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The Missouri-Cascade and Belt TMDL Planning Area Metals Total Maximum Daily Loads and Framework Water Quality Improvement Plan

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Montana Department of
Environmental Quality

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EXECUTIVE SUMMARY

This document presents a Total Maximum Daily Load (TMDL) and framework water quality restoration plan for metals-impaired streams in the Belt and Missouri-Cascade TMDL Planning Areas (TPAs). This plan was developed by the Montana Department of Environmental Quality (DEQ) and submitted to the U.S. Environmental Protection Agency (U.S. 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. The goal of TMDLs is to eventually attain and maintain water quality standards in all of Montana's streams and lakes, and to improve water quality to levels that support all state-designated beneficial water uses.

The scope of the TMDLs in this document address metals-related problems on nine metals-impaired waterbody segment streams (See **Table 1-1**). The document provides an evaluation of existing water quality data, assesses pollutant sources contributing to impairment conditions and estimates pollutant loading reductions and allocations that will result in attainment of water quality standards for metals. Below is a brief synopsis of metals-related water quality issues addressed by the Plan.

Metals

Metals-related impacts were identified as a cause of impairment on several streams in the Belt and Missouri-Cascade TMDL Planning Areas. Metals sources contributing to water quality impairment are primarily derived from abandoned mining activity. Within the Upper Belt Creek watershed, the Barker-Hughesville and Carpenter-Snow Creek National Priorities List (NPL) sites are the major contributors to water quality impairment on upper Belt Creek, Carpenter Creek, Galena Creek and Dry Fork Belt Creek. Sources include tailings and waste rock piles, discharging adits, and other various mine wastes associated with hard-rock mining over the past century and a half. Assessment and clean-up planning on these waterbodies have just begun and is being coordinated through the Montana DEQ and EPA's Superfund programs.

On lower Belt Creek and for streams in the Sand Coulee Creek (Missouri-Cascade TPA) watershed, water quality impairments are primarily the result of historic abandoned coal mining operations near the towns of Belt, Stockett and the community of Sand Coulee. Acid-mine discharge (AMD) from several seeps and discharging adits severely impacts waterbodies in these areas during periods of low-flow. To date, mitigating acid-mine discharges to local waterbodies from these sources has had limited success; however efforts to control source water may prove more effective than past remedial efforts.

It is recognized that a flexible and adaptive approach to most TMDL implementation and mitigation activities may become necessary as additional information is gained through continued monitoring, assessment and restoration activities.

SECTION 1.0 INTRODUCTION

1.1 Background

This document, Missouri-Cascade and Belt TMDL Planning Area Metals TMDLs & Framework Water Quality Improvement Plan, describes the Montana Department of Environmental Quality's (DEQ) understanding of metals-related water quality problems for pollutant-impaired streams in the Missouri-Cascade and Belt TMDL Planning Areas and presents a general framework for resolving them. Guidance for completing the plan is contained in the Montana Water Quality Act and the federal Clean Water Act.

In 1972 Congress passed the Water Pollution Control Act, more commonly known as the Clean Water Act. Its goal is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The Clean Water Act requires each state to set water quality standards to protect designated beneficial water uses and to monitor the attainment of those uses. Fish and aquatic life, wildlife, recreation, agriculture, industrial, and drinking water are all types of beneficial uses. Streams and lakes (also referred to as waterbodies) that do not meet the established standards are called "impaired waters." These waters are identified on the 303(d) List, named after Section 303(d) of the Clean Water Act, which mandates the monitoring, assessment, and listing of water quality limited waterbodies. The 303(d) List is contained within a biennial integrated water quality report. (See **Table 1-1** for a list of waters identified on the 2008 303(d) List as having impairments in the Missouri-Cascade and Belt TMDL Planning Areas, their impaired uses and probable impairment causes.)

Both Montana state law (75 MCA § 5-703) and section 303(d) of the federal Clean Water Act require the development of total maximum daily loads (TMDLs) for impaired waters where a measurable pollutant (e.g., metals, nutrients, e. coli) is the cause of the impairment. A TMDL is a loading capacity and refers to the maximum amount of a pollutant a stream or lake can receive and still meet water quality standards.

The development of TMDLs and water quality improvement strategies in Montana includes several steps that must be completed for each impaired waterbody and for each contributing pollutant (or "pollutant/waterbody combination"). These steps include:

- Characterizing the existing waterbody conditions and comparing these conditions to water quality standards. Measurable targets are defined as numeric values and set to help evaluate the stream's condition in relation to the standards.
- Quantifying the magnitude of pollutant contribution from sources.
- Establishing allowable loading limits (or total maximum daily loads) for each pollutant
- Comparing the current pollutant load to the loading capacity (or maximum loading limit/TMDL) of the particular waterbody.
- Determining the allowable loads or the necessary load reduction for each source (called "pollutant allocations").

Framework restoration strategies and recommendations are also incorporated to help facilitate TMDL implementation.

In some cases the TMDLs may not be capable of fully restoring the designated beneficial uses without the addition of other restoration measures. For example, impairment causes such as streamflow alterations or dewatering, habitat degradation, and streambank or stream channel alterations may prevent a waterbody from fully attaining its beneficial uses even after TMDLs have been implemented. These are referred to as “pollution” problems, as opposed to impairments caused by any type of discrete “pollutant,” such as sediment or metals. TMDLs, per se, are not intended to address water use support problems that are not directly associated with specific pollutants. However, many water quality restoration plans describe strategies that consider and address habitat, streamflow, and other conditions that may impair beneficial uses, in addition to problems caused by more conventional water pollutants. The desired goal of any well designed water quality improvement strategy is to enable restoration of impaired waters such that they support all designated beneficial uses and achieve and maintain full water quality standards by using comprehensive restoration approaches.

1.2 303(d) List Summary and TMDLs Written

Per federal court order, by 2012 DEQ must address all pollutant/waterbody combinations appearing on the 2008 303(d) List and which were also identified on the 1996 303(d) List. Eleven stream segments on the 2008 303(d) List were listed as impaired in the Missouri-Cascade and Belt TMDL Planning Areas (**Table 1-1)**. Waterbodies can become impaired from pollution (e.g., flow alterations and habitat degradation) and from pollutants (e.g., metals, sediment, e. coli). However, because only pollutants are associated with a load, the EPA restricts TMDL development to pollutants.

Pollutant categories and impairment causes specific to metals-related pollutants are highlighted in **Table 1-1** and are addressed within this document (see **Section 5.0**). Based on the 2008 303(d) List and a review of existing data for streams of the Missouri-Cascade and Belt TMDL Planning Areas, TMDLs were written for several metals for a variety of waterbodies identified to be exceeding water quality metals targets. **Table 1-2** provides a list of waterbodies and pollutants for which TMDLs are prepared.

1.3 Document Description

The document addresses all of the required components of a TMDL and includes an implementation and monitoring strategy as well as a description of the public involvement process. The main body of the document provides a summary of the TMDL components. Additional technical details are found in the Appendices. The document is organized as follows:

- Watershed Characterization: **Section 2.0**
- Montana Water Quality Standards: **Section 3.0**
- Description of TMDL Components: **Section 4.0**
- Metals – Comparison of Existing Data to Water Quality Targets, Sources and Loads, and TMDLs and Allocations: **Section 5.0**

- Framework Water Quality Restoration and Monitoring Strategy: **Section 6.0**
- Stakeholder and Public Involvement: **Section 7.0**

Table 1-1. 2008 303(d) Listed Waterbodies, Impairment Causes, and Impaired Beneficial Uses in the Missouri-Cascade and Belt TMDL Planning Areas.

Waterbody	Waterbody Segment ID	Impairment Cause	Pollutant Category	Impaired Uses
Belt Creek, upper	MT41U001_011	**Arsenic** **Chromium (total)** **Copper** **Lead** **Zinc**	**Metals**	Agricultural Aquatic Life Cold Water Fishery Drinking Water
		Salinity	**Metals**	Agricultural Drinking Water Industrial
		Sedimentation/Siltation	Sediment	Aquatic Life Cold Water Fishery
		Alteration in stream-side or littoral vegetative covers	NA	Aquatic Life Cold Water Fishery
Belt Creek, lower	MT41U001_012	**Arsenic** **Chromium (total)** **Copper** **Lead** **Zinc**	**Metals**	Agricultural Aquatic Life Cold Water Fishery Drinking Water Primary Contact Recreation
		Salinity	**Metals**	Agricultural Aquatic Life Cold Water Fishery Drinking Water Industrial
		Sedimentation/Siltation	Sediment	Aquatic Life Cold Water Fishery
		Alteration in stream-side or littoral vegetative covers Other anthropogenic substrate alterations	NA	Aquatic Life Cold Water Fishery
Carpenter Creek	MT41U002_010	**Cadmium** **Copper** **Lead** **Mercury**	**Metals**	Aquatic Life Cold Water Fishery Drinking Water

Table 1-1. 2008 303(d) Listed Waterbodies, Impairment Causes, and Impaired Beneficial Uses in the Missouri-Cascade and Belt TMDL Planning Areas.

Waterbody	Waterbody Segment ID	Impairment Cause	Pollutant Category	Impaired Uses
Galena Creek	MT41U002_020	**Antimony** **Arsenic** **Cadmium** **Copper** **Lead** **Zinc**	**Metals**	Agricultural Aquatic Life Cold Water Fishery Drinking Water Industrial Primary Contact Recreation
Dry Fork Belt Creek	MT41U002_030	**Cadmium** **Copper** **Lead** **Zinc**	**Metals**	Agricultural Aquatic Life Cold Water Fishery Drinking Water Primary Contact Recreation
		Sedimentation/Siltation	Sediment	Aquatic Life Cold Water Fishery
Little Belt Creek	MT41U002_040	Phosphorus (Total)	Nutrients	Primary Contact Recreation
		Total Kjehldahl Nitrogen (TKN)		Aquatic Life Cold Water Fishery Primary Contact Recreation
		Sedimentation/Siltation	Sediment	Aquatic Life Cold Water Fishery
		Chlorophyll-a	Nutrients	Aquatic Life Cold Water Fishery Primary Contact Recreation
		Alteration in stream-side or littoral vegetative covers	NA	Aquatic Life Cold Water Fishery
		Low flow alterations	NA	Aquatic Life Cold Water Fishery Primary Contact Recreation
Big Otter Creek	MT41U002_050	Nitrates	Nutrients	Aquatic Life Cold Water Fishery
		Sedimentation/Siltation	Sediment	
		Alteration in stream-side or littoral vegetative covers	NA	
		Physical substrate habitat alterations		

Table 1-1. 2008 303(d) Listed Waterbodies, Impairment Causes, and Impaired Beneficial Uses in the Missouri-Cascade and Belt TMDL Planning Areas.

Waterbody	Waterbody Segment ID	Impairment Cause	Pollutant Category	Impaired Uses
Cottonwood Creek	MT41Q002_020	**Cadmium**	**Metals**	Drinking Water
		Nickel		Aquatic Life Cold Water Fishery Drinking Water
		Zinc		
Number Five Coulee	MT41Q002_030	**Aluminum**	**Metals**	Aquatic Life Cold Water Fishery
		Cadmium		Drinking Water
		Lead		Drinking Water
		Nickel		Aquatic Life Cold Water Fishery Drinking Water
		Zinc		Aquatic Life Cold Water Fishery
Sand Coulee Creek	MT41Q002_040	**Lead**	**Metals**	Drinking Water
		Zinc		Aquatic Life Cold Water Fishery Drinking Water
		Salinity		Agricultural Industrial
Sand Coulee	MT41Q002_060	**Aluminum**	**Metals**	Aquatic Life Cold Water Fishery
		Cadmium		Drinking Water
		Nickel		Aquatic Life Cold Water Fishery Drinking Water
		Zinc		Aquatic Life Cold Water Fishery Drinking Water
		Salinity		Agricultural Industrial

* This document only addresses the pollutant categories in bold.

Table 1-2. Metals TMDL Summary: Missouri-Cascade and Belt TMDL Planning Areas

Waterbody	Waterbody Segment ID	Metal Impairment Causes (2008 303(d) List)	Metals TMDLs prepared
Belt Creek, upper	MT41U001_011	**Arsenic Chromium (total) Copper Lead Zinc Salinity**	**Arsenic Cadmium Copper Lead Zinc**
Belt Creek, lower	MT41U001_012	**Arsenic Chromium (total) Copper Lead Zinc Salinity**	**Arsenic Cadmium Iron Lead Zinc**
Carpenter Creek	MT41U002_010	**Cadmium Copper Lead Mercury**	**Arsenic Cadmium Copper Lead Iron Silver Zinc**
Galena Creek	MT41U002_020	**Antimony Arsenic Cadmium Copper Lead Zinc**	**Arsenic Cadmium Copper Lead Iron Zinc**

Table 1-2. Metals TMDL Summary: Missouri-Cascade and Belt TMDL Planning Areas

Waterbody	Waterbody Segment ID	Metal Impairment Causes (2008 303(d) List)	Metals TMDLs prepared
Dry Fork Belt Creek	MT41U002_030	**Cadmium Copper Lead Zinc**	**Arsenic Cadmium Copper Lead Iron Zinc**
Cottonwood Creek	MT41Q002_020	**Cadmium Nickel Zinc**	**Aluminum Cadmium Iron Nickel Zinc**
Number Five Coulee	MT41Q002_030	**Aluminum Cadmium Lead Nickel Zinc**	**Aluminum Cadmium Iron Nickel Zinc**
Sand Coulee Creek	MT41Q002_040	**Lead Zinc Salinity**	
Sand Coulee	MT41Q002_060	**Aluminum Cadmium Nickel Zinc Salinity**	**Aluminum Cadmium Copper Iron Nickel Zinc**

SECTION 2.0
WATERSHED DESCRIPTION

This section describes the physical, ecological, and cultural characteristics of the Missouri - Cascade and Belt watersheds (**Appendix A, Figure 2-1)**. The characterization establishes a context for impaired waters to support total maximum daily load (TMDL) planning. The areas described are referred to as the Missouri-Cascade & Belt TMDL Planning Areas (TPA). **Section 2.1** describes characteristics of the Missouri-Cascade TPA, while **Section 2.2** describes characteristics of the Belt TPA.

2.1 Missouri-Cascade Watershed Characterization

The Montana Department of Environmental Quality (DEQ) has identified four impaired waterbodies within the Missouri - Cascade TPA: Sand Coulee, Sand Coulee Creek, Number Five Coulee, and Cottonwood Creek. The impairment listings are detailed in DEQ's Integrated 305(b)/303(d) Water Quality Report (Montana Department of Environmental Quality, 2008a), and are shown on **Appendix A, Figure 2-2**. Impairment listings are summarized in **Table 1-1.**

2.1.1 Physical Characteristics

2.1.1.1 Location

The Missouri-Cascade TPA is within Cascade and Lewis and Clark Counties. The total extent is 612,095 acres, or approximately 956 square miles. The TPA is located in the Upper Missouri Basin (Accounting Unit 100301) of central Montana. The TPA includes the majority of the 10030102 fourth-code watershed (Upper Missouri – Dearborn Rivers).

The TPA spans three Level III Ecoregions: Middle Rockies (17), Northwestern Glaciated Plains (42), and Northwestern Great Plains (43). Eight Level IV Ecoregions are mapped within the TPA (Woods et al, 2002), as shown on **Appendix A, Figures 2-3a** and **2-3b**. These include: Eastern Divide Mountain (17aj), Big Snowy – Little Belt Carbonate Mountains (17q), Scattered Eastern Igneous-Core Mountains (17r), North Central Brown Glaciated Plains (42o), Foothill Grassland (42r), Judith Basin Grassland (43m), Unglaciated Montana High Plains (43o), and Limy Foothill Grassland (43u).

2.1.1.2 Topography

Elevations in the Missouri - Cascade TPA range from approximately 1,010 to 2,173 meters (3,314 – 7,130 feet) above mean sea level (**Appendix A, Figure 2-4**). The lowest point is the mouth of Sand Coulee. The highest point is Adel Mountain. The landscape is characterized by mountains, foothills and plains.

2.1.1.3 Geology

Appendix A, Figure 2-5 provides an overview of the geology, based on the 1:500,000 scale statewide map. The bedrock of the TPA includes Paleozoic and Mesozoic sedimentary rocks, and Tertiary igneous rocks. Paleozoic sedimentary rocks are exposed on the flanks and upper portions of the Little Belt Mountains. The plains and foothills of the Little Belt Mountains are dominated by Mesozoic sedimentary rocks, of which the Cretaceous section is the most extensive. Extensive coal deposits and seams are found in this section. Tertiary volcanic rocks form the Adel Mountains, and isolated igneous rocks also intruded the Little Belt Mountains.

2.1.1.4 Soils

The USGS Water Resources Division (Schwartz and Alexander, 1995) created a dataset of hydrology-relevant soil attributes, based on the USDA Natural Resources Conservation Service (NRCS) STATSGO soil database. The STATSGO data is intended for small-scale (watershed or larger) mapping, and is too general to be used at scales larger than 1:250,000. It is important to realize, therefore, that each soil unit in the STATSGO data may include up to 21 soil components. Soil analysis at a larger scale should use NRCS SSURGO data. The soil attributes considered in this characterization are erodibility and slope.

Soil erodibility is based on the Universal Soil Loss Equation (USLE) K-factor (Wischmeier and Smith, 1978). K-factor values range from 0 to 1, with a greater value corresponding to greater potential for erosion. Susceptibility to erosion is mapped on **Appendix A, Figure 2-6**, with soil units assigned to the following ranges: low (0.0-0.2), low-moderate (0.2-0.29) and moderate-high (0.3-0.4). Values of >0.4 are considered highly susceptible to erosion. No values greater than 0.37 are mapped in the TPA. The majority of the TPA (83%) is mapped with moderate-low susceptibility soils. Moderate-high susceptibility soils are mapped in 13% of the TPA. Low susceptibility soils are very limited (1%) in the TPA.

A map of slope is provided on **Appendix A, Figure 2-7**. This figure illustrates that the TPA is characterized by three landscapes: mountains, foothills and plains. The mountains are characterized by gently sloping ridgelines and peaks that are incised by steep-sided valleys.

2.1.1.5 Surface Water

The TPA includes the majority of the 10030102 fourth-code watershed (Upper Missouri – Dearborn Rivers). The National Hydrography Dataset (NHD) medium resolution data (Natural Resource Information System, 2003) includes 1,184 miles of streams mapped in the TPA. This data is compiled at 1:100,000. Missouri - Cascade watershed hydrography is illustrated on **Appendix A, Figure 2-8**.

Stream Gaging Stations

The United States Geological Survey (USGS) maintained seven gaging stations within the TPA (**Table 2-1**). Of these, three were on the Missouri River and the other four were within the Sand Coulee subwatershed. The gaging station at Ulm is the only currently active gage.

Table 2-1. USGS Stream Gages in the Missouri - Cascade / Sand Coulee TPA

Name	Number	Drainage Area (mi^2)	Agency	Period of Record
Number Five Coulee below Giffen Spring near Stockett	06078260	16.7	USGS	1994-1996
Cottonwood Creek near Stockett	06078250	--	USGS	1994-1996
Sand Coulee Creek above Cottonwood Creek at Centerville	06078230	78.8	USGS	1994-1996
Sand Coulee at Sand Coulee	06078270	6.36	USGS	1994-1996
Missouri River at Craig	06071500	17,739	USGS	1890-1892
Missouri River at Cascade	06074000	18,493	USGS	1902-1915
Missouri River near Ulm	06078200	20,941	USGS	1957 -

Stream Flow

Flow in the Missouri River is no relevant to the metals impairments in the Sand Coulee subwatershed, and are not discussed. Flow in Sand Coulee Creek and the other streams in the Sand Coulee subwatershed varies considerably over a year, and several losing reaches are generally dry by late summer. Peak flow in Sand Coulee Creek during the study was 30 cfs and typically occurs during April.

2.1.1.6 Groundwater

Hydrogeology

No studies of the overall TPA hydrogeology were identified. Regional groundwater flow is presumed to be from the Little Belt Mountains northward, with shallower local flow towards Missouri - Cascade / Sand Coulee and other streams.

The Mississippian rocks exposed in the mountains include the Mission Canyon Formation of the Madison Group, which constitutes an important regional aquifer (the Madison Aquifer). This thick sequence of carbonate rocks includes large dissolution cavities that commonly produce significant volumes of water. This aquifer is recharged by infiltration in the outcrop area, as well as by downward movement of groundwater in overlying rocks. The clastic Jurassic and Cretaceous sedimentary rocks overlying the Madison Group also provide regionally important aquifers, although not as prolific as the Madison Aquifer.

2.1.1.7 Stream Morphology

Stream morphology throughout the TPA is variable and has been historically altered in many cases to accommodate a variety of land uses and/or transportation networks. In general, streams in the Missouri - Cascade / Sand Coulee drainage originate in low elevation foothills and are predominantly driven by snowmelt and runoff. In these upper reaches of the streams, channel form and profile are generally very stable. Gradually, these systems transition downstream to meandering, low gradient systems characterized by riffle/pool complexes with well developed flood plains. Stream substrates are comprised typically of cobble sin the upper reaches and sand and gravel in the lower reaches. These low gradient, wide valley streams are typically where most alteration to stream morphology has occurred and where the most bank instability and impacts occur.

2.1.1.8 Climate

The precipitation data is mapped by Oregon State University's PRISM Group, using records from NOAA stations (Prism Group, 2004a). **Appendix A, Figure 2-9** shows the distribution of average annual precipitation. Only one climate station is located within the TPA, on the Missouri River. There are no climate stations within the Sand Coulee subwatershed.

Climate in the area is typical of mountains and plains in north-central Montana. Precipitation is most abundant in May and June. Annual average precipitation ranges from 15-27 inches in the Missouri - Cascade TPA. The mountains receive most of the moisture, and the amount received decreases with elevation, with the least falling along the Missouri River.

Climate Stations
National Oceanographic and Atmospheric Administration's (NOAA) National Weather Service operates three weather stations in the adjacent Belt TPA. In the absence of climate data from the Sand Coulee watershed, climate summaries from the Belt TPA are provided as surrogates in **Tables 2-2, 2-3** and **2-4**.

Climate data are provided by the MesoWest program, operated by the University of Utah Meteorology Department, and by the Western Regional Climate Center, operated by the Desert Research Institute at the University of Nevada-Reno.

Table 2-2. Monthly Climate Summary: Neihart 8NNW, Neihart, Montana (246008) Period of Record : 7/1/1967 to 12/31/2005

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Ave. Max. Temp (F)	34.1	38.7	43.9	52.6	61.5	70.3	78.9	79.4	68.8	56.7	41.7	35.0	55.1
Ave. Min. Temp. (F)	11.9	15.4	19.5	26.6	33.9	40.9	45.4	44.9	37.5	29.8	20.7	13.7	28.4
Ave Tot. Precip. (in.)	1.01	0.65	1.32	1.82	3.40	3.53	2.18	2.00	2.00	1.38	0.94	1.11	21.33
Ave.. Snowfall (in.)	15.0	12.0	20.3	15.4	6.8	0.7	0.0	0.0	2.4	8.7	12.6	18.1	112.1
Ave Snow Depth (in.)	10	11	8	3	1	0	0	0	0	1	2	6	3

Table 2-3. Monthly Climate Summary: Raynesford 2NNW, Raynesford, Montana (246902) Period of Record : 5/1/1970 to 12/31/2005

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Ave. Max. Temp (F)	34.8	38.5	44.8	55.0	63.8	71.9	80.4	80.8	70.0	58.3	43.4	36.3	56.5
Ave. Min. Temp. (F)	13.8	16.9	22.4	30.1	37.9	45.5	50.2	49.7	41.5	33.3	23.0	16.0	31.7
Ave Tot. Precip. (in.)	0.80	0.67	1.27	1.57	2.95	3.12	1.82	1.63	1.76	1.19	0.91	0.93	18.63
Ave.. Snowfall (in.)	15.3	10.1	16.3	7.2	2.6	0.2	0.0	0.0	0.5	3.6	9.1	14.9	79.9
Ave Snow Depth (in.)	6	5	3	1	0	0	0	0	0	0	2	5	2

Table 2-4. Monthly Climate Summary: Raynesford, Raynesford, Montana (246900) Period of Record: 5/18/1954 to 4/30/1970

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Ave. Max. Temp (F)	34.3	37.7	42.8	53.6	63.9	72.1	82.1	81.2	69.3	59.6	45.6	39.7	56.8
Ave. Min. Temp. (F)	8.8	14.0	18.4	27.7	35.7	42.1	46.0	43.6	36.0	31.0	20.9	15.8	28.3
Ave Tot. Precip. (in.)	0.69	0.51	0.52	1.31	2.87	3.60	1.52	1.38	1.59	1.09	0.68	0.67	16.42
Ave.. Snowfall (in.)	10.1	10.2	5.0	8.2	0.5	0.3	0.0	0.0	0.8	2.2	6.9	8.0	52.1
Ave Snow Depth (in.)	2	3	1	1	0	0	0	0	0	0	1	1	1

2.1.2 Ecological Parameters

2.1.2.1 Vegetation

The largest percentage (62%) of the land cover in the TPA is grassland. This area corresponds generally to the plains and the foothills of the Little Belt Mountains. Irrigated agriculture is reported for 9.2% of the TPA. Land cover is shown on **Appendix A, Figure 2-10**. Data are from the University of Montana's Satellite Imagery Land Cover (SILC) project (University of Montana, 2002).

2.1.2.2 Aquatic Life

Data on fish species distribution are collected, maintained and provided by FWP (Montana Department of Fish, Wildlife, and Parks, 2004). No fish, native or introduced, are reported in the Sand Coulee subwatershed.

2.1.2.3 Fires

The United States Forest Service (USFS) Region 1 office and the USFS remote sensing applications center provide data on fire locations from 1835 to the present. No fires are reported within the Sand Coulee subwatershed.

2.1.3 Cultural parameters

2.1.3.1 Population

An estimated 8,127 persons lived within the TPA in 2000. Population estimates are derived from census data (Census and Economic Information Center, 2002), based upon the populations reported from census blocks with centroids within the TPA boundary. Census data are mapped in **Appendix A, Figure 2-11.**

2.1.3.2 Land Ownership

Land ownership data are provided by the State of Montana CAMA database via the NRIS website (Montana State Library, 2002) and are shown on **Appendix A, Figure 2-12** and **Table 2-5**. Private lands comprise nearly 90% of the TPA.

Table 2-5. Land Ownership in the Missouri -Cascade TPA

Owner	Acres	Square Miles	% of Total
Private	550,506	860.16	89.94%
Montana State Trust Land	34,272	53.55	5.60%
US Bureau of Land Management	17,149	26.80	2.80%
Montana Fish Wildlife & Parks	2,106	3.29	0.34%
US Forest Service	1,992	3.11	0.33%
US Fish & Wildlife Service	239	0.37	0.04%
US Department of Defense	14	0.02	0.00%
County Government	9	0.01	0.00%
Total	612,095	956.40	—

2.1.3.3 Land Use and Land Cover

Land use within the TPA is dominated by forest and agriculture (**Table 2-6**). Agriculture in the lowlands is primarily related to small grain cultivation and grazing. Information on land use is based on land use and land cover (LULC) mapping completed by the USGS in the 1980s. The data are at 1:250,000 scale, and are based upon manual interpretation of aerial photographs. Land use is illustrated on **Appendix A, Figure 2-13.**

Table 2-6. Land Use in the Missouri -Cascade TPA

Land Use	Acres	Square Miles	% of Total
Grassland/Herbaceous	310,870	485.73	50.7%
Cultivated Crops	106,761	166.81	17.4%
Evergreen Forest	89,025	139.10	14.5%
Shrub/Scrub	65,463	102.29	10.7%
Pasture/Hay	13,500	21.09	2.2%
Woody Wetlands	7,348	11.48	1.2%
Mixed Forest	5,673	8.86	0.9%
Developed, Open Space	5,642	8.82	0.9%
Open Water	4,008	6.26	0.7%
Developed, Low Intensity	2,543	3.97	0.4%
Developed, Medium Intensity	937	1.46	0.2%
Emergent Herbaceous Wetlands	478	0.75	0.1%
Bare Rock/Sand/Clay	407	0.64	0.1%
Deciduous Forest	96	0.15	0.0%
Developed, High Intensity	31	0.05	0.0%

2.1.3.4 Transportation Networks

Transportation networks (road and railroads) are illustrated on **Appendix A, Figure 2-14**. The major road through the TPA is Interstate 15, which parallels the Missouri River, and an idle Burlington Northern Santa Fe rail line passes through the TPA along the Missouri River.

2.1.3.5 Mining

The area surrounding the Sand Coulee watershed is part of the Great Falls–Lewistown Coal Field. Coal beds from the upper Morrison Formation near the towns of Sand Coulee, Tracy, Centerville, and Stockett were first mined in 1876, and significant coal mining activity occurred from the late 1800's to about 1930 (Montana Department of Environmental Quality, 1998). Mines were largely abandoned by 1950. Acid mine drainage (AMD) has continued to be discharged from much of the mined areas since abandonment, and acidic water containing high levels of metals impacts many streams in the area (Reiten et al., 2006). Coal mining activity and impacts in the Sand Coulee watershed are characterized in further detail in **Section 5**.

2.1.3.6 Timber Harvest

No maps of timber harvests were identified.

2.1.3.7 Wastewater

The town of Stockett is the only permitted wastewater treatment facility reported in the Montana Pollution Discharge Elimination System (MPDES) database (Permit MT0030091) in the Sand Coulee watershed. The Sand Coulee treatment facility is a two-cell lagoon system that discharges to Cottonwood Creek just north of Stockett. Elsewhere in the TPA, wastewater treatment is provided by on-site septic systems, or by centralized sewer systems associated with the city of Great Falls.

2.1.3.8 Livestock Operations

The MPDES database records one regulated concentrated animal feeding operation (CAFO) within the TPA. The permit holder (MTG010222) is the Big Stone Hutterite Colony. The CAFO is located to the west of Sand Coulee.

2.2 Belt Watershed Characterization

The Montana Department of Environmental Quality (DEQ) has identified seven impaired waterbodies within the Belt Creek TPA: upper Belt Creek, lower Belt Creek, Belt Creek Dry Fork, Big Otter Creek, Carpenter Creek, Galena Creek, and Little Belt Creek. The impairment listings are detailed in DEQ's Integrated 305(b)/303(d) Water Quality Report (Montana Department of Environmental Quality, 2008a), and are shown on **Appendix A, Figure 2-15**. Impairment listings are summarized in **Table 1-1.**

2.2.1 Physical Characteristics

2.2.1.1 Location

The Belt TPA is within Cascade County. The total extent is 508,680 acres, or approximately 795 square miles. The TPA is located in the Upper Missouri Basin (Accounting Unit 100301) of central Montana. The TPA is coincident with the 10030105 fourth-code watershed (Belt Creek). The location is shown on **Figure 2-1**.

The TPA spans three Level III Ecoregions: Middle Rockies (17), Northwestern Glaciated Plains (42), and Northwestern Great Plains (43). Seven Level IV Ecoregions are mapped within the TPA (Woods et al, 2002), as shown on **Appendix A, Figure 2-16**. These include: Big Snowy – Little Belt Carbonate Mountains (17q), Scattered Eastern Igneous-Core Mountains (17r), North Central Brown Glaciated Plains (42o), Foothill Grassland (42r), Judith Basin Grassland (43m), Unglaciated Montana High Plains (43o), and Limy Foothill Grassland (43u).

2.2.1.2 Topography

Elevations in the Belt TPA range from approximately 582 to 2,780 meters (1,900 – 9,120 feet) above mean sea level (**Appendix A, Figure 2-17**). The lowest point is the confluence of Belt Creek and the Missouri River. The highest point is Big Baldy Mountain, in the heart of the Little Belt Mountains. The landscape is characterized by mountains, foothills and plains.

2.2.1.3 Geology

Appendix A, Figure 2-18 provides an overview of the geology, based on the 1:500,000 scale statewide map. The bedrock of the TPA includes Precambrian (pre-Belt Series metamorphic rocks and Belt Series metasedimentary rocks) rocks, Paleozoic and Mesozoic sedimentary rocks, and Tertiary igneous rocks. The Precambrian rocks are exposed in the center of the Little Belt Mountains, where erosion has stripped away overlying rocks. Paleozoic sedimentary rocks are exposed on the flanks and upper portions of the Little Belt Mountains. The plains are dominated by Mesozoic sedimentary rocks, of which the Cretaceous section is the most extensive. Tertiary igneous rocks form the core of the Highwood Mountains to the north, and isolated igneous rocks also intruded the Little Belt Mountains. Economic ore deposits are associated with both intrusions.

Older Quaternary alluvial sediments are present on dissected pediments surrounding the Little Belt Mountains. These sediments are limited in the Belt TPA. More recent alluvial deposits are located within modern stream channels that are incised into the Cretaceous sedimentary rocks.

2.2.1.4 Soils

The USGS Water Resources Division (Schwartz and Alexander, 1995) created a dataset of hydrology-relevant soil attributes, based on the USDA Natural Resources Conservation Service (NRCS) STATSGO soil database. The STATSGO data is intended for small-scale (watershed or larger) mapping, and is too general to be used at scales larger than 1:250,000. It is important to realize, therefore, that each soil unit in the STATSGO data may include up to 21 soil components. Soil analysis at a larger scale should use NRCS SSURGO data. The soil attributes considered in this characterization are erodibility and slope.

Soil erodibility is based on the Universal Soil Loss Equation (USLE) K-factor (Wischmeier and Smith, 1978). K-factor values range from 0 to 1, with a greater value corresponding to greater potential for erosion. Susceptibility to erosion is mapped in **Appendix A, Figure 2-19**, with soil units assigned to the following ranges: low (0.0-0.2), low-moderate (0.2-0.29) and moderate-high (0.3-0.4). Values of >0.4 are considered highly susceptible to erosion. No values greater than 0.37 are mapped in the TPA.

The majority of the TPA (54%) is mapped with moderate-low susceptibility soils. Slightly more than a third (36%) of the TPA is mapped with low susceptibility soils. Moderate-high susceptibility soils are mapped in 10% of the TPA.

A map of slope is provided on **Appendix A, Figure 2-20**. This figure illustrates that the TPA is characterized by three landscapes: mountains, foothills and plains. The mountains are characterized by gently sloping ridgelines and peaks that are incised by steep-sided valleys.

2.2.1.5 Surface Water

The TPA is coincident with the 10030105 fourth-code watershed. The National Hydrography Dataset (NHD) medium resolution data (USGS, 1999) includes 798 miles of streams mapped in the TPA. This data is compiled at 1:100,000. Belt Creek watershed hydrography is illustrated on **Appendix A, Figure 2-21**. The United States Geological Survey (USGS) does not maintain any gaging stations within the TPA. In the absence of USGS gaging stations, stream flow data are limited. A MBMG-DEQ study of acid mine drainage (AMD) issues near Belt (Reiten et al., 2006) includes two years of stream flow monitoring (2002-2004) on Belt Creek and other streams in the area. Flow in Belt Creek varies considerably over a year, and losing reaches are generally dry in late summer. Peak flow observed during the study was nearly 800 cfs.

2.2.1.6 Groundwater

No studies of the overall TPA hydrogeology were identified. Regional groundwater flow is presumed to be from the Little Belt Mountains northward, with shallower local flow towards Belt Creek and other streams. The Mississippian rocks exposed in the mountains include the Mission Canyon Formation of the Madison Group, which constitutes an important regional aquifer (the Madison Aquifer). This thick sequence of carbonate rocks includes large dissolution cavities that commonly produce significant volumes of water. This aquifer is recharged by infiltration in the outcrop area, as well as by downward movement of groundwater in overlying rocks. The clastic Jurassic and Cretaceous sedimentary rocks overlying the Madison Group also provide regionally important aquifers, although not as prolific as the Madison Aquifer.

The Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center (GWIC) program monitors and samples a statewide network of wells. As of June 2008, the GWIC database reports 698 wells within the TPA. Water quality data are available for 69 of those wells. The water quality data include general physical parameters: temperature, pH and specific conductance, in addition to inorganic chemistry (common ions, metals and trace elements). MBMG does not analyze groundwater samples for organic compounds.

There are 12 public water supplies within the TPA, only one of which uses surface water for its supply (Neihart). Water quality data are available for these utilities via the SDWIS State database (Montana Department of Environmental Quality, 2008b), although these data reflect the finished water provided to the public, not raw water at the source.

2.2.1.7 Stream Morphology

Stream morphology throughout the TPA is variable and has been historically altered in many cases to accommodate a variety of land uses and/or transportation networks. In general, streams in the Belt Creek drainage originate in high elevation, steep, mountainous terrain dominated by cobble substrate and are predominantly driven by snowmelt and runoff. In these areas, the streams are entrenched to moderately entrenched and are characterized by cascading step/pool to riffle dominated channels as gradient decreases. In these upper reaches of the streams, channel form and profile are generally very stable. Gradually, these systems transition downstream to meandering, low gradient systems characterized by riffle/pool complexes with well defined point bars and broad, and well developed flood plains.

2.2.1.8 Climate

Climate in the area is typical of mountains and plains in north-central Montana. Precipitation is most abundant in May and June. Annual average precipitation ranges from 15-41 inches in the Belt TPA. The mountains receive most of the moisture, and the amount received decreases with elevation, with the least falling at the confluence with the Missouri River. The precipitation data (**Appendix A, Figure 2-9**) is mapped by Oregon State University's PRISM Group, using records from NOAA stations (Prism Group, 2004b). See **Tables 2-2, 2-4** and **2-5** for climate summaries; **Appendix A, Figure 2-22** shows the distribution of average annual precipitation.

National Oceanographic and Atmospheric Administration's (NOAA) National Weather Service operates three weather station in the TPA. There are no USDA Natural Resources Conservation Service (NRCS) SNOTEL snowpack monitoring stations within the TPA, although two are located in the Little Belt Mountains just south of the TPA. Three additional climate monitoring stations are present: a MT Department of Transportation station at Monarch Canyon; a BLM remote automatic weather station (RAWS) at Porphyry Peak; and a private station between Belt and Highwood, registered with the Citizen Weather Observation Program (CWOP). RAWS stations are primarily used to assess conditions related to fire hazard, and provide telemetry to the National Interagency Fire Center in Boise, Idaho.

Climate data are provided by the MesoWest program, operated by the University of Utah Meteorology Department, and by the Western Regional Climate Center, operated by the Desert Research Institute at the University of Nevada-Reno.

2.2.2 Ecological Parameters

2.2.2.1 Vegetation

The largest percentage (43%) of the land cover in the TPA is grassland/herbaceous. This area corresponds generally to the plains. The mountains and foothills are mostly covered in evergreen forest (38% of the total area). Small grains occupy 8% of the total. Shrubland, deciduous forest and fallow land each occupy 3% of the total area. Conifers are dominated by Douglas fir and Lodgepole pine. Land cover is shown in **Appendix A, Figure 2-23** and **Figure 2-24**. Data sources include the University of Montana’s Satellite Imagery Land Cover (SILC) project (University of Montana, 2002), and USGS National Land Cover Dataset (NLCD) mapping (Montana State Library, 1992).

2.2.2.2 Aquatic Life

Fish are reported in 39 streams within the TPA. Belt Creek has the most diverse population, and all species reported in the TPA are present in this stream. Native fish species present in the TPA include: goldeye, lake chub, longnose dace, longnose sucker, mottled scuplin, mountain sucker, mountain whitefish, sand shiner, sauger, shorthead redhorse, stonecat, westslope cutthroat trout, and white sucker. Introduced species are also present, including: common carp and brook, brown and rainbow trout. Data on fish species distribution are collected, maintained and provided by FWP.

2.2.2.3 Fires

The United States Forest Service (USFS) Region 1 office and the USFS remote sensing applications center provide data on fire locations from 1835 to the present. Five fires are mapped within the TPA for this period, and are shown in **Appendix A, Figure 2-25**. A total of 2,873 acres (approximately 4.5 square miles) are mapped as burned.

2.2.3 Cultural parameters

2.2.3.1 Population

An estimated 1,979 persons lived within the TPA in 2000 (Census and Economic Information Center, 2002). Population estimates are derived from census data, based upon the populations reported from census blocks within and intersecting the TPA boundary. A reported 633 persons lived in Belt, and 91 in Neihart. Large portions of the TPA are unpopulated. Census data are mapped in **Appendix A, Figure 2-26**.

2.2.3.2 Land Ownership

Land ownership data (**Table 2-7**) are provided by the State of Montana CAMA database via the NRIS website (Montana State Library, 2002) and are shown on **Appendix A, Figure 2-27**.

Private lands comprise 61% of the TPA. Slightly more than one-third of the TPA is administered by the US Forest Service.

Table 2-7. Land Ownership

Owner	Acres	Square Miles	% of Total
Private	327,756	512.12	61%
US Forest Service	180,895	282.65	36%
Montana State Trust Land	10,851	16.95	2%
US Bureau of Land Management	3,550	5.55	0.7%
Montana Fish Wildlife & Parks	1,214	1.90	0.2%
Montana Department of Transportation	135	0.21	0.03%
Total	508,651	794.77	—

2.2.3.3 Land Use and Land Cover

Land use within the TPA is dominated by forest and agriculture (**Table 2-8**). Agriculture in the lowlands is primarily related to the cattle industry: dry grazing. Information on land use is based on land use and land cover (LULC) mapping completed by the USGS in the 1980s. The data are at 1:250,000 scale, and are based upon manual interpretation of aerial photographs. Land use is illustrated on **Appendix A, Figure 2-24.**

Table 2-8. Land Use and Land Cover in the Belt Creek TPA

Land Use	Acres	Square Miles	% of Total
Grasslands/Herbaceous	217,596.27	339.99	42.8%
Evergreen Forest	191,435.76	299.12	37.6%
Small Grains	39,843.53	62.26	7.8%
Shrubland	16,928.65	26.45	3.3%
Deciduous Forest	15,085.82	23.57	3.0%
Fallow	15,023.55	23.47	3.0%
Pasture/Hay	5,765.91	9.01	1.1%
Bare Rock/Sand/Clay	3,747.12	5.85	0.74%
Row Crops	885.10	1.38	0.17%
Commercial/Industrial/Transportation	705.67	1.10	0.14%
Transitional	690.36	1.08	0.14%
Mixed Forest	631.90	0.99	0.12%
Open Water	201.84	0.32	0.04%
Quarries/Strip Mines/Gravel Pits	65.72	0.10	0.01%
Woody Wetlands	37.77	0.06	0.01%
Low Intensity Residential	4.00	0.01	0.001%
Urban/Recreational Grasses	2.00	0.00	0.000%

2.2.3.4 Transportation Networks

Transportation networks (road and railroads) are illustrated on **Appendix A, Figure 2-28**. The TPA is bisected by US Routes 89 and 87. The network of unpaved roads on public and private lands will be further characterized as part of the source assessment. A Burlington Northern Santa Fe (BNSF) rail line passes through the TPA via Raynesford and Belt. The Great Northern Railroad formerly operated a spur line from Great Falls to Neihart, and the Montana Central Railroad operated a branch line to Barker from 1891-1903. These lines no longer exist.

2.2.3.5 Mining

Mining formerly comprised a large portion of the economy in the TPA. Abandoned mines show a preferred distribution, concentrated in three regions of the TPA (**Appendix A, Figure 2-29**). Two metal mining areas are located around Neihart/Carpenter Creek and Galena Creek. Two productive mining districts, Neihart and Hughesville, were organized in these areas. Lode deposits (mainly silver and lead, along with gold and copper at Neihart) were first worked in the late 1880s and major mining activity occurred up to the middle of the 20^{th} century. By the late 1940s, most of the mines in these districts were permanently closed or operating on an intermittent basis. Today, numerous abandoned and inactive mines are responsible for direct adit-discharges to streams, and large volumes of tailings, waste rock and mine spoils are directly impacting local streams in the Galena Creek and Carpenter Creek watersheds. Presently, these areas are designated as National Priority List (NPL) or 'Superfund' sites and active investigations to characterize the magnitude and extent of mining impacts are being conducted by the DEQ and EPA.

Coal mining was significant in the area near the town of Belt in the first decades of the 20th Century. These mines have been inactive for years, and acid mine drainage (AMD) continues to impact Belt Creek, primarily from the Anaconda Mine above the town of Belt. A lesser number of abandoned coal mines are scattered around Raynesford.

Additional detail on historic mining activity and its influence on water quality is provided in **Section 5.0**.

2.2.3.6 Timber Harvest

No maps of timber harvests were identified. The 'transitional' classification in NLCD is commonly applied to harvested or burned areas. This classification is not mapped extensively within the TPA. Transitional land cover is mapped at the southern edge of the TPA, and these areas occur in isolated patches that may correspond to smaller harvests.

2.2.3.7 Wastewater

The town of Belt maintains the only permitted wastewater treatment facility reported in the Montana Pollution Discharge Elimination System (MPDES) database (Permit MT0021571) in the Belt TPA. The Belt treatment facility is a three-cell lagoon system that discharges to Belt Creek just downstream of the town of Belt. Elsewhere in the TPA, wastewater treatment is provided by on-site septic systems. Septic system density is illustrated in **Appendix A, Figure 2-29**.

Septic system density is estimated from the 2000 census data, based on the assumption of one septic tank and drainfield for each 2.5 persons, and that sewer systems correspond to incorporated communities. Septic system density is classified as low (<50 per square mile), moderate (51-300 per square mile) or high (>300 per square mile). Nearly all of the TPA is mapped as low septic system density, with very limited areas of moderate (239 acres) and high (55 acres) density. The high and moderate density locations are located primarily around Raynesford. Neihart is mapped as sewered since it is an incorporated town, although individual septic systems are used for wastewater treatment.

2.2.3.8 Livestock Operations

The Montana Pollution Discharge Elimination System (MPDES) reports one regulated concentrated animal feeding operation (CAFO) within the TPA. The permit holder (MTG010048) is a ranch on Little Belt Creek.

SECTION 3.0
MONTANA WATER QUALITY STANDARDS

The goal of the federal Clean Water Act is to ensure that the quality of all surface waters is capable of supporting all designated uses. Water quality standards also form the basis for impairment determinations for Montana's 303(d) List, TMDL water quality improvement goals, formation of TMDLs and allocations, and standards attainment evaluations. The Montana water quality standards include four main parts: 1) stream classifications and designated uses, 2) numeric and narrative water quality criteria designed to protect the designated uses, 3) nondegradation provisions for existing high quality waters, and 4) prohibitions of various practices that degrade water quality. The components applicable to this document are reviewed briefly below. More detailed descriptions of the Montana water quality standards that apply to streams in the Missouri-Cascade and Belt TMDL Planning Areas can be found in **Appendix B**.

3.1 Missouri-Cascade and Belt TMDL Planning Areas Stream Classification and Designated Beneficial Uses

Classification is the designation of a single use or group of uses to a water body based on the potential of the water body to support those uses. All Montana waters are classified for multiple beneficial uses. All streams within the Missouri-Cascade and Belt TMDL Planning Areas watershed are classified as either B-1 or B-2, which specifies that all of the following uses must be supported: 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. While some streams might not actually be used for a specific use (e.g. drinking water supply) the quality of the water must be maintained at a level that can support that use to the extent possible based on a stream's natural potential. On the 2008 303(d) List, eleven water body segments in the Missouri-Cascade and Belt TMDL Planning Areas are listed as not supporting one or more beneficial uses (**Table 3-1**).

More detailed descriptions of Montana's surface water classifications and designated beneficial uses are provided in **Appendix B**.

Table 3-1. Waterbodies in the Missouri-Cascade and Belt TMDL Planning Areas from the 2008 303(d) List and their Associated Level of Beneficial Use Support

Waterbody	Waterbody Segment ID	Use Class	Length (Miles)	Year	Aquatic Life	Coldwater Fishery	Drinking Water	Contact Recreation	Agriculture	Industry
Upper Belt Creek	MT41U001_011	B-1	40.1	1988	N	N	N	F	P	P
Lower Belt Creek	MT41U001_012	B-2	39.4	1988	N	N	N	P	P	P
Carpenter Creek	MT41U002_010	B-1	6	1988	N	N	N	X	X	X
Galena Creek	MT41U002_020	B-1	3.5	1988	N	N	N	N	N	N
Dry Fork Belt Creek	MT41U002_030	B-1	18.9	1988	N	N	N	P	N	F
Little Belt Creek	MT41U002_040	B-1	3.2	1988	F	P	P	P	F	F

Table 3-1. Waterbodies in the Missouri-Cascade and Belt TMDL Planning Areas from the 2008 303(d) List and their Associated Level of Beneficial Use Support

Waterbody	Waterbody Segment ID	Use Class	Length (Miles)	Year	Aquatic Life	Coldwater Fishery	Drinking Water	Contact Recreation	Agriculture	Industry
Big Otter Creek	MT41U002_050	B-1	33.5	1996	P	P	X	F	X	F
Cottonwood Creek	MT41Q002_020	B-1	3.9	1988	N	N	N	X	F	F
Number Five Coulee	MT41Q002_030	B-1	15.1	1988	N	N	N	X	F	F
Sand Coulee Creek	MT41Q002_040	B-1		1988	N	N	N	X	P	P
Sand Coulee	MT41Q002_060	B-1	5.3	1992	N	N	N	X	P	P

F = Full Support, P = Partial Support, N = Not Supported, T = Threatened, X = Not Assessed (Lacking Sufficient Credible Data)

3.2 Missouri-Cascade and Belt TMDL Planning Areas Water Quality Standards

In addition to the Use Classifications described above, Montana's water quality standards include numeric and narrative criteria that are designed to protect the designated uses (**Appendix B**).

Numeric standards apply to concentrations of pollutants that are known to have adverse effects on human health or aquatic life. Pollutants for which numeric standards exist include metals, organic chemicals, and other toxic constituents. Human health standards have been set at levels to protect against long-term (lifelong) exposure as well as short-term exposure through direct contact such as swimming. Aquatic life numeric standards include chronic and acute values. *Chronic* aquatic life standards are designed to prevent effects of long-term low level exposure to pollutants, while *acute* aquatic life standards are protective of short-term exposure to pollutants. Chronic standards are more stringent than acute standards, but they can be exceeded for short periods of time, while acute standards shall never be exceeded.

Narrative standards have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric standards. Narrative standards describe either the allowable condition or an allowable increase of a pollutant over "naturally occurring" conditions or pollutant levels. DEQ uses a reference condition (naturally occurring condition) to determine whether or not narrative standards are being achieved.

The specific metals water quality standards that apply to the Missouri-Cascade and Belt TMDL Planning Areas are summarized in **Appendix B**.

SECTION 4.0
DESCRIPTION OF TMDL COMPONENTS

A TMDL is basically a loading capacity for a particular waterbody and refers to the maximum amount of a pollutant a stream or lake can receive and still meet water quality standards. A TMDL is also a reduction in pollutant loading resulting in attainment of water quality standards. More specifically, a TMDL is the sum of waste load allocations (WLAs) for point sources, and load allocations (LAs) for nonpoint sources and natural background sources. In addition, the TMDL includes a margin of safety (MOS) that accounts for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream. The allowable pollutant load must ensure that the waterbody will be able to attain and maintain water quality standards regardless of seasonal variations in water quality conditions, streamflows, and pollutant loading. TMDLs are expressed by the following equation:

$$TMDL = \Sigma WLA + \Sigma LA + MOS$$

Sections 5 includes 303(d) pollutant listings, the source assessment process for that pollutant, relevant water quality targets, a comparison of existing conditions to targets, quantification of loading from identified sources, TMDLs, and allocations to sources. The major components that figured into TMDL development are described below.

4.1 Establishing and Evaluating Targets

Because loading capacity is evaluated in terms of meeting water quality standards, quantitative water quality targets and supplemental indicators (in some cases) are developed to help assess the condition of the waterbody relative to the applicable standard(s) and to help determine successful TMDL implementation. This document outlines water quality targets for metals responsible for impairment of streams in the Missouri-Cascade and Belt TMDL Planning Areas. TMDL water quality targets help translate the numeric or narrative water quality standards for the pollutant of concern. For pollutants with established numeric water quality standards, the numeric values are used as TMDL water quality targets. For pollutants with only narrative standards, such as sediment, the water quality targets help to further interpret the narrative standard and provide an improved understanding of impairment conditions. Water quality targets for sediment typically include a suite of instream measures that link directly to the impacted beneficial use(s) and applicable water quality standard(s). The water quality targets help define the desired stream conditions and are used to provide benchmarks to evaluate overall success of restoration activities.

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 water quality impacts can vary throughout the year, often source assessments must evaluate the seasonal nature and ultimate fate of the pollutant loading. The source assessment usually helps further define the extent of the problem by putting human-caused loading into context with natural background loading.

A pollutant load is usually quantified for each point source permitted under the Montana Pollutant Discharge Elimination System (MPDES) program. Most other pollutant sources, typically referred to as nonpoint sources, are quantified by source categories, such as unpaved roads, and/or by land uses, such as crop production or forestry. These source categories or land uses can be further divided by ownership such as federal, state, or private. Alternatively, a sub-watershed (or tributaries) approach can be used whereby most or all sources are combined for quantification purposes.

The source assessments are performed at a watershed scale because all potentially significant sources of the water quality problems must be evaluated. The source quantification approaches may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading (40CFR 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.

Figure 4-1 is a schematic diagram illustrating how numerous sources contribute to the existing load and how a TMDL is determined by comparing the existing load to that which will meet standards.

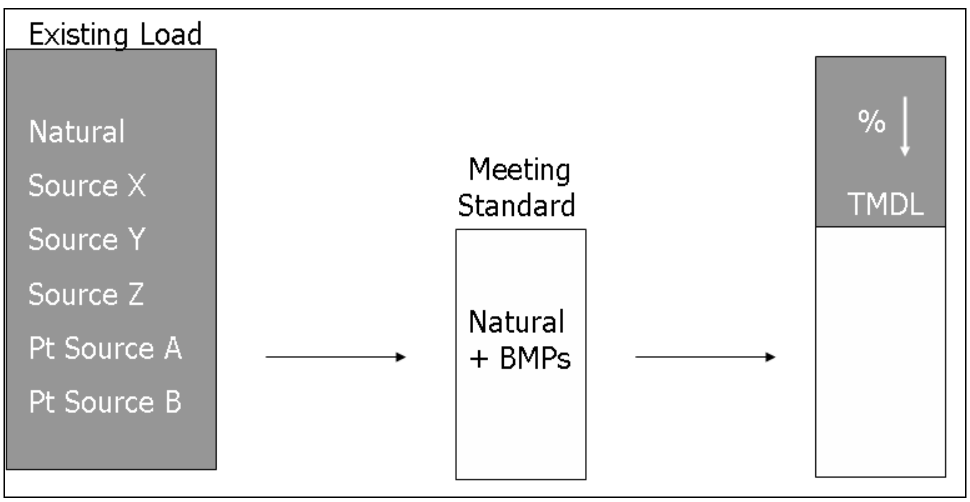

Figure 4-1. Schematic example of TMDL development.

4.3 Determining Allocations

Once the loading capacity (i.e., TMDL) is determined, that total must be divided, or allocated, among the contributing sources. Allocations are determined by quantifying feasible and achievable load reductions associated with the application of reasonable land, soil, and water conservation practices. Reasonable land, soil, and water conservation practices generally include BMPs, but additional conservation practices may be required to achieve compliance with water quality targets and restore beneficial uses. **Figure 4-2** contains a schematic diagram of how TMDLs are allocated to different sources using WLAs for point sources and LAs for natural and nonpoint sources. Under the current regulatory framework for development of TMDLs, flexibility is allowed for specifying 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, such as a percent increase in canopy density for temperature TMDLs.

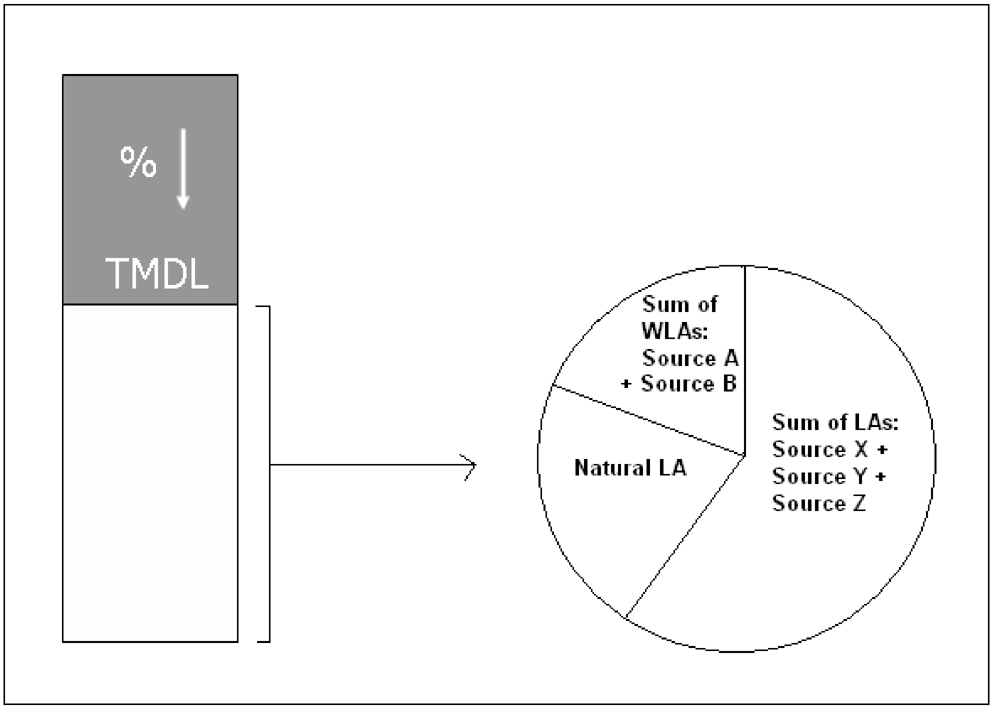

Figure 4-2. Schematic diagram of TMDL and allocations.

4.4 Margin of Safety

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

SECTION 5.0
METALS TMDL COMPONENTS

This portion of the document focuses on metals as a cause of water quality impairments in the Missouri-Cascade and Belt TMDL Planning Areas. It addresses:

- Metals beneficial use impacts
- Stream segments of concern
- Water quality data and information sources
- Water quality targets and comparison to existing conditions for each impaired stream
- Metals sources
- Metals water quality data
- Evaluation of target attainment for individual metals parameters
- Metals total maximum daily loads and allocations
- Seasonality and margin of safety

5.1 Mechanism of Effects of Excess Metals to Beneficial Uses

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

5.2 Stream Segments of Concern

A total of nine waterbody segments in the Missouri-Cascade and Belt TMDL Planning Areas were listed as impaired due to metals-related causes on the 2008 Montana 303(d) List (**Table 5-1a and Table 5-1b**). All 2008 303(d) listings are included in **Table 1-1** and the beneficial use support status of listed segments is presented in **Table 3-1**. Metals-related listings include aluminum, antimony, arsenic, cadmium, chromium, copper, iron, lead, nickel, and zinc. Salinity is also listed as a cause of impairment. In most cases in the Belt and Sand Coulee watersheds high salinity is related to high conductivity values as a result of dissolved *metals* in water samples, rather than dissolved salts (chloride) typically associated with high salinity, and so is addressed in conjunction with metals impairments.

Table 5-1a. Waterbody segments in the Belt TMDL Planning Area with metals listings on the 2008 303(d) List

Waterbody	Waterbody Segment ID	Impairment Cause
Belt Creek, upper (Headwaters to Big Otter Creek)	MT41U001_011	Arsenic Chromium (total) Copper Lead Zinc Salinity
Belt Creek, lower (Big Otter Creek to mouth)	MT41U001_012	Arsenic Chromium (total) Copper Lead Zinc Salinity
Carpenter Creek	MT41U002_010	Cadmium Copper Lead Mercury
Galena Creek	MT41U002_020	Antimony Arsenic Cadmium Copper Lead Zinc
Dry Fork Belt Creek	MT41U002_030	Cadmium Copper Lead Zinc

Table 5-1b. Waterbody segments in the Missouri-Cascade TMDL Planning Area with metals listings on the 2008 303(d) List

Waterbody	Waterbody Segment ID	Impairment Cause
Cottonwood Creek	MT41Q002_020	Cadmium Nickel Zinc
Number Five Coulee	MT41Q002_030	Aluminum Cadmium Lead Nickel Zinc
Sand Coulee Creek	MT41Q002_040	Lead Zinc Salinity
Sand Coulee	MT41Q002_060	Aluminum Cadmium Nickel Zinc Salinity

5.3 Water Quality Data and Information Sources

Anthropogenic metals sources and associated water quality impacts in the Missouri-Cascade and Belt TMDL Planning Areas are primarily the result of legacy mining impacts from abandoned and inactive coal and hardrock mines in the region. Predominant metals sources are those associated with historic mining activities and include metals derived from adits and seeps, metals-laden floodplain deposits, waste rock and tailings, and other ubiquitous sources associated with abandoned and inactive mining operations. Abandoned mine sources and impacts in the region have been well documented through a variety of recent evaluations and investigations conducted primarily by the USEPA (U.S.Environmental Protection Agency, 2005; CDM, 2005; U.S.Environmental Protection Agency, 2007; U.S.Environmental Protection Agency, unpublished) the Montana Department of State Lands (DSL) (Pioneer Technical Services, Inc., 1995), the Montana Bureau of Mines and Geology (Hargrave et al., 2000), the USFS (Maxim Technologies, Inc., 2002; Maxim Technologies, Inc., 2005) and the Doe Run Corporation (Barr Engineering, 2010). In addition to existing data sources, water quality and sediment data specific to TMDL development was also collected by DEQ during low and high flow conditions in 2009.

Data used to assist in source characterization, target evaluation, loading analysis, and development of load allocations is derived from the aforementioned water quality investigations. Due to the availability and quality of recent data, unless specified otherwise, data from 1990 to present was considered in water quality analysis. In some cases where recent significant cleanup action has occurred, data previous to the cleanup action was not considered in analyses, and is discussed in the appropriate water body evaluation section. **Table 5-2** provides a summary of water quality data compiled and utilized for target evaluation and TMDL development in the Missouri-Cascade and Belt TMDL Planning Areas. The large size of data sets precludes their inclusion in this document, and is available upon request from the DEQ. Data summaries for relevant water quality and sediment quality parameters are provided in **Section 5.4** for each impaired waterbody segment.

Table 5-2. Water quality data evaluated for TMDL development

Data Source & Data Year	Applicable 303(d)-listed Water Body Segments	Data Description
DEQ/USGS (1990-2005)	Belt Creek, lower Dry Fork Belt Creek Cottonwood Creek Number Five Coulee Sand Coulee Sand Coulee Creek	Historic DEQ/USGS data ~11sites in the Belt and Missouri-Cascade (Sand Coulee) TMDL Planning Areas
Chen-Northern (1990)	Galena Creek Dry Fork Belt Creek	Synoptic water quality data on several sites on Galena Creek, Dry Fork Belt Creek, and tributary mouths
Pioneer Technical Services (1993-1994)	Galena Creek Dry Fork Belt Creek	Synoptic water quality data on several sites on Galena Creek, Dry Fork Belt Creek, and tributary mouths
USFS/Maxim (2001-2002)	Belt Creek, upper Carpenter Creek	Water quality data from 16 sites in the upper Belt Creek watershed on USFS lands.
USFS/Maxim (2003)	Belt Creek, upper Carpenter Creek	Water quality data from 5 sites in the upper Belt Creek watershed on USFS lands – a continuation of sampling conducted in 2002.
EPA/CDM	Belt Creek, upper	Water quality data from several sites in the upper Belt

Table 5-2. Water quality data evaluated for TMDL development

Data Source & Data Year	Applicable 303(d)-listed Water Body Segments	Data Description
(2002-2004)	Carpenter Creek	Creek watershed associated with the Carpenter-Snow Creek NPL site.
BARR Engineering (1997-2009)	Galena Creek Dry Fork Belt Creek	Synoptic water quality data at 15 sites on Galena Creek and Dry Fork Belt Creek
EPA/TechLaw (2009-2010)	Belt Creek, upper Galena Creek Dry Fork Belt Creek	Synoptic water quality and sediment data at 24 sites on Belt Creek, Galena Creek, Dry Fork Belt Creek, and tributaries associated with the Barker-Hughesville NPL site.
EPA/TechLaw (2009-2010)	Belt Creek , upper Carpenter Creek	Synoptic water quality and sediment data associated with the Carpenter-Snow Creek NPL site.
DEQ WQB (2009)	Belt Creek , upper Belt Creek, lower Carpenter Creek Galena Creek Dry Fork Belt Creek Cottonwood Creek Number Five Coulee Sand Coulee Sand Coulee Creek	Synoptic water quality and sediment data at 35 sites in the Belt and Missouri-Cascade (Sand Coulee) TMDL Planning Areas
MBMG (2003-2004)	Belt Creek, lower	Synoptic water quality and sediment data at 7 sites on lower Belt Creek near the town of Belt

5.4 Water Quality Targets and Comparison to Existing Data

Water quality data described in **Section 5.3** was compiled and evaluated for attainment of water quality targets. **Section 5.4** presents the evaluation framework, metals water quality targets used in the evaluation, and metals targets attainment evaluations for each impaired waterbody given in **Table 5-1**.

5.4.1 Metals Evaluation Framework

Evaluating attainment of water quality standards for metals-related impairments, and subsequent determination of whether a TMDL is necessary for each waterbody segment involves three steps:

1. Evaluation of metals sources.

   Sources of metals in a watershed are both natural and anthropogenic. TMDLs are not developed for waterbodies that are not meeting water standards due solely to 'naturally occurring' pollutants. Consequently, metals-impaired streams must demonstrate existence of anthropogenic metals sources to be appropriate candidates for TMDL development.

2. Development of numeric water quality targets that represent water quality conditions that are unimpaired for the pollutant of concern.

   A required component of TMDL plans is the establishment of numeric water quality criteria or *targets* that represent a condition that meets Montana's ambient water quality standards. Numeric targets are measurable water quality indicators that, either by themselves or in combination with others, reflect attainment of water quality criteria (narrative and numeric) or represent a water quality condition that is unimpaired for the pollutant of concern. Metals water quality targets are presented in **Section 5.4.2**.

3. Comparison of existing data with water quality targets to evaluate water quality target attainment and, consequently, determine whether a TMDL is necessary.
   Attainment of water quality targets is evaluated by comparing existing water quality data and information to established metals water quality targets. Where exceedances of water quality targets are documented, a TMDL is developed. If there are no recent target exceedances, but there is insufficient data to fully evaluate all seasonal flow conditions, then TMDL development may not be pursued within this document. TMDL determination is based on the following assumption that natural levels of metals are below the chronic water quality criteria for aquatic life, and that single water quality samples represent a 96-hour average water quality condition.

5.4.2 Metals Water Quality Targets

Water quality targets for metals-related impairments in the Missouri-Cascade and Belt TMDL Planning Areas consist of metals water quality targets, sediment quality targets and salinity targets. Metals water quality targets are based on numeric acute and chronic metals water quality criteria for the protection of aquatic life as defined in DEQ Circular, DEQ-7, while sediment quality targets are based on narrative criteria for toxins in sediment (**Appendix B**). Salinity targets are based on general prohibitions and classification standards for B-1 and B-2 waters given in **Appendix B.**

5.4.2.1 Metals Water Quality Criteria

For metals with numeric criteria, the most protective established state numeric water quality criteria as defined in MDEQ Circular DEQ-7 (Montana Department of Environmental Quality, 2008) is adopted as the water quality target. Numeric criteria apply to both human health and aquatic life protection. The numeric aquatic life criteria for most metals are dependent upon water hardness values: as the hardness increases, the water quality criteria for a specific metal increase also. Water quality criteria (acute[1] and chronic aquatic[2] life, human health HHC) for each parameter of concern at a water hardness of 25 mg/L and 100mg/L are shown in **Table 5-3**. Acute and chronic toxicity aquatic life criteria are designed to protect aquatic life uses, while the human health standard is designed to protect drinking water uses. Attainment of *chronic* aquatic life water quality criteria are based on an average water quality metals concentration over a 96 hour period. A*cute* aquatic life water quality criteria are applied as a 'not-to-exceed' value.

[1] No surface or ground water sample concentration shall exceed these values
[2] No surface or ground water average concentration shall exceed these values based upon a 4-day (96 hr) or longer period.

Table 5-3. Metals numeric water quality targets applicable to the Missouri-Cascade and Belt TMDL Planning Areas

Metal of Concern	Aquatic Life Criteria (ug/L) at 25 mg/L Hardness		Aquatic Life Criteria (ug/L) at 100 mg/L Hardness		Human Health Criteria
	Acute	Chronic	Acute	Chronic	
Aluminum, dissolved	750	87	750	87	--
Arsenic, TR*	340	150	340	150	10
Cadmium, TR	0.52	0.10	2.13	0.27	5
Chromium, TR	579.32	27.69	1803.05	86.18	---
Copper, TR	3.79	2.85	14.00	9.33	1,300
Iron, TR	---	1,000	---	1,000	
Mercury, TR	1.70	0.91	1.70	0.91	0.05
Lead, TR	13.98	0.54	81.65	3.18	15
Nickel. TR	145.21	16.14	469.17	52.16	100
Silver, TR	0.37	---	4.06	---	100
Antimony, TR	---	---	---	---	6
Zinc, TR	37.02	37.02	119.82	119.82	2,000

*TR = total recoverable

5.4.2.2 Metals Sediment Quality Criteria

Stream sediment data may also be indicative of impairment caused by elevated metals and are used as a supplementary indicator of impairment. In addition to directly impairing aquatic life that interacts with the elevated metals in the sediment, the elevated sediment values can also be an indicator of elevated concentrations of metals during runoff conditions. This can be a particularly important supplemental indicator when high flow data is lacking. The state of Montana does not currently have numeric water quality criteria for metals in stream sediment, however general water quality prohibitions (see **Appendix B**) state that *“state surface waters must be free from substances…that will…create concentrations or combinations of materials that are toxic or harmful to aquatic life”.*

The National Oceanic and Atmospheric Administration (NOAA) has developed Screening Quick Reference Tables for stream sediment quality, and provides concentration guidelines for metals in freshwater sediments. Screening criteria concentrations come from a variety of studies and investigations, and are expressed in Probable Effects Levels (PEL). PELs represent the sediment concentration above which toxic effects to aquatic life frequently occur, and are calculated as the geometric mean of the 50th percentile concentration of the toxic effects data set and the 85th percentile of the no-effect data set (Buchman, 1999).

Table 5-4 contains the PEL values (in parts per million) for parameters of concern in the Missouri-Cascade and Belt TMDL Planning Areas.

Table 5-4. Screening level criteria for sediment metals concentrations

Metal of Concern	PEL (mg/kg)
Aluminum	--
Antimony	--
Arsenic	17.0
Cadmium	3.53

Table 5-4. Screening level criteria for sediment metals concentrations

Metal of Concern	PEL (mg/kg)
Chromium	90.0
Copper	197
Iron	--
Lead	91.3
Manganese	--
Mercury	0.486
Nickel	36.0
Silver	--
Zinc	315

PELs provide a screening tool that may assist in identification of toxic metals concentrations in stream sediments, and can be used to assist in impairment determinations and metals source assessment where water chemistry data is limited. PEL values are therefore adopted as supplemental targets that are used to evaluate whether streams are "*free from substances…that will…create concentrations or combinations of materials that are toxic or harmful to aquatic life*" **(Appendix B).** Where in-stream water quality data exceeds water quality targets, sediment quality data provide supporting information, but are not necessary to verify impairment. Where water quality data is limited or does not show exceedences of water quality targets, sediment quality data may demonstrate impairment due to toxic levels of metals in stream sediments.

5.4.2.3 Salinity Criteria

TMDL target development focuses on establishing salinity values that are protective of the most sensitive uses, aquatic life and agriculture. Salinity targets adopted for the Belt and Missouri-Cascade TMDL Planning areas are derived from previous TMDL reports and investigations in support of establishing salinity levels that are protective of agriculture and aquatic life.

Seasonal average and instantaneous maximum conductivity targets of 1,000 uS/cm and 1,400 m uS/cm were established for the Middle and Lower Teton River TMDL (Class B-2 and B-3 waters) to protect irrigation use. A seasonal TDS average of 660 mg/L (~1000 uS/cm), and a year-round maximum of 960 mg/L (~1500 uS/cm), were used as targets for TMDLs in the Sun River and Muddy Creek to protect irrigation water quality. Bauder and others (Bauder et al., 2007) described a range of aquatic life support conductivity and TDS values in a review of the salt mitigation plan for discharges to the Milk River from Lake Bowdoin; effects thresholds (LC50) for zooplankton species and fathead minnows ranged from 3,000 to 5,000 µS/cm. The recommended protective maximum conductivity criterion for the protection of aquatic life (northern pike and walleye) was 1,500 µS/cm (Skaar, 2003). Similarly, Weber-Scannell and Duffy (Phyllis K.Weber-Scannell and Lawrence K.Duffy, 2007) reviewed existing literature relating TDS levels to effects on salmonid species and other aquatic organisms and found limited impact to salmonids (trout, char, salmon, graylish, whitefish) at TDS levels <1000 mg/L (~1,500 uS/cm)

Based on these investigations, and the relationship of TDS to conductivity, a conservative value of 1,000 uS./cm is adopted as the salinity water quality target for streams in the Belt and Missouri-Cascade TMDL Planning Areas.

5.4.3 Metals Target Attainment Evaluation

For each waterbody segment listed on the 2008 303(d) List for metals (**Table 5-1**), recent water quality and sediment data is evaluated relative to the water quality targets to make a TMDL development determination. Data for existing metals listings will be evaluated first, followed by evaluation of other metals with target exceedances. Many metals impairment listings are based on data collected by the DEQ Abandoned Mines Bureau in 1993 and 1994. For most impaired streams in the Belt TPA, substantial data has been collected since this initial effort, and forms the basis for the metals target attainment evaluations below.

5.4.3.1 Carpenter Creek MT41U002_010

Carpenter Creek is 6 miles in length and extends from its headwaters to its confluence with Belt Creek downstream from the town of Neihart, (**Appendix A, Figure 2-15**). Carpenter Creek is on the 2008 303(d) List as being impaired for metals: cadmium, copper, lead, and mercury.

Metals Sources
Anthropogenic metals sources in the Carpenter Creek watershed are comprised primarily of abandoned mining activity from the Carpenter - Snow Creek Mining District. Designated a National Priority List (NPL) or 'Superfund' site in 2001, the Carpenter - Snow Creek Mining NPL site is located in the Little Belt Mountains, southeast of the city of Great Falls and includes the town of Neihart, and the Carpenter Creek and Snow Creek watersheds to the north of Neihart (**Appendix A, Figure 5-1**). Carpenter Creek flows into upper Belt Creek about 3 miles north of Neihart, and Snow Creek is a tributary to Carpenter Creek. Mining in the District began with the first claim in 1881 (Queen of the Hills mine) and continued through the mid-20th century. By 1949, most of the mines in the district were permanently closed or operating on an intermittent basis. Approximately 96 abandoned mines or mine opening have been identified in the Carpenter-Snow Creek Mining District, with at least 21 of these identified as potential sources of contamination to surface water. Waste rock and tailings, by-products of mining and milling processes, are present along the banks of Carpenter Creek, Snow Creek, Belt Creek, and tributaries: it is estimated that 189,745 cubic yards of waste rock and 170,200 cubic yards of mill tailings cover approximately 68 acres of private and public land in the district (Pioneer Technical Services, Inc., 1995). In many areas waste materials are in direct contact with surface water, and numerous mine adits have metal-laden water discharging to the local streams either directly or through groundwater flow.

Mining-related metals sources in these areas have been well documented through a variety of investigations in support of Superfund and remediation activities, and sampling studies have documented heavy metal impacts from pervasive mining waste affecting soil, groundwater, surface water and stream sediments in the District (Pioneer Technical Services, Inc., 1995; Hargrave et al., 2000; Maxim Technologies, Inc., 2002; Maxim Technologies, Inc., 2005; U.S.Environmental Protection Agency, 2005; U.S.Environmental Protection Agency, 2007). Water quality sampling has been conducted by a variety of entities, primarily the USEPA, the State of Montana and the USFS (see **Table 5-2**). **Appendix A, Figure 5-1** shows the spatial extent of historic mining activity and mine wastes in the watershed. **Appendix A, Figures 5-1a** and **5-1b** illustrate typical abandoned mining sources affecting water quality in Carpenter Creek.

Available Water Quality Data
Metals water quality and sediment data were used to evaluate attainment of water quality targets. Due to the availability of recently-collected water quality data in the watershed, data used for this evaluation was comprised of recent (collected after 2001) synoptic high and low flow sampling data collected by the EPA, the USFS, and the Montana DEQ. Six separate sampling events were conducted, capturing two high-flow and four low-flow events in Carpenter Creek since 2001. **Appendix A, Figure 5-2** shows the location of these sampling stations on Carpenter Creek and its tributaries.

Data from the mainstem of Carpenter Creek was used to evaluate attainment of metals water quality targets. A total of 30 water quality samples and 22 stream sediment samples were collected from 12 sampling locations on Carpenter Creek. A summary of water quality and sediment data from these samples is given in **Table 5-5** and **5-6**.

Table 5-5. Carpenter Creek Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Iron	Lead	Mercury	Silver	Zinc
# Samples	30	30	29	30	30	30	30	30
Min	<1.0	<0.10	0.39	30	0.1	0.0000004	<0.50	4.60
Max	10.0	15.10	300	2440	540	<0.20	2.60	2590
Median	3.0	5.35	41	182	10.8	<0.20	0.50	950
# Acute Exceedances	0	25	25	NA	7	0	4	25
Acute Exceedance Rate	0%	83%	86%	NA	23%	0%	13%	83%
# Chronic Exceedances	0	25	25	7	24	0	NA	25
Chronic Exceedance Rate	0%	83%	86%	23%	80%	0%	NA	83%

*all units in ug/L, Total Recoverable fraction

Table 5-6. Carpenter Creek Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Lead	Mercury	Zinc
# Samples	22	22	22	22	17	22
Min	4.0	1.2	62	147	0.03	130
Max	147.0	57.0	6690	14800	<0.2	9620
Median	44.5	16.0	2780	6860	0.1	2670
PEL Value	17	3.53	197	91.3	0.49	315
# Samples>PEL	19	20	19	20	0	20
PEL Exceedance Rate	86%	91%	86%	91%	0%	91%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

<u>Cadmium</u>
Carpenter Creek is listed as impaired for cadmium on the 2008 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing.

Of 30 samples collected since 2001 along the length of Carpenter Creek, 25 exceeded the acute aquatic life criteria (an 83% exceedance rate). Likewise cadmium concentrations in 20 of 22 (91%) stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, cadmium target exceedances are confirmed and a cadmium TMDL is developed for Carpenter Creek.

Copper

Carpenter Creek is listed as impaired for copper on the 2008 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 29 samples collected since 2001 along the length of Carpenter Creek, 25 exceeded the acute aquatic life criteria target (an 86% exceedance rate). Likewise copper concentration in 19 of 22 stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, copper target exceedances are confirmed and a copper TMDL is developed for Carpenter Creek.

Lead

Carpenter Creek is listed as impaired for lead on the 2008 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 30 samples collected since 2001 along the length of Carpenter Creek, seven exceeded the acute aquatic life criteria (a 23% exceedance rate) and 24 (80%) exceeded the chronic aquatic life criteria. Likewise lead concentration in 20 of 22 stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, lead target exceedances are confirmed and a lead TMDL is developed for Carpenter Creek.

Mercury

Carpenter Creek is listed as impaired for mercury on the 2008 303(d) List, based on human health criteria exceedances from samples collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994 below the Silver Dyke Tailings and the Carpenter Creek Tailings. These samples were taken during high flow conditions (May and June) and were J-flagged indicating that mercury was present but below practical quantitation limits (PQL). Of 30 water quality samples taken since 2001 on Carpenter Creek, none has exceeded acute or chronic water quality targets, and of 17 sediment samples taken during this same period, none exceeded PEL targets for Mercury. Detection limits for 26 of the 30 water quality samples were greater than the human health criteria and thus did not allow evaluation of human health criteria attainment. The four samples with lower detection limits were taken during high and low flow of 2009; none exceeded the surface water human health criteria for mercury. Due to recent data demonstrating attainment of mercury water quality targets, a mercury TMDL is not provided herein, but will remain listed as impaired until formal re-evaluation is conducted by the DEQ.

Arsenic

Carpenter Creek is not listed as impaired for arsenic on the 2008 303(d) List, however recent data provide evidence of arsenic as a cause of water quality impairment on Carpenter Creek. While water quality samples did not exceed acute or chronic arsenic targets, 19 of 22 stream sediment samples exceeded PEL targets for arsenic. (Samples that did not exceed the arsenic

PEL target were all located at the headwaters of Carpenter Creek, upstream from most historic mining influence and may represent natural background concentrations of As in sediments.) The median arsenic sediment concentration of 44.5 mg/kg is more than twice the PEL target for arsenic in sediment. Due to high levels of arsenic in stream sediments, an arsenic TMDL is developed for Carpenter Creek.

Iron

Carpenter Creek is not listed as impaired for iron on the 2008 303(d) List, however recent data provide evidence of iron as a cause of water quality impairment on Carpenter Creek. Of 30 samples, seven (23%) exceeded the chronic aquatic life criteria, with the majority (5 of 7) occurring during high flow periods. Due to exceedances of chronic aquatic life criteria, an iron TMDL is developed for Carpenter Creek.

Silver

Carpenter Creek is not listed as impaired for silver on the 2008 303(d) List, however recent data provide evidence of silver as a cause of water quality impairment on Carpenter Creek. Of 30 samples, four (13%) exceeded the acute aquatic life criteria, with all exceedances occurring during the high flow period of 2002. And, while PELs for silver have not been developed, silver concentrations in sediments downstream from mining sources are elevated up to 25 times those in the upper watershed above most mining sources, and are likely contributors to high-flow silver exceedances. Due to water quality exceedances of the acute aquatic life criteria, a silver TMDL is developed for Carpenter Creek.

Zinc

Carpenter Creek is not listed as impaired for zinc on the 2008 303(d) List, however recent data provide evidence of zinc as a cause of water quality impairment on Carpenter Creek. Of 30 samples, 25 (83%) exceeded the acute aquatic life criteria. Samples that did not exceed the water quality targets were all located at the headwaters of Carpenter Creek, upstream from most historic mining influence. Likewise zinc concentration in 20 of 22 (91%) stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Due to exceedances of acute aquatic life criteria, a zinc TMDL is developed for Carpenter Creek.

5.4.3.2 Galena Creek MT41U002_020

Galena Creek is 3.5 miles in length and extends from its headwaters to its confluence with Dry Fork Belt Creek (**Appendix A, Figure 2-15**). Galena Creek is on the 2008 303(d) List as being impaired for metals: antimony, arsenic, cadmium, copper, lead, and zinc.

Metals Sources

Anthropogenic metals sources in the Galena Creek watershed are comprised primarily of abandoned mining activity from the Barker-Hughesville Mining District. Designated a National Priority List (NPL) or ‘Superfund’ site in 2001, the Barker-Hughesville Mining District NPL site is located in the Little Belt Mountains southeast of Great Falls upstream from the community of Monarch. Galena Creek, a tributary to Dry Fork Belt Creek, is the most affected stream in the District and the primary source of metals contributing to water quality impairments. Major mining activity occurred in the District in the late 19th century through the early 20th century.

Large scale mining ceased in the 1940's but mines operated sporadically and intermittently up until the 1970s. Numerous abandoned and inactive mines in the district are responsible for several direct adit-discharges to local streams and large volumes of tailings, waste rock and mine spoils are directly impacting Galena Creek (**Appendix A, Figure 5-3**). **Appendix A, Figures 5-3a** and **5-3b** illustrate the type of abandoned mining sources affecting water quality in Galena Creek.

Mining-related metals sources in these areas have been well documented through a variety of investigations in support of Superfund and remediation activities, and sampling studies have documented heavy metal impacts from mining waste affecting soil, groundwater, surface water and stream sediments in the District (U.S.Environmental Protection Agency, unpublished; BARR Engineering, unpublished). Water quality sampling has been conducted by a variety of entities since 1990: EPA, DEQ, Barr Engineering, Pioneer Technical Services, Chen-Northern (**Table 5-2**). Significant environmental cleanup and remediation of the Block P Mill and Tailings site, a significant metals source along Galena Creek, occurred from 2004-2006. Waste tailings were removed, soils amended, and native vegetation was successfully planted (J.Grant Massey and William H Thompson, 2009).

Available Water Quality Data

Metals water quality and sediment data were used to evaluate attainment of water quality targets. Due to the significant Block P cleanup and revegetation in 2004-2006, only data collected since 2007 is used for this evaluation. Eight separate sampling events were conducted, capturing three high-flow and five low-flow events in Galena Creek since 2007. **Appendix A, Figure 5-4** shows the location of these sampling stations on Galena Creek and its tributaries.

Data from the mainstem of Galena Creek was used to evaluate attainment of metals water quality targets. Data included 39 water quality samples and nine stream sediment samples collected from several stations along the length of Galena Creek from 2007 to 2010. A summary of relevant water quality and sediment data is given in **Table 5-7** and **5-8**.

Table 5-7. Galena Creek Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Arsenic	Antimony	Cadmium	Copper	Iron	Lead	Zinc
# Samples	39	22	39	39	39	39	39
Min	0.70	<2.00	0.48	6.0	133	2.39	205
Max	15	<5.0	26	136	15400	163	7390
Median	5	<5.0	10	50	3040	43	2290
# Acute Exceedances	0	0	38	35	NA	4	39
Acute Exceedance Rate	0%	0%	97%	90%	NA	10%	100%
# Chronic Exceedances	0	0	38	35	34	35	39
Chronic Exceedance Rate	0%	0%	97%	90%	87%	90%	100%

*all units in ug/L, Total Recoverable fraction

Table 5-8. Galena Creek Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Lead	Zinc
# Samples	9	9	9	9	9
Min	82.3	4.1	163.0	1350	694
Max	416	133	2140	5600	45000
Median	275	23.1	1080	5010	5400
PEL Value	17	4	197	91	315
# Samples>PEL	9	9	8	9	9
PEL Exceedance Rate	100%	100%	89%	100%	100%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Antimony

Galena Creek is listed as impaired for antimony on the 2008 303(d) List, based on human health criteria exceedances from samples collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994 at several locations on Galena Creek. Of 22 water quality samples taken during two high flow and two low flow events in 2009 and 2010 on Galena Creek, none exceeded the antimony human health criteria (5.6 ug/L). Due to recent data demonstrating attainment of antimony water quality targets, an antimony TMDL is not provided herein, but will remain listed as impaired until formal re-evaluation is conducted by the DEQ.

Arsenic

Galena Creek is listed as impaired for arsenic on the 2008 303(d) List based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. While more recent water quality samples did not exceed acute or chronic aquatic life criteria, four samples exceeded the human health criteria for arsenic, and 100% of stream sediment samples exceeded PEL targets for arsenic. The median arsenic sediment concentration of 275 mg/kg is more than fifteen times the PEL target for arsenic in sediment. Due to human health criteria exceedances and high levels of arsenic in stream sediments, an arsenic TMDL is developed for Galena Creek.

Cadmium

Galena Creek is listed as impaired for cadmium on the 2008 303(d) List based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 39 samples collected since 2007 along the length of Galena Creek, 38 exceeded the acute aquatic life criteria (a 97% exceedance rate). Likewise cadmium concentration in all stream sediment samples collected greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, cadmium target exceedances are confirmed and a cadmium TMDL is developed for Galena Creek.

Copper

Galena Creek is listed as impaired for copper on the 2008 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 39 samples collected since 2007 along the length of Galena Creek, 35 exceeded the acute aquatic life criteria (a 90% exceedance rate). Likewise copper concentration in eight of nine stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, copper target exceedances are confirmed and a copper TMDL is developed for Galena Creek.

Lead

Galena Creek is listed as impaired for lead on the 2008 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 39 samples collected since 2007 along the length of Galena Creek, four exceeded the acute aquatic life criteria (a 10% exceedance rate) and 35 (90%) exceeded the chronic aquatic life criteria. Likewise lead concentration in all nine stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, lead target exceedances are confirmed and a lead TMDL is developed for Galena Creek.

Zinc

Galena Creek is listed as impaired for zinc on the 2008 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 39 samples collected since 2007, 39 (100%) exceeded the acute aquatic life criteria. Likewise zinc concentration in all nine stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Due to exceedances of acute aquatic life criteria, a zinc TMDL is developed for Galena Creek.

Iron

Galena Creek is not listed as impaired for iron on the 2008 303(d) List, however recent data provide evidence of iron as a cause of water quality impairment on Galena Creek. Of 39 samples collected since 2007, 34 (87%) exceeded the chronic aquatic life criteria. Due to exceedances of chronic aquatic life criteria, an iron TMDL is developed for Galena Creek.

5.4.3.3 Dry Fork Belt Creek MT41U002_030

Dry Fork Belt Creek is 3.5 miles in length and extends from its headwaters to its confluence with Dry Fork Belt Creek (**Appendix A, Figure 2-15**). Dry Fork Belt Creek is on the 2008 303(d) List as being impaired for metals: cadmium, copper, lead, and zinc.

Metals Sources

Anthropogenic metals sources in the Dry Fork Belt Creek watershed are comprised primarily of abandoned mining activity from the Barker-Hughesville Mining District. Designated a National Priority List (NPL) or 'Superfund' site in 2001, the Barker-Hughesville Mining District NPL site is located in the Little Belt Mountains southeast of Great Falls near the community of Monarch. Galena Creek, a tributary to Dry Fork Belt Creek, is the most affected stream in the District. Major mining activity occurred in the District in the late 19th century through the early 20th century. Large scale mining ceased in the 1940's but mines operated sporadically and intermittently up until the 1970s. Numerous abandoned and inactive mines in the district are responsible for several direct adit-discharges to local streams and large volumes of tailings, waste rock and mine spoils are directly impacting Galena Creek, and consequently, Dry Fork Belt Creek (**Appendix A, Figure 5-5**). A few abandoned mine and prospect pit locations exist outside the Galena Creek subwatershed, and with the exception of mill tailings along Dry Fork Belt Creek downstream of Galena Creek (MBMG, 2000) they are not thought to pose a significant risk to water quality.

Mining-related metals sources in these areas have been well documented through a variety of investigations in support of Superfund and remediation activities, and sampling studies have documented heavy metal impacts from mining waste affecting soil, groundwater, surface water and stream sediments in the District (BARR Engineering, unpublished; U.S.Environmental Protection Agency, unpublished; CDM, 2005). Water quality sampling has been conducted by a variety of entities since 1990: EPA, DEQ, Barr Engineering, Pioneer Technical Services, Chen-Northern (**Table 5-2**).

Available Water Quality Data

Metals water quality and sediment data were used to evaluate attainment of water quality targets. Data used for this evaluation consisted of recent (1997 to 2010) synoptic high and low flow sampling data. Eighteen separate sampling events were conducted, capturing seven high-flow and 11 low-flow events in Dry fork Belt Creek since 1997. **Appendix A, Figure 5-5** shows the location of these sampling stations on Dry Fork Belt Creek and its tributaries.

Data from the mainstem of Dry Fork Belt Creek was used to evaluate attainment of metals water quality targets. Data included 92 water quality samples and 14 stream sediment samples collected from several stations along the length of Dry Fork Belt Creek from 1997 to 2010. A summary of relevant water quality and sediment data is given in **Table 5-9** and **5-10**.

Table 5-9. Dry Fork Belt Creek Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Iron	Lead	Zinc
# Samples	90	89	90	90	90	85
Min	0.3	0.04	0.2	<20	0.04	<3.0
Max	83	32.7	143.0	11200	483	8310
Median	4.0	1.5	8.8	364	6.5	258
# Acute Exceedances	0	32	30	0	4	56
Acute Exceedance Rate	0%	36%	33%	0%	4%	66%
# Chronic Exceedances	0	56	39	22	33	56
Chronic Exceedance Rate	0%	63%	43%	24%	37%	66%

*all units in ug/L, Total Recoverable fraction

Table 5-10. Dry Fork Belt Creek Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Lead	Zinc
# Samples	14	14	14	14	14
Min	5.9	0.5	23.3	47.4	138
Max	380	72.2	954	6210	21200
Median	123	41.9	390	1001	11400
PEL Value	17	3.53	197	91	315

Table 5-10. Dry Fork Belt Creek Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Copper	Lead	Zinc
# Samples>PEL	12	12	10	12	2
PEL Exceedance Rate	86%	86%	71%	86%	14%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

<u>Cadmium</u>

Dry Fork Belt Creek is listed as impaired for cadmium on the 2008 303(d) List based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 89 samples collected since 1997 along the length of Dry Fork Belt Creek, 32 (36%) exceeded the acute aquatic life criteria, and 56 (63%) exceeded the chronic aquatic life criteria. Likewise cadmium concentration in 12 of 14 stream sediment samples collected greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, cadmium target exceedances are confirmed and a cadmium TMDL is developed for Dry Fork Belt Creek.

<u>Copper</u>

Dry Fork Belt Creek is listed as impaired for copper on the 2008 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 90 samples collected since 1997 along the length of Dry Fork Belt Creek, 30 (33%) exceeded the acute aquatic life criteria and 39 (43%) exceeded the chronic aquatic life criteria. Likewise copper concentration in 10 of 14 stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, copper target exceedances are confirmed and a copper TMDL is developed for Dry Fork Belt Creek.

<u>Lead</u>

Dry Fork Belt Creek is listed as impaired for lead on the 2008 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 90 samples collected since 1997 along the length of Dry Fork Belt Creek, four (4%) exceeded the acute aquatic life criteria and 33 (37%) exceeded the chronic aquatic life criteria. Likewise lead concentration in 12 of 14 stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, lead target exceedances are confirmed and a lead TMDL is developed for Dry Fork Belt Creek.

<u>Zinc</u>

Dry Fork Belt Creek is listed as impaired for zinc on the 2008 303(d) List, and is based primarily on data collected by the DEQ's Abandoned Mines Bureau in 1993 and 1994. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 85 samples, 56 (66%) exceeded the acute aquatic life criteria. Likewise zinc concentration in 12 of 14 stream sediment samples greatly exceeded PEL values established as supplemental indicators of impairment. Due to exceedances of acute aquatic life criteria, a zinc TMDL is developed for Dry Fork Belt Creek.

Arsenic

Dry Fork Belt Creek is not listed as impaired for arsenic on the 2008 303(d) List, however recent data provide evidence of arsenic as a cause of water quality impairment on Dry Fork Belt Creek. While more recent water quality samples did not exceed acute or chronic aquatic life criteria, 11 samples exceeded the human health criteria for arsenic, and 12 of 14 stream sediment samples exceeded PEL targets for arsenic. The median arsenic sediment concentration of 123 mg/kg is more than seven times the PEL target for arsenic in sediment. Due to human health criteria exceedances and high levels of arsenic in stream sediments, an arsenic TMDL is developed for Dry Fork Belt Creek.

Iron

Dry Fork Belt Creek is not listed as impaired for iron on the 2008 303(d) List, however recent data provide evidence of iron as a cause of water quality impairment on Dry Fork Belt Creek. Of 90 samples, 22 (24%) exceeded the chronic aquatic life criteria. Due to exceedances of chronic aquatic life criteria, an iron TMDL is developed for Dry Fork Belt Creek.

5.4.3.4 Upper Belt Creek MT41U001_011

Upper Belt Creek is 40.1 miles in length and extends from its headwaters above the town of Neihart, to Big Otter Creek (**Appendix A, Figure 2-15**). Upper Belt Creek is on the 2008 303(d) List as being impaired for metals: arsenic, chromium (total), copper, lead, and zinc. Salinity was also listed as a cause of impairment on the 2008 303(d) List.

Impairment listings were initially established for the entire length of Belt Creek, and were based on data collected near the town of Belt on lower Belt Creek. Belt Creek was split into two segments (MT41U001_011 and MT41U001_012), as reported on the 2004 303(d) List, and the existing pollutant listings were applied to both the upper and lower segments. Because impairment listings for upper Belt Creek are based on data collected prior to segmentation, existing listings may not be applicable. Target attainment evaluations provided in this section use data applicable to the upper segment.

Metals Sources

Anthropogenic metals sources in the upper Belt Creek watershed are comprised primarily of abandoned mining activity from two National Priorities List (NPL) or ‘Superfund’ sites: the Carpenter - Snow Creek Mining District and the Barker-Hughesville Mining District. Mining-related metals sources and impacts in these areas have been well documented through a variety of investigations in support of Superfund and remediation activities (CDM, 2005; Hargrave et al., 2000; Maxim Technologies, Inc., 2005; U.S.Environmental Protection Agency, 2007; Pioneer Technical Services, Inc., 1995; Maxim Technologies, Inc., 2002; U.S.Environmental Protection Agency, 2005; CDM, 2005; U.S.Environmental Protection Agency, unpublished; BARR Engineering, unpublished), and water quality sampling has been conducted by a variety of entities, primarily the USEPA, the State of Montana and the USFS (**Table 5-2**).

The Carpenter - Snow Creek Mining District NPL site is located in the Little Belt Mountains, southeast of the city of Great Falls and includes the town of Neihart, and the Carpenter Creek and Snow Creek watersheds north of the town of Neihart. Carpenter Creek flows into upper Belt Creek about 3 miles north of Neihart. Mining in the District began with the first claim in 1881 (Queen of the Hills mine) and continued through the mid-20th century. By 1949, most of the mines in the district were permanently closed or operating on an intermittent basis. Approximately 96 abandoned mines or mine opening have been identified in the Carpenter-Snow Creek Mining District, with at least 21 of these identified as potential sources of contamination to surface water. Waste rock and tailings, by-products of mining and milling processes, are present along the banks of Carpenter Creek, Snow Creek, Belt Creek, and tributaries: it is estimated that 189,745 cubic yards of waste rock and 170,200 cubic yards of mill tailings cover approximately 68 acres of private and public land in the district(Pioneer Technical Services, Inc., 1995). In many areas waste materials are in direct contact with surface water, and numerous mine adits have metal-laden water discharging to the local streams either directly or through groundwater flow. Several investigations have documented heavy metal impacts from mining waste affecting soil, groundwater, surface water and stream sediments in the District.

The Barker-Hughesville Mining District NPL site is located in the Little Belt Mountains southeast of Great Falls upstream from the community of Monarch. Dry Fork Belt Creek and Galena Creek, a tributary to Dry Fork Belt Creek, are the most affected streams in the District. Dry Fork Belt Creek enters Belt Creek at the community of Monarch. Major mining activity occurred in the District in the late 19th century through the early 20th century. Large scale mining ceased in the 1940's but mines operated sporadically and intermittently up until the 1970s. Numerous abandoned and inactive mines in the district are responsible for several direct adit-discharges to streams, and large volumes of tailings, waste rock and mine spoils are directly impacting Galena Creek and Dry Fork Belt Creek, tributaries to Belt Creek (CDM, 2005).

Available Water Quality Data

Metals water quality and sediment data were used to evaluate attainment of water quality targets. Data used for this evaluation consisted of recent (2009 and 2010) synoptic high and low flow sampling data. Three separate sampling events were conducted, capturing one high-flow and two low-flow events on upper Belt Creek. **Appendix A, Figure 5-6** shows the location of these sampling stations on upper Belt Creek.

Data from the mainstem of upper Belt Creek was used to evaluate attainment of metals water quality targets. Data included 25 water quality samples and 17 stream sediment samples collected from several stations along the length of upper Belt Creek in 2009 and 2010. A summary of relevant water quality and sediment data is given in **Table 5-11** and **5-12**.

Table 5-11. Upper Belt Creek Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc
# Samples	25	25	25	25	25	25
Min	<0.20	<0.04	<0.25	0.4	0.12	<2.5
Max	<10.0	0.10	<5.00	14.1	6.80	210.0
Median	<2.50	0.69	<2.50	<5.0	<1.00	60.1
# Acute Exceedances	0	0	0	2	0	6

Table 5-11. Upper Belt Creek Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc
Acute Exceedance Rate	0%	0%	0%	8%	0%	24%
# Chronic Exceedances	0	6	0	3	6	6
Chronic Exceedance Rate	0%	24%	0%	12%	24%	24%

*all units in ug/L, Total Recoverable fraction

Table 5-12. Upper Belt Creek Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc
# Samples	17	17	17	17	17	17
Min	3.9	0.48	12.70	11	18	67
Max	67.1	37.3	64.7	2590	6460	6550
Median	16.6	4.5	18.7	28	402	1420
PEL Value	17	3.53	90	197	91.3	315
# Samples>PEL	8	10	0	6	13	12
PEL Exceedance Rate	47%	59%	0%	35%	76%	71%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

<u>Arsenic</u>

Upper Belt Creek is listed as impaired for arsenic on the 2008 303(d) List. While recent water quality samples did not exceed aquatic life criteria or human health criteria, eight of seventeen (47%) of stream sediment samples exceeded PEL targets for arsenic. All seven sediment samples taken downstream of Carpenter Creek exceeded PEL values, while only one of nine samples exceeded PEL values above Carpenter Creek. Carpenter Creek is impaired for several metals and includes a variety of historic mining sources contributing to impairment (see Section 5.4.3.1) Due to high levels of arsenic in stream sediments below Carpenter Creek, an arsenic TMDL is provided for upper Belt Creek.

<u>Chromium</u>

Upper Belt Creek is listed as impaired for total chromium on the 2008 303(d) List. All 25 water quality sample results were below water quality criteria for total chromium, with the largest detection at 0.75 ug/L total chromium. Stream sediment concentrations were also below PEL values in all 17 samples. Due to recent data demonstrating attainment of chromium water quality targets, a chromium TMDL is not provided herein, but will remain listed as impaired until formal re-evaluation is conducted by the DEQ.

<u>Copper</u>

Upper Belt Creek is listed as impaired for copper on the 2008 303(d) List. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 25 samples collected along the length of upper Belt Creek, two (8%) exceeded the acute aquatic life criteria and three (12%) exceeded the chronic aquatic life criteria. Likewise copper concentrations in six of seven stream sediment samples taken downstream of Carpenter Creek greatly exceeded PEL values. Consequently, copper target exceedances are confirmed and a copper TMDL is provided for upper Belt Creek.

Lead

Upper Belt Creek is listed as impaired for lead on the 2008 303(d) List. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 25 samples collected along the length of upper Belt Creek, six (24%) exceeded the chronic aquatic life criteria. Likewise lead concentration in 13 of 17 stream sediment samples greatly exceeded PEL values, with the highest values occurring downstream of Carpenter Creek. Consequently, lead target exceedances are confirmed and a lead TMDL is provided for upper Belt Creek.

Zinc

Upper Belt Creek is listed as impaired for zinc on the 2008 303(d) List. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 25 samples, six (24%) exceeded the acute aquatic life criteria. Likewise zinc concentration in 12 of 17 stream sediment samples greatly exceeded PEL values. Due to exceedances of acute aquatic life criteria, and high sediment concentrations, a zinc TMDL is provided for upper Belt Creek.

Cadmium

Upper Belt Creek is not listed as impaired for cadmium on the 2008 303(d) List, however recent data provide evidence of cadmium as a cause of water quality impairment on upper Belt Creek. Of 25 samples collected along the length of upper Belt Creek, six (24%) exceeded the chronic aquatic life criteria. Likewise cadmium concentration in 12 of 17 stream sediment samples collected greatly exceeded PEL values established as supplemental indicators of impairment. Consequently, cadmium target exceedances are confirmed and a cadmium TMDL is provided for upper Belt Creek.

Salinity

Upper Belt Creek is listed as impaired for salinity on the 2008 303(d) List, primarily based on field measurements of water conductivity taken at sites impacted by historic mining activity in the lower Belt Creek watershed near the town of Belt during extreme low flow. As these data do not apply to the upper segment, salinity data is evaluated for the upper Belt Creek segment. Of 31 conductivity measurements taken since 2003 along the length of upper Belt Creek, all met conductivity targets (**Section 5.4.2.3**), with a high of 415 uS/cm and an average of 210 uS/cm.

Based on recent water quality data and field measurements, it appears that conductivity levels in upper Belt Creek are meeting targets and do not contribute to impairment. Due to recent data demonstrating that conductivity levels that are within expected ranges, a salinity TMDL is not provided herein, but will remain listed as impaired for salinity until formal re-evaluation is conducted by the DEQ.

5.4.3.5 Lower Belt Creek MT41U001_012

Lower Belt Creek is 39.4 miles in length and extends from Big Otter Creek to its confluence with the Missouri River (**Appendix A, Figure 2-15**). Lower Belt Creek is on the 2008 303(d) List as being impaired for metals: arsenic, chromium (total), copper, lead, and zinc. Salinity was also listed as a cause of impairment on the 2008 303(d) List.

Impairment listings were initially established for the entire length of Belt Creek, and were based on data collected near the town of Belt on lower Belt Creek. Belt Creek was split into two segments (MT41U001_011 and MT41U001_012), as reported on the 2004 303(d) List, and the existing pollutant listings were applied to both the upper and lower segments. Target attainment evaluations provided in this section use data applicable to the lower segment.

Metals Sources

Anthropogenic metals sources in the lower Belt Creek watershed are comprised primarily of abandoned mining activity from two National Priorities List (NPL) or 'Superfund' sites in the upper Belt Creek watershed (see previous section), and from abandoned coal mining and acid-mine discharge entering Belt Creek near the town of Belt along lower Belt Creek.. Historic coal mining in and around the town of Belt have resulted in acid mine discharge from several abandoned adits and mine drains that has impacted Belt Creek and local groundwater. The largest of these discharges comes from the Anaconda Mine drain, which discharges metals-laden water at a rate of approximately 132 gpm (**Appendix A, Figures 5-7a** and **5-7b**). Additional mine discharges from the French Coulee Mine Drain, the Lewis Coulee Mine and the Brodie, Meisted and Millard Mines are estimated at less that 20 gpm, cumulatively (Reiten et al., 2006). Mining-related metals sources and impacts in these areas have been well documented through a variety of investigations in support of assessment and remediation activity (Reiten et al., 2006; Duaime et al., 2004; Gammons et al., 2006). Recent water quality sampling on lower Belt Creek has been conducted primarily by the DEQ and the Montana Bureau of Mines and Geology (**Table 5-2**).

Available Water Quality Data

Metals water quality and sediment data were used to evaluate attainment of water quality targets. Data used for this evaluation consisted of recent (2003 to present) synoptic high and low flow sampling data. Four separate sampling events were conducted, capturing one high-flow and three low-flow events on lower Belt Creek. **Appendix A, Figure 5-7** shows the location of these sampling stations on lower Belt Creek.

Data from the mainstem of lower Belt Creek was used to evaluate attainment of metals water quality targets. Data included 17 water quality samples and five stream sediment samples collected from several stations along the length of lower Belt Creek. A summary of relevant water quality and sediment data is given in **Table 5-13** and **5-14**.

Table 5-13. Lower Belt Creek Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Zinc
# Samples	17	17	17	17	17	17	17
Min	0.43	0.04	0.25	1.40	12	0.37	3.7
Max	<1.0	1.36	<2.0	9.14	6010	3.80	212
Median	0.72	0.20	0.73	<2.0	208	<2.0	25.3
# Acute Exceedances	0	0	0	0	NA	0	0
Acute Exceedance Rate	0%	0%	0%	0%	NA	0%	0%

Table 5-13. Lower Belt Creek Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Arsenic	Cadmium	Chromium	Copper	Iron	Lead	Zinc
# Chronic Exceedances	0	2	0	0	2	1	0
Chronic Exceedance Rate	0%	12%	0%	0%	12%	6%	0%

*All units in ug/L, Total Recoverable fraction

Table 5-14. Lower Belt Creek Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Arsenic	Cadmium	Chromium	Copper	Lead	Zinc
# Samples	5	5	5	5	5	5
Min	10	0.25	25.2	52.9	25.6	150
Max	23.9	9.0	47.6	110	320	2040
Median	15	6.8	33.8	91.5	226	1620
PEL Value	17	3.53	90	197	91	315
# Samples>PEL	2	4	0	0	4	4
PEL Exceedance Rate	40%	80%	0%	0%	80%	80%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Arsenic

Lower Belt Creek is listed as impaired for arsenic on the 2008 303(d) List. While recent water quality samples did not exceed aquatic life criteria or human health criteria, two of five (40%) of stream sediment samples exceeded PEL targets for arsenic. Due to high levels of arsenic in Belt Creek stream sediments through and below the town of Belt, an arsenic TMDL is provided for lower Belt Creek.

Chromium

Lower Belt Creek is listed as impaired for total chromium on the 2008 303(d) List. All 17 water quality sample results were well below water quality criteria for total chromium, with the largest detection at 0.73 ug/L total chromium. Stream sediment concentrations were also below PEL values in all samples. Due to recent data showing attainment of chromium water quality targets, a chromium TMDL is not provided herein, but will remain listed as impaired until formal re-evaluation is conducted by the DEQ.

Copper

Lower Belt Creek is listed as impaired for copper on the 2008 303(d) List. Of 17 samples, none exceeded aquatic life criteria. Likewise copper concentrations in all stream sediment samples were below PEL values. Due to recent data showing attainment of copper water quality targets, a copper TMDL is not provided herein, but will remain listed as impaired until formal re-evaluation is conducted by the DEQ.

Lead

Lower Belt Creek is listed as impaired for lead on the 2008 303(d) List. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 17 samples collected, one (6%) exceeded the chronic aquatic life criteria, and lead concentration in four of five stream sediment samples exceeded PEL values, with the highest values occurring downstream of the Anaconda Mine Drain. Consequently, lead target exceedances are confirmed and a lead TMDL is provided for lower Belt Creek.

Zinc

Lower Belt Creek is listed as impaired for zinc on the 2008 303(d) List. Evaluation of data collected since the initial impairment listing verifies this impairment listing. While no recent water quality samples exceeded aquatic life criteria, zinc concentration in four of five stream sediment samples greatly exceeded PEL values. Due to high sediment concentrations, a zinc TMDL is provided for lower Belt Creek.

Cadmium

Lower Belt Creek is not listed as impaired for cadmium on the 2008 303(d) List, however recent data provide evidence of cadmium as a cause of water quality impairment on lower Belt Creek. Of 17 samples collected, two (12%) exceeded the chronic aquatic life criteria. Likewise cadmium concentration in four of five stream sediment samples collected exceeded PEL values established as supplemental indicators of impairment. Consequently, cadmium target exceedances are confirmed and a cadmium TMDL is provided for lower Belt Creek.

Iron

Lower Belt Creek is not listed as impaired for iron on the 2008 303(d) List, however recent data provide evidence of iron as a cause of water quality impairment on lower Belt Creek. Of 17 samples collected, two (12%) exceeded the chronic aquatic life criteria. Consequently, iron target exceedances are confirmed and an iron TMDL is provided for lower Belt Creek.

Salinity

Lower Belt Creek is listed as impaired for salinity on the 2008 303(d) List, primarily based on field measurements of water conductivity taken in 1997 through the town of Belt during extreme low flows. High conductivity measurements are the result of dissolved metals derived from AMD inputs, rather than typical salts (chloride) that are commonly associated with high salinity in surface waters. While conductivity values during extreme low flow can be high due to the increased influence of adit discharges on stream water quality, conductivity during most typical seasonal low-flow conditions appears to be below target levels. Of 17 conductivity measurements taken since 2003 on lower Belt Creek, all were within acceptable ranges, with a high of 737 uS/cm and an average of 473 uS/cm. However, conductivity can be significantly elevated during extreme low flow conditions when acid mine discharge from abandoned coal mining areas near the town of Belt can form a significant portion of Belt Creek's flow. As high conductivity values during low flow conditions are related to dissolved metals they are addressed through allocations and reductions provided for metals parameters.

Due to recent data demonstrating that conductivity levels that are within expected ranges, a salinity TMDL is not provided herein, but will remain listed as impaired for salinity until formal re-evaluation is conducted by the DEQ. In lieu of a salinity TMDL, TMDLs for metal-related causes of impairment will act as a surrogate TMDL for salinity/conductivity during extreme low flows, as attainment of metals targets will result in lower conductivity.

5.4.3.6 Cottonwood Creek MT41Q002_020

Cottonwood Creek is 4.3 miles in length and extends from about one mile upstream of Stockett, MT to its confluence with Sand Coulee Creek (**Appendix A, Figure 2-15**). Cottonwood Creek is on the 2008 303(d) List as being impaired for metals: cadmium, nickel and zinc.

Metals Sources
Anthropogenic metals sources are similar throughout the Sand Coulee Creek watershed (which includes Cottonwood Creek), and are comprised primarily of acid-mine discharge from a variety of abandoned coal mines from the Morrison Formation of the Great Falls-Lewistown Coal Field (GFLCF) of central Montana. The GFLCF was mined extensively for coal in the Stockett/Sand Coulee area from the late 1800s through 1950 via adits entering the coal seams at the bottom and sides of major coulees in the area. Today, mines are flooded with water and are generating acid-mine drainage that is impacting local surface and groundwater resources through direct adit discharges to stream and through infiltration of AMD waters to groundwater (Osborne et al., 1983a; Gammons et al., 2006).

While high streamflows are short in duration and driven by spring and early summer precipitation and runoff, baseflows in the Sand Coulee Creek watershed are primarily the result of groundwater discharge from the surficial Kootenai Formation. Rainfall is transmitted through the Kootenai to the underlying Morrison Formation where it discharges to local streams and groundwater through seeps and springs. Where coal seams in the Morrison have been mined, groundwater infiltrates historic mining areas creating acid water, high in dissolved metals concentrations, that can discharge to local streams and groundwater through adit openings, seeps and springs in the Morrison Formation. The extensiveness of subsurface mine workings, and the hydrologic connections between surficial recharge and subsurface transmittal of meteoric waters through the Kootenai and Morrison formation is complex. Metals sources are spread over a large area of underground workings, and are discharged to streams and groundwater through a variety of identified and unidentified adits, seeps and springs. Along Cottonwood Creek, there are multiple discharging adits, springs and seeps (**Appendix A, Figures 5-9**, **5-10**, **5-11**) that contribute acid-water and metals loads to Cottonwood Creek (Osborne et al., 1983a).

Available Water Quality Data
Metals water quality and sediment data were used to evaluate attainment of water quality targets in Cottonwood Creek. Data used for this evaluation consisted of recent (1994 to present) water quality data collected near the town of Stockett. Sixteen samples were collected, with 14 of these from below the town of Stockett and upstream from Number Five Coulee. **Appendix A, Figure 5-8** shows the location of these sampling stations on Cottonwood Creek. Three stream sediment samples were also collected in 2009 on Cottonwood Creek. A summary of relevant water quality and sediment data is given in **Table 5-15** and **5-16**.

Table 5-15. Cottonwood Creek Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Aluminum	Cadmium	Iron	Lead	Nickel	Zinc
# Samples	11	16	16	16	16	16
Min	<10	<0.04	<3.0	0.22	1.2	4.8
Max	1170	13.0	20100	17.20	1000	4800
Median	70	2.0	642	<10	75	139
# Acute Exceedances	1	1	NA	0	0	6
Acute Exceedance Rate	9%	6%	NA	0%	0%	38%
# Chronic Exceedances	5	8	7	0	6	6
Chronic Exceedance Rate	45%	50%	44%	0%	38%	38%

*All units in ug/L, Total Recoverable fraction

Table 5-16. Cottonwood Creek Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Aluminum	Cadmium	Iron	Lead	Nickel	Zinc
# Samples	3	3	3	3	3	3
Min	14100	0.56	22700	17.8	26.0	110
Max	99100	0.81	202000	66.2	90.5	578
Median	20100	0.56	34000	20.7	31.2	205
PEL Value	NA	3.53	NA	91.3	36.0	315
# Samples>PEL	NA	0	NA	0	1	1
PEL Exceedance Rate	NA	0%	NA	0%	33%	33%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

<u>Cadmium</u>

Cottonwood Creek is listed as impaired for cadmium on the 2008 303(d) List. Evaluation of data verifies this impairment listing. Of 16 samples collected, one exceeded the acute aquatic life criteria, and eight (50%) exceeded the chronic aquatic life criteria. Cadmium concentrations in stream sediment samples did not exceed PEL values. Due to exceedances of acute and chronic aquatic life criteria, a cadmium TMDL is provided for Cottonwood Creek.

<u>Nickel</u>

Cottonwood Creek is listed as impaired for nickel on the 2008 303(d) List. Evaluation of data verifies this impairment listing. Of 16 samples collected, six (38%) exceeded the chronic aquatic life criteria. Likewise nickel concentration in stream sediment samples collected downstream of Stockett exceeded PEL values established as supplemental indicators of impairment. Consequently, nickel target exceedances are confirmed and a nickel TMDL is provided for Cottonwood Creek.

<u>Zinc</u>

Cottonwood Creek is listed as impaired for zinc on the 2008 303(d) List. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 16 samples collected, 65 (31%) exceeded the acute aquatic life criteria. Likewise zinc concentration in stream sediment samples collected downstream of Stockett exceeded PEL values established as supplemental indicators of impairment. Consequently, zinc target exceedances are confirmed and a zinc TMDL is provided for Cottonwood Creek.

Aluminum

Cottonwood Creek is not listed as impaired for aluminum on the 2008 303(d) List, however recent data provide evidence of aluminum as a cause of water quality impairment on Cottonwood Creek. Of 11 samples collected, one exceeded the acute aquatic life criteria and five (45%) exceeded the chronic aquatic life criteria. Five additional samples were extremely high (>50,000 ug/L) in aluminum concentration, yet were associated with pH<6.5, precluding an evaluation of target compliance but providing evidence of large aluminum loads derived from mining activity. Aluminum concentration in stream sediment samples increased 7-fold below Stockett, and while aluminum PELs have not been established, high sediment concentrations downstream from the town of Stockett also provide evidence for in-stream aluminum sources that can contribute to impairment conditions in Cottonwood Creek. Due to exceedances of acute and chronic aquatic life criteria, an aluminum TMDL is provided for Cottonwood Creek.

Iron

Cottonwood Creek is not listed as impaired for iron on the 2008 303(d) List, however recent data provide evidence of iron as a cause of water quality impairment on Cottonwood Creek. Of 16 samples collected, seven (44%) exceeded the chronic aquatic life criteria for iron. Iron concentration in stream sediment samples increased 8-fold below Stockett, and while iron PELs have not been established, high sediment concentrations downstream from the town of Stockett also provide evidence for in-stream iron sources that can contribute to impairment conditions in Cottonwood Creek. Due to exceedances of chronic aquatic life criteria, an iron TMDL is provided for Cottonwood Creek.

5.4.3.7 Number Five Coulee MT41Q002_030

Number Five Coulee is 13.7 miles in length and extends from about one mile upstream of Stockett, MT to its confluence with Cottonwood Creek north of Stockett (**Appendix A, Figure 2-15**). Number Five Coulee is on the 2008 303(d) List as being impaired for metals: aluminum, cadmium, lead, nickel and zinc.

Metals Sources

Anthropogenic metals sources in Number Five Coulee are comprised primarily of acid-mine discharge from a variety of abandoned coal mines from the Morrison Formation of the Great Falls-Lewistown Coal Field (GFLCF) of central Montana. The GFLCF was mined extensively for coal in the Stockett/Sand Coulee area from the late 1800s through 1950 via adits entering the coal seams at the bottom and sides of major coulees in the area. Today, mines are flooded with water and are generating acid-mine drainage that is impacting local surface and groundwater resources through direct adit discharges to stream and through infiltration of AMD waters to groundwater (Osborne et al., 1983a; Gammons et al., 2006).

While high streamflows are short in duration and driven by spring and early summer precipitation and runoff, baseflows in the Sand Coulee Creek watershed are primarily the result of groundwater discharge from the surficial Kootenai Formation. Meteoric water is transmitted through the Kootenai to the underlying Morrison Formation where it discharges to local streams and groundwater through seeps and springs. Where coal seams in the Morrison have been mined, groundwater infiltrates historic mining areas creating acid water, high in dissolved metals concentrations, which can discharge to local streams and groundwater through adit openings, seeps and springs in the Morrison Formation. The extensiveness of subsurface mine workings, and the hydrologic connections between surficial recharge and subsurface transmittal of meteoric waters through the Kootenai and Morrison formation is complex. Metals sources are spread over a large area of underground workings, and are discharged to streams and groundwater through a variety of identified and unidentified adits, seeps and springs. Along Number Five Coulee, there are multiple discharging springs and seeps (**Appendix A, Figure 5-12**) that contribute acid-water and metals loads to the waterbody (Osborne et al., 1983b).

Available Water Quality Data

Metals water quality and sediment data were used to evaluate attainment of water quality targets in Number Five Coulee. Data used for this evaluation consisted of recent (1994 to present) water quality data collected near the town of Stockett: 39 samples were collected, with the majority of samples collected below Giffen Spring (near the town of Giffen) and at the mouth of Number Five Coulee. **Appendix A, Figure 5-8** shows the location of these sampling stations on Number Five Coulee. A single stream sediment sample was also collected in 2009. A summary of relevant water quality and sediment data is given in **Table 5-17** and **5-18**.

Table 5-17. Number Five Coulee Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Aluminum	Cadmium	Iron	Lead	Nickel	Zinc
# Samples	24	39	39	39	39	39
Min	17.2	0.04	3.0	0.1	3.8	3.0
Max	1700	14	63000	<10	470	1900
Median	70	2	27000	<1.0	290	1000
# Acute Exceedances	0	5	NA	0	0	25
Acute Exceedance Rate	0%	13%	NA	0%	0%	64%
# Chronic Exceedances	7	25	28	0	28	25
Chronic Exceedance Rate	29%	64%	72%	0%	72%	64%

*All units in ug/L, Total Recoverable fraction

Table 5-18. Number Five Coulee Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Aluminum	Cadmium	Iron	Lead	Nickel	Zinc
# Samples	1	1	1	1	1	1
Value	32800	4.2	171000	17.8	378	2450
PEL Value	NA	3.53	NA	91.3	36	315
# Samples>PEL	NA	1	NA	0	1	1
PEL Exceedance Rate	NA	100%	NA	0%	100%	100%

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Aluminum

Number Five Coulee is listed as impaired for aluminum on the 2008 303(d) List. Evaluation of data verifies this impairment listing. Of 39 samples collected, 15 were below pH of 6.5, precluding evaluation of numeric water quality standards. Of the 24 samples between pH of 6.5 to 9.0, seven (29%) exceeded the chronic aquatic life criteria. Due to exceedances of chronic aquatic life criteria, an aluminum TMDL is provided for Number Five Coulee.

Cadmium

Number Five Coulee is listed as impaired for cadmium on the 2008 303(d) List. Evaluation of data verifies this impairment listing. Of 39 samples collected, five (13%) exceeded the acute aquatic life criteria, and 25 (64%) exceeded the chronic aquatic life criteria. Cadmium concentration in the single stream sediment sample slightly exceeded the PEL value. Due to exceedances of acute and chronic aquatic life criteria, a cadmium TMDL is provided for Number Five Coulee.

Lead

Number Five Coulee is listed as impaired for lead on the 2008 303(d) List. All 39 water quality sample results were well below water quality criteria for lead, with the largest detection at 0.11 ug/L. Lead concentration in stream sediment was also below the PEL value. Due to recent data showing attainment of lead water quality targets, a lead TMDL is not provided herein, but will remain listed as impaired until formal re-evaluation is conducted by the DEQ.

Nickel

Number Five Coulee is listed as impaired for nickel on the 2008 303(d) List. Evaluation of data verifies this impairment listing. Of 39 samples collected, 28 (72%) exceeded the chronic aquatic life criteria. Likewise, nickel concentration in a single stream sediment sample exceeded PEL value. Consequently, nickel target exceedances are confirmed and a nickel TMDL is provided for Number Five Coulee.

Zinc

Number Five Coulee is listed as impaired for zinc on the 2008 303(d) List. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 39 samples collected, 25 (64%) exceeded the acute aquatic life criteria. Likewise zinc concentration in a stream sediment samples collected downstream of Giffen exceeded PEL values established as supplemental indicators of impairment. Consequently, zinc target exceedances are confirmed and a zinc TMDL is provided for Number Five Coulee.

Iron

Number Five Coulee is not listed as impaired for iron on the 2008 303(d) List, however recent data provide evidence of iron as a cause of water quality impairment in Number Five Coulee. Of 39 samples collected, 28 (72%) exceeded the chronic aquatic life criteria for iron. Due to exceedances of chronic aquatic life criteria, an iron TMDL is provided for Number Five Coulee.

5.4.3.8 Sand Coulee MT41Q002_060

Sand Coulee is 5.9 miles in length and extends from its headwaters above the town of Sand Coulee to its confluence with Sand Coulee Creek (**Appendix A, Figure 2-15**). Sand Coulee is on the 2008 303(d) List as being impaired for metals: aluminum, cadmium, nickel and zinc. Salinity is also listed as a cause of impairment on the 2008 303(d) List.

Metals Sources
Anthropogenic metals sources in Sand Coulee are comprised primarily of acid-mine discharge from abandoned coal mines from the Morrison Formation of the Great Falls-Lewistown Coal Field (GFLCF) of central Montana. The GFLCF was mined extensively for coal in the Stockett/Sand Coulee area from the late 1800s through 1950 via adits entering the coal seams at the bottom and sides of major coulees in the area. Today, mines are flooded with water and are generating acid-mine drainage that is impacting local surface and groundwater resources through direct adit discharges to stream and through infiltration of AMD waters to groundwater (Osborne et al., 1983a; Gammons et al., 2006).

While high streamflows are short in duration and driven by spring and early summer precipitation and runoff, baseflows in the Sand Coulee Creek watershed are primarily the result of groundwater discharge from the surficial Kootenai Formation. Meteoric water is transmitted through the Kootenai to the underlying Morrison Formation where it discharges to local streams and groundwater through seeps and springs. Where coal seams in the Morrison have been mined, groundwater infiltrates historic mining areas creating acid water, high in dissolved metals concentrations, which can discharge to local streams and groundwater through adit openings, seeps and springs in the Morrison Formation. The extensiveness of subsurface mine workings, and the hydrologic connections between surficial recharge and subsurface transmittal of meteoric waters through the Kootenai and Morrison formation is complex. Metals sources are spread over a large area of underground workings, and are discharged to streams and groundwater through a variety of identified and unidentified adits, seeps and springs.

Flows in Sand Coulee, also called ‘Straight Creek’ locally (Osborne et al., 1983a), are almost entirely made up of acid-mine discharge during low-flow periods, and typically infiltrate into the alluvium before reaching Sand Coulee Creek. Sand Coulee water quality is highly impacted by AMD waters and maintains an average pH of less than three, and high dissolved metals concentrations. **Appendix A, Figures 5-13** through **5-15** illustrate water quality conditions in Sand Coulee.

Available Water Quality Data
Metals water quality and sediment data were used to evaluate attainment of water quality targets in Sand Coulee. Data used for this evaluation consisted of recent (1994 to present) water quality data collected at sampling sites upstream and downstream from the town of Sand Coulee. A total of 13 samples were collected, with the majority of samples collected near the mouth of Sand Coulee. **Appendix A, Figure 5-16** shows the location of sampling stations in Sand Coulee. A single stream sediment sample was also collected in 2009. A summary of relevant water quality and sediment data is given in **Table 5-19** and **5-20**.

Table 5-19. Sand Coulee Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Aluminum	Cadmium	Copper	Iron	Nickel	Zinc
# Samples	13	11	12	13	13	13
Min	30	2	<10	7700	240	420
Max	706000	139	835	600000	6390	24700
Median	410000	34	130	429000	2800	11000
# Acute Exceedances	NA	10	10	NA	12	13
Acute Exceedance Rate	NA	91%	83%	NA	92%	100%
# Chronic Exceedances	NA	11	10	13	13	13
Chronic Exceedance Rate	NA	100%	83%	100%	100%	100%

*All units in ug/L, Total Recoverable fraction

Table 5-20. Sand Coulee Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Aluminum	Cadmium	Copper	Nickel	Zinc
# Samples	1	1	1	1	1
Value	21900	0.26	55.2	51	187
PEL Value	NA	3.53	197	36	315
# Samples>PEL	NA	0	0	1	0

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Aluminum

Sand Coulee is listed as impaired for aluminum on the 2008 303(d) List. Due to the influence of acid mine discharge, pH in Sand Coulee is typically below four. Because aluminum water quality criteria applies within a pH range of 6.5 to 9.0, aluminum in Sand Coulee Creek preclude evaluation based on the numeric criteria. However, given the extreme aluminum concentrations measured and its toxicity to aquatic life (Joan Baker and Carl Schofield, 1982), and the fact that aluminum impairment is present in other waterbodies (Cottonwood Creek, Number Five Coulee) from similar sources under applicable pH ranges, an aluminum TMDL is provided for Sand Coulee.

Cadmium

Sand Coulee is listed as impaired for cadmium on the 2008 303(d) List. Evaluation of data verifies this impairment listing. Of 11 samples collected, ten (91%) exceeded the acute aquatic life criteria. Cadmium concentration in the single stream sediment sample did not exceeded the PEL value, perhaps because metals are maintained in solution by low stream pH, thereby limiting precipitation. Due to exceedances of acute and chronic aquatic life criteria, a cadmium TMDL is provided for Sand Coulee.

Nickel

Sand Coulee is listed as impaired for nickel on the 2008 303(d) List. Evaluation of data verifies this impairment listing. Of 13 samples collected, 12 (92%) exceeded the acute aquatic life criteria. Likewise, nickel concentration in a single stream sediment sample exceeded PEL value. Due to exceedances of acute aquatic life criteria, a nickel TMDL is provided for Sand Coulee.

Zinc

Sand Coulee is listed as impaired for zinc on the 2008 303(d) List. Evaluation of data collected since the initial impairment listing verifies this impairment listing. Of 13 samples collected, all 13 (100%) exceeded the acute aquatic life criteria. Due to exceedances of acute aquatic life criteria, a zinc TMDL is provided for Sand Coulee.

Copper

Sand Coulee is not listed as impaired for copper on the 2008 303(d) List, however recent data provide evidence of copper as a cause of water quality impairment in Sand Coulee. Of 12 samples collected, ten (83%) exceeded the acute aquatic life criteria for copper. Due to exceedances of acute aquatic life criteria, a copper TMDL is provided for Sand Coulee.

Iron

Sand Coulee is not listed as impaired for iron on the 2008 303(d) List, however recent data provide evidence of iron as a cause of water quality impairment in Sand Coulee. Of 13 samples collected, all exceeded the chronic aquatic life criteria for iron. Due to exceedances of chronic aquatic life criteria, an iron TMDL is provided for Sand Coulee.

Salinity

Sand Coulee is listed as impaired for salinity on the 2008 303(d) List, primarily based on field measurements of water conductivity collected from 1994 through 1996. Conductivity during this time averaged over 4,000 uS/cm during the summer months, and greater than 2,000 uS/cm during the spring. As Sand Coulee is an AMD dominated stream, high conductivity measurements are the result of dissolved metals derived from AMD inputs, rather than typical salts that are commonly associated with high salinity in surface waters. As salinity impairments are directly related to AMD influences, a TMDL is not developed for salinity. Rather, TMDLs for metal-related causes of impairment will act as a surrogate TMDL for salinity/conductivity, as attainment of metals targets is expected to result in lower conductivity and attainment of salinity targets.

5.4.3.9 Sand Coulee Creek MT41Q002_040

Sand Coulee Creek segment MT41Q002_040 is 18.6 miles in length and extends from below Cottonwood Creek at the town of Centerville to its confluence with the Missouri River (**Appendix A, Figure 2-15**). Sand Coulee Creek is on the 2008 303(d) List as being impaired for metals lead and zinc. Salinity is also listed as a cause of impairment on the 2008 303(d) List.

Metals Sources

Anthropogenic metals sources in Sand Coulee Creek are similar throughout the watershed, and are comprised primarily of acid-mine discharge from abandoned coal mines from the Morrison Formation of the Great Falls-Lewistown Coal Field (GFLCF) of central Montana. The GFLCF was mined extensively for coal in the Stockett/Sand Coulee area from the late 1800s through 1950 via adits entering the coal seams at the bottom and sides of major coulees in the area. Today, mines are flooded with water and are generating acid-mine drainage that is impacting local surface and groundwater resources through direct adit discharges to stream and through infiltration of AMD waters to groundwater (Osborne et al., 1983a; Gammons et al., 2006).

While high streamflows are short in duration and driven by spring and early summer precipitation and runoff, baseflows in the Sand Coulee Creek watershed are primarily the result of groundwater discharge from the surficial Kootenai Formation. Meteoric water is transmitted through the Kootenai to the underlying Morrison Formation where it discharges to local streams and groundwater through seeps and springs. Where coal seams in the Morrison have been mined, groundwater infiltrates historic mining areas creating acid water, high in dissolved metals concentrations, which can discharge to local streams and groundwater through adit openings, seeps and springs in the Morrison Formation. The extensiveness of subsurface mine workings, and the hydrologic connections between surficial recharge and subsurface transmittal of meteoric waters through the Kootenai and Morrison formation is complex. Metals sources are spread over a large area of underground workings, and are discharged to streams and groundwater through a variety of identified and unidentified adits, seeps and springs.

During low-flow summer periods, Sand Coulee Creek is dry in many places, and the stream channel in the lower portions of Sand Coulee Creek below the town of Tracy consists primarily on groundwater-fed standing water. Abandoned mining sources along Sand Coulee Creek are less prevalent than in some of its impacted tributaries (Sand Coulee, Number Five Coulee, and Cottonwood Creek). Most major historic coal mining activity occurs in these upper tributaries to Sand Coulee Creek, and impacts tributary waters upstream from Tracy.

Available Water Quality Data

Metals water quality and sediment data were used to evaluate attainment of water quality targets in Sand Coulee Creek. Though water quality data for the segment is limited; data used for this evaluation consisted of recent (2009) water quality data collected at sampling sites within the segment downstream from the town of Centerville. A total of four samples were collected in 2009, with only a single late-summer low flow sample collected due to dry streambed conditions. **Appendix A, Figure 5-17** shows the location of sampling stations in Sand Coulee Creek. A single stream sediment samples was also collected in 2009. And while several samples were collected upstream of Centerville, these samples were collected above the stream segment of concern, and are not included in evaluation of metals targets for Sand Coulee Creek segment MT41Q002_040. A summary of relevant water quality and sediment data is given in **Table 5-21** and **5-22**.

Table 5-21. Sand Coulee Creek Water Metals Water Quality Data Summary and Aquatic Life Target Exceedances

Parameter*	Lead	Zinc
# Samples	4	4
Min	0.06	<2.50
Max	0.47	5.70
Median	0.27	<2.5
# Acute Exceedances	0	0
Acute Exceedance Rate	0%	0%
# Chronic Exceedances	0	0
Chronic Exceedance Rate	0%	0%

*All units in ug/L, Total Recoverable fraction

Table 5-22. Sand Coulee Creek Water Metals Sediment Quality Data Summary and Target Exceedances

Parameter*	Lead	Zinc
# Samples	1	1
Value	76.8	619
PEL Value	91.3	315
# Samples>PEL	0	1

*All units in mg/kg dry weight

Comparison of Metals Concentrations to Water Quality Targets and TMDL Determination

Lead

Sand Coulee Creek is listed as impaired for lead on the 2008 303(d) List, based on a single sample collected in 1995. Review of data used to make the initial impairment listing for lead suggests that this listing is uncertain and should be re-evaluated. While recent lead water quality samples are limited, all four water quality sample results collected in 2009 were well below water quality criteria for lead, with the largest detection at 0.47 ug/L. Dissolved lead concentrations in ten water quality samples on Sand Coulee Creek above the town of Centerville (just upstream of the impaired segment) all showed non-detects at a detection limit of 10 ug/L at an average water quality hardness ~200 mg/L. (At a water hardness of 200 mg/L, the chronic aquatic life criteria for lead is 7.7 ug/L, precluding evaluation of these samples to determine whether aquatic life criteria is being met). Lead concentration in stream sediment was also below the PEL value. Due to uncertain listing analysis and recent data showing attainment of lead water quality targets, a lead TMDL is not provided herein, but will remain listed as impaired until formal re-evaluation is conducted by the DEQ.

Zinc

Sand Coulee Creek is listed as impaired for zinc on the 2008 303(d) List. Review of data used to make the initial impairment listing for zinc suggest that the basis for this listing is uncertain. While recent lead water quality samples are limited, all four water quality sample results were well below water quality criteria for zinc, with the largest detection at 5.7 ug/L. And, while zinc concentration in a single stream sediment was above the PEL value, given the low sample size, a zinc TMDL is not provided herein, but will remain listed as impaired until formal re-evaluation is conducted by the DEQ.

Salinity

Sand Coulee Creek is listed as impaired for salinity on the 2008 303(d) List, primarily based on field measurements of water conductivity. While data collected in 2009 showed high conductivity results in the lower portions of the segment, data was collected from standing pools and may reflect a variety of dissolved constituents derived from groundwater contributions. Dissolved metals concentrations at these sites were not exceptionally elevated, suggesting that metals in lower Sand Coulee Creek may not be contributing substantially to high conductivity observed. As the source of salinity impairment in Sand Coulee Creek may not be the result of metals contamination, salinity impairments are not addressed in this document and a salinity TMDL is not provided herein. Sand Coulee Creek will remain listed as impaired for salinity. It is recommended that addition monitoring be conducted to ascertain sources and mechanisms contributing to high conductivity levels in lower Sand Coulee Creek.

5.4.4 Metals Target Attainment Evaluation and TMDL Development Summary

Nine individual stream segments were listed as impaired for metals-related impairments in the Belt and Missouri-Cascade TMDL Planning Areas. Review of metals target exceedances verified most metals impairments on the 2008 303(d) List, however target exceedances could not be verified for listed metals on some stream segments. Likewise, several stream exhibited target exceedances for metals that do not appear on the 2008 303(d) List. **Table 5-23** presents a summary of existing metals impairment causes and metals for which target exceedances were confirmed and for which TMDLs are prepared. A total of 45 metals requiring TMDLs are identified. TMDLs and allocations for these parameters are given in the following section.

Table 5-23. Summary of metals for which TMDLs are prepared

Waterbody	Waterbody Segment ID	Metal Impairment Causes (2008 303(d) List)	Metals TMDLs Prepared
Belt Creek, upper (Headwaters to Big Otter Creek)	MT41U001_011	Arsenic Chromium (total) Copper Lead Zinc Salinity	Arsenic Cadmium Copper Lead Zinc
Belt Creek, lower (Big Otter Creek to mouth)	MT41U001_012	Arsenic Chromium (total) Copper Lead Zinc Salinity*	Arsenic Cadmium Iron Lead Zinc
Carpenter Creek	MT41U002_010	Cadmium Copper Lead Mercury	Arsenic Cadmium Copper Lead Iron Silver Zinc
Galena Creek	MT41U002_020	Antimony Arsenic Cadmium Copper Lead Zinc	Arsenic Cadmium Copper Lead Iron Zinc
Dry Fork Belt Creek	MT41U002_030	Cadmium Copper Lead Zinc	Arsenic Cadmium Copper Lead Iron Zinc
Cottonwood Creek	MT41Q002_020	Cadmium Nickel Zinc	Aluminum Cadmium Iron Nickel Zinc

Table 5-23. Summary of metals for which TMDLs are prepared

Waterbody	Waterbody Segment ID	Metal Impairment Causes (2008 303(d) List)	Metals TMDLs Prepared
Number Five Coulee	MT41Q002_030	Aluminum Cadmium Lead Nickel Zinc	Aluminum Cadmium Iron Nickel Zinc
Sand Coulee Creek	MT41Q002_040	Lead Zinc Salinity	None
Sand Coulee	MT41Q002_060	Aluminum Cadmium Nickel Zinc Salinity*	Aluminum Cadmium Copper Iron Nickel Zinc

*Salinity listings are addressed via surrogate metals TMDLs

5.5 Metals TMDLs and Allocations

5.5.1 Metals TMDLs

As summarized in **Table 5-23**, metals total maximum daily loads are presented herein for impaired waterbodies in the Belt and Missouri-Cascade TMDL planning areas. A Total Maximum Daily Load (TMDL) is a calculation of the maximum pollutant load a waterbody can receive while maintaining water quality standards. The total maximum daily load is based on the most stringent applicable water quality criteria established in **Section 5.4.2.1** and the stream flow. With most metals, the chronic aquatic life criteria will be used to calculate the TMDL. Under high water hardness conditions however, the human health criteria for nickel and lead may apply (see **Figures 5-23** and **5-24**). In the case of arsenic and mercury, the human health criteria applies, as it is the most stringent standard. **Appendix A, Figures 5-18** through **5-26** show TMDLs for aluminum, arsenic, cadmium, copper, iron, lead, nickel, silver and zinc under various flow conditions. Where aquatic life criteria are variable based on hardness, TMDLs at a water hardness of 25 mg/L and 400 mg/L are shown. TMDLs based on human health criteria are also shown where appropriate.

Because stream flow and hardness vary seasonally, the TMDL is expressed not as a static value, but as an equation. The TMDL under a specific flow condition is calculated using the following formula:

TMDL = (X) (Y) (k)

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

The TMDL equation and curves are applicable to all metals TMDLs within this document and provide a graphical reference for illustrating TMDLs for applicable metals under variable flow and hardness conditions.

5.5.2 Metals Allocations

Metals TMDLs are allocated to point (wasteload) and nonpoint (load) sources. The TMDL is comprised of the sum of all significant point and nonpoint metals sources (natural and anthropogenic), plus a margin of safety that accounts for uncertainties in loading and receiving water analyses. In addition to metals load allocations, the TMDL must also take into account the seasonal variability of metals loads and adaptive management strategies in order to address uncertainties inherent in environmental analyses.

These elements are combined in the following equation:

TMDL = ∑WLA + ∑LA + MOS

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

Within the Missouri-Cascade and Belt TMDL Planning Areas, significant metals sources are primarily those derived from historic and abandoned mining activity over the past one hundred and fifty years. Mining sources are prevalent at several locations throughout the affected watersheds and have been well defined through previous investigations and studies supporting Superfund and remediation planning activity (see previous sections). An in-depth assessment of metals sources is not conducted herein. Rather, loading estimates from these known sources are provided using data and information gleaned from aforementioned investigations, and form the basis for metals load allocations and load reductions necessary to meet water quality criteria. Aside from metals sources associated with mining activity, other sources of metals are not believed to be a significant source contributing to water quality impairment and appear to be within naturally-occurring concentrations.

Metals source load allocations are provided for the following source categories:

- Naturally occurring metals sources
- Abandoned mining sources
- Permitted MPDES point-source discharges

Naturally occurring metals sources
Naturally occurring sources will be provided a load allocation (LA) in lbs/day based on naturally occurring metals concentrations and streamflow. Naturally occurring metals sources are those metals source that occur naturally within the watershed. As defined in ARM 17.30.602, naturally occurring sources also include *”those sources from developed areas where all reasonable land, soil and water conservation practices have been applied.”* Within the Missouri-Cascade and Belt TMDL planning areas, naturally-occurring metals concentrations are established by using in-

stream data upstream of mining sources or from locally unimpacted watersheds where metals sources are limited to those associated with natural background and low-level development. It must be noted that data from unimpacted sites within the Sand Coulee Creek watershed were not available, so natural background values from the Belt Creek TPA were used to estimate natural background values in the Sand Coulee watershed as well.

Within the Belt TMDL Planning Area, naturally-occurring metals concentrations were estimated from 13 samples taken on Upper Belt Creek, Dry Fork Belt Creek, and Carpenter Creek during both high and low flow conditions. All samples were taken upstream of developed mining lands and represent water quality conditions where "all reasonable land and soil water conservation practices have been applied." From this data set, the 75^{th} percentile metals concentration was chosen as an estimation of naturally-occurring metals concentration. In many cases, non-detects were recorded for most metals; for purposes of data analysis half the lowest detection limit was substituted for the result value. **Table 5-24** shows estimates of naturally occurring metals concentration in the Belt and Sand Coulee TMDL planning areas. These values are used to calculate load allocations to naturally occurring metals sources for impaired waterbodies.

Table 5-24. Naturally occurring metals concentrations in the Missouri-Cascade and Belt TMDL Planning Areas

Metal	Number of Samples	75^{th} Percentile value (ug/L)
Aluminum	13	38.2
Arsenic	13	1.5
Cadmium	13	0.02
Copper	13	2.5
Iron	13	110
Lead	13	1.0
Nickel	13	2.5
Silver	13	0.13
Zinc	13	5.0

Abandoned mining sources

Abandoned mining sources include a variety of discrete sources associated with historic abandoned mining activity and are typically categorized as adits, seeps, tailings piles, floodplain deposits, and other associated mining waste. Give the pervasive nature of abandoned mining activity in the affected watersheds, the sum of all abandoned mining sources contributing to a waterbody segment are treated as a composite non-permitted point source, and a composite wasteload allocation is provided for these non-permitted point sources. Composite waste loads to abandoned mining sources are calculated as the difference between the TMDL and the load allocation to naturally occurring sources and any waste loads to permitted discharges.

Permitted MPDES point-source discharges

MPDES discharges permitted by the DEQ are also provided a wasteload allocation. Two individual municipal wastewater MPDES permits exist within the Missouri-Cascade and Belt TMDL Planning Areas: Permit MT0021571 (Town of Belt) and Permit MT0030091 (Town of Stockett). Both permitted facilities are lagoon systems that discharge to impaired streams, Belt Creek and Cottonwood Creek, respectively. Metals concentrations in existing discharges are unknown (no metals data exists for permitted discharges), precluding estimates of existing metals loads. Recent permit renewals, however, include monitoring requirements for impaired metals, which will allow evaluation of metals loading in subsequent analyses. As point-sources, both permitted sources will be provided wasteload allocations, calculated using the most stringent water quality criteria and the actual discharge flow of the facility. The waste load allocation under a specific discharge flow is calculated using the following formula:

$$\mathbf{WLA_{MPDES} = (X)\,(Y)\,(k)}$$

WLA= Waste Load Allocation to MPDES- permitted discharges
X= lowest applicable metals water quality target in ug/L for a specific in-stream hardness value
Y= discharge flow in gallons per day
k = conversion factor

5.5.3 Allocations by Waterbody Segment

In the sections that follow, a loading summary and source load allocations are provided for each pollutant-waterbody combination for which a TMDL is prepared (see **Table 5-23**). Loading summaries are based on the sample data used for evaluation of metals target evaluations in **Section 5.4.3**. For each metal, water quality sample data are used to calculate metals loading estimates and the required percent load reduction to achieve the TMDL for each metal. Load estimations and allocations are based on a limited data set and are assumed to approximate general metals loading during high and low flow conditions. TMDLs and allocation summary results provided for each waterbody are calculated by averaging all available high and low flow loading events measured at the mouth of each water body segment.

5.5.3.1 Carpenter Creek MT41U002_010

Abandoned mine sources in the Carpenter Creek watershed are responsible for significant metals loading to Carpenter Creek. As there are no permitted point-sources in the watershed, metals load allocations consist of a composite wasteload allocation to abandoned mining sources and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 5.6**). Metals TMDLs for Carpenter Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$$TMDL_{Carpenter} = LA_{nat} + WLA_{abmine}$$

LA_{nat} = Load allocation to naturally occurring sources in the watershed
WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

Metals TMDLs and allocations for Carpenter Creek are calculated at the mouth of Carpenter Creek for typical high and low flow water quality conditions. Because water hardness, flows and metals concentrations are variable throughout the seasons, loads and TMDLs presented herein represent average loading conditions calculated from a variety of separate high and low flow sampling events. **Table 5-25** summarizes metals TMDLs and load allocations for Carpenter Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Table 5-25. Carpenter Creek: Metals TMDLs and Allocation Summary

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	1.753	0.263	1.490	0.439	NA
	Low flow	0.103	0.015	0.088	0.006	NA
Cadmium	High flow	0.027	0.0035	0.0241	0.755	96.3%
	Low flow	0.002	0.0002	0.0021	0.058	95.9%
Copper	High flow	0.877	0.438	0.439	32.3	97.3%
	Low flow	0.079	0.025	0.053	0.669	88.1%
Iron	High flow	234	25.7	208	402	41.8%
	Low flow	10.3	1.13	9.21	6.53	NA
Lead	High flow	0.2217	0.175	0.046	58.54	99.6%
	Low flow	0.024	0.010	0.014	0.59	95.8%
Silver	High flow	0.319	0.030	0.288	0.609	47.6%
	Low flow	0.029	0.001	0.027	0.005	NA
Zinc	High flow	11.3	0.9	10.5	135	91.6%
	Low flow	1.02	0.052	0.968	11.0	90.8%

For most metals, both high and low flow reductions are necessary to meet water quality targets. This is understandable given the extent of mining-related soil and water quality contamination in Carpenter Creek watershed. For TMDLs with no reductions indicated (NA), arsenic for instance, TMDLs and allocations are calculated; however, water quality data precludes calculation of load reductions, as empirical water quality data did not record in-stream exceedences of water quality targets. Remediation activities to reduce metals loads are expected to also address sediment-related toxicity and metals-related impairment to beneficial uses.

5.5.3.2 Galena Creek MT41U002_020

Abandoned mine sources in the Galena Creek watershed are responsible for significant metals loading to Galena Creek. As there are no permitted point-sources in the watershed, metals load allocations consist of a composite wasteload allocation to abandoned mining sources and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 5.6**). Metals TMDLs for Galena Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{Galena} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

Metals TMDLs and allocations for Galena Creek are calculated at the mouth of Galena Creek for typical high and low flow water quality conditions. Because water hardness, flows and metals concentrations are variable throughout the seasons, loads and TMDLs presented herein represent average loading conditions calculated from individual high and low flow sampling events. **Table 5-26** summarizes metals TMDLs and load allocations for Galena Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Table 5-26. Galena Creek: Metals TMDLs and Allocation Summary

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	0.380	0.057	0.323	0.657	42.1%
	Low flow	0.103	0.015	0.087	0.135	23.8%
Cadmium	High flow	0.009	0.001	0.008	0.377	97.7%
	Low flow	0.003	0.0002	0.003	0.135	97.4%
Copper	High flow	0.30	0.10	0.20	2.39	87.5%
	Low flow	0.13	0.03	0.10	0.67	81.3%
Iron	High flow	38.0	4.2	33.9	160.3	76.3%
	Low flow	10.3	1.1	9.2	39.6	74.0%
Lead	High flow	0.094	0.038	0.056	1.557	93.9%
	Low flow	0.049	0.010	0.039	0.590	91.7%
Zinc	High flow	3.84	0.19	3.65	86.37	95.5%
	Low flow	1.60	0.05	1.55	30.49	94.7%

For metals in Galena Creek, both high and low flow reductions are necessary to meet water quality targets. This is understandable given the extent of mining-related soil and water quality contamination in Galena Creek watershed.

5.5.3.3 Dry Fork Belt Creek MT41U002_030

Abandoned mine sources in the Galena Creek watershed and tailings and mine wastes along Dry Fork Belt Creek are responsible for significant metals loading to Dry Fork Belt Creek. Allocations to metals sources are given for Galena Creek in the previous section and are included in the load and composite waste load allocations provided herein for Dry Fork Belt Creek. As there are no permitted point-sources in the watershed, metals load allocations consist of a composite wasteload allocation to abandoned mining sources and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 5.6**). Metals TMDLs for Galena Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{DFBC} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

Metals TMDLs and allocations for Dry Fork Belt Creek are calculated at the mouth of Dry Fork Belt Creek for typical high and low flow water quality conditions. Because water hardness, flows and metals concentrations are variable throughout the seasons, loads and TMDLs presented herein represent average loading conditions calculated from individual high and low flow sampling events. **Table 5-27** summarizes metals TMDLs and load allocations for Dry Fork Belt Creek. Percent reduction values are the necessary load reduction to meet the TMDL.

Table 5-27. Dry Fork Belt Creek: Metals TMDLs and Allocation Summary

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	5.21	0.78	4.43	0.59	NA
	Low flow	0.17	0.03	0.14	0.02	NA
Cadmium	High flow	0.114	0.010	0.103	0.316	63.9%
	Low flow	0.006	0.0003	0.005	0.003	NA
Copper	High flow	3.80	1.30	2.50	2.21	NA
	Low flow	0.21	0.04	0.16	0.05	NA
Iron	High flow	521.4	57.4	464.0	148.2	NA
	Low flow	17.0	1.9	15.2	4.3	NA
Lead	High flow	1.15	0.52	0.63	1.67	31.2%
	Low flow	0.08	0.02	0.06	0.01	NA
Zinc	High flow	48.9	2.6	46.3	72.6	32.7%
	Low flow	2.7	0.1	2.6	0.8	NA

Exceedances of metals target values at the mouth of Dry Fork Belt Creek typically occurred during high flow conditions; however high and low flow exceedances of most metals is common in Dry Fork Belt Creek just downstream from its confluence with Galena Creek. This is understandable given the extent of mining-related soil and water quality contamination in Galena Creek watershed; however, several tailings piles and mining impacts are present along the length of Dry fork Belt Creek, too. High quality waters from tributaries downstream of Galena Creek augment the flow of Dry Fork Belt Creek and provide dilution to metals loads derived from Galena Creek, resulting in lower metals concentrations and partial attainment of water quality targets at the mouth of Dry Fork Belt Creek for some metals (Cu, As, Fe). Sediment metals concentrations, however, remain elevated throughout the reach and may influence metals concentrations at the mouth during extreme flow events. It is expected that meeting metals allocations and metals loading reductions in Galena Creek will significantly reduce metals loads entering Dry Fork Belt Creek, and assist in attainment of water quality targets and allocation in Dry Fork Belt Creek.

5.5.3.4 Upper Belt Creek MT41U001_011

Anthropogenic metals sources in the upper Belt Creek watershed are comprised primarily of abandoned mining activity from two National Priorities List (NPL) or 'Superfund' sites: the Carpenter - Snow Creek Mining District and the Barker-Hughesville Mining District in the Carpenter Creek and Dry Fork Belt Creek watersheds, respectively. Allocations to metals sources are given for these waterbodies in the previous sections and are included in the load and composite waste load allocations provided herein for upper Belt Creek. In addition to abandoned mine sources in the Carpenter Creek and Dry Fork Belt Creek, several high-priority mine sites with flowing adits and mine spoils are present along upper Belt Creek in and around the town of Neihart, upstream from Carpenter Creek (**Appendix A, Figure 5-6**). Under the Superfund program, remedial design and action has begun in the Neihart area. In 2004, contaminated soils, tailings piles and hillslopes in and around the town were removed or treated and a Record of Decision that addresses further remedial actions was approved in 2009 (US Environmental Protection Agency, 2009).

As there are no permitted point-sources, metals load allocations consist of a composite wasteload allocation to abandoned mining sources and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 5.6**). Metals TMDLs for upper Belt Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{UBelt} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all abandoned mining sources in the watershed

Most metals water quality target exceedances on upper Belt Creek are observed below tributaries heavily impacted by mining, specifically below Dry Fork Belt Greek (Galena Creek), and Carpenter Creek. High quality waters from tributary inputs augments the flow of Belt Creek lower downstream and dilute metals sourced from mining-impacted tributaries in the upper portion of Belt Creek. With the exception of a single high-flow lead exceedance, sites in the lower portion of the segment were in attainment with water quality targets. Because water hardness, flows and metals concentrations are variable throughout the seasons, loads and TMDLs presented herein represent average loading conditions calculated from individual high and low flow sampling events. **Table 5-28** summarizes metals TMDLs and load allocations for upper Belt Creek, calculated at the end of the segment.

Table 5-28. Upper Belt Creek: Metals TMDLs and Allocation Summary

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Arsenic	High flow	14.73	2.21	12.52	0.87	NA
	Low flow	1.46	0.22	1.24	0.10	NA
Cadmium	High flow	0.370	0.029	0.341	0.27	NA
	Low flow	0.055	0.003	0.052	0.02	NA
Copper	High flow	12.6	3.68	8.94	4.42	NA
	Low flow	2.0	0.36	1.63	0.35	NA
Lead	High flow	4.13	1.47	2.65	4.71	12.4%
	Low flow	0.82	0.15	0.68	0.41	NA
Zinc	High flow	162	7	155	54	NA
	Low flow	26	1	25	3	NA

Metals TMDLs and allocations for upper Belt Creek are calculated at the end of the segment (confluence with Big Otter Creek) for typical high and low flow water quality conditions. Due to flow augmentation and dilution of metals from upstream sources, most metals are attaining water quality targets and meeting the TMDL at the end of the segment. Consequently, TMDLs and allocations are provided, but percent load reductions for many metals are not given. It is expected that composite mining waste load allocations and reductions provided for tributaries Galena Creek and Carpenter Creek, when achieved, will result in attainment of composite wasteload allocations for the whole of upper Belt Creek.

5.5.3.5 Lower Belt Creek MT41U001_012

Anthropogenic metals sources in the lower Belt Creek watershed are comprised primarily of abandoned mining activity from two National Priorities List (NPL) or ‘Superfund’ sites in the upper Belt Creek watershed, and from abandoned coal mining and acid-mine discharge entering Belt Creek near the town of Belt along lower Belt Creek. Due to flow augmentation and dilution of metals loads entering upper Belt Creek from the two NPL sites in the upper watershed, metals water quality targets at the upstream end of the segment are being attained under most flow conditions.

Historic coal mining in and around the town of Belt has resulted in acid mine drainage from several abandoned adits and mine drains that has impacted Belt Creek and local groundwater. The largest of these discharges comes from the Anaconda Mine drain (**Appendix A, Figures 5-7a** and **5-7b**) Additional mine discharges from the French Coulee Mine Drain, the Lewis Coulee Mine and the Brodie, Meisted and Millard Mines also impact water quality and groundwater resources through the town of Belt. Metals water quality target exceedances on lower Belt Creek were observed below the Anaconda Mine Drain only during extreme low flows (<1cfs) when water quality in Belt Creek is severely compromised by acid mine discharge and metals concentrations in sediment below the Anaconda Drain are also significantly elevated as a result of metals from the low-pH acid mine water being precipitated from solution upon entering Belt Creek.

The town of Belt operates a permitted wastewater treatment lagoon facility that discharges to Belt Creek (MPDES Permit No. MT0021571) for which a wasteload allocation will be provided. Wasteload allocations to permitted discharges in the Planning Area are calculated using the formula in **Section 5.5.2**. To illustrate the waste allocation for a specific flow, the average daily discharge, as reported in recent discharge monitoring reports, of 0.05 million gallons per day (mgd) is used to calculate the average wasteload allocation.

Metals load allocations consist of a composite wasteload allocation to abandoned mining sources, a wasteload allocation to the city of Belt wastewater treatment facility, and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 5.6**). Metals TMDLs for upper Belt Creek are therefore the sum of the two waste load allocations and the load allocation to naturally-occurring sources:

$$TMDL_{LBelt} = LA_{nat} + WLA_{abmine} + WLA_{Belt}$$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all non-permitted abandoned mining sources in the watershed

WLA_{Belt} = Wasteload allocation to City of Belt permitted wastewater treatment facility

Because water hardness, flows and metals concentrations are variable throughout the seasons, loads and TMDLs presented herein represent average loading conditions calculated from individual high and low flow sampling events conducted in 2009 by the DEQ. Actual TMDLs and allocations are variable and dependent upon streamflow and water quality conditions. **Table 5-29** summarizes metals TMDLs and load allocations for lower Belt Creek, calculated based on flows and metals concentrations measured at the downstream end of the segment.

Table 5-29. Lower Belt Creek: Metals TMDLs and Allocation Summary

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	WLA_{Belt}	Existing Load	Percent Reduction
Arsenic	High flow	18.27	2.74	15.53	0.0042	1.41	NA
	Low flow	1.36	0.20	1.16	0.0042	0.09	NA
Cadmium	High flow	0.590	0.037	0.554	0.00013	0.219	NA
	Low flow	0.065	0.003	0.062	0.00020	0.003	NA
Iron	High flow	1827	201	1626	0.417	932	NA
	Low flow	136	15.0	121.1	0.417	55	NA
Lead	High flow	33.9	1.827	6.05	0.0018	4.6	NA
	Low flow	2.5	0.136	1.02	0.0035	0.05	NA
Zinc	High flow	709	9.1	258.9	0.061	40.2	NA
	Low flow	53	0.7	30.6	0.096	0.3	NA

During normal ranges of flows (>10cfs), it appears that metals water quality targets and load allocations are being met in lower Belt Creek, however metals from acid mine discharge continue to accumulate in sediments in toxic levels, particularly immediately downstream from the Anaconda Mine Drain. Consequently, TMDLs and allocations are provided, but percent load reductions for many metals are not given as water quality data precludes calculation of load reductions during normal flows. Composite abandoned mining waste load allocations apply at all flows, and when achieved at extreme low flows in lower Belt Creek, will result in attainment of both sediment and water quality targets.

5.5.3.6 Cottonwood Creek MT41Q002_020

Anthropogenic metals sources are similar throughout the Cottonwood Creek watershed, and are comprised primarily of acid-mine discharge from a variety of abandoned coal mines from the Morrison Formation of the Great Falls-Lewistown Coal Field (GFLCF) of central Montana. The GFLCF was mined extensively for coal in the Stockett/Sand Coulee area from the late 1800s through 1950 via adits entering the coal seams at the bottom and sides of major coulees in the area. Today, mines are flooded with water and are generating acid-mine drainage that is impacting local surface and groundwater resources through direct adit discharges to stream and through infiltration of AMD waters to groundwater (Osborne et al., 1983a; Gammons et al., 2006). The extensiveness of subsurface mine workings, and the hydrologic connections between surficial recharge and subsurface transmittal of meteoric waters through the Kootenai and Morrison formation is complex. Metals sources are spread over a large area of underground workings, and are discharged to streams and groundwater through a variety of identified and unidentified adits, seeps and springs. Along Cottonwood Creek, there are multiple discharging adits, springs and seeps (**Appendix A, Figures 5-9**, **5-10**, **5-11**) that contribute acid-water and metals loads to Cottonwood Creek (Osborne et al., 1983a). Cumulatively, these adits, seeps and acid-springs are provided a composite abandoned mining wasteload allocation.

The Town of Stockett operates a permitted wastewater treatment facility (WWTF) that discharges to Cottonwood Creek (MPDES Permit No. MT0030091) for which a wasteload allocation is provided. The Stockett WWTF is a small discharger with less than 0.10 mgd design flow, however discharge flows from the Stockett lagoon to Cottonwood Creek are intermittent and exceed daily design flows during most discharging periods. Discharge flow measurements, however, are limited and do not allow calculation of average discharge volumes. Wasteload allocations to permitted discharges in the Planning Area are calculated using the formula in **Section 5.5.2** which ensures that permitted discharges do not contribute to water quality exceedances under all discharge flow volumes. To illustrate the waste allocation for a specific stream flow however, the maximum average daily flow during discharge events , as reported in recent discharge monitoring reports, of 0.144 million gallons per day (mgd) is used to calculate the average wasteload allocation during periods of discharge.

Metals load allocations consist of a composite wasteload allocation to abandoned mining sources, a wasteload allocation to the town of Stockett wastewater treatment facility, and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 5.6**). Metals TMDLs for Cottonwood Creek are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$$TMDL_{Cottonwood} = LA_{nat} + WLA_{abmine} + WLA_{Stockett}$$

LA_{nat} = Load allocation to naturally occurring sources in the watershed
WLA_{abmine} = Composite wasteload allocation to all non-permitted abandoned mining sources in the watershed
$WLA_{Stockett}$ = Wasteload allocation to Town of Stockett permitted wastewater treatment facility

Metals water quality data and target exceedances on Cottonwood Creek were recorded during a variety of flow conditions from 1994-1996 and provide the basis for loading calculations. Because water hardness, flows and metals concentrations are variable throughout the seasons, loads and TMDLs presented herein represent average loading conditions calculated from individual high (>4 cfs) and low (<4 cfs) flow sampling events. **Table 5-30** summarizes metals TMDLs and load allocations for Cottonwood Creek, calculated for the lower portion of the segment using data collected downstream from the town of Stockett.

Table 5-30. Cottonwood Creek: Metals TMDLs and Allocation Summary

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	$WLA_{Stockett}$	Existing Load	Percent Reduction
Aluminum	High	4.338	1.91	2.35	0.08	3.51	NA
	Low	0.150	0.029	0.11	0.0095	0.23	35.2%
Cadmium	High	0.034	0.001	0.032	0.0007	0.08	58.3%
	Low	0.0023	0.00004	0.0016	0.0007	0.015	84.5%
Iron	High	49.9	5.49	43.4	0.95	9.56	NA
	Low	3.08	0.23	1.90	0.95	8.42	63.4%
Nickel	High	4.986	0.125	4.701	0.16053	5.83	14.5%
	Low	0.3082	0.00532	0.1423	0.16053	1.5682	80.3%
Zinc	High	17.3	0.249	16.7	0.37	7.58	NA
	Low	1.20	0.011	0.82	0.37	7.05	83.1%

Metals TMDLs and allocations for Cottonwood Creek are calculated at the end of the segment for typical high and low flow water quality conditions. With the exception of cadmium and nickel, TMDLs are being met under most high flow (>4cfs) conditions when increased flows from either seasonal runoff or wet conditions contribute to dilution of acid mine discharge.

TMDLs are not being met under most low-flow (<4 cfs) conditions when acid mine discharge has a greater influence on in-stream metals concentrations. It is expected that composite mining waste load allocations and reductions, when achieved, will result in attainment of TMDLs under all flow conditions.

5.5.3.7 Number Five Coulee MT41Q002_030

Anthropogenic metals sources are similar throughout the Number Five Coulee watershed, and are comprised primarily of acid-mine discharge from a variety of abandoned coal mines from the Morrison Formation of the Great Falls-Lewistown Coal Field (GFLCF) of central Montana. The GFLCF was mined extensively for coal in the Stockett/Sand Coulee area from the late 1800s through 1950 via adits entering the coal seams at the bottom and sides of major coulees in the area. Today, mines are flooded with water and are generating acid-mine drainage that is impacting local surface and groundwater resources through direct adit discharges to stream and through infiltration of AMD waters to groundwater (Osborne et al., 1983a; Gammons et al., 2006). The extensiveness of subsurface mine workings, and the hydrologic connections between surficial recharge and subsurface transmittal of meteoric waters through the Kootenai and Morrison formation is complex. Metals sources are spread over a large area of underground workings, and are discharged to streams and groundwater through a variety of identified and unidentified adits seeps and springs. Within Number Five Coulee, there are discharging adits, springs and seeps that contribute acid-water and metals loads to Number Five Coulee (Osborne et al., 1983a). Cumulatively, these adits, seeps and acid-springs are provided a composite abandoned mining wasteload allocation.

As there are no permitted discharges in the Number Five Coulee watershed, metals load allocations consist of a composite wasteload allocation to abandoned mining sources and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 5.6**). Metals TMDLs for Number Five Coulee are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{No5} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed
WLA_{abmine} = Composite wasteload allocation to all non-permitted abandoned mining sources in the watershed

Stream flow in Number Five Coulee is driven primarily by early spring snowmelt and precipitation events, and typically attenuates to a baseflow of <1.0 cfs during summer months. It is not uncommon for Number Five Coulee to be dry during summermonths, flowing only during wet periods or following precipitation events. Metals water quality data and target exceedances in Number Five Coulee were recorded during several low flow conditions from 1994-1996 and provide the basis for loading calculations. A single high flow event was recorded and provides the basis for high flow load estimates. Because water hardness, flows and metals concentrations are variable throughout the seasons, loads and TMDLs presented herein represent average low-flow loading conditions calculated from individual high (>2 cfs) and low (<2 cfs) flow sampling events. **Table 5-31** summarizes metals TMDLs and load allocations for Number Five Coulee, calculated for the lower portion of the segment.

Table 5-31. Number Five Coulee: Metals TMDLs and Allocation Summary

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Aluminum	High	3.3	1.5	1.9	11.9	71.9%
	Low	0.22	0.10	0.12	0.44	49.3%
Cadmium	High	0.0257	0.0008	0.0249	0.02	NA
	Low	0.0019	0.0001	0.0019	0.005	62.6%
Iron	High	38.3	4.2	34.1	0.3	NA
	Low	2.5	0.3	2.3	12.9	80.3%
Nickel	High	3.83	0.10	3.74	0.77	NA
	Low	0.254	0.006	0.248	0.53	52.4%
Zinc	High	13.0	0.19	12.8	0.12	NA
	Low	0.99	0.013	0.974	1.32	25.3%

Metals TMDLs and allocations for Number Five Coulee are calculated at the end of the segment for high and low flow water quality conditions. With the exception of aluminum, TMDLs are being met under high flow (>2cfs) conditions when increased flows from either seasonal runoff or wet conditions contribute to dilution of acid mine discharge. TMDLs are not being met under most low-flow (<2 cfs) conditions when acid mine discharge has a greater influence on in-stream metals concentrations. It is expected that composite mining waste load allocations and reductions, when achieved, will result in attainment of TMDLs under all flow conditions.

5.5.3.8 Sand Coulee MT41Q002_060

Anthropogenic metals sources in Sand Coulee are comprised primarily of acid-mine discharge from abandoned coal mines from the Morrison Formation of the Great Falls-Lewistown Coal Field (GFLCF) of central Montana. The GFLCF was mined extensively for coal in the Stockett/Sand Coulee area from the late 1800s through 1950 via adits entering the coal seams at the bottom and sides of major coulees in the area. Today, mines are flooded with water and are generating acid-mine drainage that is impacting local surface and groundwater resources through direct adit discharges to stream and through infiltration of AMD waters to groundwater (Osborne et al., 1983a; Gammons et al., 2006). The extensiveness of subsurface mine workings, and the hydrologic connections between surficial recharge and subsurface transmittal of meteoric waters through the Kootenai and Morrison formation is complex. Metals sources are spread over a large area of underground workings, and are discharged to streams and groundwater through a variety of identified and unidentified adits, seeps and springs.

Flows in Sand Coulee, also called ‘Straight Creek’ locally (Osborne et al., 1983a), are almost entirely made up of acid-mine discharge during low-flow periods, and typically infiltrate into the alluvium before reaching Sand Coulee Creek. Sand Coulee water quality is highly impacted by AMD waters and maintains an average pH of less than three, resulting in high dissolved metals concentrations.

As there are no permitted discharges in the Sand Coulee watershed, metals load allocations consist of a composite wasteload allocation to abandoned mining sources and a load allocation to naturally-occurring metals sources. A margin of safety (MOS) is implicit in this allocation scheme, through a variety of conservative assumptions (see **Section 5.6**). Metals TMDLs for Sand Coulee are therefore the sum of the WLA to abandoned mines and the LA to naturally-occurring sources:

$TMDL_{SandCoulee} = LA_{nat} + WLA_{abmine}$

LA_{nat} = Load allocation to naturally occurring sources in the watershed

WLA_{abmine} = Composite wasteload allocation to all non-permitted abandoned mining sources in the watershed

Metals water quality data and target exceedances in Sand Coulee were recorded during several low flow conditions from 1994-1996 and provide the basis for loading calculations and reductions. A single high flow event was recorded and provides the basis for high flow load estimates. Because water hardness, flows and metals concentrations are variable throughout the seasons, loads and TMDLs presented herein represent average low-flow loading conditions calculated from individual high (>2 cfs) and low (<2 cfs) flow sampling events. **Table 5-32** summarizes metals TMDLs and load allocations for Sand Coulee.

Table 5-32. Sand Coulee: Metals TMDLs and Allocation Summary

Metal	Flow	TMDL	LA_{nat}	WLA_{abmine}	Existing Load	Percent Reduction
Aluminum	High	1.18	0.52	0.66	0.4	NA
	Low	0.06	0.03	0.04	210	99.9%
Cadmium	High	0.0102	0.00027	0.0099	0.027	62.2%
	Low	0.0007	0.00002	0.0007	0.025	97.3%
Copper	High	0.41	0.034	0.378	0.068	NA
	Low	0.023	0.0019	0.021	0.055	58.4%
Iron	High	0.41	0.034	0.378	104	87.0%
	Low	0.75	0.08	0.66	244	99.7%
Nickel	High	1.35	0.034	1.32	3.24	58.3%
	Low	0.075	0.002	0.073	1.52	95.1%
Zinc	High	5.24	0.07	5.17	5.67	7.7%
	Low	0.289	0.004	0.285	6.13	95.3%

Metals TMDLs and allocations for Sand Coulee are calculated for high and low flow water quality conditions. Metals concentrations are significantly elevated due to the contribution of acid mine drainage, and exceed total maximum daily loads during all but the highest flow conditions. Low flows were typically less that 1.0 cfs, while the highest flow recorded was 2.5 cfs. It is expected that composite mining waste load allocations and reductions, when achieved, will result in attainment of TMDLs under all flow conditions.

5.6 Seasonality and Margin of Safety

All TMDL documents must consider the seasonal variability, or seasonality, on water quality impairment conditions, maximum allowable pollutant loads in a stream (TMDLs), and load allocations. TMDL development must also incorporate a margin of safety into the load allocation process to account for uncertainties in pollutant sources and other watershed conditions, and ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. This section describes the considerations of seasonality and a margin of safety in the Missouri-Cascade and Belt TPA metal TMDL development process.

5.6.1 Seasonality

Seasonality addresses the need to ensure year round beneficial use support. Seasonality was considered for assessing loading conditions and for developing water quality targets, TMDLs, and allocation schemes. For metals TMDLs, seasonality is critical due to varying metals loading pathways and varying water hardness during high and low flow conditions. Loading pathways associated with overland flow and erosion of metals-contaminated soils and wastes tend to be the major cause of elevated metals concentrations during high flows, with the highest concentrations and metals loading typically occurring during the rising limb of the hydrograph. Loading pathways associated with groundwater transport and/or adit discharges tend to be the major cause of elevated metals concentrations during low or base flow conditions. Hardness tends to be lower during higher flow conditions, thus leading to lower water quality standards for some metals during the runoff season. Seasonality is addressed in this document as follows:

- Metals concentrations and loading conditions are evaluated for both high flow and low flow conditions.
- Metals TMDLs incorporate stream flow as part of the TMDL equation.
- Metals targets apply year round, with monitoring criteria for target attainment developed to address seasonal water quality extremes associated with loading and hardness variations.
- Example targets, TMDLs and load reduction needs are developed for high and low flow conditions.

5.6.2 Margin of Safety

The margin of safety is to ensure that TMDLs and allocations are sufficient to sustain conditions that will support beneficial uses. All metals TMDLs incorporate an implicit MOS in several ways. The implicit margin of safety is applied by using conservative assumptions throughout the TMDL development process and is addressed by the following:

- Target attainment, refinement of load allocations, and, in some cases, impairment validations and TMDL-development decisions are all based on an adaptive management approach that relies on future monitoring and assessment for updating planning and implementation efforts.
- Chronic aquatic life ctiteria were used to calculate a daily load limit rather than a 96-hour load limit
- Sediment metals concentration criteria were used as secondary indicators.

5.7 Uncertainty and Adaptive Management

Uncertainties in the accuracy of field data, applicable target values, source assessments, loading calculations, and other considerations are inherent when assessing and evaluating environmental variables for TMDL development. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainties through adaptive management approaches is a key component of ongoing TMDL implementation and evaluation. Uncertainties, assumptions, and considerations are addressed throughout this document and point to the need to refine analysis, conduct further monitoring, and address unknowns in order to develop better understanding of impairment conditions and the processes that affect impairment. This process of adaptive management is predicated on the premise that TMDLs, allocations, and the analyses supporting them are not static, but are processes subject to modification and adjustment as new information and relationships are understood.

The adaptive management process allows for continual feedback on the progress of restoration activities and status of beneficial uses. It provides the flexibility to refine targets as necessary to ensure protection of the resource or to adapt to new information concerning target achievability. For instance, as a result of additional monitoring and source refinement additional WLAs may be necessary for abandoned mines that are found to be discrete sources and the allocations and margin of safety may be modified. Components may be changed to improve ways of achieving and measuring success. A remediation and monitoring framework is closely linked to the adaptive management process, and is addressed in Section 8.0.

The water quality targets and associated metals TMDLs developed for the Missouri-Cascade and Belt TPAs are based on future attainment of water quality standards. In order to achieve attainment, all significant sources of metal loading must be addressed via all reasonable land, soil, and water conservation practices. It is recognized however, that in spite of all reasonable efforts, attainment of water quality targets may not be possible due to the potential presence of unalterable human-caused sources. For this reason, an adaptive management approach is adopted for all metals targets described within this document. Under this adaptive management approach, all metals identified in this plan as requiring TMDLs will ultimately fall into one of the three categories identified below:

- Implementation of remediation and restoration activities resulting in full attainment of restoration targets for all parameters;
- Implementation of remediation and restoration activities fails to result in target attainment due to underperformance or ineffectiveness of restoration actions. Under this scenario the waterbody remains impaired and will require further restoration efforts associated with the pollutants of concern. The target may or may not be modified based on additional information, but conditions still exist that require additional pollutant load reductions to support beneficial uses and meet applicable water quality standards. This scenario would require some form of additional, refocused restoration work.
- Implementation of restoration activities fails to result in target attainment, but target attainment is deemed unachievable even though all applicable monitoring and restoration activities have been completed. Under this scenario, site-specific water quality standards and/or the reclassification of the waterbody may be necessary. This would then lead to a new target (and TMDL) for the pollutant(s) of concern, and the new target could either reflect the existing conditions at the time or the anticipated future conditions associated with the restoration work that has been performed.

The DEQ Remediation Division, EPA Superfund Program, and/or DEQ Standards Program personnel will lead this effort within DEQ to make determinations concerning the appropriateness of specific mine cleanup activities relative to expectations for mining cleanup efforts for any impairment condition associated with mining impacts. This includes consideration of appropriate evaluation of cleanup options, actual cleanup planning and design, as well as the appropriate performance and maintenance of the cleanup activities. Where NPDES permitted point sources are involved, the DEQ Permitting Program will also be involved. Determinations on the performance of all aspects of restoration activities, or lack thereof, will then be used along with available in-stream data to evaluate the appropriateness of any given target and beneficial use support. Reclamation activities and monitoring conducted by other parties, including but not limited to the USFS and EPA, should be incorporated into the process as well. The information will also help determine any further cleanup/load reduction needs for any applicable waterbody and will ultimately help determine the success of water quality restoration.

It is acknowledged that construction or maintenance activities related to restoration, construction/maintenance, and future development may result in short term increase in surface water metals concentrations. For any activities that occur within the stream or floodplain, all appropriate permits should be obtained before commencement of the activity. Federal and State permits necessary to conduct work within a stream or stream corridor are intended to protect the resource and reduce, if not completely eliminate, pollutant loading or degradation from the permitted activity. The permit requirements typically have mechanisms that allow for some short term impacts to the resource, as long as all appropriate measures are taken to reduce impact to the least amount possible.

SECTION 6.0
IMPLEMENTATION AND MONITORING

Implementation and monitoring addresses activities intended to remediate metals impacts to water quality and the gathering of water quality data to 1) further understand metals sources and impacts and 2) track the success of mitigation and remediation actions designed to improve and restore water quality. This section discusses strategies for remediation and mitigation of metals-impaired streams in the Missouri-Cascade and Belt TMDL planning areas, focusing on how to meet conditions that will likely achieve water quality targets and TMDLs presented previously in this document.

6.1 Remediation and Mitigation and Monitoring Strategy

Within the Missouri-Cascade and Belt TMDL Planning Areas, impacts to water quality are derived from four major source areas:

- Carpenter-Snow Creek NPL (Superfund) Site
- Barker-Hughesville NPL (Superfund) Site
- Abandoned coal mining in and around the town of Belt
- Abandoned coal mining in and around the towns of Stockett and Sand Coulee

Metals sources and impacts to stream from these four main areas are well known and have been investigated and documented through a variety of studies (see **Section 5.0**). This document does not attempt to offer new solutions or mitigation plans to remedy over a century of pervasive mining impacts in these areas. Rather, this document provides reference to and summarizes on-going remediation and mitigation planning efforts and activities already in place.

Remediation and mitigation of metals impacts from the Carpenter-Snow Creek and the Barker-Hughesville NPL sites fall under the authority of the **Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).** CERCLA (a.k.a. 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 the application of a strict, joint and several 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, or liable parties no not exist, 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. With respect to the Carpenter-Snow Creek and Barker-Hughesville NPL sites, findings of liability have been pursued and cleanup and remediation actions and planning have begun.

6.1.1 Carpenter-Snow Creek NPL Site

Within the Carpenter-Snow Creek NPL site, the EPA and DEQ have conducted joint assessments and evaluations of mining-impacted sites in the areas surrounding Neihart, and in 2004 a time-critical removal action was initiated by EPA Region 8's Emergency Response Team. In 2009, the EPA issued a Record of Decision (EPA, 2009) in accordance with CERCLA that presented the Selected Remedy for the Neihart Community Soils Area of Neihart Operable Unit 1 of the Carpenter-Snow Creek NPL site. This area includes contaminated soils, tailings piles and mine wastes in and around the town of Neihart along upper Belt Creek upstream from Carpenter Creek. Presently, EPA is in the process of conducting site assessments and sampling in the Carpenter Creek watershed in support of future remedial and mitigation activity. These investigations in the Carpenter-Snow Creek NPL sites represents initial planning and source characterization activity that will inform future cleanup and action plans for Upper Belt Creek, Carpenter Creek and its tributaries.

6.1.2 Barker-Hughesville NPL Site

Similar CERCLA processes are in progress in support of remedial actions in the Barker-Hughesville NPL site. In 2004, the USFS and EPA signed an Action Memorandum for the Block P Mill Tailings within the Galena Creek watershed that required the Responsible Party, the Doe Run Company, to consolidate and cap the Block P Tailings site. Work was completed on the Block P Tailings in 2005, yet other considerable unmitigated sources contributing to metals impairment remain in the watershed. In 2005 EPA completed a source characterization report that provides additional information on each of 47 separate mines, adits, and waste piles in the watershed. Presently, the EPA, along with the DEQ and USFS are conducting further investigations and evaluating remedial alternatives for future cleanup under CERCLA authority. Results of these efforts will inform remediation and mitigation plans for metals cleanup in the Galena and Dry Fork Belt Creek watersheds, and will also affect water quality improvements in both upper and lower Belt Creek.

Because Superfund/CERCLA clean-up goals may not correspond to Montana water quality standards, additional remediation may be necessary to meet metals TMDLs. However, after all planned remediation work is complete, effectiveness and trends monitoring should be conducted to determine if additional measures are needed to meet the TMDLs and to assess if target attainment may not be achievable for all metals. Water quality monitoring will be a component of remedial actions in the aforementioned NPL sites and will inform any future monitoring recommendations in these watersheds that may be needed for evaluation of water quality target attainment and total maximum daily loads. Monitoring recommendations for these NPL sites are not provided herein, but will rely on the results and outcomes of extensive CERCLA investigations and processes currently underway. It is expected that future evaluation of target attainment will utilize these process and data.

6.1.3 Abandoned Coal Mining near Belt, Stockett, and Sand Coulee

Metals sources and impacts to lower Belt Creek and streams in the Sand Coulee watershed from abandoned coal mines in and around the towns of Belt, Stockett and Sand Coulee have been characterized most recently by Gammons et al, 2006. Reclamation and mitigation efforts and successes to date have been limited, primarily due to the pervasive nature of the contamination, the broad extent of underground mine workings, and the lack of long-term funding and viable long-term solutions to fix the problem. Reclamation and mitigations efforts thus far have been implemented but with limited results. Efforts to control acid mine discharge have include constructed treatment wetlands, limestone-lined discharge channels, and anoxic limestone drains (Gammons, 2006).

While efforts to manage and treat acid discharge water has been met with disappointing results, technologies that address managing and controlling source water, rather than discharge water, are being investigated as potential possibilities to reduce metals loading to surface and ground waters. Given the extensiveness of underground workings and the funding and infrastructure required to address such a large problem, it is not expected that solutions will come quickly or without great cost. An increased understanding, however, of the mechanisms contributing to metals impairments is a step closer to developing viable technologies and remedial strategies. As understanding and technology advances, hopes are that pilot projects will provide successes in which to develop more feasible long-term plans form remediation and ultimate restoration of water quality.

As mechanisms driving the formation and discharge of acid mine waters are well understood, further monitoring recommendations to characterize water quality are not provided. Rather, monitoring should be conducted in concert with proposed remediation or restoration projects to evaluate the success of failure of such projects and should inform future remedial actions.

SECTION 7.0
PUBLIC INVOLVEMENT

Stakeholder and public involvement is a component of TMDL planning supported by EPA guidelines and Montana State Law (MCA 75-5-703, 75-5-704), which directs the 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, advisory committees, and the public were solicited to participate.

Stakeholders, including the Cascade County Conservation District, Montana Department of Fish, Wildlife & Parks, USFS Lewis & Clark National Forest, US Environmental Protection Agency, Cascade County Commission, as well as local watershed advisory groups were kept abreast of the TMDL process through periodic notifications and information dissemination. Stakeholder review drafts were provided to several agency representatives, conservation district and government representatives, and representatives from conservation and watershed groups. Stakeholder comments, both verbal and written, were accepted and are addressed within the document.

Upon completion of the draft TMDL document, and prior to EPA submittal, the DEQ issues a press release and enters into a Public Comment Period. During this time frame, the draft TMDL document is made available for general public comment, and DEQ addresses and responds to all formal public comments.

The formal public comment period for the Missouri-Cascade and Belt TMDL Planning Area Metals TMDLs & Framework Water Quality Improvement Plan was initiated on December 3, 2010 and closed on December 27, 2010. There were two public meeting on December 20, 2010. One meeting was at the Belt Senior Center in Belt, MT and the other was at Fish, Wildlife and Parks Region 4 office, Great Falls, MT. DEQ provided an overview of the Missouri-Cascade and Belt TMDL Planning Area Metals TMDLs & Framework Water Quality Improvement Plan, made copies of the document available to the public, solicited public input and comment on the plan. The announcement for that meeting was distributed among the technical advisors, stakeholders and interested parties, state and federal agencies, interest groups, advisory committees, and the public, and advertised in the following newspapers: The Great Falls Tribune and the Belt School Paper. There were no official public comments received during the public comment period.

SECTION 8
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APPENDIX A
MAPS AND FIGURES

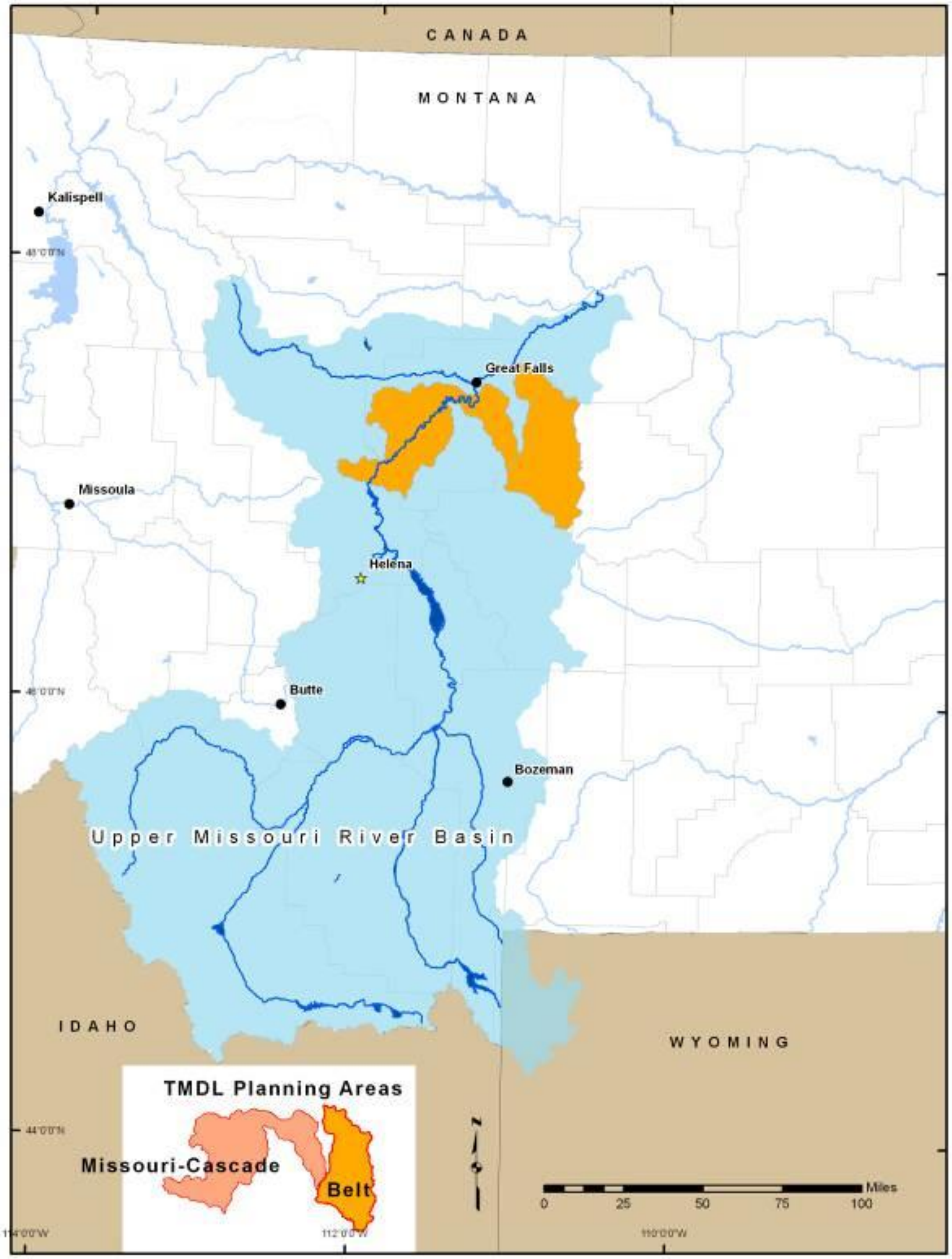

Figure 2-1. Location Map: Missouri-Cascade and Belt TMDL Planning Areas

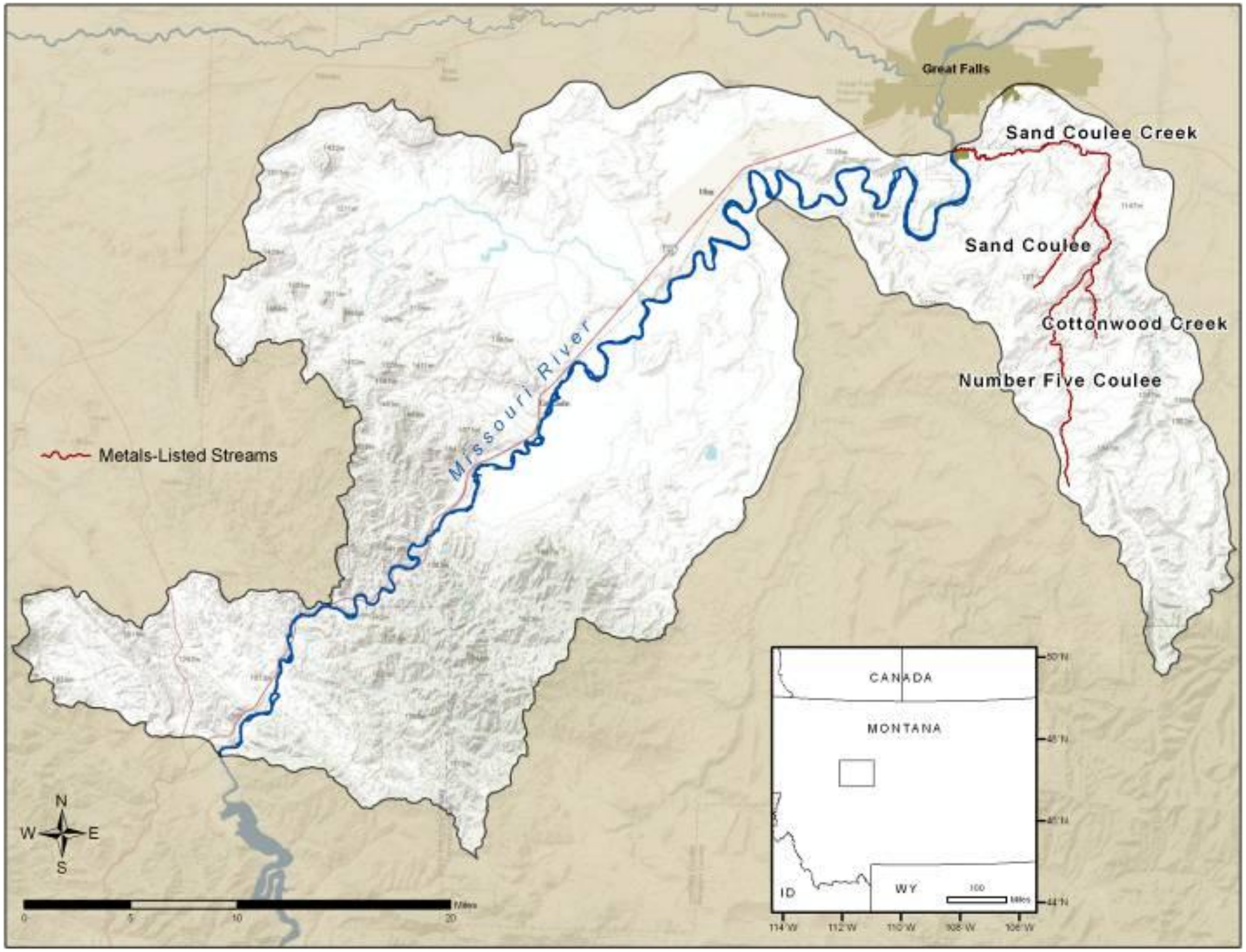

Figure 2-2. Metals-impaired Streams in the Missouri-Cascade TMDL Planning Area

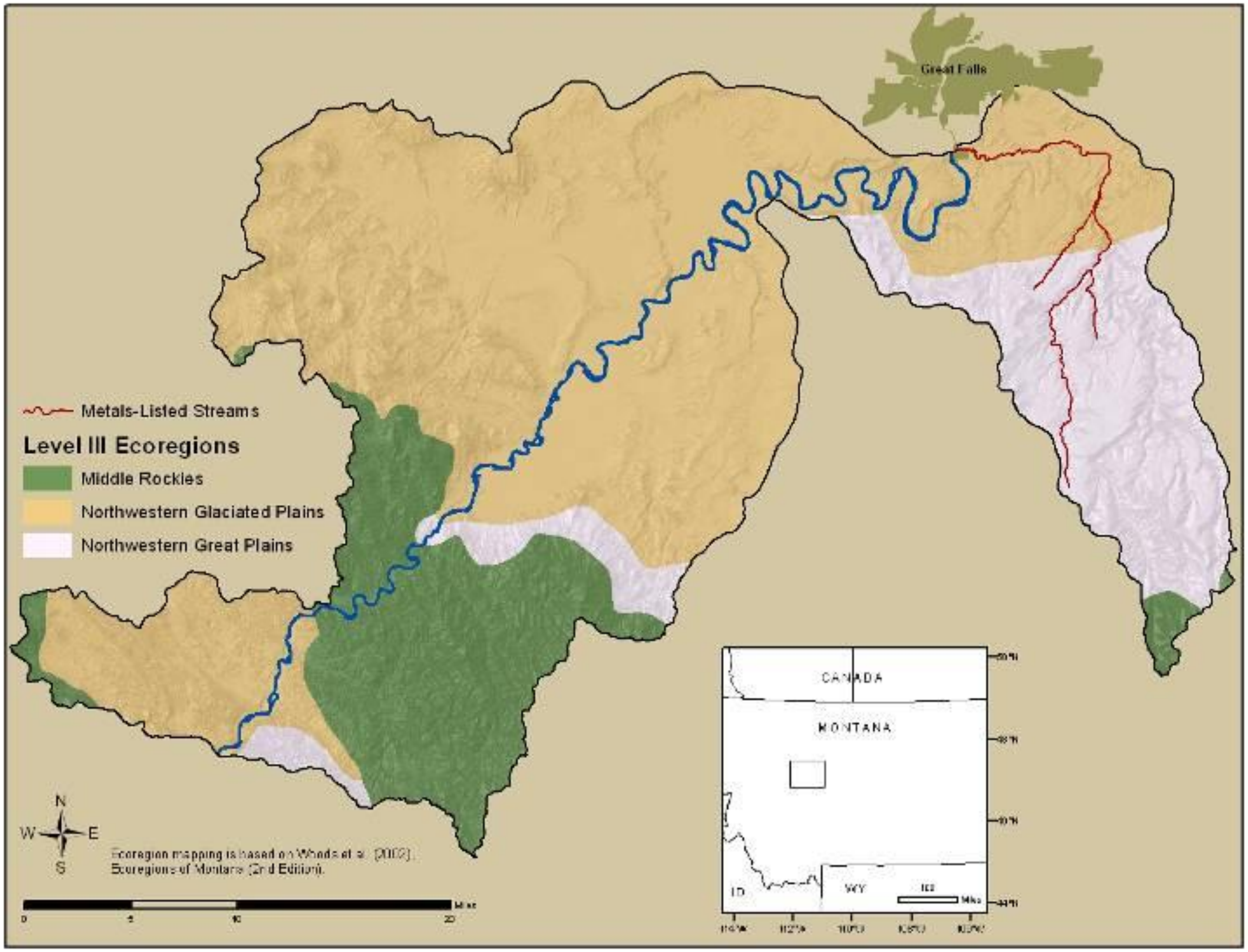

Figure 2-3a. Level III Ecoregions: Missouri-Cascade TMDL Planning Area

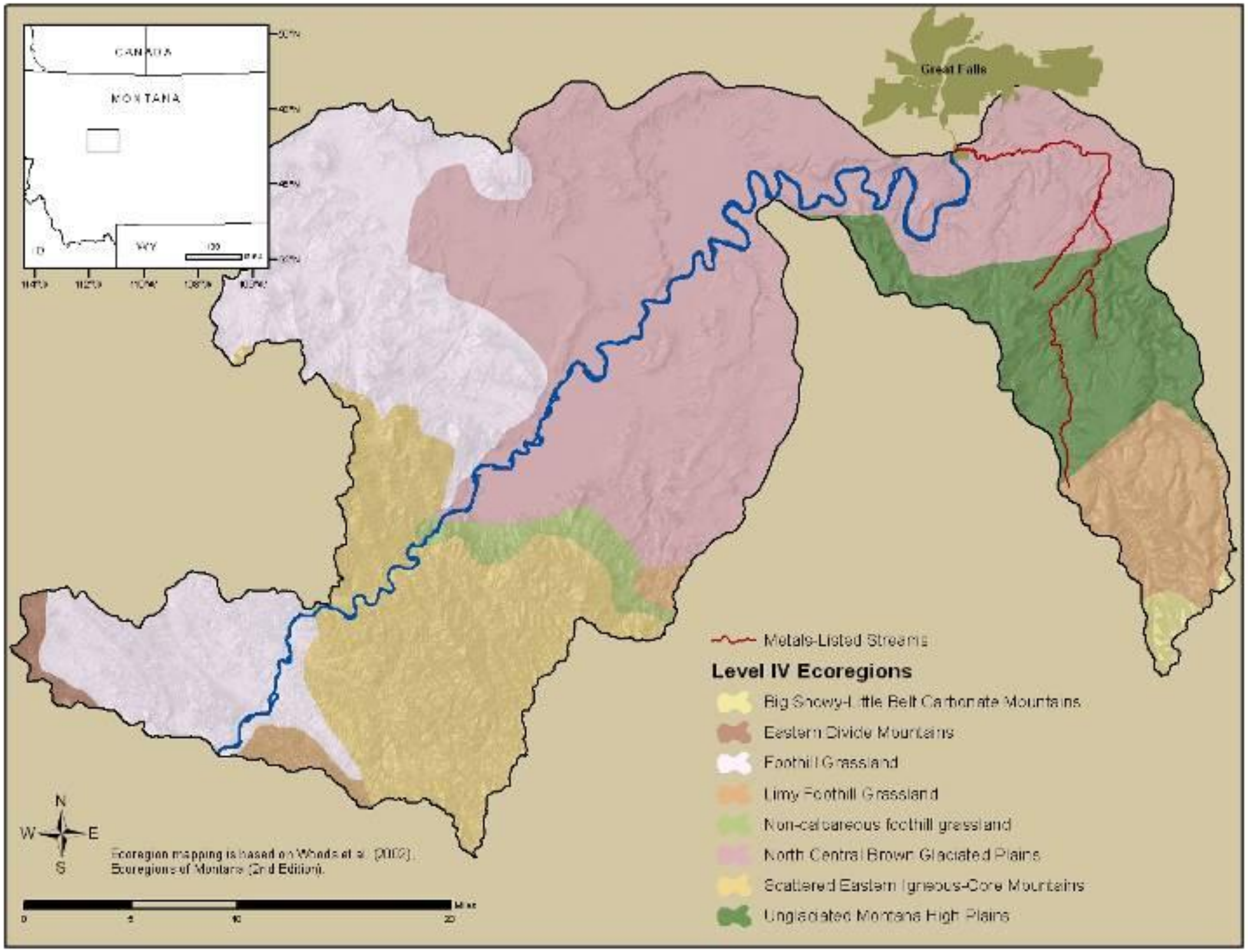

Figure 2-3b. Level IV Ecoregions: Missouri-Cascade TMDL Planning Area

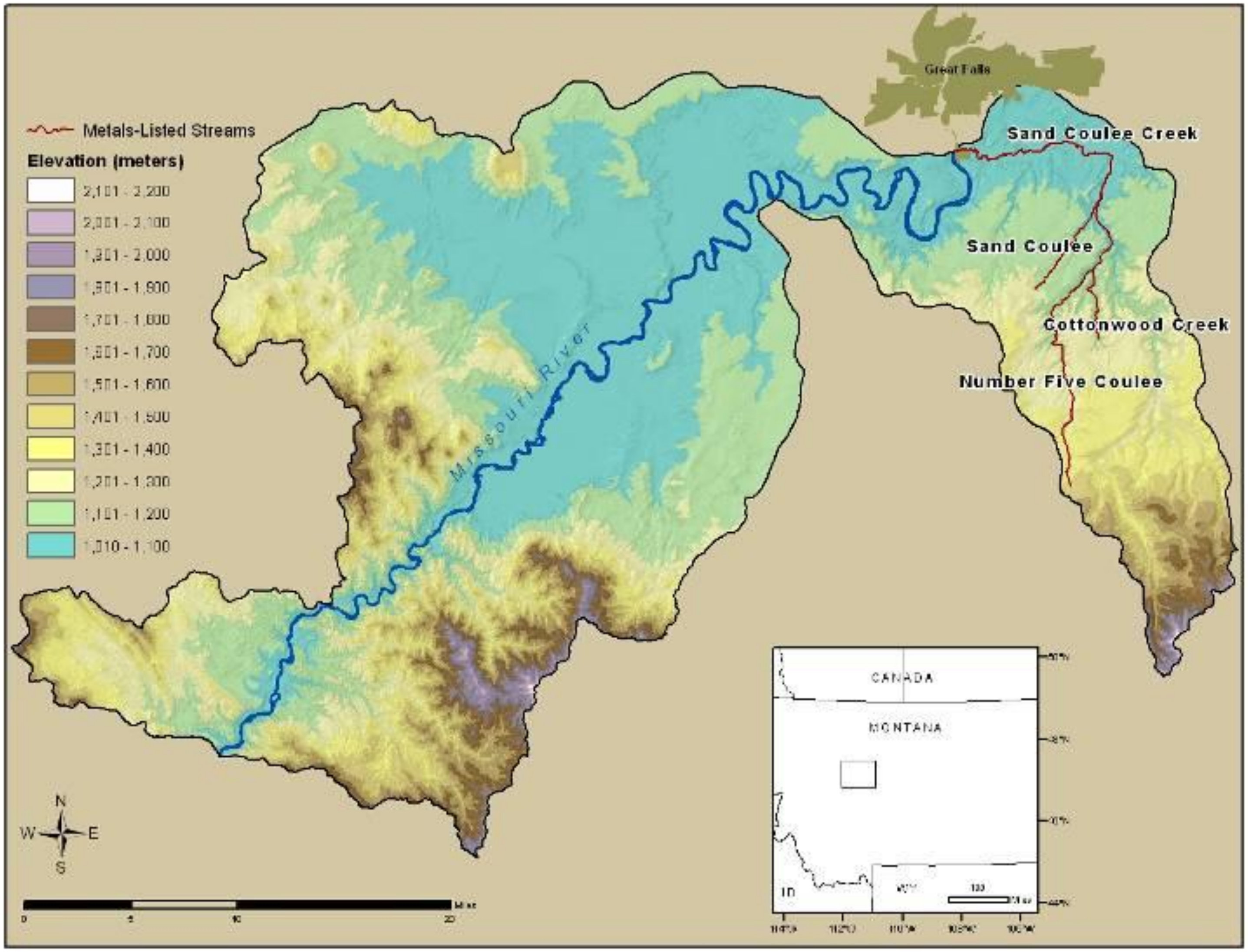

Figure 2-4. Topography: Missouri-Cascade TMDL Planning Area

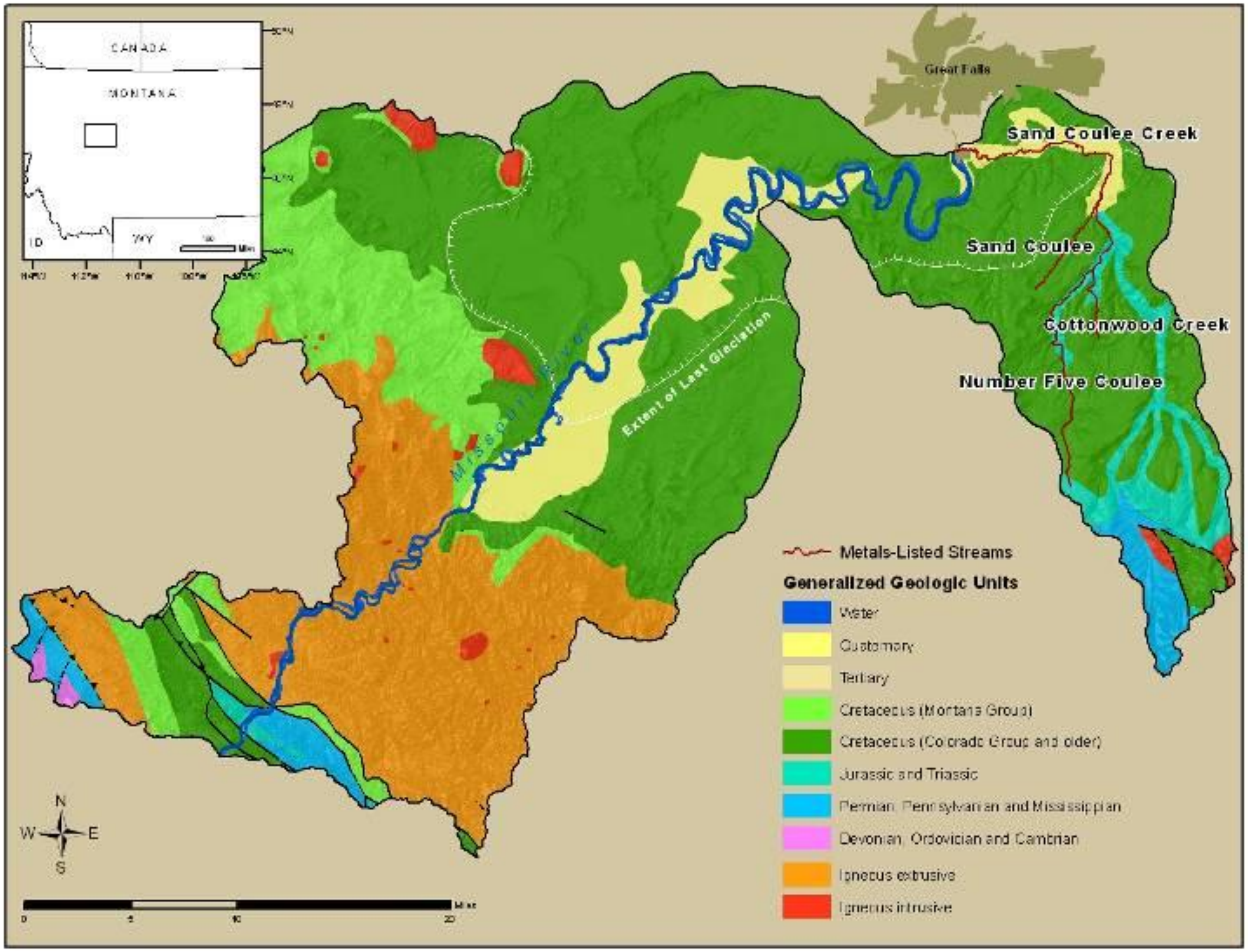

Figure 2-5. Geology: Missouri-Cascade TMDL Planning Area

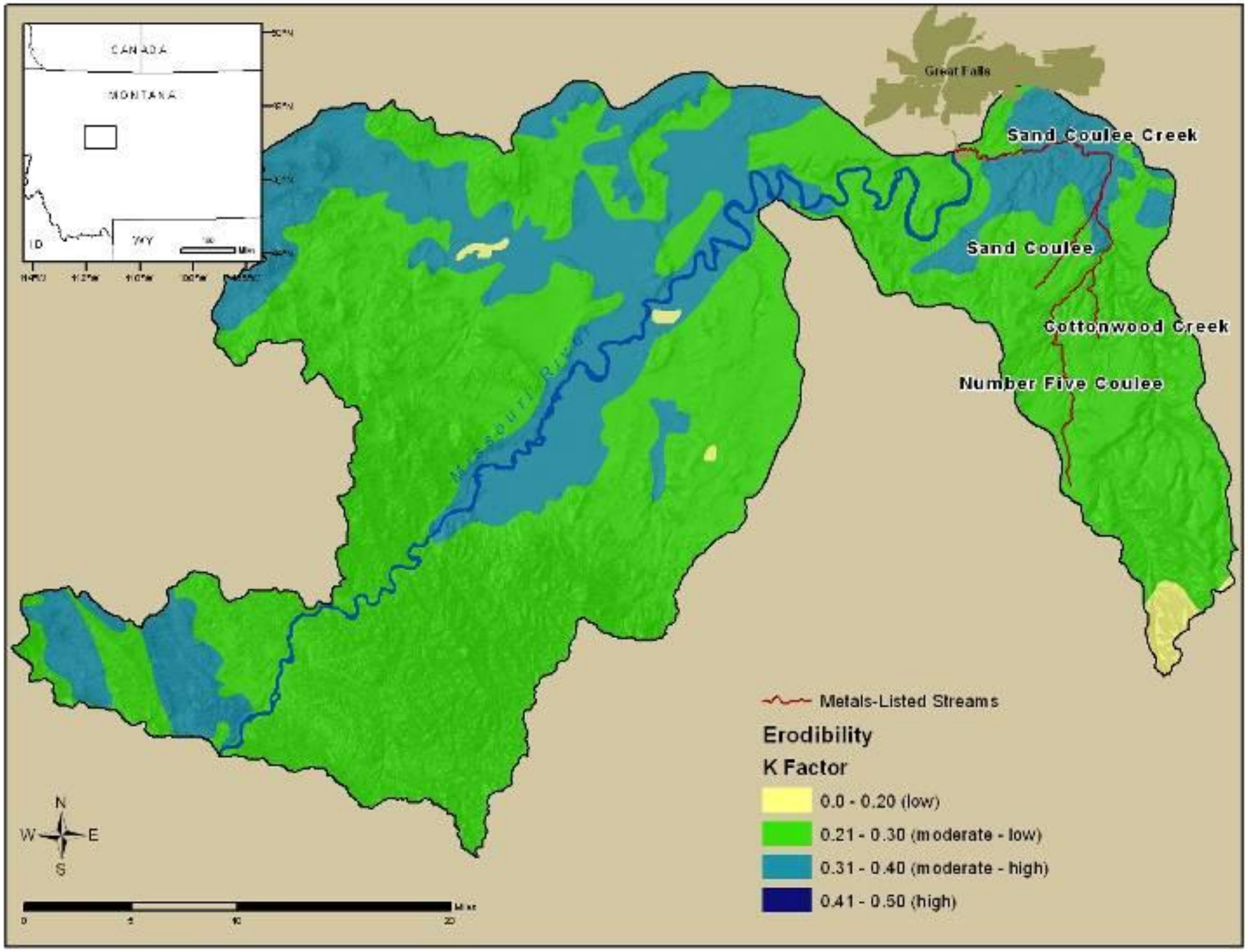

Figure 2-6. Erodibility: Missouri-Cascade TMDL Planning Area

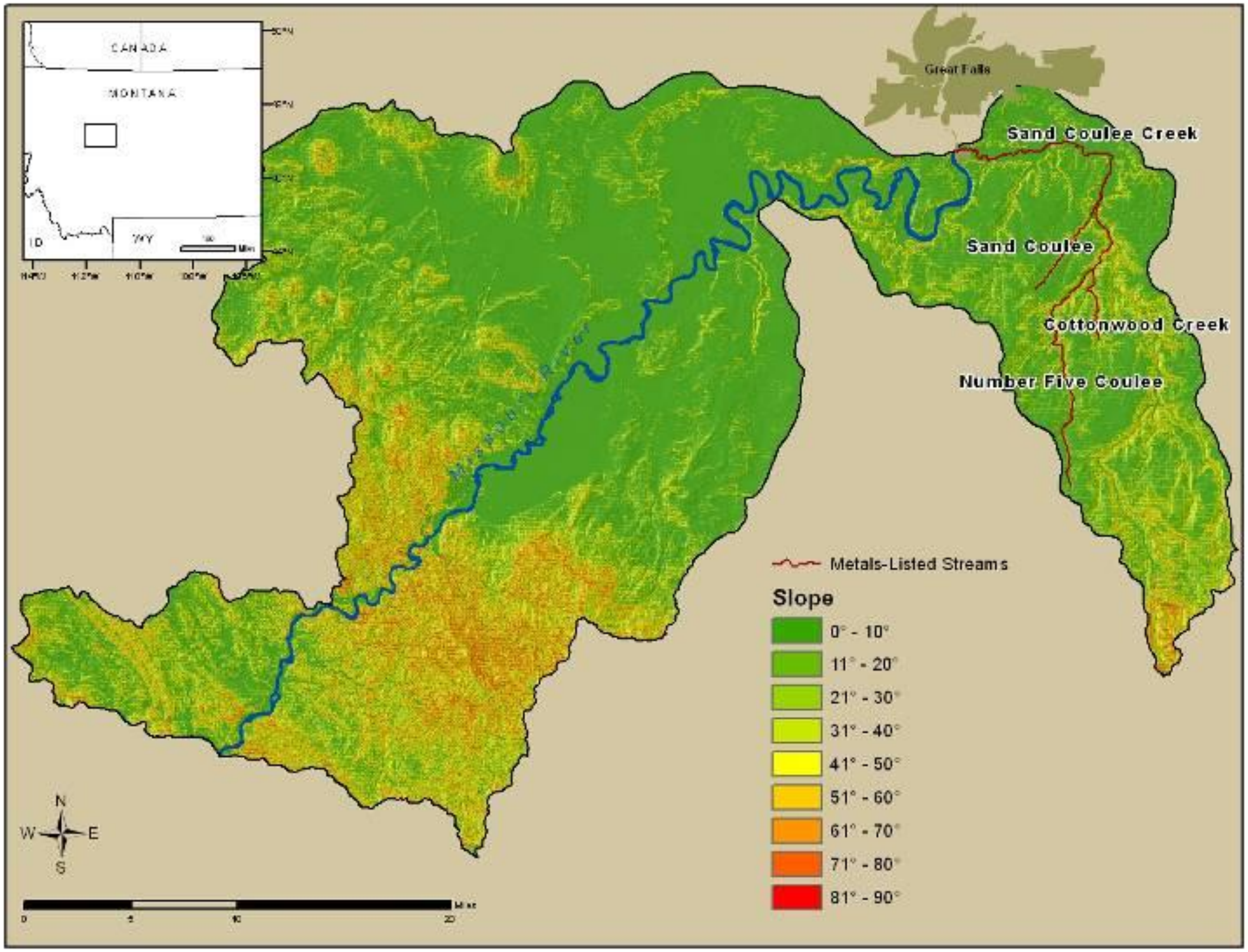

Figure 2-7. Slope: Missouri-Cascade TMDL Planning Area

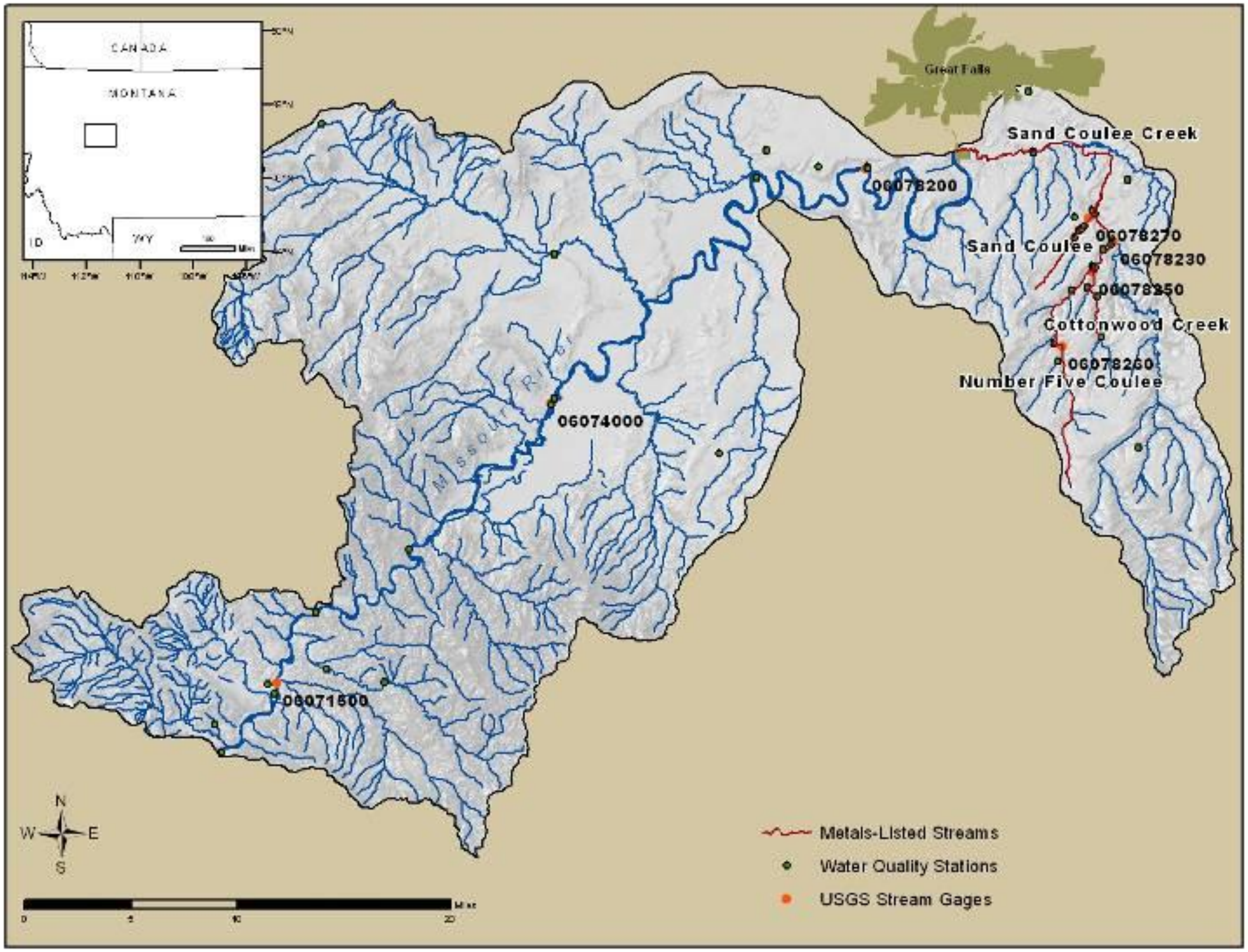

Figure 2-8. Hydrography: Missouri-Cascade TMDL Planning Area

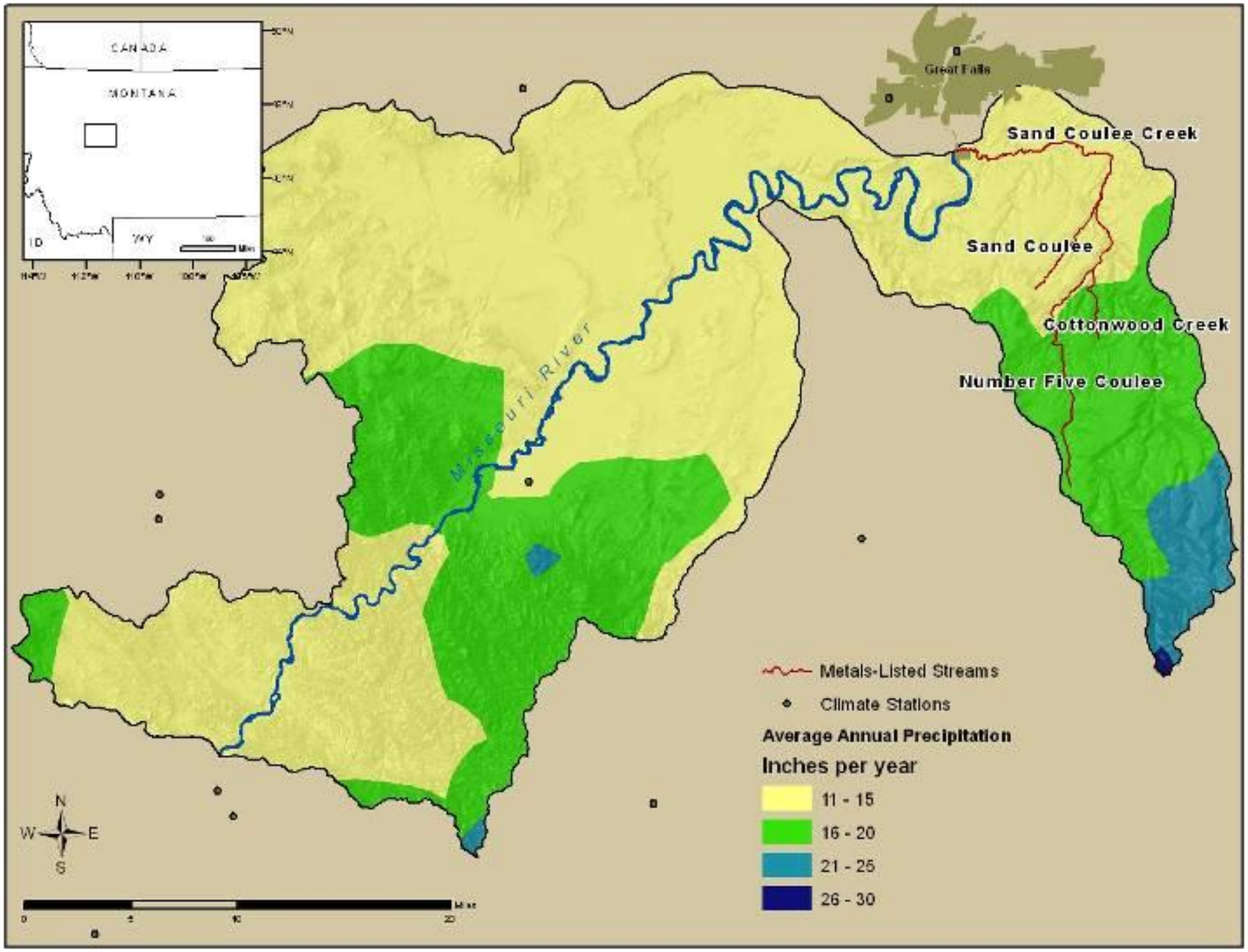

Figure 2-9. Precipitation: Missouri-Cascade TMDL Planning Area

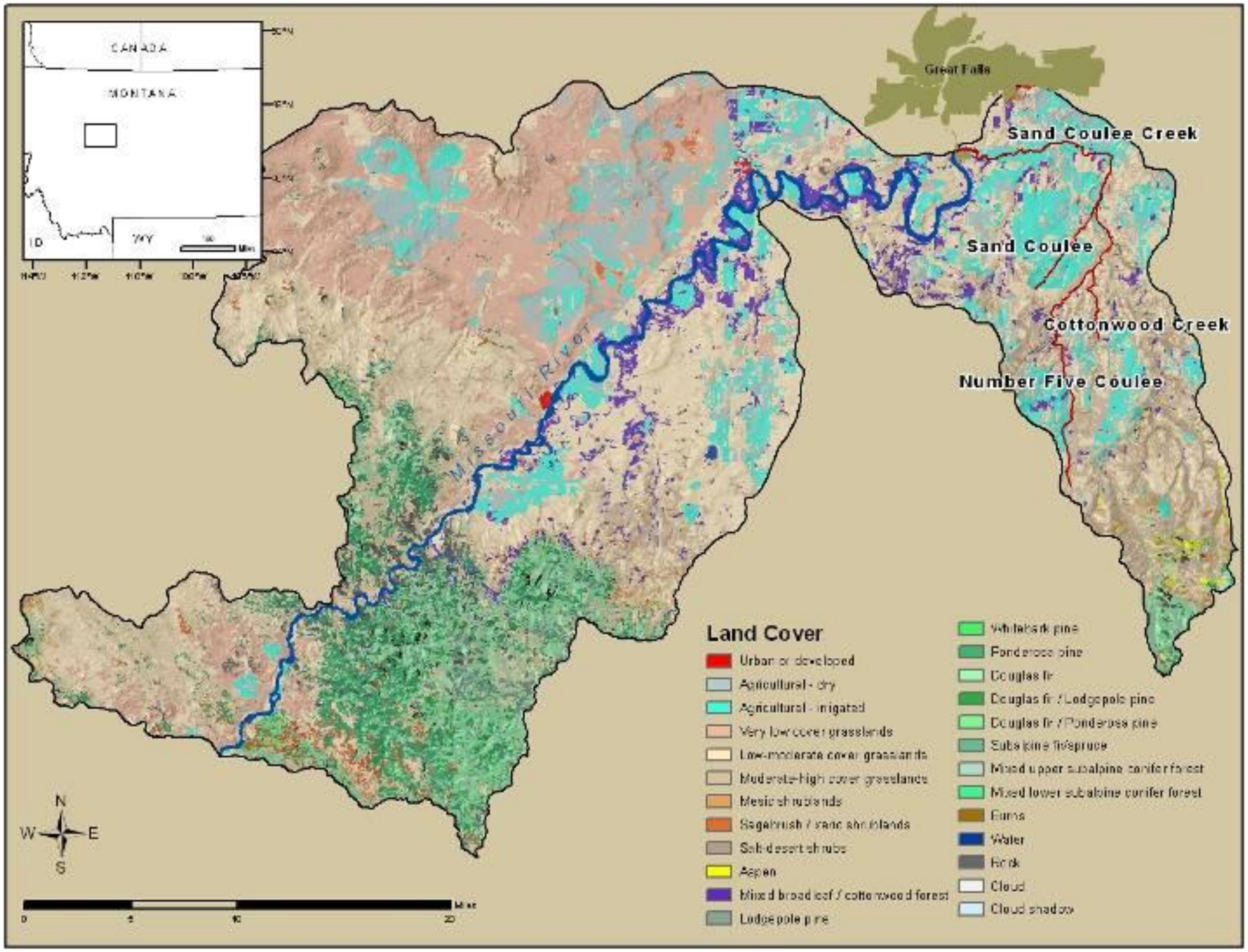

Figure 2-10. Land Cover: Missouri-Cascade TMDL Planning Area

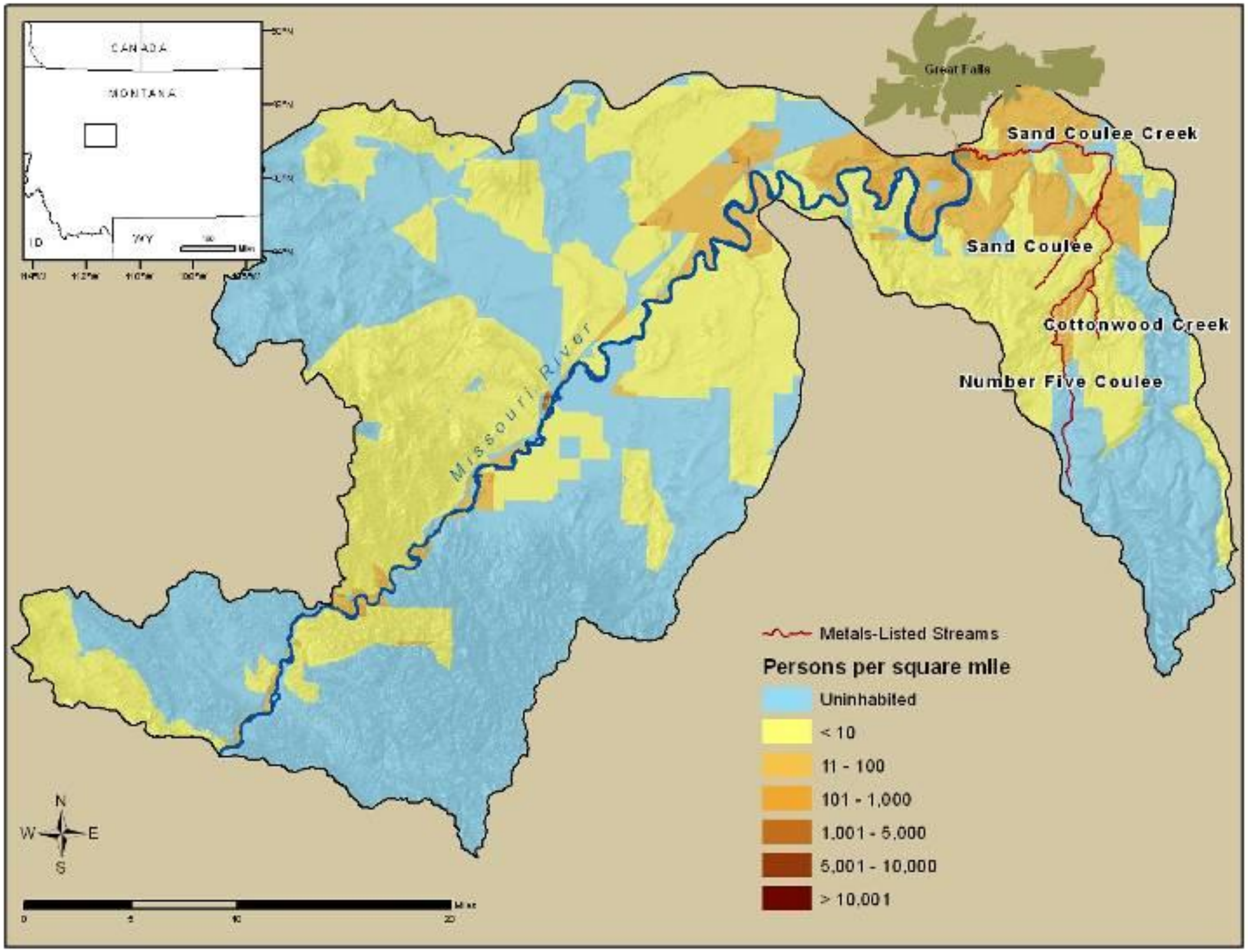

Figure 2-11. Census Data: Missouri-Cascade TMDL Planning Area

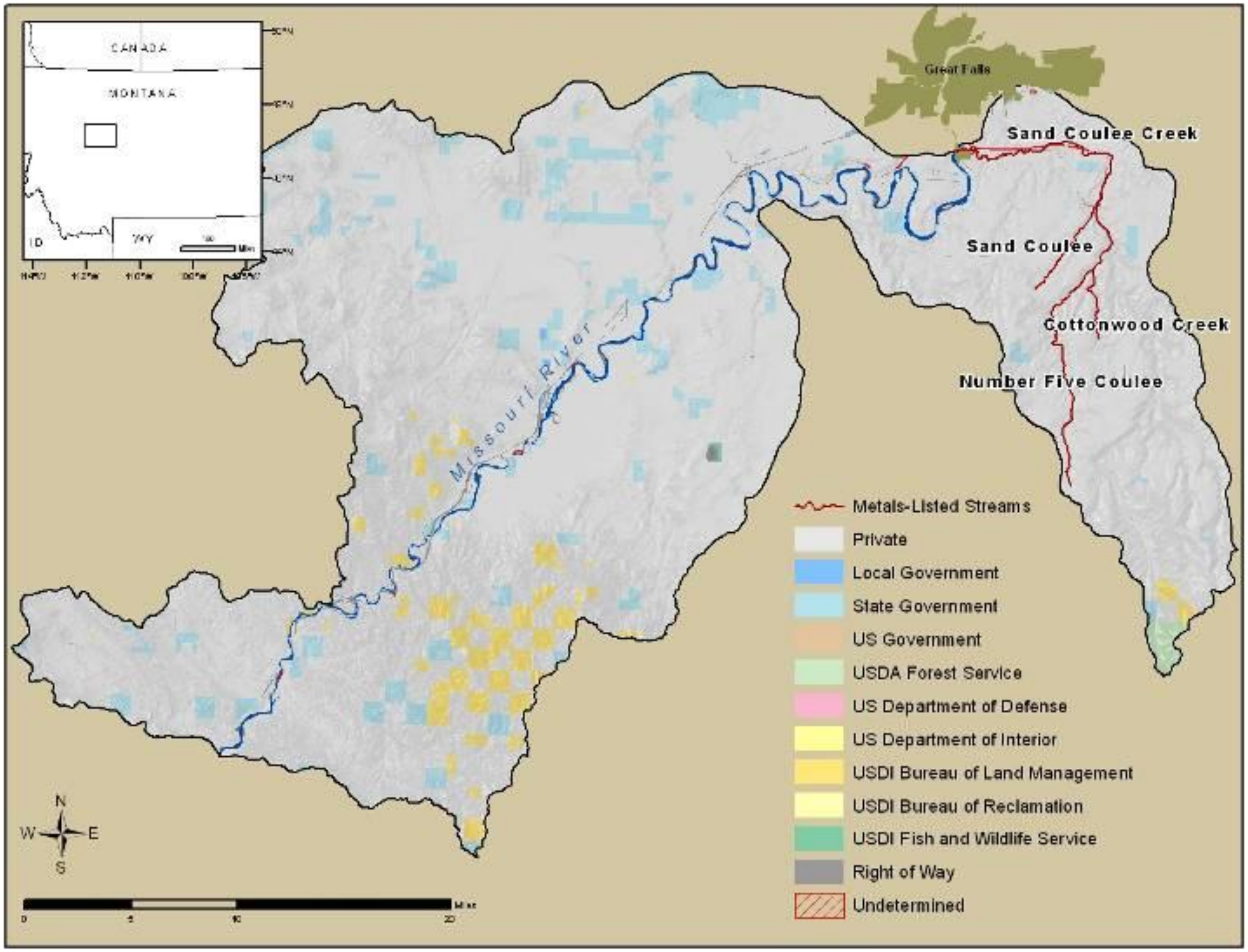

Figure 2-12. Land Ownership: Missouri-Cascade TMDL Planning Area

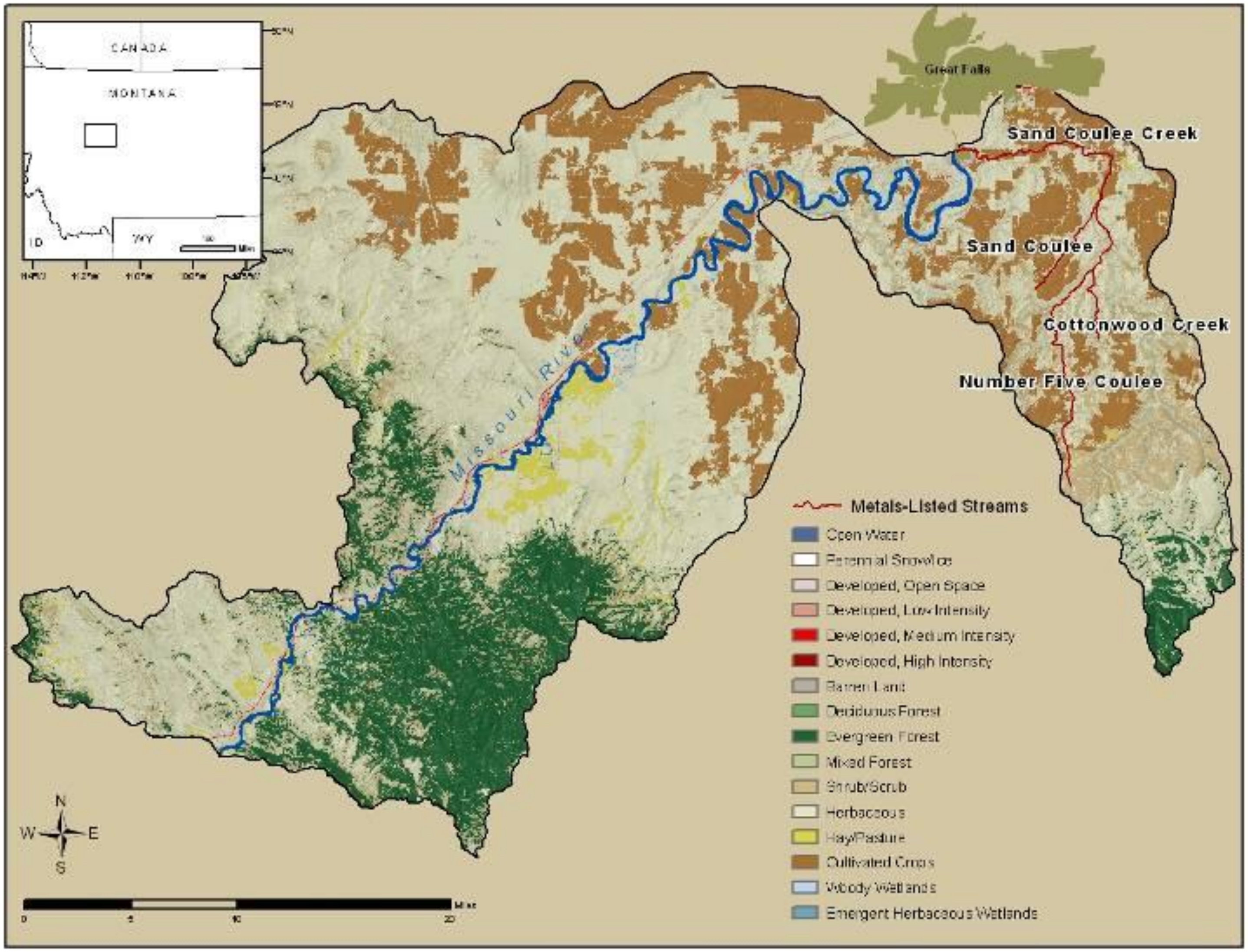

Figure 2-13. Land Use: Missouri-Cascade TMDL Planning Area

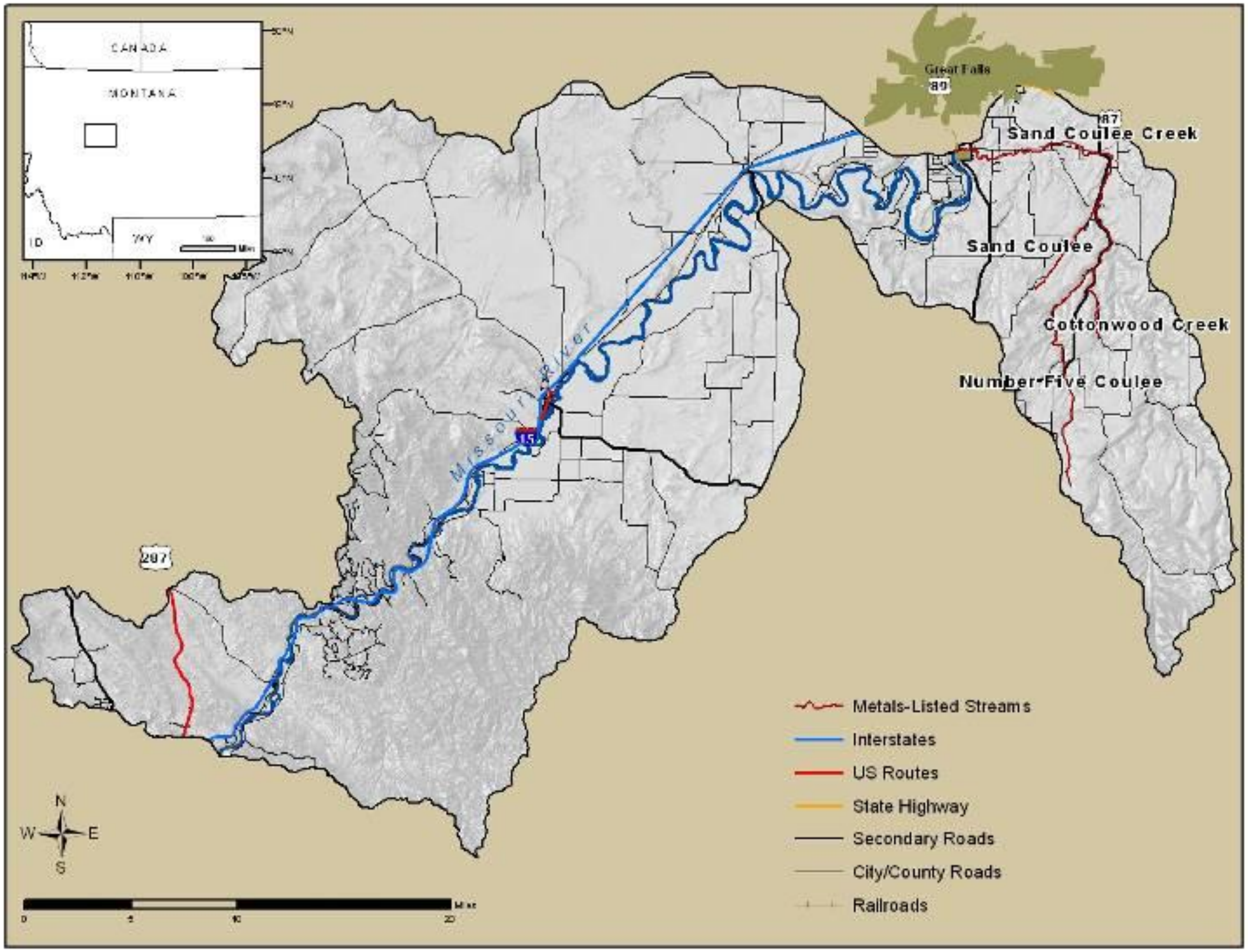

Figure 2-14. Transportation Networks: Missouri-Cascade TMDL Planning Area

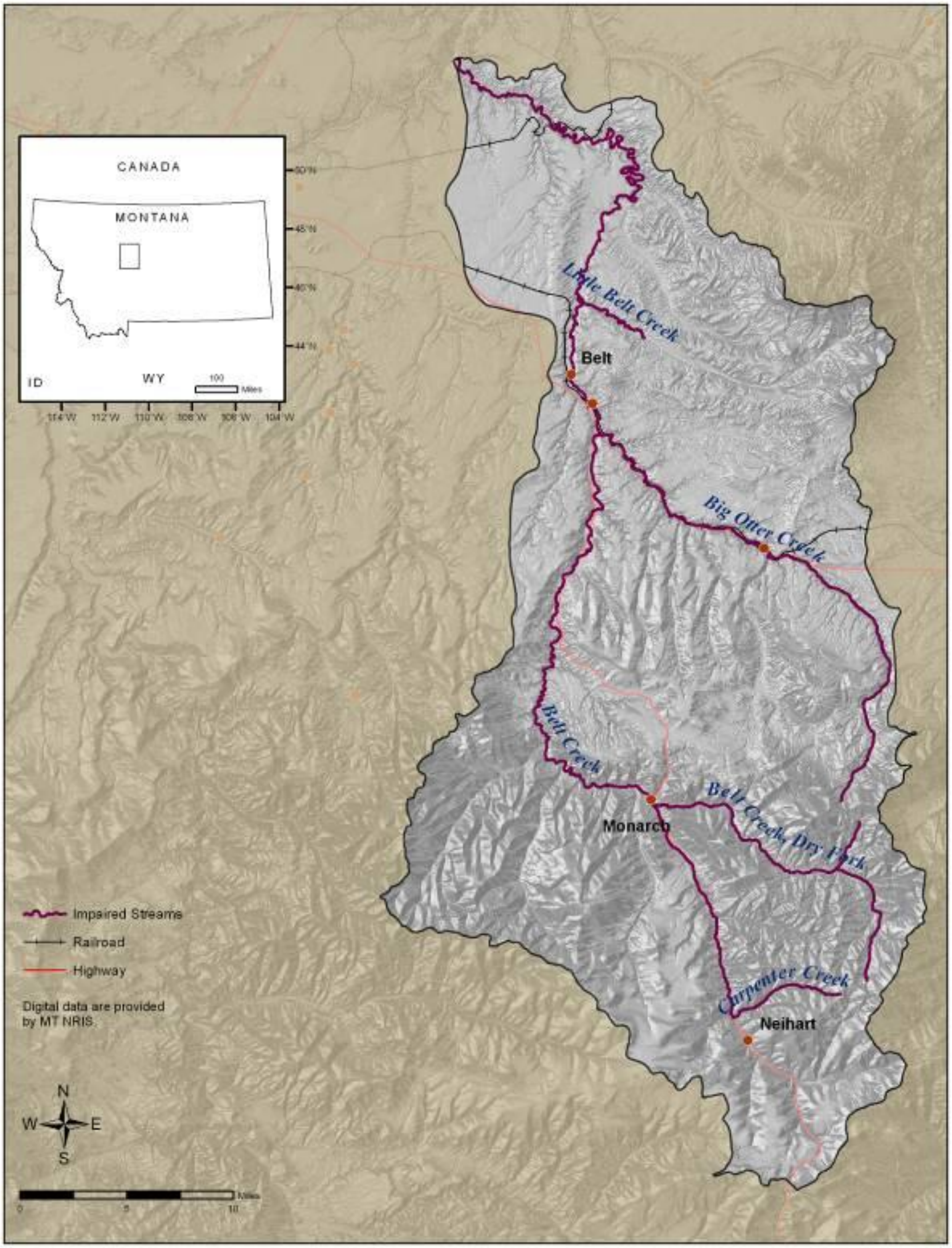

Figure 2-15. Metals-impaired streams in the Belt TMDL Planning Area

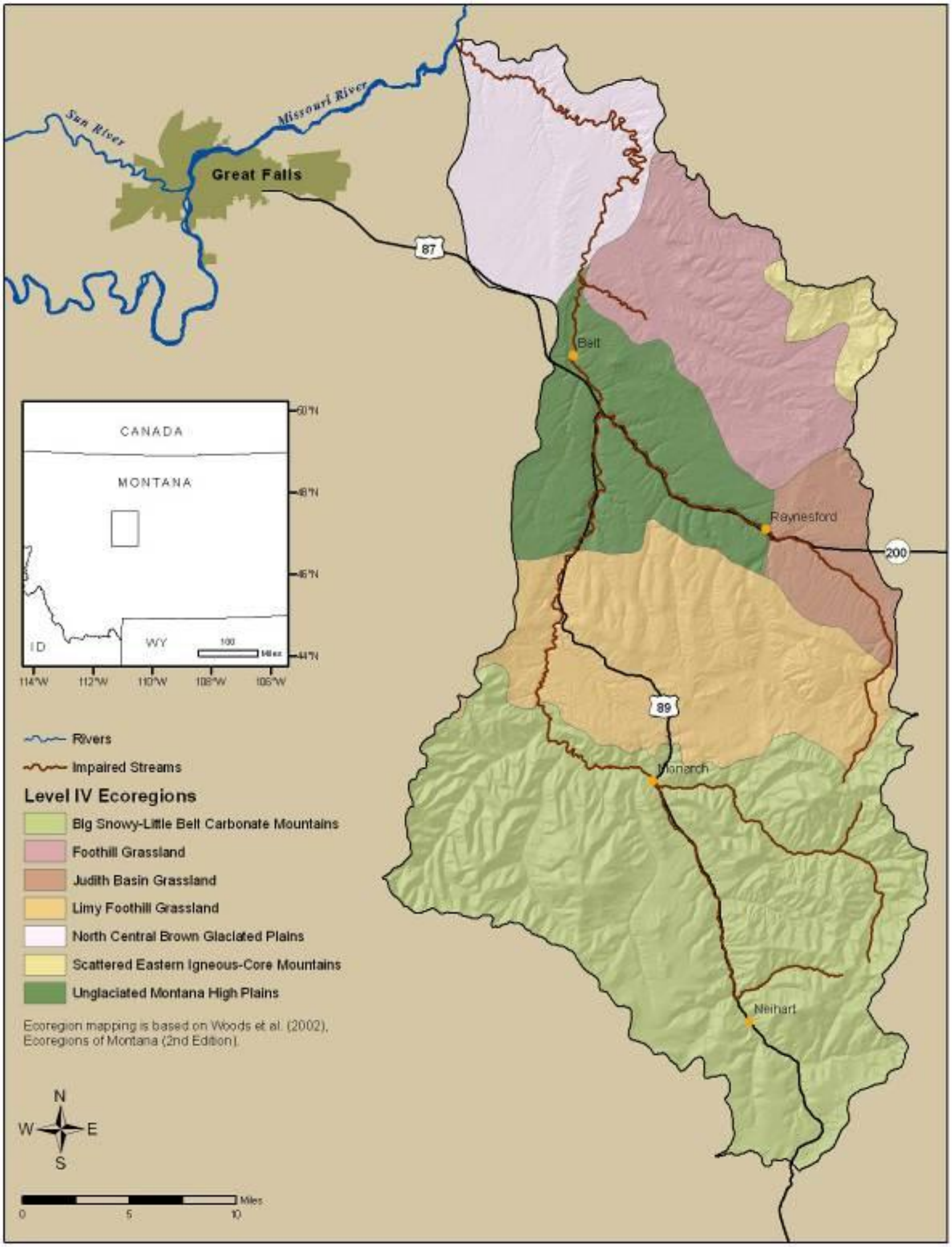

Figure 2-16. Level IV Ecoregions: Belt TMDL Planning Area

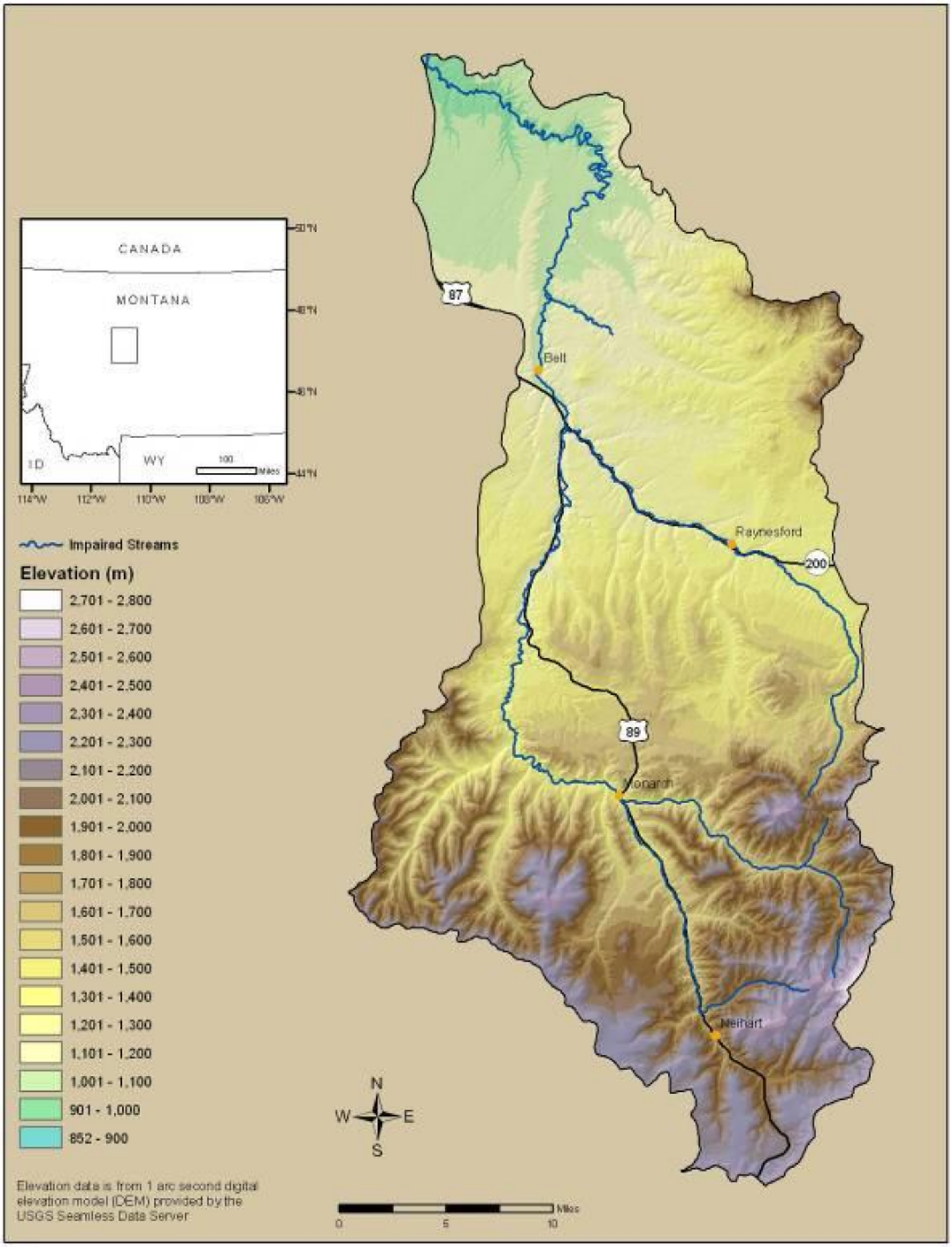

Figure 2-17. Topography: Belt TMDL Planning Area

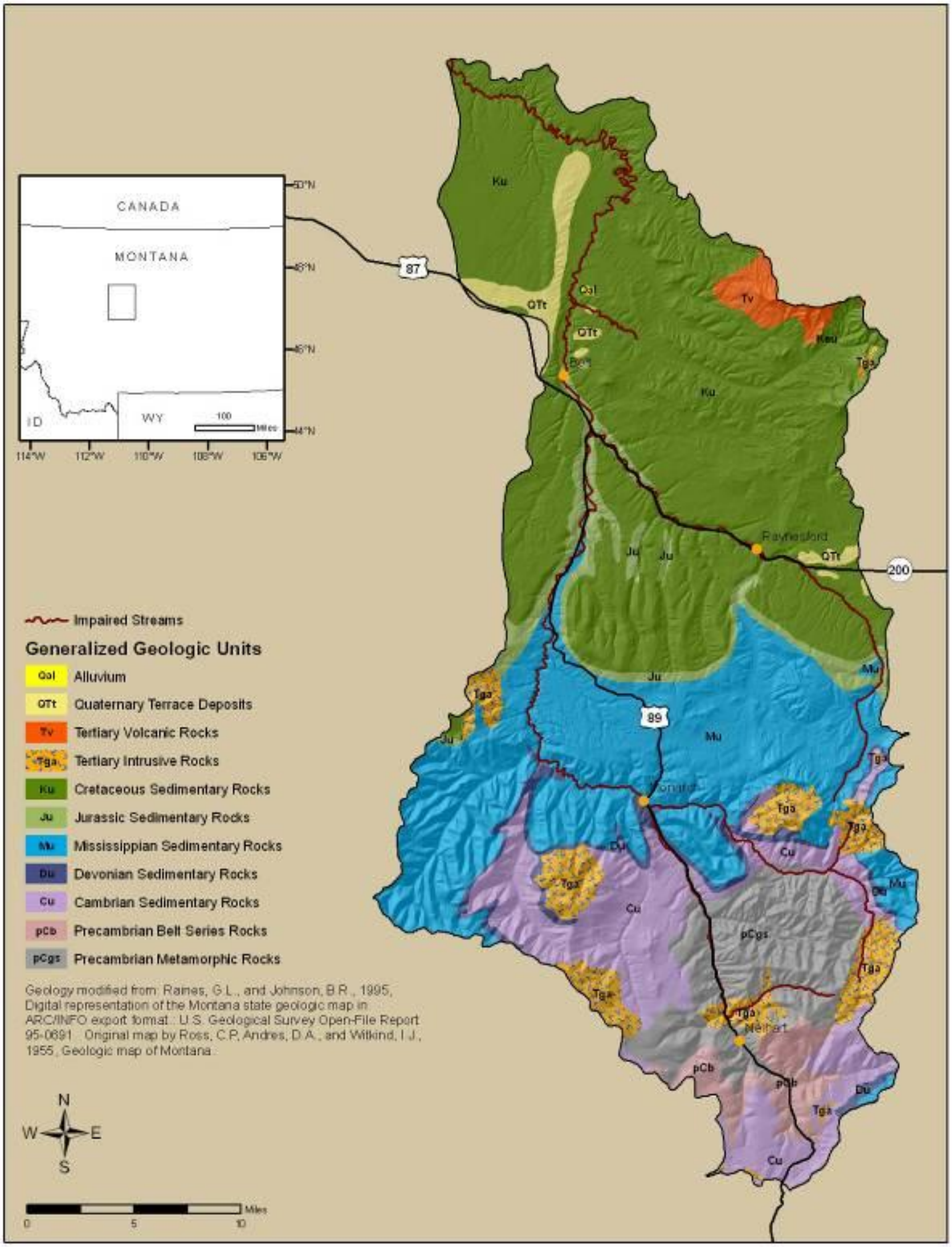

Figure 2-18. Geology: Belt TMDL Planning Area

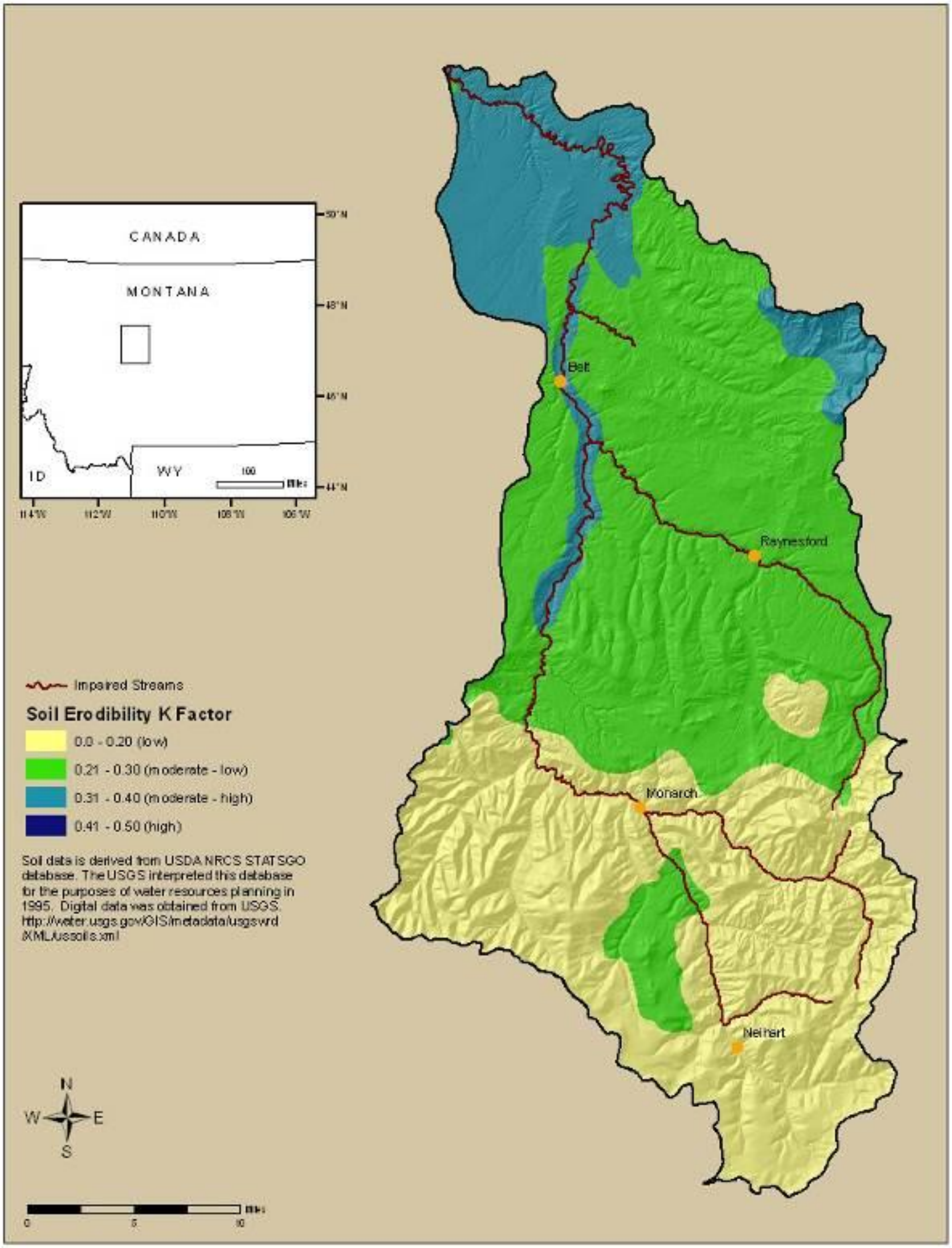

Figure 2-19. Erodibility: Belt TMDL Planning Area

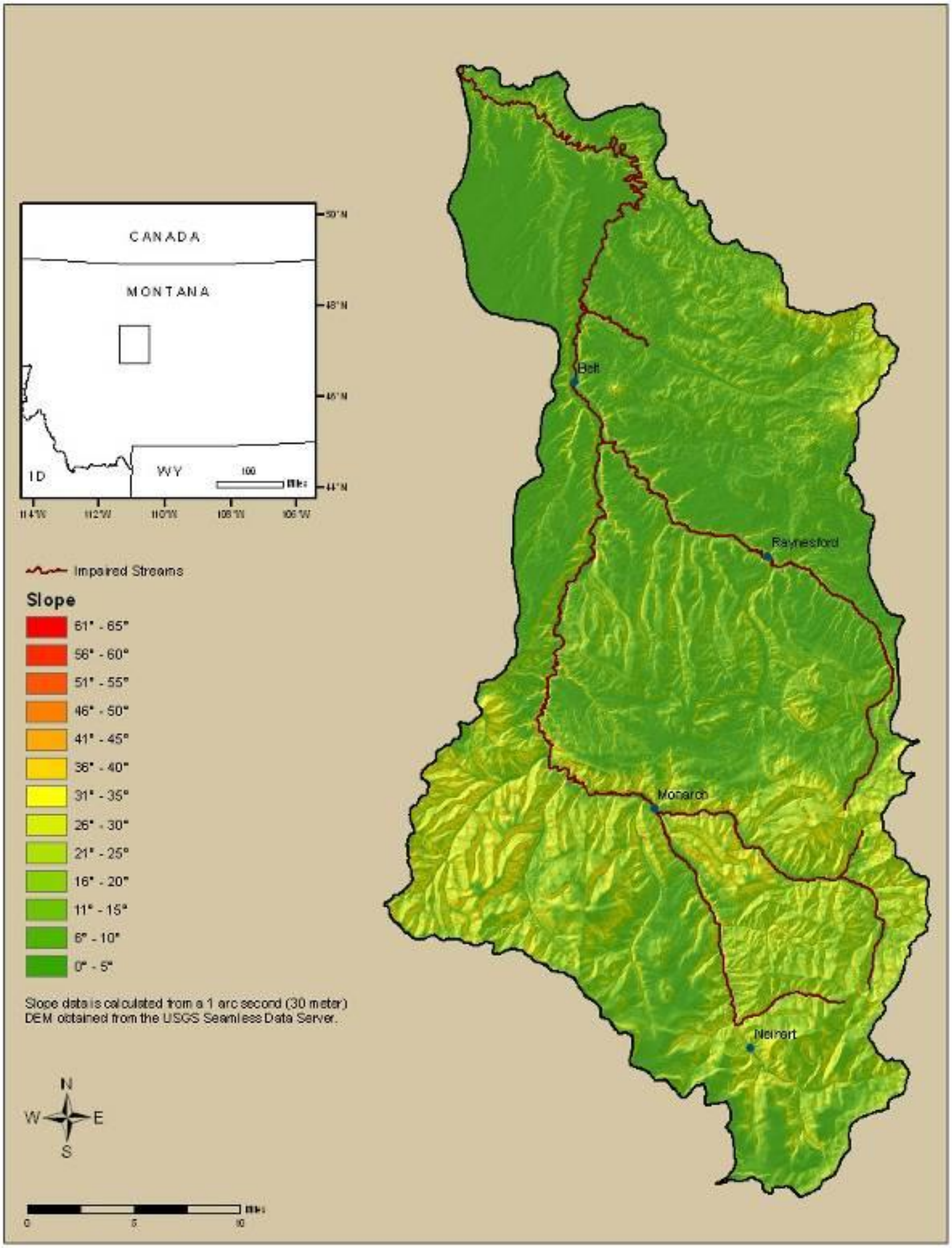

Figure 2-20. Slope: Belt TMDL Planning Area

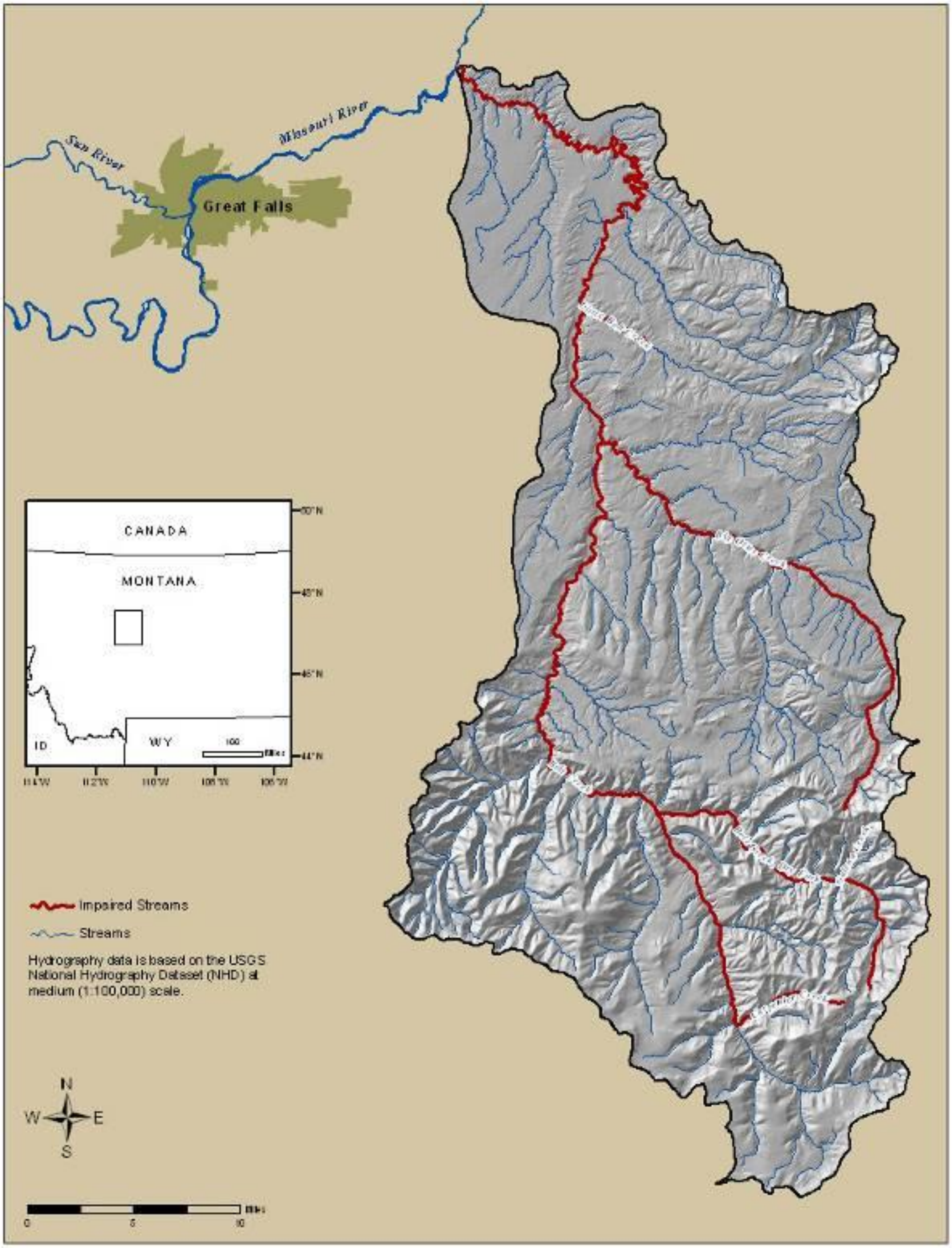

Figure 2-21. Hydrography: Belt TMDL Planning Area

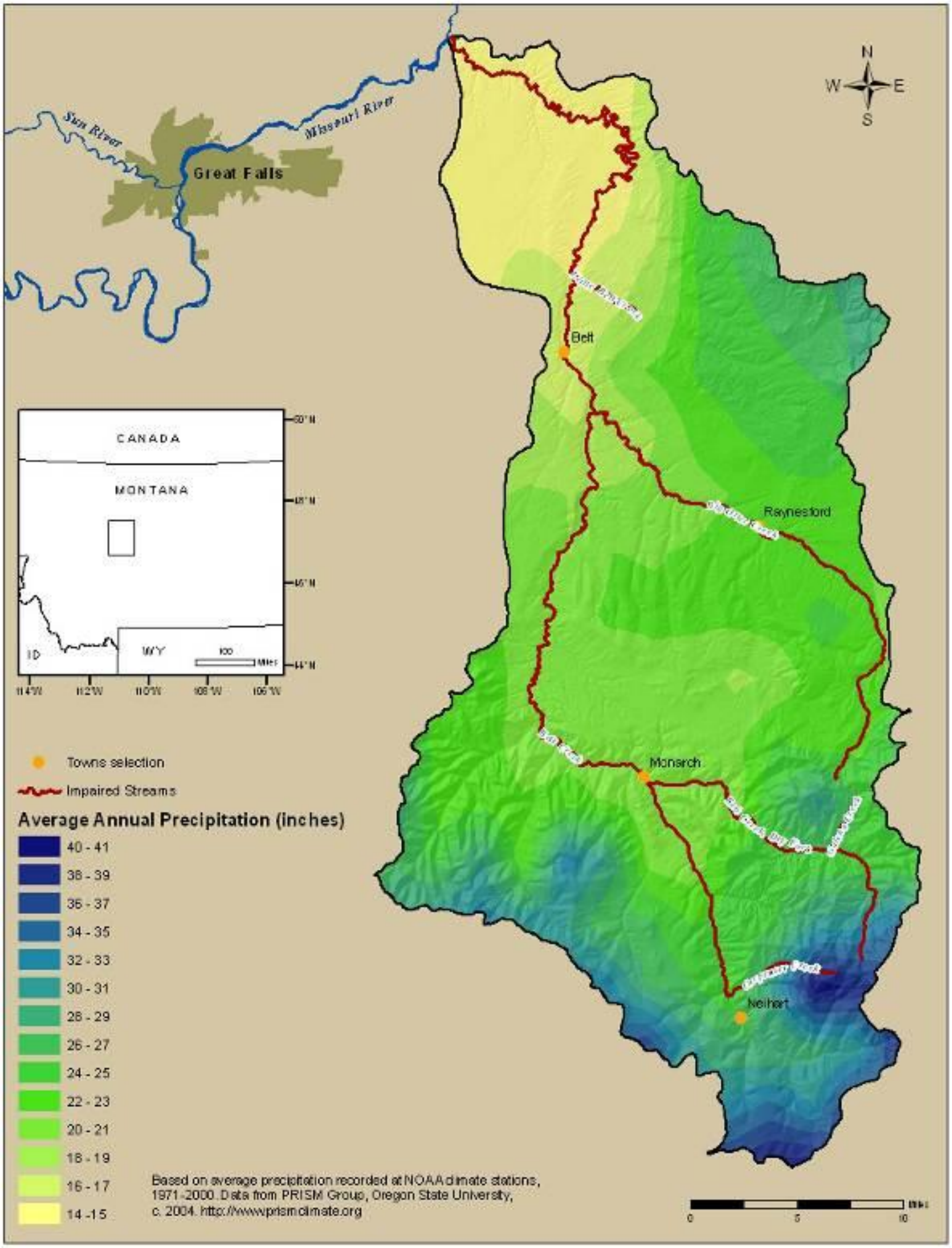

Figure 2-22. Precipitation: Belt TMDL Planning Area

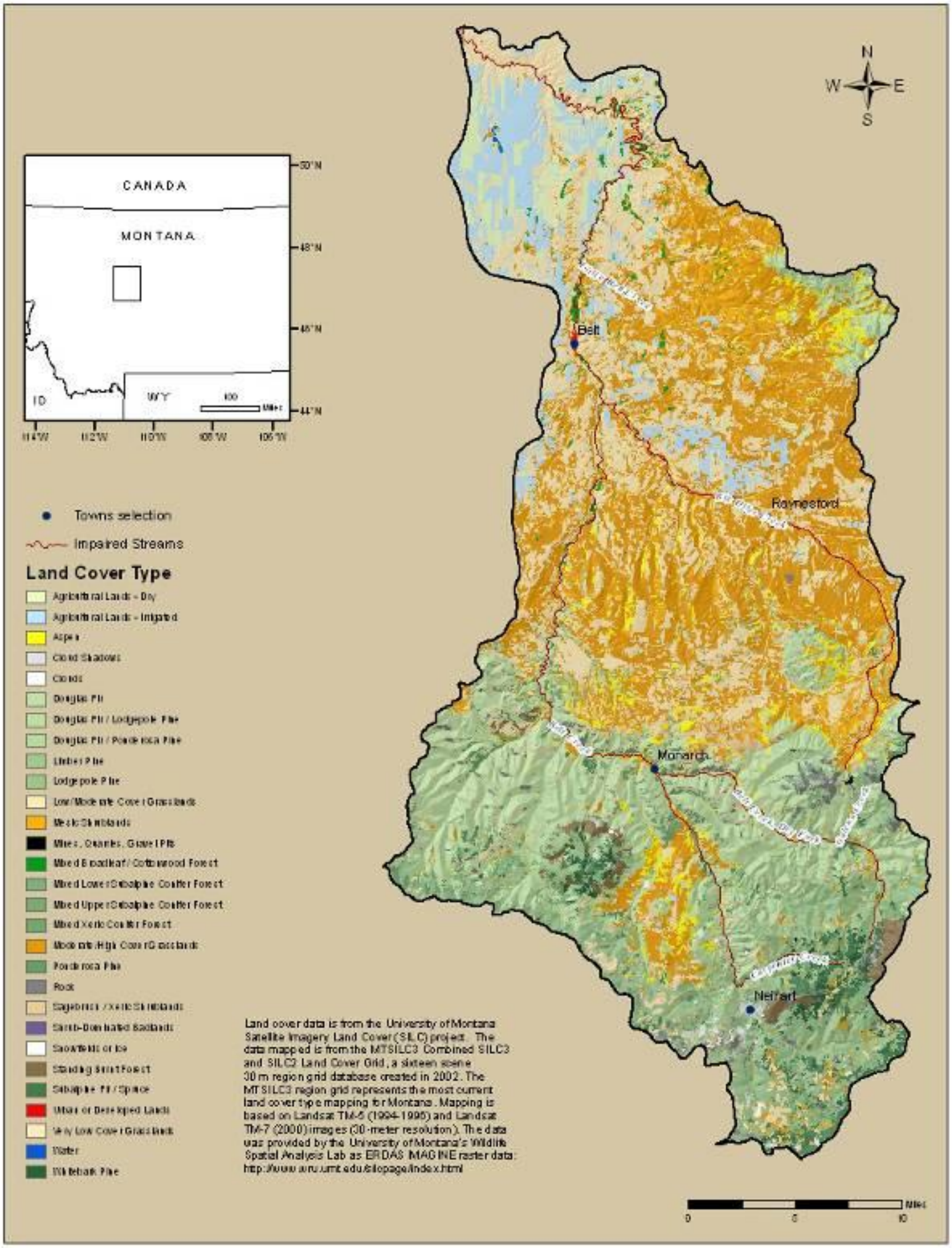

Figure 2-23. Land Cover: Belt TMDL Planning Area

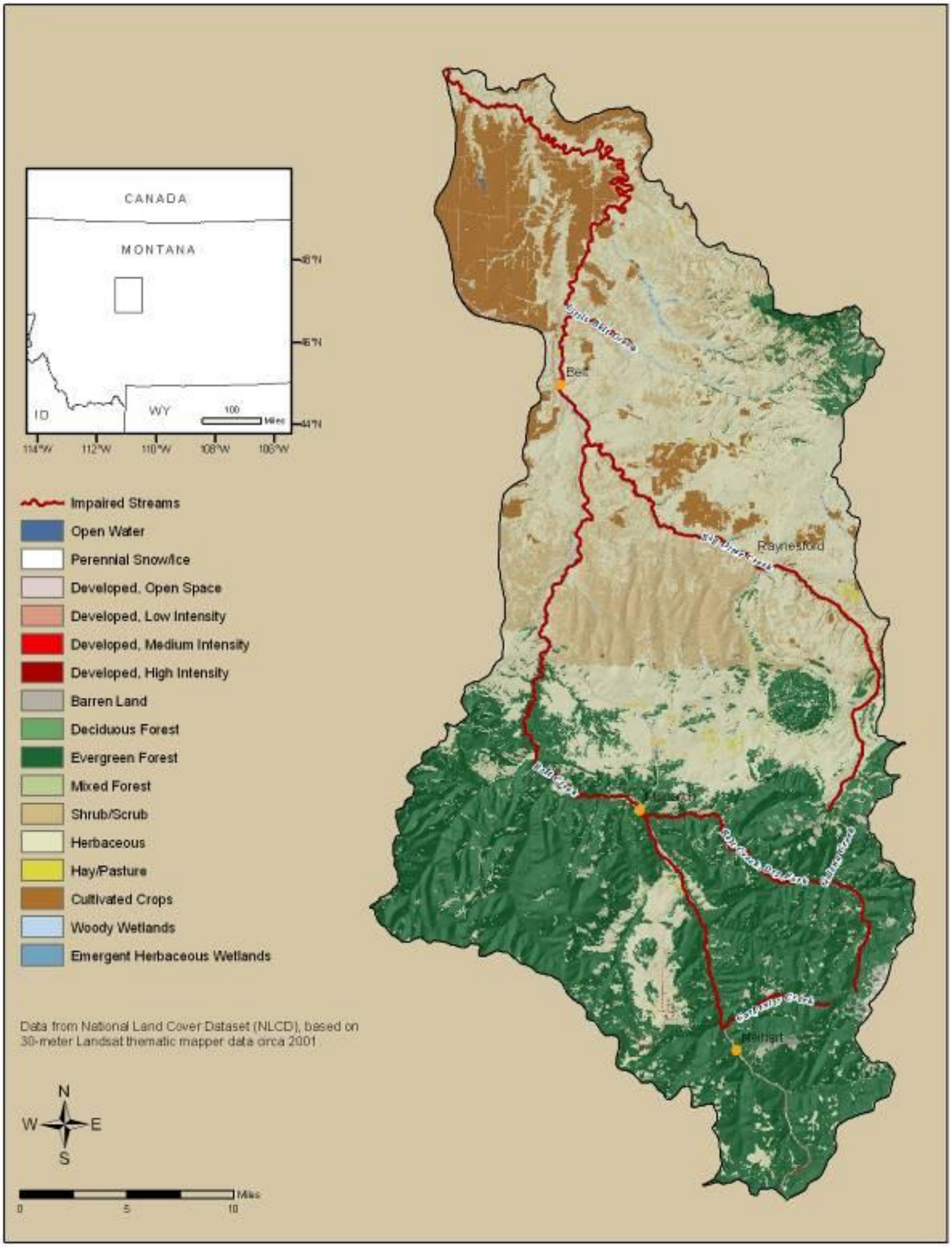

Figure 2-24. Land Use: Belt TMDL Planning Area

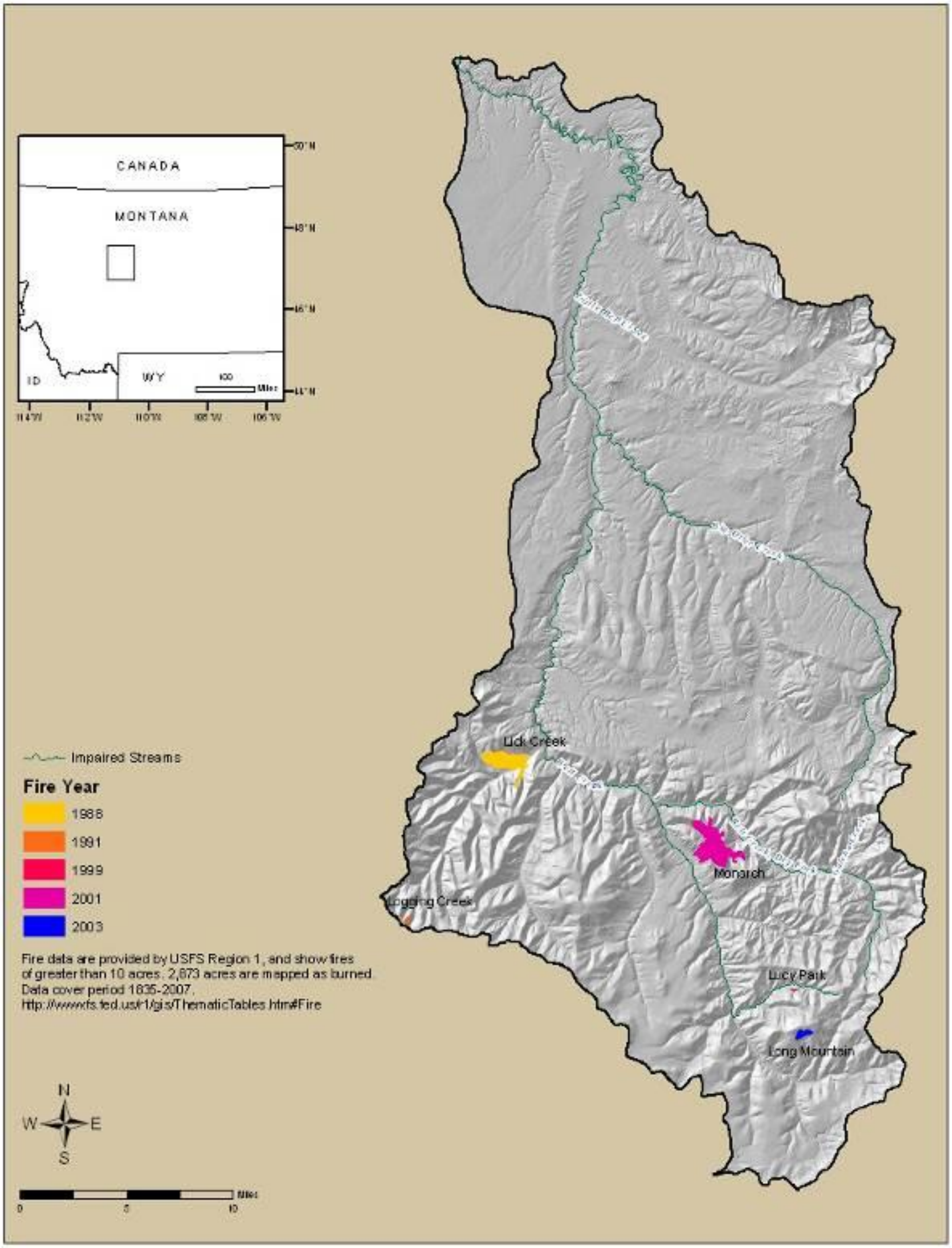

Figure 2-25. Wildfire: Belt TMDL Planning Area

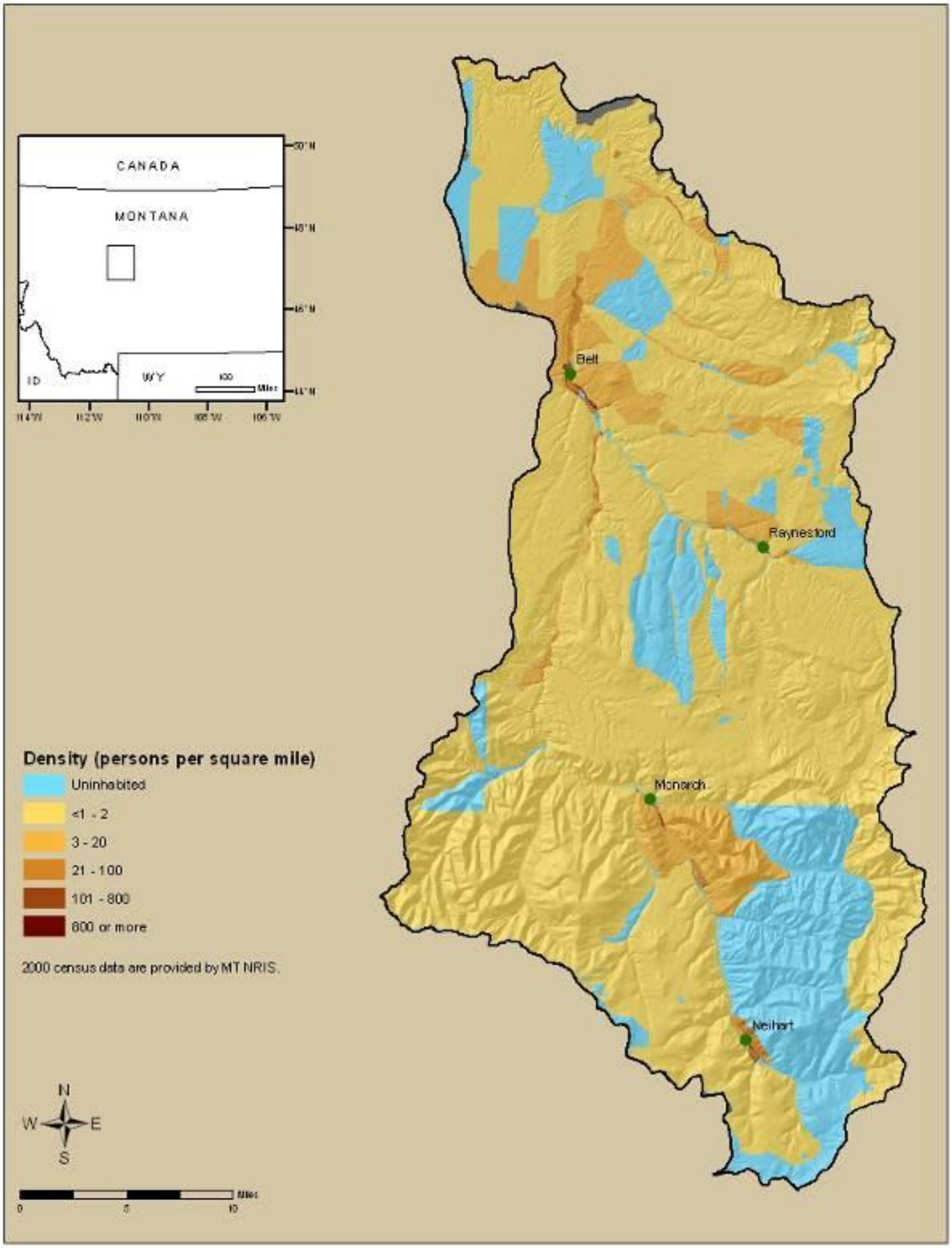

Figure 2-26. Census Data: Belt TMDL Planning Area

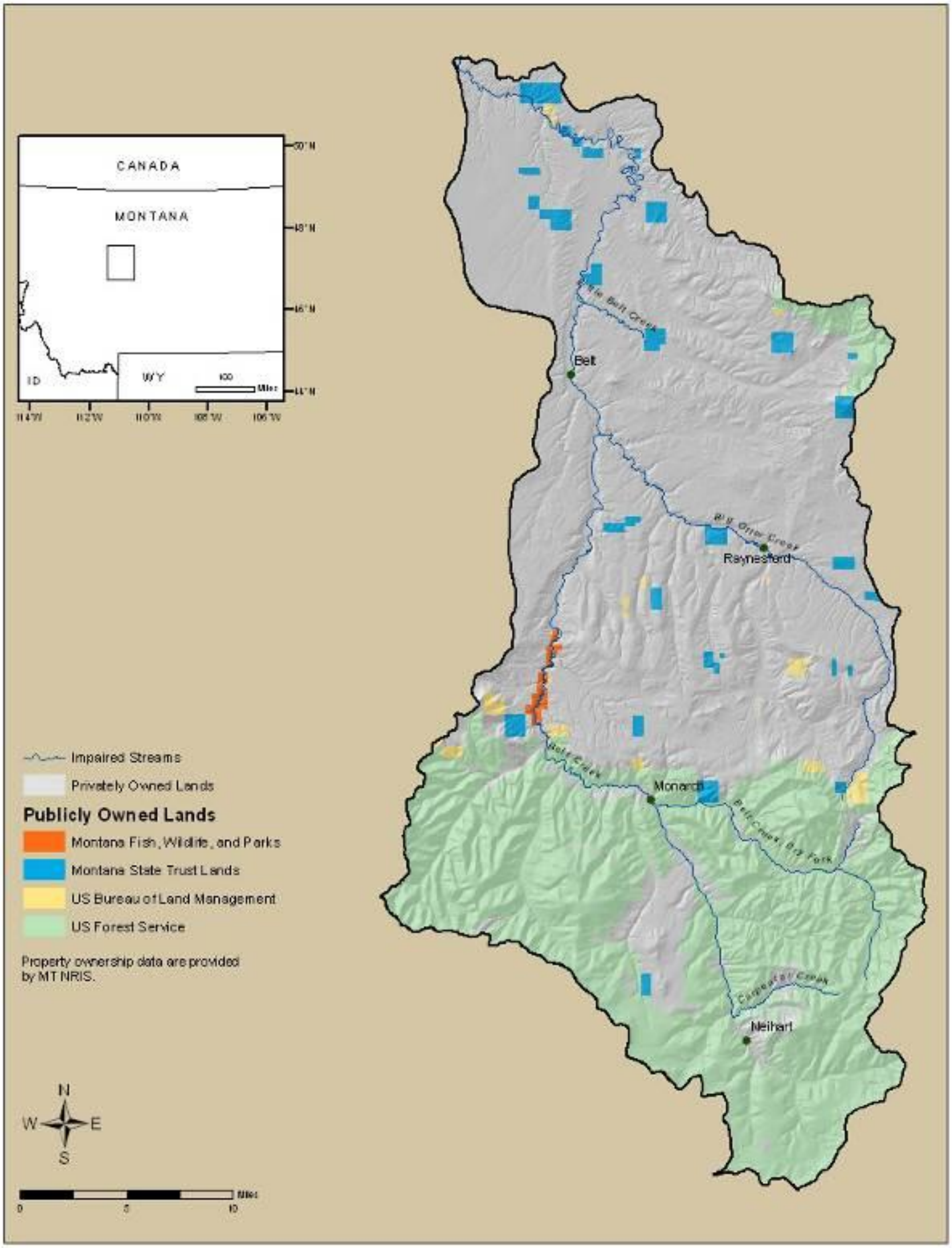

Figure 2-27. Land Ownership: Belt TMDL Planning Area

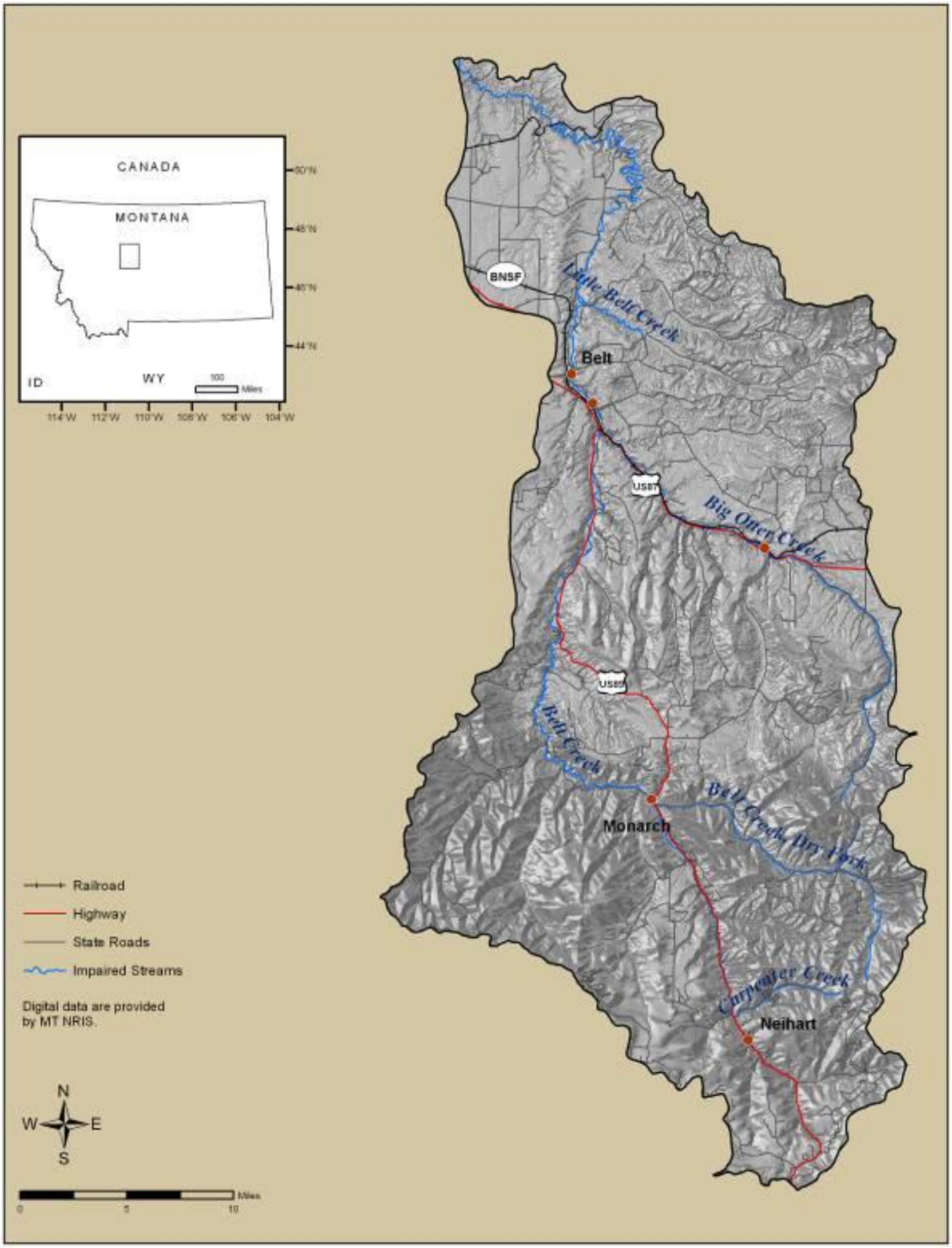

Figure 2-28. Transportation Networks: Belt TMDL Planning Area

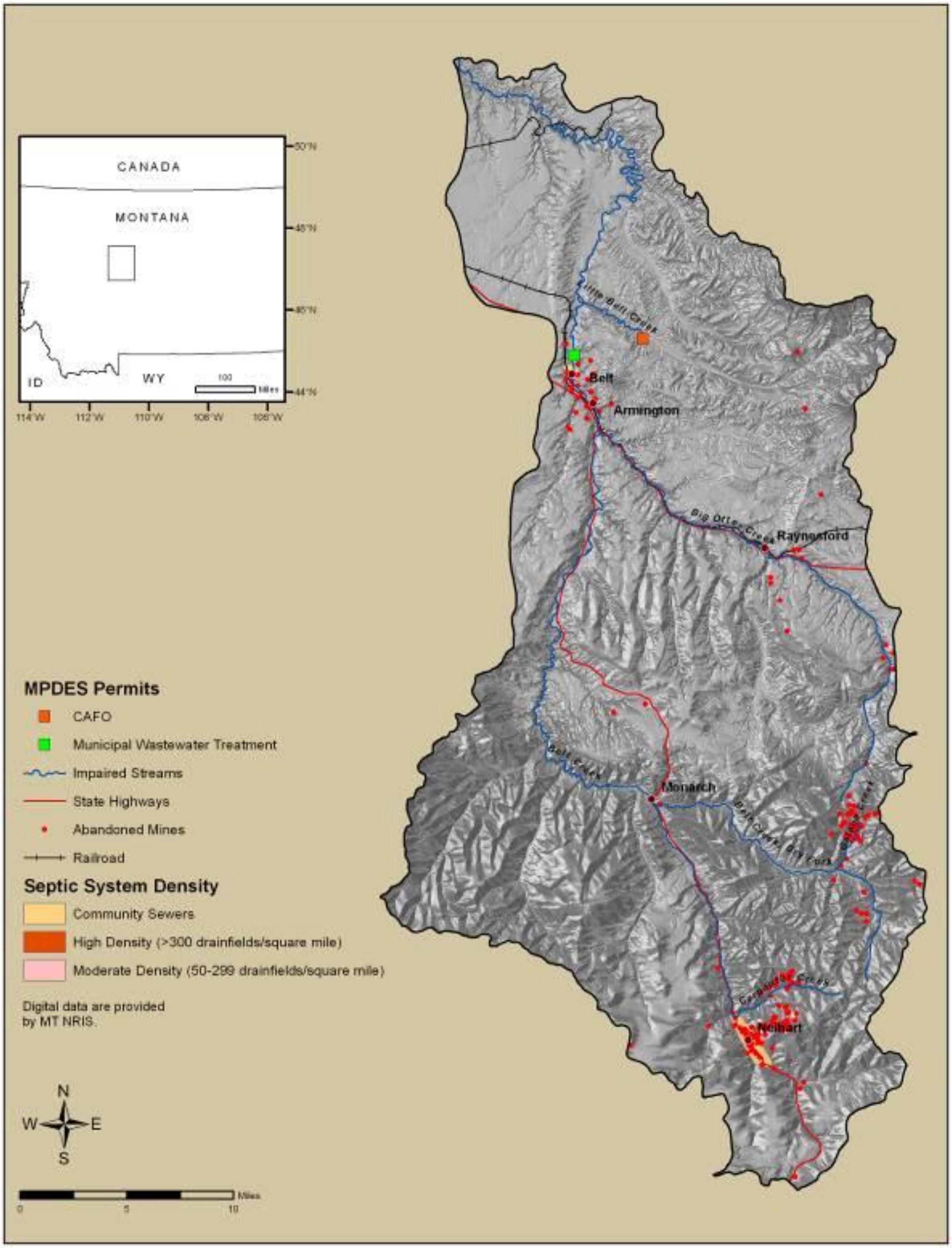

Figure 2-29. Point Sources: Belt TMDL Planning Area

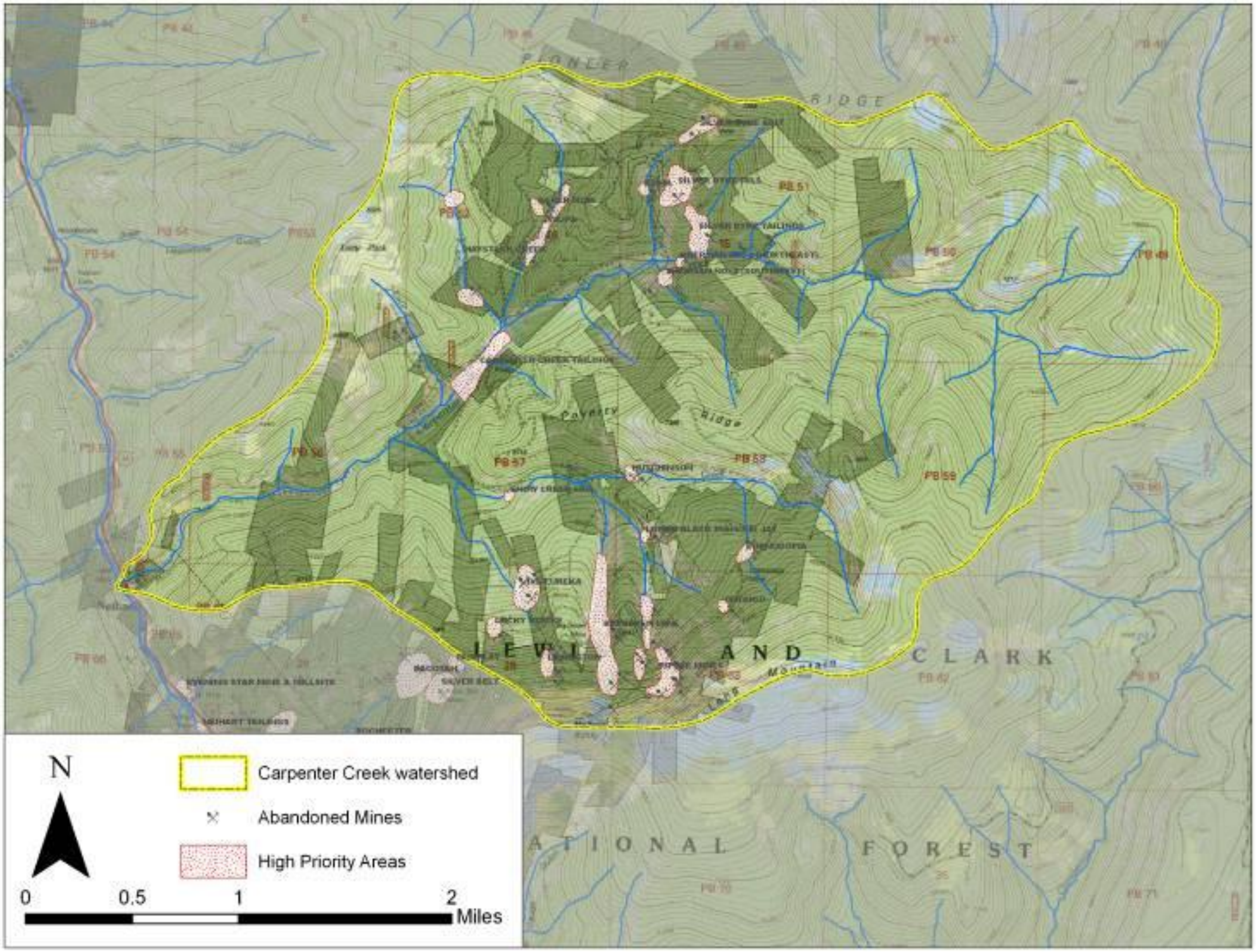

Figure 5-1. Carpenter Creek Historic and Abandoned Mining Sources

	
Figure 5-1a. Carpenter Creek Tailings	**Figure 5-1b. Silver Dyke Tailings: Tributary to Carpenter Creek**

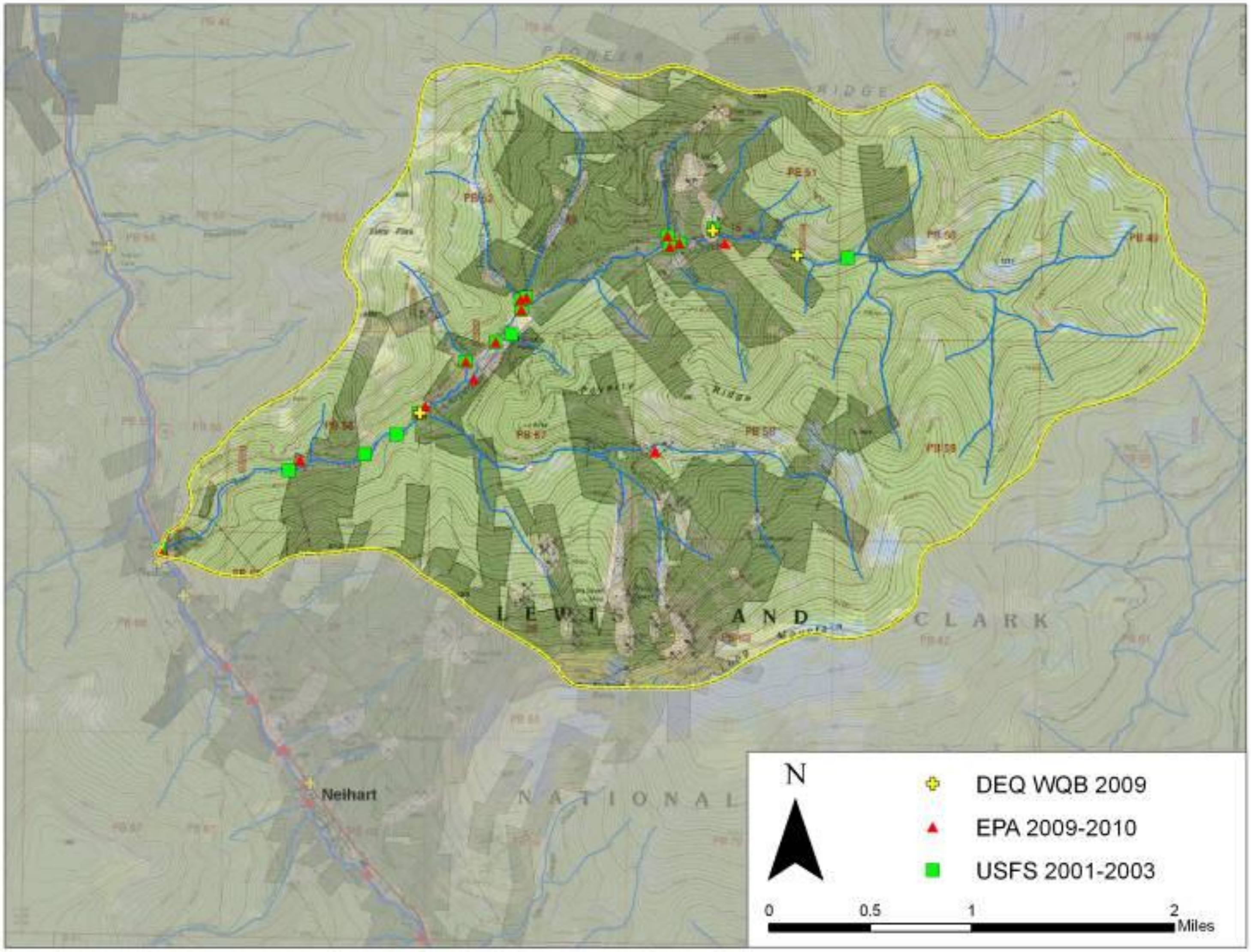

Figure 5-2. Carpenter Creek Water Quality Sampling Stations

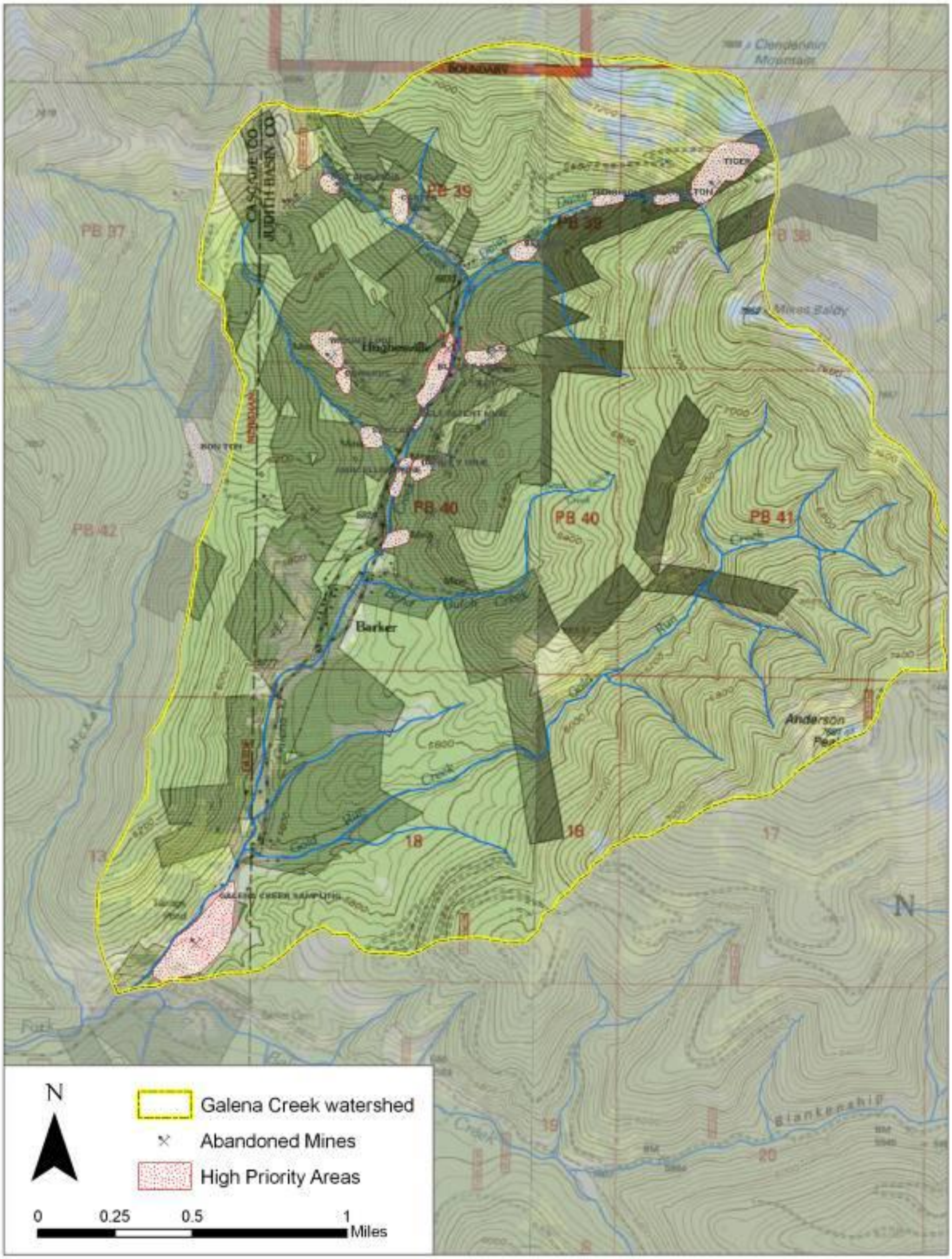

Figure 5-3. Galena Creek Historic and Abandoned Mining Sources

Figure 5-3a. Galena Creek Mine Adit & Mine Wastes

Figure 5-3b. Galena Creek Mine Drain/Adit

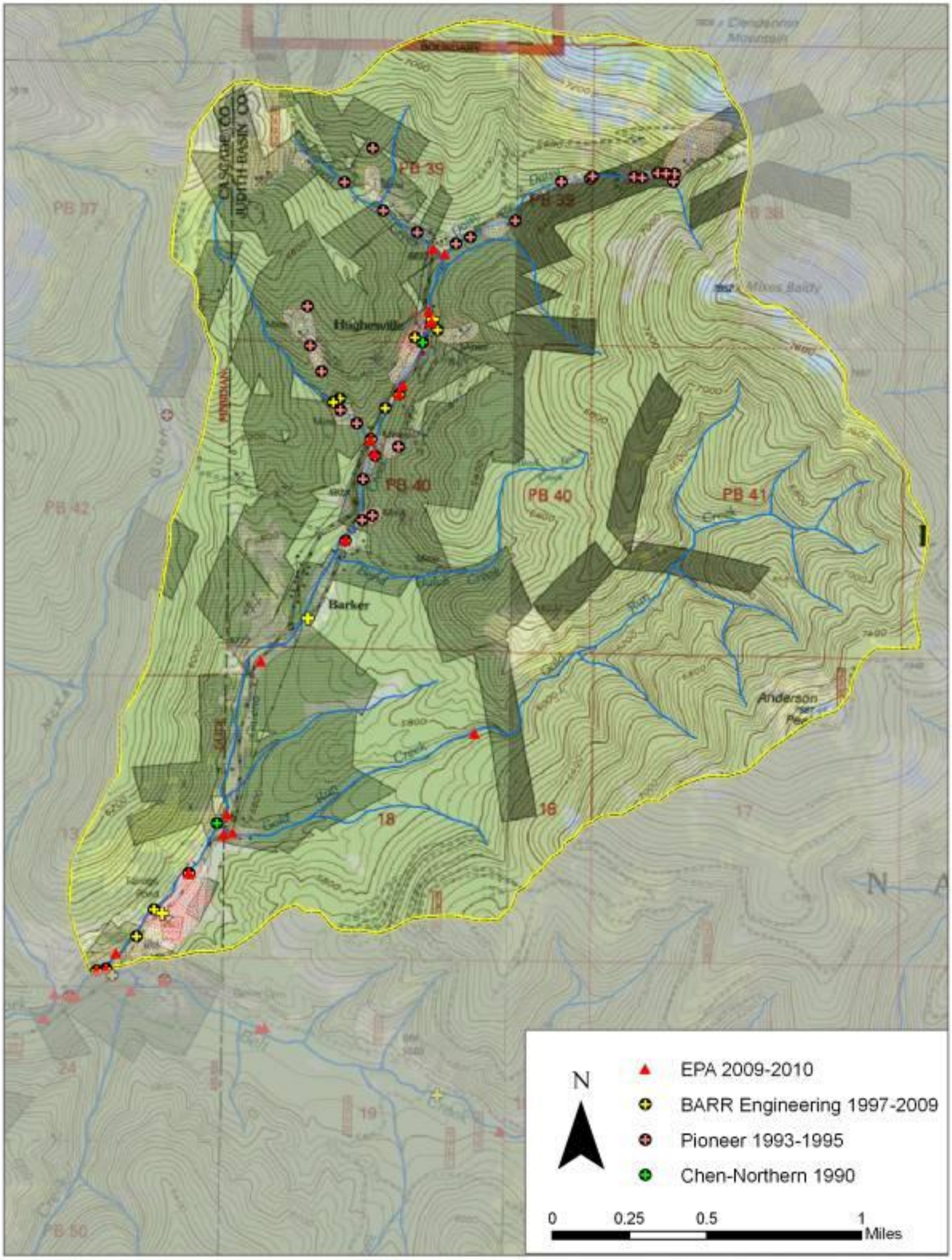

Figure 5-4. Galena Creek Water Quality Sampling Stations

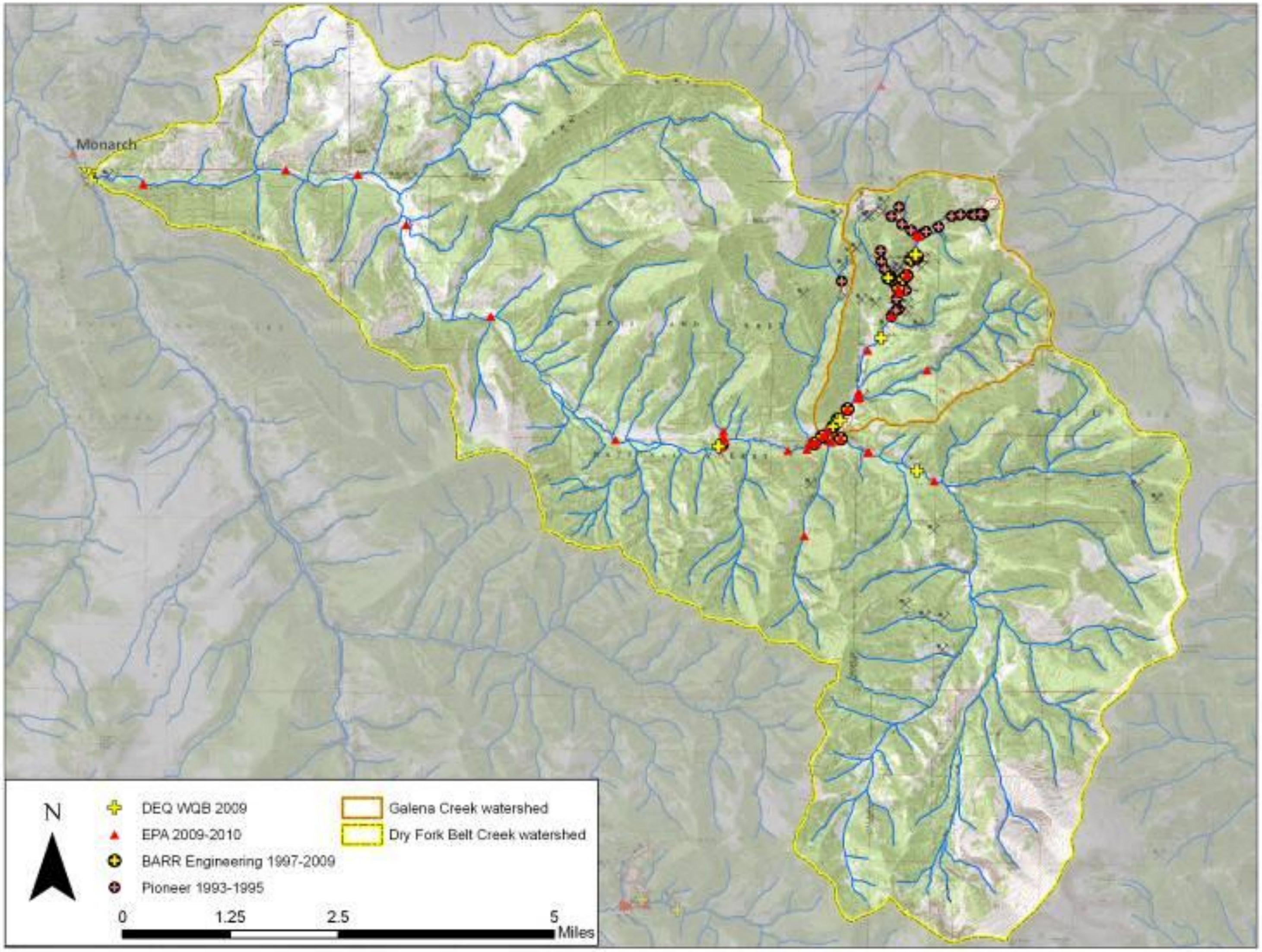

Figure 5-5. Dry Fork Belt Creek Water Quality Sampling Stations

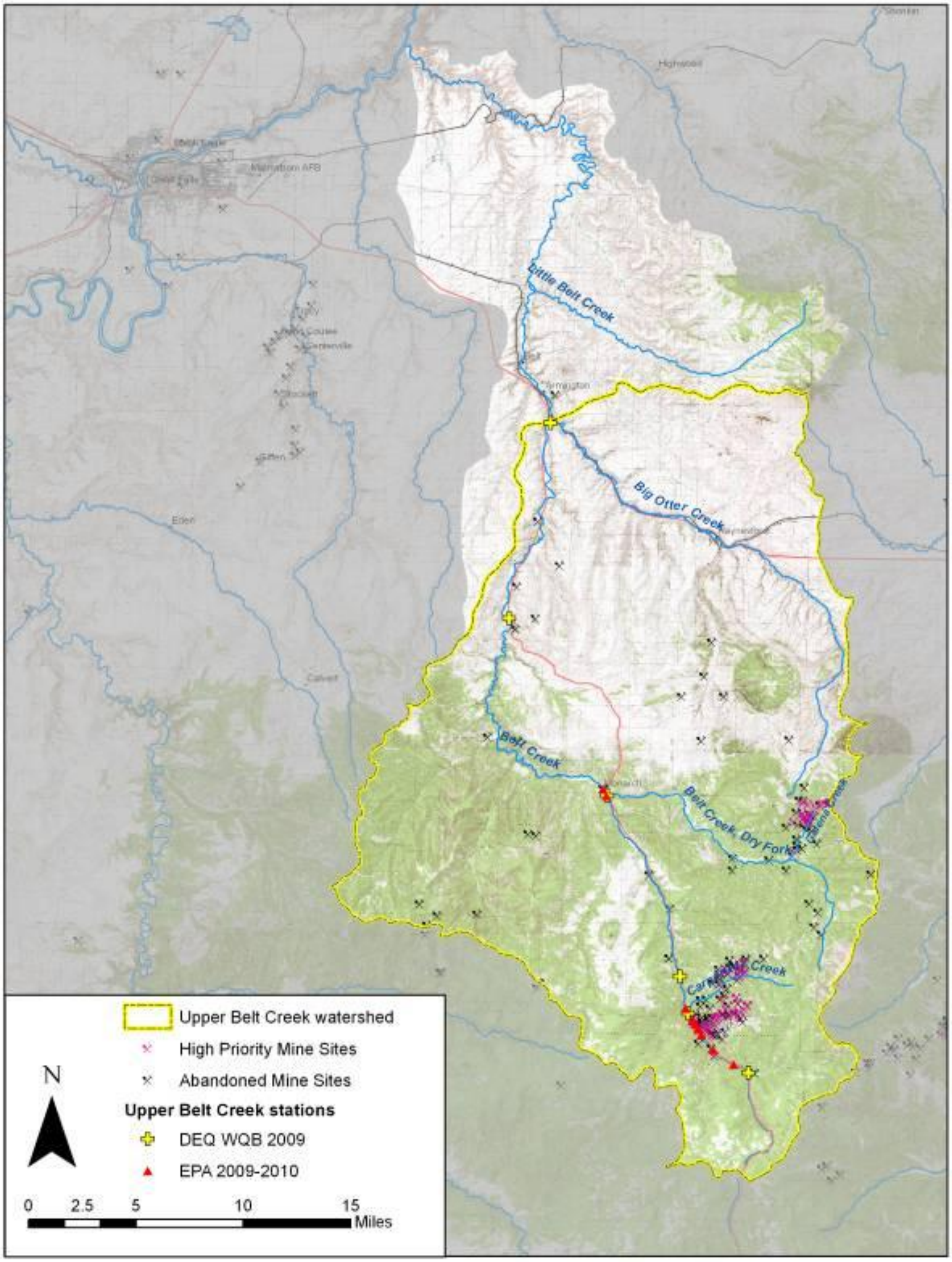

Figure 5-6. Upper Belt Creek Water Quality Sampling Stations

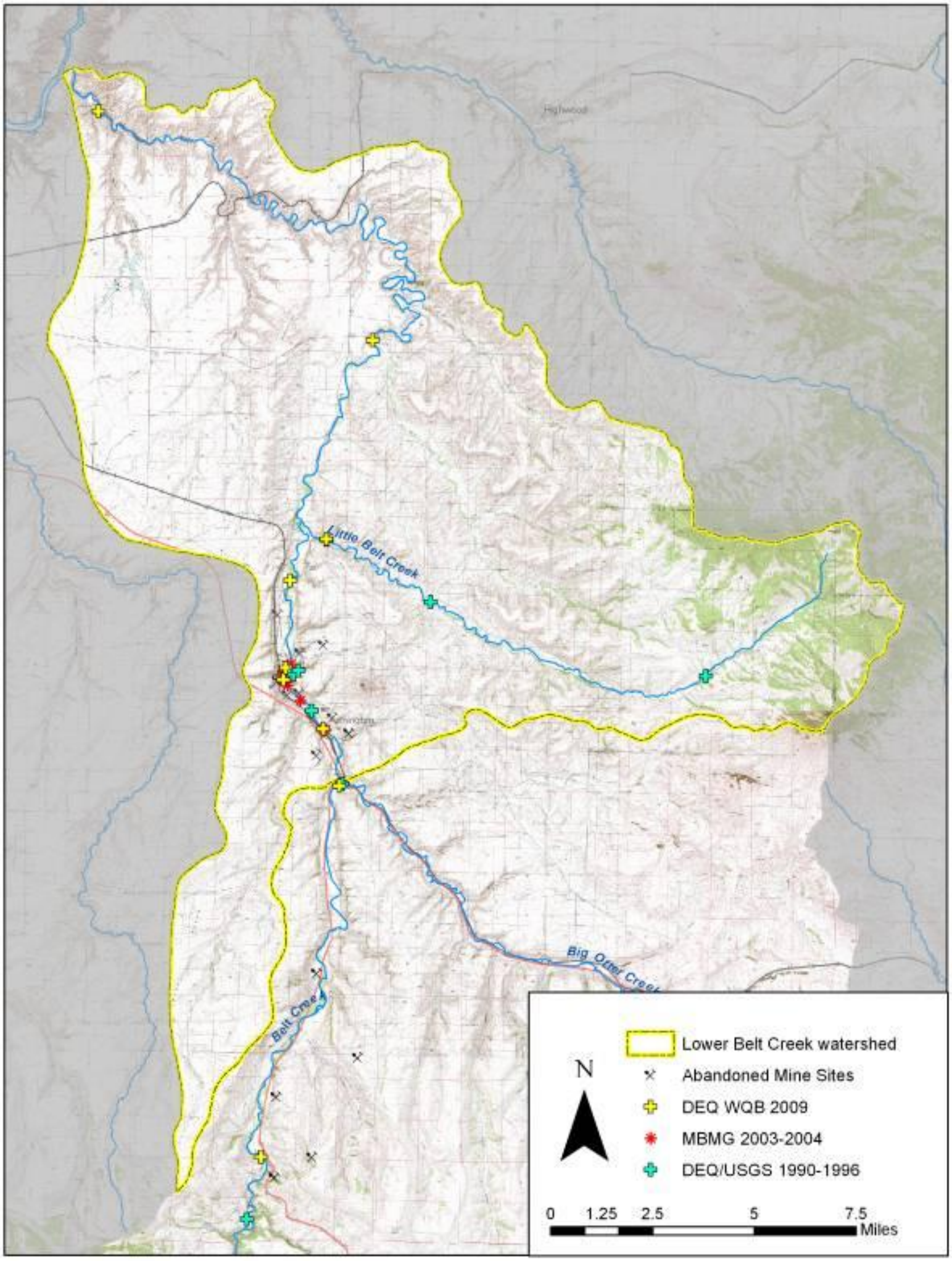

Figure 5-7. Lower Belt Creek Water Quality Sampling Stations

Figure 5-7a. Anaconda Mine Drain discharging to Belt Creek

Figure 5-7b. Belt Creek below Anaconda Mine Drain

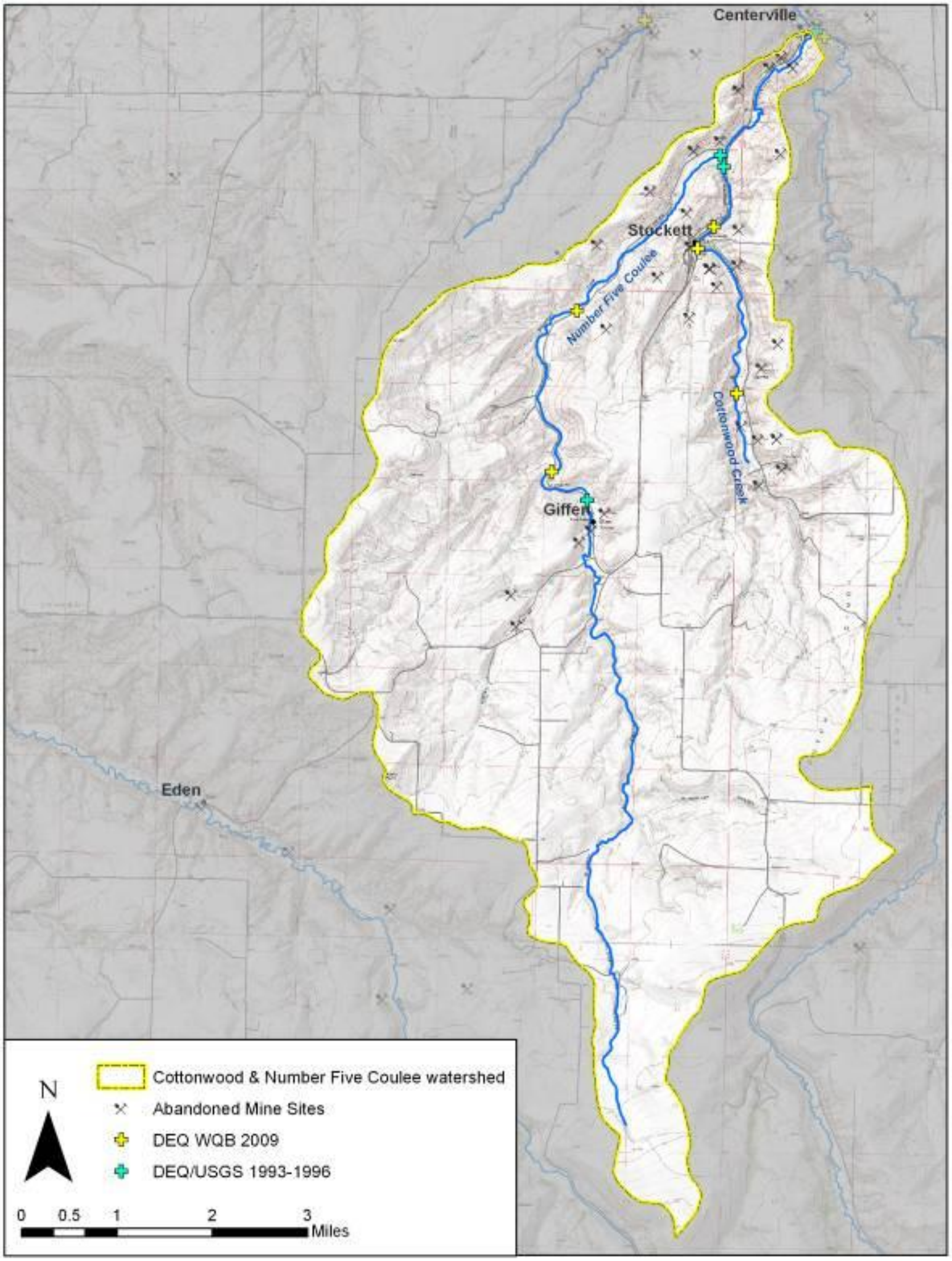

Figure 5-8. Cottonwood Creek and Number Five Coulee Water Quality Sampling Stations

		
Figure 5-9. Acid Mine Discharge entering Cottonwood Creek at Stockett	**Figure 5-10. Acid Mine Discharge entering Cottonwood Creek upstream of Stockett**	**Figure 5-11. Acid Mine Discharge (2) entering Cottonwood Creek upstream of Stockett**

Figure 5-12. Acid Mine Drainage to Number Five Coulee

Figure 5-13. Lower Sand Coulee

Figure 5-14. Acid mine drainage to Sand Coulee

Figure 5-15. Mine Spoils in Sand Coulee

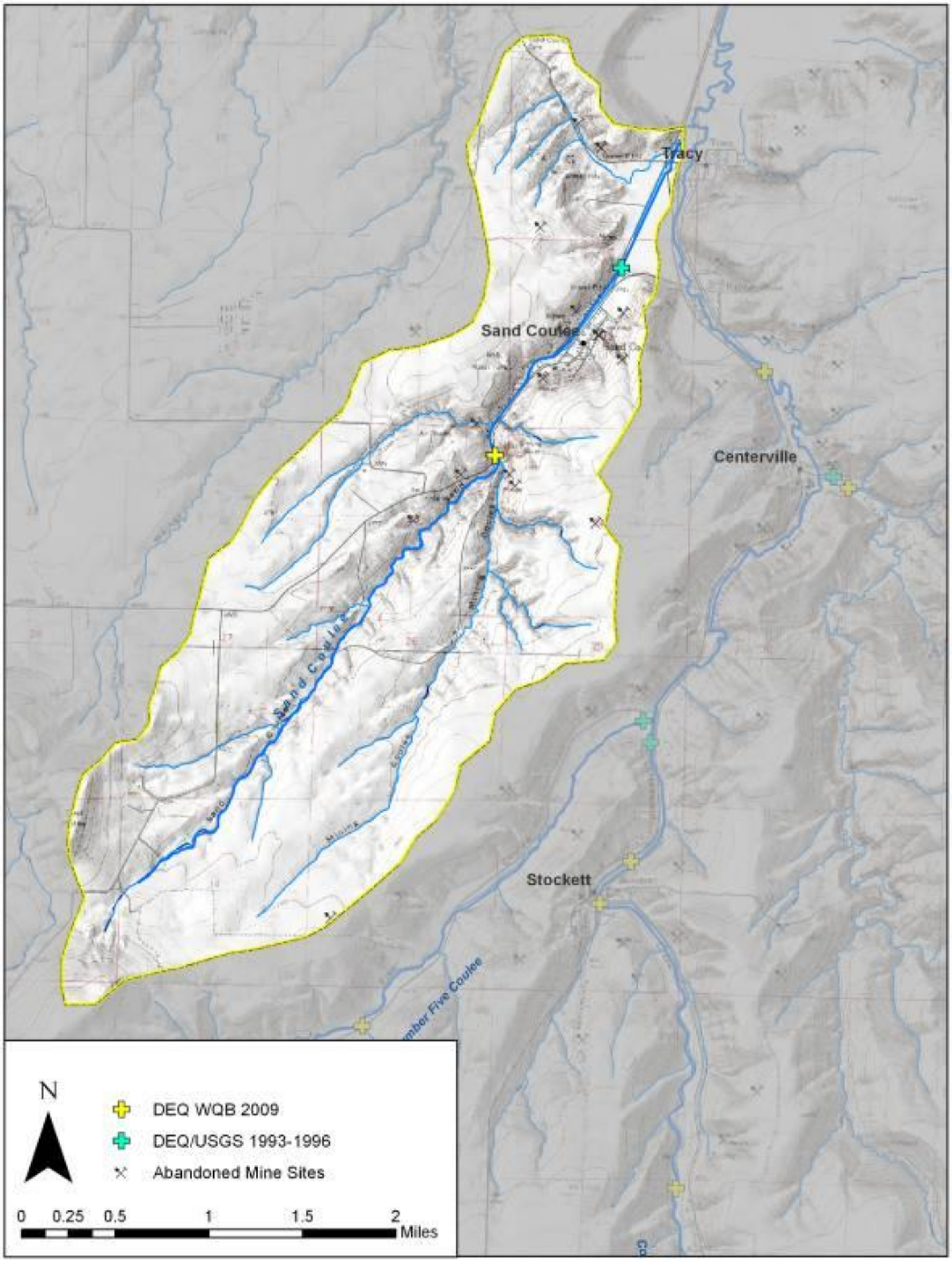

Figure 5-16. Sand Coulee Water Quality Sampling Stations

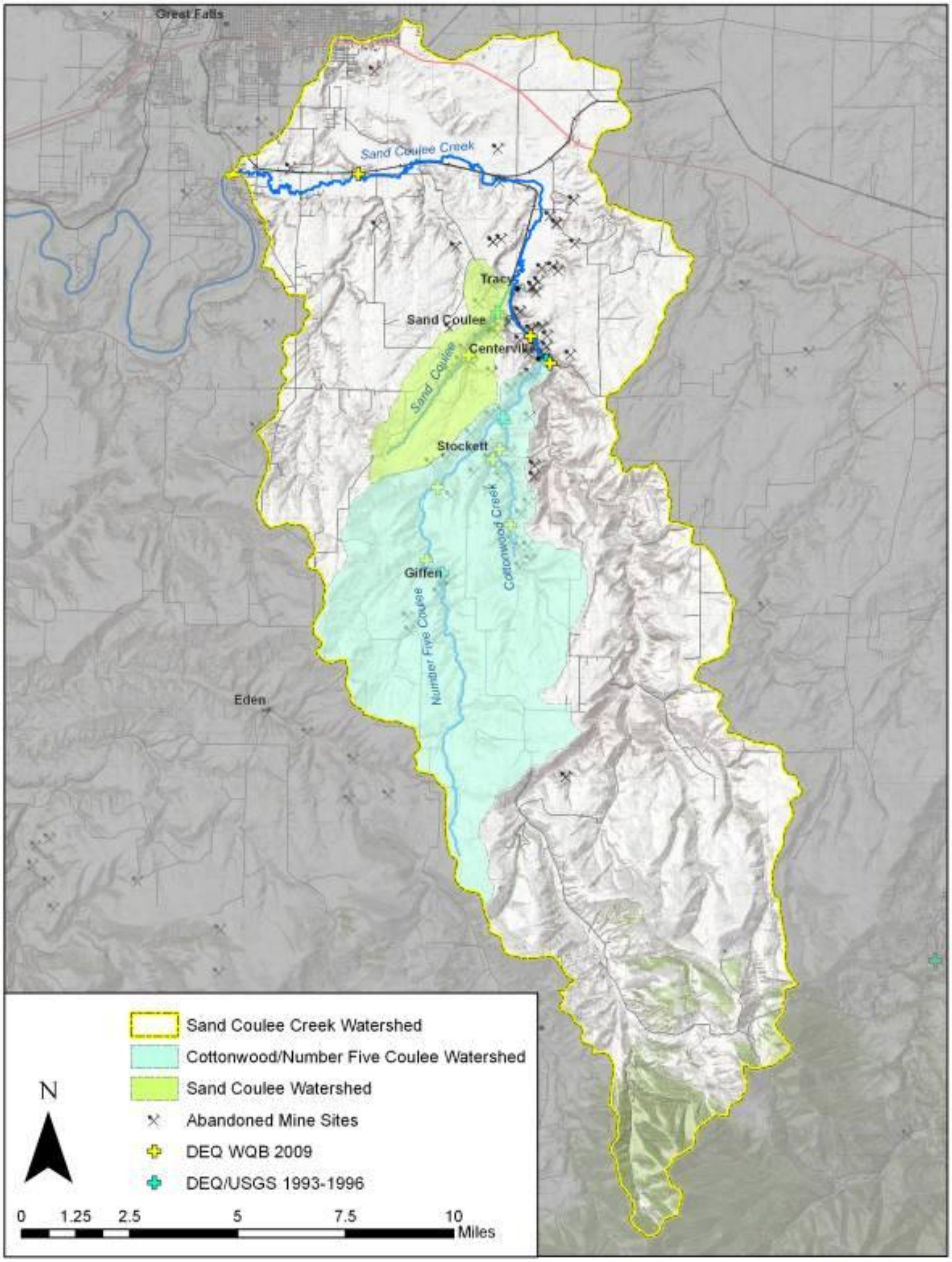

Figure 5-17. Sand Coulee Creek Water Quality Sampling Stations

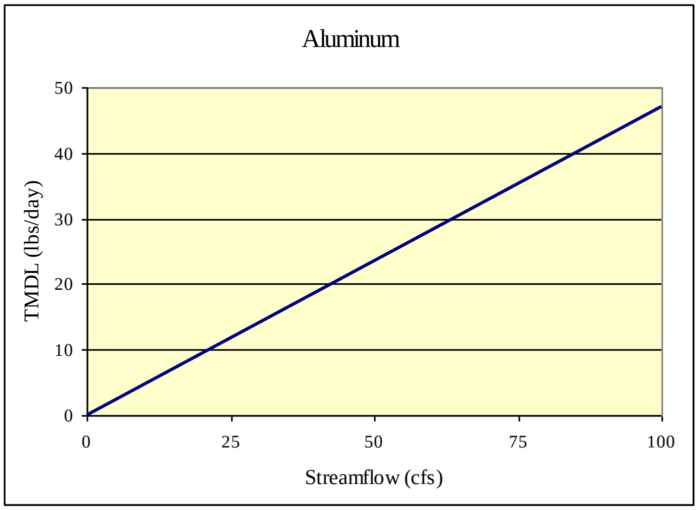

Figure 5-18. Aluminum TMDL as a function of flow

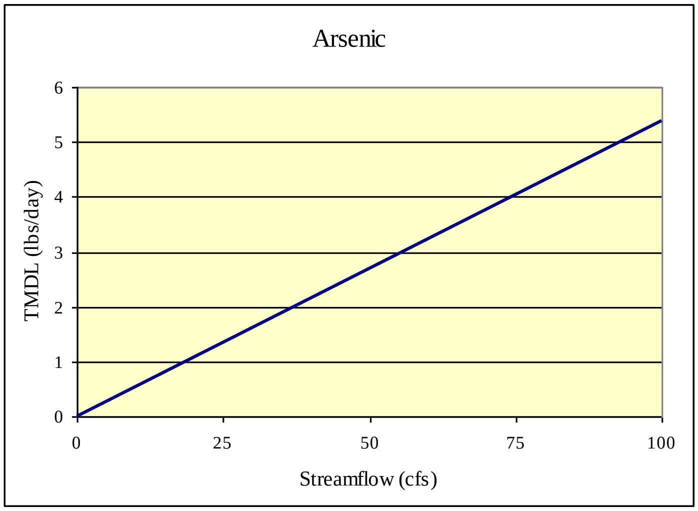

Figure 5-19. Arsenic TMDL as a function of flow

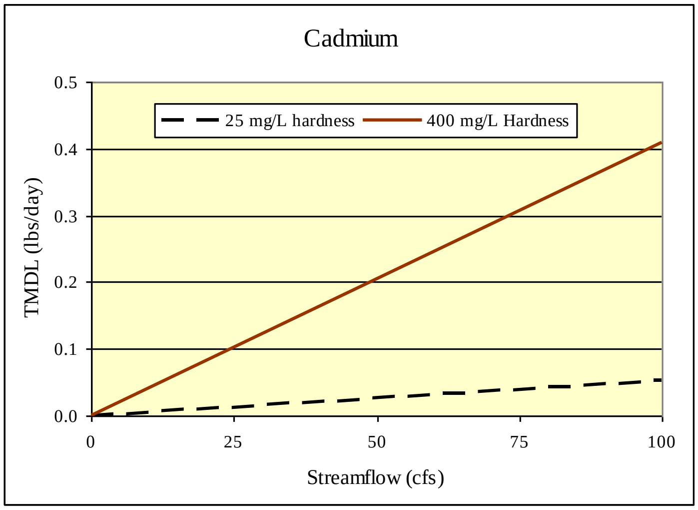

Figure 5-20. Cadmium TMDL as a function of flow

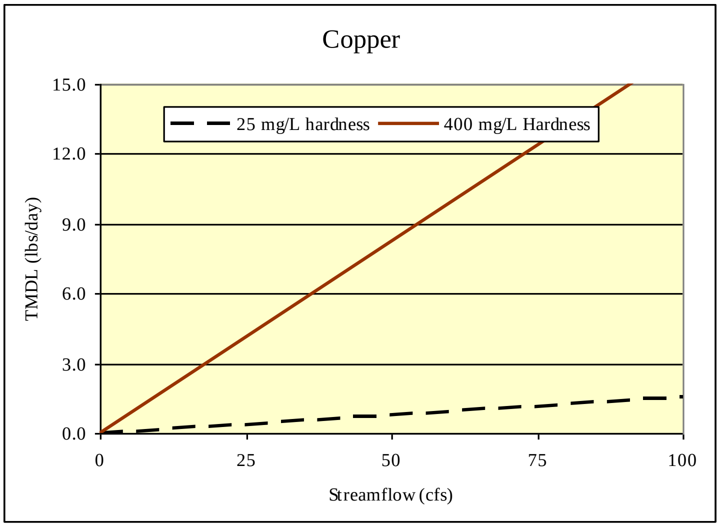

Figure 5-21. Copper TMDL as a function of flow

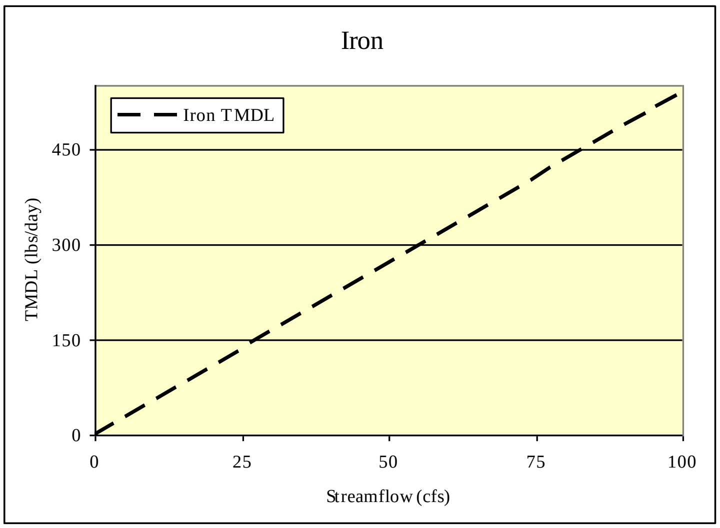

Figure 5-22. Iron TMDL as a function of flow

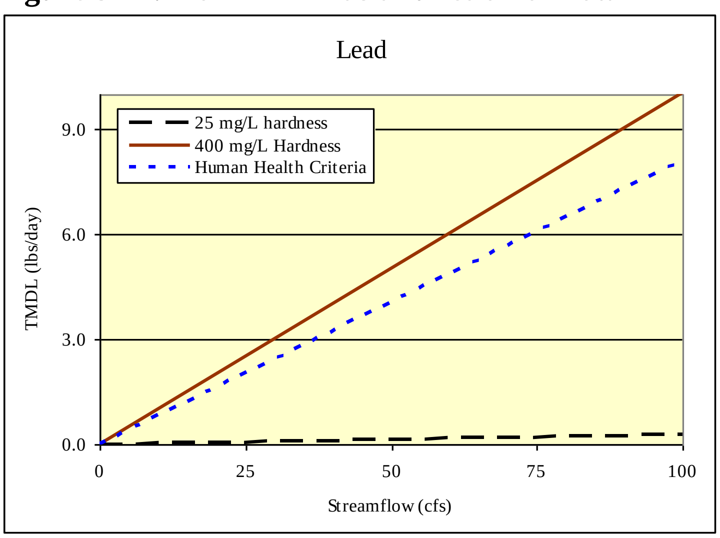

Figure 5-23. Lead TMDL as a function of flow

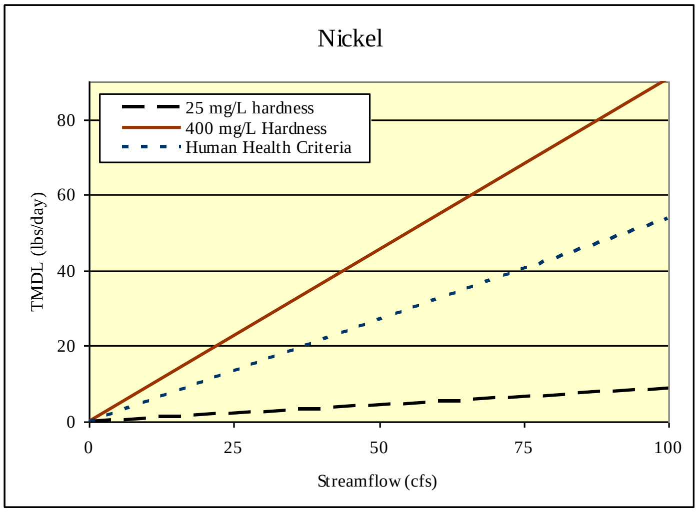

Figure 5-24. Nickel TMDL as a function of flow

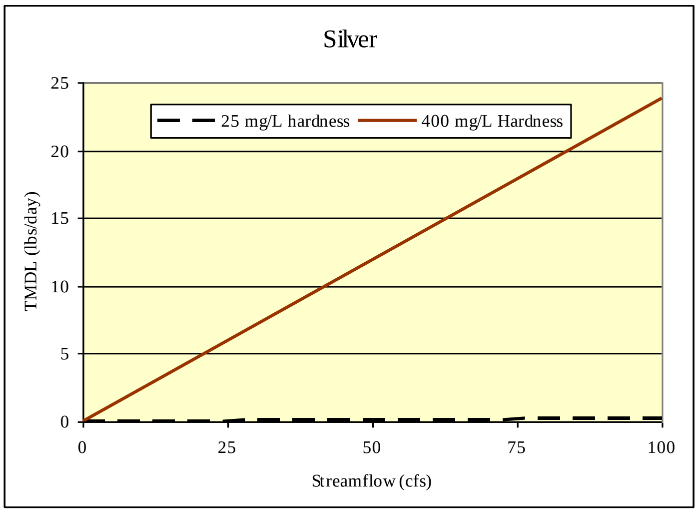

Figure 5-25. Silver TMDL as a function of flow

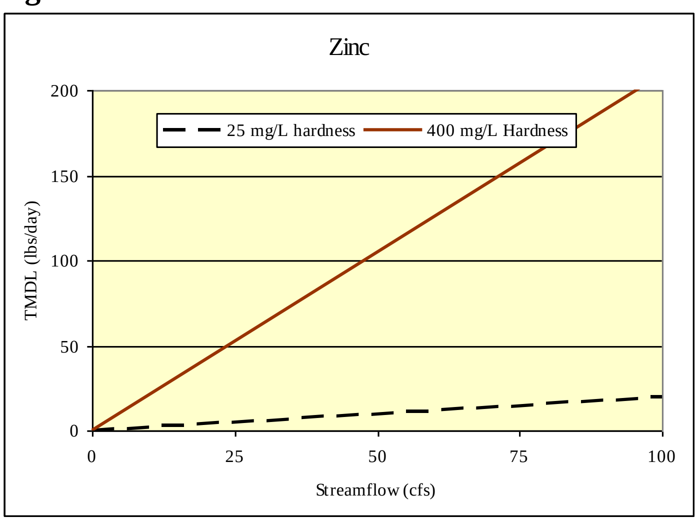

Figure 5-26. Zinc TMDL as a function of flow

APPENDIX B
REGULATORY FRAMEWORK AND REFERENCE CONDITION APPROACH

This appendix presents details regarding DEQ's regulatory framework for TMDL development and presents applicable Montana Water Quality Standards (WQS) for metals-related water quality impairments in the Missouri-Cascade and Belt TMDL Planning Areas

B.1 TMDL Development Requirements

Section 303 of the Federal CWA and the Montana WQA (Section 75-5-703) requires development of TMDLs for impaired waterbodies that do not meet Montana WQS. Although waterbodies can become impaired from pollution (e.g. flow alterations and habitat degradation) and pollutants (e.g. nutrients, sediment, metals, pathogens, and temperature), the CWA and Montana State Law (75-5-703) both require TMDL development for waters impaired only by pollutants. Section 303 also requires states to submit a list of impaired waterbodies to EPA every two years. Prior to 2004, EPA and DEQ referred to this list 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 problems (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 water body is used for consistency; the actual methodology is identified in DEQ's Water Quality Assessment Process and Methods (Montana Department of Environmental Quality, 2006). This methodology was developed via a public process and was incorporated into the EPA-approved 2000 version of the 305(b) report (now also referred to as the Integrated Report).

Under Montana State Law, an "impaired water body" is defined as a water body or stream segment for which sufficient credible data show that the water body or stream segment is failing to achieve compliance with applicable WQS (Montana Water Quality Act; Section 75-5-103(11)). A "threatened water body" is defined as a water body or stream segment for which sufficient credible data and calculated increases in loads show that the water body 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 of the CWA require states to develop all necessary TMDLs for impaired or threatened waterbodies. There are no threatened waterbodies within the Missouri-Cascade and Belt TMDL Planning Areas.

A TMDL is a pollutant budget for a waterbody identifying the maximum amount of the pollutant that a water body can assimilate without causing applicable WQS to be exceeded. 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.

To satisfy the Federal CWA and Montana State Law, TMDLs will be developed for each metals water body-pollutant combination identified on Montana's 2008 303(d) List of impaired waters in the Missouri-Cascade and Belt TMDL Planning Areas. 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.

B.2 Applicable Water Quality Standards

Water quality standards include the uses designated for a water body, the legally enforceable narrative or numeric criteria that ensure that the uses are supported, and a nondegradation policy that protects the high quality of a water body. The ultimate goal of this TMDL document, once implemented, is to ensure that all designated beneficial uses are fully supported and all standards are met. Pollutants addressed in this Water Quality Planning Framework include salinity and a variety of metals identified on the 2008 303(d) List as causes of impairment. This section provides a summary of the applicable water quality standards for metals. Metals water quality standards form the basis for metals water quality and sediment targets described in **Section 5**.

B.2.1 Classification and Beneficial Uses

Classification is the assignment (designation) of a single or group of uses to a water body based on the potential of the water body 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 Bureau of Environmental Review (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 water body 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 may 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.

Descriptions of Montana's surface water classifications and designated beneficial uses are presented in **Table B-1**. All waterbodies within the Missouri-Cascade and Belt TMDL Planning Areas are classified as B-1 or B-2 (see **Section 3.1, Table 3-1** for individual stream classifications).

Table B-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.
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.

B.2.2 Standards

In addition to the Use Classifications described above, Montana's water quality standards include numeric and narrative criteria as well as a nondegradation policy.

Numeric surface water quality criteria have been developed for many parameters to protect human health and aquatic life. These numeric criteria are in the Department Circular DEQ-7 (Montana Department of Environmental Quality, 2004). The numeric human health water quality criteria 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., life long) exposures as well as through direct contact such as swimming.

The numeric aquatic life criteria 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 criteria are protective of long-term exposure to a parameter. The protection afforded by the chronic criteria includes detrimental effects to reproduction, early life stage survival and growth rates. In most cases the chronic criteria is more stringent than the corresponding acute criteria. Acute aquatic life criteria are protective of short-term exposures to a parameter and are not to be exceeded.

High quality waters are afforded an additional level of protection by the nondegradation rules (ARM 17.30.701 et. seq.,) and in statute (75-5-303 MCA). Changes in water quality must be "non-significant", or an authorization to degrade must be granted by the Department. 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 water body.

Narrative criteria have been developed for substances or conditions for which sufficient information does not exist to develop specific numeric criteria. The term "Narrative Standards" commonly refers to the General Prohibitions in ARM 17.30.637 and other descriptive portions of the surface water quality standards. The General Prohibitions are also called the "free from" standards; that is, the surface waters of the state must be free from substances that impair the beneficial uses of a water body.

The narrative and numeric water quality criteria applicable to metals-related pollutants addressed in the Missouri-Cascade and Belt TMDL Planning Areas are summarized below.

Metals
Water quality standards that are applicable to metals impairments include both numeric water quality criteria given in DEQ-7 (**Table B-2**) and general prohibitions (narrative criteria) given in **Table B-3.** As water quality criteria for many metals is dependent upon water hardness, **Table B-2** presents acute and chronic metals numeric water quality criteria at water harnesses of 25 mg/L and 100 mg/L for metals of concern in the Missouri-Cascade and Belt TMDL Planning Areas. Also presented in **Table B-2** is the Human Health Criteria (HHC): note that for mercury and arsenic, the HHC is lower than applicable chronic criteria.

Table B-2. Metals Numeric Water Quality Criteria for the Missouri-Cascade and Belt TMDL Planning Areas

Metal of Concern	Aquatic Life Criteria (ug/L) at 25 mg/L Hardness		Aquatic Life Criteria (ug/L) at 100 mg/L Hardness		HHC
	Acute	Chronic	Acute	Chronic	
Aluminum, dissolved	750	87	750	87	--
Arsenic, TR	340	150	340	150	10
Cadmium, TR	0.52	0.10	2.13	0.27	5
Chromium, TR	579.32	27.69	1803.05	86.18	---
Copper, TR	3.79	2.85	14.00	9.33	1,300
Iron, TR	---	1,000	---	1,000	
Mercury, TR	1.70	0.91	1.70	0.91	0.05
Lead, TR	13.98	0.54	81.65	3.18	15
Nickel. TR	145.21	16.14	469.17	52.16	100
Silver, TR	0.37	---	4.06	---	100
Antimony, TR	---	---	---	---	6
Zinc, TR	37.02	37.02	119.82	119.82	2,000

In addition to numeric criteria given in **Table B-2**, narrative criteria also provides protection of beneficial uses. Toxic levels of metals in stream sediment are prohibited via ARM 17.30.637 (1)(d)). Metals concentrations in stream sediment are addressed via the suite of narrative criteria presented in **Table B-3**. The relevant narrative criteria do not allow for 'concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life.' This is interpreted to mean that water quality goals should strive toward a condition in which any increases in metals concentration in sediment above naturally occurring levels are not harmful, detrimental or injurious to beneficial uses (see definitions in **Table B-3**). Evaluation of numeric and narrative criteria for specific metals impairments by stream segment is given in **Section 5**.

Table B-3. Applicable Rules for Metals Concentrations in Sediment

Rule(s)	Criteria
17.30.623 (1) 17.30.624 (1)	Waters classified B-1 (B-2) 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.
17.30.623(2) 17.30.624(2)	No person may violate the following specific water quality standards for waters classified B-1 (B-2).
17.30.623 (2) (f) 17.30.624 (2) (f)	(f) No increases are allowed above naturally occurring concentrations of sediment or suspended sediment (except as permitted in 75-5-318, MCA), settleable solids, oils, or floating solids, which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation,
17.30.623 (2) (h) 17.30.624 (2) (h)	(h) Concentrations of carcinogenic, bioconcentrating, toxic, radioactive, nutrient, or harmful parameters may not exceed the applicable standards set forth in department Circular DEQ-7.

Table B-3. Applicable Rules for Metals Concentrations in Sediment

Rule(s)	**Criteria**
17.30.637	General Prohibitions
17.30.637(1)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will.
17.30.637(1)(d)	Create concentrations or combinations of materials that are toxic or harmful to human, animal, plant, or aquatic life.

Salinity

Water quality standards that are applicable to salinity impairments include narrative criteria consisting of B-1 and B-2 classification standards and general prohibitions given in **Table B-3.** Beneficial uses most sensitive to high salinity in the Belt and Missouri-Cascade TPAs include aquatic life and agricultural (irrigation water) uses. In-stream salinity levels must therefore be supportive of those uses.

References

Montana Department of Environmental Quality. 2004. Circular WQB-7: Montana Numeric Water Quality Standards. Helena, MT: Montana Department of Environmental Quality (MDEQ). http://www.deq.state.mt.us/wqinfo/Circulars/WQB-7.PDF.

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