received from the Plum Creek. Excerpts of the comments and DEQ's comment responses are presented below. The original comment letters are held on file at DEQ and may be viewed upon request.

**Comment #1:** Overall, we think DEQ has taken a thoughtful approach to evaluating nutrient impairments in the watershed. The document is clear, and decisions and approaches are well outlined and justified.

> **DEQ Response to Comment #1:** Thank you. We appreciate the comment.

**Comment #2:** One disagreement is in the TP listing for West Fork Ashby Creek. WF Ashby has had numerous improvements to grazing management over the past decade and has seen marked recovery. My evaluation of DEQ's data indicates the stream is fully supporting its beneficial uses. Chlorophyll-*a* and algal biomass levels are very low. And Macroinvertebrate metrics indicate full support. The stream is just slightly higher than the nutrient target for TP. As Montana currently has a narrative criterion for nutrients, it is my understanding that there must be demonstrated impairment for a listing. I respectfully request that DEQ further consider the decision to list WF Ashby Creek as impaired for nutrients prior to finalizing the TMDL.

> **DEQ Response to Comment #2:** The total phosphorus listing for West Fork Ashby Creek resulted from the assessment of recently collected data and the process laid out in DEQ's nutrients assessment method (Suplee and Sada de Suplee, 2011). The nutrients concentration values used to assess for nutrients are numeric interpretations of the narrative standard. These values, provided by Suplee et al. (2008) and Suplee and Watson (2013)are used to prevent the excessive growth of algae most years under naturally varying conditions. The target values developed by Suplee et al. (2008) and Suplee and Watson (2013) for the Middle Rockies level III ecoregion (in which the Lower Blackfoot TMDL planning area resides) represent values that, when exceeded, tend to increase algal growth to nuisance levels and adversely affect macroinvertebrate populations. The total phosphorus targets were consistently exceeded in this stream and may support conditions that periodically produce nuisance levels of algae, especially if physical conditions such as shade change along the stream. DEQ also considered that there were some controllable sources of nutrients along West Fork Ashby Creek that can be managed to reduce nutrient loading. As a result, DEQ decided to keep the total phosphorus impairment for West Fork Ashby Creek. Although the algae and macroinvertebrate samples indicate no impairment for West Fork Ashby Creek, there is uncertainty associated with their use. DEQ uses a TMDL implementation evaluation program that will consider additional management and water quality information to evaluate long term conditions in West Fork Ashby Creek. A longer term data set may provide useful for assessing if DEQ's nutrient targets based on regional studies are appropriate for application in West Fork Ashby Creek during future TMDL evaluations. In addition, a streamlined site-specific nutrient criteria development process will be presented to the Nutrient Work Group on September 5, 2013. West Fork Ashby Creek is likely a candidate for this process. Data collection required for this process may not necessarily be performed by DEQ but could be completed by stakeholders following DEQ Standard Operating Procedures. We recommend coordination with the DEQ standards program if data collection is undertaken by stakeholders.

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# APPENDIX A – WATERSHED DESCRIPTION MAPS

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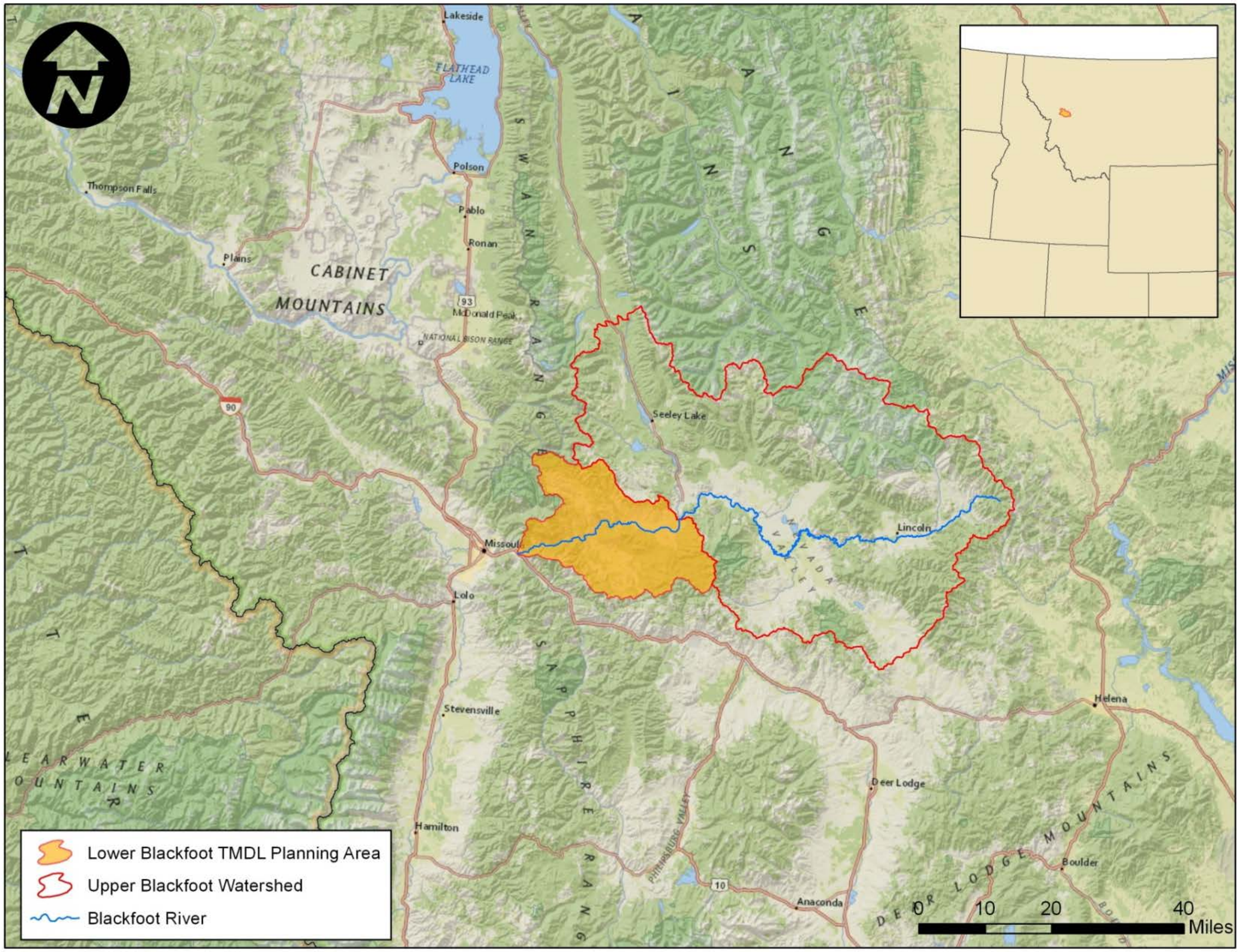


Figure A-1. Lower Blackfoot Watershed

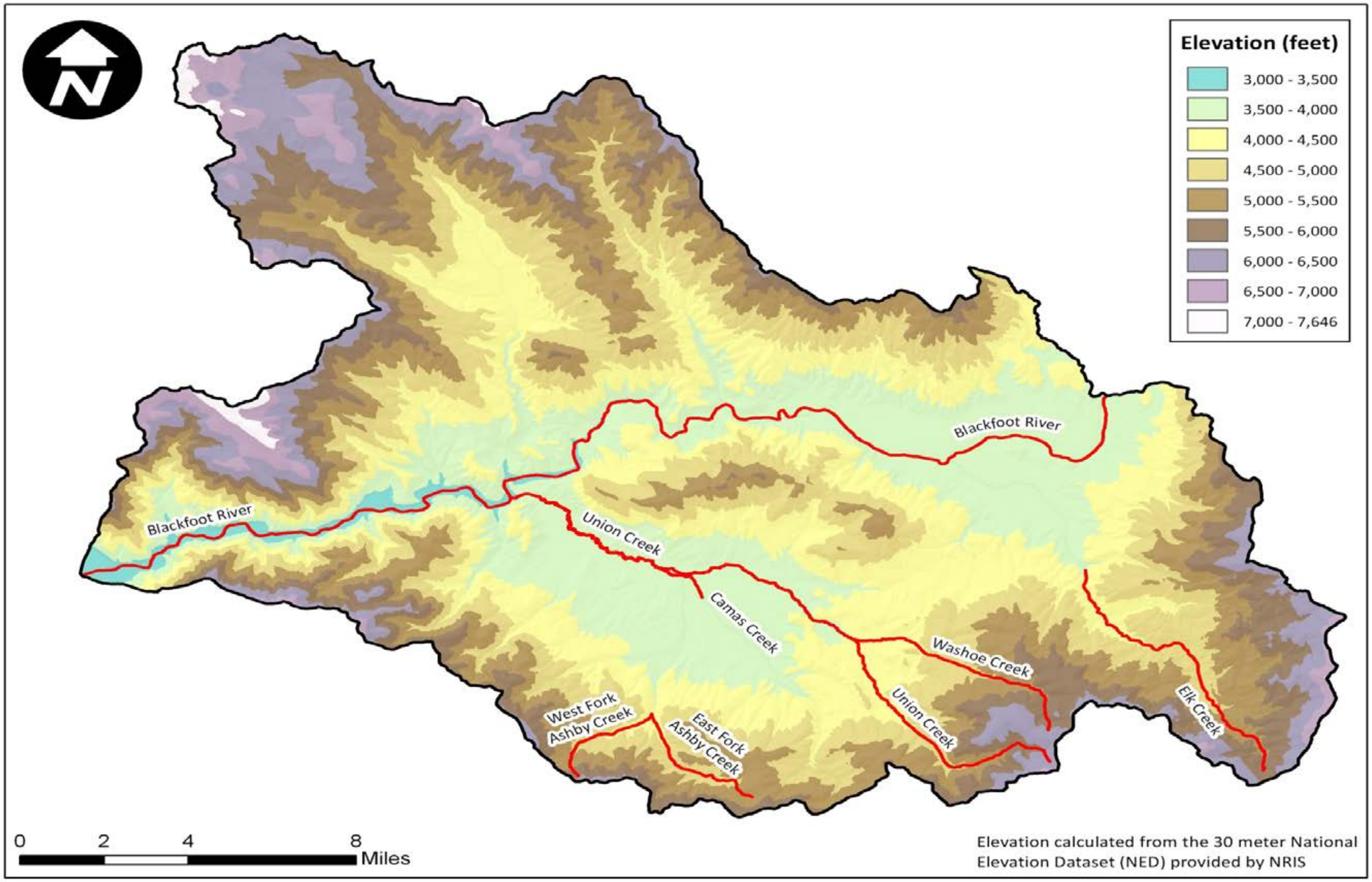
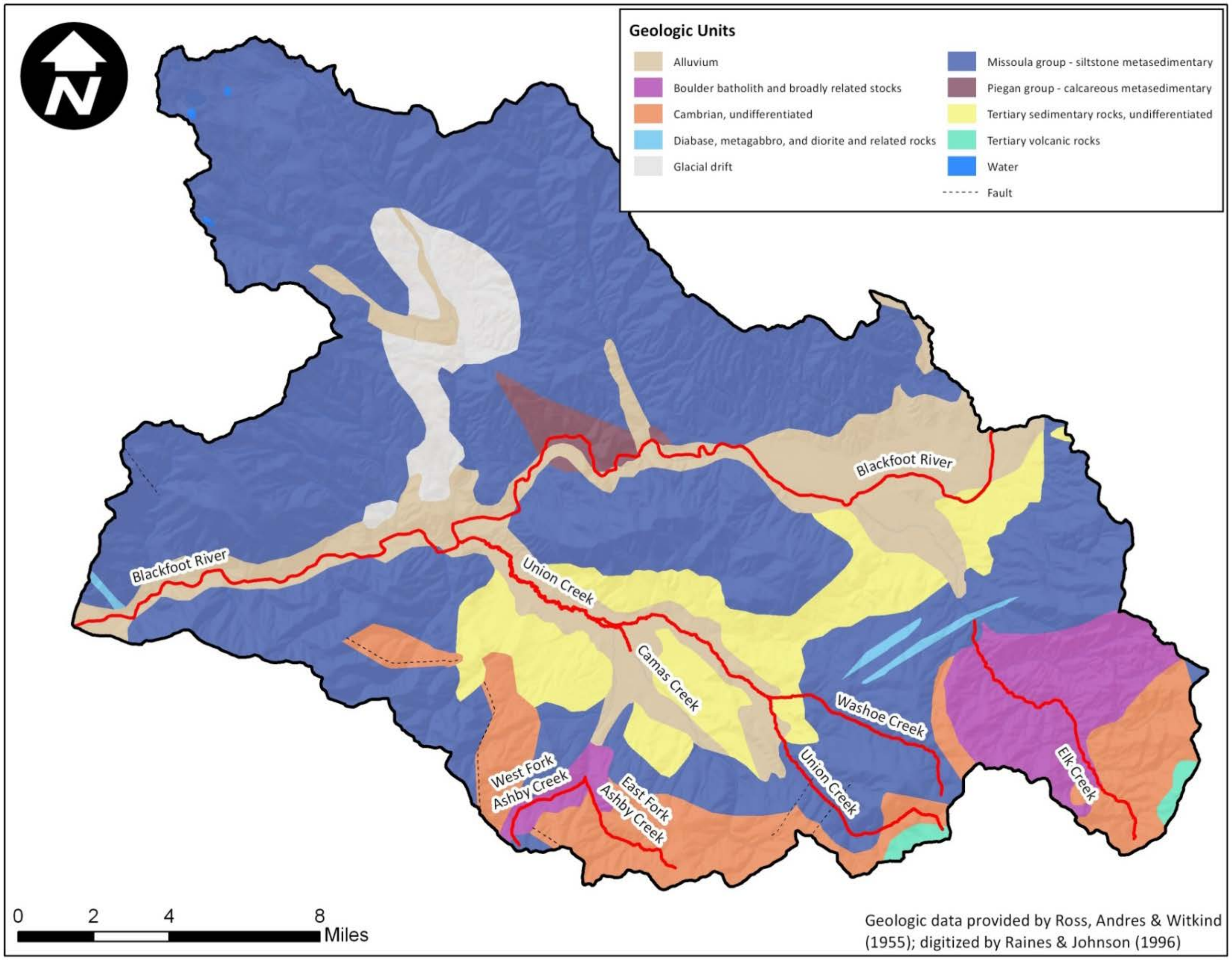
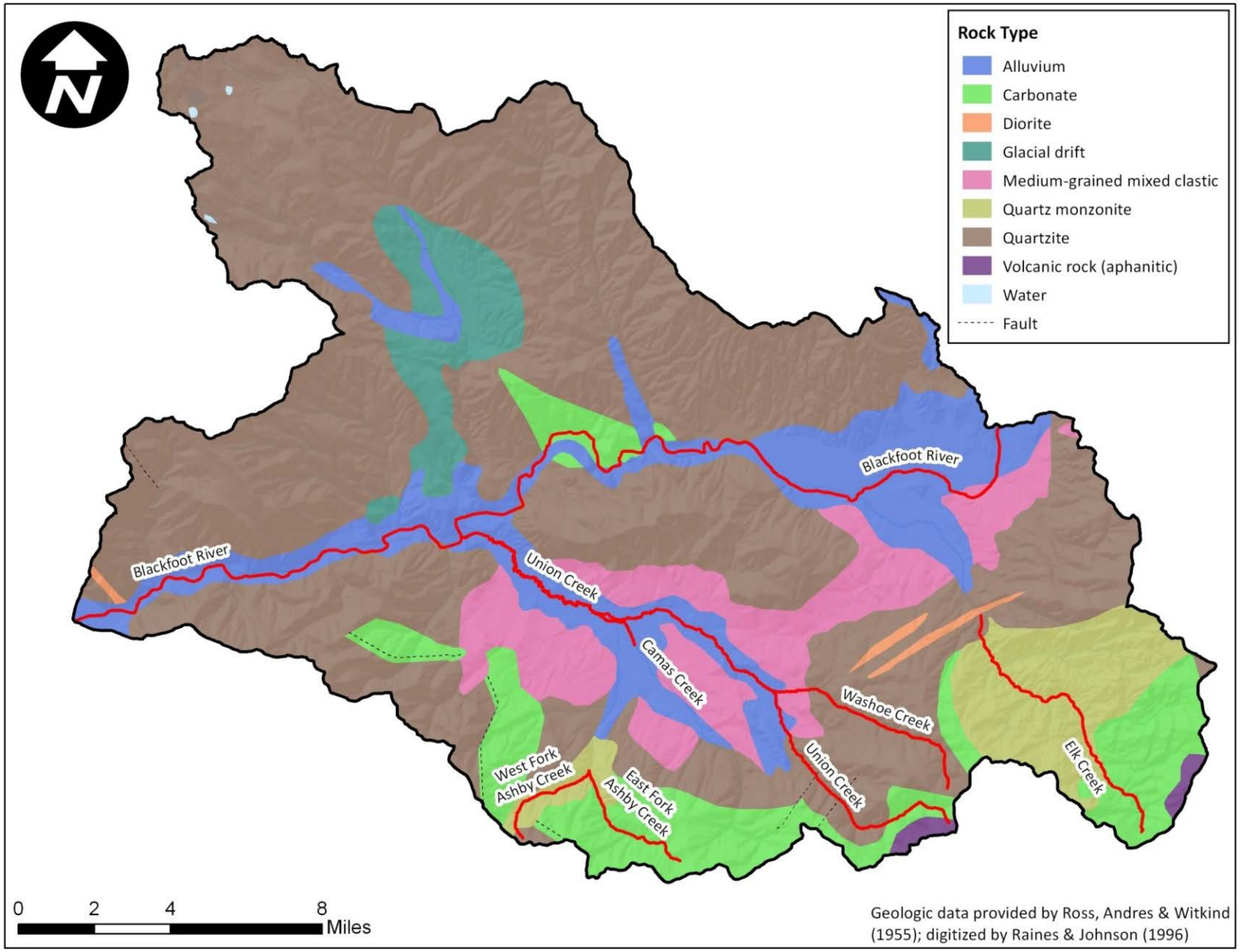


**Figure A-2. Lower Blackfoot Elevation**



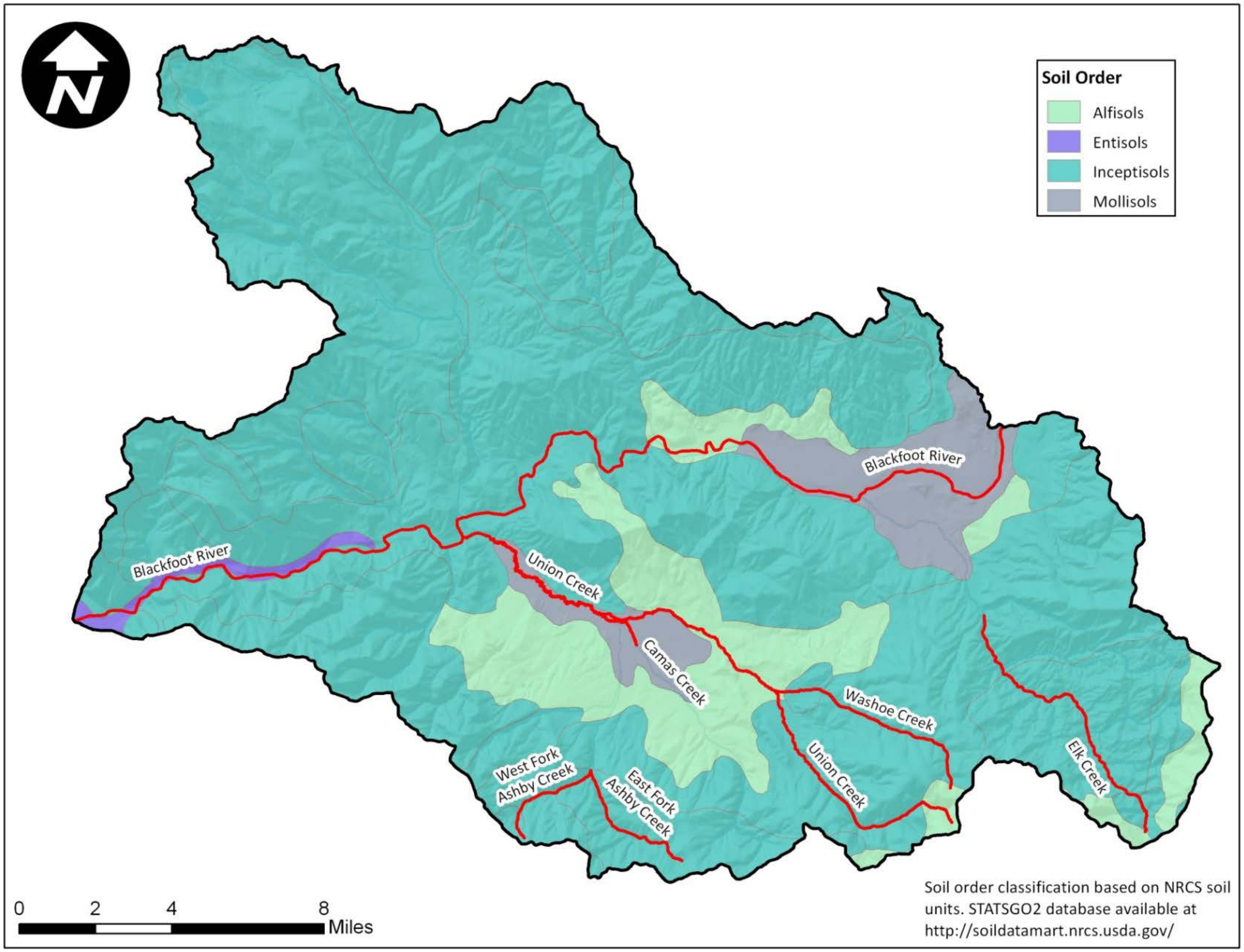
Geologic data provided by Ross, Andres & Witkind (1955); digitized by Raines & Johnson (1996)

**Figure A-3. Lower Blackfoot Geologic Data**



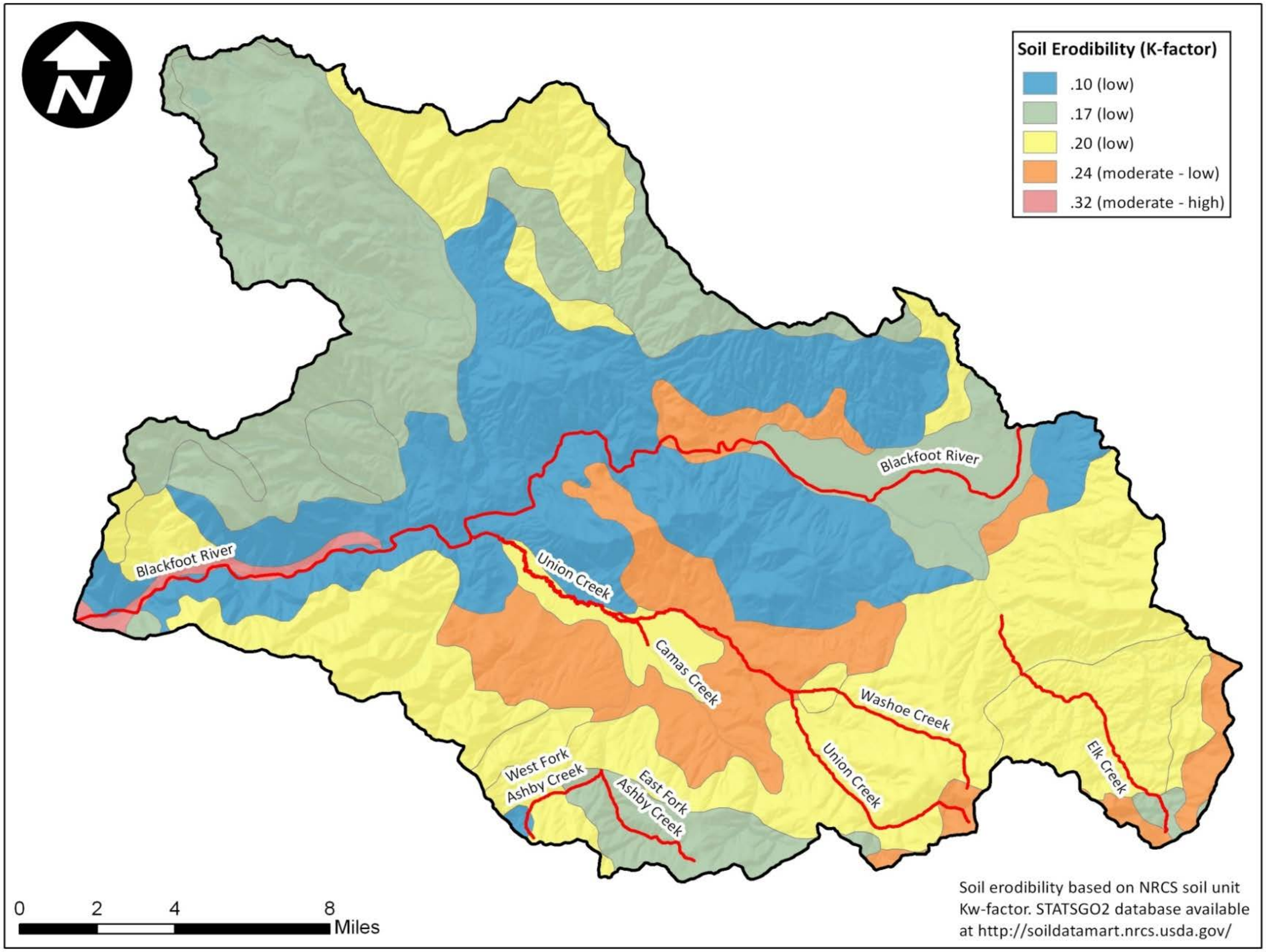
Geologic data provided by Ross, Andres & Witkind (1955); digitized by Raines & Johnson (1996)

**Figure A-4. Lower Blackfoot Geologic Rock Type**



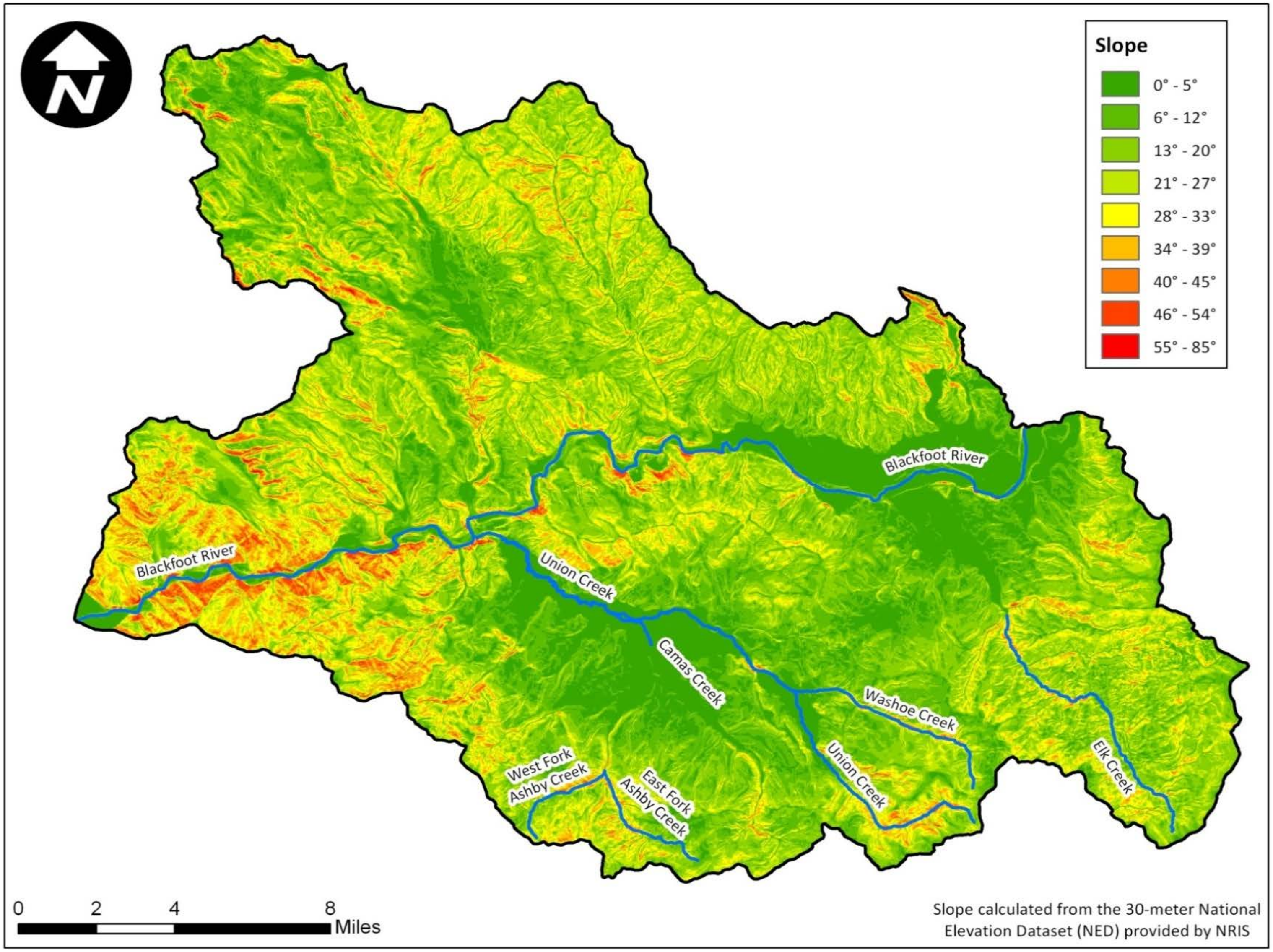
Soil order classification based on NRCS soil units. STATSGO2 database available at http://soildatamart.nrcs.usda.gov/

Figure A-5. Lower Blackfoot Soils



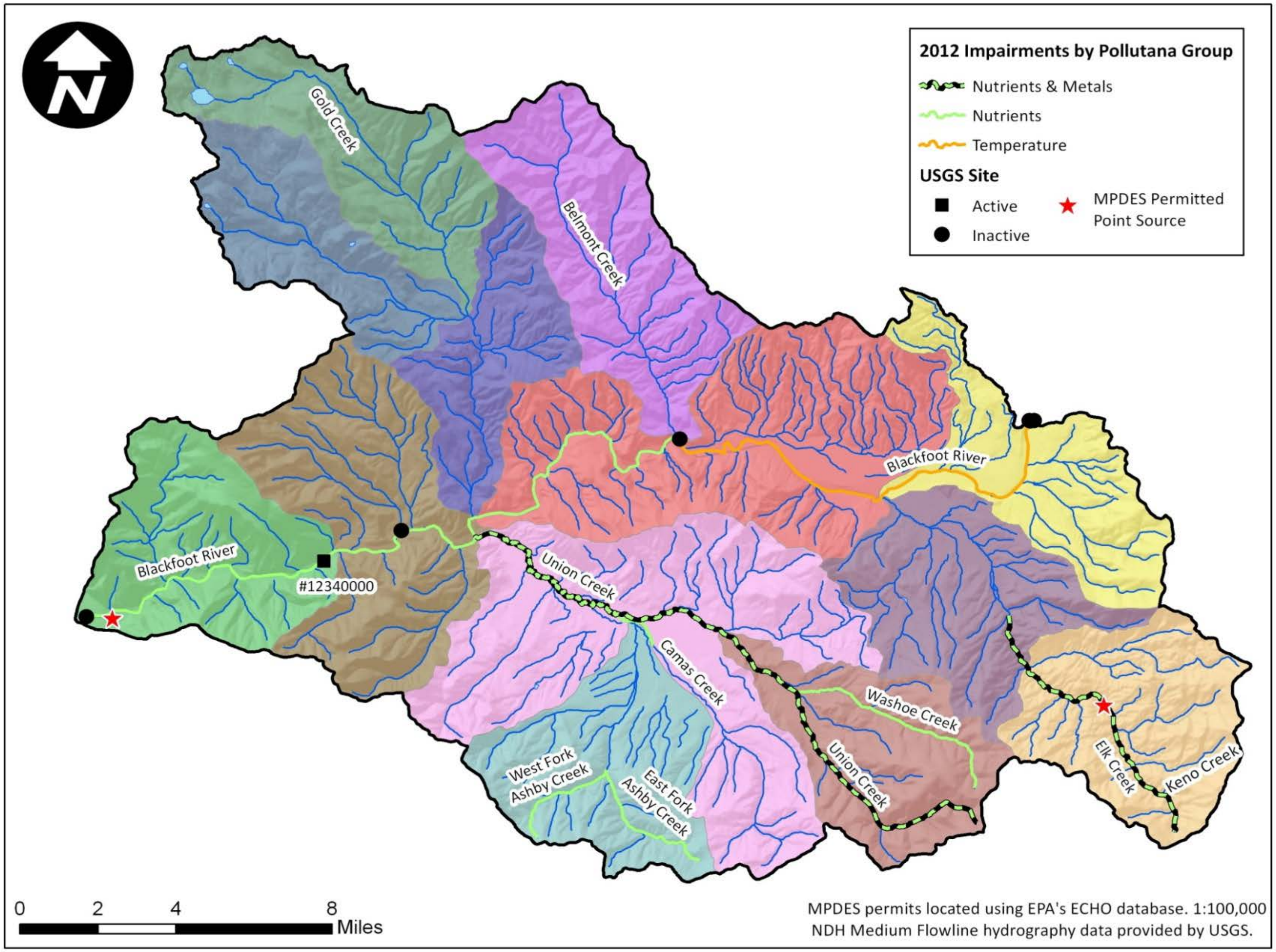
Soil erodibility based on NRCS soil unit Kw-factor. STATSGO2 database available at http://soildatamart.nrcs.usda.gov/

**Figure A-6. Lower Blackfoot Soil Erodibility**



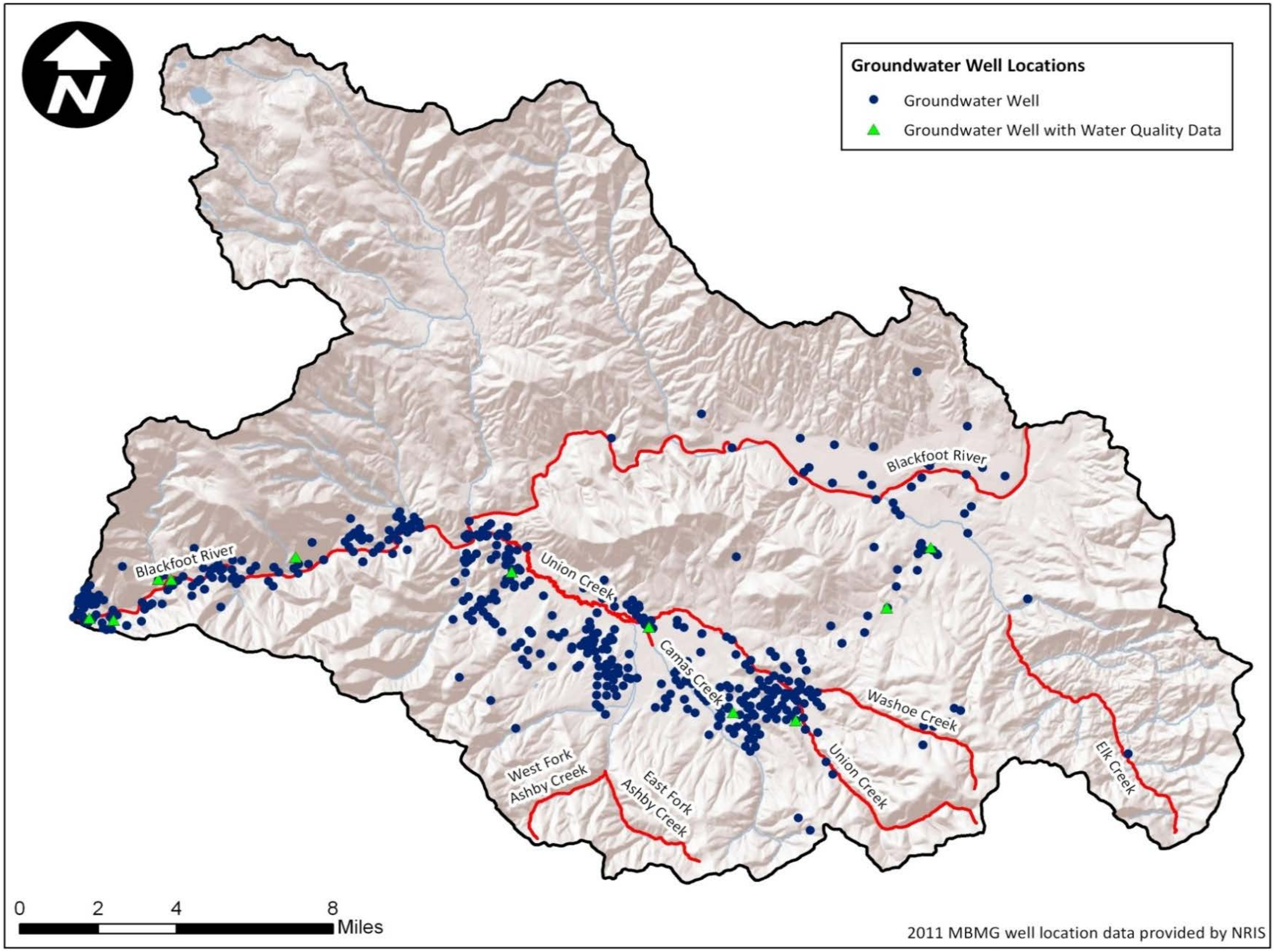
Slope calculated from the 30-meter National Elevation Dataset (NED) provided by NRIS

Figure A-7. Lower Blackfoot Slopes



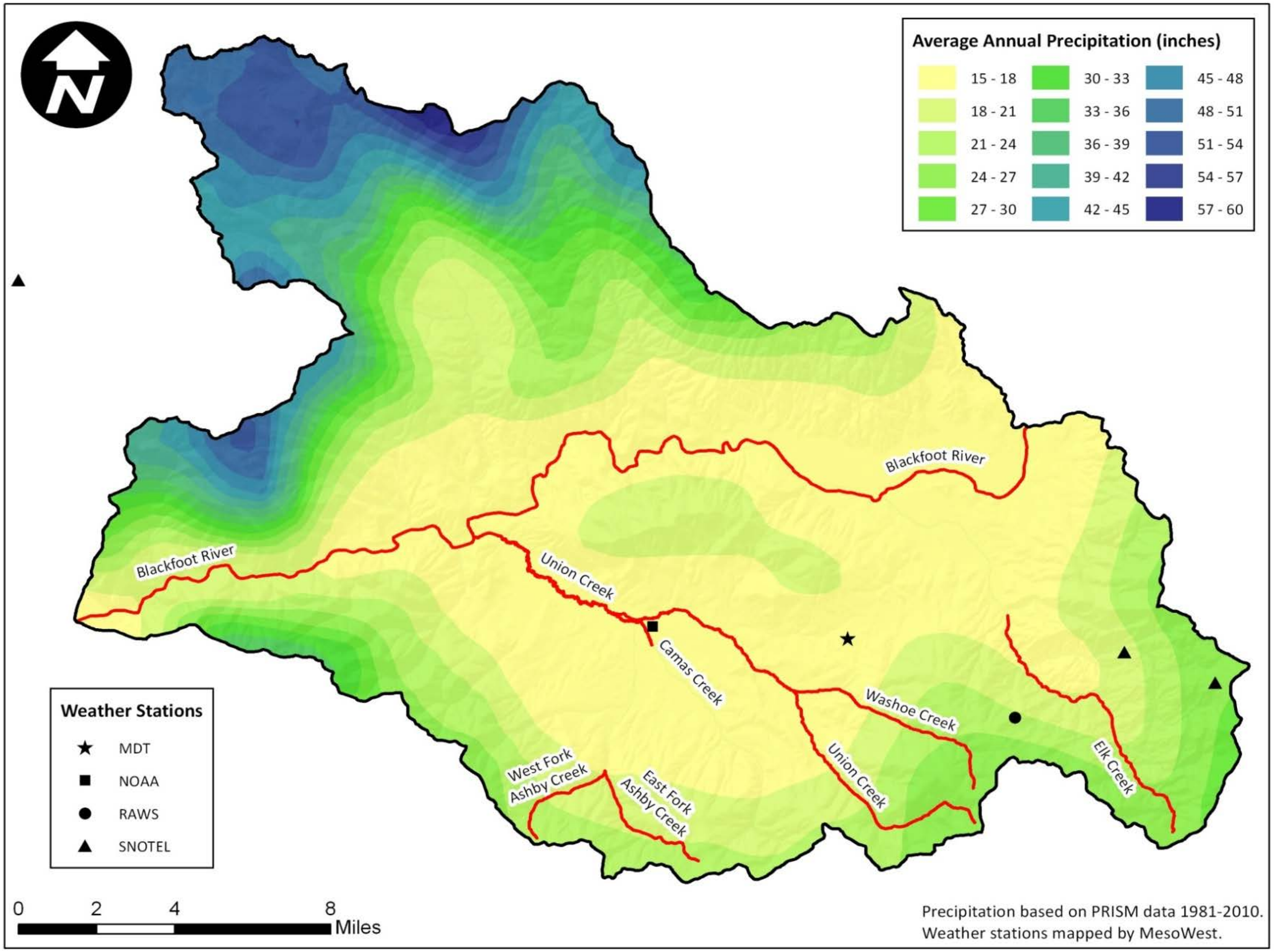
MPDES permits located using EPA's ECHO database. 1:100,000
NDH Medium Flowline hydrography data provided by USGS.

**Figure A-8. Lower Blackfoot MPDES Permits**



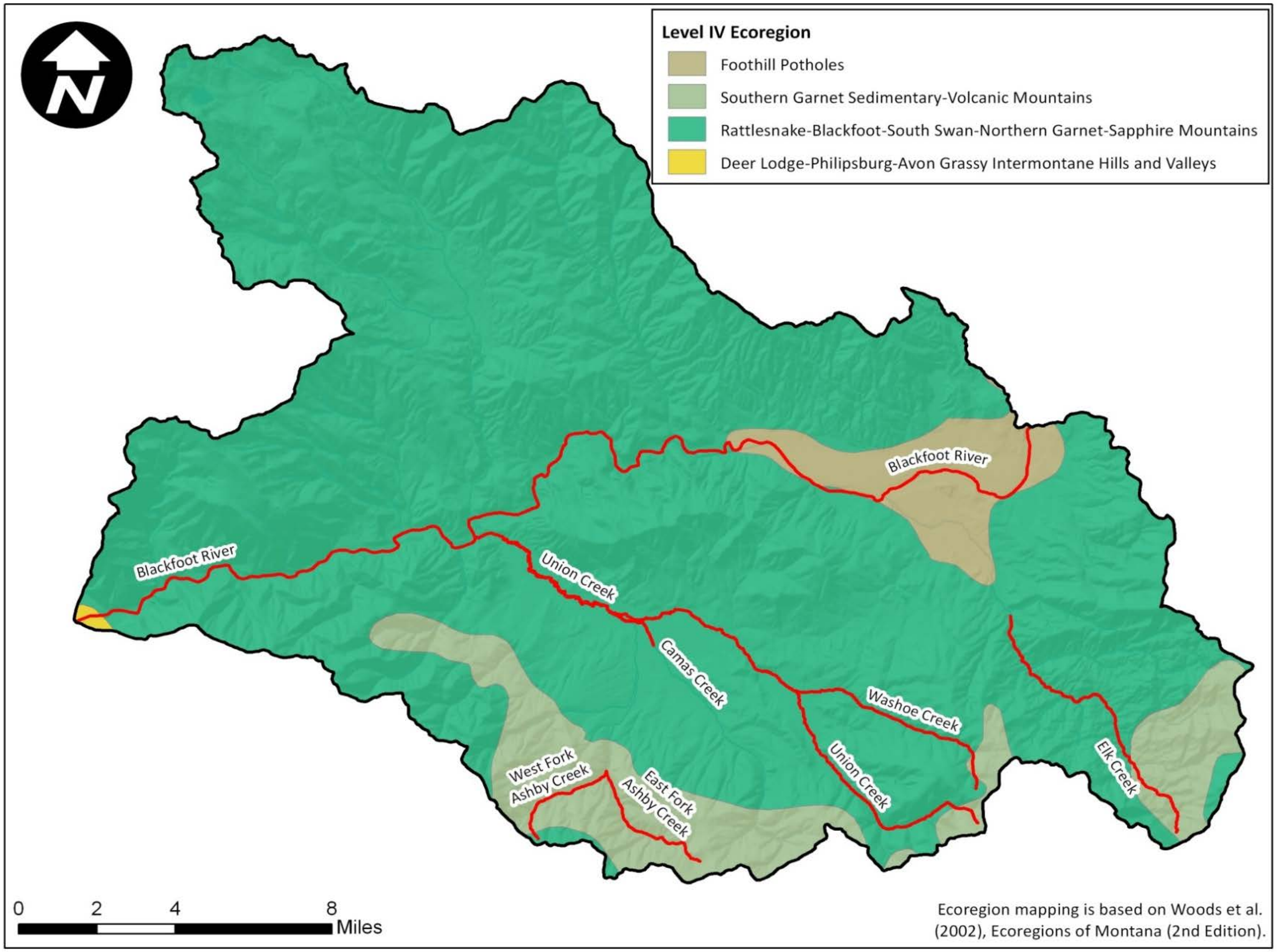
2011 MBMG well location data provided by NRIS

Figure A-9. Lower Blackfoot Groundwater Well Locations



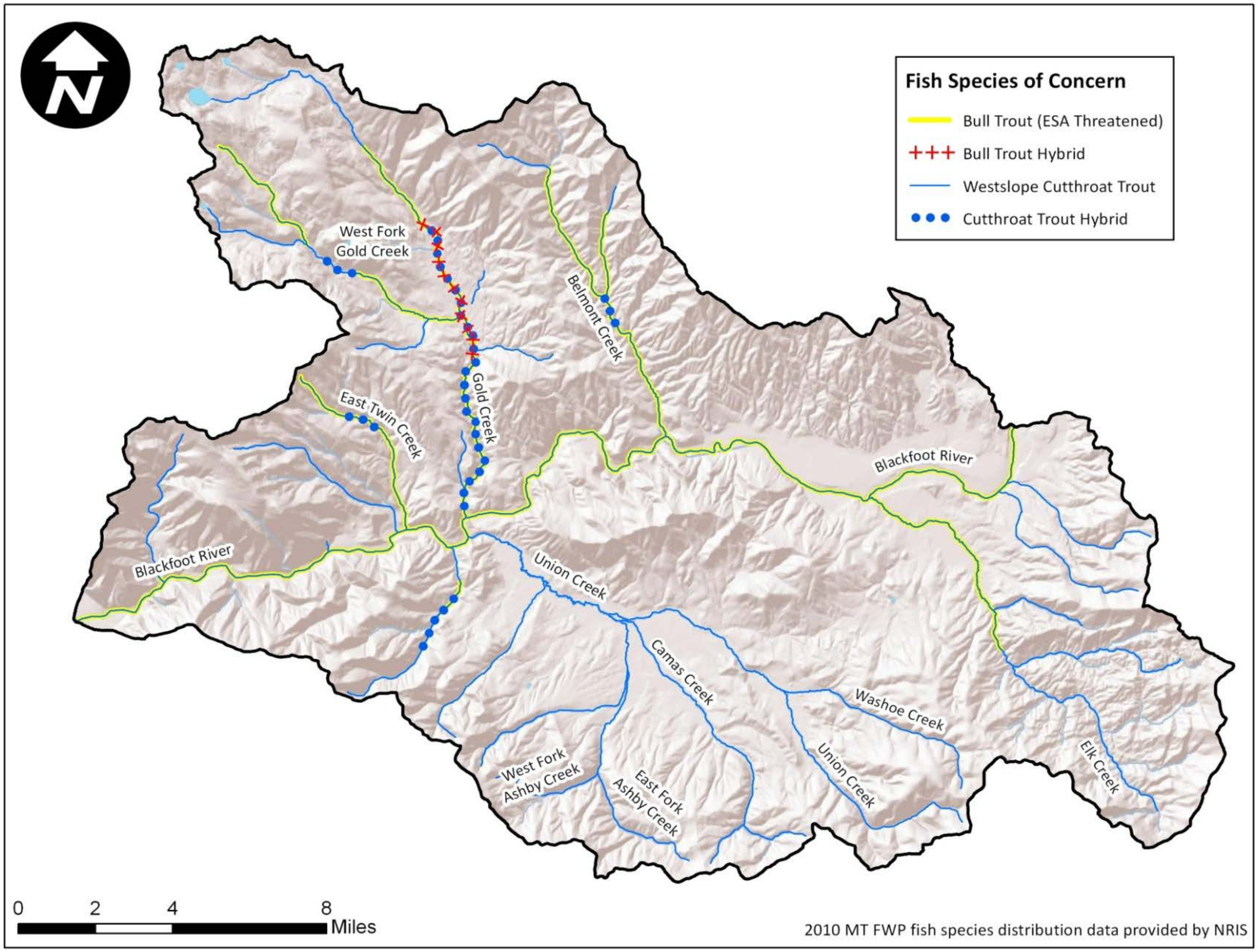
Precipitation based on PRISM data 1981-2010.
Weather stations mapped by MesoWest.

Figure A-10. Lower Blackfoot Precipitation



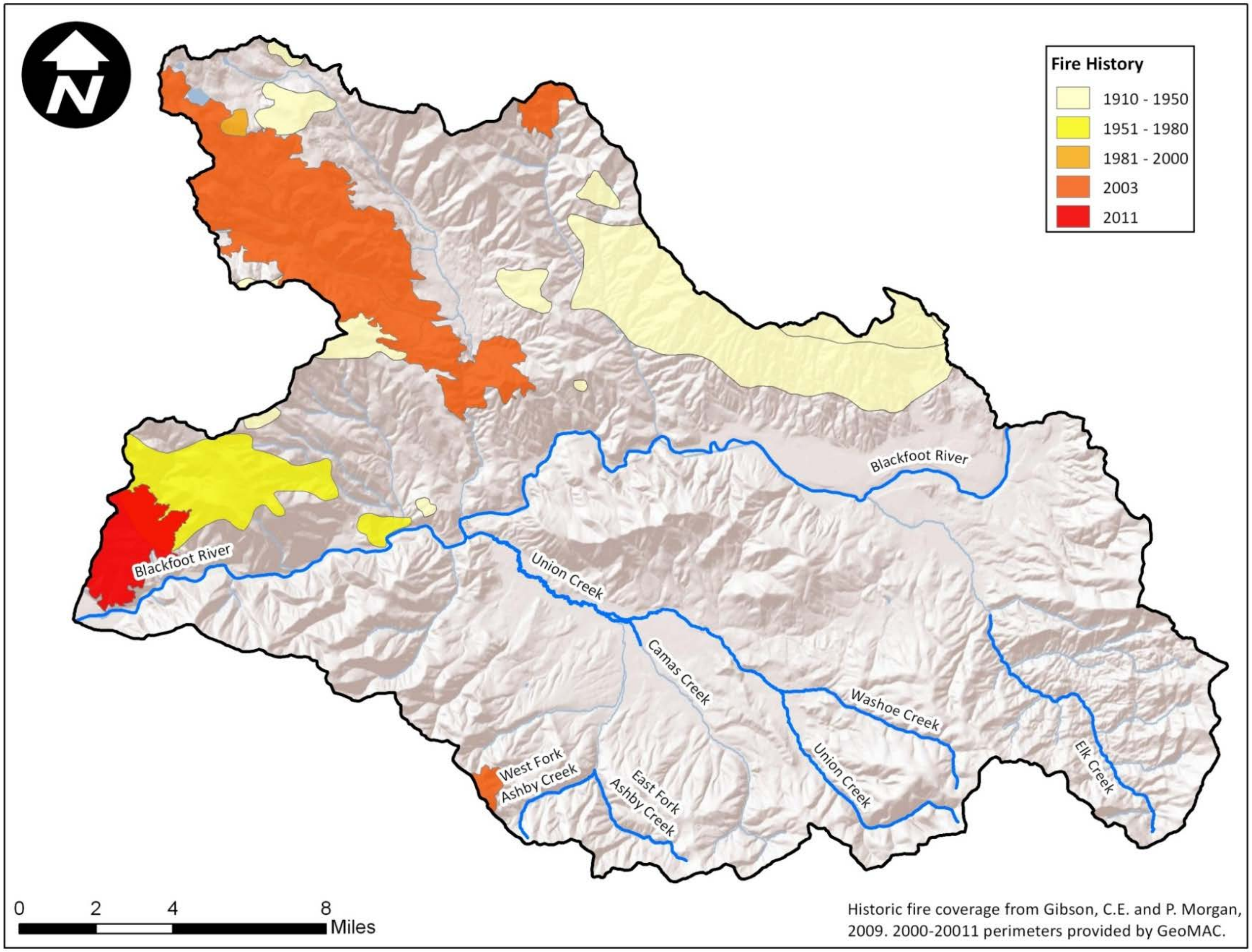
Ecoregion mapping is based on Woods et al. (2002), Ecoregions of Montana (2nd Edition).

Figure A-11. Lower Blackfoot Ecoregions



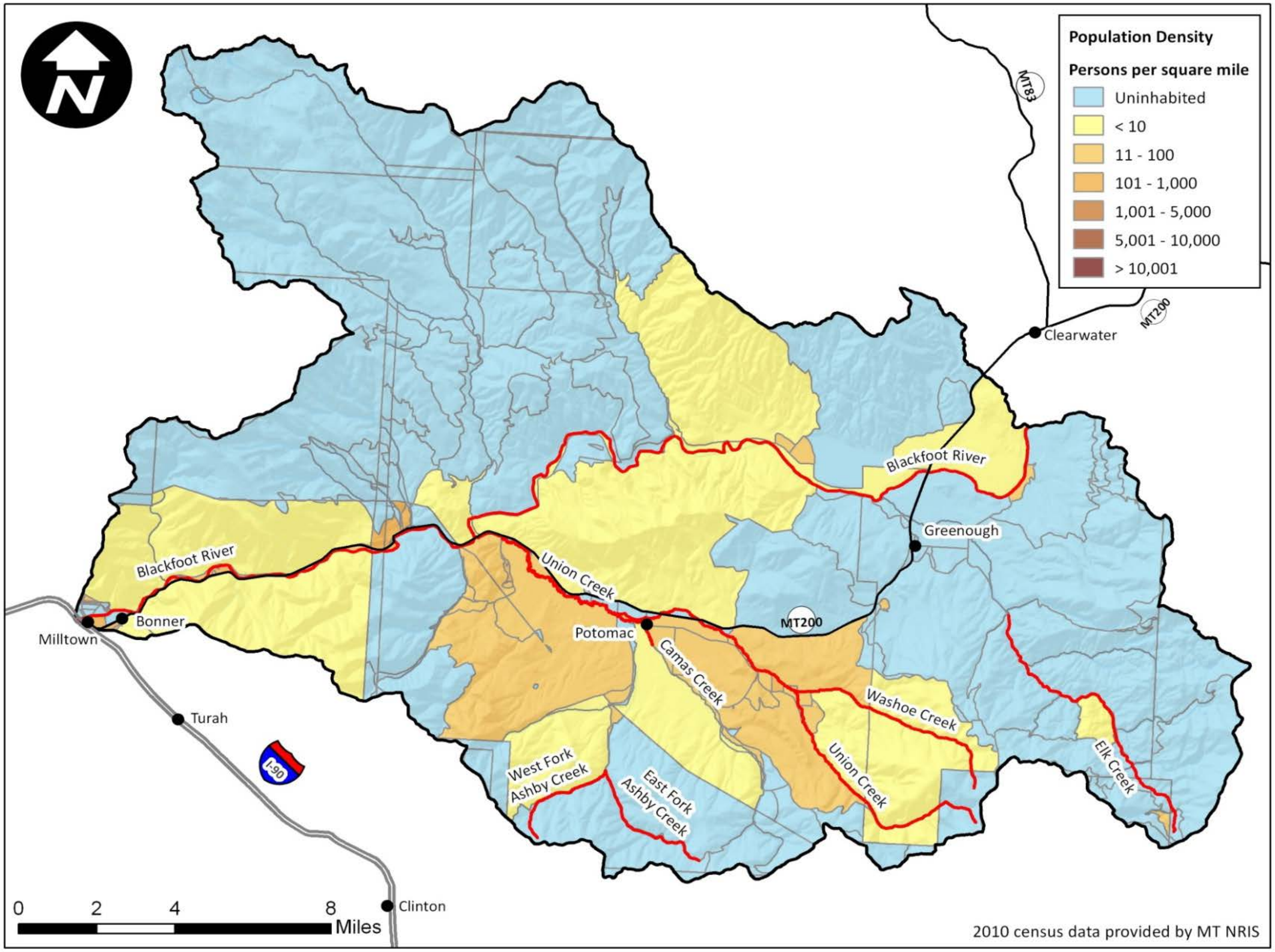
2010 MT FWP fish species distribution data provided by NRIS

**Figure A-12. Lower Blackfoot Fish Species of Concern**



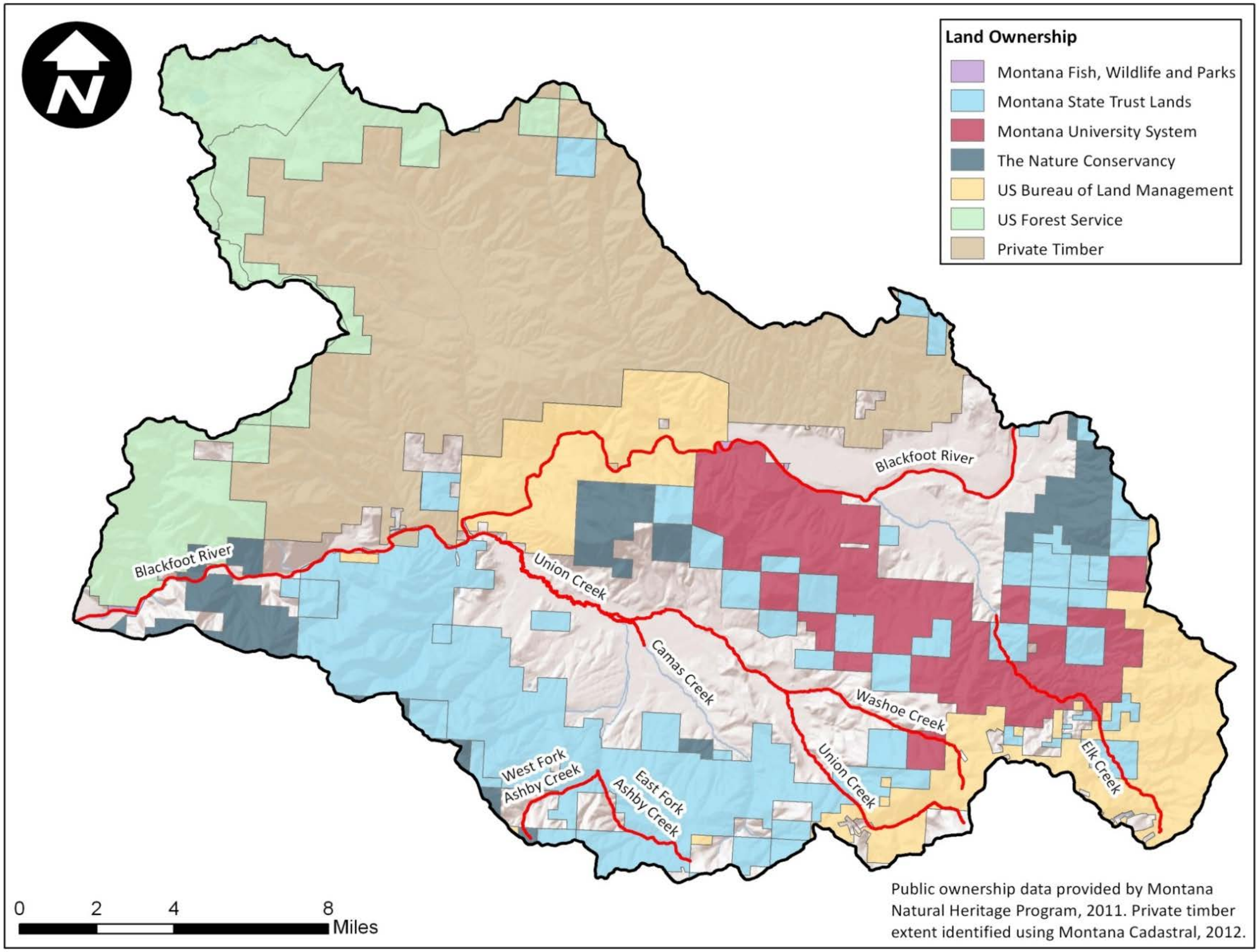
Historic fire coverage from Gibson, C.E. and P. Morgan, 2009. 2000-20011 perimeters provided by GeoMAC.

**Figure A-13. Lower Blackfoot Historic Fires**



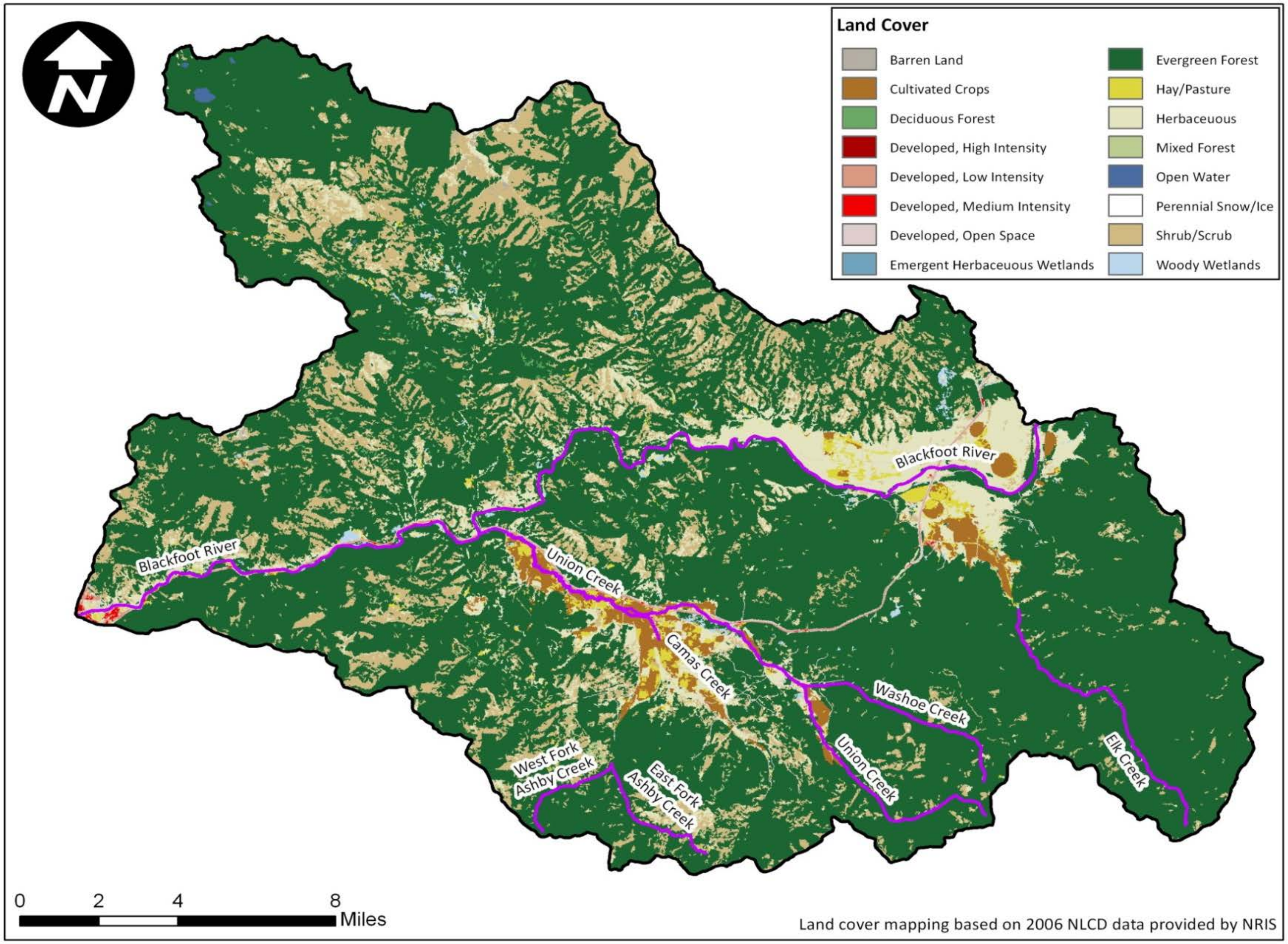
2010 census data provided by MT NRIS

Figure A-14. Lower Blackfoot Population Density



Public ownership data provided by Montana Natural Heritage Program, 2011. Private timber extent identified using Montana Cadastral, 2012.

**Figure A-15. Lower Blackfoot Land Ownership**



Land cover mapping based on 2006 NLCD data provided by NRIS

Figure A-16. Lower Blackfoot Land Cover

# APPENDIX B – TABLE OF 2012 IMPAIRED WATERBODIES, IMPAIRED USES, AND IMPAIRMENT STATUS

**Table B-1. Status of Waterbody Impairments in the Lower Blackfoot TPA based on the 2012 Integrated Report**

| Waterbody & Location Description | Waterbody ID | Impairment Cause | TMDL Pollutant Category | Impairment Cause Status |
|---|---|---|---|---|
| **BELMONT CREEK**, headwaters to mouth (Blackfoot River) | MT76F006_070 | Sedimentation/Siltation | Sediment | Sediment TMDL contained in a previous document (2009) |
| **BLACKFOOT RIVER**, Belmont Creek to mouth (Clark Fork) | MT76F001_033 | Ammonia (Un-ionized) | Nutrients | Not impaired based on updated assessment |
| **CAMAS CREEK**, 1 mile above mouth to mouth (Union Creek) | MT76F006_060 | Sedimentation/Siltation | Sediment | Sediment TMDL contained in a previous document (2009) |
| | | Phosphorus (Total) | Nutrients | TP TMDL in this document |
| | | Low flow alterations | Not Applicable: Non-Pollutant | Addressed by sediment TMDL contained in a previous document (2009) |
| **EAST FORK ASHBY CREEK**, headwaters to mouth (Ashby Creek) | MT76F006_050 | Alteration in stream-side or littoral vegetative covers | Not Applicable: Non-Pollutant | Addressed by sediment TMDL contained in a previous document (2009) |
| | | Sedimentation/Siltation | Sediment | Sediment TMDL contained in a previous document (2009) |
| | | Nitrate/Nitrite (Nitrite + Nitrate as N) | Nutrients | Not impaired based on updated assessment |
| | | Phosphorus (Total) | Nutrients | Not impaired based on updated assessment |
| **ELK CREEK**, headwaters to Stinkwater Creek | MT76F006_031 | Physical substrate habitat alterations | Not Applicable: Non-Pollutant | Addressed by sediment TMDL contained in a previous document (2009) |
| | | Sedimentation/Siltation | Sediment | Sediment TMDL contained in a previous document (2009) |
| | | Cadmium | Metals | Not impaired based on updated assessment |
| | | Nitrogen, Nitrate | Nutrients | Nitrate TMDL in this document |
| **ELK CREEK**, Stinkwater Creek to mouth (Blackfoot River) | MT76F006_032 | Sedimentation/Siltation | Sediment | Sediment TMDL contained in a previous document (2009) |
| | | Alteration in stream-side or littoral vegetative covers | Not Applicable: Non-Pollutant | Addressed by sediment TMDL contained in a previous document (2009) |
| | | Temperature, water | Temperature | Temperature TMDL contained in a previous document (2009) |
| **KENO CREEK**, headwaters to mouth (Elk Creek) | MT76F006_040 | Sedimentation/Siltation | Sediment | Sediment TMDL contained in a previous document (2009) |

**Table B-1. Status of Waterbody Impairments in the Lower Blackfoot TPA based on the 2012 Integrated Report**

| Waterbody & Location Description | Waterbody ID | Impairment Cause | TMDL Pollutant Category | Impairment Cause Status |
|---|---|---|---|---|
| **UNION CREEK**, headwaters to mouth (Blackfoot River) | MT76F006_010 | Copper | Metals | Not impaired based on updated assessment |
| | | Arsenic | Metals | Not impaired based on updated assessment |
| | | Physical substrate habitat alterations | Not Applicable: Non-Pollutant | Addressed by sediment TMDL contained in a previous document (2009) |
| | | Solids (Suspended/Bedload) | Sediment | Sediment TMDL contained in a previous document (2009) |
| | | Phosphorus (Total) | Nutrients | TP TMDL in this document |
| | | Temperature, water | Temperature | Temperature TMDL contained in a previous document (2009) |
| | | Iron | Metals | Iron TMDL contained in a previous document (2009) |
| **WASHOE CREEK**, Headwater to mouth (Union Creek) | MT76F006_090 | Sedimentation/Siltation | Sediment | Sediment TMDL contained in a previous document (2009) |
| | | Phosphorus (Total) | Nutrients | TP TMDL in this document |
| | | Nitrate/Nitrite (Nitrite + Nitrate as N) | Nutrients | Addressed by TN TMDL as a surrogate |
| | | Nitrogen (Total) | Nutrients | TN TMDL in this document |
| | | Chlorophyll-a | Not Applicable: Non-Pollutant | Addressed by TP and TN TMDLs in this document |
| **WEST FORK ASHBY CREEK**, headwaters to mouth (East Fork Ashby Creek) | MT76F006_020 | Alteration in stream-side or littoral vegetative covers | Not Applicable: Non-Pollutant | Addressed by sediment TMDL contained in a previous document (2009) |
| | | Sedimentation/Siltation | Sediment | Sediment TMDL contained in a previous document (2009) |
| | | Phosphorus (Total) | Nutrients | TP TMDL in this document |

# APPENDIX C – REGULATORY FRAMEWORK AND REFERENCE CONDITION APPROACH

This appendix presents details about applicable Montana Water Quality Standards (WQS) and the general and statistical methods used for development of reference conditions.

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# ACRONYMS

| Acronym | Definition |
|---|---|
| ARM | Administrative Rules of Montana |
| BER | Board of Environmental Review (Montana) |
| CFR | Code of Federal Regulations |
| CWA | Clean Water Act |
| DEQ | Department of Environmental Quality (Montana) |
| EPA | Environmental Protection Agency (U.S.) |
| MCA | Montana Code Annotated |
| TMDL | Total Maximum Daily Load |
| TN | Total Nitrogen |
| TP | Total Phosphorus |
| TPA | TMDL Planning Area |
| TSS | Total Suspended Solids |
| UAA | Use Attainability Analysis |
| WQA | Water Quality Act |
| WQS | Water Quality Standards |

# C1.0 TMDL DEVELOPMENT REQUIREMENTS

Section 303(d) of the federal Clean Water Act (CWA) and the Montana Water Quality Act (WQA) (Section 75-5-703) requires development of total maximum daily loads (TMDL) for impaired waterbodies that do not meet Montana WQS. Although waterbodies can become impaired from non-pollutant (e.g. low flow alterations and habitat degradation) and pollutants (e.g. nutrients, sediment, metals, pathogens, and temperature), the CWA and Montana state law (75-5-703) require TMDL development only for impaired waters with pollutant causes. Section 303(d) also requires states to submit a list of impaired waterbodies to the U.S. Environmental Protection Agency (EPA) every two years. Prior to 2004, EPA and the Montana Department of Environmental Quality (DEQ) referred to this list simply as the 303(d) list.

Since 2004, EPA has requested that states combine the 303(d) list with the 305(b) report containing an assessment of Montana's water quality and its water quality programs. EPA refers to this new combined 303(d)/305(b) report as the Integrated Water Quality Report. The 303(d) list also includes identification of the probable cause(s) of the water quality impairment (e.g. pollutants such as metals, nutrients, sediment, pathogens or temperature), and the suspected source(s) of the pollutants of concern (e.g. various land use activities). State law (MCA 75-5-702) identifies that a sufficient credible data methodology for determining the impairment status of each waterbody is used for consistency. The impairment status determination methodology is described in Section 4.0 of Montana's Water Quality Integrated Report (Montana Department of Environmental Quality, 2012b).

Under Montana state law, an "impaired waterbody" is defined as a waterbody or stream segment for which sufficient credible data show that the waterbody or stream segment is failing to achieve compliance with applicable WQS (Montana Water Quality Act; Section 75-5-103(11)). A "threatened waterbody" is defined as a waterbody or stream segment for which sufficient credible data and calculated increases in loads show that the waterbody or stream segment is fully supporting its designated uses, but threatened for a particular designated use because of either (a) proposed sources that are not subject to pollution prevention or control actions required by a discharge permit, the nondegradation provisions, or reasonable land, soil, and water conservation practices or (b) documented adverse pollution trends (Montana WQA; Section 75-5-103(31)). State law and Section 303(d) of the CWA require states to develop all necessary TMDLs for impaired or threatened waterbodies. There are no threatened waterbodies within the Lower Blackfoot TMDL Planning Area (TPA).

A TMDL is a pollutant budget for a waterbody identifying the maximum amount of the pollutant that a waterbody can assimilate without causing applicable WQS to be exceeded (violated). TMDLs are often expressed in terms of an amount, or load, of a particular pollutant (expressed in units of mass per time such as pounds per day). TMDLs must account for loads/impacts from point and nonpoint sources in addition to natural background sources and must incorporate a margin of safety and consider influences of seasonality on analysis and compliance with WQS. **Section 4.0** of the main document provides a description of the components of a TMDL.

To satisfy the federal CWA and Montana state law, TMDLs are developed for each waterbody-pollutant combination identified on Montana's 303(d) list of impaired or threatened waters, and are often presented within the context of a water quality restoration or protection plan. State law (Administrative Rules of Montana 75-5-703(8)) also directs Montana DEQ to "…support a voluntary program of reasonable land, soil, and water conservation practices to achieve compliance with water quality standards for nonpoint source activities for waterbodies that are subject to a TMDL…" This is an important directive that is reflected in the overall TMDL development and implementation strategy within this plan. It is important to note that water quality protection measures are not considered voluntary where such measures are already a requirement under existing federal, state, or local regulations.

# C2.0 APPLICABLE WATER QUALITY STANDARDS

WQS include the uses designated for a waterbody, the legally enforceable standards that ensure that the uses are supported, and a nondegradation policy that protects the high quality of a waterbody. The ultimate goal of this total maximum daily load document, once implemented, is to ensure that all designated beneficial uses are fully supported and all water quality standards are met. Water quality standards form the basis for the targets described in **Section C2.1**. Nutrients pollutants are addressed in this framework water quality improvement plan. This section provides a summary of the applicable water quality standards for nutrients.

## C2.1 CLASSIFICATION AND BENEFICIAL USES

Classification is the assignment (designation) of a single or group of uses to a waterbody based on the potential of the waterbody to support those uses. Designated uses or beneficial uses are simple narrative descriptions of water quality expectations or water quality goals. There are a variety of "uses" of state waters including growth and propagation of fish and associated aquatic life; drinking water; agriculture; industrial supply; and recreation and wildlife. The Montana WQA directs the Board of Environmental Review (BER) (i.e., the state) to establish a classification system for all waters of the state that includes their present (when the Act was originally written) and future most beneficial uses (ARM 17.30.607-616) and to adopt standards to protect those uses (ARM 17.30.620-670).

Montana, unlike many other states, uses a watershed-based classification system, with some specific exceptions. As a result, *all* waters of the state are classified and have designated uses and supporting standards. All classifications have multiple uses and in only one case (A-Closed) is a specific use (drinking water) given preference over the other designated uses. Some waters may not actually be used for a specific designated use, for example as a public drinking water supply; however, the quality of that waterbody must be maintained suitable for that designated use. When natural conditions limit or preclude a designated use, permitted point source discharges or nonpoint source activities or pollutant discharges must not make the natural conditions worse.

Modification of classifications or standards that would lower a water's classification or a standard (i.e., B-1 to a B-3), or removal of a designated use because of natural conditions, can only occur if the water was originally misclassified. All such modifications must be approved by the BER, and are undertaken via a Use Attainability Analysis (UAA) that must meet EPA requirements (40 CFR 131.10(g), (h) and (j)). The UAA and findings presented to the BER during rulemaking must prove that the modification is correct and all existing uses are supported. An existing use cannot be removed or made less stringent.

All streams within the Lower Blackfoot TMDL Planning Area (TPA) are classified as B-1. Descriptions of Montana's surface water classifications and designated beneficial uses are presented in **Table C2-1**.

**Table C2-1. Montana Surface Water Classifications and Designated Beneficial Uses**

| Classification | Designated Uses |
|---|---|
| **A-CLOSED CLASSIFICATION:** | Waters classified A-Closed are to be maintained suitable for drinking, culinary and food processing purposes after simple disinfection |
| **A-1 CLASSIFICATION:** | Waters classified A-1 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment for removal of naturally present impurities. A-1 waters must be maintained suitable for bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. |
| **B-1 CLASSIFICATION:** | Waters classified B-1 are to be maintained suitable for 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; and agricultural and industrial water supply. |
| **B-2 CLASSIFICATION:** | Waters classified B-2 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. |
| **B-3 CLASSIFICATION:** | Waters classified B-3 are to be maintained suitable for drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. |
| **C-1 CLASSIFICATION:** | Waters classified C-1 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. |
| **C-2 CLASSIFICATION:** | Waters classified C-2 are to be maintained suitable for bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. |
| **C-3 CLASSIFICATION:** | Waters classified C-3 are to be maintained suitable for bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agriculture and industrial water supply. |
| **I CLASSIFICATION:** | The goal of the State of Montana is to have these waters fully support the following uses: drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. |

## C2.2 STANDARDS

In addition to the use classifications described above, Montana's WQS include numeric and narrative criteria as well as a nondegradation policy.

### Numeric Standards

Numeric surface water quality standards have been developed for many parameters to protect human health and aquatic life. These standards are in the Department Circular DEQ-7 (Montana Department of Environmental Quality, 2012a). The numeric human health standards have been developed for parameters determined to be toxic, carcinogenic, or harmful and have been established at levels to be protective of long-term (i.e., lifelong) exposures as well as through direct contact such as swimming.

The numeric aquatic life standards include chronic and acute values that are based on extensive laboratory studies including a wide variety of potentially affected species, a variety of life stages and durations of exposure. Chronic aquatic life standards are protective of long-term exposure to a parameter. The protection afforded by the chronic standards includes detrimental effects to reproduction, early life stage survival and growth rates. In most cases the chronic standard is more stringent than the corresponding acute standard. Acute aquatic life standards are protective of short-term exposures to a parameter and are not to be exceeded.

**Narrative Standards**
Narrative standards have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric standards. The term “Narrative Standards” commonly refers to the General Prohibitions in ARM 17.30.637 and other descriptive portions of the surface WQS. The General Prohibitions are also called the “free from” standards; that is, the surface waters of the state must be free from substances attributable to discharges, including thermal pollution, that impair the beneficial uses of a waterbody. Uses may be impaired by toxic or harmful conditions (from one or a combination of parameters) or conditions that produce undesirable aquatic life. Undesirable aquatic life includes bacteria, fungi, and algae.

The standards applicable to the list of pollutants addressed in the Lower Blackfoot TPA are summarized below. In addition to the standards below, the beneficial-use support standard for B-1 streams, as defined above, can apply to other conditions, often linked to non-pollutants, limiting aquatic life. These other conditions can include effects from chlorophyll-*a*, dewatering/flow alterations, and effects from habitat modifications.

**Nondegradation Policy**
High quality waters are afforded an additional level of protection by the nondegradation policy as stated in statute (75-5-303 MCA) and administrative rules (ARM 17.30.701 et. seq.,). Changes in water quality must be “non-significant”, or an authorization to degrade must be granted by the Montana Department of Environmental Quality. However, under no circumstance may standards be exceeded. It is important to note that waters that meet or are of better quality than a standard are high quality for that parameter, and nondegradation policies apply to new or increased discharges to that waterbody. ()

## C.2.2.1 Nutrient Standards

The narrative standards applicable to nutrients in Montana are contained in the General Prohibitions of the surface water quality standards (ARM 17.30.637 et. Seq.,). The prohibition against the creation of “*conditions which produce undesirable aquatic life*” is generally the most relevant to nutrients. Undesirable aquatic life includes bacteria, fungi, and algae. Montana has recently developed draft nutrient criteria for total nitrogen (TN) and total phosphorus (TP) based on the level III ecoregion in which a stream is located (Suplee and Watson, 2013). In addition, Suplee et al. (2008), developed a target for nitrate (also known as nitrate+nitrite nitrogen or $NO_2$+$NO_3$) for the Middle Rockies Level III Ecoregion that provides an appropriate numeric translation of the applicable narrative nutrient water quality standard. For the Middle Rockies Level III Ecoregion, draft water quality criteria for TN and TP and the target for nitrate are presented in **Table C2-2**. This target and the proposed criteria are growing season, or summer, values applied from July 1st through September 30th. Additionally, numeric human health standards exist for nitrogen (**Table C2-3**), but the narrative standard is most applicable to nutrients as the concentration in most waterbodies in Montana is well below the human health standard and the nutrients contribute to undesirable aquatic life at much lower concentrations than the human health standard.

**Table C2-2. Nitrate Target and Proposed Numeric Nutrient and Criteria for the Middle Rockies Ecoregion**

| Parameter | Criteria/Target |
|---|---|
| Nitrate (Nitrate+Nitrite) | ≤ 0.100 mg/L (1) |
| Total Nitrogen | ≤ 0.300 mg/L (2) |
| Total Phosphorus | ≤ 0.030 mg/L (2) |

(1) From Suplee et al., 2008

(2) From Suplee and Watson, 2012

**Table C2-3. Human Health Standards for Nitrogen for the State of Montana.**

| Parameter | Human Health Standard (µL)[1] |
|---|---|
| Nitrate as Nitrogen ($NO_3$-N) | 10,000 |
| Nitrite as Nitrogen ($NO_2$-N) | 1,000 |
| Nitrate plus Nitrite as N | 10,000 |

[1] Maximum Allowable Concentration.

# C3.0 REFERENCE CONDITIONS

## C3.1 REFERENCE CONDITION CONCEPT AS DESCRIBED IN MONTANA'S 2012 WATER QUALITY INTEGRATED REPORT

A number of Montana's narrative water standards require that water quality be compared to "naturally occurring," conditions. The state of Montana has defined naturally occurring as "conditions or materials present from runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservations practices have been applied" (ARM 17.30.602[19]). The Administrative Rules of Montana (ARM) then define reasonable land, soil and water conservation practices as those that, in essence, completely protect all beneficial water uses (ARM 17.30.602[24]). Thus, human activities in a watershed are an integral component of the landscape, as long as those activities do not negatively impact the various beneficial uses of the water (drinking, recreation, fisheries, etc.). The Montana Department of Environmental Quality (DEQ) uses the reference condition concept to evaluate the difference between current water quality conditions and naturally occurring conditions.

The reference condition concept asserts that for any group of waterbodies there are relatively undisturbed examples that represent the natural biological, physical, and chemical integrity of a region. These examples, or reference sites, reflect a waterbody's greatest potential for water quality given historic land use activities (Montana Department of Environmental Quality, 2012b). All classes of waters are subject to the provision that there can be no increase above naturally occurring concentrations of sediment and settleable solids, oils, or floating solids sufficient to create a nuisance or render the water harmful, detrimental, or injurious. Since naturally occurring concentrations depend on site-specific factors, DEQ applies the reference condition concept and reference sites to assess compliance with such narrative standards.

Waterbodies used to determine reference condition are not necessarily pristine or perfectly suited to giving the best possible support to all possible beneficial uses. Reference condition also does not reflect an effort to turn the clock back to conditions that may have existed before human settlement, but is intended to accommodate natural variations in biological communities, water chemistry, etc. due to climate, bedrock, soils, hydrology, and other natural physiochemical differences. The intention is to differentiate between natural conditions and widespread or significant alterations of biology, chemistry, or hydrogeomorphology due to human activity. Therefore, reference conditions should reflect minimum impacts from human activities. It attempts to identify the potential condition that could be attained (given historical land use) by the application of reasonable land, soil, and water conservation practices. DEQ realizes that pre-settlement water quality conditions usually are not attainable.

Comparison of conditions in a waterbody to reference waterbody conditions must be made during similar season and/or hydrologic conditions for both waters. For example, the Total Suspended Solids (TSS) of a stream at base flow during the summer should not be compared to the TSS of reference condition that would occur during a runoff event in the spring. In addition, a comparison should not be made to the lowest or highest TSS values of a reference site, which represent the outer boundaries of reference conditions.

The following methods may be used to determine reference conditions:

**Primary Approach**

- Comparing conditions in a waterbody to baseline data from minimally impaired waterbodies that are in a nearby watershed or in the same region having similar geology, hydrology, morphology, and/or riparian habitat.
- Evaluating historical data relating to condition of the waterbody in the past.
- Comparing conditions in a waterbody to conditions in another portion of the same waterbody, such as an unimpaired segment of the same stream.

**Secondary Approach**

- Reviewing literature (e.g. a review of studies of fish populations, etc., that were conducted on similar waterbodies that are least impaired.
- Seeking expert opinion (e.g. expert opinion from a regional fisheries biologist who has a good understanding of the waterbody’s fisheries health or potential).
- Applying quantitative modeling (e.g. applying sediment transport models to determine how much sediment is entering a stream based on land use information, etc.).

DEQ uses the primary approach for determining reference condition if adequate regional reference data are available and uses the secondary approach to estimate reference condition when there is no regional data. DEQ often uses more than one approach to determine reference condition, especially when regional reference condition data are sparse or nonexistent.

# C4.0 REFERENCES

Montana Department of Environmental Quality. 2012a. 2012 Circular DEQ-7. Helena, MT: Montana Department of Environmental Quality. http://deq.mt.gov/wqinfo/Circulars.mcpx. Accessed 1/15/2013a.

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Suplee, Michael W., Arun Varghese, and Joshua Cleland. 2008. Developing Nutrient Criteria for Streams: An Evaluation of the Frequency Distribution Method. *Journal of the American Water Resources Association.* 43(2): 456-472.

Suplee, Michael W. and Vicki Watson. 2013. Scientific and Technical Basis of the Numeric Nutrient Criteria for Montana's Wadeable Streams and Rivers - Update 1. Helena, MT: Montana Department of Environmental Quality. http://deq.mt.gov/wqinfo/Standards/PDF/ScienceTech2013FnlCom.pdf. Accessed 5/16/2013.

# APPENDIX D – SURFACE WATER CHEMISTRY, ALGAE, MACROINVERTEBRATE, AND GROUNDWATER CHEMISTRY DATA, LOWER BLACKFOOT TPA

**Table D-1. Recent Surface Water Nutrients and Flow Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Collection Date | Latitude | Longitude | Flow (cfs) | Total N per Sulfate Method (mg/L) | Total P (mg/L) | $NO_2+_3$ Combined (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 8/11/2004 | 46.82341 | -113.59688 | 2.05 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 8/11/2004 | 46.82341 | -113.59688 | - | - | 0.021 | 0.08 |
| MTWTRSHD_WQX | Ashby Creek East Fork | AHSW-2 | 9/19/2006 | 46.81586 | -113.59210 | - | - | 0.02 | 0.07 |
| MTWTRSHD_WQX | Ashby Creek East Fork | AHSW-2 | 9/19/2006 | 46.81586 | -113.59210 | 1.86 | - | - | - |
| MTWTRSHD_WQX | Ashby Creek East Fork | AHSW-2 | 7/29/2009 | 46.81586 | -113.59210 | - | 0.07 | 0.014 | 0.09 |
| MTWTRSHD_WQX | Ashby Creek East Fork | AHSW-2 | 7/29/2009 | 46.81586 | -113.59210 | 2.49 | - | - | - |
| MTWTRSHD_WQX | Ashby Creek East Fork | AHSW-2 | 8/22/2009 | 46.81586 | -113.59210 | - | 0.1 | 0.017 | 0.08 |
| MTWTRSHD_WQX | Ashby Creek East Fork | AHSW-2 | 8/22/2009 | 46.81586 | -113.59210 | 2.4 | - | - | - |
| MTWTRSHD_WQX | Ashby Creek East Fork | AHSW-2 | 9/24/2009 | 46.81586 | -113.59210 | - | 0.16 | 0.014 | 0.08 |
| MTWTRSHD_WQX | Ashby Creek East Fork | AHSW-2 | 9/24/2009 | 46.81586 | -113.59210 | 2.25 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 8/2/2011 | 46.80170 | -113.57290 | - | 0.068 | 0.034 | 0.008 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 8/2/2011 | 46.80170 | -113.57290 | 0.65 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 8/2/2011 | 46.82341 | -113.59688 | - | 0.14 | 0.022 | 0.074 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 8/2/2011 | 46.82341 | -113.59688 | 3.42 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC02 | 8/2/2011 | 46.80940 | -113.58780 | - | 0.16 | 0.017 | 0.094 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC02 | 8/2/2011 | 46.80940 | -113.58780 | 2.77 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 8/3/2011 | 46.80170 | -113.57290 | - | 0.053 | 0.009 | 0.006 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 8/3/2011 | 46.80170 | -113.57290 | 0.92 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 9/6/2011 | 46.82341 | -113.59688 | - | 0.098 | 0.022 | 0.079 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 9/6/2011 | 46.82341 | -113.59688 | 3.16 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC02 | 9/7/2011 | 46.80940 | -113.58780 | - | 0.121 | 0.019 | 0.101 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC02 | 9/7/2011 | 46.80940 | -113.58780 | 2.99 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 9/7/2011 | 46.80170 | -113.57290 | - | 0.06 | 0.009 | 0.014 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 9/7/2011 | 46.80170 | -113.57290 | 1.18 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 7/7/2012 | 46.82341 | -113.59688 | - | 0.08 | 0.012 | 0.06 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 7/7/2012 | 46.82341 | -113.59688 | 3.16 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC02 | 7/7/2012 | 46.80940 | -113.58780 | - | 0.08 | 0.008 | 0.07 |

**Table D-1. Recent Surface Water Nutrients and Flow Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Collection Date | Latitude | Longitude | Flow (cfs) | Total N per Sulfate Method (mg/L) | Total P (mg/L) | $NO_2+_3$ Combined (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC02 | 7/7/2012 | 46.80940 | -113.58780 | 2.46 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 7/7/2012 | 46.80170 | -113.57290 | - | < 0.05 | 0.007 | < 0.01 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 7/7/2012 | 46.80170 | -113.57290 | 0.92 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC01 | 8/11/2004 | 46.82190 | -113.60166 | - | - | 0.043 | 0.04 |
| MTWTRSHD_WQX | Ashby Creek West Fork | AHSW-3 | 9/19/2006 | 46.81929 | -113.60859 | - | - | 0.04 | < 0.01 |
| MTWTRSHD_WQX | Ashby Creek West Fork | AHSW-3 | 9/19/2006 | 46.81929 | -113.60859 | 0.2858 | - | - | - |
| MTWTRSHD_WQX | Ashby Creek West Fork | AHSW-3 | 7/29/2009 | 46.81929 | -113.60859 | - | 0.05 | 0.005 | 0.01 |
| MTWTRSHD_WQX | Ashby Creek West Fork | AHSW-3 | 7/29/2009 | 46.81929 | -113.60859 | 0.54 | - | - | - |
| MTWTRSHD_WQX | Ashby Creek West Fork | AHSW-3 | 8/22/2009 | 46.81929 | -113.60859 | - | 0.05 | 0.037 | < 0.01 |
| MTWTRSHD_WQX | Ashby Creek West Fork | AHSW-3 | 8/22/2009 | 46.81929 | -113.60859 | 0.4 | - | - | - |
| MTWTRSHD_WQX | Ashby Creek West Fork | AHSW-3 | 9/24/2009 | 46.81929 | -113.60859 | 0.36 | - | - | - |
| MTWTRSHD_WQX | Ashby Creek West Fork | AHSW-3 | 9/24/2009 | 46.81929 | -113.60859 | - | 0.08 | 0.044 | < 0.01 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 8/1/2011 | 46.82430 | -113.59800 | - | 0.086 | 0.044 | 0.007 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 8/1/2011 | 46.82430 | -113.59800 | 1 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 9/7/2011 | 46.82430 | -113.59800 | - | 0.065 | 0.041 | 0.012 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 9/7/2011 | 46.82430 | -113.59800 | 0.62 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC03 | 9/7/2011 | 46.81640 | -113.61580 | - | 0.059 | 0.037 | 0.013 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC03 | 9/7/2011 | 46.81640 | -113.61580 | 0.41 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 7/7/2012 | 46.82430 | -113.59800 | - | < 0.05 | 0.036 | < 0.01 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 7/7/2012 | 46.82430 | -113.59800 | 1.08 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC03 | 7/7/2012 | 46.81640 | -113.61580 | - | < 0.05 | 0.023 | < 0.01 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC03 | 7/7/2012 | 46.81640 | -113.61580 | 0.65 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 8/10/2012 | 46.82430 | -113.59800 | - | < 0.05 | 0.039 | < 0.01 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 8/10/2012 | 46.82430 | -113.59800 | 0.5 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC03 | 8/10/2012 | 46.81640 | -113.61580 | - | 0.08 | 0.029 | < 0.01 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC03 | 8/10/2012 | 46.81640 | -113.61580 | 0.24 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC03 | 9/27/2012 | 46.81640 | -113.61580 | - | <0.05 | 0.032 | <0.01 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC03 | 9/27/2012 | 46.81640 | -113.61580 | 0.27 | - | - | - |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 9/27/2012 | 46.82430 | -113.59800 | - | <0.05 | 0.037 | <0.01 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 9/27/2012 | 46.82430 | -113.59800 | 0.42 | - | - | - |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC10 | 8/18/2004 | 46.88197 | -113.58898 | - | - | 0.204 | 0.02 |

**Table D-1. Recent Surface Water Nutrients and Flow Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Collection Date | Latitude | Longitude | Flow (cfs) | Total N per Sulfate Method (mg/L) | Total P (mg/L) | $NO_2+_3$ Combined (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| MTWTRSHD_WQX | Camas Creek | CMSW-1 | 9/19/2006 | 46.87813 | -113.58018 | - | - | 0.05 | 0.08 |
| MTWTRSHD_WQX | Camas Creek | CMSW-1 | 9/19/2006 | 46.87813 | -113.58018 | 2.26 | - | - | - |
| MTWTRSHD_WQX | Camas Creek | CMSW-1 | 8/23/2009 | 46.87813 | -113.58018 | 1.6 | - | - | - |
| MTWTRSHD_WQX | Camas Creek | CMSW-1 | 8/23/2009 | 46.87813 | -113.58018 | - | 0.56 | 0.038 | 0.35 |
| MTWTRSHD_WQX | Camas Creek | CMSW-1 | 9/26/2009 | 46.87813 | -113.58018 | 3.14 | - | - | - |
| MTWTRSHD_WQX | Camas Creek | CMSW-1 | 9/26/2009 | 46.87813 | -113.58018 | - | 0.19 | 0.024 | 0.09 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC10 | 8/5/2011 | 46.88197 | -113.58898 | - | 0.756 | 0.074 | 0.404 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC10 | 8/5/2011 | 46.88197 | -113.58898 | 7.34 | - | - | - |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 8/5/2011 | 46.87590 | -113.58010 | - | 0.627 | 0.053 | 0.323 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 8/5/2011 | 46.87590 | -113.58010 | 6.13 | - | - | - |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 9/8/2011 | 46.87590 | -113.58010 | - | 0.408 | 0.036 | 0.248 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 9/8/2011 | 46.87590 | -113.58010 | 4.84 | - | - | - |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC10 | 7/8/2012 | 46.88197 | -113.58898 | - | 0.28 | 0.035 | 0.06 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC10 | 7/8/2012 | 46.88197 | -113.58898 | 3.66 | - | - | - |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 7/8/2012 | 46.87590 | -113.58010 | - | 0.21 | 0.031 | 0.08 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC10 | 9/27/2012 | 46.88197 | -113.58898 | - | 0.19 | 0.024 | 0.03 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC10 | 9/27/2012 | 46.88197 | -113.58898 | 2.57 | - | - | - |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 9/27/2012 | 46.87590 | -113.58010 | - | 0.39 | 0.032 | 0.05 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 9/27/2012 | 46.87590 | -113.58010 | 8.37 | - | - | - |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 8/7/2011 | 46.82023 | -113.29061 | - | 0.062 | 0.028 | < 0.005 |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 8/7/2011 | 46.82023 | -113.29061 | 0.12 | - | - | - |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 9/9/2011 | 46.82023 | -113.29061 | - | 0.072 | 0.024 | < 0.005 |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 9/9/2011 | 46.82023 | -113.29061 | 0.63 | - | - | - |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 7/8/2012 | 46.82023 | -113.29061 | - | < 0.05 | 0.02 | < 0.01 |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 7/8/2012 | 46.82023 | -113.29061 | 0.09 | - | - | - |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 8/11/2012 | 46.82023 | -113.29061 | - | < 0.05 | 0.018 | < 0.01 |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 8/11/2012 | 46.82023 | -113.29061 | 0.05 | - | - | - |
| MTWTRSHD_WQX | Elk Creek | ECSW-2 | 9/19/2006 | 46.88676 | -113.38394 | - | - | 0.04 | < 0.01 |
| MTWTRSHD_WQX | Elk Creek | ECSW-2 | 9/19/2006 | 46.88676 | -113.38394 | 3.19 | - | - | - |
| MTWTRSHD_WQX | Elk Creek | ECSW-3 | 9/19/2006 | 46.86344 | -113.35694 | - | - | 0.04 | < 0.01 |
| MTWTRSHD_WQX | Elk Creek | ECSW-3 | 9/19/2006 | 46.86344 | -113.35694 | 3.45 | - | - | - |

**Table D-1. Recent Surface Water Nutrients and Flow Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Collection Date | Latitude | Longitude | Flow (cfs) | Total N per Sulfate Method (mg/L) | Total P (mg/L) | $NO_2+_3$ Combined (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| MTWTRSHD_WQX | Elk Creek | ECSW-4 | 9/19/2006 | 46.83628 | -113.31207 | 2.18 | - | - | - |
| MTWTRSHD_WQX | Elk Creek | ECSW-2 | 7/27/2009 | 46.88676 | -113.38394 | 10.5 | - | - | - |
| MTWTRSHD_WQX | Elk Creek | ECSW-3 | 7/27/2009 | 46.86344 | -113.35694 | 8.7 | - | - | - |
| MTWTRSHD_WQX | Elk Creek | ECSW-3 | 7/27/2009 | 46.86344 | -113.35694 | - | 0.1 | 0.046 | < 0.01 |
| MTWTRSHD_WQX | Elk Creek | ECSW-2 | 7/27/2009 | 46.88676 | -113.38394 | - | 0.11 | 0.048 | < 0.01 |
| MTWTRSHD_WQX | Elk Creek | ECSW-2 | 8/20/2009 | 46.88676 | -113.38394 | 5 | - | - | - |
| MTWTRSHD_WQX | Elk Creek | ECSW-3 | 8/20/2009 | 46.86344 | -113.35694 | 4.1 | - | - | - |
| MTWTRSHD_WQX | Elk Creek | ECSW-3 | 8/20/2009 | 46.86344 | -113.35694 | - | 0.08 | 0.033 | < 0.01 |
| MTWTRSHD_WQX | Elk Creek | ECSW-2 | 8/20/2009 | 46.88676 | -113.38394 | - | 0.07 | 0.034 | < 0.01 |
| MTWTRSHD_WQX | Elk Creek | ECSW-2 | 9/24/2009 | 46.88676 | -113.38394 | 4.18 | - | - | - |
| MTWTRSHD_WQX | Elk Creek | ECSW-3 | 9/24/2009 | 46.86344 | -113.35694 | 3.63 | - | - | - |
| MTWTRSHD_WQX | Elk Creek | ECSW-3 | 9/24/2009 | 46.86344 | -113.35694 | - | 0.13 | 0.031 | < 0.01 |
| MTWTRSHD_WQX | Elk Creek | ECSW-2 | 9/24/2009 | 46.88676 | -113.38394 | - | 0.08 | 0.033 | < 0.01 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC02 | 8/4/2011 | 46.88640 | -113.38420 | - | 0.098 | 0.042 | < 0.005 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC02 | 8/4/2011 | 46.88640 | -113.38420 | 11.57 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC03 | 8/6/2011 | 46.82000 | -113.29150 | - | 0.099 | 0.019 | 0.086 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC03 | 8/6/2011 | 46.82000 | -113.29150 | 1.08 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 8/7/2011 | 46.83660 | -113.31360 | - | 0.06 | 0.024 | 0.031 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 8/7/2011 | 46.83660 | -113.31360 | 5.12 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC05 | 8/7/2011 | 46.86030 | -113.33070 | - | 0.073 | 0.036 | < 0.005 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC05 | 8/7/2011 | 46.86030 | -113.33070 | 9.8 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC06 | 8/7/2011 | 46.86510 | -113.36120 | - | 0.102 | 0.046 | < 0.005 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC06 | 8/7/2011 | 46.86510 | -113.36120 | 12.02 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC07 | 8/8/2011 | 46.87340 | -113.37370 | - | 0.074 | 0.042 | < 0.005 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC07 | 8/8/2011 | 46.87340 | -113.37370 | 11.98 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC02 | 9/7/2011 | 46.88640 | -113.38420 | - | 0.067 | 0.036 | < 0.005 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC02 | 9/7/2011 | 46.88640 | -113.38420 | 7.75 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC03 | 9/9/2011 | 46.82000 | -113.29150 | - | 0.108 | 0.014 | 0.106 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC03 | 9/9/2011 | 46.82000 | -113.29150 | 0.37 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC05 | 9/9/2011 | 46.86030 | -113.33070 | - | 0.055 | 0.023 | 0.006 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC05 | 9/9/2011 | 46.86030 | -113.33070 | 5.65 | - | - | - |

**Table D-1. Recent Surface Water Nutrients and Flow Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Collection Date | Latitude | Longitude | Flow (cfs) | Total N per Sulfate Method (mg/L) | Total P (mg/L) | $NO_2{+}_3$ Combined (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 9/10/2011 | 46.83660 | -113.31360 | - | 0.064 | 0.021 | 0.041 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 9/10/2011 | 46.83660 | -113.31360 | 4.37 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC06 | 9/10/2011 | 46.86510 | -113.36120 | - | 0.065 | 0.033 | < 0.005 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC06 | 9/10/2011 | 46.86510 | -113.36120 | 7.83 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC07 | 9/11/2011 | 46.87340 | -113.37370 | - | 0.06 | 0.03 | < 0.005 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC07 | 9/11/2011 | 46.87340 | -113.37370 | 7.01 | - | - | - |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 8/11/2012 | 46.83660 | -113.31360 | - | < 0.05 | 0.015 | 0.02 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 8/11/2012 | 46.83660 | -113.31360 | 3.38 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-2 | 9/19/2006 | 46.88445 | -113.59592 | - | - | 0.04 | 0.29 |
| MTWTRSHD_WQX | Union Creek | UNSW-2 | 9/19/2006 | 46.88445 | -113.59592 | 3.75 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-1 | 9/19/2006 | 46.91265 | -113.67024 | - | - | 0.07 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | UNSW-1 | 9/19/2006 | 46.91265 | -113.67024 | 2.32 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-4 | 9/19/2006 | 46.81243 | -113.45113 | 0.2485 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 9/19/2006 | 46.85785 | -113.49674 | - | - | 0.03 | 0.06 |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 9/19/2006 | 46.85785 | -113.49674 | 0.43 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-5 | 9/19/2006 | 46.81987 | -113.45967 | - | - | 0.02 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | UNSW-5 | 9/19/2006 | 46.81987 | -113.45967 | 0.253 | - | - | - |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-6 | 7/28/2009 | 46.88604 | -113.57264 | 0.39 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-2 | 7/28/2009 | 46.88445 | -113.59592 | 3.78 | - | - | - |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-8 | 7/28/2009 | 46.86603 | -113.51689 | 1.16 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 7/28/2009 | 46.85785 | -113.49674 | 0.59 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 7/28/2009 | 46.85785 | -113.49674 | - | 0.22 | 0.045 | 0.03 |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-8 | 7/28/2009 | 46.86603 | -113.51689 | - | 0.21 | 0.064 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-6 | 7/28/2009 | 46.88604 | -113.57264 | - | 0.18 | 0.084 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | UNSW-2 | 7/28/2009 | 46.88445 | -113.59592 | - | 0.76 | 0.064 | 0.45 |
| MTWTRSHD_WQX | Union Creek | UNSW-5 | 7/28/2009 | 46.81987 | -113.45967 | - | 0.08 | 0.026 | 0.01 |
| MTWTRSHD_WQX | Union Creek | UNION_12 | 7/28/2009 | 46.91304 | -113.66899 | - | 0.58 | 0.111 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | UNION_12 | 7/28/2009 | 46.91304 | -113.66899 | 4.61 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-1 | 7/28/2009 | 46.91265 | -113.67024 | - | 0.56 | 0.116 | 0.02 |
| MTWTRSHD_WQX | Union Creek | UNSW-1 | 7/28/2009 | 46.91265 | -113.67024 | 4.03 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-1 | 8/21/2009 | 46.91265 | -113.67024 | 5.1 | - | - | - |

**Table D-1. Recent Surface Water Nutrients and Flow Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Collection Date | Latitude | Longitude | Flow (cfs) | Total N per Sulfate Method (mg/L) | Total P (mg/L) | $NO_2+_3$ Combined (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| MTWTRSHD_WQX | Union Creek | UNION_12 | 8/21/2009 | 46.91304 | -113.66899 | 5.6 | - | - | - |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-6 | 8/21/2009 | 46.88604 | -113.57264 | 0.8 | - | - | - |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-8 | 8/21/2009 | 46.86603 | -113.51689 | 0.6 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-2 | 8/21/2009 | 46.88445 | -113.59592 | 3.9 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 8/21/2009 | 46.85785 | -113.49674 | 0.3 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 8/21/2009 | 46.85785 | -113.49674 | - | 0.26 | 0.038 | 0.03 |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-8 | 8/21/2009 | 46.86603 | -113.51689 | - | 0.4 | 0.062 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-6 | 8/21/2009 | 46.88604 | -113.57264 | - | 0.17 | 0.072 | 0.04 |
| MTWTRSHD_WQX | Union Creek | UNSW-2 | 8/21/2009 | 46.88445 | -113.59592 | - | 0.46 | 0.037 | 0.29 |
| MTWTRSHD_WQX | Union Creek | UNSW-1 | 8/21/2009 | 46.91265 | -113.67024 | - | 0.38 | 0.076 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | UNION_12 | 8/21/2009 | 46.91304 | -113.66899 | - | 0.68 | 0.084 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | UNSW-5 | 8/22/2009 | 46.81987 | -113.45967 | - | 0.13 | 0.025 | 0.04 |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 9/24/2009 | 46.85785 | -113.49674 | - | 0.39 | 0.052 | 0.03 |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 9/24/2009 | 46.85785 | -113.49674 | 0.01 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-1 | 9/25/2009 | 46.91265 | -113.67024 | 3.18 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNION_12 | 9/25/2009 | 46.91304 | -113.66899 | 3.45 | - | - | - |
| MTWTRSHD_WQX | Union Creek | UNSW-2 | 9/25/2009 | 46.88445 | -113.59592 | 2.62 | - | - | - |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-6 | 9/25/2009 | 46.88604 | -113.57264 | 0.69 | - | - | - |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-8 | 9/25/2009 | 46.86603 | -113.51689 | 0.15 | - | - | - |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-8 | 9/25/2009 | 46.86603 | -113.51689 | - | 0.24 | 0.076 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-6 | 9/25/2009 | 46.88604 | -113.57264 | - | 0.25 | 0.075 | 0.09 |
| MTWTRSHD_WQX | Union Creek | UNSW-2 | 9/25/2009 | 46.88445 | -113.59592 | - | 0.55 | 0.031 | 0.34 |
| MTWTRSHD_WQX | Union Creek | UNION_12 | 9/25/2009 | 46.91304 | -113.66899 | - | 0.43 | 0.062 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | UNSW-1 | 9/25/2009 | 46.91265 | -113.67024 | - | 0.44 | 0.056 | < 0.01 |
| MTWTRSHD_WQX | Union Creek | UNSW-5 | 9/26/2009 | 46.81987 | -113.45967 | - | 0.06 | 0.018 | < 0.01 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC02 | 8/3/2011 | 46.91280 | -113.66980 | - | 0.447 | 0.072 | 0.011 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC02 | 8/3/2011 | 46.91280 | -113.66980 | 11.03 | - | - | - |
| MDEQ_WQ_WQX | Union Creek | C03UNONC03 | 8/3/2011 | 46.88650 | -113.57170 | - | 0.224 | 0.085 | 0.008 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC03 | 8/3/2011 | 46.88650 | -113.57170 | 1.6 | - | - | - |
| MDEQ_WQ_WQX | Union Creek | C03UNONC04 | 8/4/2011 | 46.85970 | -113.49990 | - | 0.289 | 0.089 | 0.012 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC04 | 8/4/2011 | 46.85970 | -113.49990 | 1.93 | - | - | - |

**Table D-1. Recent Surface Water Nutrients and Flow Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Collection Date | Latitude | Longitude | Flow (cfs) | Total N per Sulfate Method (mg/L) | Total P (mg/L) | $NO_{2}+_{3}$ Combined (mg/L) |
|---|---|---|---|---|---|---|---|---|---|
| MDEQ_WQ_WQX | Union Creek | C03UNONC05 | 8/5/2011 | 46.88260 | -113.58880 | - | 0.447 | 0.132 | 0.022 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC05 | 8/5/2011 | 46.88260 | -113.58880 | 1.5 | - | - | - |
| MDEQ_WQ_WQX | Union Creek | C03UNONC02 | 9/9/2011 | 46.91280 | -113.66980 | - | 0.302 | 0.047 | < 0.005 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC02 | 9/9/2011 | 46.91280 | -113.66980 | 2.89 | - | - | - |
| MDEQ_WQ_WQX | Union Creek | C03UNONC03 | 9/10/2011 | 46.88650 | -113.57170 | - | 0.144 | 0.066 | 0.011 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC03 | 9/10/2011 | 46.88650 | -113.57170 | 0.31 | - | - | - |
| MDEQ_WQ_WQX | Union Creek | C03UNONC04 | 9/11/2011 | 46.85970 | -113.49990 | - | 0.155 | 0.059 | 0.011 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC04 | 9/11/2011 | 46.85970 | -113.49990 | 0.59 | - | - | - |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC02 | 8/12/2004 | 46.85909 | -113.48562 | - | - | 0.09 | 0.03 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC01 | 8/13/2004 | 46.83934 | -113.40154 | - | - | 0.035 | 0.04 |
| MTWTRSHD_WQX | Washoe Creek | WSSW-1 | 9/19/2006 | 46.85890 | -113.49415 | - | - | 0.07 | < 0.01 |
| MTWTRSHD_WQX | Washoe Creek | WSSW-1 | 9/19/2006 | 46.85890 | -113.49415 | 0.48 | - | - | - |
| MTWTRSHD_WQX | Washoe Creek | WSSW-1 | 8/21/2009 | 46.85890 | -113.49415 | 0.4 | - | - | - |
| MTWTRSHD_WQX | Washoe Creek | WSSW-1 | 8/21/2009 | 46.85890 | -113.49415 | - | 0.29 | 0.077 | < 0.01 |
| MTWTRSHD_WQX | Washoe Creek | WSSW-1 | 9/24/2009 | 46.85890 | -113.49415 | - | 0.22 | 0.08 | < 0.01 |
| MTWTRSHD_WQX | Washoe Creek | WSSW-1 | 9/24/2009 | 46.85890 | -113.49415 | 0.15 | - | - | - |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 8/6/2011 | 46.82870 | -113.39790 | - | 0.02 | 0.036 | < 0.005 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 8/6/2011 | 46.82870 | -113.39790 | 0.03 | - | - | - |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 9/8/2011 | 46.82870 | -113.39790 | - | 0.064 | 0.037 | 0.007 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 9/8/2011 | 46.82870 | -113.39790 | 0.02 | - | - | - |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 7/8/2012 | 46.82870 | -113.39790 | 0.1 | - | - | - |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 7/8/2012 | 46.82870 | -113.39790 | - | < 0.05 | 0.017 | < 0.01 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 8/11/2012 | 46.82870 | -113.39790 | - | < 0.05 | 0.017 | < 0.01 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 8/11/2012 | 46.82870 | -113.39790 | 0.01 | - | - | - |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 9/28/2012 | 46.82870 | -113.39790 | - | 0.05 | 0.02 | <0.01 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 9/28/2012 | 46.82870 | -113.39790 | 0.03 | - | - | - |

**Table D-2. Recent Algal Measure Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Latitude | Longitude | Collection Date | Algal Measure | Result Value | Result Unit |
|---|---|---|---|---|---|---|---|---|
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 46.8017 | -113.57290 | 8/3/2011 | Chlorophyll *a*, corrected for pheophytin | 20.86 | mg/m2 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 46.82341 | -113.59688 | 8/2/2011 | Chlorophyll *a*, corrected for pheophytin | 51.26 | mg/m2 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 46.82341 | -113.59688 | 9/6/2011 | Chlorophyll *a*, corrected for pheophytin | 18.14 | mg/m2 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC03 | 46.8017 | -113.57290 | 8/3/2011 | Ash-Free Dry Mass | 27.14 | g/m2 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 46.82341 | -113.59688 | 8/2/2011 | Ash-Free Dry Mass | 13.88 | g/m2 |
| MDEQ_WQ_WQX | Ashby Creek East Fork | C03ASEFC01 | 46.82341 | -113.59688 | 9/6/2011 | Ash-Free Dry Mass | 9.11 | g/m2 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 46.8243 | -113.59800 | 8/1/2011 | Chlorophyll *a*, corrected for pheophytin | 2.44 | mg/m2 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 46.8243 | -113.59800 | 9/7/2011 | Chlorophyll *a*, corrected for pheophytin | 3.48 | mg/m2 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 46.8243 | -113.59800 | 8/10/2012 | Chlorophyll *a*, corrected for pheophytin | 18 | mg/m2 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 46.8243 | -113.59800 | 8/1/2011 | Ash-Free Dry Mass | 3.28 | g/m2 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 46.8243 | -113.59800 | 9/7/2011 | Ash-Free Dry Mass | 2.46 | g/m2 |
| MDEQ_WQ_WQX | Ashby Creek West Fork | C03ASWFC02 | 46.8243 | -113.59800 | 8/10/2012 | Ash-Free Dry Mass | 4.63 | g/m2 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC10 | 46.88197 | -113.58898 | 8/5/2011 | Chlorophyll *a*, corrected for pheophytin | 16.87 | mg/m2 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 46.8759 | -113.58010 | 8/5/2011 | Chlorophyll *a*, corrected for pheophytin | 20.85 | mg/m2 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 46.8759 | -113.58010 | 9/8/2011 | Chlorophyll *a*, corrected for pheophytin | 44.12 | mg/m2 |
| MTWTRSHD_WQX | Camas Creek | CMSW-1 | 46.878131 | -113.58018 | 8/23/2009 | Chlorophyll *a*, corrected for pheophytin | 42.01 | mg/m2 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC10 | 46.88197 | -113.58898 | 8/5/2011 | Ash-Free Dry Mass | 150.68 | g/m2 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 46.8759 | -113.58010 | 8/5/2011 | Ash-Free Dry Mass | 9.17 | g/m2 |
| MDEQ_WQ_WQX | Camas Creek | C03CMASC01 | 46.8759 | -113.58010 | 9/8/2011 | Ash-Free Dry Mass | 26.03 | g/m2 |
| MTWTRSHD_WQX | Camas Creek | CMSW-1 | 46.878131 | -113.58018 | 8/23/2009 | Ash-Free Dry Mass | 66.3 | g/m2 |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 46.82023 | -113.29061 | 8/7/2011 | Chlorophyll *a*, corrected for pheophytin | 5.15 | mg/m2 |

**Table D-2. Recent Algal Measure Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Latitude | Longitude | Collection Date | Algal Measure | Result Value | Result Unit |
|---|---|---|---|---|---|---|---|---|
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 46.82023 | -113.29061 | 9/9/2011 | Chlorophyll *a*, corrected for pheophytin | 2.37 | mg/m2 |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 46.82023 | -113.29061 | 8/7/2011 | Ash-Free Dry Mass | 112.83 | g/m2 |
| MDEQ_WQ_WQX | Day Gulch | C03DAYG01 | 46.82023 | -113.29061 | 9/9/2011 | Ash-Free Dry Mass | 3.06 | g/m2 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 46.8366 | -113.31360 | 8/7/2011 | Chlorophyll *a*, corrected for pheophytin | 38.14 | mg/m2 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 46.8366 | -113.31360 | 9/10/2011 | Chlorophyll *a*, corrected for pheophytin | 55.54 | mg/m2 |
| MTWTRSHD_WQX | Elk Creek | ECSW-1 | 46.926805 | -113.43901 | 8/20/2009 | Chlorophyll *a*, corrected for pheophytin | 6.87 | mg/m2 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 46.8366 | -113.31360 | 8/11/2012 | Chlorophyll *a*, corrected for pheophytin | 188.70 | mg/m2 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 46.8366 | -113.31360 | 8/7/2011 | Ash-Free Dry Mass | 56.76 | g/m2 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 46.8366 | -113.31360 | 9/10/2011 | Ash-Free Dry Mass | 19.41 | g/m2 |
| MDEQ_WQ_WQX | Elk Creek | C03ELKC04 | 46.8366 | -113.31360 | 8/11/2012 | Ash-Free Dry Mass | 87.45 | g/m2 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC04 | 46.8597 | -113.49990 | 8/4/2011 | Chlorophyll *a*, corrected for pheophytin | 8.12 | mg/m2 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC03 | 46.8865 | -113.57170 | 8/3/2011 | Chlorophyll *a*, corrected for pheophytin | 22.99 | mg/m2 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC03 | 46.8865 | -113.57170 | 9/10/2011 | Chlorophyll *a*, corrected for pheophytin | 25.47 | mg/m2 |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 46.857851 | -113.49674 | 8/23/2009 | Chlorophyll *a*, corrected for pheophytin | 35.75 | mg/m2 |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-6 | 46.88604 | -113.57264 | 8/22/2009 | Chlorophyll *a*, corrected for pheophytin | 36.99 | mg/m2 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC04 | 46.8597 | -113.49990 | 8/4/2011 | Ash-Free Dry Mass | 47.29 | g/m2 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC03 | 46.8865 | -113.57170 | 8/3/2011 | Ash-Free Dry Mass | 68.85 | g/m2 |
| MDEQ_WQ_WQX | Union Creek | C03UNONC03 | 46.8865 | -113.57170 | 9/10/2011 | Ash-Free Dry Mass | 14.26 | g/m2 |
| MTWTRSHD_WQX | Union Creek | UNSW-3 | 46.857851 | -113.49674 | 8/23/2009 | Ash-Free Dry Mass | 33 | g/m2 |
| MTWTRSHD_WQX | Union Creek | LBF-UNSW-6 | 46.88604 | -113.57264 | 8/22/2009 | Ash-Free Dry Mass | 27.80 | g/m2 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 46.8287 | -113.39790 | 8/6/2011 | Chlorophyll *a*, corrected for pheophytin | 17 | mg/m2 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 46.8287 | -113.39790 | 9/8/2011 | Chlorophyll *a*, corrected for pheophytin | 4.06 | mg/m2 |

**Table D-2. Recent Algal Measure Data for the Lower Blackfoot TPA**

| Org ID | Waterbody Name | Site ID | Latitude | Longitude | Collection Date | Algal Measure | Result Value | Result Unit |
|---|---|---|---|---|---|---|---|---|
| MTWTRSHD_WQX | Washoe Creek | WSSW-1 | 46.858896 | -113.49415 | 8/23/2009 | Chlorophyll *a*, corrected for pheophytin | 9.88 | mg/m2 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 46.8287 | -113.39790 | 8/6/2011 | Ash-Free Dry Mass | 60.38 | g/m2 |
| MDEQ_WQ_WQX | Washoe Creek | C03WASOC03 | 46.8287 | -113.39790 | 9/8/2011 | Ash-Free Dry Mass | 3.87 | g/m2 |
| MTWTRSHD_WQX | Washoe Creek | WSSW-1 | 46.858896 | -113.49415 | 8/23/2009 | Ash-Free Dry Mass | 13 | g/m2 |

**Table D-3. Recent macroinvertebrate data for the Lower Blackfoot TPA**

| Site ID | Waterbody Name | Latitude | Longitude | Collection Date | HBI |
|---|---|---|---|---|---|
| C03ASEFC01 | Ashby Creek East Fork | 46.82190 | -113.60166 | 8/11/2004 | 3.20 |
| C03ASEFC01 | Ashby Creek East Fork | 46.82190 | -113.60166 | 8/2/2011 | 3.02 |
| C03ASEFC03 | Ashby Creek East Fork | 46.80201 | -113.57493 | 8/3/2011 | 3.68 |
| C03ASEFC01 | Ashby Creek East Fork | 46.82190 | -113.60166 | 9/6/2011 | 2.91 |
| C03ASWFC01 | Ashby Creek West Fork | 46.85164 | -113.09771 | 8/11/2004 | 2.03 |
| C03ASWFC02 | Ashby Creek West Fork | 46.82468 | -113.59780 | 8/1/2011 | 3.29 |
| C03ASWFC02 | Ashby Creek West Fork | 46.82468 | -113.59780 | 9/7/2011 | 3.07 |
| C03CMASC10 | Camas Creek | 46.88197 | -113.58898 | 8/18/2004 | 6.02 |
| C03CMASC10 | Camas Creek | 46.88197 | -113.58898 | 8/5/2011 | 5.11 |
| C03CMASC01 | Camas Creek | 46.87681 | -113.57843 | 9/8/2011 | 4.39 |
| C03CMASC01 | Camas Creek | 46.87681 | -113.57843 | 8/5/2011 | 4.92 |
| C03DAYG02 | Day Gulch | 46.81963 | -113.29183 | 9/21/2006 | 4.86 |
| C03DAYG01 | Day Gulch | 46.82045 | -113.28960 | 8/7/2011 | 5.58 |
| C03DAYG01 | Day Gulch | 46.82045 | -113.28960 | 9/9/2011 | 4.12 |
| C03ELKC04 | Elk Creek | 46.83634 | -113.31414 | 8/7/2011 | 3.81 |
| C03ELKC04 | Elk Creek | 46.83634 | -113.31414 | 9/10/2011 | 3.33 |
| C03UNONC03 | Union Creek | 46.88680 | -113.57156 | 9/10/2011 | 5.48 |
| C03UNONC03 | Union Creek | 46.88680 | -113.57156 | 8/3/2011 | 4.90 |
| C03UNONC04 | Union Creek | 46.85954 | -113.50082 | 8/4/2011 | 5.30 |
| C03WASOC03 | Washoe Creek | 46.82890 | -113.39818 | 9/8/2011 | 2.72 |
| C03WASOC01 | Washoe Creek | 46.85909 | -113.48562 | 8/13/2004 | 2.00 |
| C03WASOC02 | Washoe Creek | 46.77601 | -114.73550 | 8/12/2004 | 4.42 |

**Table D-4. Groundwater chemistry data for the Lower Blackfoot TPA**

| Sample ID | QWIC ID | Watershed | Latitude | Longitude | County | Type | NO3 as N | OPO4 as P |
|---|---|---|---|---|---|---|---|---|
| 1999Q0109 | 67843 | Camas Creek | 46.88073 | -113.57832 | MISSOULA | WELL | 1.29 P | |
| 2008Q0002 | 67843 | Camas Creek | 46.88073 | -113.57832 | MISSOULA | WELL | 0.724 P | <0.05 |
| 1996Q0202 | 150113 | East Fork Ashby Creek | 46.81174 | -113.58944 | MISSOULA | STREAM | <.05 | <.1 |
| 1996Q0020 | 149534 | Elk Creek | 46.82330 | -113.32910 | GRANITE | MINE DRAINAGE | 0 | <.1 |
| 1996Q0028 | 149541 | Elk Creek | 46.82130 | -113.32750 | GRANITE | MINE DRAINAGE | 0 | <.1 |
| 1993Q0399 | 132637 | Elk Creek | 46.82472 | -113.30234 | GRANITE | POND | 0.023 | <0.05 |
| 1996Q0029 | 149542 | Elk Creek | 46.82330 | -113.32880 | GRANITE | MINE DRAINAGE | 0 | <.1 |
| 1996Q0034 | 149547 | Elk Creek | 46.82110 | -113.32750 | GRANITE | MINE DRAINAGE | 0.05 | <.1 |
| 1996Q0033 | 149546 | Elk Creek | 46.81550 | -113.31860 | GRANITE | MINE DRAINAGE | 0.05 | <.1 |
| 200259 | 169695 | Union Creek | 46.89611 | -113.65653 | MISSOULA | WELL | <0.05 U | <0.10 U |
| 1999Q0351 | 67827 | Union Creek | 46.89920 | -113.65300 | MISSOULA | WELL | .75 P | <1.0 |
| 2009Q5087 | 187512 | Union Creek | 46.84806 | -113.49625 | MISSOULA | WELL | 0.279 | |
| 1999Q0103 | 67829 | Union Creek | 46.89920 | -113.65300 | MISSOULA | WELL | <.25 P | <.05 |
| 1996Q0027 | 149540 | Washoe Creek | 46.83720 | -113.40520 | MISSOULA | MINE DRAINAGE | <.05 | <.1 |
| 1996Q0025 | 149538 | Washoe Creek | 46.83880 | -113.40750 | MISSOULA | STREAM | <.05 | <.1 |

# APPENDIX E – NITROGEN AND PHOSPHOROUS MIGRATION AND ATTENUATION ASSESSMENT FROM SUBSURFACE WASTEWATER TREATMENT SYSTEMS

## INTRODUCTION

This document presents a summary of the factors affecting migration and attenuation of nitrogen and phosphorus after disposal from subsurface wastewater treatment systems (i.e., septic systems). This summary is used to support methods proposed for determining nitrogen and phosphorus reduction as these nutrients migrate towards surface waters.

The methods described in the document should not be used to determine nutrient attenuation on a small scale (e.g. single development/municipality discharge) due to the potentially wide variation in nutrient attenuation between sources in similar settings. These methods are designed for use on a larger basin-wide scale that effectively allows averaging of the processes that occur in the subsurface.

While the processes of nutrient attenuation described in this document are well documented, the attenuation percentages proposed are estimates. Where possible, the results of the methods described should be verified with site-specific data.

## NITROGEN

Nitrogen in partially treated domestic wastewater (in the septic tank) is primarily in the form of ammonia. Disposal of wastewater in a properly constructed and sized drainfield will typically provide sufficient oxygen and naturally occurring bacteria to convert the ammonia to nitrite and then quickly to nitrate. Studies and regulations commonly assume that most or all the nitrogen is converted to nitrate after proper septic tank and drainfield (conventional) treatment quaq (Idaho Department of Environmental Quality, 2002; Montana Department of Environmental Quality, 2009; National Decentralized Water Resources Capacity Development Project, 2005; Heatwole and McCray, 2006; Morgan et al., 2007; Toor et al., 2011). Unless an advanced wastewater system is used (referred to as a level 2 system in Montana), conventional treatment removes between 10 and 30 percent of the nitrogen in the wastewater (Costa et al., 2002; Gold and Sims, 2000; Laak, 1981; Lowe et al., 2007; Pell and Nyberg, 1989; Rosen et al., 2006; Seabloom et al., 2004). That treatment level is accounted for in the nitrogen concentration (50 mg/L) that Montana estimates is discharged from the typical septic system serving a single-family home. Septic systems are not designed to complete the final step of the nitrogen cycle, conversion of nitrate to nitrogen gas (denitrification), which then dissipates into the atmosphere and does not have any further impacts to groundwater or surface water. Denitrification generally occurs after drainfield treatment, and is difficult to predict.

In Montana, the estimated nitrate loading rate for a single-family home septic system is based on an average concentration of 50 mg/L and an average effluent rate of 200 gallons per day (Montana Department of Environmental Quality, 2009). Those concentration and effluent rates are within the range of published values (Environmental Research Laboratory-Duluth, 2002). Those values provide a nitrogen loading rate of 30.5 lbs/year for a conventional wastewater system. For comparison purposes, the nitrogen loading rate for a level 2 system is 14.6 lbs/year.

Denitrification requires the correct environment to occur; the key factors are adequate temperature (typically above 10 $^{o}$C), a food source for the bacteria (typically carbon), an anoxic environment (generally an oxygen range of less than 1-2 mg/L), and the correct bacteria. A riparian zone with shallow groundwater is the most common environment that has those conditions (Gilliam, 1994; Gold and Sims, 2000; Harden and Spruill, 2008; McDowell et al., 2005; Rosenblatt et al., 2001). A carbon source is cited as the most common limiting factor for denitrification (Gold and Sims, 2000; Rivett et al., 2008; Kobus and Kinzelbach, 1989). Studies have identified “micro-sites” of low oxygen in shallow groundwaters, which are typically assumed to be rich in oxygen, to provide the necessary anoxic environment (Gold and Sims, 2000; Jacinthe et al., 1998; Parkin, 1987). The required bacteria are generally ubiquitous in the environment, and will naturally thrive when the conditions are correct and there is a nitrogen source. However, it should be noted that the U.S. Environmental Protection Agency (EPA) Environmental Research Laboratory (2002) stated that “Denitrification has been found to be significant in the saturated zone only in rare instances where carbon or sulfur deposits are present”. This conclusion is contrary to the numerous studies that have found high denitrification rates in common environments; the same EPA document recognizes some of those studies.

Because fine-grained soils are more likely to contain two of the conditions necessary for denitrification, anoxic conditions and carbon, fine-grained soils typically provide better conditions for denitrification than coarse-grained soils (Briar and Dutton, 2000; Mueller et al., 1995; Tesoriero and Voss, 1997; Umari et al., 1995). Anderson (1998) used results from several studies to show a correlation (r=0.91) between denitrification rates and soil organic content. One study (Ricker et al., 1994) estimated the amount of denitrification beneath drainfields as 15% for sandy soils and 25% for finer soils.

Denitrification rates are site-specific and the rates can vary considerably in similar environments (Robertson et al., 1991; Starr and Gillham, 1989). Some studies have provided measurable chemical characteristics to determine where denitrification is more likely to occur (Minnesota Pollution Control Agency, 1999; Trojan et al., 2002), but the studies typically only provide relative denitrification rates (e.g. high or low). However, several studies (National Decentralized Water Resources Capacity Development Project, 2005; Kirkland, 2001; McCray et al., 2005), have published a specific denitrification rate based on the median of cumulative frequency distributions of field measured denitrification rates (0.025 day-1). At that rate, it takes over 10 years to denitrify all of the nitrate from a source. At typical groundwater velocity rates of 0.1 to 10 ft/day wastewater could travel between 400 and 40,000 feet in that time. Using a single denitrification rate for all situations may be unrealistic as one study indicated it would take a denitrification rate that ranges over 3 orders of magnitude to provide a 95% confidence interval (Heatwole and McCray, 2006). McCray et al. (2005) could not correlate soil type to denitrification rate due to variability in the existing data; therefore the median denitrification rate was not used for the proposed method of estimating nitrate reduction.

Another factor that has been correlated with denitrification is travel time in the environment: the longer the nitrate is in the environment the more time it has to encounter the correct conditions for denitrification (Kroeger et al., 2006). Distance is used in the proposed methods instead of travel time because it is easier to measure distances than groundwater travel time which requires three parameters that are difficult and/or expensive to measure for large areas: hydraulic gradient, hydraulic conductivity and effective porosity.

Based on the existing information, the following method has been developed to estimate the nitrogen reduction as wastewater migrates from a drainfield to a receiving surface. This method uses a matrix (see **Table E-1**) combining three factors that impact the amount of denitrification: soil type beneath the drainfield; soil type in the riparian area; and distance to surface water. In **Table E-1**, each drainfield is assigned a percent nitrate reduction for each of the three criteria. The percent reductions for each column are then added to provide the total percent nitrate removal for that septic system. The nitrate loading rate (30.5 lbs/year for a conventional system) to the surface water is then reduced accordingly. Any system with a 100% or higher reduction contributes no nitrate to the surface water.

This method assumes steady-state conditions; it does not account for the time needed for the nitrogen load from a new discharge source to migrate towards the receiving surface water. That lag time is dependent on the travel rate through both the vadose and saturated zones.

This method (and the phosphorus method described below) does not account for failing septic systems because the number of hydraulically failing systems where wastewater is flowing at the surface (and likely to bypass natural treatment in soils) is typically a small percentage of the total number of septic systems on a basin wide scale and is not a significant nutrient load for total maximum daily load purposes. A surfacing, failing system is also likely to be repaired quickly, further minimizing any impacts to surface waters. However, there may be site-specific situations where failing septic systems are a significant source and need to be accounted for using a different method.

**Table E-1. Nitrogen Attenuation Factors for Septic System Discharges to Groundwater**

| Percent Nitrogen Load Reduction[1] | Soil Type @ Drainfield[2] | Soil Type within 100' of surface water[2] | Distance to surface water (ft) |
|---|---|---|---|
| 0 | A | A | 0 – 100 |
| 10 | B | | 101 – 500 |
| 20 | C | B | 501 – 5,000 |
| 30 | D | C | 5,001 – 20,000 |
| 50 | | D | 20,001+ |

**Notes:**

[1] The total nitrogen reduction is the sum of the individual reductions for each column of the table. For example a drainfield that is in a type C soil (20%) that drains to a surface water with type B soil (20%) and is 200 feet from the surface water (10%) would reduce their nitrogen load to the surface water by 50% from what is discharged from the drainfield.

[2] Soil descriptions are available via the Natural Resources Conservation Service (NRCS) web soil survey at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm Once the area of interest has been defined information is accessed by clicking on following links: “Soil Data Explorer” – “Soil Properties and Qualities” -- “Soil Qualities and Features” – “Drainage Class”. The NRCS soil survey has seven soil drainage classes that are correlated to the A, B, C and D designation in the table as follows:

A = excessively drained or somewhat excessively drained
B = well drained or moderately well drained
C = somewhat poorly drained
D = poorly drained or very poorly drained

Within the defined area of interest, the soil survey application provides the percent of soil types with these attributes. That feature provides a quick way to determine the percent of each soil type and therefore the percent reduction for each area of interest defined.

## PHOSPHORUS

Phosphorus, which has much lower mobility than nitrogen, is removed in soils below drainfields by two primary processes, adsorption and precipitation. Precipitation is a slower process compared to adsorption but may be the more important process for retarding the migration of phosphorus. Soils may have a limited amount of adsorption capacity which could allow migration of phosphorus after reaching equilibrium (Gold and Sims, 2000). However, precipitation reactions may occur indefinitely with the correct conditions thereby limiting phosphorus migration indefinitely (Lombardo, 2006; Robertson et al., 1998). Lombardo (2006) estimated that phosphorus travel times to nearby surface waters could range from tens of years to hundreds of years depending on the types of soils between the source and waterbody. The vadose zone is considered the primary location for phosphorus retardation, once it reaches groundwater phosphorus migration is generally faster than in the vadose zone.

In Montana, the estimated phosphorus loading rate for a single-family home septic system is based on an average concentration of 10.6 mg/L and an average effluent rate of 200 gallons per day (Montana Department of Environmental Quality, 2009). Those concentration and effluent rates are within the range of published values (EPA Environmental Research Laboratory 2002). Those values provide a loading rate of 6.44 lbs/year for a conventional wastewater system.

Non-calcareous soils retard the movement of phosphorus more than calcareous soils due to the calcareous soils ability to maintain pH levels where phosphorus precipitation does not readily occur (Lombardo, 2006; Robertson et al., 1998). Typically, non-calcareous soils are derived from igneous or metamorphic parent rocks. Lombardo (2006) defined calcareous soils as those containing more than 15% calcium carbonate and non-calcareous soils as those containing less than 1% calcium carbonate.

Finer-grained soils also tend to retard phosphorus migration more than coarser soils due primarily to their greater surface area that provides more locations for adsorption.

Easily measurable wastewater phosphorus plumes extend a relatively short distance from the source, creating high concentrations of phosphorus in soils immediately below drainfields with low levels beyond that location (Gold and Sims, 2000; Lombardo, 2006; Makepeace and Mladenich, 1996; Reneau et al., 1989; Robertson et al., 1998). This indicates that a significant portion of the phosphorus is quickly bound up shortly after being discharged. However, in many cases low level phosphorus detection limits are not used in groundwater analyses, and the existence of long, low concentration phosphorus plumes may have been overlooked (Houston, 2001).

Due to the small amount of phosphorus that migrates significant distances, some methods assume that only failing systems contribute phosphorus to surface water. For example, the MANAGE (Measured Annual Nutrient Loads from Agricultural Environments) nutrient migration model (Kellogg et al., 2006) only accounts for phosphorus discharges from failing drainfields. Other information (National Decentralized Water Resources Capacity Development Project, 2005; Gold and Sims, 2000; McDowell et al., 2005) also implicates failing or improperly sited drainfields (e.g., drainfields located over shallow groundwater, in coarse soils, or too close to surface water) as a greater threat to surface water than properly constructed and sited systems.

Lombardo (2006) suggested that phosphorus migration to surface waters is only a problem in areas with high groundwater tables and higher groundwater velocities (the report provided a lower end for the high velocities of approximately 0.2 to 3 ft/day). Below those velocities soils typically contain higher amounts of clay and/or silt, thus increasing the soils adsorption capacity.

Except for failing or poorly sited septic systems, existing evidence indicates that only small amounts of phosphorus migrate to surface waters, but that in some cases even small amounts can have noticeable impacts to surface water quality. To be consistent with existing information on phosphorus migration the proposed method to estimate phosphorus reduction was designed to estimate relatively high percentages of phosphorus removal.

Based on the existing information, the following method has been developed to estimate the phosphorus reduction as wastewater migrates from a drainfield to a receiving surface. This method uses (**Table E-2**) a matrix, similar to the one used for nitrogen , combining three factors that impact the amount of phosphorus reduction: soil type beneath the drainfield; calcium carbonate percent in the soil beneath the drainfield; and distance to surface water. In **Table E-2**, each drainfield is assigned a percent phosphorus reduction for only one of the three soil type columns (which combines the soil and calcium carbonate type), and then an additional percent phosphorus reduction for the last column (distance to surface water). The percent reductions for each column are then added to provide the total percent phosphorus removal for that septic system. The phosphorus loading rate (6.44 lbs/year for a conventional or level 2 system) to the surface water is then reduced accordingly. Any system with a 100% or higher reduction contributes no phosphorus to the surface water.

This method assumes steady-state conditions; it does not account for the time needed for the phosphorus load from a new discharge source to migrate towards the receiving surface water. That lag time is dependent on the travel rate through both the vadose and saturated zones.

**Table E-2. Phosphorus Attenuation Factors for Septic System Discharges to Groundwater**

| Percent Phosphorus Load Reduction(1) | Soil Type @ Drainfield(2, 3) (CaCO3 <= 1%) | Soil Type @ Drainfield(2, 3) (CaCO3 >1% and <15%) | Soil Type @ Drainfield(2, 3) (CaCO3 >=15%) | Distance to surface water (ft) |
|---|---|---|---|---|
| 0 | A | A | A | 0 – 100 |
| 10 | | | B | |
| 20 | | B | C | |
| 30 | B | | D | 101 - 500 |
| 40 | | C | | |
| 60 | C | D | | 501 - 5,000 |
| 90 | D | | | |
| 100 | | | | 5,001 + |

**Notes:**

(1) The total phosphorus reduction is the sum of the individual reductions for the soil type (only use one of the three soil columns) and the distance to surface water. For example a drainfield that is in a type B soil with less than 1% CaCO3 (30%) and is 200 feet from the surface water (30%) would reduce their nitrogen load to the surface water by 60% from what is discharged from the drainfield.

(2) Soil descriptions are available via the NRCS web soil survey at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm Once the area of interest has been defined information is accessed by clicking on following links: “Soil Data Explorer” – “Soil Properties and Qualities” -- “Soil Qualities and Features” – “Drainage Class”. The NRCS soil survey has seven soil drainage classes that are correlated to the A, B, C and D designation in the table as follows:

A = excessively drained or somewhat excessively drained
B = well drained or moderately well drained
C = somewhat poorly drained
D = poorly drained or very poorly drained

Within the defined area of interest, the soil survey application provides the percent of soil types with these attributes. That feature provides a quick way to determine the percent of each soil type and therefore the percent reduction for each area of interest defined.

(3) CaCO3 percent is available via the NRCS web soil survey at: http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm Once the area of interest has been defined

information is accessed by clicking on following links: "Soil Data Explorer" – "Soil Properties and Qualities" -- "Soil Chemical Properties" – "Calcium Carbonate (CaCO3)". Within the defined area of interest, the soil survey application provides the percent of land with the percent of CaCO3. That feature provides a quick way to determine the percent of area of different CaCO3 percentages and therefore the percent reduction for each area of interest defined.

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