Water Quality Restoration Plan and Total Maximum Daily Loads (TMDLs) for the Lake Helena Watershed Planning Area:

Volume I – Watershed Characterization and Water Quality Status Review

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Prepared for the Montana Department of Environmental Quality

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EXECUTIVE SUMMARY

This document presents the results of the first of several phases of the water quality restoration process for the Lake Helena watershed to establish Total Maximum Daily Loads (TMDLs), or limits, on the pollutants entering the watershed. The report includes (1) a characterization of the Lake Helena watershed, (2) a description of the applicable water quality standards, and (3) an assessment and description of the known pollution problems and their geographical locations based on the currently available data. The report is intended to set the stage for the development of a comprehensive, watershed-wide water quality restoration plan in the coming months.

The Lake Helena Watershed TMDL Planning Area (TPA) drains approximately 620 square miles of west-central Montana. The watershed includes the drainages of Prickly Pear Creek, Tenmile Creek, and Silver Creek, in addition to Lake Helena and the Lake Helena Causeway Arm of Hauser Reservoir. Twenty stream segments and two reservoir segments in the Lake Helena TPA appeared on Montana's 1996 Clean Water Act Section 303(d) List as either impaired or threatened relative to their ability to support the designated water uses defined in Montana's water quality standards. The suspected causes of impairment included flow alteration, habitat alterations, thermal modifications, suspended solids, siltation, turbidity, nutrients, un-ionized ammonia, salinity/total dissolved solids/chlorides, other inorganics, metals, pH, priority organics, and unknown toxicity. Cold-water fish and other aquatic life, drinking water, primary contact recreation (swimming), and agricultural and industrial uses were the beneficial uses listed as impaired or threatened. The Montana Department of Environmental Quality (MDEQ) revised the 303(d) list in 2002 using a new procedure, and the status of some beneficial uses and causes of impairment for several segments changed as a result of the revised listing procedure. Three additional stream segments were added to the list after 1996 and a fourth segment was removed from the list in 2004 based on new data.

This project re-evaluated the currently available data on water quality and assessed beneficial water uses in 25 individual segments of the following 18 water bodies in the Lake Helena watershed:

Clancy Creek	Corbin Creek	Golconda Creek
Granite Creek (Austin Creek)	Granite Creek (Sevenmile Creek)	Jackson Creek
Jennie's Fork	Lake Helena	Lump Gulch
Middle Fork Warm Springs Creek	North Fork Warm Springs Creek	Prickly Pear Creek
Sevenmile Creek	Silver Creek	Skelly Gulch
Spring Creek	Tenmile Creek	Warm Springs Creek

The evaluation has tentatively concluded that TMDL water quality restoration plans will be required for 43 individual pollutant and water body combinations in the Lake Helena watershed. These include 20 stream segments totalling 145 stream miles and 1,600 lake acres that are impacted by heavy metals and related problems, 17 segments totalling 121 stream miles with excess quantities of sediment, and 17 segments totalling 41 stream miles and 1,600 lake acres that are impaired as result of nutrients and related pollutants.

The specific pollution problems and affected water bodies that will be addressed by the forthcoming Lake Helena watershed water quality restoration plan and TMDLs are summarized in Table ES-1.

Table ES-1. Water quality status of suspected impaired water bodies and required TMDLs in the Lake Helena watershed.

Water Body Name and Number	Suspected Impairment Causes	Conclusions	Proposed Action
Clancy Creek, MT41I006_120	Sediment	Impaired	A TMDL will be written.
	Nutrients	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Corbin Creek, MT41I006_090	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
	Temperature	Unknown	A TMDL will not be written at this time.
	Salinity/total dissolved solids/chlorides	Impaired for salinity and total dissolved solids. Not impaired for chlorides.	A TMDL will not be written. Impairments will be addressed by the metals TMDL.
Golconda Creek, MT41I006_070	Sediment	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for cadmium and lead.
Granite Creek, MT41I006_179	Habitat alterations	Not impaired	A TMDL will not be written.
Granite Creek, MT41I006_230	Metals	Unknown	A TMDL will not be written at this time.
Jackson Creek, MT41I006_190	Sediment	Not impaired	A TMDL will not be written.
Jennie's Fork, MT41I006_210	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for lead.
Lake Helena, MT41I007_010	Sediment	Unknown	A TMDL will not be written at this time.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for arsenic and lead.
	Temperature	Unknown	A TMDL will not be written at this time.

Water Body Name and Number	Suspected Impairment Causes	Conclusions	Proposed Action
Lump Gulch, MT41I006_130	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for cadmium, copper, lead, and zinc.
Middle Fork Warm Springs Creek, MT41I006_100	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, lead, and zinc.
North Fork Warm Springs Creek, MT41I006_180	Sediment	Impaired	A TMDL will be written.
	Low dissolved oxygen, organic enrichment	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, and zinc.
Prickly Pear Creek, MT41I006_060	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for lead.
Prickly Pear Creek, MT41I006_050	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for cadmium, lead, and zinc.
Prickly Pear Creek, MT41I006_040	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
	Temperature[a]	Impaired	A TMDL will be written.
Prickly Pear Creek, MT41I006_030	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for arsenic and lead.
	Temperature	Impaired	A TMDL will be written.
Prickly Pear Creek, MT41I006_020	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Total ammonia	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, and lead.
	Temperature	Impaired	A TMDL will be written.

Water Body Name and Number	Suspected Impairment Causes	Conclusions	Proposed Action
Prickly Pear Creek, MT41I006_010	Metals	Not evaluated	TMDL needs will be addressed as part of Hauser Reservoir TMDL.
Sevenmile Creek, MT41I006_160	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for copper and lead.
Silver Creek, MT41I006_150	Metals	Impaired	A TMDL will be written for arsenic and mercury.
	Priority organics	Not impaired	A TMDL will not be written.
Skelly Gulch, MT41I006_220	Sediment	Impaired	A TMDL will be written.
	Metals	Not impaired	A TMDL will not be written.
Spring Creek, MT41I006_080	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Tenmile Creek, MT41I006_141	Sediment	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Tenmile Creek, MT41I006_142	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Tenmile Creek, MT41I006_143	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Warm Springs Creek, MT41I006_110	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, lead, and zinc.

[a] These impairment causes have not been reflected on past 303(d) lists but were identified during this review.

1.0 INTRODUCTION

1.1 Background

The Lake Helena Watershed TMDL planning area (TPA) is located in west-central Montana and encompasses an area of nearly 620 square miles. The watershed is bounded by the Continental Divide to the west and by the Elkhorn Mountains to the southeast (Figure 1-1). In general, streams in the watershed exhibit a dendritic pattern, flowing toward Lake Helena and the Missouri River in the northeastern part of the watershed. The three major drainages of the watershed are Silver, Tenmile, and Prickly Pear Creeks. Major tributaries include Sevenmile Creek in the Tenmile drainage, and Warm Springs Creek, Lump Gulch, Clancy Creek, and McClellan Creek in the Prickly Pear Creek drainage. The mountainous areas of the watershed are part of the Northern Rockies ecoregion while the Helena Valley area surrounding Lake Helena is part of the Montana Valley and Foothill Prairies ecoregion (Omernik, 1987). Approximately 68 percent of the watershed is located within Lewis and Clark County, and the remaining 32 percent lies within Jefferson County. Montana’s capital city, Helena, is near the center of the watershed.

A number of stream segments in the Lake Helena watershed, and Lake Helena proper, are designated as “water quality-limited” or “threatened” and have been placed on Montana’s list of water bodies in need of restoration, a list prepared in accordance with Section 303(d) of the Clean Water Act and known as the “303(d) list.” The following water bodies were listed as impaired on Montana’s 1996 303(d) list and are addressed in this document (see Section 3 for more details regarding the 303(d) listing status of these water bodies):

Clancy Creek	Corbin Creek	Golconda Creek
Granite Creek (Austin Creek)	Granite Creek (Sevenmile Creek)	Jackson Creek
Jennie’s Fork	Lake Helena	Lump Gulch
Middle Fork Warm Springs Creek	North Fork Warm Springs Creek	Prickly Pear Creek
Sevenmile Creek	Silver Creek	Skelly Gulch
Spring Creek	Tenmile Creek	Warm Springs Creek

The TMDL and water quality restoration planning process in Montana involves several steps. The first step consists of characterizing the environment in which the water bodies exist (this step is referred to as “watershed characterization”). This is followed by developing a thorough understanding of the water quality problem (what pollutant is causing the impairment and how is the impairment manifested in the water body – referred to in this report as “water quality impairment status”) and establishing water quality goals (“targets”). Once the water quality problem has been defined, the next step is to identify all significant sources of pollutants (“source assessment”). Then, the maximum load of a pollutant (for example, sediment, nutrients, or metals) that a water body is able to assimilate and still fully support its designated uses is determined (the total maximum daily load or TMDL). Next, the pollutant load is allocated among all sources within the watershed, including natural sources (i.e., “allocation”), and voluntary (for nonpoint sources) and regulatory control (for point sources) measures are identified for attaining the source allocations (i.e., “restoration strategy”). Last, a monitoring plan and associated corrective feedback loop are established to ensure that the control measures are effective at restoring water quality and all designated beneficial water uses.

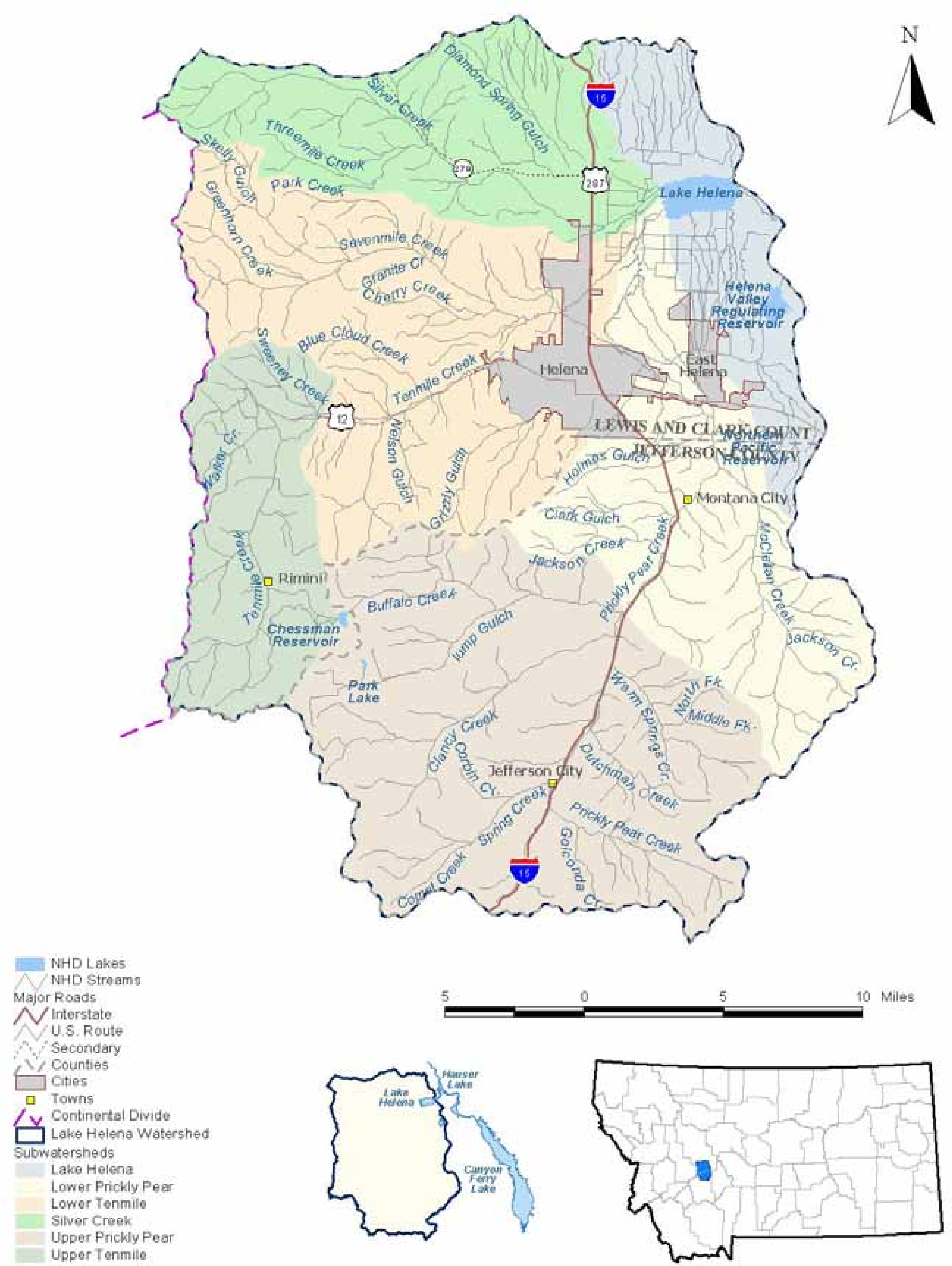

Figure 1-1. General location of the Lake Helena watershed.

1.2 Document Purpose and Content

This report, volume I of the Lake Helena Watershed Water Quality Restoration Plan, is intended to provide a foundation for water quality improvement by confirming and documenting existing water quality impairments, evaluating the causes of impairment, establishing water quality goals, and preliminarily evaluating the potential sources of impairment. The primary function of this report is to clearly describe and characterize the existing conditions of all the water bodies in the TPA that appeared on Montana's 303(d) list and determine their current impairment status. The findings in this report therefore determine whether or not TMDLs should be established for the water bodies studied, although final formal impairment status changes will not be made until MDEQ prepares the 2006 section 303(d) list. Comments from all interested parties are welcomed on this Volume I report. Although EPA and MDEQ will not be preparing a revised version of this report, all data and comments will be considered during the preparation of the draft TMDLs and the 2006 section 303(d) list.

The physical, chemical, and biological characteristics of the watershed are described in Section 2, Watershed Characterization. A summary and evaluation of all available water quality information are presented in Section 3, Water Quality Impairment Status.

1.3 Future Phases

Future phases of the TMDL process that will be presented in the next volume of the Lake Helena Watershed Restoration Plan (expected to be released in 2005) will include a more detailed assessment of the sources of water quality impairment, final water quality goals or targets, TMDLs, load allocations, a restoration strategy, and a monitoring strategy. These subsequent phases will build upon the information presented in this report.

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2.0 WATERSHED CHARACTERIZATION

The purpose of this section is to put Lake Helena and the 303(d)-listed tributaries into context within the environment in which they occur. A general discussion of location, environmental characteristics, and socioeconomic characteristics is included below. A more detailed watershed characterization can be found at the end of this report in Appendix A, Lake Helena Watershed Characterization.

2.1 General Watershed Characteristics

The Lake Helena watershed is in west-central Montana and encompasses an area of nearly 620 square miles (Figure 2-1). There are three major streams in the watershed—Silver, Tenmile, and Prickly Pear Creeks. All three flow into Lake Helena, which is a regulated reservoir formed in the old creek valleys just north of the city of Helena, Montana. Lake Helena eventually flows into Hauser Reservoir on the Missouri River. Other impoundments in the watershed are the Chessman Reservoir, Scott Reservoir, and the Helena Valley Regulating Reservoir, all of which are part of the City of Helena's water supply storage and delivery system.

The Lake Helena watershed is in the semi-arid region of Montana and receives between 12 to 16 inches of precipitation per year. Snow generally averages from 50 to 63 inches per year. Both rain and snow are heavily influenced by the dramatic elevation changes found in the watershed (3,600 to 9,400 feet above sea level). Evergreen forest and grasslands are the dominant land cover types, comprising over 70 percent of the total area. Agricultural lands are concentrated in the valley in the northeastern portion of the watershed where irrigation water is readily available.

Approximately 55,000 people live within the Lake Helena watershed, mostly in the cities of Helena, East Helena, and Montana City. The rate of population growth in the Helena Valley has fluctuated over the years, varying with the economy and other factors. On average, there has been an 18 percent increase in population every decade since 1950. Most of land in the watershed is privately owned, although various tribal, state, and federal agencies hold title to portions of the area. Federal land holdings, represented by agencies such as the U.S. Forest Service and the Bureau of Land Management (BLM), make up approximately 40 percent of the watershed area. The U.S. Forest Service is the largest federal landowner in the watershed, and its lands are the second largest land holdings in the watershed.

Mining has been and continues to be an important industry in the Lake Helena watershed. Heavy metals, limestone, sand, and gravels have all been mined at one time. Mining and mine drainage, particularly from abandoned mines, can have a detrimental effect on water quality and aquatic health. Extensive agricultural development, timber harvesting, road construction, livestock grazing, and wildfires have also altered the natural ecology of the Lake Helena watershed. These changes and their implications for water quality are discussed in more detail in Section 3 of this report.

Figure 2-1. Streams in the Lake Helena watershed.

2.2 Water Body Characteristics

Lake Helena is a shallow water body located northeast of the city of Helena, Montana. Its surface area is approximately 3.2 square miles (2,072 acres). When Hauser Dam was constructed on the Missouri River, the wetlands in the lower reaches of Silver and Prickly Pear Creeks were flooded, creating Lake Helena. In 1945, an earthen causeway and control mechanisms were constructed to separate Hauser Reservoir and Lake Helena, allowing the two to be regulated independently. The major tributaries flowing into Lake Helena are Prickly Pear Creek, Tenmile Creek, Silver Creek and their tributaries.

A network of intermittent and perennial streams and canals drains the Lake Helena watershed. Mountain streams of varying sizes have perennial flow due to snowmelt, precipitation, and discharge from bedrock aquifers, while many of the smaller tributaries in the valley regions of the watershed are intermittent. All canals and ditches are concentrated in agricultural areas surrounding Lake Helena in the Helena Valley. Seasonal dewatering occurs in the lower sections of Silver, Tenmile, and Prickly Pear Creeks as a result of irrigation withdrawals and losses to groundwater. However, seasonal flooding occurs in these same streams as a result of spring runoff and unpredictable winter thaws (Wetlands Community Partnership, 2001). During drought years, many of the streams in the watershed run dry.

2.3 Stream Flow

Stream flow varies from site to site and from season to season in the Helena Valley as a result of complex patterns of precipitation and runoff, groundwater and surface water interactions, and water diversions and storage. Flow increases in streams are attributed to tributary inflows or groundwater discharge, and flow depletions occur as a result of irrigation diversions and seepage to groundwater (USGS, 2001). A series of tile drains was installed throughout much of the Helena Valley during the late 1950s. The drainage system has lowered the elevation of the shallow aquifer, drained numerous acres of historical wetlands, caused the loss of natural infiltration and groundwater recharge areas, and reduced surface flows in lower Tenmile, Prickly Pear, and possibly Silver Creeks. The tile drains discharge directly into Lake Helena as a series of open drains.

Ten U.S. Geological Survey (USGS) flow gages with recent flow data were analyzed to obtain a general understanding of flow patterns from the tributary headwaters to Lake Helena (Table 2-1). Flow patterns at most of the stations show peaks in late April and again in early June due to snowmelt runoff and precipitation. In general, flows in Lake Helena watershed streams are low and fairly constant from September through March. The highest flows can be expected during the months of April and June, and these are typically one to two orders magnitude greater than the base flow levels.

Table 2-1. Selected USGS stream gages in the Lake Helena watershed.

		Drainage Area			
Station ID	**Gage Name**	**Acres**	**Square Miles**	**Start Date**	**End Date**
06061900	McClellan Creek near East Helena	21,248	33	Sep 1988	Sep 1990
06061500	Prickly Pear Creek near Clancy	122,880	192	Jul 1908	Sep 2001
06058900	Prickly Pear Creek below Anderson Gulch near Jefferson City	8,960	14	Oct 1988	Sep 1990
06064150	Tenmile Creek above Prickly Pear Creek near Helena	120,320	188	May 1997	Sep 1998
06064100	Tenmile Creek at Green Meadow Drive at Helena	103,040	161	May 1997	Sep 1998
06063000	Tenmile Creek near Helena	61,760	97	Aug 1908	Sep 1998
06062990	Tenmile Creek at State Nursery Bridge near Helena	N/A	N/A	Mar 1990	Aug 1992
06062750	Tenmile Creek at Tenmile Water Treatment Plant near Rimini	32,704	51	May 1997	Sep 2001
06062500	Tenmile Creek near Rimini	19,776	31	Oct 1914	Sep 2001
06063600	Sevenmile Creek below Granite Creek near Helena	N/A	N/A	Mar 1990	Sep 1991

2.4 Water Use

Irrigation in the Helena Valley began in the 1880s. Water from Prickly Pear, Tenmile, and Silver Creeks was diverted for irrigation purposes as land claims were granted. The construction of the present irrigation system began in 1957 and was completed in 1959. By 1950, more than 8,000 acres of formerly productive land in the low-lying areas of the Helena Valley became saturated because of seepage from irrigation canals and infiltration from flood-irrigated fields. The Bureau of Reclamation installed several irrigation drains beginning in 1958, in part to drain previously saturated land but also to accommodate the additional irrigation water imported from the Missouri River. Portions of some canals in the valley are lined with polyvinyl chloride (PVC), compacted earth, asphalt, or concrete (Kendy et al., 1998).

The Helena Valley Irrigation District receives about 81,300 acre-feet of water diverted from the Missouri River annually. The water is diverted from Canyon Ferry Dam about 15 miles east of Helena. Turbine-driven pumps below the dam (the Helena Valley Pumping Plant) lift water to the Helena Valley Canal Tunnel and feeder canal. The feeder canal flows 8.3 miles across the Spokane Bench to the Helena Valley Regulating Reservoir, which has a volume of 5,900 acre-feet. The reservoir discharges water into the valley section of the Helena Valley Canal, which nearly encircles the Helena Valley alluvial plain and distributes water into the central part of the Helena Valley through an extensive network of lateral canals (Figure 2-2). The length of the Helena Valley Canal is 31.7 miles, 10.2 miles of which are lined and 21.5 miles are unlined. Of the 64.4 miles of lateral canals, 51.9 are lined and 12.5 are unlined. A 56.6-mile drainage system consisting of 26.6 miles of open drains and 29.9 miles of pipe drains prevents irrigated land from becoming saturated (Kendy et al., 1998).

Irrigation practices in the Lake Helena watershed help to sustain crops through the arid summer growing season. The Helena Valley Irrigation District manages irrigation in the Helena Valley totaling 15,608 acres, 12,500 acres of which are flood-irrigated. The district is proposing to increase the total irrigated acreage by 2,600 acres (Foster, 2004; USBR, 2004a).

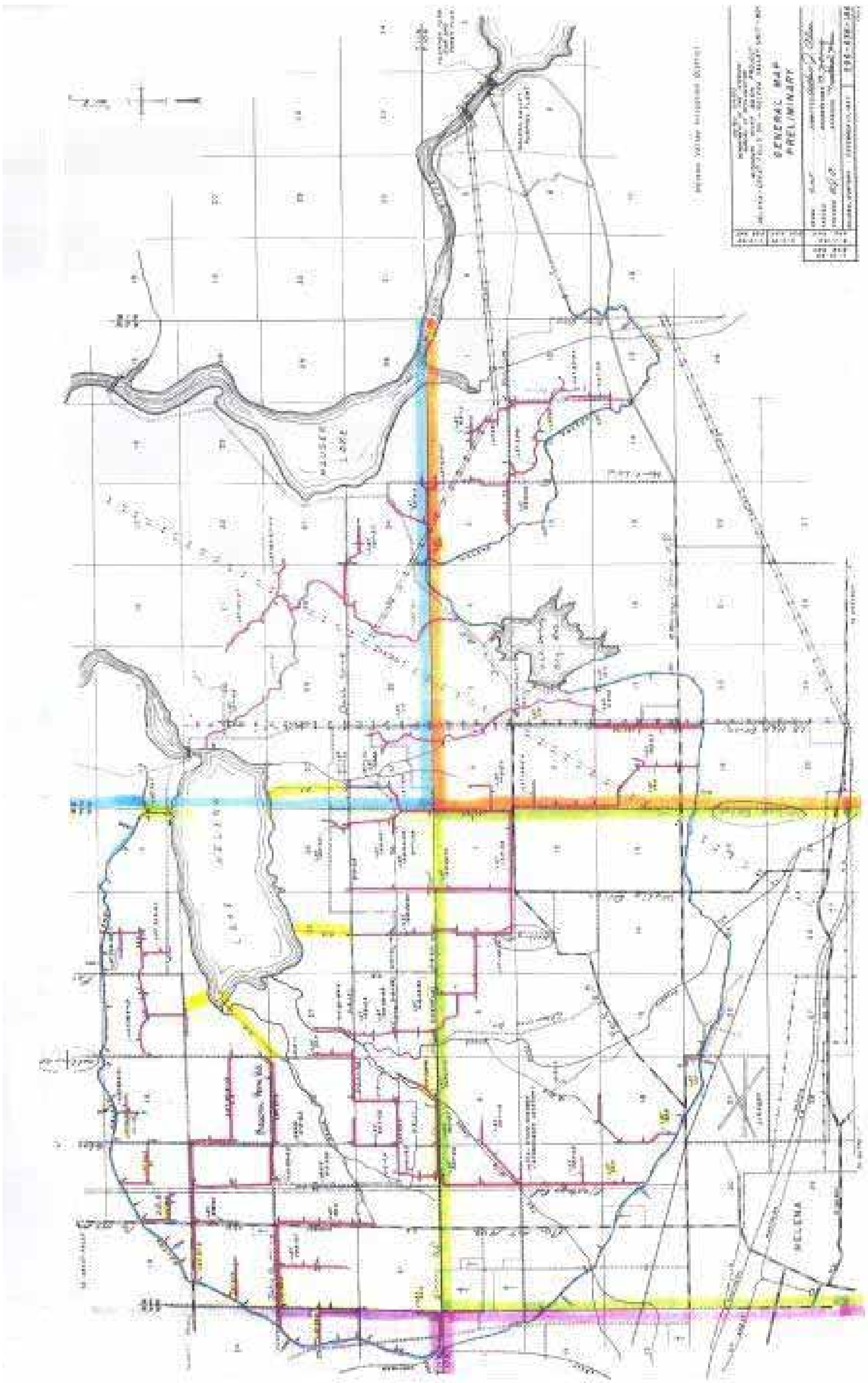

Figure 2-2. Map of irrigation canals and drains in the Helena Valley Irrigation District.

3.0 WATER QUALITY IMPAIRMENT STATUS

This section of the document first describes the water quality status of stream and lake segments in the Lake Helena watershed, as presented in past and current versions of the Montana 303(d) list. This is followed by a summary of the applicable water quality standards and a translation of those standards into proposed water quality goals and indicators. The remainder of this section is devoted to a review of the available chemical, physical, and biological water quality data for each listed water body, including new information that may not have been considered during the preparation of past 303(d) lists. A weight-of-evidence approach is used to draw conclusions about the present status of each water body relative to TMDL development needs.

3.1 Montana 303(d) List Status

A summary of the 303(d) list status and history of listings is provided in Table 3-1. Figure 3-1 shows the locations of suspected impaired and threatened segments in the Lake Helena watershed, as identified in the 1996–2004 303(d) lists. As mentioned in Section 1.1, all necessary TMDLs must be completed for all pollutant and water body combinations appearing on Montana's 1996 303(d) list. The 1996 303(d) list reported that Corbin, Clancy, Golconda, Granite, Prickly Pear, Sevenmile, Silver, Spring, Tenmile, Warm Springs, and Middle Fork Warm Springs Creeks, and Jennie's Fork, Lump Gulch, Skelly Gulch, and Lake Helena were impaired (MDEQ, 1996). Listed causes of impairment for these water bodies included habitat alterations, flow alteration, thermal modifications, siltation, suspended solids, turbidity, nutrients, un-ionized ammonia, salinity/total dissolved solids/chlorides, metals, other inorganics (sulfate), pH, priority organics, and unknown toxicity (see Table 3-2). The most common impaired beneficial uses in the Lake Helena watershed were cold-water fisheries and aquatic life.

The U.S. Environmental Protection Agency (EPA) has made a determination that some categories of water quality impairment are best resolved through measures other than TMDLs. The following impairments have all been placed in a general category of "pollution" for which TMDLs are not required: habitat alterations, fish habitat degradation, channel incisement, bank erosion, riparian degradation, stream dewatering, and flow alterations. On the other hand, TMDLs are required to address impairments caused by discrete "pollutants," such as heavy metals, nutrients, and sediment (Dodson, 2001). The Lake Helena water quality restoration plan focuses on this latter category, but it attempts to understand the relationships between general pollution problems (such as bank erosion) and those caused by specific pollutants (such as sediment). Although no TMDLs will be established to specifically address the "pollution" problems described above, the problems will be addressed as sources of impairment within the context of TMDLs developed for the related "pollutants" of concern.

It should also be noted here that the project team has determined that any and all water quality impairments in the Lake Helena Causeway Arm of Hauser Reservoir (Prickly Pear Creek segment MT41I006_010) will be addressed as part of a future water quality restoration plan for Hauser Reservoir rather than as a component of the Lake Helena plan. This is appropriate because the Causeway Arm is a major part of Hauser Reservoir. The water quality problems in the Causeway Arm cannot be resolved separately from those in Hauser Reservoir and the entire upper Missouri River system.

Table 3-1. Impaired streams on the Montana 303(d) list within the Lake Helena watershed and associated impaired beneficial uses.

Water Body and Stream Description	Water Body Number	Use Class	Year	Aquatic Life	Fisheries – Cold-water	Drinking Water	Swimmable (Recreation)	Agriculture	Industry
Clancy Creek, from the headwaters to the mouth (Prickly Pear Creek)	MT41I006_120	B-1	1996	P	P	P	P		
			2000	N	N	N	X	F	F
			2002	N	N	N	F	F	F
			2004	N	N	N	F	F	F
Corbin Creek, from the headwaters to the mouth (Spring Creek)	MT41I006_090	B-1	1996	N	N	N	N	N	
			2000	N	N	N	N	P	P
			2002	N	N	N	N	P	P
			2004	N	N	N	N	P	P
Golconda Creek, from the headwaters to the mouth (Prickly Pear Creek) T7N R3W	MT41I006_070	B-1	1996	N	N	N	N		
			2000	N	N	N	X	F	F
			2002	N	N	N	X	F	F
			2004	N	N	N	X	F	F
Granite Creek, from the headwaters to the mouth (Austin Creek – Greenhorn Creek – Sevenmile Creek)	MT41I006_179	B-1	1996		T				
			2004	F	F	F	F	F	F
Granite Creek, from the headwaters to the mouth (Sevenmile Creek)	MT41I006_230	B-1	2002	X	X	N	X	X	X
			2004	X	X	N	X	X	X
Jackson Creek, from the headwaters to the mouth (McClellan Creek – Prickly Pear Creek)	MT41I006_190	B-1	1998	P	P				
			2000	X	X	X	X	X	X
			2002	X	X	F	F	F	F
			2004	X	X	F	F	X	X
Jennie's Fork, from the headwaters to the mouth (Silver Creek – Missouri River)	MT41I006_210	B-1	1996	N	N	N	N		
			2000	X	X	X	X	X	X
			2002	X	X	F	F	F	F
			2004	X	X	X	X	X	X
Lake Helena	MT41I007_010	B-1	1996	P	P		P		
			2000	X	X	N	X	F	F
			2002	X	X	N	X	F	F
			2004	X	X	N	X	F	F
Lump Gulch, from the headwaters to the mouth (Prickly Pear Creek)	MT41I006_130	B-1	1996	P	P	P			
			2000	N	N	N	X	F	F
			2002	N	N	N	X	F	F
			2004	N	N	N	X	F	F

Water Body and Stream Description	Water Body Number	Use Class	Year	Aquatic Life	Fisheries – Cold-water	Drinking Water	Swimmable (Recreation)	Agriculture	Industry
Middle Fork Warm Springs Creek, from the headwaters to the mouth (Warm Springs Creek – Prickly Pear Creek)	MT41I006_100	B-1	1996	P	P				
			2000	N	N	N	X	X	X
			2002	N	N	N	F	F	F
			2004	N	N	N	F	F	F
North Fork Warm Springs Creek, from the headwaters to the mouth (Warm Springs Creek – Prickly Pear Creek)	MT41I006_180	B-1	1998	P	P				
			2000	X	X	F	X	X	X
			2002	F	P	N	F	F	F
			2004	F	P	F	F	F	X
Prickly Pear Creek, from the headwaters to Spring Creek	MT41I006_060	B-1	1996		T				
			2000	N	F	N	F	P	F
			2002	N	P	N	F	P	F
			2004	N	P	N	F	P	F
Prickly Pear Creek, from Spring Creek to Lump Gulch	MT41I006_050	B-1	1996	N	N	P	N	N	
			2000	N	N	N	F	P	F
			2002	N	N	N	F	P	F
			2004	N	N	N	F	P	F
Prickly Pear Creek, from Lump Gulch to Montana Highway 433 crossing	MT41I006_040	B-1	1996	P	P			P	
			2000	N	N	N	F	P	F
			2002	N	N	N	F	P	F
			2004	N	N	N	F	P	F
Prickly Pear Creek, from Highway 433 Crossing to the Helena wastewater treatment plant discharge ditch	MT41I006_030	I	1996	N	N	N	N	N	
			2000	N	N	N	P	P	P
			2002	N	N	N	P	P	P
			2004	N	N	N	P	P	P
Prickly Pear Creek, from the Helena wastewater treatment plant discharge ditch to Lake Helena	MT41I006_020	I	1996	N	N	N	N	N	
			2000	N	N	N	X	F	P
			2002	N	N	N	P	F	P
			2004	N	N	N	P	F	P
Prickly Pear Creek, from Lake Helena to Hauser Lake	MT41I006_010	B-1	1996	P	P		P		
			2000	X	X	N	X	X	X
			2002	X	X	N	X	X	X
			2004	X	X	N	X	X	X
Sevenmile Creek, from the headwaters to the mouth (Tenmile Creek)	MT41I006_160	B-1	1996		T				
			2000	X	X	X	F	X	X
			2002	P	P	F	F	F	F
			2004	P	P	F	F	F	F

Water Body and Stream Description	Water Body Number	Use Class	Year	Aquatic Life	Fisheries – Cold-water	Drinking Water	Swimmable (Recreation)	Agriculture	Industry
Silver Creek, from the headwaters to the mouth (Lake Helena)	MT41I006_150	B-1	1996	N	N	P	N		
			2000	N	N	N	P	F	P
			2002	N	N	N	P	F	P
			2004	N	N	N	P	F	P
Skelly Gulch, tributary of Greenhorn Creek – Sevenmile Creek	MT41I006_220	B-1	1996	P	P				
			2000	X	X	X	X	X	X
			2002	P	P	F	F	F	F
			2004	P	P	F	F	F	F
Spring Creek, from Corbin Creek to the mouth (Prickly Pear Creek)	MT41I006_080	B-1	1996	N	N	N	N	N	
			2000	N	N	N	P	N	P
			2002	N	N	N	P	N	P
			2004	N	N	N	P	N	P
Tenmile Creek, from the headwaters to the Helena public water supply intake above Rimini	MT41I006_141	A-1	1996	P	P	P	P		
			2000	N	N	N	F	F	F
			2002	P	P	N	F	F	F
			2004	P	P	N	F	F	F
Tenmile Creek, from the Helena public water supply intake above Rimini to the Helena water treatment plant	MT41I006_142	B-1	1996	P	P	P	P		
			2000	N	N	N	N	N	N
			2002	N	N	N	N	N	N
			2004	N	N	N	N	N	N
Tenmile Creek, from the Helena water treatment plant to the mouth (Prickly Pear Creek)	MT41I006_143	B-1	1996	P	P	P	P		
			2000	N	N	N	P	F	F
			2002	P	P	N	P	F	F
			2004	P	P	N	P	F	F
Warm Springs Creek, from the Middle Fork to the mouth (Prickly Pear Creek)	MT41I006_110	B-1	1996	P	P				
			2000	X	X	N	X	X	X
			2002	P	P	N	F	F	F
			2004	P	P	N	F	F	F

F = Full Support; **P** = Partial Support; **N** = Not Supported; **T** = Threatened; **X** = Not Assessed (Insufficient Credible Data).

Table 3-2. Probable causes of water quality impairment in the Lake Helena watershed identified in 1996–2004 Montana 303(d) lists.

Water body	1996 Causes	2000 Causes	2002 Causes	2004 Causes
Clancy Creek	Metals Nutrients Habitat alterations Siltation Suspended solids	Metals (Did not meet SCD for Primary Contact Recreation)	*Arsenic* *Channel incisement* *Lead* *Mercury* *Metals* *Other habitat alterations* *Siltation*	*Arsenic* *Channel incisement* *Lead* *Mercury* *Metals* *Other habitat alterations* *Siltation*
Corbin Creek	Metals Other inorganics Salinity/TDS/ chlorides Suspended solids pH	Metals Suspended solids pH Thermal modifications Habitat alterations	*Metals* *Other habitat alterations* *pH* *Suspended solids* *Thermal modifications*	*Metals* *Other habitat alterations* *pH* *Suspended solids* *Thermal modifications*
Golconda Creek	Metals Suspended solids Turbidity Unknown toxicity	Metals	*Metals*	*Metals*
Granite Creek	Habitat alterations	Arsenic Cadmium	*Arsenic* *Cadmium* *Metals*	*Arsenic* *Cadmium* *Metals*
Jackson Creek	**1998 Listing:** Siltation	*(Did not meet SCD)*	*(Did not meet SCD for Aquatic Life, Cold-water Fishery)*	*(Did not meet SCD for Aquatic Life, Cold-water Fishery)*
Jennie's Fork	Metals Siltation	*(Did not meet SCD)*	*(Did not meet SCD for Aquatic Life, Cold-water Fishery)*	*(Did not meet SCD for Aquatic Life, Cold-water Fishery)*
Lake Helena	Metals Nutrients Suspended solids Thermal modifications	Lead Arsenic	*Arsenic* *Lead* *Metals*	*Arsenic* *Lead* *Metals*
Lump Gulch	Metals Suspended solids	Cadmium Mercury Copper Lead Zinc	*Cadmium* *Copper* *Lead* *Mercury* *Metals* *Zinc*	*Cadmium* *Copper* *Lead* *Mercury* *Metals* *Zinc*
Middle Fork Warm Springs Creek	Metals Habitat alterations Siltation	Arsenic Mercury Copper Zinc	*Arsenic* *Copper* *Mercury* *Metals* *Other habitat*	*Arsenic* *Copper* *Mercury* *Metals* *Other habitat*

Water body	1996 Causes	2000 Causes	2002 Causes	2004 Causes
			alterations Siltation Zinc	*alterations Siltation Zinc*
North Fork Warm Springs Creek	**1998 Listing:** Siltation	*(Did not meet SCD)*	*Arsenic Bank erosion Fish habitat degradation Metals Organic enrichment/Low dissolved oxygen Other habitat alterations Siltation*	*Arsenic Bank erosion Fish habitat degradation Metals Organic enrichment/Low dissolved oxygen Other habitat alterations Siltation*
Prickly Pear Creek MT41I006_060	Metals Suspended solids	Metals Fish habitat degradation Habitat alterations	*Fish habitat degradation Metals Other habitat alterations*	*Fish habitat degradation Metals Other habitat alterations*
Prickly Pear Creek MT41I006_050	Siltation Suspended solids	Metals Fish habitat degradation Bank erosion Habitat alterations Siltation	*Bank erosion Fish habitat degradation Metals Other habitat alterations Siltation*	*Bank erosion Fish habitat degradation Metals Other habitat alterations Siltation*
Prickly Pear Creek MT41I006_040	Flow alteration Metals Habitat alterations	Metals Siltation Fish habitat degradation Habitat alterations	*Fish habitat degradation Metals Other habitat alterations Siltation*	*Fish habitat degradation Metals Other habitat alterations Siltation*
Prickly Pear Creek MT41I006_030	Flow alteration Metals Habitat alterations Siltation Suspended solids	Metals Dewatering Siltation Fish habitat degradation Riparian degradation Nutrients Thermal modifications	*Dewatering Fish habitat degradation Flow alteration Metals Nutrients Other habitat alterations Riparian degradation Siltation Thermal modifications*	*Dewatering Fish habitat degradation Flow alteration Metals Nutrients Other habitat alterations Riparian degradation Siltation Thermal modifications*

Water body	1996 Causes	2000 Causes	2002 Causes	2004 Causes
Prickly Pear Creek MT41I006_020	Flow alteration Metals Nutrients Habitat alterations Siltation Suspended solids Un-ionized ammonia	Metals Un-ionized ammonia Nutrients Thermal modifications Siltation Dewatering Fish habitat degradation Bank erosion	*Bank erosion* *Dewatering* *Fish habitat degradation* *Flow alteration* *Metals* *Nutrients* *Other habitat alterations* *Siltation* *Thermal modifications* *Un-ionized ammonia*	*Bank erosion* *Dewatering* *Fish habitat degradation* *Flow alteration* *Metals* *Nutrients* *Other habitat alterations* *Siltation* *Thermal modifications* *Un-ionized ammonia*
Prickly Pear Creek MT41I006_010	Nutrients Suspended solids Thermal modifications	Arsenic	*Arsenic* *Metals*	*Arsenic* *Metals*
Sevenmile Creek	Habitat alterations Siltation	*(Did not meet SCD)*	*Flow alteration* *Metals* *Nutrients* *Other habitat alterations* *Riparian degradation* *Siltation*	*Flow alteration* *Metals* *Nutrients* *Other habitat alterations* *Riparian degradation* *Siltation*
Silver Creek	Flow alteration Metals Habitat alterations Priority organics	Metals Habitat alterations Flow alteration Priority organics	*Flow alteration* *Metals* *Other habitat alterations* *Priority organics*	*Flow alteration* *Metals* *Other habitat alterations* *Priority organics*
Skelly Gulch	Siltation	*(Did not meet SCD)*	*Metals* *Siltation*	*Metals* *Siltation*
Spring Creek	Metals Nutrients Habitat alterations Suspended solids pH	Metals Dewatering Fish habitat degradation Habitat alterations Riparian Degradation	*Dewatering* *Fish habitat degradation* *Flow alteration* *Metals* *Other habitat alterations* *Riparian degradation*	*Dewatering* *Fish habitat degradation* *Flow alteration* *Metals* *Other habitat alterations* *Riparian degradation*

Water body	1996 Causes	2000 Causes	2002 Causes	2004 Causes
Tenmile Creek MT41I006_141	Flow alteration Metals Habitat alterations Siltation pH	Mercury Lead Arsenic Copper Cadmium Zinc Metals Turbidity Habitat alterations	*Arsenic* *Cadmium* *Copper* *Lead* *Mercury* *Metals* *Other habitat alterations* *Siltation* *Zinc*	*Arsenic* *Cadmium* *Copper* *Lead* *Mercury* *Metals* *Other habitat alterations* *Siltation* *Zinc*
Tenmile Creek MT41I006_142	Flow alteration Metals Habitat alterations Siltation pH	Arsenic Cadmium Lead Zinc Copper Flow alteration Metals	*Arsenic* *Cadmium* *Copper* *Flow alteration* *Lead* *Metals* *Siltation* *Zinc*	*Arsenic* *Cadmium* *Copper* *Flow alteration* *Lead* *Metals* *Siltation* *Zinc*
Tenmile Creek MT41I006_143	Flow alteration Metals Habitat alterations Siltation pH	Arsenic Lead Cadmium Copper Mercury Zinc Flow alteration Siltation Habitat alterations	*Arsenic* *Cadmium* *Copper* *Flow alteration* *Lead* *Mercury* *Metals* *Nutrients* *Other habitat alterations* *Siltation* *Zinc*	*Arsenic* *Cadmium* *Copper* *Flow alteration* *Lead* *Mercury* *Metals* *Nutrients* *Other habitat alterations* *Siltation* *Zinc*
Warm Springs Creek	Metals Suspended Solids	Arsenic Lead	*Arsenic* *Cadmium* *Lead* Metals Siltation	*Arsenic* *Cadmium* *Lead* Metals Siltation

Source: MDEQ, 2003, 2004.
SCD = Sufficient Credible Data

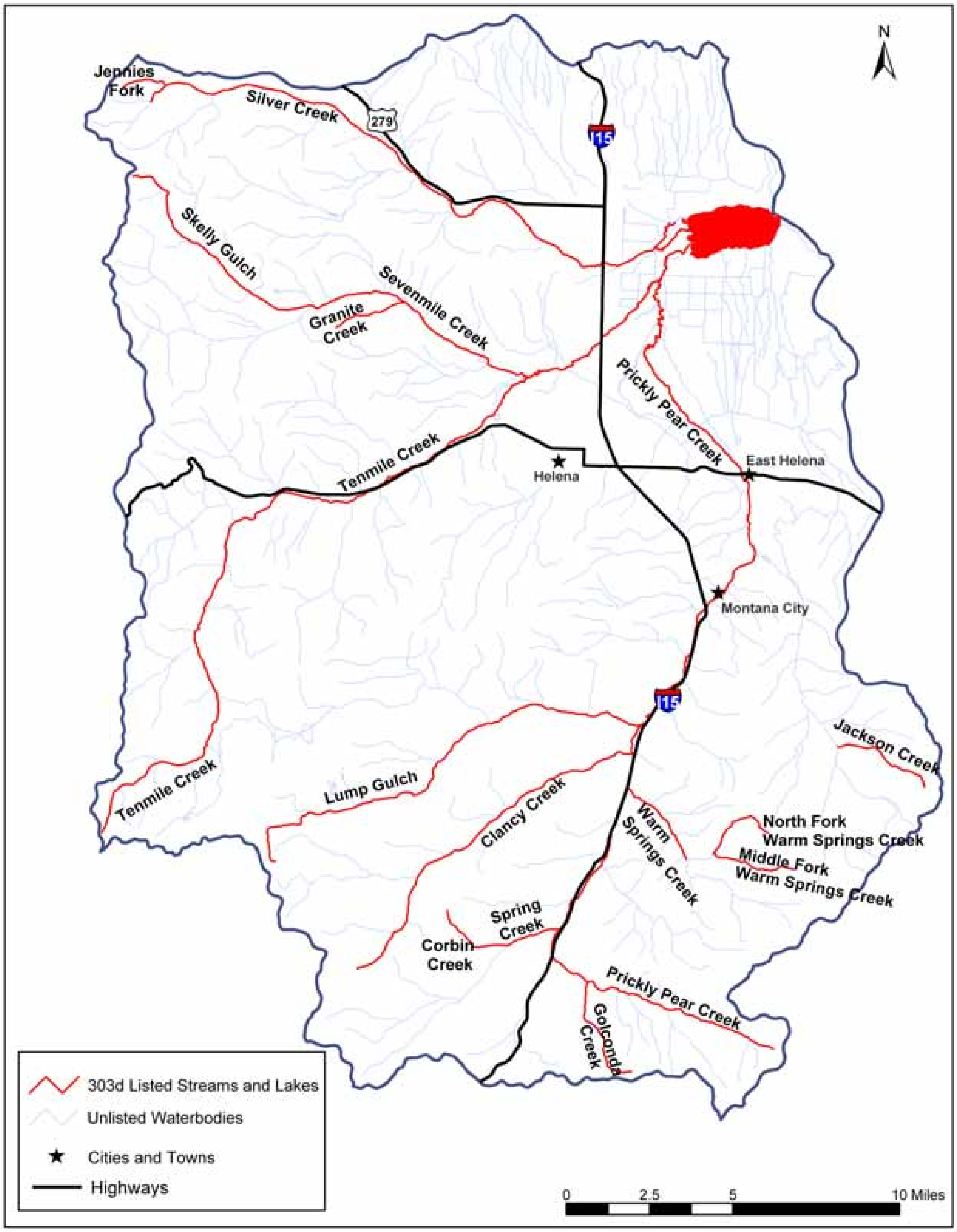

Figure 3-1. Locations of 1996–2004 303(d)-listed stream segments in the Lake Helena watershed.

3.2 Applicable Water Quality Standards

Water quality standards include the uses designated for a water body, the legally enforceable standards that ensure that the uses are supported, and a non-degradation policy that protects the existing high quality of a water body. The ultimate goal of the Lake Helena watershed water quality restoration plan is to ensure that all designated beneficial uses of the water bodies in the watershed are fully supported and all standards are met.

The pollutants addressed in the Lake Helena water quality restoration plan are nutrients, dissolved oxygen, ammonia, sedimentation/siltation, metals, pH, and thermal modifications/water temperature. For many of these pollutants (metals, ammonia, dissolved oxygen), Montana has numeric standards which specify an average or maximum value that must not be exceeded. In other cases (sedimentation/siltation, nutrients), Montana has narrative standards which indicate that water quality goals should strive toward a reference condition that reflects the water body's greatest potential. Thermal modifications and pH are addressed through a combination of numeric and narrative standards. Both have numeric guidelines that specify a range of allowable changes over "naturally occurring" levels. However, naturally occurring levels in the streams are interpreted using the narrative standards found in the general water quality provisions.

A complete summary of the applicable water quality standards is attached as Appendix B of this report. These standards form the basis for the water goals and indicators, and are described in further detail in Section 3.3.

3.3 Water Quality Goals and Indicators

To develop a TMDL, it is necessary to establish quantitative water quality goals, referred to in this document as targets. TMDL targets must represent the applicable numeric or narrative water quality standards and full support of all associated beneficial uses. For many pollutants with established numeric water quality standards, the water quality standard is used directly as the TMDL target. For pollutants with only narrative standards, the selected target must be a water body-specific, measurable interpretation of the narrative standard. The pollutants of concern in the Lake Helena watershed with established numeric water quality standards that can be directly applied as TMDL targets are metals (arsenic, cadmium, copper, lead, and zinc), ammonia, and dissolved oxygen. Other pollutants in the Lake Helena watershed, including nutrients/organic enrichment and sedimentation/siltation, have only narrative standards, and targets must be identified that are water body-specific, measurable interpretations of the narrative standard.

Because there is no single direct measure of beneficial use impairment associated with nutrients, sediment, or temperature, a suite of water quality targets and supplemental indicators has been selected for use in combination with one another. In light of the available data, the targets are considered to be the most reliable and robust measures of nutrient and sediment impairment and beneficial use support. The proposed supplemental indicators are not sufficiently reliable to be used alone as a measure of nutrient impairment. These are used as supplemental information, in combination with the targets, to better define potential nutrient and sediment impairments. When combined, the targets and supplemental indicators address the physical, biological, and chemical characteristics of the waters, as well as the presence or absence of potential human sources that may be contributing to impairments.

Targets

As described in the discussions of individual targets presented in the following paragraphs, there is a documented relationship between the selected target values and beneficial use support, or sufficient reference data are available to establish a threshold value representing “natural” conditions. In addition to having a documented relationship with the suspected impaired beneficial use, the targets have direct relevance to the pollutants of concern. The targets, therefore, are relied upon as threshold values that, if exceeded (as determined by sufficient data), indicate water quality impairment. The targets will also be applied as water quality goals by which the ultimate success of implementation of this plan will be measured in the future.

Supplemental Indicators

The supplemental indicators provide supporting or collaborative information or both when used in combination with the targets. In addition, some of the supplemental indicators are necessary to determine whether exceedances of targets are a result of natural versus anthropogenic (human-caused) causes. However, the proposed supplemental indicators are not sufficiently reliable to be used alone as a measure of impairment because (1) the cause-effect relationship between the supplemental indicators and beneficial use impairments is weak or uncertain or both; (2) the supplemental indicators cannot be used to isolate an impairment associated with individual pollutants (for example, to differentiate between an impairment caused by excessive levels of sediment versus high concentrations of metals); or (3) there is too much uncertainty associated with the supplemental indicators to have a high level of confidence in the result.

Water Quality Targets and Supplemental Indicators Applied to Beneficial Use Impairment Determinations

The beneficial use impairment determinations presented in Section 3.4 are based on a weight-of-evidence approach in combination with the application of best professional judgment. The weight-of-evidence approach is outlined in Figure 3-2 and is applied as follows. If none of the target values are exceeded, the water is considered to be fully supporting its uses and no TMDL is necessary. This is true even if one or more of the supplemental indicator values are exceeded. On the other hand, if one or more of the target values are exceeded, the circumstances around the exceedance are investigated and the supplemental indicators are used to provide additional information to support a determination of impairment/non-impairment. The circumstances around the exceedance of a target value are investigated before it is automatically assumed that the exceedance represents human-caused impairment (for example: Are the data reliable and representative of the entire reach? Might the exceedance be a result of natural causes such as floods, drought, fire, or the physical character of the watershed?). In addition, the supplemental indicators assist by providing collaborative and supplemental information, and the weight of evidence of the complete suite of targets and supplemental indicators is used to make the impairment determination.

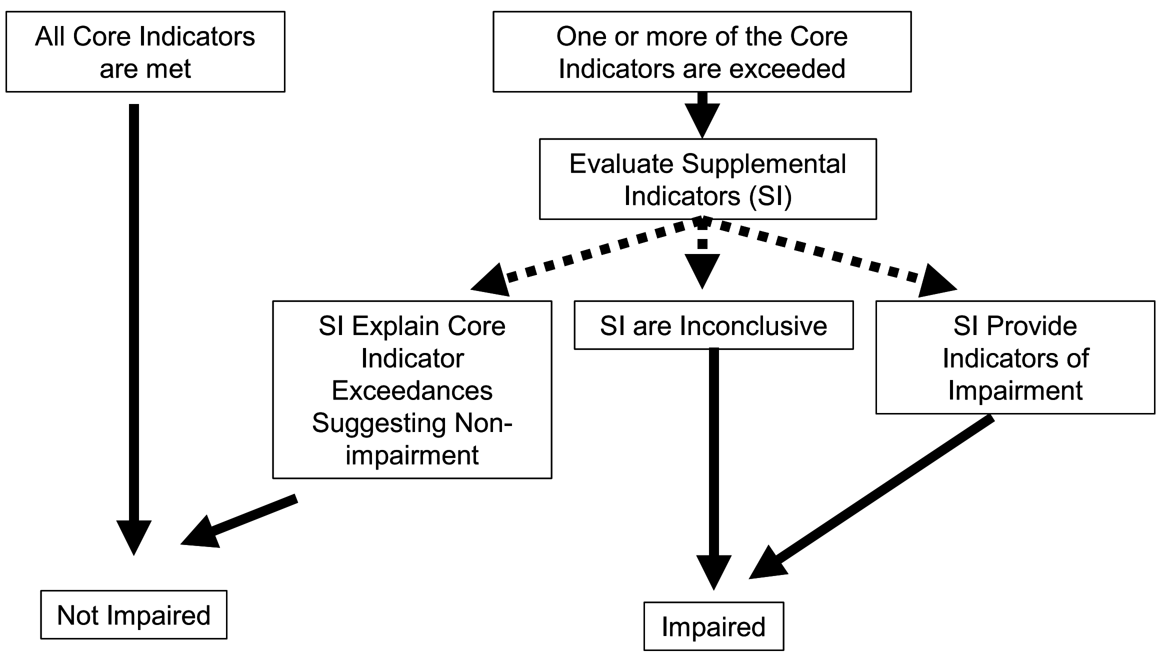

Figure 3-2. Weight-of-evidence approach for determining beneficial use impairments.

3.3.1 Proposed Nutrient Targets and Supplemental Indicators for Streams in the Lake Helena TPA

Because of the interrelated nature of nutrient, organic enrichment/low dissolved oxygen, and total ammonia impairments, water quality targets for them are discussed together in this section under the general heading of nutrients. The proposed targets and supplemental indicators for nutrient and nutrient-related impairments in the streams of the Lake Helena watershed are summarized in Table 3-3 below and are discussed in more detail in the paragraphs that follow. Nutrient targets for Lake Helena itself are discussed in Section 3.3.2.

Table 3-3. Proposed nutrient targets and supplemental indicators for streams in the Lake Helena TPA.

Water Quality Targets	Threshold Values
Total Nitrogen	< 0.34 mg/L[a]
Total Kjeldahl Nitrogen	< 0.30 mg/L[a]
Total Phosphorus	< 0.027 mg/L[a]
Total Ammonia-Nitrogen[b]	Less than the Montana water quality standard as defined in Circular WQB-7 (7)(2002), Appendix B.
Diurnal Variability in Dissolved Oxygen and pH	Low variability in diurnal rates (using hourly readings of dissolved oxygen and pH from a multiple-day data set collected with a data sonde). ▪ dissolved oxygen percent saturation < 115% during afternoon hours ▪ no dissolved oxygen deficit as defined in Circular WQB-7 (15) ▪ pH values not exceeding pH standards defined in Circular WQB-7
Benthic Algae	< 37 mg/m^2
Supplemental Indicators	**Recommended Values**
Soluble Reactive Phosphorus	< 0.011 mg/L
Nitrate plus Nitrite-Nitrogen	< 0.04 mg/L
Dissolved Oxygen[d]	Meeting or exceeding concentrations defined in Circular WQB-7 (15) (2002)
Macroinvertebrate Index of Biotic Integrity (IBI) for Montana Valley and Foothill Prairie (MVFP) streams	> 75
Macroinvertebrate Hilsenhoff Index of Biotic Integrity (HBI)	< 3.5
Periphyton Indices	Best professional judgment - Site-specific determinations based on several community, biological, and pollution indices, and comparison with the least impaired reference conditions in Montana (described in more detail below)
Anthropogenic Nutrient Sources	No significant sources identified based on field surveys

Notes: mg/L = milligrams per liter; mg/m^2 = milligrams per square meter.
[a] Expressed as a 5-year median concentration.
[b] This indicator is applied only to streams listed for Total Ammonia Nitrogen.
[c] The total ammonia standard varies depending on stream temperature and pH.
[d] This indicator is applied to streams listed for nutrients/organic enrichment and low dissolved oxygen.

3.3.1.1 In-stream Nutrient Concentrations

In-stream total nitrogen, total Kjeldahl nitrogen, and total phosphorus are proposed as targets for the nutrient-related impairments in the streams of the Lake Helena watershed. Water quality targets for the streams were calculated on the basis of in-stream concentrations of nitrogen and phosphorus and were derived from reference stream information for the watershed as well as published criteria. Nutrient data from reference streams were collected by MDEQ in 2001 and by Land & Water Consulting in 2003 (Appendix D). All the reference streams are located in EPA's nutrient Ecoregion II, sub-ecoregion 15 (Northern Rockies) or sub-ecoregion 16 (Montana Valley Foothill Prairies) (USEPA, 2000a). Five reference streams were sampled in the watershed in 2001, and seven reference streams were sampled in 2003. The locations of the 2003 reference stream stations are shown in Table 3-4. EPA's recommended limits for nutrient concentrations in rivers and streams in Ecoregion II, sub-ecoregions 15 and 16, were also reviewed during the selection of proposed targets (USEPA, 2000a). The recommendations are for total phosphorus, total nitrogen, and total Kjeldahl nitrogen (TKN), and they are proposed here as 5-year median concentrations. The threshold values are shown in Table 3-3, above.

Table 3-4. Lake Helena TPA reference stream monitoring locations.

Site ID	Site Type	Description
	New	Moose Creek above City Diversion near Rimini, MT
M09MNTRC01	Established	Monitor Creek 3 miles upstream from Rimini, MT
M09MCCLC02	Established	McClellan Creek downstream of confluence of Crystal Creek
M09SKLYG01	Established	Skelly Gulch downstream of private land (Spring Creek Ranch Association)
	New	Minnehaha Creek
M09MFWSC01	Established	Warm Springs Creek, Middle Fork, 500 feet downstream of private land
M09WMSC01	Established	Warm Springs Creek, 1 mile north of Clancy, MT

3.3.1.2 Total Ammonia - Nitrogen

Total ammonia is proposed as a target for the nutrient-related impairments in the streams of the Lake Helena TPA. High concentrations of total ammonia in the water column can be toxic to aquatic life. For streams listed as impaired due to total ammonia nitrogen, Table 3-5 in the Montana Numeric Water Quality Standards (Circular WQB-7 [7] [2002]) will be used to calculate the pH-dependent values of the acute toxicity criterion for total ammonia. Table 3-6 in Circular WQB-7 (7)(2002) will be used to calculate temperature and pH-dependent values of the chronic toxicity criterion for total ammonia in the presence or absence of early life stages of fish (MDEQ, 2002).

3.3.1.3 Diurnal Dissolved Oxygen and pH

Dissolved oxygen and pH are proposed as targets for the nutrient-related impairments in the streams of the Lake Helena TPA. Large diurnal fluctuations in dissolved oxygen or pH can be indicative of nutrient enrichment in streams because algae produce oxygen during the day and consume it at night. High densities of algae can cause supersaturated levels of dissolved oxygen, and high pH during the day.

Dissolved oxygen levels of more than 115 percent saturation have been shown to be harmful to aquatic life (Behar, 1996). Fluctuations in pH and dissolved oxygen were analyzed for several streams in the Lake Helena TPA during 2003 by taking samples during pre-dawn hours (for minimum dissolved oxygen and pH) and afternoon hours (for maximum pH and dissolved oxygen). Significant fluctuations between values for these two time periods were considered to be indicative of excessive algal growths. Using the hourly readings of dissolved oxygen and pH from a multiple-day data set collected with a data sonde, the following thresholds were used as threshold values:

- dissolved oxygen percent saturation not exceeding 115 percent during afternoon hours
- dissolved oxygen concentrations not less than the dissolved oxygen numeric standard defined in Circular WQB-7 (15) (during pre-dawn hours)
- pH values not exceeding pH standards (during afternoon hours) as defined in Circular WQB-7.

3.3.1.4 Periphyton

The amount of benthic algae is proposed as a target for the nutrient-related impairments in streams of the Lake Helena TPA. Benthic algae are found growing on stream bottom substrates, in contrast to free-living algae found in the water column of lakes and large rivers (phytoplankton). Benthic algae data help to provide a better understanding of the cumulative and intermittent impacts that might have occurred over time in a stream, and are useful for determining whether impairments due to nutrients are present. A value of less than 37 milligrams per square meter (mg/m^2) of attached algae is recommended as a threshold indicator value for streams that are not impaired for nutrients based on mean summer benthic algae data (as measured from natural substrates) from the 2001 and 2003 sampling of reference streams in the Lake Helena TPA.

3.3.1.5 Soluble Reactive Phosphorus

Soluble reactive phosphorus is proposed as a supplemental indicator for the nutrient-related impairments in the streams of the Lake Helena TPA. Nutrients released into streams in a dissolved inorganic form can be readily taken up by aquatic plants and can cause nuisance levels of attached algae. A value of more than 0.011 milligrams per liter (mg/L) for dissolved inorganic phosphorus measured as soluble reactive phosphorus is recommended as a supplemental indicator value for the prevention of nuisance algal growths in streams of the Lake Helena watershed. This value was derived from the 2001 and 2003 sampling of reference streams in the Lake Helena watershed.

3.3.1.6 Nitrate+Nitrite - Nitrogen

Nitrate+Nitrite (NO_3+NO_2) is proposed as a supplemental indicator for the nutrient-related impairments in the streams of the Lake Helena TPA. Similar to soluble reactive phosphorus, nitrate and nitrite are soluble forms of nutrients that are readily taken up by algae. A value of more than 0.04 mg/L for nitrate+nitrite was determined to be an appropriate supplemental indicator value based on the 2001 and 2003 sampling of reference streams in the Lake Helena watershed.

3.3.1.7 Dissolved Oxygen

The Montana dissolved oxygen standard is 5.0 mg/L as a 1-day minimum concentration and will be used as a supplemental indicator for nutrient-related aquatic life use impairment in Lake Helena watershed streams.

3.3.1.8 Macroinvertebrate Index of Biological Integrity

Aquatic invertebrates are frequently used as a component of bioassessments because they are important indicators of stream ecosystem health (Bollman, 2003a). Long lives, complex life cycles, and limited mobility mean there is ample time for the benthic invertebrate community to respond to the cumulative effects of environmental perturbations (Bollman, 2003a). The macroinvertebrate Index of Biological Integrity is used as a supplemental indicator for nutrient-related impairments in the Lake Helena TPA.

Benthic macroinvertebrate data for the Lake Helena TPA were compiled from four different reports: Eakin (1998) and Bollman (2000, 2001, 2003a). The three Bollman data sets are from benthic macroinvertebrate sampling and assessments over a three-year period (2000–2003). The Eakin (1998) data set is for lower Tenmile and Sevenmile Creeks. All assessment data were from six sub-watersheds in the Lake Helena watershed: Sevenmile Creek, Tenmile Creek, Clancy Creek, North Fork Warm Springs Creek, Spring Creek, and Prickly Pear Creek (lower segments). Macroinvertebrate data were also collected by MDEQ staff from 1997 to 2001 and by Land & Water Consulting in 2003.

Macroinvertebrate data are typically evaluated using a "multimetric index" developed for Montana water bodies (Bollman, 2001). Biological metrics are designed to test for population sensitivity or response to varying degrees of human-induced impacts. Scores are assigned to the individual metrics and the total score allows comparison between sampling sites, and between reference and test streams. Historically, MDEQ has used three ecoregional indices for assessing aquatic life use attainment: (1) the Mountain IBI, (2) the Foothill Valley and Plains IBI, and (3) the Plains IBI. The original mountain and plains indices were developed using best professional judgment to select metrics viewed as responsive to environmental stressors. All of the Lake Helena streams that have been sampled for macroinvertebrates are located within the Montana Valley and Foothill Prairies (MVFP) ecoregion. Therefore, the MVFP index (Bollman, 2001) is the most appropriate for use in the Lake Helena TPA.

MDEQ's scoring criteria (Bukantis, 1998) were applied to the MVFP IBI. The maximum possible score is 100 percent. Total scores greater than 75 percent are considered to be within the range of expected natural variability and represent full support of beneficial aquatic life uses. Streams scoring between 25 and 75 are considered as partially supporting their aquatic life uses, and scores lower than 25 percent represent non-support. Thus, the total index score and the percentage of the total index score are included for each site, when available. A score of greater than 75 is recommended as a supplemental indicator of nutrient-related impairments in streams of the Lake Helena watershed.

3.3.1.9 Hilsenhoff Biotic Index

The Hilsenhoff Biotic Index (HBI) is an abundance weighted index developed to assess impacts from organic pollution (Hilsenhoff, 1987). Since the original HBI was developed in Wisconsin, the HBI metric is used to "screen" for possible indications of nutrient impacts. Bahls et al. (1992) determined that the average HBI value for Montana Mountain reference streams was less than four. A conservative value of 3.5 would provide a threshold for comparison and is proposed as a nutrient supplemental indicator.

3.3.1.10 Periphyton Indices

Periphyton are recommended as an additional biological assemblage for evaluating water quality conditions (USEPA, 1997, 2003). Diatoms, in particular, are considered useful water quality indicators because so much is known about the relative pollution tolerance of different taxa and the water quality preferences of common species (Bahls, 2003; Barbour et al., 1999). MDEQ uses several different diatom indices to assess stream condition. Those indicating impairment due to organic loading were used as supplemental indicators for nutrient-related impairments in the Lake Helena TPA.

Periphyton values from the Lake Helena watershed were compared with biocriteria (numeric thresholds) developed for streams in the Rocky Mountain ecoregion of Montana. Best professional judgment was used, and site-specific determinations for the Lake Helena watershed streams were based on several community, biological, and pollution indices. These indices were also compared with reference conditions in Montana. These criteria are based on metric values measured in least-impaired reference streams and metric values measured in streams that are known to be impaired by various sources and causes of pollution (Bahls, 2004). For the Lake Helena watershed, periphyton assessment data were compiled from three different reports: Bahls (1997, 2001, 2004). All assessment data were from five sub-watersheds in the Lake Helena watershed basin: Sevenmile Creek, Tenmile Creek, North Fork Warm Springs Creek, Spring Creek, and Prickly Pear Creek (lower segments). Appropriate indices were used, and they include species richness, pollution index values, pollution tolerant classes, taxonomic composition, algal genera, diatom metrics, biological integrity, and comparison with least-impaired reference conditions for streams in western Montana.

3.3.1.11 Nutrient Source Assessment

A visual, screening-level assessment of sediment, nutrients, and metals sources was conducted in the Lake Helena watershed in summer 2003 as a precursor to a more detailed pollution source evaluation (to be completed during the next phase of the TMDL process). Results from the source assessment were used as an additional supplemental indicator for evaluating nutrient-related impairments. This assessment included photo documentation, global positioning system (GPS) locational indexing, and narrative descriptions of current and potential sources of water quality impairment in all stream segments of the Lake Helena TPA that appeared on the 303(d) list. Each of the 25 individual 303(d) segments were surveyed from available access points and road networks, and relevant features were documented. Obvious water quality impairments associated with the identified sources were noted (for example, turbid water, nuisance algae, dewatered stream channels).

A sediment source assessment was carried out for Helena National Forest streams that appeared on the 303(d) list. Some of these streams were also on Montana's 303(d) list for nutrient or nutrient-related impairments. The source assessment consisted of office and field reconnaissance followed by on-the-ground surveys (Sampling and Analysis Plan, Lake Helena Planning Area Draft Report, July 2003 [Tetra Tech and Land & Water Consulting, 2003]).

The source assessment for the Lake Helena watershed reflected the findings of the 2003 summer field source assessment, field sampling (chemical, physical, and biological), aerial photography inventory (photographs dating mostly from the late 1990s), and the U.S. Forest Service sediment source assessment. The full results of the source assessment are summarized in Appendix C of this report. A proposed threshold for this supplemental indicator is “no significant anthropogenic sources identified” based on standard field survey methods.

3.3.2 Nutrients - Lake Helena

Determining appropriate nutrient targets and supplemental indicators for Lake Helena is a complex undertaking due to the lake’s unique features (e.g., shallow flooded arm of Hauser Reservoir). Because of these features, regional standards developed for other lakes may or may not be appropriate. Therefore, targets and indicators were selected based on a suite of data including both regional targets and the results of a modeling analysis. The selected targets and indicators are shown in Table 3-5 and further discussed in Sections 3.3.2.1 through 3.3.2.5.

Table 3-5. Preliminary nutrient targets and supplemental indicators for Lake Helena.

Water Quality Targets	Threshold Values
Water Column Chlorophyll *a*	5-year average < 9 µg/L Maximum < 14 µg/L
Total Phosphorus	5-year average < 27 µg/L Maximum < 36 µg/L
Supplemental Indicators	**Recommended Values**
Freshwater aquatic life standard for dissolved oxygen (early life and other life stages)	Circular WQB-7 (15) (2002) 1-day minimum > 5 mg/L
Fish population presence and population estimates data	Stable or improving trends
Anthropogenic nutrient sources[a]	No significant sources identified based on field surveys

Notes: µg/L = micrograms per liter; mg/L = milligrams per liter.
[a]This supplemental indicator is applied only to the verification of impairment determinations. This is not intended to be a water quality goal.

3.3.2.1 Ecoregion Approach

Trophic state is the measure of the productivity of a lake or reservoir, and it is directly related to the level of nutrients (phosphorus and nitrogen) entering the lake or reservoir from its watershed. Lakes tend to become eutrophic (more productive) when nitrogen and phosphorus inputs are high. Eutrophic lakes often have nuisance algal blooms, limited clarity, and low dissolved oxygen concentrations, which can result in impaired aquatic life and recreational uses. Carlson’s Trophic State Index (TSI) attempts to measure the trophic state of a lake by measuring nitrogen, phosphorus, chlorophyll *a*, and depth using Secchi disc depth measurements (Carlson, 1977). MDEQ uses Carlson’s TSI, and these TSI values are compared with standard reference conditions for specific nutrient ecoregions. Lake Helena is in EPA’s nutrient Ecoregion II, sub-ecoregion 17. Lake Helena’s trophic state index varied between 50 and 70 TSI in 2002 and 55 to 79 in 2003 (Appendix D).

In 2003, MDEQ staff analyzed the overall relationship between the lake’s relative depth and Carlson’s TSI for Western Montana lakes (personal communication, M. Suplee, March 2003). The trophic relationship is a logarithmic one, with higher Carlson’s TSI values associated with shallow lakes and lower values associated with deeper lakes. As a preliminary step toward identifying a potential Carlson TSI target for Lake Helena, MDEQ evaluated the following seven lakes in Western Montana:

- Georgetown Lake
- Lake Mary Ronan
- Rogers Lake
- Teepee Lake
- Glen Lake
- Peterson Lake
- Swan Lake

These lakes as a group had a mean Carlson's chlorophyll-*a* TSI of approximately 38 with a 25th percentile of 35. The 25th percentile of all lakes in a region can sometimes be used in place of a reference population because the 25th percentile from the entire population has been shown to roughly approximate the 75th percentile for a reference population. Therefore, the reference TSI value for Lake Helena using this methodology would be 35. Using Carlson's equations, a TSI value of 35 is equal to a water column chlorophyll-*a* concentration of 1.5 µg/L (micrograms per liter) and a total phosphorus concentration of 8.5 µg/L. Therefore, these values are potential nutrient targets for Lake Helena.

3.3.2.2 Modeling Approach

Several potential problems exist with using the ecoregion approach described above to determine nutrient targets for Lake Helena. These problems are associated with the unique nature of the lake and therefore its dissimilarity with the other Montana lakes mentioned in Section 3.3.2.1. Lake Helena is not a natural lake; it is a wetland area that was flooded with the creation of Hauser Reservoir. Inflows to the lake are artificially high because of the input of a significant volume of water used for irrigation purposes, resulting in increased nutrient loadings as well as reduced residence times. The lake also has a relatively large ratio of watershed area to lake area (192), which suggests that natural nutrient loadings would be greater in Lake Helena than in lakes with smaller ratios (the watershed area to lake area ratios for the seven lakes listed above are not available). Finally, the lake's location in the Helena Valley suggests that wind-induced mixing may be an important factor in overall lake conditions.

Because of these concerns, a modeling approach was used to determine potential nutrient targets. The Generalized Watershed Loadings Function (GWLF) watershed model was linked to the BATHTUB lake model to simulate nutrient and chlorophyll-*a* concentrations in Lake Helena. The models were run for two scenarios – existing conditions and "natural" conditions (no anthropogenic sources of nutrients) – for the years 1993 through 2003. Results from the natural scenario indicated that chlorophyll-*a* concentrations in the lake would range from 5.2 to 13.7 µg/L with a long-term average of 9.3 µg/L. Total phosphorus concentrations under natural conditions were predicted to range from 19 µg/L to 35 µg/L with a long-term average of 27 µg/L. The results of the natural scenario are proposed as targets for the Lake Helena watershed and are presented in Table 3-5 on the preceding page. Additional information about model setup, inputs, and results is included in Appendix E.

3.3.2.3 Dissolved Oxygen

Dissolved oxygen is necessary to sustain fish populations. Fish such as trout require more dissolved oxygen than warm-water species. Eutrophic lakes occasionally have levels of dissolved oxygen below the minimum for fish to survive, and fish kills can result. The Montana dissolved oxygen standard is 5.0 mg/L as a 1-day minimum concentration and is used as a supplemental indicator to assess the nutrient impairment of Lake Helena.

3.3.2.4 Fisheries

Fish represent the higher trophic levels in lakes. They serve as a surrogate for many physical and biological parameters such as adequate flow, spawning and rearing habitat, appropriate food sources, and proper environmental conditions. Montana Fish, Wildlife and Parks has been conducting fish surveys and estimating fish populations in Lake Helena. Supplemental information including species presence and general population trend data will be used to provide narrative information for Lake Helena.

3.3.2.5 Nutrient Source Assessment

As stated previously, a visual, screening-level assessment of sediment, nutrients, and metals sources in the Lake Helena watershed was conducted in summer 2003 as a precursor to a more detailed pollution source evaluation. Information on anthropogenic-related sources of nutrients in Lake Helena was considered as a supplemental indicator for making the impairment determination. A proposed threshold for this supplemental indicator is “no significant anthropogenic sources identified” based on standard field survey methods.

3.3.3 Proposed Sediment Targets and Supplemental Indicators for Streams in the Lake Helena TPA

The proposed sediment targets and supplemental indicators are summarized in Table 3-6 and described in detail in the paragraphs that follow.

Table 3-6. Proposed sediment targets and supplemental indicators for streams in the Lake Helena TPA.

Water Quality Targets	Proposed Criteria
Percentage of subsurface fines < 6.4 mm size class, expressed as a reach average, in McNeil core samples collected in trout spawning gravel beds.	(1) The reach average value must be less than or equal to the average value for Helena National Forest reference stream core samples collected in similar riparian land type aggregates or, (2) when the riparian aggregate land type is unknown, the reach average value must be less than or equal to the average value for all Helena National Forest reference stream core samples.[a]
Percentage of subsurface fines < 0.85 mm size class, expressed as a reach average, in McNeil core samples collected in trout spawning gravel beds.	(1) Reach average value must be less than or equal to the average value for Helena National Forest reference stream core samples collected in similar riparian land type aggregates or, (2) when the riparian aggregate land type is unknown, the reach average value must be less than or equal to the average value for all Helena National Forest reference stream core samples.[a]
Supplemental Indicators	**Proposed Criteria**
Channel width/depth ratio	Comparable to reference values.[a]
Bank erosion hazard index (BEHI) score	Comparable to reference values.[a]
Median surface particle size (D_{50})	Comparable to reference values.[a]
Proper Functioning Condition (PFC) riparian assessment	“Proper Functioning Condition” or “Functional – at Risk” with an upward trend.
Suspended sediment concentration	< 10 mg/L at low to moderate flows; ≤ 40 mg/L at all times.
Total suspended solids concentration	< 10 mg/L at low to moderate flows.
Macroinvertebrate clinger taxa richness	≥ 14
Trichoptera taxa richness	≥ 4
Diatom siltation index	Not exceeding a rating of “minor impairment”
Fish population metrics	MFISH rating of “best” or “substantial.”[b]
Anthropogenic sediment sources	No significant sources identified based on field surveys.

Note: mm = millimeters.
[a] Specific criteria are defined in Appendix F.
[b] When not limited by other than water quality or sediment-related habitat constraints.

The proposed targets for sediment include reach-averaged fine sediment concentrations of less than the 6.4- millimeter (mm) and 0.85-mm size classes as measured in McNeil core samples collected in trout spawning gravel beds, as described below.

3.3.3.1 McNeil Core Samples – Percentage of Subsurface Substrate Fines

The percentage of subsurface substrate fines is proposed as a target for the sediment-related impairments in the Lake Helena TPA. A McNeil core sampler is a device used to measure size fractions of subsurface substrate particles. The McNeil sampler was originally designed to measure the amount of fine sediment in spawning gravels, but has also been used to monitor substrate fines for cumulative watershed analyses (Bunte and Abt, 2001). Increases in fine subsurface sediment have been linked to land management activities, and research has shown a statistically significant inverse relation between the amount of fine sediment less than 6.4 mm in spawning beds and successful salmonid fry emergence (Reiser and Bjornn, 1979; Chapman and McLeod, 1987; Weaver and Fraley, 1991; McHenry et al., 1994; Rowe et al., 2003). Fines less than 6.4 mm have been referred to as “trapping fines,” while fines less than 0.85 mm have been referred to as “intrusive fines” (Rowe et al., 2003). The amount of fines less than 0.85 mm is thought to signal the level of disturbance in a watershed (Young et al., 1991; Magee and McMahon, 1996).

The Helena National Forest has been collecting McNeil core data from spawning gravel beds in streams supporting salmonid fisheries since 1986 (Appendix F). Almost 600 cores have been collected from salmonid fisheries streams located within 13 different riparian land type aggregates. There are 31 riparian land type aggregates common to the landscape of the Helena National Forest and the Lake Helena watershed (Appendix F). McNeil core values for the percentage of fines were stratified by riparian land type aggregates in Helena National Forest in an attempt to account for the geomorphic variability of core sampling sites. Reach-averaged McNeil core reference values were set based on the averages of percentages of fines less than 6.4 mm and less than 0.85 from riparian land type aggregates. In instances where riparian land type aggregates were undefined for McNeil core samples, reference values were set on the basis of the combined averages for the percentages of fines less than 6.4 mm and less than 0.85 mm as computed for all cores.

Reference values for the percentage of fines less than 6.4 mm ranged from 56.8 percent to 28.8 percent, while reference values for the percentage of fines less than 0.85 mm ranged from 19.6 percent to 7.5 percent (Appendix F). The upper range of the percentage of fines for both parameters occurred within the riparian aggregate 27, Friable Loamy Glacial Till and Moraines. This was the only riparian aggregate with seemingly excessive reference values because the next highest values were 35.7 percent and 10.2 percent, respectively. The proposed sediment target values for the Lake Helena watershed streams are based on the Helena National Forest data set. Reach-averaged target values apply only to McNeil core samples collected using the methods developed by the Helena National Forest (Appendix F; personal communication, B. Stuart, August 2003). Typically, six cores per reach are collected in spawning gravels (usually found at pool tailouts) to a depth of 4 inches, a depth that was determined from spawning redd studies in the Intermountain West. All core sample data collected from the Lake Helena 303(d)-listed streams are included in Appendix F.

Site-specific conditions such as recent wildfires within a watershed may warrant the selection of unique indicator values that differ slightly from those presented above, or special interpretation of the data relative to the proposed sediment indicator values. See Appendix F for summary tables of McNeil core data for the Lake Helena watershed.

3.3.3.2 Channel Cross-Section Metrics

Channel cross-section metrics are proposed as a supplemental indicator for the sediment-related impairments in the Lake Helena TPA. The U.S. Forest Service has collected channel cross-section metrics for least-impaired reference stream reaches in an attempt to define expected channel characteristics based on the Rosgen Level II stream classification system (Rosgen and Silvey, 1996). Two reference data sets were acquired: one from the Helena National Forest and one from Pete Bengeyfield of the Beaverhead-Deerlodge National Forest for southwestern Montana and Greater Yellowstone Area streams. The Helena National Forest reference stream data consist of 29 Rosgen Level II classified streams, which were mostly A- and B-type streams (Appendix F). Because of the somewhat limited nature of the Helena National Forest data set, stream type averages were not calculated. Instead, comparisons were made on the basis of similar stream orders and riparian land type aggregates, as well as Rosgen stream types. The southwestern Montana and Greater Yellowstone Area data consist of average values for Rosgen Level I and Level II stream types based on 229 streams (131 are E-type streams, which are not well represented among the 303(d)-listed streams in the Lake Helena watershed) (Appendix F).

Representative reaches of the listed streams and stream segments in the Lake Helena TPA were chosen for cross-sectional surveys (see the 2003 Lake Helena Sampling and Analysis Plan [Tetra Tech and Land & Water Consulting, 2003]). The reach investigations followed protocols established by the Helena National Forest. All cross-sectional measurements collected for Lake Helena streams appearing on the 303(d) list for sediment impairment are included in Appendix F.

Three channel metrics were selected to evaluate the nature and potential for sediment transport and deposition: width-to-depth ratio, bank erosion hazard index, and median surface particle size.

3.3.3.3 Width-to-Depth Ratio

Average bankfull width and bankfull depth are two cross-sectional measurements that are important variables in determining channel pattern. For that reason, they are proposed as supplemental indicators. The ratio of bankfull width to bankfull depth is thought to be indicative of the "quasi-equilibrium" relationship between stream discharge and load transport (Ritter et al., 1995). In general, an increasing width-to-depth ratio is correlated to stream aggradation and bank erosion (Knighton, 1998; Rowe et al., 2003).

Reach-averaged width-to-depth ratios from the Lake Helena 303(d) stream segments were compared with Helena National Forest and/or southwestern Montana and Greater Yellowstone Area reference streams of similar Rosgen stream type. A deviation greater than 25 percent from the reference average was generally considered to indicate excessive deposition of fines. See Appendix F for summary tables of reference stream width-to-depth ratios used for the Lake Helena watershed.

3.3.3.4 Bank Erosion Hazard Index

The bank erosion hazard index (BEHI) is a composite metric of streambank characteristics (bank height, bankfull height, rooting depth, bank angle, surface protection, and bank materials/composition) (Rosgen and Silvey, 1996) and is used as an additional supplemental indicator for sediment impairments. Measurements for each metric, when combined, produce an overall score of bank erosion potential. Low values indicate a low potential for bank erosion.

Reach-averaged BEHI scores for the Lake Helena 303(d) stream segments were compared with southwestern Montana and Greater Yellowstone Area reference streams of similar Rosgen Level I stream type. A deviation of more than 25 percent from the reference average was generally considered to indicate increased potential for bank erosion and instability. See Appendix F for summary tables of reference stream BEHI data used for the Lake Helena watershed.

3.3.3.5 Median Particle Size

Wolman pebble counts, which provide an estimate of the distribution of particles sizes in a stream reach, are proposed as supplemental indicators for sediment. Pebble count data can be interpreted to compare median particle sizes and size class distributions between streams, and to evaluate the percentage of fines smaller than a specific size. For surveyed reaches within the Lake Helena watershed as well as the reference data, the "zigzag" adaptation of the Wolman pebble count was used so that reach features were sampled in a continuum (Bevenger and King, 1995).

Reach-averaged median particle size, D_{50}, from the Lake Helena watershed 303(d)-listed stream segments were compared with Helena National Forest and southwestern Montana and Greater Yellowstone Area reference streams of similar Rosgen level stream types. A deviation from the reference average of less than one size class was generally considered to indicate excessive deposition of surface fines.

3.3.3.6 Riparian Assessment

The Proper Functioning Condition method is a qualitative method for "assessing the physical functioning of riparian-wetland areas" (Prichard, 1998) and is proposed as a supplemental indicator for sediment. The hydrologic processes, riparian vegetation characteristics, and erosion/deposition capacities of streams are evaluated for a selected stream reach. The final rating is a professional judgment call based on responses to a series of yes/no questions. The possible ratings for a reach are "Proper functioning condition" (PFC), "Functional – at risk" (FAR), or "Non-functional" (NF).

Following the Helena National Forest reach survey protocol, Proper Functioning Condition assessments were conducted on representative reaches of the Lake Helena watershed stream segments. The supplemental indicator for sediment water quality was PFC, or FAR with an upward (improving) trend.

3.3.3.7 Suspended Sediment Data

Suspended sediment or suspended solids data were available for seven reference streams in the Lake Helena TPA and were used as supplemental indicators. Reference streams were chosen with the aide of the Helena National Forest, on the basis of riparian land type aggregates. These data have been evaluated where available and were considered as collaborative evidence in support of water quality impairment status conclusions presented in Section 3.5. Suspended sediment and suspended solids data for reference streams and Lake Helena are presented in Appendix F.

Depth-integrated suspended sediment data from the USGS National Water Information System were available for 1989–1990 and 1997–2001 for the following reference streams: Dutchman Creek, McClellan Creek, Minnehaha Creek, Monitor Creek, Moose Creek, South Fork Warm Springs Creek, and Walker Creek (53 values in all). The values represented low- as well as high-flow conditions and produced a range of measurements from 1 to 128 mg/L. The average of all values was 13.8 mg/L, with a median of 6.0 mg/L and a standard deviation of 23.7 mg/L. Further examination of the seasonal distribution of the data suggests that values would not be expected to exceed 10 mg/L during winter, summer, or fall. The 90th percentile value for the entire data set, which included high-flow samples, was 40 mg/L. Based on the distribution of these reference data, a suggested supplemental indicator value for suspended sediment concentration is less than 10 mg/L during low- to moderate-flow periods, while no values should exceed 40 mg/L at any time.

Total suspended solids concentrations were analyzed from grab samples collected in 2003 by Land & Water Consulting from McClellan, Dutchman, South Fork of Warm Springs, Shingle Mill, Walker, and Moose Creeks. All streams were sampled during low-flow conditions and most results were reported as less than 1 mg/L or less than 10 mg/L. The highest recorded value was 2 mg/L on Walker Creek. Based on these reference data, a suggested supplemental indicator value for total suspended solids is less than 10 mg/L. Because no reference data were available for high-flow conditions, the proposed supplemental indicator value of less than 10 mg/L should be applied only during low- to moderate-flow periods.

3.3.3.8 Macroinvertebrates

As described in Section 3.3.1.8, macroinvertebrate data were collected in several of the Lake Helena watershed streams by MDEQ from 1997 to 2001, and by Land & Water Consulting in 2003. Aquatic macroinvertebrates are used in bioassessments because they are important indicators of stream ecosystem health (Bollman, 2003a). The proposed macroinvertebrate supplemental indicators for sediment are intended to integrate multiple stressors and pollutants to provide an assessment of the overall aquatic life use condition, as well as a focused assessment of sediment-caused impairments. Macroinvertebrate data were used as supplemental indicators for making sediment-related impairment determinations.

In addition to the overall index score, individual metrics are proposed to diagnose potential stressors. One metric used by Bollman as an indicator of possible sediment impacts in Mountain and Foothill Valley and Plains streams is the richness of trichoptera taxa, where sites with fewer taxa (a minimum of four taxa) suggest sediment impacts (Bollman, 2000). Many trichoptera taxa construct fixed retreats or have adaptations for attachment to substrates in flowing waters (Merritt and Cummins, 1996). For that reason, the deposition of fine sediment limits habitat suitability for many trichoptera taxa. The presence of fewer than four trichoptera taxa suggests the possibility of sediment impairment.

Clinger taxa richness can also be indicative of possible sediment impacts. A minimum of 14 clinger taxa are expected in least-impaired streams in the Mountain ecoregion (Bollman, 2001). Mountain streams with fewer than 14 clinger taxa are considered influenced by sediment.

The use of macroinvertebrate indices as diagnostic tools to detect potential causes of impairment is a science that is still under development. The results, therefore, should be interpreted with caution. However, given the current state of knowledge, the proposed supplemental macroinvertebrate indicators provide the best available measure of aquatic life support.

3.3.3.9 Periphyton

Similar to macroinvertebrate assessments, periphyton assessments are converted to metric assessments to determine the level of impairment and support of aquatic life beneficial uses. Periphyton assessments are used as supplemental indicators for sediment-related impairments. In addition to the overall biological integrity score, the individual metric of the siltation index is proposed to diagnose potential impairment by sediment. The siltation index evaluates the abundance of motile diatoms in a sample and “assumes a direct correlation between the amount of accumulating sediment on the stream bottom and the percentage of motile species" (Bahls, 1997).

For the Lake Helena watershed, periphyton assessment data were compiled from five different reports (Bahls 1997, 1998, 2001, 2003, and 2004). The assessment data were from five sub-watersheds in the Lake Helena watershed: Sevenmile Creek, Tenmile Creek, North Fork Warm Springs Creek, Spring Creek, and Prickly Pear Creek (lower segments). The proposed supplemental indicator criterion for the siltation index is the criterion that it not exceed the threshold for minor impairment. The impairment threshold criteria are based on metric values measured in least-impaired reference streams and metric values measured in streams that are known to be impaired by various causes and sources of pollution (Bahls, 2004). The threshold for minor sediment impairment is a siltation index value of 20 or more.

3.3.3.10 Fish Population Data

As stated in Section 3.3.2.4, Montana Fish, Wildlife and Parks and the U.S. Forest Service have been conducting fish species inventories and population estimates in many of the streams of the Lake Helena watershed and in Lake Helena proper. Supplemental information pertaining to fish species presence, general population trend data, and habitat quality will be used as supplemental sediment indicators for the Lake Helena watershed. However, the fisheries information and quality ratings that are available will not be used as specific supplemental indicator variables.

3.3.3.11 Anthropogenic Sediment Sources

Consideration of sediment sources is important given that TMDLs are necessary only for impairments caused by anthropogenic sources. In 2003, Tetra Tech, Land & Water Consulting, and the Helena National Forest conducted a preliminary source assessment (Appendix C). A final source assessment will be completed during the next phase of the TMDL process. Results from the preliminary assessment were used as an additional supplemental indicator for evaluating sediment-related impairments. Field inventory, geographic information systems (GIS), and aerial photography were used to provide a screening-level assessment of sediment sources in the Lake Helena watershed.

Although the source assessment was somewhat limited in scope, roads and channel alterations caused by mines, roads, and agriculture appeared to be the largest contributors of sediment in the Lake Helena watershed. The Boulder Batholith, a large intrusive body of quartz monzonite, is the dominant geology in the watershed. Although the area is naturally erosion-prone, land disturbance in the Boulder Batholith appears to have significantly increased erosion rates.

Results of the source assessment were taken into consideration in evaluating sediment-related impairments. This "supplemental indicator" will be applied only to assist in verifying water quality impairment determinations. No specific water quality indicator variables involving sediment sources are proposed.

3.3.4 Metals

For many pollutants with established numeric water quality standards, the water quality standard is used directly as the TMDL target and target. This is the case for the metals of concern in the Lake Helena watershed, which include arsenic, cadmium, copper, lead, and zinc.

The *Circular WQB-7, Montana Numeric Water Quality Standards* contains numeric water quality standards for Montana's surface water and groundwater. The standards in Circular WQB-7 are set at the levels necessary to protect the uses of the waters. They are based on the best available scientific evidence relating the concentration of pollutants to effects on aquatic life and human health. These numeric standards will be used as TMDL targets for metals.

There are three different numeric standards for each metal: acute and chronic toxicity aquatic life standards designed to protect aquatic life uses, and the human health standard, designed to protect drinking water uses. Table 3-7 shows the acute and chronic aquatic life standards and the human health standards applicable to the metals of concern in the Lake Helena watershed. Both the acute and chronic aquatic life standards for cadmium, copper, lead, and zinc are hardness-dependent. The criteria are calculated using the formulas shown in Appendix G of this report.

Circular WQB-7 states that no sample is to exceed the calculated acute aquatic life criteria, and no 4-day period or longer is to exceed the calculated chronic aquatic life criteria. No sample is to exceed the human health criteria.

To determine whether a water body is meeting the established standards, an analysis of the frequency and magnitude of the exceedances of the aquatic life and human health criteria is needed for the metals of concern. An evaluation of (1) the number of samples exceeding the aquatic life and/or human health criteria compared with the total number of samples, (2) the average concentration of all samples compared with the aquatic life and/or human health criteria, and (3) the magnitude of the highest measured concentration is performed to make an impairment determination. If the data are limited, and there are no exceedances of the standards, a preliminary decision is made that the sampled water body segments are not impaired. Those particular segments will need to be closely monitored in the future to address the uncertainty in that determination.

It should be noted that data on both total metals and total recoverable metals were collected in the Lake Helena watershed. The more rigorous "total" digestion method is strong enough to liberate metals bound to more resistant suspended particulates (such as granitics). Metals with strong bonds are not generally considered bioavailable because there are few natural processes that can dissociate them the way the "total" digestion method does. The metals standards in Montana's Circular WQB-7 are therefore based on "total recoverable" metals as referenced in the Code of Federal Regulations (40 CFR Part 136; Appendix B, Section 2.5). Despite this, the analysis presented in this study was made using both "total" and "total recoverable" metals data for two primary reasons: (1) to increase the volume of available data; and (2) because differences between the two methodologies are usually very minor or result in an impairment determination that is simply conservative toward protection of the water resource.

Table 3-7. Montana numeric surface water quality standards for metals.

Parameter	Aquatic Life (acute) (µg/L)[a]	Aquatic Life (chronic) (µg/L)[b]	Human Health (µg/L)[a]
Arsenic (TR)	340	150	18 [d]
Cadmium (TR)	1.05 at 50 mg/L hardness[c]	0.16 at 50 mg/L hardness[c]	5
Copper (TR)	7.3 at 50 mg/L hardness[c]	5.2 at 50 mg/L hardness[c]	1,300
Lead (TR)	82 at 100 mg/L hardness[c]	3.2 at 100 mg/L hardness[c]	15
Zinc (TR)	67 at 50 mg/L hardness[c]	67 at 50 mg/L hardness[c]	2,000

Note: TR = total recoverable.
[a]Maximum allowable concentration.
[b]No 4-day (96-hour) or longer period average concentration may exceed these values.
[c]The standard is dependent on the hardness of the water, measured as the concentration of $CaCO_3$ (mg/L) (see Appendix G for the coefficients to calculate the standard).
[d] The human health standard for arsenic is currently 18 µg/L, but will change to 10 µg/L in 2006.

3.3.5 Thermal Modifications

The proposed temperature targets and supplemental indicators are summarized in (Table 3-8) and are described in detail in the paragraphs that follow.

Table 3-8. Proposed water temperature targets and supplemental indicators for streams in the Lake Helena TPA.

Water Quality Target	Thresholds
Water Temperature: A change in temperature due to anthropogenic sources, or variation from a reference condition.	A-1, B-1 Class Waters: ≤ 1° F when water temperature is < 67° F; ≤ 0.5° F when water temperature is > 67° F. I Class Waters: No increase in naturally occurring water temperature.
Supplemental Indicators	**Proposed Criteria**
Riparian Assessments: Proper Functioning Condition (PFC) rating and associated source assessment	No significant disturbance of riparian vegetation
Fish population metrics	MFISH rating of "best" or "substantial"[a]

[a]When not limited by other than water quality or habitat constraints.

3.3.5.1 Water Temperature

Several independent studies have shown strong correlations between the health and behavior of cold-water fish (salmonids) and water temperature (Coutant, 1977; Cherry et al., 1977; Bell, 1986; Lee and Rinne, 1980). Increased water temperature can affect fish reproduction and feeding habits. In addition, warmer water temperatures can lead to a shift in fish species from cold-water to warm-water fish. Increases in water temperature are not normally lethal to fish because the fish can avoid areas of warmer water by migrating to other parts of the river. However, prolonged periods of extremely warm water temperatures can be fatal.

The Montana Administrative Rules (ARM) state that for A-1 and B-1 class waters "the maximum allowable increase over naturally occurring temperature (if the naturally occurring temperature is less than 67º Fahrenheit) is 1° (F) and the rate of change cannot exceed 2° F per hour" (ARM 17.30.629). Furthermore, if the natural occurring temperature is greater than 67º F, the maximum allowable increase is 0.5º F (ARM 17.30.622(e), ARM 17.30.623(e)).

For waters classified as "I," no increase in naturally occurring temperature is allowed that will or is likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife (ARM 17.30.628(e)).

Natural conditions, where they could be identified, determined the numeric criteria used as the temperature targets for the suspected thermally modified streams in the Lake Helena TPA.

3.3.5.2 Riparian Assessments

Examinations of the riparian areas were conducted for the suspected thermally impaired stream segments. Shade provided by riparian vegetation reduces the amount of surface area that is exposed to thermal energy. Riparian vegetation can also provide a control on channel form such as width-to-depth ratio. This is important for water temperature concerns because shallow, low-volume water bodies are more easily heated. The suspected thermally modified streams were assessed using the Proper Functioning Condition method (Prichard, 1998). The riparian vegetation characteristics assessed using the Proper Functioning Condition methodology are of particular interest for the suspected thermally modified segments. This supplemental indicator will be applied only to assist in verifying water quality impairment determinations. No specific water quality indicator variables involving thermal sources are proposed.

Consideration of disturbance in the riparian area is important given that TMDLs are necessary only for impairments caused by anthropogenic sources. In 2003, Tetra Tech, Land & Water Consulting, and the Helena National Forest conducted a preliminary source assessment (Appendix C). They used field inventory, GIS, and aerial photography to conduct a screening-level assessment of riparian condition in the Lake Helena TPA. Results of the source assessment were taken into consideration in evaluating temperature-related impairments. This supplemental indicator will only be applied to assist in verifying water quality impairment determinations. No specific water quality indicator variables involving thermal sources are proposed.

3.3.5.3 Fish Population Data

As stated in Section 3.3.2.4, Montana Fish, Wildlife and Parks and the U.S. Forest Service have been conducting fish species inventories and estimating fish populations in many of the streams in the Lake Helena watershed and in Lake Helena proper. Supplemental information pertaining to the presence of fish species, general population trend data, and habitat quality will be used to support the targets and supplemental temperature indicators for the Lake Helena watershed. However, the fisheries information and quality ratings that are available will not be used as specific supplemental indicator variables.

3.3.6 pH

Montana has narrative standards for pH that are linked to the "natural" condition of the stream. This takes into account the fact that streams can have a wide range of natural pH values, and therefore it is difficult to set numeric standards. Extensive research by EPA and others has shown that pH can have direct and indirect effects on stream water chemistry and the biota of aquatic ecosystems. A pH range from 5 to 9 is not directly toxic to fish, but a decline in pH from 6.5 to 5.0 was found to result in a progressive reduction in salmonid egg production and hatching success (USEPA, 1991). The emergence of certain aquatic insects also declines below a pH of 6.5. From this and other data, EPA has concluded that pH should range between 6.5 and 9.0 in order to protect aquatic life (USEPA, 1991). Streams sampled in the Lake Helena watershed in 2003 (except Corbin Creek) had pH values ranging from 6.7 to 8.9, which suggests that the natural pH of streams in this region is within EPA's proposed pH range. Therefore, a minimum pH of 6.5 and a maximum pH of 9 were selected as TMDL targets.

Metals concentrations and pH values are linked by solubility processes in the stream. High metals concentrations, especially high concentrations of iron, can lead to low pH values. Also, low pH values increase the solubility of some metals. Because of this linkage, it is important that both metals concentrations and pH meet water quality standards to protect beneficial uses. The metals criteria in MDEQ Circular WQB-7 are therefore proposed as supplemental indicators for pH (Table 3-9).

Table 3-9. pH targets and supplemental indicators for Lake Helena TPA streams.

Water Quality Targets	**Threshold Values**
Minimum pH	6.5
Maximum pH	9.0
Supplemental Indicator	**Recommended Value**
Montana Metals Criteria	As documented in MDEQ Circular WQB-7

3.3.7 Salinity/Total Dissolved Solids/Chlorides

Salinity targets and supplemental indicators were chosen based on crop sensitivity to irrigation water and biological response to salinity. Ayers and Westcot (1985) documented the effects of salinity on various crops and yield. For alfalfa (the most sensitive crop assumed to be grown in the Corbin Creek watershed), crop yields are affected by irrigation water with salinity concentrations of more than 1,300 micro-Siemens per centimeter (µS/cm) (2,000 µS/cm soil water assuming a 20 percent leaching fraction). Therefore, an average value of 1,300 µS/cm was chosen as a salinity target for Corbin Creek (Table 3-10).

Salinity can also affect in-stream biological uses, and several studies have documented population shifts or toxicity because of salinity (Klarich and Regele, 1980; McKee and Wolfe, 1963; Mount et al., 1997). Montana Fish, Wildlife and Parks conducted a detailed review of toxicity studies and found relevant toxicity studies for fathead minnows, freshwater crustaceans, walleye, and northern pike. The draft review concluded that 1,500 µS/cm SC levels were protective of these species (Skaar, 2003), and therefore the 1,300 µS/cm target identified for the protection of agricultural uses should also protect aquatic life beneficial uses.

Table 3-10. Salinity targets and supplemental indicators for Corbin Creek.

Water Quality Target	Threshold Value
Average Specific Conductance	1,300 µS/cm

3.3.8 Chlorides

Montana currently does not have numeric standards for chlorides. EPA recommends chloride standards for streams and rivers that are based on the aquatic toxicity for plant, fish, and invertebrate species (USEPA, 1999). EPA recommends an acute standard of 860 mg/L and a chronic standard of 230 mg/L. These standards are proposed here as target values for Lake Helena watershed streams.

Table 3-11. Proposed chloride target values for the Lake Helena TPA.

Water Quality Targets	Threshold Values
Chloride Concentration (maximum)	< 860 mg/L
Chloride Concentration (average)	< 230 mg/L

3.3.9 Priority Organics

DDE (dichlorodiphenyl-dichloroethylene) is a breakdown product of DDT (dichlorodiphenyltrichloroethane), which was once widely used as a pesticide throughout the United States. Although banned, DDT and DDE still exist in the atmosphere and soils. Both bond strongly to soils and break down over a period of 2 to 15 years (ATSDR, 2002). DDE is listed by EPA as a "probable human carcinogen," and has been shown to cause reproductive and liver damage in bird species (USEPA, 1980). The Montana water quality standard for DDE is a maximum of 0.0059 µg/L to protect human health, and this standard is also protective of aquatic life. A maximum DDE concentration of 0.0059 µg/L is proposed as a target for streams in the Lake Helena watershed.

3.4 Current Water Quality Impairment Status

This section presents summaries and evaluations of all available water quality data for water bodies in the Lake Helena watershed appearing on Montana's 1996 and subsequent 303(d) lists. The reviews evaluate all currently available data for each stream or reservoir segment by suspected impairment cause category (for example, metals, nutrients, sediment). The data reviews include new monitoring information that was collected specifically for this purpose in summer 2003 and 2004. The 2003 and 2004 monitoring locations are shown in relation to the 303(d)-listed segments in Figure 3-3. The weight-of-evidence approach described in Section 3.3, an approach that uses a suite of targets and supplemental indicators, has been applied to verify and/or reconsider each of the water quality impairments on the 1996 303(d) list. Supporting documentation is provided for each water body within each of the three major tributary drainages to Lake Helena, and for Lake Helena itself.

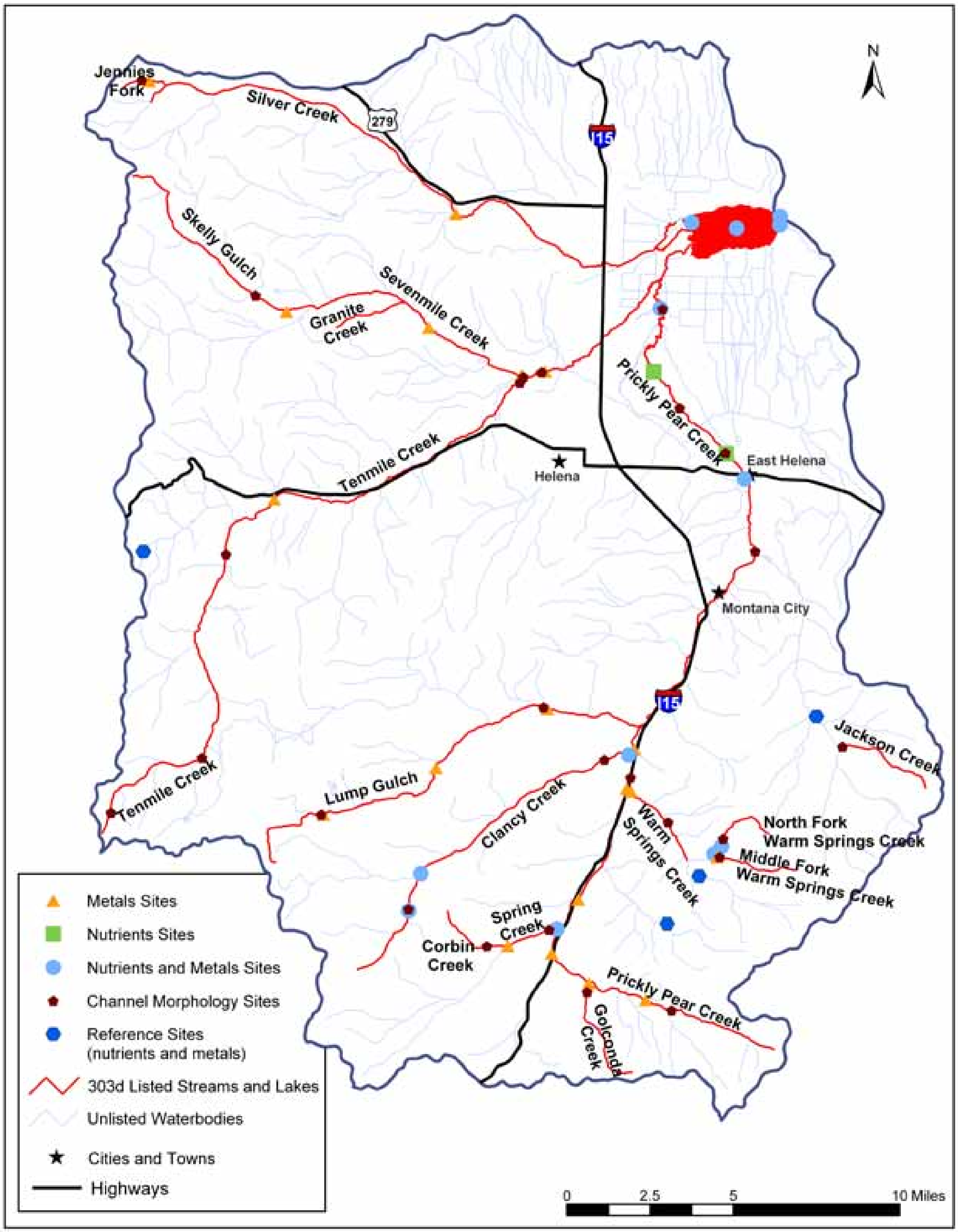

Figure 3-3. 303(d)-listed segments and 2003–2004 water quality monitoring stations in the Lake Helena watershed.

3.4.1 Prickly Pear Creek Drainage

This section presents summaries and evaluations of all available water quality data for water bodies in the Prickly Pear Creek drainage. Maps of the Upper Prickly Pear and Lower Prickly Pear drainage areas are provided in Figure 3-4 and Figure 3-5.

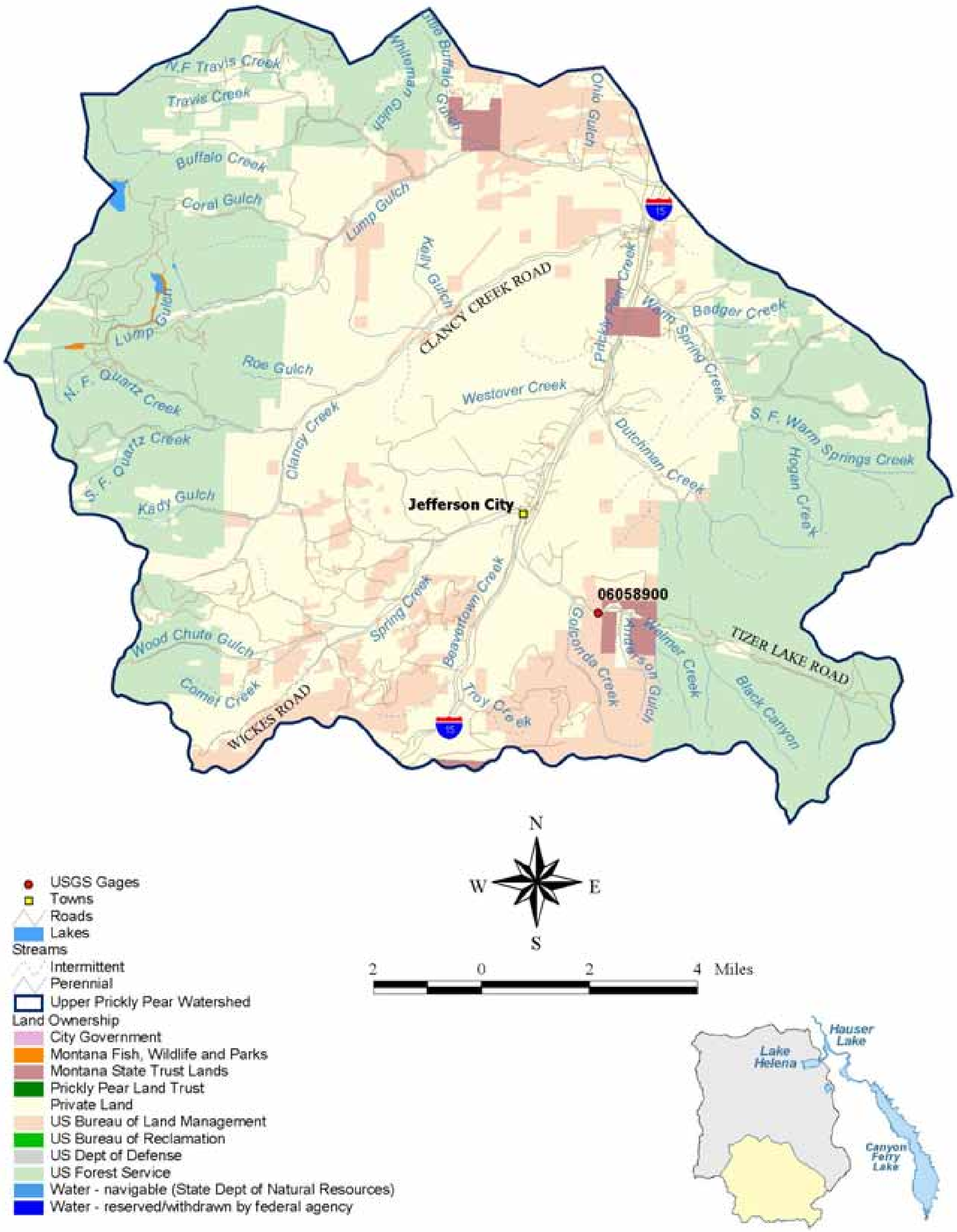

Figure 3-4. Map of the Upper Prickly Pear Creek Watershed.

Figure 3-5. Map of the Lower Prickly Pear Creek Watershed.

3.4.1.1 Prickly Pear Creek from the Headwaters to Spring Creek (MT41I006_060)

In 1996, the cold-water fishery uses in this 8.7-mile headwater segment of Prickly Pear Creek were listed as threatened due to suspended solids and metals. The basis for the suspended solids listing is a 1981 report that describes undesirable channel and riparian conditions resulting from historical placer mining. The worst of these conditions begins at the confluence with Golconda Creek. In subsequent years the segment has not been listed for suspended solids. However, fish habitat and habitat alterations have been added to the list as sources of pollution. The rationale for the metals listing is unknown. In 2000, the impaired water uses were changed to include aquatic life and drinking water (non-supporting), and agriculture (partial support). Fisheries uses were upgraded from threatened to fully supporting. A typical view of this segment is shown in the photo below.

A review of the currently available data is provided below. Available sediment-related data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey on the Helena National Forest that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from two sites within the Helena National Forest's administrative boundary, suspended sediment data, and fish population data. Metals data include a total of 11 in-stream water chemistry samples taken between October 2000 and August 2003.

Prickly Pear Creek from headwaters to Spring Creek

Pollution Sources

The 2003 preliminary source assessment identified roads and geology as the primary sediment sources for this section of Prickly Pear Creek. The Helena National Forest conducted a road sediment survey on the forest portion of the creek and identified 11 sites that, based on modeling using the Water Erosion Prediction Project (WEPP) model, contribute approximately 5.2 tons of sediment per year to the stream (USDA, 2004). The aerial photography inventory showed eight road crossings and road encroachment along 30 percent of the stream. The last one-third mile of the stream segment was channelized during construction of Interstate 15. Most of the additional source assessment inventory sites outside the forest consisted of road-related sources, such as problem culverts and road sediment delivery points.

The primary geology of this sub-watershed is the Boulder Batholith, which consists of highly erodible quartz monzonite. The field source assessment showed poorly developed soils with gully formations on steep slopes in upland areas and on road cut-and-fill slopes. Deposition of sand was observed in the stream channel at many sites. The aerial photography inventory showed that extensive conifer and deciduous riparian buffers were present on the Helena National Forest portion of the stream. As the valley bottom widths increased downstream, the widths of deciduous riparian buffers tended to decrease and were variable depending on individual ownership and proximity to the Tizer Lake Road. Some logging has occurred on state and private lands, but the sites do not appear to be recent harvests.

Although one placer mine site was observed within the Helena National Forest administrative boundary, extensive channel alterations from historical mining do not begin until below the confluence with Golconda Creek. A historical placer gold dredge operation just above I-15 marks where the stream becomes incised, overly widened, and straightened as a result of the operation. Currently, the placer site is heavily grazed with consequent removal of riparian vegetation and bank trampling.

In summary, sediment sources generated by road runoff and road placement are probably the biggest contributors of sediment to this segment of Prickly Pear Creek. Land disturbance appears to exacerbate erosion in the Boulder Batholith geology and the poorly developed soils of this sub-watershed. Severe channel alterations begin below the confluence with Golconda Creek, which are likely in-channel sources of sediment.

Expected relevant sources of metals in the stream segment are a tributary stream and historical mining activities in the immediate drainage area. Golconda Creek flows into this segment and is likely a significant contributor of metals. Most of the drainage area falls within the Alhambra mining district, although there are sections of Elkhorn and Colorado mining districts in the basin. The Montana Bureau of Mines and Geology (MBMG) Abandoned and Inactive Mines database shows placer, mineral prospect, surface, surface-underground, and underground historical mining activities in the drainage area of the stream. The mining types listed include lode and placer. In the past, these mines produced silver, lead, zinc, manganese, molybdenum, and gold. None of the mines in the drainage area of this segment are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites.

Channel Survey

In 2003 the Helena National Forest conducted a field investigation along this section of Prickly Pear Creek, about 1 mile upstream of the forest's administrative boundary. The Helena National Forest determined that the stream is a Rosgen stream type A2a+. The width-to-depth ratio was 7.5, which is similar to other reference A-type streams inventoried by the Helena National Forest (Table 3-12). The stream banks were predominately lined with boulders, which led to a "low," or "very stable" Bank Erosion Hazard Index (BEHI) rating. This BEHI rating is actually better than the average for southwestern Montana and Greater Yellowstone Area least-impaired reference A-type streams, but not unexpected for boulder-dominated stream banks. D_{50} as determined in a zigzag Wolman pebble count consisted of small boulders. Although no Helena National Forest reference streams are specifically A2a+, this large median particle size indicates that excessive deposition of finer-sized particles is probably not occurring at this site.

The channel survey included a Proper Functioning Condition assessment. The Helena National Forest rated this site as attaining Proper Functioning Condition (PFC), but noted some sediment deposition. The riparian land type aggregate assigned to this site is 27, defined as Friable Loamy Glacial Till Moraines. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common and can be excessive.

Table 3-12. Summary of cross-sectional data for Prickly Pear Creek, Segment MT41I006_060.

Parameter	Result	Comparable to Reference
Width/depth ratio	7.5	Yes
BEHI	Low	Yes
D_{50}	Small boulders	NA
PFC	PFC	Yes

McNeil Cores

McNeil core data are available for two sites on this section of Prickly Pear Creek, both of which are within the Helena National Forest's administrative boundary (Table 3-13). The oldest cores (six cores) were collected in 1993 in the southeast quarter of Section 14, Township 7N, Range 3W. The riparian aggregate here was determined to be 25, defined as Compact Loamy Glacial Till Moraines. The average percentage of fines less than the 6.4 mm was 30.8 percent of the samples, with average fine fines (less than 0.85mm) at 11.6 percent. These values are elevated when compared with the means for fines from the reference values for riparian aggregate 25. The percentage of fines less than 6.4 mm for this site is 7 percent greater than the mean for cores from the reference riparian aggregate 25, and the fine fines are 55 percent above the mean.

The second set of McNeil cores were collected in 1995. The exact location of the cores sites (n=9) is unknown; thus, a riparian aggregate land type cannot be established. The average percentage of fines less than 6.4 mm was 37.6 percent, with average fine fines at 11.5 percent. Both values for percentage of fines are 15 percent greater than the means for all Helena National Forest reference core samples combined (which was necessary because the riparian aggregate land type was unknown).

Table 3-13. Summary of McNeil core data for Prickly Pear Creek, Segment MT41I006_060.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
25	1993	30.8	11.6	Fine fines value is elevated.
Unknown	1995	37.6	11.5	Both fines values are elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Data were available for three sites along this segment of Prickly Pear Creek, with 14 samples taken from 1989 to 2001. The highest value collected was 15 mg/L in May 2001 at a sampling site above Beavertown Creek. The suspended sediment data had an average of 5.6 mg/L and a median of 4.5 mg/L. All of these values are comparable to suspended sediment values from selected reference streams (Table 3-14).

Table 3-14. Statistical summary of suspended sediment data for Prickly Pear Creek, Segment MT41I006_060.

Mean	5.6 mg/L
Median	4.5 mg/L
Standard deviation	4.6 mg/L
Maximum	15.0 mg/L
Number of samples	14
Number of sample sites	3

In 2003, four visual observations of turbidity were recorded at two sites along this segment of Prickly Pear Creek. All observations reported the water clarity as clear, yet the observations were made during the recessional limb of peak flow or during low-flow conditions.

Macroinvertebrates

No recent data were available at the time of this writing.

Periphyton

No recent data were available at the time of this writing.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' Montana Fisheries Information System (MFISH) and data from the Helena National Forest. Prickly Pear Creek is managed as a trout fishery. Genetically pure westslope cutthroat trout (*Oncorhynchus clarki lewisi*), a species of special concern, are common year-round residents in this segment of Prickly Pear Creek. The overall habitat and sport fishery rating for this section of the creek is "substantial," which is the next rating below "best." A complex scoring system is taken into consideration in order to assign an overall value to the habitat and sport fishery of a particular stream. Points are awarded based on the presence of fish species of special concern, fish populations, spawning habitat quality, biomass, angling access, stream esthetics, and angling use per year.

Metals Concentrations

The project team evaluated a total of 11 in-stream water chemistry samples taken between October 2000 and August 2003. All samples were below the human health and aquatic life criteria for all metals, with one exception. The chronic aquatic life criterion for lead was exceeded in one sample, which is equivalent to 9.1 percent of all samples. Also, the average lead concentration for all available samples was 7.6 percent above the chronic aquatic life criterion level. This evidence suggests this segment does not meet the aquatic life water quality standards and target values for lead.

Although neither the human health nor the aquatic life criteria were exceeded, the highest measured concentrations for cadmium and copper were 82 percent and 73 percent of the chronic aquatic life criteria levels, respectively. These are borderline levels. This evidence suggests this segment meets the human health and aquatic life water quality standards and target values for arsenic, cadmium, copper, and zinc. Cadmium and copper should be closely monitored in the future to confirm this statement.

Prickly Pear Creek Segment MT41I006_060 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width/depth ratio, median surface particle size, BEHI, and Proper Functioning Condition rating), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediment, fisheries, and heavy metals concentrations in the water column.

The supplemental indicator values for channel metrics and suspended sediment data were met or exceeded. Recent fisheries data suggest that there are reaches of valuable westslope cutthroat trout habitat in this segment of the stream, primarily in the upper 2 to 3 miles of the stream segment. However, values for the percentage of fines in McNeil cores were elevated against the target values.

Results from the 2003 preliminary source assessment revealed that there were active sediment sources affecting this stream segment, and that impairments and channel condition appeared to worsen in a downstream manner. Unfortunately, little physical or chemical data are available for the segment of the stream below the Helena National Forest boundary. Because target McNeil core values are exceeded within the Helena National Forest administrative boundary, it is assumed that they are also exceeded below the forest boundary.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Prickly Pear Creek Segment MT41I006_060 are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

The available data also suggest that Prickly Pear Creek from headwaters to Spring Creek is impaired by lead. A TMDL will therefore be developed to address the lead impairment.

3.4.1.2 Prickly Pear Creek from Spring Creek to Lump Gulch (MT41I006_050)

In 1996, this 7-mile segment of Prickly Pear Creek was listed as not supporting aquatic life, cold-water fisheries, swimming, and agricultural uses due to suspended solids and siltation. The basis for the listings are five reports dating back to the 1980s that summarize undesirable channel conditions, such as stream channelization, lack of riparian vegetation, and bank erosion. In subsequent years, the segment has been listed as not supporting aquatic life, cold-water fisheries, and drinking water uses, and partially supporting agricultural uses, because of siltation, fish habitat degradation, habitat alterations, bank erosion, and metals. A typical view of this segment is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey on the creek below Alhambra that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from the reach surveyed in 2003, suspended sediment data, macroinvertebrate data, fish population data, and a total of 11 in-stream water chemistry samples taken between June 2000 and August 2003.

Prickly Pear Creek from Spring Creek to Lump Gulch

Pollution Sources

The 2003 preliminary source assessment identified were roads and riparian grazing as the primary sediment sources for this section of Prickly Pear Creek. Most of the source assessment inventory sites consisted of road sources, such as road sediment delivery points. The aerial photography inventory showed 16 road crossings. Roughly 91 percent of the stream segment has been channelized to accommodate the construction of I-15 and the railroad.

The primary geology of this sub-watershed is the Boulder Batholith, which consists of highly erodible quartz monzonite. Deposition of sand was observed in the stream channel at many sites. The aerial photography inventory showed that the widths of deciduous riparian buffers ranged from 30 to 100 feet and were correlated to their distance from roads. This segment is surrounded by private land, and the dominant adjacent land use consists of a transportation corridor.

The majority of this segment of Prickly Pear Creek has been placer mined, and gravel tailings piles line the stream banks in many areas. The stream is incised, overly widened, and straightened as a result of historical mining and the position of roadways. Some parcels of land along this segment are grazed with resultant removal of riparian vegetation, bank trampling, and bank slumping.

In summary, sediment sources generated by road runoff and road placement are probably the biggest contributors of sediment to this segment of Prickly Pear Creek. Tributary streams, such as Spring Creek and Warm Springs Creek, are also likely sediment sources. Localized sources such as grazing are present as well. Severe channel alterations from placer mining and the transportation corridor have probably affected the flow regime along this segment.

Expected relevant sources of metals to the stream segment are upstream sources, tributary streams, and historical mining activities in the immediate drainage area. The segment's upstream reach (Prickly Pear Creek 060) and tributaries (including Spring Creek, Clancy Creek, and Warm Springs Creek) are likely to contribute metals. In addition, during field sampling efforts, spring seeps were noted entering Prickly Pear Creek from placer tailings piles along the stream. The immediate drainage area of the listed segment falls within the Alhambra and Clancy mining districts. The MBMG Abandoned and Inactive Mines database reports mineral location, surface, surface-underground, underground, and other, "unknown" mining activities in the immediate drainage area of the stream segment. The historical mining types include lode and placer. In the past these mines produced gold, silver, copper, lead, zinc, and uranium. None of the mines in the immediate drainage area of this segment are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation along this section of Prickly Pear Creek, just below the Alhambra RV Park. The stream's entrenchment ratio and sinuosity were out of balance with the valley type setting, reflecting channel confinement and straightening. Without channel modifications, the stream reach probably would be a Rosgen stream type C4. The width-to-depth ratio was 18.4, which is comparable to the average for southwestern Montana and Greater Yellowstone Area reference C-type streams (Table 3-15). Reference information was not available for Helena National Forest C-type streams. The BEHI rating was "moderate." The BEHI score was about 25 percent above the average (less stable) for southwestern Montana and Greater Yellowstone Area reference C-type streams, but within the same overall rating category. D_{50} as determined in a zigzag Wolman pebble count consisted of coarse gravels. This particle size is one size-class smaller than the range expected for reference C4 stream types, based on data collected for southwestern Montana and the Greater Yellowstone Area.

The channel survey included a Proper Functioning Condition assessment. Tetra Tech and Land & Water Consulting rated this site as “Non-functional” (NF), noting pool infilling, monotonous riparian vegetation, and severe impairment to channel function resulting from channelization. The riparian land type aggregate assigned to this site is 29, defined as Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fine are common but generally not excessive.

Table 3-15. Summary of cross-sectional data for Prickly Pear Creek, Segment MT41I006_050.

Parameter	Result	Comparable to Reference
Width/depth ratio	18.4	Yes
BEHI	25.4	No
D_{50}	Coarse gravels	No
PFC	NF	No

McNeil Cores

McNeil core data are available for one site on this section of Prickly Pear Creek, which corresponds with the channel survey site. Six cores were collected in 2003. The riparian aggregate here was determined to be 29 (Alluvial Floodplains and Terraces) (Table 3-16). The average percentage of fines less than 6.4 mm was 30.2 percent, with average fine fines (less than 0.85 mm) at 10.2 percent. The percentage of fines less than 6.4 mm for this site is actually lower than the mean from reference cores for this riparian aggregate. But, the percentage of fines less than 0.85 mm is about 26 percent greater than the reference value average.

Table 3-16. Summary of McNeil core data for Prickly Pear Creek, Segment MT41I006_050.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
29	2003	30.2	10.2	Fine fines value is elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Data were available for two sites along this segment of Prickly Pear Creek, with nine samples taken from 2000 to 2001. The highest value recorded was 33 mg/L in May 2001 at the sampling site at the Alhambra RV Park (below Warm Springs Creek) (Table 3-17). The suspended sediment data had an average of 7.9 mg/L with a median of 6.0 mg/L. All these values are comparable to suspended sediment values from selected reference streams.

Table 3-17. Statistical summary of suspended sediment data for Prickly Pear Creek,Segment MT41I006_050.

Mean	7.9 mg/L
Median	6.0 mg/L
Standard deviation	9.8 mg/L
Maximum	33.0 mg/L
Number of samples	9
Number of sample sites	2

In 2003, six visual observations of turbidity were recorded at three sites along this segment of Prickly Pear Creek. All observations reported the water clarity as clear, yet the observations were made during the recessional limb of peak flow or during base flow conditions.

Macroinvertebrates

Biological data were available for one sample taken in June 2001 near Clancy. The habitat rating for this site was "suboptimal" because of sediment deposition, substrate embeddedness, lack of bank stabilizing riparian vegetation, and stream channelization. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2002a). The metric score of 67 percent indicated slight impairment and partial support of aquatic life uses. Sixteen clinger taxa and nine trichoptera taxa were found at the site, but 9 percent of the organisms sampled prefer fine sediment habitats. Although these finding appear to be contradictory, Bollman explains this difference by noting slack as well as swift moving waters were probably sampled.

Periphyton

No recent data were available at the time of this review.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database. Prickly Pear Creek is managed as a trout fishery. While no species of special concern are thought to live in this segment of Prickly Pear Creek, many other fish, such as brown trout, rainbow trout, longnose sucker, and mottled sculpin, are thought to be abundant. The overall habitat and sport fishery rating for this section of the creek is "substantial," which is the next rating below "best."

Metals Concentrations

The project team evaluated a total of 11 in-stream water chemistry samples taken between June 2000 and August 2003. Arsenic concentrations in all samples were below the human health and aquatic life criteria. Although the average arsenic concentration of all samples was 64 percent lower than the human health criterion, the highest measured concentration was 80 percent of the criterion. This is a borderline value. This evidence suggests that the segment meets the human health and aquatic life water quality standards and target values for arsenic, but it should be closely monitored in the future to confirm this statement.

Cadmium concentrations in 18 samples, or the equivalent of 78 percent of samples, exceeded the chronic aquatic life criterion. The average concentration for all samples was 46 percent higher than the chronic aquatic life criterion, and the highest measured concentration was 2.5 times the chronic aquatic life criterion for cadmium. No samples exceeded the human health criterion. This evidence shows that this segment does not meet the aquatic life standards and target value for cadmium.

Copper concentrations in all samples were below the human health and aquatic life criteria. Although, the average copper concentration for all samples was 69 percent lower than the chronic aquatic life criterion, the highest measured concentration was 82 percent of the criterion. This is a borderline value. Overall, this evidence suggests that the segment is not impaired by copper, but it should be closely monitored in the future.

Lead concentrations in five samples, or the equivalent of 22 percent of samples, exceeded the chronic aquatic life criterion. The highest measured lead concentration was 5.9 times the chronic aquatic life criterion. The average of all samples was just five percent lower than the chronic aquatic life criterion. One sample exceeded the human health criterion; the concentration of this sample was 27 percent higher than the human health criterion. This evidence shows that this segment does not meet the aquatic life and human health target values for lead.

Zinc concentrations in 12 samples, or the equivalent of 52 percent of the samples, exceeded the acute and chronic aquatic life criteria for zinc. The average concentration for all samples was four percent higher than the chronic and acute aquatic life criteria for zinc. The highest measured concentration was two times the acute and chronic aquatic life criteria. No samples exceeded the human health criterion for zinc. This evidence shows that this segment does not meet the aquatic life standards and target values for zinc.

Prickly Pear Creek Segment MT41I006_050 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width/depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediment concentrations, macroinvertebrates, fisheries, and water chemistry (metals).

The supplemental indicator values for suspended sediment and macroinvertebrates were met or exceeded. The only channel metric meeting the standards was the width-to-depth ratio. A smaller than expected size-class for median particle size might mean that deposition of surface fines is occurring. The BEHI value was elevated indicating that stream banks might be a potential source of sediment, while a Proper Functioning Condition rating of NF suggested that the channel is unable to sustain expected hydrologic, riparian vegetation, and sediment transport capacities. Recent fisheries data suggest that this segment of the stream provides valuable habitat for many fish species. Yet, values for the percentage of fines less than 0.85 mm from McNeil cores were elevated against the target values.

Results from the 2003 preliminary source assessment revealed that there were active sediment sources affecting this stream segment, and that impairments to channel condition were present for most of the length of this segment. Targets and supplemental indicator values such as D_{50}, Proper Functioning Condition rating, and percentage of subsurface fines less than 0.85 mm were not being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Prickly Pear Creek Segment MT41I006_050 are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

The available evidence also suggests that Prickly Pear Creek from Spring Creek to Lump Gulch is impaired by cadmium, lead, and zinc. TMDLs will therefore be developed to address the cadmium, lead, and zinc impairments.

3.4.1.3 Prickly Pear Creek from Lump Gulch to Wylie Drive (MT41I006_040)

In 1996, the aquatic life, cold-water fishery, and agricultural water uses in this 11-mile segment of Prickly Pear Creek were listed as partially supported because of habitat alterations, flow alterations, and metals. The basis for the listings was four reports dating back to the 1980s that summarized undesirable channel conditions, such as stream channelization and substrate embeddedness, and a total of 11 in-stream water chemistry samples taken between June 1999 and August 2003. In subsequent years, the segment has been listed as not supporting aquatic life, cold-water fishery, and drinking water uses, and partially supporting agricultural uses, because of siltation, habitat alterations, fish habitat degradation, and metals. Although this segment of Prickly Pear Creek is not listed for thermal modifications, data collected from a continuous recording thermograph in 2003 indicate the probability of thermal modifications. A typical view of this segment is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey of the creek below McClellan Creek confluence that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from the reach surveyed in 2003, suspended sediment data, macroinvertebrate and periphyton data, fish population data, and water chemistry data.

Prickly Pear Creek from Lump Gulch to Wylie Drive

Pollution Sources

The 2003 preliminary source assessment identified roads as the primary sediment sources for this section of Prickly Pear Creek. Most of the source assessment inventory sites consisted of road-related sources, such as road sediment delivery points. The aerial photography inventory showed 17 road crossings. Nearly 57 percent of the stream segment is channelized by I-15, the railroad, secondary roads, ASARCO, and the City of East Helena.

The primary geology of this sub-watershed is the Boulder Batholith, with Tertiary sediments prominent in the valley bottom. Deposition of sand and fine gravels was observed in the stream channel at many sites. The aerial photography inventory showed that gravel bars were visible in the stream in the section between Montana City and East Helena. The widths of deciduous riparian buffers ranged from 0 to 400 feet and were correlated to distance from roads. This segment is surrounded by private land, and the dominant adjacent land use consists of a transportation corridor.

The upper of portion of this segment of Prickly Pear Creek has been placer mined. The stream is incised, overly widened, and straightened as a result of historical mining and the position of roadways. Between Montana City and ASARCO, riparian vegetation is dense, yet the channel remains constricted between the highway and the railroad. Just before reaching the ASARCO facility, the stream is diverted by two canals into a wetland holding pond for the facility before passing through a small dam. The dam is likely a barrier to some fish species, and probably contributes to an overall decrease in stream gradient and an increase in channel embeddedness. The stream is channelized in a series of dikes through the town of East Helena. Just before the Wylie Drive road crossing, channel alterations for the Helena Valley irrigation canal and possibly for flood control are visible.

In summary, road runoff and road placement are probably the biggest contributors of sediment to this segment of Prickly Pear Creek. Tributary streams such as Lump Gulch are also likely sediment sources. The dam at ASARCO might be impeding sediment transport. Severe channel alterations from placer mining, ASARCO, the City of East Helena, the Helena Valley irrigation canal, and the transportation corridor have altered the channel's form.

Expected relevant sources of metals in the stream segment are upstream sources, tributary streams, and historical mining activities in the immediate drainage area. The segment's upstream reach (Prickly Pear Creek 050) and the tributary Lump Gulch are likely to contribute metals. The immediate drainage area falls within the Alhambra, Clancy, and Montana City mining districts. The MBMG Abandoned and Inactive Mines database reports mineral location, placer, processing plant, prospect, surface, surface-underground, and other, unknown mining activities in the immediate drainage area of the stream segment. The historical mining types include lode, mill, placer, quarry, and smelter. In the past these mines produced gold, silver, copper, and lead. None of the mines in the immediate drainage area of this segment are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites. Recent or currently operating processing plants that might have an impact on metals loads to the stream include the ASARCO East Helena Lead Smelter and Kaiser Cement.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation along this section of Prickly Pear Creek, just below the confluence with McClellan Creek. This site was selected as a reference reach for the mainstem of Prickly Pear Creek because it is in better condition than other segments of the stream. However, it is far from pristine. The stream's entrenchment ratio and sinuosity were out of balance with the valley type setting, reflecting channel confinement and straightening.

Without channel modifications, the stream reach probably would be a Rosgen stream type C4. The width-to-depth ratio was 30.5, 44 percent greater than the average for southwestern Montana and Greater Yellowstone Area C-type reference streams (Table 3-18). The "moderate" BEHI score was very close to the averages for southwestern Montana C-type reference streams. D_{50} as determined in a zigzag Wolman pebble count consisted of very coarse gravels. This particle size is within the range expected for reference C4 stream types based on data collected for the Greater Yellowstone Area.

The channel survey included an assessment of Proper Functioning Condition. The field crew rated this site as "Functional – at risk" (FAR), noting vigorous riparian vegetation. However, pool development was not well defined. The riparian land type aggregate assigned to this site is 29, defined as Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fine are common but generally not excessive.

Table 3-18. Summary of cross-sectional data for Prickly Pear Creek, Segment MT41I006_040.

Parameter	Result	Comparable to Reference
Width/depth ratio	30.5	No
BEHI	21.7	Yes
D_{50}	Very coarse gravels	Yes
PFC	FAR	NA (trend unknown)

McNeil Cores

McNeil core data is available for one site on this section of Prickly Pear Creek, which corresponds with the channel survey site. Six cores were collected in 2003. The riparian aggregate here was determined to be 29 (Alluvial Floodplains and Terraces) (Table 3-19). The average percentage of fines less than 6.4 mm was 28.3 percent, with average fine fines (< 0.85 mm) at 9.3 percent. The percentage of fines less than 6.4 mm for this site is actually lower than the mean from reference cores for this riparian aggregate. However, the percentage of fines less than 0.85 mm was 15 percent greater than the reference value average.

Table 3-19. Summary of McNeil core data for Prickly Pear Creek, Segment MT41I006_040.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
29	2003	28.3	9.3	Fine fines value is elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Data were available for one site along this segment of Prickly Pear Creek, with 21 samples taken from 1999 to 2002. The highest recorded value was 104 mg/L in April 2001 near Clancy (Table 3-20). The suspended sediment data showed an average of 26.6 mg/L with a median of 11.0 mg/L. These values are about 50 percent greater than the average suspended sediment values from selected reference streams.

In June 2001, one visual observation of turbidity reported the water clarity as clear along this segment of Prickly Pear Creek at Clancy. In 2003, three turbidity observations were recorded along this segment of Prickly Pear Creek at East Helena. One observation reported the water clarity as clear, and two reported the water clarity as slightly turbid. The observations of slight turbidity were made in August and might have been associated with algal growth.

Table 3-20. Statistical summary of suspended sediment data for Prickly Pear Creek, Segment MT41I006_040.

Mean	26.6 mg/L
Median	11.0 mg/L
Standard deviation	32.5 mg/L
Maximum	104 mg/L
Number of samples	21
Number of sample sites	1

Macroinvertebrates

Macroinvertebrate data were available from one sample taken in August 2003 above East Helena. The macroinvertebrate habitat rating for this site was "suboptimal" because bank alterations and an inadequate riparian zone. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman 2003a). The metric score of 56 percent indicated slight impairment and partial support of aquatic life uses. Sixteen clinger taxa and six trichoptera taxa were found at the site, and Bollman concluded that "fine sediment did not limit access to stony substrate habitats" (Bollman, 2003a).

Periphyton

Periphyton data from one sample taken in August 2003 above East Helena were available. Sampling results were compared with reference biocriteria metrics established for the Rocky Mountain Ecoregions of Montana (Bahls, 2004). Diatom metrics indicated moderate impairment and partial support of aquatic life uses. Bahls concluded that the impairment was primarily due to organic loading and secondarily due to sedimentation. The diatom siltation index was close to exceeding the threshold for minor impairment.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database. Prickly Pear Creek is managed as a trout fishery. No species of special concern are thought to live in this segment of Prickly Pear Creek. Brown and rainbow trout and mottled sculpin are thought to be abundant in the upper half of this segment, while longnose and white suckers are though to be abundant in the lower half of this segment. The overall habitat and sport fishery rating for the upper section of this segment is "substantial," while the lower portion of this segment is rated "moderate."

Metals Concentrations

The project team evaluated a total of 11 in-stream water chemistry samples taken between June 1999 and August 2003. Arsenic concentrations in seven of the 11 samples exceeded the human health criterion. The average concentration in all samples was 14.5 percent higher than the human health criterion. The highest measured arsenic concentration was three times the human health criterion. No samples exceeded aquatic life criteria for arsenic. This evidence shows that this segment does not meet the human health standard and target value for arsenic.

Cadmium concentrations in five samples, or the equivalent of 25 percent of all samples, exceeded the chronic aquatic life criterion. The average cadmium concentration of all samples was 35 percent higher than the chronic aquatic life criterion. The highest measured concentration was 4.6 times the chronic aquatic life criterion. No exceedances of the human health criterion for cadmium were observed. This evidence shows that this segment does not meet the aquatic life water quality standard and target threshold for cadmium.

Copper concentrations in four samples, or the equivalent of 20 percent of all samples, exceeded the chronic aquatic life criterion. Of those, the concentrations in three samples also exceeded the acute aquatic life criterion. The highest measured concentration of copper was 2.3 times the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence shows that this segment does not meet the aquatic life standard and target threshold for copper.

Lead concentrations in 14 samples, or 70 percent, exceeded the chronic aquatic life criterion. Of those, the concentrations in four samples also exceeded the human health criterion. The highest measured concentration was 18.7 times the chronic aquatic life criterion, and 3.60 times the human health criterion. The average of all samples was 312 percent higher than the chronic aquatic life level. This evidence shows that this segment does not meet the human health standard and aquatic life target value for lead.

Zinc concentrations in six samples, or the equivalent of 30 percent of all samples, exceeded the acute and chronic aquatic life criteria. The highest measured concentration was 1.9 times the acute and chronic aquatic life criteria. No samples exceeded the human health criterion for zinc. This evidence shows that this segment does not meet the aquatic life water quality standards and target value for lead.

Thermal Modifications

In the summer of 2003 a thermograph was deployed in this segment of Prickly Pear Creek, at the sampling site above East Helena (M09PKPRC04). Maximum daily recorded temperatures were greater than or equal to 80 ºF from July 18 to July 22, and the water temperature exceeded 67 ºF every day from July 4 to September 4, 2003 (Figure 3-6).

Table 3-21. Statistical summary of continuous logging water temperature data from July 4 to September 4, 2004 for Prickly Pear Creek, MT41I006_040.

Mean	67.9° F
Median	67.5° F
Standard deviation	4.8° F
Maximum	80.6° F
Number of samples	3024

This segment of Prickly Pear Creek is classified as B-1, and is expected to support a cold-water fishery. 67 ºF is often used as a survival threshold for salmonids. Data from the thermograph deployed in 2003 reveal that average temperature remained above 67 ºF from July 4 to September 4 in 2003.

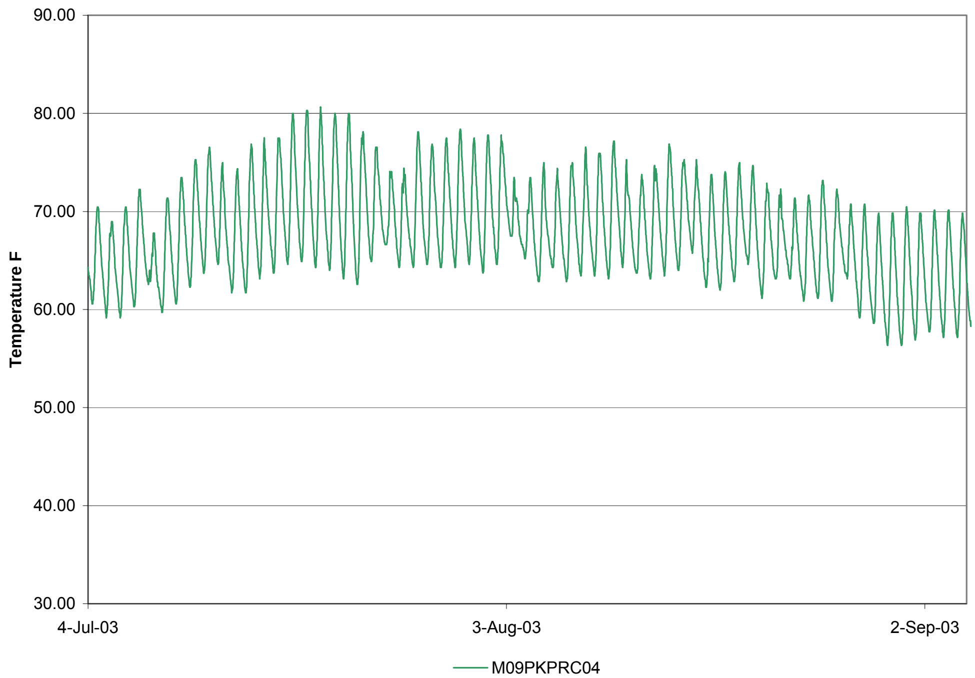

Figure 3-6. Continuous logging water temperature data from July 4 to September 4, 2003 for Prickly Pear Creek, MT41I006_040.

Prickly Pear Creek Segment MT41I006_040 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediment, macroinvertebrates, periphyton, fisheries, and water chemistry (metals).

The supplemental indicator values for D_{50}, BEHI, and macroinvertebrates were met or exceeded. The only channel metric that did not meet standards was the width-to-depth ratio. The excessive width-to-depth ratio is probably a reflection of the channel alterations from historical placer mining and might not necessarily represent a widening of the stream course due to excessive sediment loads. However, a Proper Functioning Condition rating of FAR in part reflected that the stream did not appear to be able to transport adequate sediment loads. Suspended sediment values were higher than expected. Although diatom metrics for sedimentation were just below the threshold for minor impairment, Bahls concluded that sedimentation was a major limiting factor at the site. Recent fisheries data suggest that the upper segment of the stream provides valuable habitat for many fish species. Yet, values for the percentage of fines less than 0.85 mm from McNeil cores were elevated against the target values.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment, and that numerous impairments to channel condition occurred for most of the length of this segment. Targets and supplemental values such as width-to-depth ratio, Proper Functioning Condition rating, percentage of subsurface fines less than 0.85 mm, and suspended sediment were not being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Prickly Pear Creek Segment MT41I006_040 are impaired by suspended solids and siltation. A TMDL will therefore be developed to address the sediment impairment.

The available water chemistry data suggest that Prickly Pear Creek from Lump Gulch to the Montana Highway 433 crossing is impaired by arsenic, cadmium, copper, lead, and zinc. TMDLs will therefore be developed to address the arsenic, cadmium, copper, lead, and zinc impairments.

In-stream temperature data were available from a continuous logging thermograph deployed in this segment of Prickly Pear Creek. The weight-of-evidence suggests that Prickly Pear Creek from Lump Gulch to Wylie Drive is impaired by thermal modifications. The temperature target was thought to be exceeded when the thermograph recorded mean temperatures above 67 ºF for the time period of July 4 to September 4, 2003. Following the collection of additional data and further analysis, a TMDL will be developed to address the temperature impairment.

3.4.1.4 Prickly Pear Creek from Wylie Drive to Helena Wastewater Treatment Plant Discharge (MT41I006_030)

Stream segment MT41I006_030 was listed on Montana's 1996 303(d) list as not supporting aquatic life, cold-water fisheries, drinking water, swimming, and agricultural water uses because of siltation, suspended solids, habitat alterations, flow alterations, and metals. This segment is approximately 5 miles in length. In subsequent years, aquatic life, cold-water fisheries, and drinking water have been listed as not supported, while swimming and agricultural water uses have been listed as partially supported, because of thermal modifications, fish habitat degradation, riparian degradation, and nutrients, in addition to the causes of impairment listed in 1996. A typical view of this segment is shown in the photo below.

Prickly Pear Creek from Wylie Drive to Helena Wastewater Treatment Plant Discharge

The basis for the listings are five reports dating back to the 1980s that summarize undesirable channel conditions, such as stream channelization, channel braiding, substrate embeddedness, and removal of riparian vegetation. The supporting data also include the results of in-stream water chemistry sampling conducted between July 2003 and September 2004. A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), two cross-sectional surveys of the creek below Wylie Drive and below Canyon Ferry Road, McNeil core subsurface fines from the reach below Wylie Drive, suspended sediment data, macroinvertebrate and periphyton data, fish population data, synoptic temperature data, SSTEMP stream temperature modeling, and water chemistry data for nutrients, ammonia, dissolved oxygen, and metals. Both cross-sectional surveys included Proper Functioning Condition assessments and Wolman pebble counts.

<u>Pollution Sources</u>

The 2003 preliminary source assessment identified riparian grazing, bare stream banks, and roads as the primary sediment sources for this segment of Prickly Pear Creek. Most of the source assessment inventory sites showed grazing-related sources, such as bank trampling and vegetation removal. The aerial photography inventory showed five road crossings. About 30 percent of the stream segment is channelized for irrigation canals and a gravel mining operation.

The primary geology of this sub-watershed is the Boulder Batholith, with Tertiary and Quaternary sediments prominent in the Helena Valley. The aerial photography inventory showed that gravel bars were visible in the stream near the gravel mining operation. The widths of deciduous riparian buffers ranged from 0 to 230 feet and were correlated to land management practices. This segment is surrounded by private land, and the dominant land use consists of irrigated hay fields and pasture.

In summer 2003, a major irrigation diversion just below the City of East Helena removed most of the water flow from the creek. Another diversion between Wylie Drive and Canyon Ferry Road left the stream dry at Canyon Ferry Road for most of the summer. The irrigation diversions probably affect the flow regime and sediment transport capacity of this segment of Prickly Pear Creek. Most of the major impacts on the channel occur before the Canyon Ferry Road crossing.

In summary, sediment sources generated by localized sources (grazing, eroding stream banks) and road runoff are probably the biggest contributors of sediment to this segment of Prickly Pear Creek. Irrigation diversions severely deplete the flow of this section of Prickly Pear Creek, and probably inhibit transport of sediment. Channel alterations for irrigation networks and a gravel mining operation have altered channel form.

There is a variety of anthropogenic sources of nutrients in this watershed that affect this stream segment. During a July 17, 2003, field visit, the stream smelled very organic above Stansfield Lake. According to the 2003 preliminary source assessment, agricultural nonpoint sources probably contribute nutrients. Diffuse sources of sediment and nutrients from grazing, subdivisions, and rural housing might also affect the stream. Agricultural water diversions severely deplete stream flows in the summer, thereby concentrating nutrients and/or exacerbating their effects. The primary land uses adjacent to the stream are agricultural, including hay fields and pasture. In 2003, irrigation withdrawals left a dry streambed at Canyon Ferry Road from early July through September. Also noted in Prickly Pear Creek from Wylie Drive to the Helena wastewater treatment plant outfall were poor riparian conditions, grazing impacts, and a metallic sheen on the water surface. In summer 2003, the stream was documented as having a flow of less than 0.5 cubic feet per second (cfs) downstream from a major irrigation diversion point.

The segment's upstream reaches (Prickly Pear Creek 040) are likely contributors of metals. In addition, Kendy et al. identified the following potential arsenic sources in the Lake Helena Valley: irrigation water from the Missouri River, aerially deposited particulate emissions from smelter operations, naturally occurring arsenic minerals, arsenic sorbed or coprecipitated to iron oxyhydroxide coatings, and waterborne contaminants from historical mining and industrial activities.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted two field investigations along this section of Prickly Pear Creek, just below Wylie Drive and below Canyon Ferry Road. At both sites, the stream's sinuosity was out of balance with the valley type setting, reflecting straightening of the channel. The entrenchment ratio at Wylie Drive displayed channel confinement, while the entrenchment ratio below Canyon Ferry Road was typical of a C-type stream (unconfined). Without channel modifications, both reaches would probably be Rosgen stream type C4.

At the site below Wylie Drive, the width-to-depth ratio was 30.4, or 43 percent greater than the average for southwestern Montana and Greater Yellowstone Area reference stream C-type streams (Table 3-22). The BEHI rating was low, and actually more stable than the averages for southwestern Montana C-type reference streams. D_{50} as determined in a zigzag Wolman pebble count consisted of very coarse gravels. This particle size is within the range expected for reference C4 stream types, based on data collected for southwestern Montana and the Greater Yellowstone Area. Part of the channel survey included an assessment of PFC. Tetra Tech/Land & Water rated the reach below Wylie Drive as "Non-functional"

(NF). The field crew noted that the stream was under-sized for the available channel, had a limited riparian zone, and displayed excess sediment deposition.

At the site below Canyon Ferry Road, the width-to-depth ratio was 47.2, over two times greater than the average for southwestern Montana and Greater Yellowstone Area reference stream C-type streams. The BEHI rating was "moderate." The BEHI score was slightly above the average (less stable) for southwestern Montana and Greater Yellowstone Area reference stream C-type streams, but within 10 percent of the reference value. D_{50} as determined in a zigzag Wolman pebble count consisted of coarse gravels. This particle size is one size-class smaller than the range expected for reference C4 stream types, based on data collected for the Greater Yellowstone Area. Part of the channel survey included a Proper Functioning Condition assessment. The field crew rated the reach below Canyon Ferry Road as "Non-functional" (NF). The main reason for the rating was lack of flow, followed by the lack of diverse riparian vegetation. At the time of the survey, succulent vegetation was growing in the channel.

The riparian land type aggregate assigned to both survey sites is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive.

Table 3-22. Summary of cross-sectional data for Prickly Pear Creek, Segment MT41I006_030.

Site	Parameter	Result	Comparable to Reference
Below Wylie Drive	Width/depth ratio	30.4	No
Below Wylie Drive	BEHI	18	Yes
Below Wylie Drive	D_{50}	Very coarse gravels	Yes
Below Wylie Drive	PFC	NF	No
Below Canyon Ferry Road	Width/depth ratio	47.2	No
Below Canyon Ferry Road	BEHI	22.3	Yes
Below Canyon Ferry Road	D_{50}	Coarse gravels	No
Below Canyon Ferry Road	PFC	NF	No

<u>**McNeil Cores**</u>

McNeil core data are available for one site on this segment of Prickly Pear Creek, which corresponds to the channel survey site below Wylie Drive. Six cores were collected in 2003. The riparian aggregate here was determined to be 29, Alluvial Floodplains and Terraces (Table 3-23). The average percentage of fines less than 6.4 mm was 25.3percent, with average fine fines (less than 0.85 mm) at 6.1percent. The percentages of fines for both categories of fines are actually lower than the mean from reference cores for this riparian aggregate. The percentages of fines for both categories are about 25 percent less than the reference value averages.

Table 3-23. Summary of McNeil core data for Prickly Pear Creek, Segment MT41I006_030.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
29	2003	25.3	6.1	Yes

Suspended Sediment Concentrations

Few recent data were available for this segment of Prickly Pear Creek. In the summers of 2003 and 2004, six total suspended solids samples were collected at two sites. The highest value collected was 5.7 mg/L in August 2003 above Stansfield Lake. No values were greater than what would be expected based on values from selected reference streams for suspended solids. However, most of the samples were collected during the receding limb of the hydrograph and during low flows.

In 2003 and 2004, eight visual observations of turbidity were recorded at two sites along this segment of Prickly Pear Creek. Seven observations of turbidity reported the water clarity as clear, and one reported the water clarity as slightly turbid below Wylie Drive. The observation of slight turbidity was reported in August 2003, and might have been influenced by algal growth and livestock in the stream upstream of the sampling site.

Macroinvertebrates

Macroinvertebrate data were available from two sampling events in August 2003. The first sampling site below Wylie Drive had a macroinvertebrate habitat rating of "suboptimal" because of marginal flow status and disruption of bank vegetation. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2003a). The metric score of 28 percent indicated moderate impairment and partial support of aquatic life uses. Eight clinger taxa and four trichoptera taxa were found at the site, and Bollman concluded that fine sediment might be limiting habitat for macroinvertebrates.

The second sampling site above Stansfield Lake had a habitat rating of "suboptimal" because of marginal flow status and a limited riparian zone. The metric score of 39 percent indicated moderate impairment and partial support of aquatic life uses. Eleven clinger taxa and four trichoptera taxa were found at the site, and once again Bollman concluded that fine sediment might be limiting habitat for macroinvertebrates.

Species composition at both sites suggested water quality was impaired by nutrient enrichment. The elevated biotic index at the Stansfield station could be associated with nutrient enrichment. The functional composition assemblage expected by filter feeders was dominant, suggesting nutrient enrichment (Bollman, 2003a). The HBI (4.99–6.00) from the two stations on this segment indicated some organic to fairly high significant organic pollution in this stream segment (Appendix D).

Periphyton

Periphyton data were also available from the two sampling events in August 2003. Sampling sites corresponded to the sites sampled for aquatic insects. Sampling results were compared with reference biocriteria metrics established for the Rocky Mountain Ecoregions of Montana (Bahls, 2004). At the sampling site below Wylie Drive, diatom metrics indicated minor impairment but full support of aquatic life uses. Bahls concluded that the impairment was primarily due to organic loading. The siltation index was below the threshold for minor impairment. A review of the sample processing notes indicated that little sediment was evident in the sample.

At the sampling site below Wylie Drive, diatom metrics indicated minor impairment and full support of aquatic life uses. Bahls concluded that the impairment was primarily due to organic loading. The siltation index was below the threshold for minor impairment. A review of the sample processing notes indicated that little sediment was evident in this sample as well.

Genera of green algae that were quite tolerant to organic pollution were common to abundant at this location when sampled in 2003. *Gomphonema parvulum* and *Gomphonema clavatum* were among the most abundant species. The latter species is somewhat tolerant of organic pollution. Most of the diatoms indicated eutrophic conditions. Macrophytes were present at the station above Stansfield Lake (M09PRPRC01). Other green algae were abundant here and indicated some organic enrichment. A diatom that is somewhat tolerant of organic pollution was the second most abundant species, and another pollution-tolerant diatom was the next most abundant (Bahls, 2004).

Several filamentous algal blooms were documented during the field visits, and on July 17, 2003, and August 28, 2003, an estimated 60 percent of the stream bottom was covered with algae. Diatom algae were also present in large proportions. Heavy growths of filamentous algae were noted in Prickly Pear Creek below East Helena during a 24-hour dissolved oxygen survey in August 2003. Abundant macrophytes and filamentous green algae growth were present at the Prickly Pear Creek station above Stansfield Lake (M09PRPRC01) just above the City of Helena wastewater outfall in August 2003.

During July and August 2003, three of four benthic algae values collected from Prickly Pear Creek above Stansfield Lake showed very high levels and were above the 37 mg/m^2 supplemental indicator value. Field forms completed during summer 2004 monitoring indicated that microalgae were observed in heavy concentrations (60 percent substrate coverage) at the station above Stansfield Lake. At the station below East Helena, microalgae and macroalgae showed 80 percent substrate coverage. Benthic algae values were very high from these two stations (51–81 mg/m^2) and well above the 37-mg/m^2 supplemental indicator value.

Fish Populations

The project team examined data from the Montana Fish, Wildlife and Parks MFISH database. Prickly Pear Creek is managed as a trout fishery. No species of special concern are thought to live in this segment of Prickly Pear Creek. Brown trout and mottled sculpin are reported to be common to abundant in this segment, and longnose sucker, white sucker, and rainbow trout are all year-round residents. Rainbow trout are rare to abundant in this lower stream segment of Prickly Pear Creek.

The overall habitat and sport fishery rating for the upper section of this segment is “moderate.” Montana Fish, Wildlife and Parks lists this entire segment as a chronic dewatering stream of concern. This designation applies to “streams that support important or contribute to important fisheries that are significantly dewatered by man-caused flow depletions,” and where “dewatering is a significant problem in virtually all years” (MFISH).

Nutrient and Dissolved Oxygen Data

Field measurements taken at the Prickly Pear Creek station below East Helena (M09PKPRC05) in July and August 2003 showed low dissolved oxygen concentrations. At the station above Stansfield Lake (M09PKPRC01), temperature, pH, and turbidity values were normal, dissolved oxygen was in the high range (10.1–13.8 mg/L), and flows were low in July and August 2003. Prickly Pear Creek was dry at the station at Canyon Ferry Road (M09PKPRC03) in July and August 2003.

Field measurements taken at the station below East Helena in late August 2004 showed a dissolved oxygen reading of 8.2 mg/L and a pH of 8.1 at a higher than average stream flow of 22.1 cfs. Stream flows were influenced by heavy rains in the valley the previous week. Flows were elevated above those taken in July and August 2003. Flow levels were approximately 8.2 cfs on August 27, 2004.

No nutrient data were available for the post-1996 period prior to the 2003 sampling events. In 2003, 50 percent of the samples collected (2 of 4) exceeded the total nitrogen target value of 0.34 mg/L at two stations, and 25 percent of the samples (1/4) exceeded the 0.027 mg/L total phosphorus target value. Nitrate + nitrite values in July and August 2003 were above the proposed supplemental indicator level of 0.04 mg/L at the station above Stansfield Lake.

In 2004, two of two samples exceeded the total phosphorus target value of 0.027 mg/L at the two stations in this segment. One sample taken at the station above Stansfield Lake had a soluble reactive phosphorus value above the supplemental indicator level of 0.011 mg/L. Two of two nitrate + nitrite-N values were above the proposed supplemental indicator level of 0.04 mg/L at each of the two stations.

In this stream segment, two 24-hour dissolved oxygen surveys were conducted in August 2003 at two stations (M09PKPRC01 and M09PKPRC05) (Appendix D). During the 24-hour dissolved oxygen survey at Prickly Pear Creek above Stansfield Lake in August 2003, dissolved oxygen fluctuated from a low of 4.6 mg/L at a night to a high of 9.1 mg/L during the mid-afternoon, indicating an abundance of primary productivity and a reduction of dissolved oxygen as a result of plant respiration (Appendix D).

Metals Concentrations

A total of four water samples for metals analysis were taken from this segment between July 2003 and August 2003. Arsenic concentrations in all samples exceeded the human health criterion. The average concentration in all samples was 145 percent higher than the human health criterion. The highest measured concentration was three times the human health criterion. No samples exceeded the aquatic life criteria for arsenic. This evidence shows that this segment does not meet the human health water quality criterion for arsenic.

Lead concentrations in all samples exceeded the chronic aquatic life criterion. The average concentration of all samples was 23 percent higher than the chronic aquatic life criterion. The highest measured concentration was 1.37 times the chronic aquatic life criterion. No samples exceeded the human health criterion for lead. This evidence shows that this segment does not meet the aquatic life chronic toxicity criterion for lead.

All samples were well below the human health and aquatic life (acute and chronic) criteria for cadmium, copper, and zinc. The limited evidence suggests that this segment meets the human health and aquatic life water quality standards for cadmium, lead, and zinc. Because of the limited data, this segment should be closely monitored in the future to confirm this statement.

Thermal Modifications

Limited temperature data were available for this segment of Prickly Pear Creek. During the summers of 2003 and 2004 eight temperature observations were recorded at two stations during synoptic sampling events (Table 3-24). The maximum temperature of 75.6° F was recorded on August 12, 2003, just before 5 p.m. at the sampling site below Wylie Drive (M09PKPRC05). Very low flows were observed in this segment of Prickly Pear Creek during summer 2003. As mentioned earlier, the stream went dry for about one-half mile of this segment near Canyon Ferry Road during the summer irrigation seasons of 2003 and 2004. All the temperatures recorded in 2003 and 2004 at the site above Stansfield Lake (M09PKPRC01, near the end of the segment) were below 70° F, and reflected the stabilizing influence of groundwater discharge on the stream's temperature.

Table 3-24. Statistical summary of synoptic water temperature data for Prickly Pear Creek, MT41I006_030.

Mean	64.9° F
Median	65.0° F
Standard deviation	7.7° F
Maximum	75.6° F
Number of samples	8
Number of sample sites	2

No suitable reference streams were identified for this segment of Prickly Pear Creek because of the stream's I classification. To assess "naturally occurring temperatures" in this segment of Prickly Pear Creek so that the temperature criteria could be more directly applied, SSTEMP modeling was conducted (Bartholow, 2002).

SSTEMP is a simplified, steady-state model capable of predicting the change in temperature along a stream reach. The model simulates the various natural heat flux processes found in a stream such as convection, conduction, and long- and short-wave radiation. Some of the various user inputs to the model are shown below.

- Hydrology: segment inflow, segment outflow, inflow temperature
- Channel geometry: segment length, upstream and downstream elevation, wetted width and depth, Manning's "n"
- Meteorology: segment latitude, average daily air temperature, relative humidity, wind speed, ground temperature, thermal gradient, possible sun (percentage), percentage of shade, time of the year

The model predicts mean, minimum, and maximum temperatures at a specified reach outflow under steady-state conditions. It also assumes that conditions along the reach such as air temperature, shade, and channel shape do not change. See Appendix H for a detailed discussion of the modeling procedures, scenarios, and results.

SSTEMP was used to simulate current conditions in Prickly Pear Creek (under the assumption that the stream flowed for the entire length of the segment) and various restoration conditions (for example, augmented flows). The model was calibrated with flow and temperature data obtained on August 7, 2003, during a 24-hour survey (Figure 3-7). The 24-hour survey occurred during hot, low-flow conditions in which the most pronounced changes in temperature (critical conditions) were expected to occur. The calibration model for segment MT41I006_030 produced a mean temperature of 68.7 ^{o} F. This result is within 1 percent of the measured value of 69.4 ^{o} F (Appendix H, Table 6).

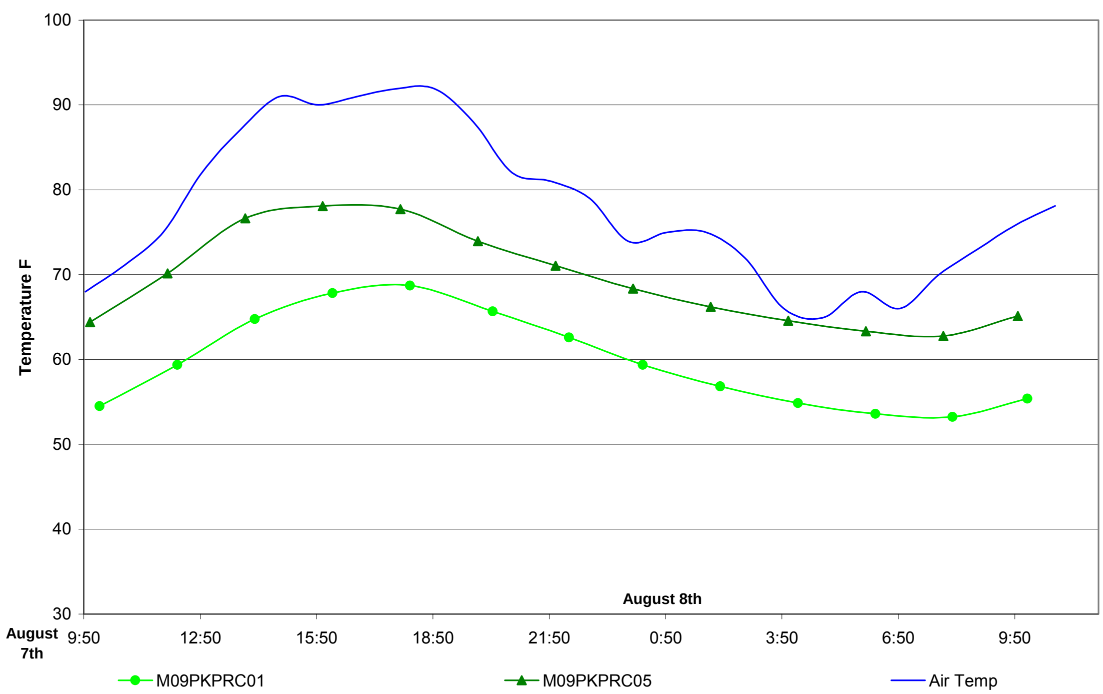

Figure 3-7. Diurnal water temperatures recorded on August 7–8, 2003 in Prickly Pear Creek, MT41I006_030

The model was then run for various flow conditions to predict water temperatures under various simulated scenarios. The model predicted a mean temperate of 64.3 °F under "natural conditions" which is 4.4 degrees less than the current mean temperature (Table 3-25). (The assumptions used for assessing "natural conditions" are described in Appendix H). This difference of 4.4° F is above the standard that allows for only a 1-degree increase in water temperature.

Table 3-25. Current water temperature conditions versus natural conditions for Prickly Pear Creek, MT41I006_030.

Segment	Current Temperature (Mean)	Calibration Model Uncertainty (Mean)	Natural Temperature (Mean)	Natural Model Uncertainty (Mean)	Difference from Natural Value (Best and Worst Case)
MT41I006_030	68.7 ° F	± 1.0 ° F	64.3 ° F	± 0.8 ° F	**+4.4** ° F (2.6 to 6.3)

Prickly Pear Creek Segment MT41I006_030 Water Quality Impairment Summary

The project reviewed data on potential pollution sources, channel metrics, (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediment, macroinvertebrates, periphyton, fisheries, stream temperatures, SSTEMP modeling, and water chemistry and dissolved oxygen.

The supplemental indicator values for D_{50} (median particle size) and BEHI were met or exceeded at the upstream sampling site. D_{50} at the downstream sampling site was smaller than expected, and might be a reflection of the effects of reduced bedload transport capacity due to artificially reduced flows. Only the channel metric of width-to-depth ratio did not meet standards at either site. The excessive width-to-depth ratios are probably a reflection of a widening of the stream course due to aggradation, and/or channel alterations for irrigation. A PFC rating of "Non-functional" (NF) at both sites reflected that the stream is unable to sustain expected hydrologic characteristics, riparian vegetation, and sediment transport capacities. Values for both classes of fines from McNeil cores were below the target values. Suspended sediment values were not adequate to make a determination. The results from the macroinvertebrates and diatom samples were contradictory. Recent fisheries data suggest that this segment of the stream provides limited habitat for few fish species.

The 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment, and that impairments to channel condition occurred for most of the length of this segment. Chronic dewatering of this segment presented a challenge for the interpretation of impairment status. However, supplemental indicator values such as width-to-depth ratio, D_{50}, Proper Functioning Condition rating, and macroinvertebrate indices were not being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Prickly Pear Creek Segment MT41I006_030 are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

The weight of evidence suggests that Prickly Pear Creek from Wylie Drive to the Helena wastewater treatment plant discharge is also impaired by nutrients. The available in-stream chemistry data indicate that total nitrogen, nitrate and nitrite, total phosphorus, and soluble reactive phosphorus concentrations exceed the proposed targets and supplemental indicator values. Periphyton density was also measured to be more than the proposed indicator value and large diurnal dissolved oxygen fluctuations were observed, indicating the presence of excessive algae. Furthermore, the macroinvertebrate data suggest that the aquatic community is stressed, partly due to nutrient enrichment. Potential nutrient sources include grazing, agricultural activities, and rural and subdivision developments. The loads from these sources are due to dewatering of the stream and the lack of healthy riparian vegetation. A TMDL will therefore be developed to address the nutrient impairment.

The available water chemistry data for metals suggest that Prickly Pear Creek from its crossing with Montana Highway 433 to the Helena wastewater treatment plant discharge ditch is also impaired by arsenic and lead. TMDLs will therefore be developed to address the arsenic and lead impairments.

Although limited in-stream temperature data were available, the weight of evidence suggests that Prickly Pear Creek from Wylie Drive to the Helena wastewater treatment plant discharge is impaired by thermal modifications. The temperature target was thought to be exceeded when the SSTEMP modeling analysis estimated mean water temperatures to be between 2 ºF and 4 ºF higher than natural. Results of the riparian assessments indicate that there are areas along this segment of Prickly Pear Creek with limited riparian zones. Neither of the two survey sites were rated as being in Proper Functioning Condition, in part because of the characteristics and/or lack of riparian vegetation. Again, recent fisheries data suggest that this segment of the stream provides limited habitat for few fish species. Pending the collection of additional data and further analysis, a TMDL will therefore be developed to address the temperature impairment.

3.4.1.5 Prickly Pear Creek from Helena WWTP Discharge Ditch to Lake Helena (MT41I006_020)

Stream segment MT41I006_020 was listed on Montana's 1996 303(d) list as not supporting aquatic life, cold-water fisheries, drinking water, swimming, and agricultural water uses because of siltation, suspended solids, habitat alterations, flow alterations, metals, nutrients, and un-ionized ammonia (the latter changed to total ammonia in 2002 following revisions of the Montana water quality standards). This segment is approximately 6 miles in length. In subsequent years, agricultural water uses were upgraded to full support, while thermal modifications, fish habitat degradation, and bank erosion were added to the suspected causes of impairment. A typical view of this segment is shown in the photo below.

The basis for the listings was three reports dating back to the late 1970s and early 1980s that summarized undesirable channel conditions, such as bank erosion, substrate embeddedness and removal of riparian vegetation. The supporting data also include the results of in-stream water chemistry and biological sampling conducted between July 2003 and September 2004.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey on the creek above Sierra Road that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from the reach surveyed in 2003, suspended sediment data, macroinvertebrate and periphyton data, fish population data, synoptic temperature data, SSTEMP stream temperature modeling, and water chemistry data for nutrients, ammonia, dissolved oxygen, and metals.

Prickly Pear Creek from Helena WWTP discharge ditch to Lake Helena

Pollution Sources

The 2003 preliminary source assessment identified localized and nonpoint agricultural sources, bare stream banks, and roads as the primary sediment sources for this segment of Prickly Pear Creek. Most of the source assessment inventory sites showed grazing-related sources, such as bank trampling and vegetation removal. The aerial photography inventory showed four road crossings. Major channelization of this segment was not apparent.

The primary geology of this sub-watershed is the Boulder Batholith, with Tertiary and Quaternary sediments prominent in the Helena Valley. The aerial photography inventory showed that failing stream banks were evident in areas with little to no riparian vegetation. At the mouth of the creek, deltaic sediment deposition was visible in Lake Helena. The widths of deciduous riparian buffers ranged from 0 to 215 feet and were correlated to land management practices. This segment is surrounded by private land, and the dominant land use consists of irrigated hay fields and pasture.

Upstream dewatering affects this reach of Prickly Pear Creek with groundwater discharge and irrigation return flow making a significant contribution to summer flow levels. Again, it is thought that the artificial dewatering of the channel affects the flow regime and sediment transport capacity of this segment of Prickly Pear Creek.

This stream segment is also affected by nutrients and metals. Irrigation return flows, grazing practices, a mixture of other agricultural nonpoint sources, upstream sources, and the Helena wastewater treatment plant contribute nutrients to this segment of Prickly Pear Creek. Diffuse sediment and nutrient sources from rural housing might also affect the stream. The Helena wastewater treatment plant outfall and groundwater discharges contribute to stream flow in this segment. Riparian condition and stream bank stability were poor in the reach just below the Helena wastewater treatment plant discharge. Poor grazing management practices were documented where excess nutrients, trampled banks, and a lack of riparian vegetation were observed. Before intercepting discharge from the wastewater treatment plant, groundwater recharge makes up the majority of flow in the stream.

The segment's upstream reaches (Prickly Pear Creek 030) are likely contributors of metals. In addition, Kendy et al. (1998) identified the following potential arsenic sources in the Lake Helena Valley: irrigation water from the Missouri River, aerially deposited particulate emissions from smelter operations, naturally occurring arsenic minerals, arsenic sorbed or coprecipitated to iron oxyhydroxide coatings, and waterborne contaminants from historical mining and industrial activities.

Channel Survey

In 2003, Tetra Tech and Land & Water Consulting conducted a field investigation along this section of Prickly Pear Creek, above Sierra Road. The stream's entrenchment ratio and sinuosity were out of balance with the valley type setting, reflecting channel confinement and straightening. Currently an F5, without channel modifications, the stream reach probably would be a Rosgen stream type C4. The width-to-depth ratio was 16.8, which is 21 percent less than the average for southwestern Montana and Greater Yellowstone Area C-type reference streams (Table 3-26). The BEHI rating was "high." The BEHI score was 84 percent higher (less stable) than the average for southwestern Montana and Greater Yellowstone Area C-type reference streams. D_{50} as determined in a zigzag Wolman pebble count consisted of very coarse sand. Although sands are the dominant substrate at this site, it is the professional opinion of the surveyors that the stream should naturally have gravels as the dominant substrate. Very coarse sand is four size-classes smaller than the range expected for C4-type reference streams, based on data collected for southwestern Montana and the Greater Yellowstone Area.

Part of the channel survey included an assessment of Proper Functioning Condition. Tetra Tech and Land & Water Consulting rated this site as "Non-functional" (NF), noting riprapped banks and lack of diverse or stabilizing riparian vegetation. The riparian land type aggregate assigned to this site is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive.

Table 3-26. Summary of cross-sectional data for Prickly Pear Creek, Segment MT41I006_020.

Parameter	Result	Comparable to Reference
Width/depth ratio	16.8	No
BEHI	37.3	No
D_{50}	Very coarse sands	No
PFC	NF	No

McNeil Cores

McNeil core data are available for one site on this segment of Prickly Pear Creek, which corresponds with the channel survey site. Six cores were collected in 2003. The riparian aggregate here was determined to be 29 (Alluvial Floodplains and Terraces) (Table 3-27). The average percentage of fines less than 6.4 mm was 42.3 percent, with average fine fines (less than 0.85mm) at 10.5 percent. These values are elevated by comparison with the means for fines from reference cores for riparian aggregate 29. The percentage of fines less than 6.4 mm for this site is about 25 percent greater than the reference value average, while the fine fines are 30 percent above the reference value average.

Table 3-27. Summary of McNeil core data for Prickly Pear Creek, Segment MT41I006_020.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
29	2003	42.3	10.5	Both fines values are elevated.

Suspended Sediment Concentrations

Few recent data were available for this segment of Prickly Pear Creek. In summer 2003 and summer and fall 2004, six total suspended solids samples were collected at one site. The highest value collected was 44 mg/L in July 2003 at Sierra Road. This value is about four times greater than what would be expected based on low-flow values from selected reference streams for total suspended solids.

In 2003 and 2004, seven turbidity observations were recorded along this segment of Prickly Pear Creek at one site. Two turbidity observations reported the water clarity as turbid, two reported the water clarity as slightly turbid, and three reported the water clarity as clear.

Macroinvertebrates

Macroinvertebrate data from one sample taken in August 2003 above Sierra Road were available. The habitat rating for this site was marginal due to lower than expected stream flows, lack of in-stream habitat, and a limited riparian zone. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2003a). The metric score of 33 percent indicated moderate impairment and partial support of aquatic life uses. Twelve clinger taxa and four trichoptera taxa were found at the site, and Bollman concluded that "fine sediment deposition may have limited benthic habitat availability" (2003a).

Sampling site M09PKPRC02 above the Tenmile Creek confluence was moderately impaired and partially supported uses according to the 2003 macroinvertebrate report (Bollman, 2003a). The insect assemblage suggested nutrient enrichment. Water quality continued to be degraded downstream above Tenmile Creek. Nutrient enrichment was evidenced by prolific filter feeders and an abundance of tolerant animals, including mayflies, and microcaddisflies which are commonly associated with filamentous algae. The HBI score (5.04) indicated some organic pollution (Bollman, 2003a).

Periphyton

Periphyton data were available from one sample taken in August 2003 at a location on Prickly Pear Creek above Tenmile Creek (Sierra Road). Sampling results were compared with reference biocriteria metrics established for the Rocky Mountain Ecoregions of Montana (Bahls, 2004). Diatom metrics indicated moderate impairment and partial support of aquatic life uses. Bahls concluded that the primary cause of impairment was sedimentation. The siltation index exceeded the threshold for moderate impairment. Sampling notes indicated that considerable sediment was present.

Field notes taken on August 28, 2003 indicated substrate coverage was approximately 100 percent, with very homogeneous brown diatom algae and a few filamentous green algae. The 2003 periphyton survey results indicated moderate impairment at Prickly Pear Creek above Tenmile Creek. The primary cause of impairment was identified as sedimentation and the secondary cause as excessive organic loading. This site was dominated by filamentous green algae and diatom species tolerant of nutrient enrichment. Diatoms were extremely numerous. The dominant diatom species here was *Nitzschia amphibia.* This is a highly motile diatom that is somewhat tolerant of organic pollution. The next three most abundant species above Tenmile Creek were also tolerant of organic loading. Macrophytes were also common. The presence of filamentous green algae indicated elevated nutrient concentrations. This site was the only site that had red algae. Among the genera of freshwater red algae, *Audouinella* is the most tolerant of organic pollution. The site supported only eight genera of non-diatom algae, which was the smallest number among Prickly Pear Creek sites sampled in 2003. Most diatoms indicated eutrophic conditions at the Prickly Pear Creek site above Tenmile Creek (Bahls, 2004).

Field notes recorded during monitoring activities on July 27, 2004 at the Prickly Pear Creek station above Tenmile Creek indicated that macroalgae densities were again high with approximately 40 percent of substrate coverage. At the end of August 2004, macroalgae substrate coverage was also heavy with approximately 50 percent coverage. This had declined to 45 percent coverage by mid-September 2004, and levels of filamentous algae were described as heavy.

Fish Populations

The project team examined data from the Montana Fish, Wildlife and Parks' MFISH database. Prickly Pear Creek is managed as a trout fishery. No species of special concern are thought to live in this segment of Prickly Pear Creek. Longnose and white suckers are the only species of fish though to be abundant in this segment. The overall habitat and sport fishery rating for this segment is "moderate." Montana Fish, Wildlife and Parks lists most of this segment as a chronic dewatering stream of concern.

Nutrient-related Data

Field parameter measurements in July and August 2003 at the Prickly Pear Creek station above Tenmile Creek showed moderately high specific conductance values of 592 μS/cm to 623 μS/cm and dissolved oxygen readings ranging from 9.7 to 14.0 mg/L. Stream flows did not vary widely and were measured at 15.7 to 17.5 cfs during July and August (Appendix D).

Field parameter measurements from July to the middle of September 2004 at this same station showed very high dissolved oxygen readings (13.1–14.5 mg/L) and moderate flows ranging from 8.4 cfs on July 27, 2004, to 22.1 cfs at the end of August (the latter due to rainstorms the previous week). Flows remained in the moderate range in the month of September 2004 (18.8–31.4 cfs) (Appendix D). The higher flows occurred toward the end of the month and could have been due to the cessation of irrigation with wastewater effluent from the City of Helena or the termination of irrigation water withdrawals from Prickly Pear Creek.

No post-1996 ammonia-nitrogen data were available prior to the 2003–2004 sampling efforts. The City of Helena wastewater treatment plant was upgraded in June 2001. The original listing for this segment of Prickly Pear Creek was based on historical data for monitoring stations located below the treatment plant discharge before the facility was upgraded. Two total ammonia samples taken on July 17, 2003, and August 8, 2003, at Prickly Pear Creek above Tenmile Creek were below Montana's acute and chronic total ammonia nitrogen standards for early life fish stages (Appendix D). Four other total ammonia samples (taken on July 27, August 27, and September 9 and 24, 2004, at this same station on Prickly Pear Creek) were also below Montana's acute and chronic total ammonia nitrogen standards for early life fish stages (Appendix D).

No data for other nutrient variables were available for the post-1996 period until the 2003–2004 sampling efforts. One station, Prickly Pear Creek above Tenmile Creek, showed exceedances in all samples during the 2003 monitoring for total Kjeldahl nitrogen, total nitrogen, and total phosphate (Nitrate + nitrite-N values were also above the supplemental indicator value of 0.04 mg/L in July and August 2003. Soluble reactive phosphorus was extremely high (0.556–0.587 mg/L) and well above the supplemental indicator value of 0.011 mg/L in July and August 2003 (Appendix D). Very large diurnal fluctuations were documented at this station during the 24-hour dissolved oxygen sampling in August 2003 (Appendix D). Twenty-four-hour dissolved oxygen values ranged from a low of 4.9 mg/L late at night to a high of 17.9 mg/L in the mid-afternoon. Total suspended solids values were high in mid-July 2003 (44 mg/L) and well above the supplemental indicator value of 23 mg/L. The 2003 periphyton chlorophyll-*a* values were very high, ranging from 113 to 332 mg/m^2. The supplemental indicator value for periphyton chlorophyll *a* was established at 37 mg/m^2 (Appendix D).

During each of the 2004 sampling events, Prickly Pear Creek above Tenmile Creek showed exceedances of all of the nutrient targets and supplemental indicators, with the exception of total ammonia. total Kjeldahl nitrogen concentrations ranged from 0.398 to 0.46 mg/L, total nitrogen ranged from 1.37 to 2.6 mg/L, and total phosphorus ranged from 0.458 to3.45 mg/L. Nitrate + nitrite-N varied from 0.99 to 2.21 mg/L and soluble reactive phosphorus was ranged from 0.281 to 0.348 mg/L, which are above the supplemental indicator value thresholds (Appendix D). The 2004 periphyton chlorophyll-*a* measurements were also very high and ranged from 44.2 to 89.9 mg/m^2 from August through September 2004 (Appendix D).

Metals Concentrations

Only two in-stream water chemistry samples taken between July and August 2003 were available for evaluation. Arsenic concentrations in both samples exceeded the human health criterion. One sample exceeded the chronic aquatic life criterion for cadmium. The concentration in this sample was 1.8 times the chronic human health criterion. One sample exceeded the human health and chronic aquatic life criteria for lead. This sample was 2.8 times the chronic aquatic life criterion, and 1.73 times the human health criterion. Both samples were below the human health and aquatic life criteria for copper and zinc. The limited evidence suggests that this segment meets the human health and aquatic life criteria for copper and zinc. Because of the limited data, this segment should be closely monitored in the future to confirm this statement.

Thermal Modifications

Limited temperature data were available for this segment of Prickly Pear Creek. Six temperature observations were recorded at one station during synoptic sampling events in the summers of 1995, 2003, and 2004 (Table 3-28). A maximum temperature of 73.4° F was recorded on July 17, 2003, at 1:30 p.m. at the Prickly Pear Creek sampling site above Tenmile Creek (Sierra Road, M09PKPRC02). All the temperatures recorded in 2004 were below 70° F, whereas all the temperatures recorded in 2003 were above 70° F. This reflected the difference between the summer temperatures of 2003 (extremely hot) and 2004 (mild).

Table 3-28. Statistical summary of synoptic water temperature data for Prickly Pear Creek, MT41I006_030.

Mean	66.0° F
Median	68.7° F
Standard deviation	7.7° F
Maximum	73.4° F
Number of samples	6
Number of sample sites	1

No suitable reference streams were identified for this segment of Prickly Pear Creek primarily because of the stream's I classification. In order to assess "naturally occurring temperatures" in this segment of Prickly Pear Creek so that the temperature criteria could be more directly applied, SSTEMP modeling was conducted (Bartholow, 2002). See Appendix H for a detailed discussion of the modeling procedures, scenarios, and results.

SSTEMP was used to simulate current conditions in Prickly Pear Creek and various restoration conditions (for example, increased riparian vegetation density). The model was calibrated with flow and temperature data obtained on August 7, 2003, during a 24-hour survey (Figure 3-8). The survey occurred during hot, low-flow conditions when the most pronounced changes in temperature would be expected (critical conditions). The calibration model for segment MT41I006_020 produced a mean temperature of 64.1 ^{o} F. This result is within 1 percent of the measured value of 65.0 ^{o} F (Appendix H, Table 6).

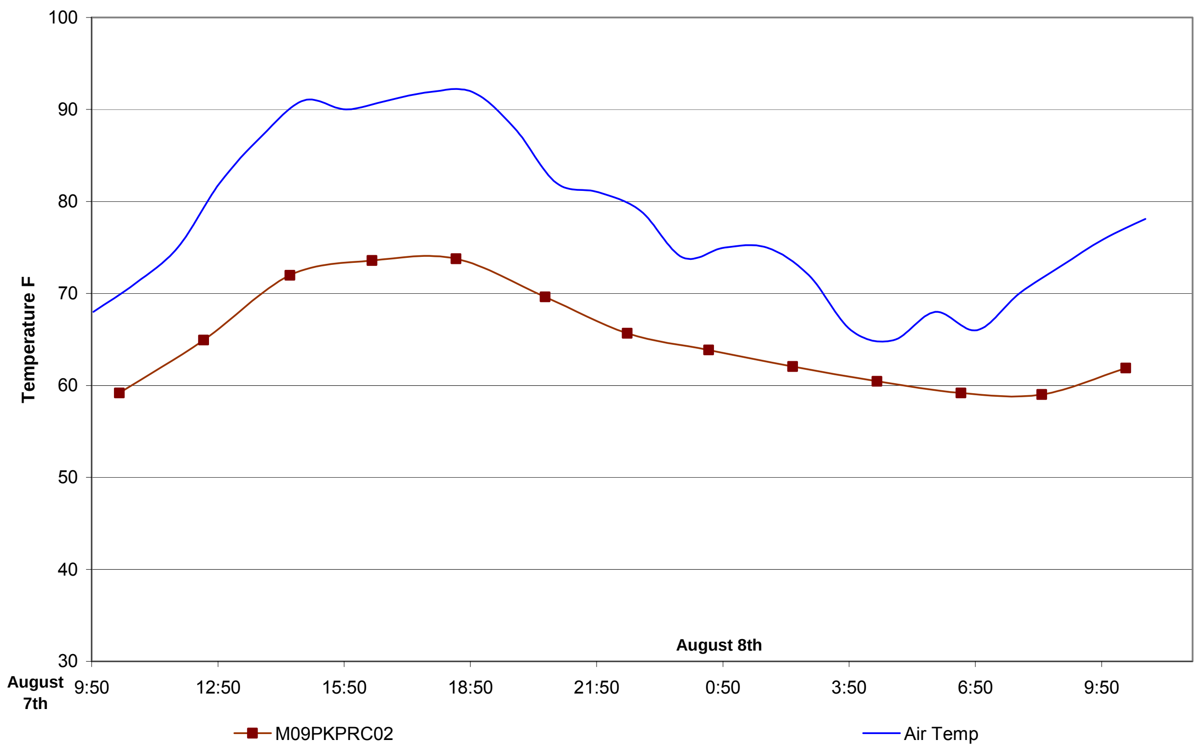

Figure 3-8. Diurnal water temperatures recorded on August 7–8, 2003 in Prickly Pear Creek, MT41I006_020

The model was then run for various flow conditions to predict water temperatures under various simulated scenarios, including "natural" conditions. The model predicted a mean temperature under natural conditions of 63.9° F, which is 0.2 degrees less than the current mean temperature (Table 3-29). This difference of 0.2° F does not violate the temperature standard for class B-1 streams (streams naturally less than 67° F). However, once model uncertainty is accounted for, the worst-case scenario predicts that the stream could be as much as 3.2 degrees above its natural temperature.

Table 3-29. Current water temperature conditions versus natural conditions for Prickly Pear Creek, MT41I006_030.

Segment	Current Temperature (Mean)	Calibration Model Uncertainty (Mean)	Natural Temperature (Mean)	Natural Model Uncertainty (Mean)	Difference from Natural Value (Best and Worst Case)
MT41I006_020	64.1 ° F	± 1.8 ° F	63.9 ° F	± 1.2 ° F	-0.2 ° F (2.8 to **3.2**)

<u>Prickly Pear Creek Segment MT41I006_020 Water Quality Impairment Summary</u>

The project team has reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition rating), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediment, macroinvertebrates, periphyton, fisheries, stream temperatures, SSTEMP modeling, and water chemistry and dissolved oxygen.

No targets or supplemental sediment indicators were met. Width-to-depth ratio was less than expected and is probably a reflection of channel alterations or flow depletion. D_{50} at the survey site was much smaller than expected, and might be a reflection of the effects of reduced bedload transport capacity caused by artificially reduced flows and/or excessive deposition of fine sediments. The BEHI rating of high indicated that the stream banks are likely sources of sediment in the stream and might not be capable of withstanding high flows. A Proper Functioning Condition rating of "Non-functional" (NF) at the channel survey site reflected that the stream is unable to sustain expected hydrologic characteristics, riparian vegetation, and sediment transport capacities. Values for both classes of fines from McNeil cores were above the target values. Suspended sediment values were not adequate to make a determination. The results of the macroinvertebrate and diatom samples indicate impairment by sedimentation. Recent fisheries data suggest that this segment of the stream provides limited habitat for few fish species.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment. Although chronic dewatering of this segment could present a challenge for the interpretation of impairment status, no targets and few supplemental sediment indicators were being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in this segment are impaired by siltation and suspended solids. A TMDL will therefore be developed to address the sediment impairment.

The weight of evidence suggests that Prickly Pear Creek from the Helena wastewater treatment plant discharge ditch to Lake Helena is impaired by nutrients. The available in-stream chemistry data indicate that total nitrogen, total Kjeldahl nitrogen, nitrate and nitrite, total phosphorus, and soluble reactive phosphorus concentrations exceed the proposed targets and supplemental indicators. Periphyton chlorophyll *a* was also measured at greater than the proposed indicator value, and large diurnal dissolved oxygen fluctuations were observed, indicating the presence of excessive algae. Furthermore, the macroinvertebrate and periphyton data suggest that the aquatic community is stressed, partly due to nutrient enrichment. Potential nutrient sources include irrigation return flows, grazing, discharge from the wastewater treatment plant, agricultural activities, and rural developments. A TMDL will therefore be developed to address the nutrient impairment. All of the samples taken for total ammonia-nitrogen in 2003 and 2004 were below Montana's acute and chronic total ammonia nitrogen standards for early life fish stages (Appendix D), reflecting a resolution of this former problem as a result of wastewater treatment plant upgrades and summer irrigation usage of much of the plant's effluent. Therefore, a TMDL will not be developed to address total ammonia.

Relative to metals, the very limited available evidence suggests that Prickly Pear Creek from the Helena wastewater treatment plant discharge ditch to Lake Helena is impaired by arsenic, cadmium, and lead. TMDLs will therefore be developed to address the arsenic, cadmium, and lead impairments.

Very limited in-stream temperature data were available for this segment of Prickly Pear Creek. However, the weight of evidence suggests that Prickly Pear Creek from Wylie Drive to the Helena wastewater treatment plant discharge is impaired due to thermal modifications. When uncertainty is factored into the SSTEMP modeling analysis, the temperature target could be exceeded by 3 ºF above the natural temperature. Results of the riparian assessments indicate that there are areas along this segment of Prickly Pear Creek with limited riparian zones. The stream survey site was rated as "Non-functional" (NF), in part due to the characteristics of the riparian vegetation. Pending the collection of additional data and further analysis, a TMDL will therefore be developed to address the temperature impairment.

3.4.1.6 Golconda Creek from the Headwaters to the Mouth (MT41I006_070)

In 1996, the cold-water fishery, aquatic life, drinking water, and body contact recreational uses in the 3.7 miles of Golconda Creek were listed as not supported because of suspended solids, turbidity, metals, and unknown toxicity. One basis for the listing was a citizen complaint in 1989 that the creek would turn milky white during high flows. The source of the turbidity was found to be tailings piles at the headwaters of a tributary stream to Golconda Creek. In subsequent years, the segment has been listed for siltation, channel incisement, other habitat alterations, and metals (including specific reference to arsenic, lead, and mercury). The unknown toxicity listing was removed from the 303(d) lists once the sources of milky turbidity were discovered (the tailings piles). A typical view of Golconda Creek is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey 1.5 miles above the mouth that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from the reach surveyed in 2003, suspended sediment data, fish population data, and the results of four in-stream water chemistry samples taken between October 2000 and August 2003.

Golconda Creek

Pollution Sources

The 2003 preliminary source assessment identified roads, geology, tributary streams, and mining operations as the primary sediment sources for Golconda Creek. The aerial photography inventory showed two road crossings and road encroachment along 20 percent of the stream.

The primary geology of this sub-watershed is the Boulder Batholith, which consists of highly erodible quartz monzonite. The field source assessment revealed poorly developed soils with gully formations on steep slopes in upland areas and on road cut-and-fill slopes. Deposition of sand was observed in the stream channel at the field sampling sites. The aerial photography inventory showed that extensive conifer and deciduous riparian buffers were present in the headwaters and along most of the stream managed by the BLM. Closer to the mouth, the widths of riparian buffers are reduced by development and landscaping in the floodplain. Some clear-cut logging has occurred on BLM lands in the vicinity of tributary streams to the west of Golconda Creek, but the sites do not appear to be recent harvest operations.

No evidence of placer mining was observed, but a large mine dump of waste rock was visible just upslope from the creek near the mouth on private property. Most of the creek is surrounded by BLM lands that are managed for grazing. The last half-mile of the creek is surrounded by private property that is developed for rural home sites.

In summary, sediment sources generated by road runoff and erosive geology are probably the biggest contributors of sediment to Golconda Creek. Land disturbance appears to exacerbate erosion in the Boulder Batholith geology and the poorly developed soils of this sub-watershed.

Expected relevant sources of metals in the stream are the historical mining activities in the watershed. During source assessment efforts, old mining areas were observed in tributary drainages to the west of the main stem of Golconda Creek, and significant mining disturbances were observed on private lands near the main stem. The entire drainage area of the stream falls within the Alhambra mining district of Montana. The MBMG Abandoned and Inactive Mines database reports surface-underground, prospect, and underground mining activities in the watershed. The historical mining types include lode mining. In the past these mines produced copper, silver, lead, gold, and zinc. The State of Montana's inventory of mine sites shows three mines in the drainage: Buckeye, Golconda, and Big Chief. The last of these three is closest to the stream and once produced lead, zinc, gold, and silver. None of the mines in the basin is listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation on Golconda Creek, about 1.5 miles above the mouth. The field crew determined the stream to be a Rosgen stream type B4a. The width-to-depth ratio was 9.4, which is comparable to B4a and A4 reference streams that the Helena National Forest has inventoried (Table 3-30). The BEHI rating was "moderate." The BEHI score was slightly above the average (less stable) for southwestern Montana and Greater Yellowstone Area A- and B-type reference streams, but within 15 percent of the reference values. D_{50} as determined in a zigzag Wolman pebble count consisted of very coarse gravels. This median particle size is within the range expected for A4 and B4 reference stream types, based on data collected for the Helena National Forest and southwestern Montana and the Greater Yellowstone Area.

Part of the channel survey included a Proper Functioning Condition assessment. The field crew rated this site as "Proper Functioning Condition" (PFC), but noted some sediment deposition. The riparian land type aggregate assigned to this site is 11, defined as Granitic Rock – Rolling Uplands. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common and can be excessive.

Table 3-30. Summary of cross-sectional data for Golconda Creek, MT41I006_070.

Parameter	Result	Comparable to Reference
Width/depth ratio	9.4	Yes
BEHI	23.7	Yes
D_{50}	Very coarse gravels	Yes
PFC	PFC	Yes

McNeil Cores

McNeil core data are available for one site on Golconda Creek, which corresponds to the channel survey site. Six cores were collected. The riparian aggregate here was determined to be 11, Granitic Rock – Rolling Uplands (Table 3-31). The average percentage of fines less than 6.4 mm was 35.6 percent, with average fine fines (less than 0.85 mm) at 12.4 percent. The percentage of fines less than 6.4 mm for this site is about equal to the mean from reference cores for this riparian aggregate, but the fine fines are 22 percent above the mean.

Table 3-31. Summary of McNeil core data for Golconda Creek, MT41I006_070.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
11	2003	35.6	12.4	Fine fines value is elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Few data were available for Golconda Creek. Two samples for suspended sediment were collected at one site in 2000 and 2001. The highest value collected was 3 mg/L in May 2001.

In 2003, two turbidity observations were recorded for Golconda Creek at one site above the mouth. Both observations reported the water clarity as clear, yet the observations were made during the recessional limb of peak flow and also during low flow.

Macroinvertebrates

No recent data are available.

Periphyton

No recent data are available.

Fish Populations

The project team examined data from the Montana Fish, Wildlife and Parks' MFISH database. Montana Fish, Wildlife and Parks has no listing information or management strategy for Golconda Creek.

Metals Concentrations

Cadmium concentrations in all samples exceeded the chronic aquatic life criterion. The average cadmium concentration in all samples was 63.8 percent higher than the chronic aquatic life criterion. The highest measured value was 2.3 times the chronic aquatic life criterion. No samples exceeded the human health criterion for cadmium. This evidence shows that this segment does not meet the aquatic life criterion for cadmium.

Lead concentrations in all samples exceeded the chronic aquatic life criterion. The average of all samples was 627 percent higher than the chronic aquatic life criterion. The highest measured value was 16.2 times the chronic aquatic life criterion for lead. No samples exceeded the human health criterion for lead. This evidence shows that this segment does not meet the aquatic life criterion for lead.

All samples were below the human health and aquatic life criteria for arsenic, copper, and zinc. The highest measured concentration of zinc was 78 percent of the chronic aquatic life criterion. This is a borderline value. This evidence suggests that this segment meets the human health and aquatic life criteria for arsenic, copper, and zinc. Because of the limited data, this segment should be closely monitored in the future to confirm this statement.

Golconda Creek MT41I006_070 Water Quality Impairment Summary

The project team has reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediment, fisheries, and water column metals concentrations.

Comparisons against the targets and supplemental indicators are mixed. Supplemental indicators for all channel metrics were met. A Proper Functioning Condition rating of PFC reflects that the stream is able to sustain expected hydrologic characteristics, riparian vegetation, and sediment transport capacities. The percentage of fines less than 0.85 mm from McNeil cores was slightly above the target value, but the percentage of fines less than 6.4 mm was about equal to the target value. Suspended sediment data were not adequate to make a determination.

Results from the 2003 preliminary source assessment revealed that eroding sediment sources affecting the stream were enhanced by the erosive granitic geology. Best management practices for roads were warranted along the upper end of Golconda Road. Most of the targets and supplemental indicators were being met. The value for fine fines was two-tenths of a percentage point outside the 95 percent confidence interval for the mean, and the median value was within the 95 percent confidence interval.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Golconda Creek are not impaired by sediment. A TMDL therefore will not be developed to address sediment impairment.

The limited water chemistry data suggest that Golconda Creek is impaired by cadmium and lead. TMDLs will therefore be developed to address the cadmium and lead impairments.

3.4.1.7 Corbin Creek from the Headwaters to the Mouth (MT41I006_090)

In 1996, the aquatic life, cold-water fishery, drinking water, recreational, and agricultural uses in the 2.5 miles of Corbin Creek were listed as non-supported because of suspended solids, metals, pH, salinity/total dissolved solids/chlorides, and other inorganics. The basis for the 1996 listing was a series of reports dating from the 1980s to 1990s that described severe impairments of the stream from abandoned mines and riparian grazing. In subsequent years, agricultural water uses were upgraded from non-supporting to partially supporting, and thermal modifications and habitat alterations were added to the list of impairment causes for Corbin Creek. Salinity, total dissolved solids, and chlorides did not appear as impairment causes on either the 2002 or 2004 303(d) lists. A typical view of Corbin Creek is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey about a half-mile above the mouth that included a Proper Functioning Condition assessment and Wolman pebble counts, suspended sediment data, fish population data, synoptic temperature data, and the results of two in-stream water chemistry samples taken between July and August 2003. Earlier water chemistry data that were available for Corbin Creek were not included in the analysis because they do not reflect current water quality conditions.

Corbin Creek

Pollution Sources

The 2003 preliminary source assessment identified roads, grazing, geology, and mine reclamation as the primary sediment sources for Corbin Creek. The aerial photography inventory showed six road crossings and road encroachment along 17 percent of the stream. The stream is channelized though the town of Corbin. Field source assessment sites consisted primarily of road and grazing sources.

The primary geology of this sub-watershed is the Boulder Batholith, which consists of highly erodible quartz monzonite. During the field source assessment, gully and rill erosion on steep slopes and on road cut-and-fill slopes were observed transporting sediment directly to the stream. Excessive deposition of sand was observed in the stream channel. The aerial photography inventory showed that sparse riparian buffers were present only in the headwaters portion of the stream. Most of the creek is surrounded by private lands, which are managed for grazing. The last one-quarter mile of the creek flows through the small town of Corbin.

Extensive channel alterations from historical mining and mine reclamation begin up the southern headwater tributary. The stream is incised, overly widened, and straightened. In an effort to remove toxic mine spoils and related contaminants, the Montana State Mine Waste Cleanup Bureau reclaimed a half-mile of the channel about a mile above the mouth. There has been little re-growth of riparian vegetation. During field sampling in summer 2003, the creek was dry at the mouth beginning in early July. Upstream, flow was observed at less than 1 cfs for most of the season.

In summary, sediment sources generated by road runoff, grazing, and channel alterations from mine reclamation are probably the biggest contributors of sediment to Corbin Creek. Land disturbance appears to exacerbate erosion in the Boulder Batholith geology and the poorly developed soils of this sub-watershed. Severe channel alterations begin after the first road crossing and continue on to the mouth.

Expected significant contributors of metals to the stream segment are historical hard rock mining activities in the watershed. Most of the drainage area of the stream falls within the Colorado mining district of Montana, with a small part of the headwaters in the Clancy district. The MBMG Abandoned and Inactive Mines database reports mineral location, surface, surface-underground, and underground mining activities in the watershed. The historical mining types include placer mining. In the past, these mines produced copper, silver, lead, zinc, and gold. Two of the mines in the basin are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites: Bertha and Alta mines – both in the Colorado mining district portion of the watershed. As was mentioned earlier, recent reclamation efforts have taken place in the watershed.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation on Corbin Creek, about one-half mile above the mouth. The field crew determined the stream to be a Rosgen stream type B5a, but without disturbance it should probably have been a B4a. The width-to-depth ratio was 30.9, which is about two times greater than other Ba-type reference streams that the Helena National Forest has inventoried, as well as other A- and B-type reference streams that have been inventoried for southwestern Montana and the Greater Yellowstone Area (Table 3-32). This is probably a reflection of the channel alterations from mine reclamation. The BEHI rating was "high," which is 80 percent above the average (less stable) for southwestern Montana and Greater Yellowstone Area reference stream A- and B-type streams. D_{50} as determined in a zigzag Wolman pebble count consisted of coarse sands. There are no similar A5 or B5 reference streams to compare this value with. However, as mentioned before, it is the professional opinion of the surveyors that the stream should naturally have gravels as the dominant substrate.

Part of the channel survey included an assessment of Proper Functioning Condition. The field crew rated this site as "Non-functional" (NF), citing excessive sediment deposition, lack of flow, and lack of riparian vegetation. The riparian land type aggregate assigned to this site is 11, Granitic Rock – Rolling Uplands. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common and can be excessive.

Table 3-32. Summary of cross-sectional data for Corbin Creek, MT41I006_090.

Parameter	Result	Comparable to Reference
Width/depth ratio	30.9	No
BEHI	38.6	No
D_{50}	Coarse sands	NA
PFC	NF	No

McNeil Cores

McNeil core data are not available for Corbin Creek. No cores were taken, based on the professional judgment that fish do not inhabit the stream.

Suspended Sediment Concentrations

High turbidity levels in Corbin Creek documented prior to the 1996 303(d) listing were thought to originate from suspended solids or excessive aluminum concentrations. Turbidity values from sampling in April 1980 were as high as 480 Jackson Candle Units.

There are no recent suspended sediment data for Corbin Creek. In 2003, two turbidity observations were recorded on Corbin Creek at one site above the mouth. The first observation in July reported the water as slightly turbid with a rust-colored tint. The second observation reported the water clarity as clear.

Macroinvertebrates

No recent data are available.

Periphyton

No recent data are available.

Fish Populations

Data were examined from the Montana Fish, Wildlife and Parks' MFISH database. Montana Fish, Wildlife and Parks has no listing or management strategy for Corbin Creek and the Helena National Forest has not documented fish presence either.

Metals Concentrations

The results of only two recent sample analyses made between July and August 2003 were available for review. Samples taken previously were not evaluated because they do not reflect current conditions of the stream.

One of the samples exceeded the human health criterion for arsenic. The arsenic concentration in this sample was 1.3 times the human health criterion for arsenic. Both samples were below the aquatic life criteria for arsenic. This evidence suggests that this segment does not meet the human health criterion for arsenic.

Cadmium concentrations in both samples exceeded the human health and aquatic life (chronic and acute) criteria. The average of both samples was 141 percent, 3,255 percent, and 660 percent higher than the aquatic life acute, aquatic life chronic, and human health criteria, respectively. The highest measured concentration was 52 times the chronic aquatic life criterion. This value was 11.8 times the human health criterion. This evidence shows that this segment does not meet the human health and aquatic life standards for cadmium.

Copper concentrations in both samples exceeded the acute and chronic aquatic life criteria. The average of all samples was 397 percent and 797 percent higher than the aquatic life acute and chronic criteria, respectively. The highest measured concentration was 16 times the chronic aquatic life criterion. None of the samples exceeded the human health criterion. This evidence shows that this segment does not meet the aquatic life standards for copper.

One sample exceeded both the human health and the chronic aquatic life criteria for lead. This sample was 3.6 times the human health criterion, and 1.5 times the chronic aquatic life criterion. The average of all samples was 120 percent higher than the human health criterion, and just 10 percent lower than the chronic aquatic life criterion. This evidence shows that this segment does not meet the human health or aquatic life standards for lead.

Zinc concentrations in both samples exceeded the human health and chronic and acute aquatic life criteria. The average concentration of both samples was 3,831 percent, 3,831 percent, and 1,137 percent higher than the aquatic life acute, aquatic life chronic, and human health criteria for zinc. The highest measured concentration was 67.9 times the chronic and acute aquatic life criteria, and 21.4 times the human health criterion. This evidence shows that this segment does not meet the human health or aquatic life standards for zinc.

Thermal Modifications

Very limited temperature data were available for Corbin Creek. In summer 2003, two temperature observations were recorded at one station during synoptic sampling events. The maximum temperature of 78.8 °F was recorded on August 18, 2003, just before 4 p.m. at the sampling site above the town of Corbin. A thermograph was deployed in Corbin Creek, but the stream went dry at the thermograph site within 2 weeks of deployment. The actual date the stream went dry is unknown, and thus the data were not considered. Extremely low flows were observed in Corbin Creek during the summer of 2003, with all measured flows well under 0.5 cfs.

“Naturally occurring temperatures” were not assessed in Corbin Creek in part because of the unique unnatural circumstances that mining and mine reclamation have imposed on Corbin Creek, and also because of the fact that fish do not inhabit the stream.

Salinity/Total Dissolved Solids/Chlorides

Very little recent salinity data were available for Corbin Creek. The two salinity samples obtained in 2003 (1,171 and 1,915 µS/cm) indicated that the salinity targets are exceeded. However, 2003 was a very dry year with little flow and the samples might not represent normal conditions in the creek. Figure 3-9 compares the samples obtained at several streams in the Lake Helena watershed in 2003. Even though all the streams had very low flow, only Corbin Creek exceeded the average and maximum targets. In addition, the maximum salinity in Corbin Creek was more than twice any other salinity concentration (Table 3-33). Together, this information suggests that Corbin Creek is impaired because of salinity and total dissolved solids.

As discussed above, beneficial uses are impaired by metals (arsenic, cadmium, copper, lead, and zinc) in Corbin Creek. Metals are usually one small portion of the total dissolved solids in a stream. However, high metals concentrations (as seen in Corbin Creek) also result in elevated total dissolved solids and salinity. The metals data shows that trace metals make up an unusually large proportion of the total dissolved solids in Corbin Creek (Table 3-34). Arsenic, cadmium, copper, lead, and zinc make up almost 2 percent of the total dissolved solids – three orders of magnitude more than in other streams in the Lake Helena watershed. Iron (although not sampled) is also most likely very high as well, because red precipitates were noted in the stream during sampling.

In conclusion, the available data suggest that Corbin Creek is impaired by salinity and total dissolved solids but not chlorides. Furthermore, the impairment is likely associated with the extremely high trace metals concentrations rather than high concentrations of sulfates, sodium, or chlorides.

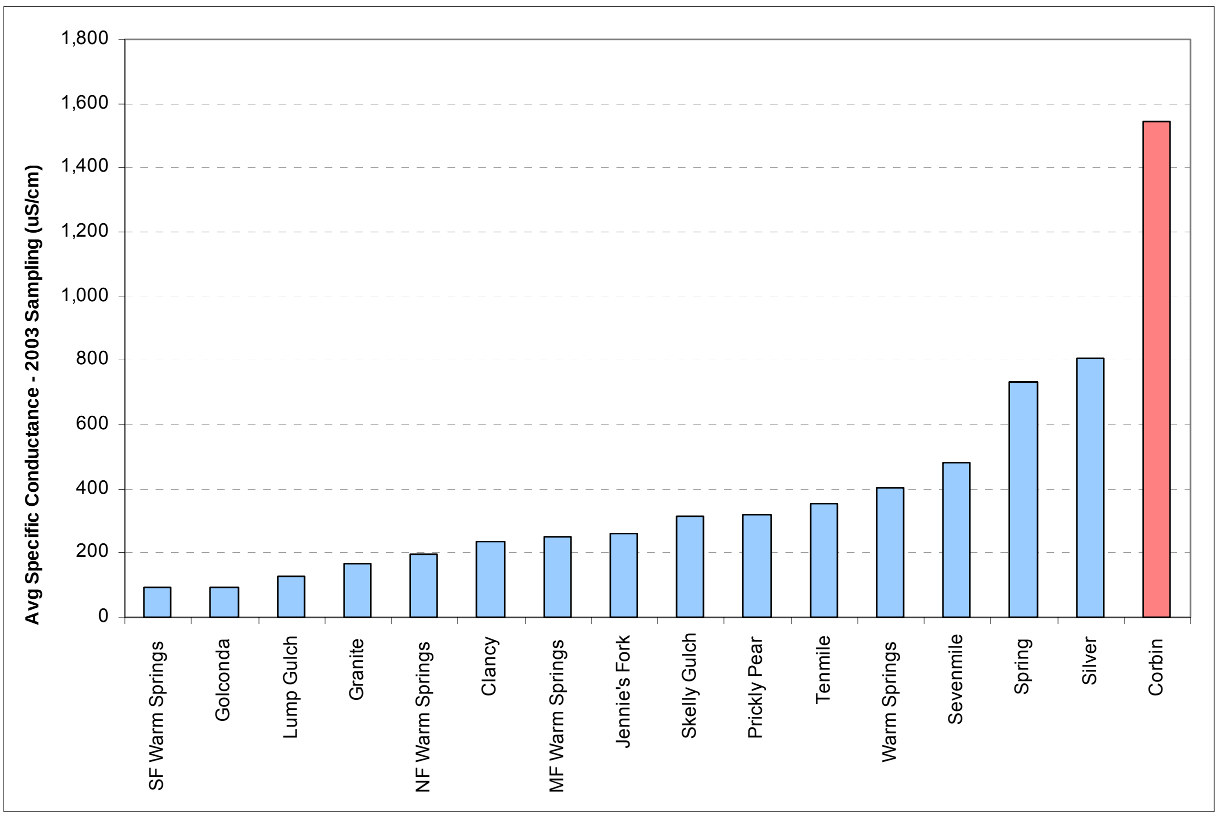

Figure 3-9. Average salinity in selected streams in the Lake Helena watershed in 2003.

Table 3-33. Summary of salinity data in selected streams in the Lake Helena watershed (µS/cm).

Major Water Body	Count	Min	Max	Avg
Clancy Creek	6	192	289	236
Corbin Creek	**2**	**1,171**	**1,915**	**1,543**
Golconda Creek	2	89	103	96
Granite Creek	2	140	195	167
Jennie's Fork	2	254	269	262
Lump Gulch	6	79	176	126
Prickly Pear Creek	22	71	623	319
Sevenmile Creek	4	402	554	481
Silver Creek	2	772	838	805
Skelly Gulch	2	313	318	316
Spring Creek	3	666	773	735
Tenmile Creek	3	156	506	356
Warm Springs Creek	2	338	467	403
Warm Springs Creek Middle Fork	2	227	272	250
Warm Springs Creek North Fork	3	185	211	195
Warm Springs Creek South Fork	1	91	91	91

Table 3-34. Average metals concentrations in selected streams in the Lake Helena watershed, 2003 sampling (µg/L)

Major Water Body	Arsenic	Cadmium	Copper	Lead	Zinc	Sum
Clancy Creek	14.8	0.6	5.0	4.5	93.0	**98**
Corbin Creek	7.0	38.0	427.5	33.0	24,735.0	**24,768**
Golconda Creek	1.0	0.2	1.0	4.5	27.0	**32**
Granite Creek	1.5	0.1	1.0	1.0	1.0	**2**
Jennie's Fork	4.0	0.1	4.5	9.5	41.5	**51**
Lump Gulch	2.2	0.3	1.2	1.0	87.2	**88**
Prickly Pear Creek	8.0	0.3	2.2	4.3	50.9	**55**
Sevenmile Creek	17.3	0.1	1.0	1.0	1.0	**2**
Silver Creek	15.5	0.1	5.0	3.5	1.0	**5**
Skelly Gulch	9.5	0.1	1.0	1.0	1.0	**2**
Spring Creek	22.5	1.4	34.5	68.0	235.5	**304**
Tenmile Creek	20.3	0.3	1.3	1.0	42.3	**43**
Warm Springs Creek	14.5	0.1	1.0	1.0	7.0	**8**
Warm Springs Creek - Middle Fork	42.0	0.7	1.0	1.5	179.5	**181**
Warm Springs Creek - North Fork	3.7	0.1	1.0	1.0	1.0	**2**
Warm Springs Creek - South Fork	6.0	0.1	1.0	1.0	1.0	**2**
Median	**8.8**	**0.2**	**1.1**	**1.3**	**34.3**	**37**

Corbin Creek MT41I006_090 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), fisheries, stream temperature data, and water chemistry. Because Corbin Creek does not currently support fish, it would be inappropriate at this point in time to set TMDL target values based on the percentage of subsurface fines. However, once toxicant levels are reduced in the stream, Corbin Creek should be expected to sustain a fish population and the application of the McNeil core targets could be appropriate.

Although data for the target sediment variables are unavailable, no supplemental indicator threshold values are being met. An extremely high width-to-depth ratio suggests the probability of hydromodification associated with channel alterations and possibly mine reclamation. D_{50} at the survey site was estimated to be an order of size-class smaller than expected, and is probably a reflection of excessive deposition of fine sediments as well as an indication of the extreme channel alterations that have occurred. A Proper Functioning Condition rating of “Non-functional” reflects that the stream is unable to sustain expected hydrologic characteristics, riparian vegetation, and sediment transport capacities. A “high” BEHI rating indicated that the stream banks are likely sources of sediment to the stream and might not be capable of withstanding high flows. Suspended sediment data values were not adequate to make a determination.

Results from the 2003 preliminary source assessment revealed that actively eroding sediment sources were affecting the stream. These sources were enhanced by the erosive granitic geology. Regarding sediment inputs, an almost total lack of riparian vegetation indicates that runoff is minimally filtered before entering the stream, and that stream banks are potentially unstable. An apparent loss of channel maintaining flows has negative implications for sediment load transport.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Corbin Creek are impaired by siltation and possibly suspended solids. A TMDL will therefore be developed to address the sediment impairment.

Despite the very limited number of available water chemistry samples, there is overwhelming evidence that suggests Corbin Creek is impaired by arsenic, cadmium, copper, lead, and zinc. TMDLs will be developed to address the arsenic, cadmium, copper, lead, and zinc impairments.

At this time, insufficient information is available to make a decision on thermal impairments in Corbin Creek. However, the available data suggest that impairments due to metals and siltation currently far outweigh any concerns posed by thermal modifications. The stream survey site was rated as Non-functional, in part because of an almost total lack of riparian vegetation. Fisheries data suggest that the stream is not inhabited by fish. It is not recommended that a TMDL for temperature be prepared at this time. Once pollutant levels are reduced in the stream, Corbin Creek should be able to sustain a fish population and the application of the B-1 temperature targets would be appropriate.

The available data suggest that Corbin Creek is impaired by salinity and total dissolved solids but not by chlorides. Furthermore, the impairment is likely associated with extremely high trace metals concentrations rather than high concentrations of sulfates, sodium, or chlorides. The project team finds that a specific TMDL to address salinity and total dissolved solids issues is not warranted pending implementation of a metals TMDL.

3.4.1.8 Spring Creek from Corbin Creek to the Mouth (MT41I006_080)

In 1996, this 1.7-mile segment of Spring Creek was listed as not supporting its designated aquatic life, cold-water fishery, drinking water, recreation, and agricultural water uses because of suspended solids, habitat alterations, nutrients, metals, and pH. The basis for the listing was elevated concentrations of metals, total suspended solids, and turbidity in grab samples collected from 1974 to 1981, and a report that described turbid water conditions in the stream during storm events only below the confluence with Corbin Creek. In subsequent years, recreational water uses were upgraded from non-supporting to partially supporting, and dewatering, fish habitat degradation, and riparian degradation were added to the list of impairment causes. A typical view of Spring Creek from Corbin Creek to the mouth is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey about three-quarters of a mile above the mouth that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from the reach surveyed in 2003, suspended sediment data, fisheries rating information, water chemistry analysis results, and macroinvertebrate and periphyton bioassessment information.

Spring Creek from Corbin Creek to the mouth

Pollution Sources

The 2003 preliminary source assessment identified grazing, geology, and mine reclamation as the primary sediment sources for this segment of Spring Creek. Head cutting was observed at the mouth of the stream. The aerial photography inventory showed three road crossings and road encroachment along 14 percent of the stream. Virtually the entire segment of the creek above the town of Jefferson City has been channelized by mine reclamation.

The primary geology of this sub-watershed is the Boulder Batholith, with Quaternary alluvium present in the valley. Sands and fine gravels were prominent substrate materials in the stream channel. The aerial photography and field inventories determined that riparian buffers were virtually absent. Most of the creek is surrounded by private lands that are used for grazing and rural housing. The last one-quarter mile of the creek flows through the small town of Jefferson City.

Extensive channel alterations from mine reclamation begin near the confluence with Corbin Creek. In an effort to remove toxic mine spoils and related contaminants, the Montana Tunnels Mine reclaimed most of the listed portion of Spring Creek. The channel is basically a ditch and the stream is incised and straightened. There is little bank stabilizing riparian vegetation. During field sampling in summer 2003, the stream was observed to leave its constructed channel for a small section about a quarter of a mile below Corbin Creek. Just above where the listed segment begins on Spring Creek, the Montana Tunnels Mine has a holding pond and water transfer station for pumping water up to its operation. This has led to channel incisement and dewatering at the mouth (dry in July during the source assessment). Also noted were an overall lack of riparian vegetation, grazing pasture along the section before Jefferson City, and tailings piles lining the banks throughout the town of Jefferson City. The field sampling and aerial photo analysis in 2003 led to the conclusion that the likelihood for discharges from septic tank fields was low.

Grazing and channel alterations from mine reclamation are probably the biggest contributors of sediment to Spring Creek. Historical lode mining, road construction, mine reclamation work, inter-basin water transfers from Prickly Pear Creek, water withdrawals from the Montana Tunnels Mine, and livestock grazing have altered stream morphology and aquatic habitat. Diffuse sediment and nutrient sources associated with rural home sites might also affect the stream. More localized impacts are present along Spring Creek in the town of Jefferson City.

Expected relevant sources of metals to the stream segment are a tributary stream, inter-basin water transfers from Prickly Pear Creek, and historical mining activities in the immediate drainage area. Flow from Corbin Creek and historical mill tailings deposits are likely contributors of metals to the stream. Most of the drainage area falls within the Colorado mining district, although there is a small section in the Clancy mining district. The MBMG Abandoned and Inactive Mines database shows mineral location and underground mining activities in the drainage area of the stream. The historical mining types include lode, placer, and mill. In the past these mines produced silver, copper, lead, zinc, gold, and uranium. Within the basin, the Corbin Flats Mine is listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites. Three other mines in the Colorado mining district and upstream of the listed segment are also listed in State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites: Washington, Bluebird, and the Wickes Smelter.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation along this section of Spring Creek, about three-quarters of a mile above the mouth. The field crew determined that the stream did not fit a Rosgen stream type classification, but would probably be an E4 or C4 channel without alterations. Sinuosity was low indicating channel straightening, and the entrenchment ratio was large enough to indicate non-confinement. The width-to-depth ratio was 9.6, which is typical of incised E-type channels (Table 3-35). The BEHI rating was borderline between "moderate" and "high." D_{50} as determined in a zigzag Wolman pebble count consisted of fine gravels.

The channel survey included an assessment of Proper Functioning Condition. The field crew rated this site as "Non-functional" (NF), noting excessive fines, lack of riparian vegetation, and channel alterations. The riparian land type aggregate assigned to this site is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive. However, influence from the granitic geology could elevate the fines values slightly.

Table 3-35. Summary of cross-sectional data for Spring Creek, MT41I006_080.

Parameter	Result	Comparable to Reference
Width/depth ratio	9.6	NA
BEHI	29.6	NA
D_{50}	Fine gravels	NA
PFC	NF	No

McNeil Cores

McNeil core data are available for one site on this segment of Spring Creek, which corresponds to the channel survey site. Six cores were collected. The riparian aggregate here was determined to be 29, Alluvial Floodplains and Terraces. The average percentage of fines less than 6.4 mm was 69.6 percent, with average fine fines (less than 0.85 mm) at 21.2 percent (Table 3-36). These values are extremely elevated against the means for fines from reference cores for riparian aggregate 29. The percentage of fines less than 6.4 mm for this site is 105 percent greater than the reference value average, while the fine fines are 162 percent above the reference value average.

Table 3-36. Summary of McNeil core data for Spring Creek, MT41I006_080.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
29	2003	69.6	21.2	Both fines values are elevated.

Suspended Sediment Concentrations

Few recent data were available for this segment of Spring Creek. The USGS National Water Information System had two records for suspended sediment from sampling at two sites in 2000. The highest value collected was 18 mg/L in October at a location near the mouth. This value is greater than what would be expected based on values from selected reference streams for suspended sediment. However, it is possible that the sampling was affected by runoff.

Six total suspended solids samples were collected near the mouth in the summer of 2003 and summer and fall of 2004. The highest value collected was 84 mg/L in August 2003. This value is much greater than what would be expected based on values from selected reference streams for suspended solids. The August 2003 sample was not collected during a runoff event, but it is suspected that the Montana Tunnels Mine was releasing water at the time.

In 2003 and 2004, seven visual observations of water turbidity levels were made at three sites along this segment of Spring Creek. Five turbidity observations reported the water clarity as clear, one reported the water clarity as slightly turbid, and one recorded the water clarity as turbid. The observation of slight turbidity was reported in mid-July 2003, and the observation of turbidity was reported in early August 2003.

Macroinvertebrates

Macroinvertebrate data collected in August 2003 indicated that Spring Creek near Jefferson City was moderately impaired and did not support designated uses. The macroinvertebrate habitat rating for this site was "poor" because of unstable stream banks, altered channel morphology, and an inadequate riparian zone. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2003a). The metric score of 22 percent indicated moderate impairment and non-support of aquatic life uses. Five clinger taxa and one trichoptera taxa were found at the site, and Bollman concluded that fine sediment was most likely limiting benthic habitat (2003a).

Midges, other flies, and tubificid worms dominated the aquatic invertebrate sample collected from Spring Creek at Jefferson City. Nutrient enrichment might have resulted in hypoxic sediments. The HBI (5.61) indicated the presence of fairly significant organic pollution. On August 7–8, 2003, field notes indicated some algal growth and mosses in the stream. On August 28, 2003, field notes indicated that diatoms were present in all slower areas of the stream comprising perhaps 40 percent of the substrate. During July 27, 2004, field notes indicated significant quantities of macrophytes growing in the stream channel immediately upstream of the sampling site.

Periphyton

Periphyton data were available from one sample taken in August 2003 at a location just above Jefferson City. Sampling results were compared with reference biocriteria metrics established for the Rocky Mountain Ecoregions of Montana (Bahls, 2004). Diatom metrics indicated minor impairment and full support of aquatic life uses. Bahls concluded that the impairment was primarily due to organic loading and secondarily due to heavy metals and excessive sedimentation. The siltation index exceeded the threshold for minor impairment. Sample notes indicate that "heavy sediment" was present in the sample.

The 14 major diatom species from Spring Creek represented pollution-tolerant classes 3, 2, and 1, and are either sensitive to organic pollution, somewhat tolerant of organic pollution, or very tolerant of organic pollution. Three of the remaining seven major diatom species in Spring Creek are very tolerant of organic pollution (pollution tolerance class 1) and the other four are somewhat tolerant of organic pollution (Appendix D).

Fish Populations

The project team examined data from the Montana Fish, Wildlife and Parks' MFISH database. Spring Creek is managed as a trout fishery, yet there were no fish species or population trend data available for Spring Creek in the MFISH database or from the Helena National Forest. The overall habitat and sport fishery rating for Spring Creek in MFISH is "limited," which is the lowest rating possible.

Nutrient-related Data

Field measurements taken in July and August 2003 at station M09SPRGC01 showed normal pH and dissolved oxygen values (7.6–8.1 and 7.6–9.0 mg/L, respectively), while specific conductance was moderately high (666–773 µS/cm). Stream flows were minimal (0.1–0.84 cfs), and the water had a slight level of turbidity (Appendix D).

Four field measurements taken from July through September 2004 at the same location showed similar results. pH values ranged from 7.7 to 8.2, dissolved oxygen ranged from 6.1 to 9.8 mg/L, and stream flows were recorded at from 0.1 to 0.25 cfs. Turbidity levels were reported as clear from July through the end of September 2004 (Appendix D).

Water chemistry data for this site in July and August 2003 showed exceedances of target values for total Kjeldahl nitrogen (one of two samples), total nitrogen (two of two samples), and total phosphorus (two of two samples) (Appendix D). Total phosphorus was recorded at 0.205 mg/L and total nitrogen at 1.05 mg/L on August 11, 2003. Nitrate + nitrite-N and soluble reactive phosphorus values were also above the supplemental indicator values in July and August 2003. A total suspended solids concentration of 84 mg/L was also above the supplemental indicator value of 23 mg/L in August 2003 (Appendix D).

During summer 2004, no exceedances of total nitrogen or total Kjeldahl nitrogen target values were seen in four separate samples. One analysis for total phosphorus, reported at 0.050 mg/L, exceeded the target value of 0.027 mg/L on July 27, 2004 (Appendix D). No individual soluble reactive phosphorus measurements during summer 2004 were elevated relative to the supplemental indicator values. Two of four nitrate + nitrite-N were measurements were high, and exceeded the supplemental indicator values. These occurred in late August and early September 2004. One total suspended solids value (41.5 mg/L) from this station was also above the supplemental indicator level of 23 mg/L in July 2004 (Appendix D). Periphyton chlorophyll-*a* values were low (0.022–15.5 mg/m^2) in July–September 2004 and well below any level of concern.

There were no large fluctuations of dissolved oxygen during a 24-hour survey conducted on August 7–8, 2003 (Appendix D). Dissolved oxygen concentrations ranged from 8.1 to 9.4 mg/L.

Metals Concentrations

The project team evaluated a limited total of four in-stream water chemistry samples taken between October 2000 and August 2003. Arsenic concentrations in three samples exceeded the human health criterion. The average of all samples was 60 percent higher than the human health criterion. The highest measured concentration was 3.2 times the human health criterion. No samples exceeded the aquatic life criteria for arsenic. This evidence shows that this segment does not meet the human health criterion for arsenic.

Cadmium concentrations in all samples exceeded the chronic aquatic life criterion. The average concentration of all samples was 111 percent higher than the chronic aquatic life criterion. The highest measured concentration was three times the chronic aquatic life criterion. No exceedances of the cadmium human health criterion were observed. This evidence shows that this segment does not meet the chronic aquatic life criterion for cadmium.

One sample, or 25 percent of all samples, exceeded both the acute and the chronic aquatic life criteria for copper. The concentration of this sample was 2.2 times the chronic aquatic life criterion. No samples exceeded the human health criterion for copper. This evidence shows that this segment does not meet the aquatic life standards for copper.

Lead concentrations in two samples (50 percent of all samples) exceeded the human health and chronic aquatic life criteria. The average lead concentration in all samples was 234 percent higher than the chronic aquatic life criterion, and 232 percent higher than the human health criterion. The highest measured concentration was 8.3 times the human health criterion. This sample was also 8.3 times the chronic aquatic life criterion for lead. This evidence shows that this segment does not meet the human health or aquatic life criteria for lead.

One sample (25 percent of all samples) exceeded the acute and chronic aquatic life criteria for zinc. This sample was just 1.02 times the acute and chronic aquatic life criteria. No samples exceeded the human health criterion for zinc. This evidence suggests this segment does not meet the aquatic life criteria for zinc. Because of the limited data, this segment should be closely monitored in the future to confirm this statement.

Spring Creek Segment MT41I006_080 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics(width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediment, macroinvertebrates, periphyton, fish habitat ratings, and water chemistry and dissolved oxygen.

The target and supplemental indicator values for all sediment measures were not met. Channel metrics were not comparable to reference streams, and that in itself signals potential problems for channel condition. D_{50} at the survey site was estimated to be one size-class smaller than expected, and is probably a reflection of excessive deposition of fine sediments as well as an indication of the extreme channel alterations that have occurred. The BEHI rating of “high” indicated that the stream banks are likely sources of sediment in the stream and might not be capable of withstanding high flows. A Proper Functioning Condition rating of “Non-functional” (NF) reflected that the stream is unable to sustain expected hydrologic characteristics, riparian vegetation, and sediment transport capacities. Values for both classes of fines from McNeil cores were above the target values. Suspended sediment data were not adequate to make a determination. The results of the macroinvertebrate and diatom samples both indicate impairment by sedimentation. Recent fisheries data suggest that this segment of the stream provides poor fish habitat.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment. No targets and few supplemental indicator values were being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Spring Creek Segment MT41I006_050 are impaired by siltation and possibly suspended solids. A TMDL will therefore be developed to address the sediment impairment.

The weight of evidence suggests that Spring Creek from Corbin Creek to the mouth has enough available data to warrant an impairment listing for nutrients. Six water chemistry samples were taken from July through August 2003 and from July to September 2004 during very low to moderate flow conditions. The available in-stream chemistry data indicated that total nitrogen, total Kjeldahl nitrogen, nitrate + nitrite-nitrogen, total phosphorus, and soluble reactive phosphorus concentrations exceeded the proposed target and supplemental indicator threshold values. No large fluctuations in dissolved oxygen were observed in a 24-hour period, which would have indicated the presence of excessive algal growths.

However, large macrophyte growths were noted upstream of the sampling site in 2004. In addition, metals loading to Spring Creek from Corbin Creek and associated algal toxicity might have prevented the development of nuisance algal growths in this segment of Spring Creek. The 2003 macroinvertebrate and periphyton data suggested minor to moderate impairment due to nutrient enrichment. Potential nutrient sources include sediment, rural home developments, pasture lands, dewatering, and an overall lack of riparian vegetation. A TMDL will be developed to address the nutrient listing.

The limited recent metals data suggest that Spring Creek from Corbin Creek to the mouth is impaired by arsenic, cadmium, copper, lead, and zinc. TMDLs will therefore be developed to address the arsenic, cadmium, copper, lead, and zinc impairments.

3.4.1.9 Middle Fork Warm Springs Creek from the Headwaters to the Mouth (MT41I006_100)

Middle Fork Warm Springs Creek is a tributary of Warm Springs Creek, which is a tributary of Prickly Pear Creek. The listed segment (MT41I006_100)of the Middle Fork extends for 2.7 miles from the headwaters to the mouth. In 1996, the cold-water fishery and aquatic life uses in the Middle Fork Warm Springs Creek were listed as partially supported because of siltation, habitat alterations, and metals. The basis for the listing is unknown. However, a habitat survey performed in 2001 reported substrate embeddedness, erosion-prone banks, and excessive road sediment inputs. In 2000, the stream was listed only for metals, while in 2002 siltation and other habitat alterations were again added as contributing causes of impairment. The 2000 and 2002 303(d) lists showed aquatic life, cold-water fishery, and drinking water uses as non-supported, and included arsenic, copper, and zinc as specific metals-related causes. A typical view of this segment is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey on the Helena National Forest (Helena National Forest) that included a Proper Functioning Condition assessment and pebble counts, McNeil core subsurface fines from two sites within the Helena National Forest, suspended sediment data, macroinvertebrate data, fish population measures, and water chemistry data.

Middle Fork Warm Springs Creek

Pollution Sources

The 2003 preliminary source assessment identified roads, waste rock tailings in the creek, and geology as the primary sediment and possibly metals sources for the Middle Fork of Warm Springs Creek. The Helena National Forest conducted a road sediment survey on the forest portion of the creek and identified 13 sites that, based on modeling using the Water Erosion Prediction Project (WEPP), contribute approximately 11.6 tons of sediment per year to the stream (USDA, 2004). The aerial photography inventory showed two road crossings and road encroachment along 56 percent of the stream. Most of the source assessment inventory sites consisted of road and mine sources.

The primary geology of this sub-watershed is the Boulder Batholith, which consists of highly erodible quartz monzonite. During the field source assessment, mine spoils were documented in the stream and floodplain, and areas of stream aggradation were observed. Channel incision was observed downstream of a breached mining dam. The aerial photography inventory showed that riparian buffers were extensive except where mine spoils prevented vegetative growth or where the road encroached on the stream. Extensive logging has occurred on private land within the Helena National Forest administrative boundary, but the site does not appear to be a recent harvest.

In summary, sources associated with roads and mine spoils are probably the biggest contributors of pollution to the Middle Fork of Warm Springs Creek. Land disturbance appears to exacerbate erosion in the Boulder Batholith geology and poorly developed soils of this sub-watershed. Severe channel alterations from mining occur near the headwaters of the stream and continue for a little over a mile downstream.

Expected significant contributors of metals to the stream segment are historical hard rock mining activities in the sub-watershed. A large tailings mine dump, observed in the middle of the stream during source assessment visits to the watershed, prevented vegetation growth and disrupted the natural channel.

Water in upper Middle Fork of Warm Springs Creek had a metallic sheen that might have been associated with the presence of metals ions. The headwaters of the creek fall within the McClellan mining district while the rest is within the Alhambra mining district. The MBMG Abandoned and Inactive Mines database reports surface, underground, mineral location, and prospect mining activities in the watershed. The historical mining types include placer, lode, and mill. In the past these mines produced gold, silver, lead, and copper. Two of the mines in the upstream section of the sub-watershed, Middle Fork Warm Springs (Alhambra district) and Solar Silver (Warm Springs district), are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites and are slated for cleanup. The state's inventory shows 12 other mines in this watershed.

Channel Survey

In 2003 the Helena National Forest conducted a field investigation on the Middle Fork of Warm Springs Creek, just above the confluence with the North Fork, and determined the stream to be a Rosgen stream type B5, but probably a B4 without channel disturbance. The width-to-depth ratio was 7.3, which is typical of incised channels and not comparable to reference B-type channels (Table 3-37). The BEHI rating was "low," and is actually better than the average for southwestern Montana B-type reference streams. D_{50} as determined in a zigzag Wolman pebble count consisted of very coarse sands. Although no Helena National Forest or Greater Yellowstone Area reference streams are specifically B5, this small median particle size probably indicates that excessive deposition of finer sized particles is occurring at this site.

The channel survey included an assessment of Proper Functioning Condition. The Helena National Forest rated this site "Functional – at risk" (FAR), and noted that the stream is attaining a new capacity. The riparian land type aggregate assigned to this site is 11, Granitic Rock – Rolling Uplands. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common and can be excessive.

Table 3-37. Summary of cross-sectional data for Middle Fork Warm Springs Creek, MT41I006_100.

Parameter	Result	Comparable to Reference
Width/depth ratio	7.3	No
BEHI	12.7	Yes
D_{50}	Very coarse sands	NA
PFC	FAR	Yes, upward trend

McNeil Cores

McNeil core data are available for two sites on the Middle Fork of Warm Springs Creek, both of which are within the Helena National Forest's administrative boundary. The oldest cores (six cores) were collected in 1993 in the southeastern quarter of Section 30, Township 8N, Range 2W. The riparian aggregate here was determined to be 11, Granitic Rock – Rolling Uplands (Table 3-38). The average percentage of fines less than 6.4 mm was 40 percent, with average fine fines (less than 0.85 mm) at 15.4 percent. These values are elevated against the means for fines from reference cores for riparian aggregate 11. The percentage of fines less than 6.4 mm for this site is 12 percent greater than the mean for reference riparian aggregate 11 cores, while the fine fines are 51 percent greater.

The second set of McNeil cores was collected in 2003 and corresponds to the channel survey site. Six cores were collected, and the riparian aggregate was once again determined to be 11. The average percentage of fines less than 6.4 mm was 71.3 percent, with the average fine fines at 16.9 percent. Results for the averages of both categories of fines are extremely elevated against the means for fines from reference cores for riparian aggregate 11. The percentage of fines less than 6.4 mm for this site is 99 percent greater the mean for reference riparian aggregate 11 cores, while the fine fines are 66 percent greater.

Table 3-38. Summary of McNeil core data for Middle Fork Warm Springs Creek, MT41I006_100.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
11	1993	40	15.4	Both fines values are elevated.
11	2003	71.3	16.9	Both fines values are elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Data were available for four sites along the creek, with 11 samples taken in 2000–2001. The highest value collected was 34 mg/L in June 2000 at the sampling site above the confluence with the North Fork (Table 3-39). The suspended sediment data had an average of 10.8 mg/L with a median of 7.0 mg/L. All of these values are comparable to values from selected reference streams for suspended sediment.

Table 3-39. Statistical summary of suspended sediment data for Middle Fork Warm Springs Creek, MT41I006_100.

Mean	10.8 mg/L
Median	7.0 mg/L
Standard deviation	10.5 mg/L
Maximum	34.0 mg/L
Number of samples	11
Number of sample sites	4

In August 2001, MDEQ staff collected one total suspended solids sample near the confluence with the North Fork. The total suspended solids value was less than 10 mg/L. In 2003, two visual observations of turbidity were recorded above the confluence with the North Fork. All observations reported the water clarity as clear, yet the observations were made during the recessional limb of peak flow and also during low flow.

Macroinvertebrates

Biological data from one sample taken in August 2001 near the Middle Fork's confluence with the North Fork were available. The macroinvertebrate habitat rating for this site was "optimal." Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2002b). The metric score of 94 percent indicated non-impairment and full support of aquatic life uses. Seventeen clinger taxa and seven trichoptera taxa were found at the site. Bollman concluded that fine sediments did not impair access to benthic habitat.

Periphyton

No recent data were available at the time of this writing.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database, and from the Helena National Forest. The Middle Fork of Warm Springs Creek is managed as a trout fishery. Brook trout are the only fish species thought to be common year-round residents of the creek. The overall habitat and sport fishery rating for this segment of the creek is "moderate."

Metals Concentrations

The project team evaluated a total of 27 in-stream water chemistry samples taken between June 2000 and August 2003. Arsenic concentrations in 25 of the 27 samples exceeded the human health criterion. The average concentration of all samples was 271 percent higher than the human health criterion. The highest measured concentration was 8.7 times the human health criterion for arsenic. No exceedances of the aquatic life criteria were observed. This evidence shows that this segment does not meet the human health standard for arsenic.

Cadmium concentrations in 26 samples, or the equivalent of 96 percent of all samples, exceeded the chronic aquatic life criterion. Of these, two also exceeded the acute aquatic life criterion, and one exceeded the human health criterion. The average concentration was 379 percent higher than the chronic aquatic life criterion. The highest measured concentration was 38 times the chronic aquatic life criterion, and 2.26 times the human health criterion. This evidence shows this segment does not meet the human health or aquatic life standards for cadmium.

Copper concentrations in all samples where below the human health and aquatic life criteria. This evidence suggests that this segment meets the human health and aquatic life standards for copper.

Lead concentrations in six samples, or the equivalent of 22 percent of all samples, exceeded the chronic aquatic life criterion. Of these, two also exceeded the human health criterion. The average of all samples was 12 percent higher than the chronic aquatic life criterion. The highest measured concentration was 8.2 times the chronic aquatic life criterion, and 2.0 times the human health criterion. This evidence shows that this segment does not meet the human health or aquatic life criteria for lead.

Zinc concentrations in 24 samples, or 89 percent of all samples, exceeded the acute and chronic aquatic life criteria. Of these, one sample also exceeded the human health criterion. The average concentration of all samples was 175 percent higher than the acute and chronic aquatic life criteria. The highest measured concentration was 25 times the acute and chronic aquatic life criteria, and 1.7 times the human health criterion. This evidence shows that this segment does not meet the human health or aquatic life criteria for zinc.

Middle Fork Warm Springs Creek MT41I006_100 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics(width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediment, macroinvertebrates, fisheries, and water chemistry.

No targets and few supplemental indicator values were met for sediment impairments. Although the Helena National Forest survey crew felt that the stream was attaining a new level of capability, many channel metrics were not comparable to reference streams. For instance, the BEHI rating of “low” was a reflection of the vigorous riparian vegetation observed at the sample site. However, the small width-to-depth ratio indicated channel incision and the D_{50} at the survey site was estimated to be smaller than expected. A Proper Functioning Condition rating of “Functional – at risk” (FAR) reflected that the stream was starting to adjust to channel alterations, but was not yet maintaining expected characteristics. Values for both sets of McNeil core samples exceeded target values, with the most recent cores displaying extreme deposition of fines in subsurface substrates. Suspended sediment values did not appear to exceed supplemental indicator values. In addition, the results from the macroinvertebrates sample did not indicate impairment from sedimentation. Recent fisheries data suggest that this segment of the stream provides moderate fish habitat.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment. No target values were being met and supplemental indicators revealed mixed results.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in the Middle Fork of Warm Springs Creek MT41I006_100 are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

The available water chemistry data suggest that the Middle Fork Warm Spring Creek is impaired by arsenic, cadmium, lead, and zinc. TMDLs will therefore be developed to address the arsenic, cadmium, lead, and zinc impairments.

3.4.1.10 North Fork Warm Springs Creek from the Headwaters to the Mouth (MT41I006_180)

The North Fork of Warm Springs Creek was added to the 303(d) list in 1998. The segment, which extends for 3.5 miles from its headwaters to the mouth, was originally listed as partially supporting its designated aquatic life and cold-water fishery uses because of siltation. However, its status changed in 2002 when it was listed as partially supporting cold-water fishery use and not supporting drinking water use because of metals, arsenic, bank erosion, fish habitat degradation, other habitat alterations, and organic enrichment/low dissolved oxygen. A typical view of the North Fork of Warm Springs Creek is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey on the Helena National Forest (Helena National Forest) that included a Proper Functioning Condition assessment and Wolman pebble counts, suspended sediment data, macroinvertebrate and periphyton data, fish population measures, and water chemistry monitoring results.

North Fork Warm Springs Creek

Pollution Sources

Most of the stream flows through a section of the Helena National Forest Elkhorn Management Unit. This area of the Elkhorn is managed for big game habitat and optimal water quality. The stream also flows through a section of private land, which has some dispersed housing along the creek.

The 2003 preliminary source assessment identified roads and geology as the primary sediment sources for this segment of the North Fork of Warm Springs Creek. The Helena National Forest conducted a road sediment survey on the forest portion of the creek and identified 27 sites that, based on modeling using the Water Erosion Prediction Project (WEPP) model, contribute approximately 15 tons of sediment per year to the stream (USDA, 2004). The aerial photography inventory showed two road crossings and road encroachment along 26 percent of the stream.

The primary geology of this sub-watershed is the Boulder Batholith, which consists of highly erodible quartz monzonite. The channel inventory showed deposition of sand in the stream channel. At the end of July 2003, the creek went dry at the mouth and was observed to carry flow to Warm Springs Creek only after rain. The aerial photography inventory showed that extensive conifer and deciduous riparian buffers were present on the Helena National Forest portion of the stream, but were limited in width on a small section of private property below the headwaters. Field sampling showed that the lower portion of the stream had healthy riparian vegetation. In summary, road runoff is probably the biggest contributor of sediment to the North Fork of Warm Springs Creek.

This stream segment is also affected by metals and habitat alterations. Expected significant contributors of metals to the stream segment are historical mining activities in the watershed. The majority of the drainage area of the stream falls within the Alhambra mining district. The MBMG Abandoned and Inactive Mines database reports underground mining activities in the watershed. The historical mining types include lode mining. In the past these mines produced gold, silver, lead, and copper. The state's inventory of mines shows two hard rock mines close to the headwaters and one mine close to the mouth of the stream. None of the mines in the basin is listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites.

Channel Survey

In 2003 the Helena National Forest conducted a field investigation on the North Fork of Warm Springs Creek, about one-half mile upstream of the mouth, and determined the stream to be a Rosgen stream type B4a. The width-to-depth ratio was 16.2, which is similar to other reference Ba-type streams that the Helena National Forest has inventoried (Table 3-40). The BEHI rating was in the mid-range of "moderate," which is about 17 percent greater than the average for B-type reference streams for southwestern Montana and the Greater Yellowstone Area. D_{50} as determined in a zigzag Wolman pebble count consisted of very fine gravels. The two B4a Helena National Forest reference streams had D_{50} particle sizes one and three size-classes larger than very fine gravels, while southwestern Montana and the Greater Yellowstone Area reference B4 streams average four size-classes larger.

The channel survey included a Proper Functioning Condition assessment. The Helena National Forest rated this site as "Functional – at risk" (FAR), citing excess sediment deposition and channel instability. The riparian land type aggregate assigned to this site is 11, Granitic Rock – Rolling Uplands. Surface and subsurface fines are common and can be excessive in this riparian aggregate, according to the Helena National Forest data.

Table 3-40. Summary of cross-sectional data for North Fork Warm Springs Creek, MT41I006_180.

Parameter	Result	Comparable to Reference
Width/depth ratio	16.2	Yes
BEHI	24	Yes
D_{50}	Very fine gravels	No
PFC	FAR	NA (trend not apparent)

McNeil Cores

No recent data are available.

Suspended Sediment Concentrations

Few recent data were available for the North Fork of Warm Springs Creek. The USGS National Water Information System had two records for suspended sediment from one sampling site taken in 2000 and 2001. The highest value collected was 5 mg/L in May 2001. Five total suspended solids samples were collected from two sites in the summer of 2003 and summer and fall of 2004. The highest value collected was 4.35 mg/L in August 2004. Three turbidity observations were recorded in 2003 and 2004. All observations reported the water clarity as clear, yet the observations were made during the recessional limb of peak flow and also during low flow.

Macroinvertebrates

Macroinvertebrate data from one sample taken in July 2000 above the mouth were available. The habitat rating for this site was "suboptimal" because of substrate embeddedness and sediment deposition. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2000). The metric score of 94 percent indicated non-impairment and full support of aquatic life uses. Fourteen clinger taxa and six trichoptera taxa were found at the site, and Bollman concluded that fine sediment probably does not limit benthic access to stony substrate habitats (Bollman, 2000).

Periphyton

Periphyton data from one sample taken in July 2000 above the mouth were available. Sampling results were compared with reference biocriteria metrics established for the Rocky Mountain Ecoregions of Montana (Bahls, 2001). Diatom metrics indicated moderate impairment and partial support of aquatic life uses. Bahls concluded that the impairment was due to heavy metals, excessive sedimentation, and organic loading. The siltation index exceeded the threshold for moderate impairment. However, Bahls concluded that the sediment impairment could be partially due to natural causes, including an erosive natural geology and the Warm Springs wildfire of 1988.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database and from the Helena National Forest. The North Fork of Warm Springs Creek is managed as a trout fishery. However, no data exist on fish population estimates. The overall habitat and sport fishery rating for this section of the creek is "limited," which is the lowest rating.

The U.S. Forest Service's fish distribution map for the Helena National Forest (USFS, 2003) indicates that brook trout were surveyed in this stream. There were no additional fisheries data available from the MFISH database.

Nutrient-related Data

Only a small amount of attached algae was observed in the North Fork of Warm Springs Creek during an August 2003 24-hour dissolved oxygen survey. Field measurements for dissolved oxygen made in July and August 2003 ranged from 7.8 to 10.2 mg/L (Appendix D). No violations of state dissolved oxygen standards for early life stages or other life stages of brook trout were documented in July and August 2003 when the dissolved oxygen sampling and field measurements were made.

No nutrient data were available for the post-1996 period prior to sampling in 2003. Out of 26 dissolved oxygen measurements taken during a 24-hour dissolved oxygen survey on August 7–8, 2003, no readings were below 6 mg/L. Individual dissolved oxygen measurements ranged between 6.0 and 7.8 mg/L. There were no large fluctuations noted during the 24-hour dissolved oxygen survey at monitoring stations near the mouth (M09WSNFC01) and above the Middle Fork (M09WSNFC02) (Appendix D). Nitrogen concentrations measured during summer 2003 did not appear to be a problem and both total Kjeldahl nitrogen and total nitrogen values were below the target values. Three total phosphorus values measured in 2003 ranged from 0.028 to 0.031 mg/L and were slightly above the target value 0.027 mg/L. 2003 total suspended solids values were low (1.15–1.51 mg/L), and were well below the supplemental indicator value of 23 mg/L (Appendix D).

The North Fork of Warm Springs Creek was sampled again at one station above the Middle Fork (M09WSNFC02) on August 27 and September 24, 2004. Field notes from these sampling efforts indicated there was more abundant riparian vegetation along the stream in 2004 than in 2003. Field measurements for dissolved oxygen showed concentrations ranging from 8.5 to 9.5 mg/L. Slightly higher flows were also recorded in the North Fork in 2004 (0.1–0.16 cfs) than in 2003. These higher flows were most likely due to recent rain. Algal and macrophyte growth in the stream in 2004 ranged from light to moderate according to the field notes. Periphyton chlorophyll-*a* values ranged from 26 to 27.4 mg/m^2 and were below the target value of 37 mg/m^2.

No target values for total phosphorus, total Kjeldahl nitrogen, or total nitrogen were exceeded in 2004 in samples collected in the North Fork of Warm Springs Creek above the Middle Fork. Nitrate + nitrite-N values were low as well, although two analyses for soluble reactive phosphorus were slightly elevated relative to the supplemental indicator thresholds.

Metals Concentrations

A total of seven in-stream water chemistry samples taken between October 2000 and August 2003 were evaluated. Arsenic concentrations in one sample (14.3 percent of all samples) exceeded the human health criterion. The concentration of this sample was 2.4 times the human health criterion. No samples exceeded the aquatic life criteria for arsenic. This evidence suggests that this segment does not meet the human health standard for arsenic.

Cadmium concentrations in one sample (14.3 percent of all samples) exceeded the chronic aquatic life criterion for cadmium. The concentration for this sample was 2.1 times the chronic aquatic life criterion. No samples exceeded the human health criterion for cadmium. This evidence suggests that this segment does not meet the aquatic life water quality standards for cadmium.

Copper concentrations in all samples were below the human health and aquatic life criteria. This evidence suggests that this segment meets the human health and aquatic life water quality standards for copper.

Lead concentrations in all samples were below the human health and aquatic life criteria. The highest measured value was 80 percent of the chronic aquatic life criterion. This is a borderline value. This evidence suggests this segment meets the aquatic life and human health standards for lead.

Zinc concentrations in one sample (14.3 percent of all samples) exceeded the acute and chronic aquatic life criteria. The zinc concentration in this sample was 1.6 times the acute and chronic aquatic life criteria. No samples exceeded the human health criterion. This evidence suggests this segment does not meet the aquatic life standards for zinc.

North Fork Warm Springs Creek MT41I006_180 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), suspended sediments, macroinvertebrates, periphyton, fisheries, and water chemistry.

No data are available for the target sediment parameters, and results from the supplemental indicator values are mixed. The supplemental indicator D_{50} was not met. D_{50} at the survey site was potentially at least one size-class smaller than expected, and might be a reflection of excessive deposition of fine sediments. However, data collected by the Helena National Forest for a B type reference stream in the same riparian aggregate also had the same D_{50}, but the gradient was about one degree less. The Proper Functioning Condition rating of “Functional – at risk” (FAR) was given mainly on the basis of excess sediment deposition. Suspended sediment data values were not adequate to make a determination. The results of the macroinvertebrate and diatom samples were contradictory. Recent fisheries data suggest that this stream provides limited habitat for few fish species.

Results of the 2003 Helena National Forest road sediment survey indicate that the Warm Springs Creek Road could contribute up to 15 tons of sediment to the creek annually. Although target sediment data are unavailable, many supplemental indicator values support the conclusion of impairment by sedimentation.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in the North Fork of Warm Springs Creek are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

The weight-of-evidence suggests that the North Fork of Warm Springs Creek (from the headwaters to the mouth) is not impaired by low dissolved oxygen or organic enrichment. The available in-stream dissolved oxygen data (more than 30 samples) from July and August 2003 indicate no large diurnal fluctuations of dissolved oxygen from two stations on this segment. Field notes indicate very little algae or aquatic growth during any of the sampling efforts. The lower portion of the stream was characterized as having healthy riparian vegetation during the source assessment work. The macroinvertebrate data also indicate that the biology fully supports designated uses. Therefore, a TMDL will not be developed to address low dissolved oxygen or organic enrichment.

The available water chemistry data suggest that the North Fork of Warm Springs Creek is impaired by arsenic, cadmium, and zinc. TMDLs will therefore be developed to address the arsenic, cadmium, and zinc impairments.

3.4.1.11 Warm Springs Creek from the Middle Fork to the Mouth (MT41I006_110)

In 1996, this 3-mile segment of Warm Springs Creek was listed as partially supporting aquatic life and cold-water fishery uses because of suspended solids and metals. The basis for the original listing is unknown. However, MDEQ habitat assessments conducted in 1999 and 2001 indicated that pool infilling and embeddedness are common. In subsequent years, the segment was listed as not supporting drinking water use and partially supporting aquatic life and cold-water fishery uses. Impairment causes included metals (arsenic, lead, and cadmium) and siltation. A typical view of this segment is shown in the photo below.

A review of the available data is provided below. These data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey about a mile and a half above the mouth that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from the reach surveyed in 2003, suspended sediment data, macroinvertebrate and fish population data, and a total of eight in-stream water chemistry samples taken between October 2000 and August 2003.

Warm Springs Creek

Pollution Sources

The 2003 preliminary source assessment identified roads and geology as the primary sediment sources for this segment of Warm Springs Creek. The aerial photography inventory showed 11 road crossings and road encroachment along 4 percent of the stream. Channelization at the mouth of the stream occurs due to I-15. Source assessment inventory sites consisted primarily of road sediment delivery sites.

The primary geology of this sub-watershed is the Boulder Batholith, with Quaternary alluvium present in the valley. Deposition of sand was observed in the stream channel during the channel inventory and pool infilling was common. The aerial photography inventory showed that deciduous riparian buffers were variable depending on landowner and typically ranged from 30 to 145 feet. Most of the creek is surrounded by private lands used for rural housing. In summary, road runoff is probably the biggest contributor of sediment to Warm Springs Creek.

Expected relevant sources of metals in the stream segment are tributary streams, possible natural hot springs, and historical mining activities in the immediate drainage area. The tributaries, the North Fork and Middle Fork of Warm Springs, are likely significant contributors of metals. The immediate drainage area of this stream falls within the Alhambra mining district. The MBMG Abandoned and Inactive Mines database shows hot spring, mineral location, and underground mining activities in the drainage area of the stream. The historical mining types include lode and placer mining. In the past these mines produced gold, silver, lead, copper, and zinc. The Alhambra Hot Springs Mine is listed in the State of Montana’s inventory of High Priority Abandoned Hardrock Mine Sites.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation on Warm Springs Creek, about 1.5 miles above the mouth. The field crew determined the stream to be a Rosgen stream type C4. The width-to-depth ratio was 17.2, which is comparable to C-type reference streams for southwestern Montana and the Greater Yellowstone Area (Table 3-41). The BEHI rating was in the upper range of “moderate,” which is 29 percent greater than C-type reference streams for southwestern Montana and the Greater Yellowstone Area. D_{50} as determined in a zigzag Wolman pebble count consisted of coarse gravels. The D_{50} was one size-class smaller than for the C-type reference streams in the southwestern Montana and Greater Yellowstone Area.

Part of the channel survey included a Proper Functioning Condition assessment. The field crew rated this site as “Functional – at risk” (FAR), citing excess sediment deposition, lack of pools, and channel alterations (culverts, riprap). The riparian land type aggregate assigned to this site is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive. However, the influence of the granitic geology could elevate the fines values slightly.

Table 3-41. Summary of cross-sectional data for Warm Springs Creek, MT41I006_110.

Parameter	Result	Comparable to Reference
Width/depth ratio	17.2	Yes
BEHI	26.3	No
D_{50}	Coarse gravels	No
PFC	FAR	Yes

McNeil Cores

McNeil core data are available for one site on this segment of Warm Springs Creek—the channel survey site. Only three cores were collected due to the difficulty of locating sites with spawning characteristics. The riparian aggregate here was determined to be 29, Alluvial (Borolls) Floodplains and Terraces (Table 3-42). The average percentage of fines less than 6.4 mm was 39.9 percent, with average fine fines (less than 0.85 mm) at 12.9 percent. The percentage of fines less than 6.4 mm for this site is 18 percent greater than the reference value average, while the fine fines are 59 percent above the reference value average.

Table 3-42. Summary of McNeil core data for Warm Springs Creek, MT41I006_110.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
29	2003	39.9	12.9	Both fines values are elevated.

Suspended Sediment Concentrations

Few recent data were available for Warm Springs Creek. The USGS National Water Information System had three records for suspended sediment from one site near the mouth sampled in 2000 and 2001. The highest value collected was 14 mg/L in October 2000. MDEQ staff collected one total suspended solids sample near the mouth in August 2001. The value was more than 10 mg/L. Two turbidity observations were recorded during summer sampling in 2003. All observations reported the water clarity as clear, yet the observations were made during the recessional limb of peak flow and also during low flow.

Macroinvertebrates

Macroinvertebrate data from one sample taken in August of 2001 above the mouth were available. The habitat rating for this site was "suboptimal" because of substrate embeddedness and channel alteration. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2002b). The metric score of 33 percent indicated moderate impairment and partial support of aquatic life uses. Clinger richness was not given. Seven trichoptera taxa were found at the site. Bollman concluded that fine sediment probably does not limit benthic access to stony substrate habitats (2002b).

Periphyton

No recent data are available.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database, and from the Helena National Forest. Warm Springs Creek is managed as a trout fishery, and eastern brook trout are the only species thought to be common. The overall habitat and sport fishery rating for this section of the creek is "moderate."

Metals Concentrations

The project team evaluated a total of eight in-stream water chemistry samples taken between October 2000 and August 2003. Arsenic concentrations in seven of the eight samples exceeded the human health criterion. The average concentration of all samples was 34 percent higher than the human health criterion. The highest measured arsenic concentration was 1.6 times the human health criterion. No exceedances of the aquatic life criteria were observed for arsenic. This evidence suggests that this segment does not meet the human health water quality standard for arsenic.

One sample (12.5 percent of all samples) exceeded the chronic aquatic life criterion for cadmium. This sample was 1.6 times the chronic aquatic life criterion. No exceedances of the human health criterion were observed for cadmium. The limited evidence suggests that this segment does not meet the aquatic life water quality standards for cadmium.

No samples were found to exceed either the human health or the aquatic life criteria for copper. The limited evidence suggests that this segment meets the human health and aquatic life criteria for copper. This segment should be monitored closely in the future to confirm this statement.

One sample (12.5 percent of all samples) exceeded the chronic aquatic life criterion for lead. This sample was 1.2 times the chronic aquatic life criterion. No exceedances of the human health criterion were observed for lead. The limited evidence suggests that this segment does not meet the aquatic life standard for lead.

One sample (12.5 percent of all samples) exceeded the acute and chronic aquatic life criteria for zinc. The concentration was 1.13 times the acute and chronic aquatic life criteria levels. No exceedances of the human health criterion were observed for zinc. This evidence suggests that this segment does not meet the aquatic life water quality standards for zinc.

Warm Springs Creek MT41I006_110 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics(width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediment, macroinvertebrates, fisheries, and water chemistry.

The target sediment values are not being met and results from the supplemental indicator values are mixed. Supplemental indicators for the channel metrics of BEHI and D_{50} were not met. An elevated BEHI rating indicates that stream banks might be a source of sediment to the stream. D_{50} at the survey site was one size-class smaller than expected and might be a reflection of excessive deposition of fine sediments. The Proper Functioning Condition rating of “Functional – at risk” (FAR) was given mainly on the basis of excessive sediment deposition. Suspended sediment data were not adequate to make a determination. The results of the macroinvertebrates sample suggest non-impairment by fine sediments, yet the corresponding habitat survey scores were low because of embeddedness. Recent fisheries data suggest that this stream provides moderate habitat for few fish species.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment. No target values were being met and supplemental indicators revealed mixed results.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Warm Springs Creek are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

The available water chemistry analysis results suggest that Warm Springs Creek from Middle Fork to the mouth is impaired by arsenic, cadmium, lead, and zinc. TMDLs will therefore be developed to address the arsenic, cadmium, lead, and zinc impairments.

3.4.1.12 Clancy Creek from the Headwaters to the Mouth (MT41I006_120)

Stream segment MT41I006_100, approximately 11.6 miles in length, was listed as partially supporting aquatic life, cold-water fishery, drinking water, and recreational uses on Montana's 1996 303(d) list. In subsequent years, the list was modified to show aquatic life, cold-water fishery, and drinking water uses as non-supporting. Impairment causes in 1996 included siltation, suspended solids, habitat alterations, nutrients, and metals. Channel incisement and lead, arsenic, and mercury were added to the list of impairment causes in later 303(d) lists. A typical view of Clancy Creek is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), two cross-sectional surveys on the creek below the Gregory Mine and above the town of Clancy, McNeil core subsurface fines from both survey sites, suspended sediment data, macroinvertebrate data, fish population measures, and a total of 18 in-stream water chemistry samples taken between June 2000 and August 2003. Both cross-sectional surveys included a Proper Functioning Condition assessment, and Wolman pebble counts.

Clancy Creek

Pollution Sources

The 2003 preliminary source assessment identified roads, grazing, geology, and mine waste as the primary sediment sources for this segment of Clancy Creek. Most of the source assessment inventory sites consisted of road and grazing sites. The aerial photography inventory showed eight road crossings and road encroachment along 12 percent of the stream. About 47 percent of the stream segment is channelized from historical placer mining operations and from I-15 for a small section near the mouth.

The primary geology of this sub-watershed is the Boulder Batholith, with Quaternary sediments prominent in the lower floodplains. The aerial photography inventory showed that hard rock mining and grazing sources were most notable in the upper portion of the segment. Below Quartz Creek, severe alterations from placer mining begin and continue almost to the town of Clancy. The stream has been widened, straightened, and incised as a result of placer mining, which might have altered the stream's hydrology in addition to its morphology. The widths of deciduous riparian buffers ranged from 0 to 115 feet and were correlated to land management practices, including hay cultivation, placer tailings mounds, and development close to the stream. Private property borders most of the stream, and the BLM is the only other landowner. The primary land use is grazing, with a deferred rotation grazing system on BLM lands. There is also evidence of past beaver activity. From the confluence of Quartz Creek to the mouth, the primary land uses are hay fields and pasture, and rural housing.

In summer 2003, extensive gully and rill erosion was observed on the upper portions of Clancy Creek Road delivering sediment directly to the stream. This segment is surrounded by private land, with the dominant land uses of pasture and hay fields, and rural housing. The last one-half mile of the creek flows through the small town of Clancy. In summary, road runoff and localized sources (grazing, tailings piles) are probably the biggest contributors of sediment to Clancy Creek. Placer mining operations have altered the channel's form.

Expected significant contributors of metals to the stream segment are historical mining activities in the upper watershed. The source assessment showed that, among the 303(d)-listed segments in the Lake Helena TPA, placer mine tailings are the most extensive on Clancy Creek. The headwaters of the watershed fall within the Colorado mining district while the rest is within the Clancy mining district. The MBMG Abandoned and Inactive Mines database reports mineral location, placer, underground, and surface-underground mining activities in the watershed. The historical mining types include placer, lode, and mill. In the past these mines produced manganese, lead, silver, copper, zinc, and gold. Three mines in the headwaters—Gregory, Argentine, and Crawley Camp—are within the Colorado district and are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites. The state's inventory shows at least 10 other mines in the headwaters area of this watershed.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted two field investigations along Clancy Creek, just below the Gregory Mine and above the town of Clancy.

At the site below the Gregory Mine, the field crew determined the stream to be a Rosgen stream type B4. The width-to-depth ratio was 9.8, which is less than most of the reference stream data for Helena National Forest reference B4 stream types and less than the average of southwestern Montana and Greater Yellowstone Area B-type streams. The width-to-depth ratio does reflect channel incision and is more typical of A- and G-type streams. The BEHI rating was in the lower range of "moderate," but was 15 percent above the average for B-type reference streams for southwestern Montana and the Greater Yellowstone Area. D_{50} as determined in a zigzag Wolman pebble count consisted of coarse gravels. The

D_{50} was comparable to other Helena National Forest B4 reference streams, and was one size-class smaller than in southwestern Montana and Greater Yellowstone Area B-type reference streams.

The channel survey included an assessment of Proper Functioning Condition. Tetra Tech and Land & Water Consulting rated the reach below the Gregory Mine as "Non-functional" (NF). The field crew noted that road, grazing, and mining impacts were present. The riparian land type aggregate assigned to this survey site is 18, defined as Volcanic Rock – Rolling Uplands. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface fines are not very common and subsurface fines are common but generally not excessive.

At the site above the town of Clancy, the field crew determined the stream to be a Rosgen stream type B4c. The stream is probably recovering from an F4 channel form, and would probably be a C4 stream under natural conditions. The width-to-depth ratio was 28, more than 30 percent greater than the average for southwestern Montana and Greater Yellowstone Area C-type reference streams and more than 50 percent greater than the reference B-type average (Table 3-43). The BEHI rating was "moderate." The BEHI rating was in the lower range of moderate, and was within 10 percent of the average for C-type reference streams in southwestern Montana and the Greater Yellowstone Area and 12 percent of the average for B-type streams. D_{50} as determined in a zigzag Wolman pebble count consisted of fine gravels. The D_{50} was three size-classes under southwestern Montana and Greater Yellowstone Area reference C4 and B4-type streams.

The channel survey included a Proper Functioning Condition assessment. The field crew rated the reach above Clancy as "Non-functional" (NF). The main reason for the rating was severe channel alteration from placer mining, followed by riparian impacts from grazing. The riparian land type aggregate assigned to the survey sites is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive.

Table 3-43. Summary of cross-sectional data for Clancy Creek, MT41I006_120.

Site	Parameter	Result	Comparable to Reference
Below the Gregory Mine	Width/depth ratio	9.8	No
Below the Gregory Mine	BEHI	23.5	Yes
Below the Gregory Mine	D_{50}	Coarse gravels	Yes
Below the Gregory Mine	PFC	NF	No
Above Clancy	Width/depth ratio	28	No
Above Clancy	BEHI	22.9	Yes
Above Clancy	D_{50}	Fine gravels	No
Above Clancy	PFC	NF	No

McNeil Cores

McNeil core data are available for two sites on Clancy Creek—the channel survey sites. Six cores were collected at the site below the Gregory mine. The riparian aggregate here was determined to be 18, Volcanic Rock – Rolling Uplands (Table 3-44). The average percentage of fines less than 6.4 mm was 30.5 percent, with average fine fines (less than 0.85 mm) at 7.4 percent. These values are slightly below the range expected based on the means for fines from all reference cores collected by the Helena National Forest (there are no reference cores specifically from aggregate 18).

The second set of McNeil cores was collected at the site above Clancy. Six cores were collected, and the riparian aggregate was determined to be 29, Alluvial Floodplains and Terraces. The average percentage of fines less than 6.4 mm was 49.7 percent, with average fine fines at 17.5 percent. Results for the averages of both categories of fines are extremely elevated against the means for fines from reference cores for riparian aggregate 29. The percentage of fines less than 6.4 mm for this site is 47 percent greater than the mean for reference riparian aggregate 29 cores, while the fine fines are 116 percent greater.

Table 3-44. Summary of McNeil core data for Clancy Creek, MT41I006_120.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
18	2003	30.5	7.4	Yes
29	2003	49.7	17.5	Both fines values are elevated.

Suspended Sediment Concentrations

Few recent data were available from the USGS National Water Information System for Clancy Creek. From 2000 to 2001, nine suspended sediment samples were collected at three sites. The highest value collected was 26 mg/L in May 2001 near the town of Clancy. The MDEQ gathered total suspended solids data from 2001 to 2003, collecting eight samples at three sites. The highest value was 35 mg/L in August 2001 just upstream of the town of Clancy. Although the data set is limited, no values were greater than what would be expected based on suspended sediment values from selected reference streams. In 2003, six turbidity observations were recorded on Clancy Creek at three sites. All observations reported the water clarity as clear.

Macroinvertebrates

Macroinvertebrate data from one sample taken in August 2001 near the headwaters were available. The macroinvertebrate habitat rating for this site was "optimal." Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2001). The metric score of 56 percent indicated slight impairment and partial support of aquatic life uses. Five clinger taxa and four trichoptera taxa were found at the site, and Bollman concluded that fine sediment might be limiting habitat for macroinvertebrates. In addition, the macroinvertebrate survey suggested water quality might be impaired by nutrients associated with large organic debris (leaves, grass blades, or twigs), reducing the numbers of mayflies (Bollman, 2003a).

Periphyton

No recent data were available; however, the 2001 MDEQ stream reach assessment form reported the results of a visual assessment of aquatic plant growth, which consisted predominantly of diatom algae.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database and data from the Helena National Forest. Clancy Creek is managed as a trout fishery. Brook trout are common year-round residents in Clancy Creek below the confluence with Kady Gulch, while genetically pure westslope cutthroat trout, a species of special concern, have been found in the upper 2 miles of the stream. The

Helena National Forest's fisheries data concur with the MFISH data. The overall habitat and sport fishery rating for Clancy Creek is "moderate."

Nutrient-related Data

The available post-1996 data did not have sufficient temporal and spatial resolution for a determination regarding possible nutrient impairments in Clancy Creek. Several total Kjeldahl nitrogen and total nitrogen measurements (two of eight available) and total phosphorus measurements (three of eight) were elevated in 2001 relative to the target values (Appendix D). In summer 2003, only one total phosphorus measurement of six taken was above the total phosphorus target value, and the rest of the nutrient variables (total nitrogen and soluble reactive phosphorus) were measured at concentrations below the target and supplemental indicator values (Appendix D).

During an August 2003 24-hour dissolved oxygen survey in lower Clancy Creek (M09CLNCC04), field notations reported good flow conditions (approximately 3 cfs) and limited algal growth. No large diurnal fluctuations in dissolved oxygen were recorded and individual measurements ranged from 7.3 to 9.1 mg/L. Six periphyton chlorophyll-*a* samples collected in 2003 yielded measurements ranging from 5.0 to 40 mg/m^2. Total suspended solids values in six samples were all below the supplemental indicator threshold and these ranged from less than 1 to 9.5 mg/L (Appendix D).

The dissolved oxygen survey in August 2003 showed no violations of dissolved oxygen standards designed to protect early life stages or other life stages of cutthroat trout in the upper sections of this creek (Appendix D). The readings were also below dissolved oxygen thresholds for early life stages or other life stages of brook trout.

Metals Concentrations

The project team evaluated a total of 18 in-stream water chemistry samples taken between June 2000 and August 2003. Arsenic concentrations in seven samples exceeded the human health criterion. The average concentration in all samples was 28 percent higher than the human health criterion. The highest measured concentration was 3.7 times the human health criterion for arsenic. No samples exceeded the aquatic life criteria for arsenic. This evidence suggests this segment does not meet the human health criterion for arsenic.

Cadmium concentrations in six samples (33 percent of all samples) exceeded the chronic aquatic life criterion. The average concentration of all samples was 68 percent higher than the chronic aquatic life criterion. The highest measured concentration was 7.1 times the chronic criterion for cadmium. No exceedances of the human health criterion were observed. This evidence shows this segment does not meet the aquatic life criterion for cadmium.

Lead concentrations in three samples (17 percent of all samples) exceeded the chronic aquatic life criterion. Of these, one also exceeded the human health criterion. The average concentration for all samples was just 11 percent below the chronic aquatic life criterion. The highest measured concentration observed was 5.7 times the chronic aquatic life criterion, and 1.3 times the human health criterion. This evidence shows that this segment does not meet the human health or aquatic life criteria for lead.

Zinc concentrations in five samples (28 percent of all samples) exceeded the acute and chronic aquatic life criteria. The highest measured concentration was 2.5 times the acute and chronic aquatic life criteria. No exceedances of the human health criterion were observed. This evidence shows this segment does not meet the aquatic life criteria for zinc.

Clancy Creek MT41I006_120 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediments, macroinvertebrates, fisheries, and water chemistry.

The data suggest that sediment impairments in Clancy Creek increase in a downstream direction. At the upstream site, all targets and many supplemental indicator values were met or exceeded. The Proper Functioning Condition rating of “Non-functional” (NF) was mainly made because the stream was not meeting expected hydrologic and riparian characteristics. Yet, the macroinvertebrate sample collected in the headwaters indicated a possibility of impairment by fine sediments. At the lower survey site target values and many supplemental indicator values were not met. The only channel metric to meet standards was BEHI. However, the excessive width-to-depth ratio is probably a reflection of the channel alterations from historical placer mining and does not necessarily represent a widening of the stream course due to excessive sediment loads. However, a smaller than expected D_{50} and a Proper Functioning Condition rating of NF both indicate sediment transport issues. Available suspended sediment data were inadequate for a determination, but the highest recorded values were measured near the mouth. Recent fisheries data suggest that the upper portion of the stream provides habitat for westslope cutthroat trout.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment. Numerous impairments to channel condition occurred along many reaches of the channel. At the sampling site above Clancy, targets and supplemental indicator values were not being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Clancy Creek Segment MT41I006_120 are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

The weight of evidence suggests that Clancy Creek (from the headwaters to the mouth) is not impaired by nutrients. Only one total phosphorus sample of six samples collected at three stations in this segment in July and August 2003 was above the total phosphorus target value. The remaining nutrient samples collected from these three stations in 2003 (total nitrogen, total phosphorus, soluble reactive phosphorus) were under the target or supplemental indicator values. The available in-stream dissolved oxygen data from July and August 2003 indicate no large diurnal fluctuations of dissolved oxygen at one station on this segment. Five periphyton chlorophyll-*a* values and six total suspended solids samples were below the proposed supplemental indicator value ranges. Therefore, a TMDL will not be developed to address low dissolved oxygen or organic enrichment.

The available water chemistry data suggest that Clancy Creek is impaired by arsenic, cadmium, copper, lead, and zinc. TMDLs will therefore be developed to address the arsenic, cadmium, copper, lead, and zinc impairments.

3.4.1.13 Lump Gulch from the Headwaters to the Mouth (MT41I006_130)

In 1996, the cold-water fishery, aquatic life, and drinking water uses in the 14.5 miles of Lump Gulch were listed as partially supported because of suspended solids and metals. In subsequent years, Lump Gulch was listed as not supporting cold-water fishery, aquatic life, and drinking water uses, and cadmium, mercury, copper, lead, and zinc were added to the list of metals. Suspended solids were removed as a suspected cause of impairment. The basis for the listing is from inventories performed in 1980 and 1994 that describe eroding stream banks and anthropogenic sediment inputs to the stream. An Environmental Impact Statement released in 2000 by the Helena National Forest described a thousand-fold increase in sediment inputs over natural conditions because of human-caused disturbance (based on models). Water chemistry data supported the metals listings. A typical view of Lump Gulch is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), two cross-sectional surveys on the creek above the confluence with the Park Lake drainage and below Little Buffalo Gulch, McNeil core subsurface fines from three survey sites, suspended sediment data, fish population information, and water chemistry data from a total of 29 samples taken between June 2000 and August 2003. Both cross-sectional surveys included a Proper Functioning Condition assessment and Wolman pebble counts.

Lump Gulch

Pollution Sources

The 2003 preliminary source assessment identified roads, grazing, geology, and mine waste as the primary sediment sources for Lump Gulch. The Helena National Forest conducted a road sediment survey on the forest portion of the creek and identified five sites that, based on modeling using the Water Erosion Prediction Project (WEPP) model, contribute approximately 3 tons of sediment per year to the stream (USDA, 2004). Most of the source assessment inventory sites consisted of road and mine sources. The aerial photography inventory showed 17 road crossings and road encroachment along 22 percent of the stream.

The primary geology of this sub-watershed is the Boulder Batholith, with Quaternary sediments prominent in the lower floodplains. The aerial photography inventory revealed that hard rock mining, grazing, and logging sources were notable on the Helena National Forest portion of the segment. The channel has been altered as a result of historical mining, and is incised and artificially embanked in many areas in the upper half of the stream. Below the Helena National Forest's administrative boundary, housing development is prominent and riparian buffer widths decrease.

In summary, road runoff and localized sources (grazing, tailings piles) are probably the biggest contributors of sediment to Lump Gulch. Historical hard rock mining operations have altered the channel's form.

Expected significant contributors of metals to the stream segment are historical mining activities in the upper watershed. The headwaters of the watershed fall within the Clancy mining district. The MBMG Abandoned and Inactive Mines database reports mineral location, placer, surface, and underground mining activities in the watershed. The historical mining types include placer, lode, and mill. In the past these mines produced lead, copper, zinc, silver, gold, and uranium. In the headwaters area there are over 10 historical hard rock mines, including 4 sites in Frohner Basin and the Clancy district— Nellie Grant, Frohner (two mines), and General Grant—that are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites. The aerial photography assessment showed the drainage to be disrupted by historical mining dams at the Frohner Meadows Mine. The Helena National Forest documented along this stretch of the stream included road sediment delivery points, mine waste rock dumps, a mining dam, and channel incision.

Channel Survey

In 2003 Tetra Tech, Land & Water Consulting, and the Helena National Forest conducted two field investigations along Lump Gulch, above the confluence with the Park Lake drainage and below Little Buffalo Gulch.

At the site above the confluence with the Park Lake drainage, the Helena National Forest determined the stream to be a Rosgen stream type B4a. The width-to-depth ratio was 21.3, which is greater than reference stream data for Helena National Forest B4a reference stream types and 59 percent greater than the average for southwestern Montana and Greater Yellowstone Area B-type streams. The BEHI rating was in the lower range of "moderate," and about equal to the average for B-type reference streams for southwestern Montana and the Greater Yellowstone Area. D_{50} as determined in a zigzag Wolman pebble count consisted of very coarse gravels. The D_{50} was comparable to other Helena National Forest B4a reference streams, and southwestern Montana and Greater Yellowstone Area B reference streams.

The channel survey included a Proper Functioning Condition assessment. The Helena National Forest rated the reach above Park Lake as "Functional – at risk" (FAR), noting that the stream is recovering from channel alterations. The field crew noted that the stream was incised with areas of vertical unstable banks, and that pool infilling was occurring. The riparian land type aggregate assigned to this survey site is 27, Friable Loamy Glacial Till Moraines. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface fines are common and subsurface fines can be excessive.

At the site below Little Buffalo Gulch, the field crew determined the stream to be a Rosgen stream type B4c. The width-to-depth ratio was 12.2, which is comparable to reference stream data for Helena National Forest B4 reference stream types and as well as the average for southwestern Montana and Greater Yellowstone Area B-type streams (Table 3-45). The BEHI rating was in the lower range of "moderate" and within 5 percent of the average for B-type reference streams for southwestern Montana and the Greater Yellowstone Area. D_{50} as determined in a zigzag Wolman pebble count consisted of fine gravels. The D_{50} was smaller than most Helena National Forest B4 s reference stream types and three size-classes smaller than southwestern Montana and Greater Yellowstone Area B4-type reference streams.

Part of the channel survey included a Proper Functioning Condition assessment. The field crew rated the reach below Little Buffalo Gulch as "Functional – at risk" (FAR). The stream was noted as being incised but stabilizing, with a fair amount of sediment deposition.   The riparian land type aggregate assigned to the survey sites is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive. However, the influence of the granitic geology could elevate the fines values slightly.

Table 3-45. Summary of cross-sectional data for Lump Gulch, MT41I006_130.

Site	Parameter	Result	Comparable to Reference
Above Park Lake	Width/depth ratio	21.3	No
Above Park Lake	BEHI	21	Yes
Above Park Lake	D_{50}	Very coarse gravels	Yes
Above Park Lake	PFC	FAR	Yes
Below Little Buffalo Gulch	Width/depth ratio	12.2	Yes
Below Little Buffalo Gulch	BEHI	21.5	Yes
Below Little Buffalo Gulch	D_{50}	Fine gravels	No
Below Little Buffalo Gulch	PFC	FAR	Yes

McNeil Cores

McNeil core data are available for three sites on Lump Gulch, two of which are within the Helena National Forest's administrative boundary. The oldest cores (six cores) were collected in 1989. The exact location of the core sites is unknown; therefore, a riparian aggregate cannot be determined (Table 3-46). The average percentage of fines less than 6.4 mm was 51.5 percent, with average fine fines at 17.7 percent. The percentage of fines less than 6.4 mm for this site is 57 percent greater than the mean for all reference cores collected by the Helena National Forest, and the fine fines are 77 percent above the mean.

The Helena National Forest collected the second set of McNeil cores (three cores) in 2003 at the field survey site above Park Lake. The riparian aggregate here was determined to be 27, defined as Friable

Loamy Glacial Till Moraines. The average percentage of fines less than 6.4 mm was 44.6 percent, with average fine fines (less than 0.85 mm) at 7.1 percent. These values are over 20 percent less than the means for fines from reference cores for riparian aggregate 27.

The third set of McNeil cores was collected at the site below Little Buffalo Gulch. Six cores were collected, and the riparian aggregate was determined to be 29, Alluvial Floodplains and Terraces. The average percentage of fines less than 6.4 mm was 45.5 percent, with average fine fines at 17.8 percent. The averages for both categories of fines are elevated against the means for fines from reference cores for riparian aggregate 29. The percentage of fines less than 6.4 mm for this site is 34 percent greater the mean for reference riparian aggregate 29 cores, while the fine fines are 12 percent greater.

Table 3-46. Summary of McNeil core data for Lump Gulch, MT41I006_130.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
Unknown	1989	51.5	17.7	Both fines values are elevated.
27	2003	44.6	7.1	Yes
29	2003	45.5	17.8	Both fines values are elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Data were available for nine sites on Lump Gulch, with 25 samples taken from 2000 to 2001. The highest value collected was 23 mg/L in May 2001 at the sampling site above Frohner Meadows (Table 3-47). The suspended sediment data had an average of 4.8 mg/L with a median of 3.0 mg/L. All of these values are comparable to values from selected reference streams for suspended sediment.

Table 3-47. Statistical summary of suspended sediment data for Lump Gulch, MT41I006_130.

Mean	4.8 mg/L
Median	3.0 mg/L
Standard deviation	5.2 mg/L
Maximum	23.0 mg/L
Number of samples	25
Number of sample sites	9

In 2003, six turbidity observations were recorded at three sites along Lump Gulch. Five observations reported the water clarity as clear. The July observation above Park Lake reported the water as slightly turbid with an orange tint. The observations were made during the recessional limb of peak flow and also during low flow.

Macroinvertebrates

No recent data are available.

Periphyton

No recent data are available.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database and data from the Helena National Forest. Lump Gulch is managed as a trout fishery. According to MFISH, brook trout and mottled sculpin are common year-round residents in the lower 5 miles of Lump Gulch, while genetically pure westslope cutthroat trout, a species of special concern, and rainbow/cutthroat hybrids have been found in the upper 6 miles of the stream. The Helena National Forest estimates that brook trout occupy Lump Gulch for as much as 11 miles upstream from the mouth. The overall habitat and sport fishery rating for Lump Gulch is "moderate."

Metals Concentrations

The project team evaluated a total of 29 samples taken between June 2000 and August 2003. Arsenic concentrations in all samples were below the human health and aquatic life criteria. This evidence shows this segment meets the human health and aquatic life criteria for arsenic.

Cadmium concentrations in 12 samples (41 percent of the available samples) exceeded the chronic aquatic life criterion. Of these, four also exceeded the acute aquatic life criterion. The average of all samples was 218 percent higher than the chronic aquatic life criterion. The highest measured concentration was 20.7 times the chronic aquatic life criterion. This evidence shows this segment does not meet the aquatic life criteria for cadmium.

Copper concentrations in two samples (seven percent of all samples) exceeded the chronic aquatic life criterion. The highest measured concentration was 1.10 times the chronic aquatic life criterion. No samples were above the human health criterion. This evidence suggests that this segment does not meet the aquatic life water quality standards for copper.

Lead concentrations in three samples (10 percent of all samples) exceeded the chronic aquatic life criterion for lead. The highest measured concentration was 2.24 times the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence shows this segment does not meet the aquatic life standards for lead.

Zinc concentrations in 14 samples (48 percent of all samples) exceeded the acute and chronic aquatic life criteria for zinc. The average concentration of all samples was 160 percent higher than the acute and chronic aquatic life criteria. The highest measured concentration was 23 times the acute and chronic aquatic life criteria. No samples exceeded the human health criterion. This evidence shows this segment does not meet the aquatic life standards for zinc.

Lump Gulch MT41I006_130 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediments, fisheries, and water chemistry.

Results from the data assessment are mixed, but the majority of target values were not met. At the upper sample site, target values were met and most supplemental values were met except for the width-to-depth ratio. The elevated width-to-depth ratio is probably a reflection of the severe channel alterations that have occurred from mining, and does not necessarily reflect stream aggradation. However, the fines data collected at an unknown sampling location in the upper portion of Lump Gulch did not meet subsurface fines target thresholds. At the lower sample site, targets were exceeded but many supplemental indicator values were met. A smaller than expected D_{50} at this site could indicate deposition of surface fines, which was noted during the Proper Functioning Condition assessment. Suspended sediment values were comparable to reference conditions. Recent fisheries data suggest that the upper portion of the stream provides habitat for westslope cutthroat trout and rainbow/cutthroat hybrids.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment. Numerous impairments to channel condition occurred along many reaches of the channel. The majority of target values were not being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Lump Gulch Segment MT41I006_130 are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

The more recent water chemistry data suggest that Lump Gulch is impaired by cadmium, copper, lead, and zinc. TMDLs will therefore be developed to address the cadmium, copper, lead, and zinc impairments.

3.4.1.14 Jackson Creek from the Headwaters to the Mouth (MT41I006_190)

In 1998, the cold-water fishery and aquatic life uses in the 2.5 miles of Jackson Creek were listed as partially supported because of siltation. The basis for the listing is unknown, and in 1998 and subsequent years the stream was removed from the 303(d) list because of insufficient credible data. A typical view of Jackson Creek is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey above the mouth that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from the reach surveyed in 2003, suspended sediment data, and fisheries population information.

Jackson Creek

Pollution Sources

The 2003 preliminary source assessment identified fire effects, geology, and roads as the primary sediment sources for Jackson Creek. The aerial photography inventory showed 10 road crossings and road encroachment along 4 percent of the stream. No source assessment sites were taken in the field because of access constraints.

The primary geology of this sub-watershed is the Boulder Batholith, which consists of highly erodible quartz monzonite. Deposition of sand was observed in the stream channel at the field sampling site. In 1988, the whole drainage was burned over in the Warm Springs wildfire. The aerial photography assessment, which was based on 1999 vintage, post-fire photos, showed that most vegetation present in the sub-watershed was restricted to riparian areas. The headwaters area has extremely rugged terrain with exposed rock outcrops and rock slides. There is some dispersed housing near the creek on the private land close to the creek's mouth.

In summary, fire effects and erosive geology are probably the biggest contributors of sediment to Jackson Creek. Land disturbance appears to exacerbate erosion in the Boulder Batholith geology and the poorly developed soils of this sub-watershed.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation on Jackson Creek, above the mouth. The field crew determined the stream to be a Rosgen stream type B4a. The width-to-depth ratio was 15.7, which is comparable to a B4a, and other B4 reference streams that the Helena National Forest has inventoried. The BEHI rating was "moderate" (Table 3-48). The BEHI score is about equal to the average for southwestern Montana and Greater Yellowstone Area A- and B-type reference streams. D_{50} as determined in a zigzag Wolman pebble count consisted of coarse gravels. This median particle size is comparable to Helena National Forest B4a and B4 reference streams and one size-class smaller than the range expected for southwestern Montana and the Greater Yellowstone Area B4 reference streams.

The channel survey included a Proper Functioning Condition assessment. The field crew rated this site as "Proper Functioning Condition" (PFC), but noted some sediment deposition. The riparian land type aggregate assigned to this site is 10, defined as Granitic Rock – Mountain Slopes and Ridges. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common and can be excessive.

Table 3-48. Summary of cross-sectional data for Jackson Creek, MT41I006_190.

Parameter	Result	Comparable to Reference
Width/depth ratio	15.7	Yes
BEHI	21.2	Yes
D_{50}	Coarse gravels	Yes
PFC	PFC	Yes

McNeil Cores

McNeil core data are available for one site on Jackson Creek—the channel survey site. Six cores were collected. The riparian land type aggregate here was determined to be 10, Granitic Rock – Mountain Slopes and Ridges (Table 3-49). The average percentage of fines less than 6.4 mm was 38.6 percent, with average fine fines (less than 0.85mm) at 13.3 percent. The percentage of fines less than 6.4 mm for this site is 8 percent greater than the mean for reference riparian aggregate cores, and the fine fines are 30 percent above the mean.

Table 3-49. Summary of McNeil core data for Jackson Creek, MT41I006_190.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
10	2003	38.6	13.3	Both fines values are elevated.

Suspended Sediment Concentrations

Few recent data were available for Jackson Creek. The MDEQ collected two samples for total suspended sediment in 2000 and 2001 near the mouth. The highest value collected was 5.4 mg/L in September 2001.

Macroinvertebrates

Macroinvertebrate data from one sample taken in September of 2002 above the mouth were available. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2003b). Eighteen clinger taxa and eight trichoptera taxa were found at the site, and Bollman concluded that fine sediment did not limit benthic habitat.

Periphyton

Periphyton data from one sample taken in August of 2002 above the mouth were available. Sampling results were compared with reference biocriteria metrics established for the Rocky Mountain Ecoregions of Montana (Bahls, 2003). Diatom metrics indicated minor impairment and partial support of aquatic life use. Bahls concluded that the impairment was primarily due to organic loading and possibly metals. However, the siltation index did exceed the threshold for moderate impairment.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database and data from the Helena National Forest. MFISH has no listing or management strategy for Jackson Creek. The Helena National Forest estimates that brook trout occupy Jackson Creek to about 1.5 miles upstream from the mouth.

Jackson Creek MT41I006_190 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediments, macroinvertebrates, periphyton, and fisheries.

Comparisons to the targets and supplemental indicator values are mixed. Supplemental indicators for all channel metrics were met. A Proper Functioning Condition rating of PFC reflects that the stream is able to sustain expected hydrologic characteristics, riparian vegetation, and sediment transport capacities. Values for fines less than 0.85 mm from McNeil cores were slightly above the target values, but values for fines less than 6.4 mm were about equal to target reference values. Suspended sediment data values were not adequate to make a determination. Biological data results were contradictory, but neither report concluded that sediment posed a limit to aquatic life. Recent fisheries data suggest that the stream provides habitat for few fish species.

Results from the 2003 preliminary source assessment revealed that sediment sources affecting the stream were primarily caused by natural sources (the 1988 Warm Springs Fire). Most of the supplemental indicator values were being met, and the target value exceedance was not extremely aberrant.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Jackson Creek are not impaired by siltation. Therefore a TMDL will not be developed to address sediment impairment.

3.4.2 Tenmile Creek Drainage

This section presents summaries and evaluations of all available water quality data for water bodies in the Tenmile Creek drainage. Maps of the Upper Tenmile and Lower Tenmile drainage areas are provided in Figure 3-10 and Figure 3-11.

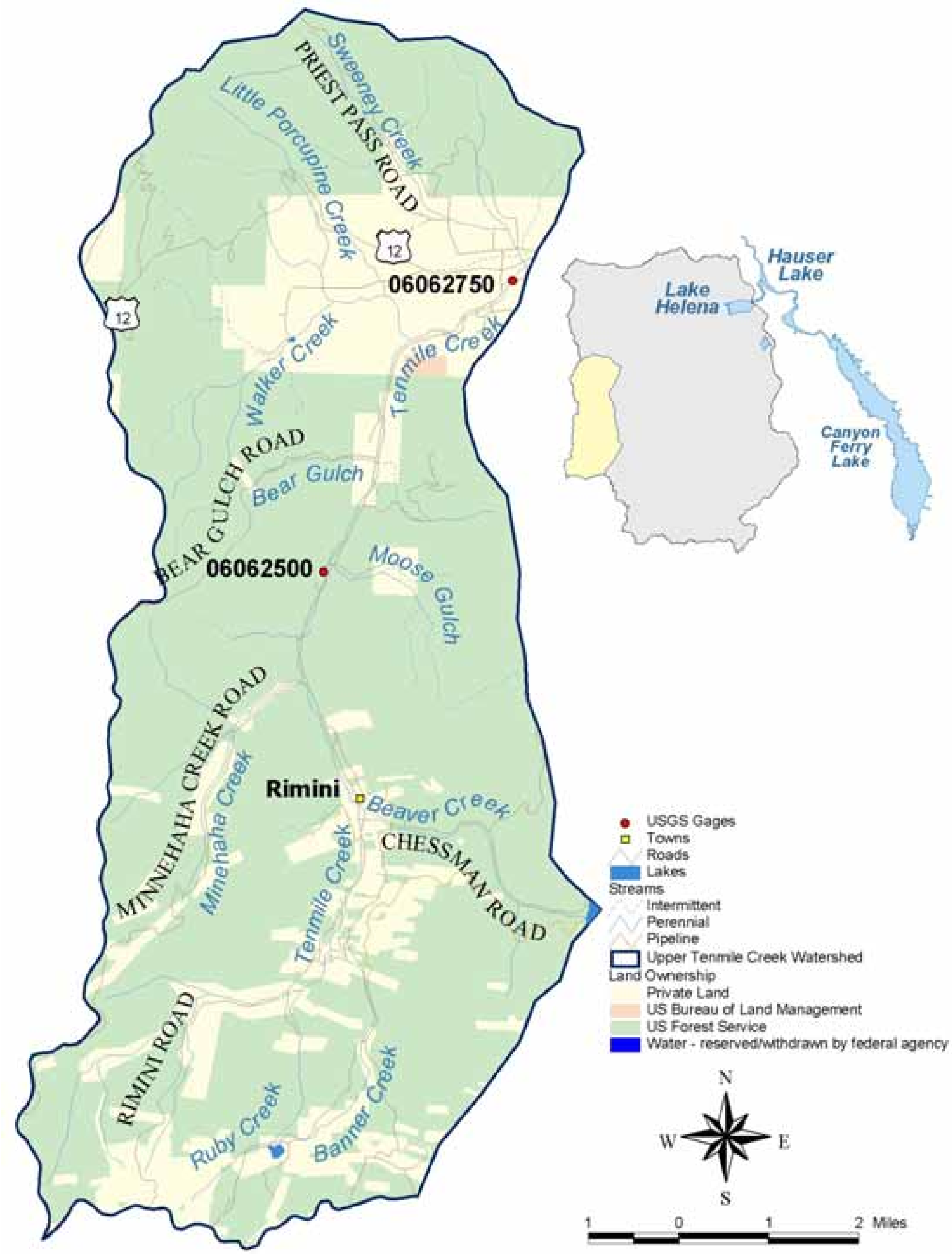

Figure 3-10. Upper Tenmile Creek Watershed.

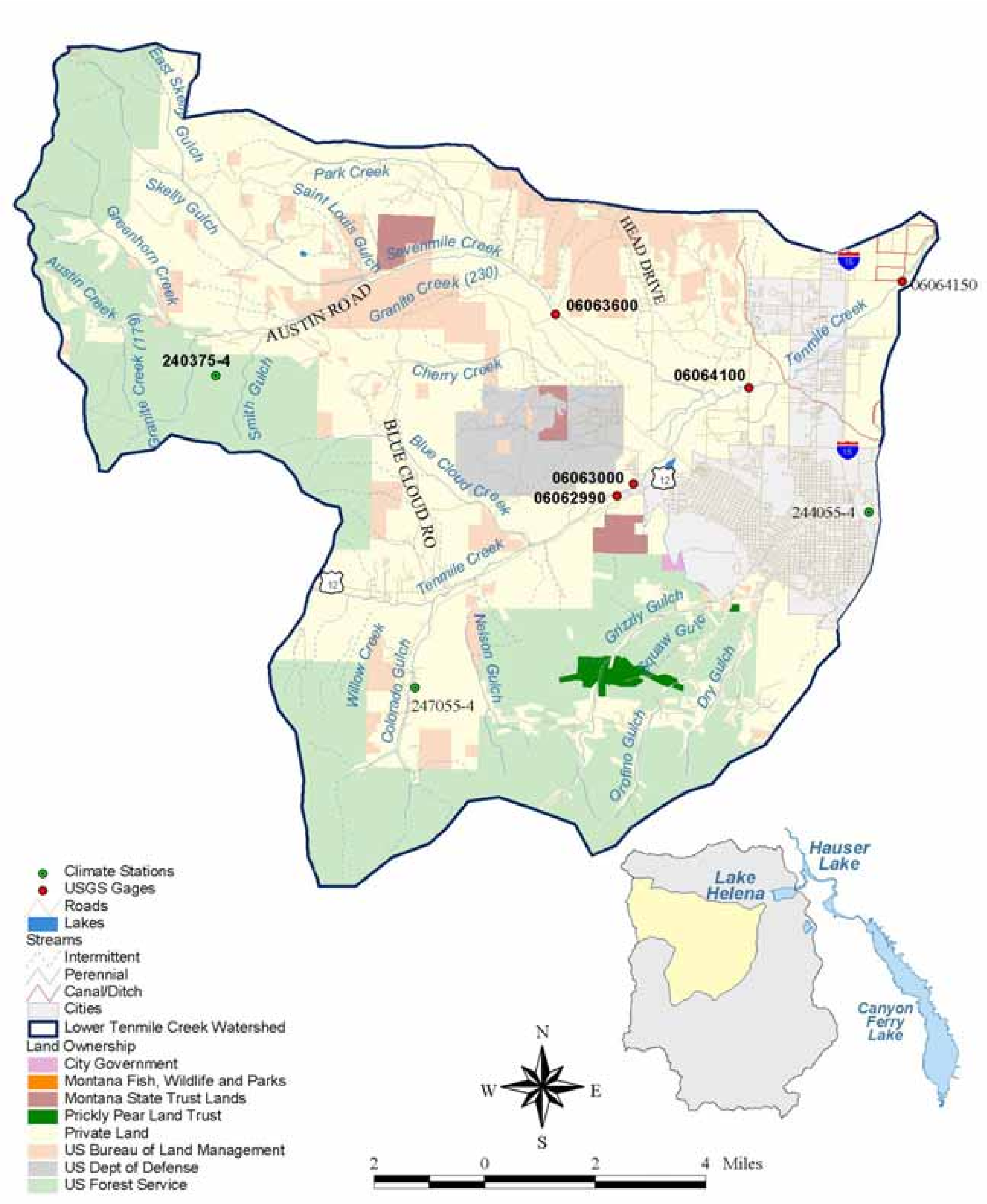

Figure 3-11. Lower Tenmile Creek Watershed.

3.4.2.1 Tenmile Creek from the Headwaters to Helena Public Water Supply Intake above Rimini (MT41I006_141)

In 1996, the aquatic life, cold-water fishery, drinking water, and recreational uses of this 6-mile segment of Tenmile Creek were listed as only partially supported because of siltation, habitat alterations, flow alterations, metals, and pH. In subsequent 303(d) lists, the segment was listed as not supporting its designated aquatic life, cold-water fishery, and drinking water uses, while recreational uses were reassessed at a level of full support. The list of impairment causes was expanded to include turbidity, and the specific metals cadmium, arsenic, lead, zinc, and copper. A typical view of this segment is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), two cross-sectional surveys on the creek in the headwaters and above the confluence with Banner Creek, McNeil core subsurface fines from one survey site, suspended sediment data, macroinvertebrate and periphyton data, fish population measures, and a total of 34 in-stream water chemistry samples taken between May 1997 and September 2001. Both cross-sectional surveys included a Proper Functioning Condition assessment, and Wolman pebble counts.

Tenmile Creek from headwaters to Helena public water supply intake above Rimini

Pollution Sources

The 2003 preliminary source assessment identified roads and channel alterations as the primary sediment sources for this segment of Tenmile Creek. The Helena National Forest conducted a road sediment survey on the forest portion of the creek and identified seven sites on the segment that, based on modeling using the Water Erosion Prediction Project (WEPP) model, contribute approximately 0.76 ton of sediment per year to the stream (USDA, 2004). Another 14 sites on tributary streams to this segment were estimated to contribute 8.7 tons of sediment annually. Most of the source assessment inventory sites were road and mine sites. The aerial photography inventory showed five road crossings and road encroachment along 35 percent of the stream.

The primary geology of this sub-watershed is the Boulder Batholith. The aerial photography inventory showed that upslope logging and exposed stream banks were notable on this portion of Tenmile Creek. Stream incisement was noticeable. Riparian buffer widths were variable due to moderate road encroachment (Rimini Road and secondary Helena National Forest roads), and from private land uses.

In summary, road runoff and localized sources (channel alterations) are probably the biggest contributors of sediment to Tenmile Creek. Historical mining operations and road placement have altered the channel's form.

Expected relevant sources of metals to the stream segment are historical hard rock mining activities in the immediate drainage area. The drainage area of this segment of the stream falls within the Rimini mining district. The MBMG Abandoned and Inactive Mines database shows mineral location, placer, surface, surface-underground, underground, and other unknown mining activities in the drainage area of the stream. The historical mining types include lode, mill, and placer. In the past these mines produced gold, silver, lead, copper, manganese, zinc, and arsenic. Of the more than 20 mines present in the headwaters area, 12 are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites: Valley Forge/Susie, Red Water, Red Mountain, Tenmile Mine, National Extension, Monte Cristo, Se Se S13, Queensbury, Peerless Jenny/King, Monitor Creek Tailings, Peter, and Woodrow Wilson. The Helena National Forest documented placer tailings and historical mining dams during the source assessment.

EPA added the Upper Tenmile Creek Mining Area to the Superfund National Priorities List on October 22, 1999. Superfund mine waste removals began in the 1999 field season and continued through 2002 (USEPA, 2003). EPA has completed the cleanup in the high priority areas (Red Mountain, Bunker Hill, Susie Peerless/Jenny/King, and part of the Upper Valley Forge Mine sites) and will address 70 remaining mine sites. Cooperating agencies have combined resources to expedite a watershed cleanup with the U.S. Forest Service taking the lead role in cleaning up wastes on its property within the Superfund Site boundary (Beatrice, Justice, and Armstrong Mines). Cleanup expenses are shared by EPA and the Forest Service where individual mines involve both federal and private lands (upper Valley Forge Mine). EPA and the Forest Service also share construction and maintenance costs of joint mine waste repository (USEPA, 2003).

Channel Survey

In 2003 the Helena National Forest conducted two field investigations along this segment of Tenmile Creek: (1) in the headwaters, and (2) above the confluence with Banner Creek.

At the site in the headwaters, the Helena National Forest determined the stream to be a Rosgen stream type E4b. The width-to-depth ratio was 5.2, which is slightly less than the ration for the one E4 Helena

National Forest reference stream but 33 percent greater than the average of southwestern Montana and Greater Yellowstone Area E-type reference streams (Table 3-50). The BEHI rating was “low” and equal to the average for E-type reference streams for southwestern Montana and the Greater Yellowstone Area. D_{50} as determined in a zigzag Wolman pebble count consisted of coarse gravels. The D_{50} was in the same size-class as other E4 reference streams for southwestern Montana and the Greater Yellowstone Area.

The channel survey included a Proper Functioning Condition assessment. The Helena National Forest rated the headwaters reach as “Proper Functioning Condition” (PFC), noting that the site could be used as a reference reach. The riparian land type aggregate assigned to this survey site is 24, defined as Granitic Glacial Till Moraines. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface fines and subsurface fines are common but usually not excessive.

At the site above Banner Creek, the field crew determined the stream to be a Rosgen stream type B3. The width-to-depth ratio was 23.8, which is elevated against reference stream data for Helena National Forest B3 and B3a reference streams and 78 percent greater than the average for southwestern Montana and Greater Yellowstone Area B-type reference streams. The stream banks were predominately lined with boulders, which led to a “low” or very stable BEHI rating. This BEHI rating is actually better than the average for southwestern Montana and Greater Yellowstone Area B-type reference streams, but should be expected for boulder-dominated stream banks. D_{50} as determined in a zigzag Wolman pebble count consisted of small cobbles. The D_{50} was comparable to Helena National Forest B3 reference streams and southwestern Montana and Greater Yellowstone Area B-type reference streams.

The channel survey included a Proper Functioning Condition assessment. The field crew rated the reach above Banner Creek as “Functional – at risk” (FAR). The stream was noted as being incised, with a fair amount of sediment deposition. The riparian land type aggregate assigned to the survey site is 22, Granitic Rock – Glaciated Mountain Slopes. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common and can be excessive.

Table 3-50. Summary of cross-sectional data for Tenmile Creek, Segment MT41I006_141.

Site	Parameter	Result	Comparable to Reference
Headwaters	Width/depth ratio	5.2	Yes
Headwaters	BEHI	Low	Yes
Headwaters	D_{50}	Coarse gravels	Yes
Headwaters	PFC	PFC	Yes
Above Banner Creek	Width/depth ratio	23.8	No
Above Banner Creek	BEHI	Low	Yes
Above Banner Creek	D_{50}	Small cobbles	Yes
Above Banner Creek	PFC	FAR	NA, trend not apparent

McNeil Cores

McNeil core data are available for one site on this segment of Tenmile Creek— the survey site above Banner Creek. Six cores were collected, and the riparian aggregate here was determined to be 22, Granitic Rock – Glaciated Mountain Slopes (Table 3-51). The average percentage of fines less than 6.4

mm was 39.1 percent, with average fine fines (less than 0.85 mm) at 7.4 percent. The percentage of fines less than 6.4 mm for this site is 20 percent greater than the mean for all Helena National Forest reference cores (there are no reference cores for riparian aggregate 22), while the fine fines are 26 percent below the mean.

Table 3-51. Summary of McNeil core data for Tenmile Creek, Segment MT41I006_141.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
22	2003	39.1	7.4	Fines < 6.4 mm value is elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Data were available for four sites on this segment of Tenmile Creek, with 32 samples taken from 1997 to 2001. The highest value collected was 31 mg/L in May 1997 at the sampling site below Spring Creek (Table 3-52). The suspended sediment data had an average of 9.5 mg/L with a median of 7 mg/L. All of these values are comparable to values from selected reference streams for suspended sediment.

Table 3-52. Statistical summary of suspended sediment data for Tenmile Creek, Segment MT41I006_141.

Mean	9.5 mg/L
Median	7.0 mg/L
Standard deviation	9.3 mg/L
Maximum	31.0 mg/L
Number of samples	32
Number of sample sites	4

Macroinvertebrates

Macroinvertebrate data were available from two bioassessment reports. The first report evaluated data collected in a location on Tenmile Creek below Banner Creek over a 3-year period from 1997 to 1999. Sampling results were evaluated using the MDEQ's Rapid Bioassessment Protocols (McGuire, 2000). The 3-year average metric score indicated non-impairment and full support of aquatic life uses. Clinger richness was not reported, but an average of 13.5 trichoptera taxa were found at the site.

The second report evaluated macroinvertebrates collected below the confluence with Monitor Creek in July 2001. The site had a habitat rating of "optimal." Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2001). The metric score of 83 percent indicated non-impairment and full support of aquatic life use. Twelve clinger taxa and eight trichoptera taxa were found at the site. The assessment report suggested that road sediment might limit benthic habitat potential despite the optimal habitat rating.

Periphyton

Periphyton data were available for three sample locations on upper Tenmile Creek. Sampling occurred in September 1998 above Banner Creek, below Banner Creek, and at the City of Helena's water diversion. Diatom metrics progressed from ratings of minor impairment at the upstream location to severe impairment at the downstream site. None of the suspected impairment causes included sedimentation and the siltation index was below the threshold for minor impairment at all sites.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database and data from the Helena National Forest. Tenmile Creek is managed as a trout fishery. According to MFISH, mottled sculpin are the only fish species thought to be common year-round residents in this segment of Tenmile Creek. The Helena National Forest estimates that brook trout occupy this segment of Tenmile Creek about a mile below the headwaters, while rainbow trout have been found 5 miles below the headwaters. The overall habitat and sport fishery rating for Tenmile Creek is "moderate."

Metals Concentrations

The project team evaluated a total of 34 in-stream water chemistry samples taken between May 1997 and Sept 2001. Arsenic concentrations in eight samples exceeded the human health criterion. Of those, one was also above the chronic aquatic life criterion. The average arsenic concentration in all samples was 71 percent higher than the human health criterion. The highest measured concentration was 16.7 times the human health criterion, and 1.10 times the chronic aquatic life criterion. This evidence shows that this segment does not meet the human health criterion for arsenic.

Cadmium concentrations in 28 samples (82 percent of the samples evaluated) exceeded the chronic aquatic life criterion. Of those, 24 also exceeded the acute aquatic life criterion, and three exceeded the human health criterion. The average value of all samples was 358 percent and 2,382 percent higher than the acute and chronic aquatic life criteria, respectively. The highest measured value was 321 times the chronic aquatic life criterion, and 6.0 times the human health criterion. This evidence shows this segment does not meet the human health and aquatic life standards for cadmium.

Copper concentrations in 32 samples (94 percent of the samples) exceeded the chronic aquatic life criterion. All of those were also above the acute aquatic life criterion. The average value of all samples was 499 percent and 697 percent higher than the acute and chronic aquatic life criteria, respectively. The highest measured value was 73 times the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence shows that this segment does not meet the aquatic life standards for copper.

Lead concentrations in 29 samples (85 percent of the samples) exceeded the chronic aquatic life criterion. Of those, four samples also exceeded the acute aquatic life criterion and 3 samples exceeded the human health criterion. The average value of all samples was 1,393 percent higher than the chronic aquatic life criterion. The highest measured value was 139 times the chronic aquatic life criterion and 4.7 times the human health criterion. This evidence shows that this segment does not meet the human health or aquatic life criteria for lead.

Zinc concentrations in 30 samples (88 percent of the samples) exceeded the acute and chronic aquatic life criteria for zinc. One sample exceeded the human health criterion. The average value of all samples was 789 percent higher than the acute and chronic aquatic life criteria. The highest measured value was 86 times the acute and chronic aquatic life criteria, and 1.6 times the human health criterion. This evidence shows that this segment does not meet the human health and aquatic life criteria for zinc.

Tenmile Creek MT41I006_141 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85mm, suspended sediments, macroinvertebrates, periphyton, fisheries, and water chemistry.

Comparisons with the sediment targets and supplemental indicator values produced inconsistent conclusions. At the upper survey site, all supplemental values were met and the site was recommended as a reference reach. At the lower sample site, target values were only exceeded for the percentage of fines less than 6.4mm and all supplemental indicator values were met except for width-to-depth ratio. The percentage of fines less than 6.4 mm for the lower site was not excessively elevated against the mean for all Helena National Forest reference cores. The elevated width-to-depth ratio is probably a reflection of the severe channel alterations caused by mining, and does not necessarily reflect stream aggradation. Suspended sediment data values were comparable to reference. Biological indicators suggest non-impairment from sedimentation. Recent fisheries data suggest that the stream provides habitat for few fish species, but fish habitat is most likely limited by metals toxicity.

Results from the 2003 preliminary source assessment revealed that eroding sediment sources affecting the stream were enhanced by the erosive granitic geology. Most of the targets and supplemental values were being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Tenmile Creek segment MT41I006_141 are not impaired by siltation or suspended solids. A TMDL will therefore not be developed for sediment.

The available water chemistry analysis results suggest that Tenmile Creek from the headwaters to the Helena public water supply intake above Rimini is impaired by arsenic, cadmium, copper, lead, and zinc. TMDLs will therefore be developed to address the arsenic, cadmium, copper, lead, and zinc impairments.

3.4.2.2 Tenmile Creek from Helena Public Water Supply Intake above Rimini to Helena Water Treatment Plant (MT41I006_142)

Segment MT41I006_142 of Tenmile Creek extends 7.7 miles from the Helena public water supply intake above Rimini to the Helena Water Treatment Plant. In 1996, the aquatic life, cold-water fishery, drinking water, and recreational uses of this 7.7-mile segment of Tenmile Creek were listed as only partially supported because of siltation, habitat alterations, flow alterations, metals, and pH. In subsequent 303(d) lists, the former uses plus agricultural and industrial uses were rated as not supported because of siltation (2002 list), and because of flow alterations and metals, specifically arsenic, cadmium, copper, lead, and zinc (2000 and 2002 lists). A typical view of this segment is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey on the creek below Bear Gulch that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from the reach surveyed in 2003, suspended sediment data, macroinvertebrate and periphyton data, fish population information, and a total of 20 in-stream water chemistry samples taken between May 1997 and July 2003.

Tenmile Creek from Helena PWS intake above Rimini to Helena WTP

Pollution Sources

The 2003 preliminary source assessment identified roads and riparian grazing as the primary sediment sources for this segment of Tenmile Creek. The Helena National Forest conducted a road sediment survey on the forest portion of the creek and identified 11 sites that, based on modeling using the Water Erosion Prediction Project (WEPP) model, contribute approximately 1.3 tons of sediment per year to the stream (USDA, 2004). Most of the source assessment inventory sites consisted of road sites. The aerial photography inventory showed 20 road crossings and road encroachment along 50 percent of the stream segment. The stream channel has been straightened in proximity to the Rimini Road, as evidenced by at least seven meander cutoffs.

The primary geology of this sub-watershed is the Boulder Batholith, which consists of highly erodible quartz monzonite. Quaternary alluvium is present in the lower floodplain. Direct sediment delivery to the stream from the Rimini Road was observed in many locations as well as deposition of sand in the stream channel. The aerial photography inventory revealed evident stream incisement, eroding stream banks, and lack of flow. Intermittent logging has occurred in the hill slopes surrounding tributary streams. The widths of riparian buffers were limited because of encroachment from the Rimini Road.

In summary, road runoff and road placement are probably the biggest contributors of sediment to this segment of Tenmile Creek. Channel alterations from road placement and flow withdrawal by the City of Helena have affected channel form and the flow regime along this segment.

Expected relevant sources of metals in this stream segment include adjacent abandoned mines and pollutant inputs from the stream's headwaters area (Tenmile Creek 141). The immediate drainage area falls within the Rimini mining district. The MBMG Abandoned and Inactive Mines database reports mineral location, underground, and other, "unknown" mining activities in the drainage area of the stream. The historical mining types include lode and placer. In the past these mines produced gold, silver, lead, and zinc. Four mines are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites: Bear Gulch, Upper Valley Forge, Beatrice, and Armstrong Mine.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation along this section of Tenmile Creek, below the Bear Gulch confluence. The stream's entrenchment ratio and sinuosity were out of balance with the valley type setting, reflecting channel confinement and straightening. Without channel modifications, the stream reach probably would be a Rosgen stream type B4c. The width-to-depth ratio was 15.8, which is comparable to other Helena National Forest B4 reference streams and 18 percent greater than the average for southwestern Montana and Greater Yellowstone Area B-type reference streams (Table 3-53). The BEHI rating was "low," which is actually better than the average for southwestern Montana and Greater Yellowstone Area B-type reference streams. D_{50} as determined in a zigzag Wolman pebble count consisted of very coarse gravels. This particle size is within the range expected for B4-type reference streams, based on data collected by the Helena National Forest and for southwestern Montana and the Greater Yellowstone Area.

The channel survey included a Proper Functioning Condition assessment. Tetra Tech and Land & Water Consulting rated this site as "Functional – at risk" (FAR), noting that the stream was under-sized for the available channel. Sediment deposition was observed as was a limited riparian zone. The riparian land type aggregate assigned to this site is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive.

Table 3-53. Summary of cross-sectional data for Tenmile Creek, Segment MT41I006_142.

Parameter	Result	Comparable to Reference
Width/depth ratio	15.8	Yes
BEHI	11.2	Yes
D_{50}	Very coarse gravels	Yes
PFC	FAR	Yes (flow issues)

McNeil Cores

McNeil core data are available for one site on this segment of Tenmile Creek—the channel survey site. Six cores were collected in 2003. The riparian aggregate here was determined to be 29, Alluvial Floodplains and Terraces (Table 3-54). The average percentage of fines less than 6.4 mm was 38 percent, with average fine fines (less than 0.85 mm) at 10.3 percent. The percentage of fines less than 6.4 mm for this site is 12 percent greater than the mean for Helena National Forest reference cores, and the fine fines are 27 percent above the mean.

Table 3-54. Summary of McNeil core data for Tenmile Creek, Segment MT41I006_142.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
29	2003	38	10.3	Both fines values are elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Data were available for two sites along this segment of Tenmile Creek. Eighteen samples were taken from 1997 to 2001. The highest observed value was 34 mg/L in May of 1997 at the sampling site at the water treatment plant (end of the segment) (Table 3-55). The suspended sediment data had an average of 8.8 mg/L with a median of 5.0 mg/L. All of these values are comparable to suspended sediment values for selected reference streams.

Table 3-55. Statistical summary of suspended sediment data for Tenmile Creek, Segment MT41I006_142.

Mean	8.8 mg/L
Median	5.0 mg/L
Standard deviation	9.0 mg/L
Maximum	34.0 mg/L
Number of samples	18
Number of sample sites	2

In 2003, two turbidity observations were recorded at the water treatment plant. One observation reported the water clarity as clear, and the August observation reported that the stream was dry.

Macroinvertebrates

Macroinvertebrate data were available from one bioassessment report prepared in 2000. Sampling occurred on this segment of Tenmile over a 3-year period from 1997 to 1999 at sites in Rimini, at the Mill

Creek confluence, and below Moose Creek. Sampling results were evaluated using the MDEQ's Rapid Bioassessment Protocols (McGuire, 2000). The 3-year average metric scores for all sites varied from non-impairment to slight impairment, with full support of aquatic life uses indicated at the upper and lower sites, and partial support suggested at the Mill Creek confluence. Clinger richness was not reported and 3-year averages for trichoptera taxa richness ranged from 5.7 to 14.7. The highest trichoptera taxa richness was reported at the site below Moose Creek. Water quality and biointegrity were concluded to be impaired by metals.

Periphyton

Periphyton data were available from two bioassessment reports. The first report evaluated periphyton data collected on Tenmile Creek in July 1997 at a location near the Helena water treatment plant. The diatom metric values indicated minor impairment and partial support of aquatic life use. This conclusion was based on indications of metals impairment from the Rocky Mountain Ecoregion bioassessment protocols (Bahls, 1997). However, in comparison with ecoregional reference sites, siltation was listed as an additional limiting factor. The siltation index was above the threshold for minor impairment.

A second bioassessment reported on sampling that occurred in September 1998 at locations below Spring Creek, at the Chessman Reservoir turnoff, above Minnehaha Creek, above Moose Creek, and at the Helena water treatment plant. Diatom metrics suggested impairment ranging from severe to minor in an upstream to downstream direction. The assessment, which relied on the Rocky Mountain Ecoregion protocols, did not include sedimentation as a cause of impairment. However, in comparison with a reference site above Banner Creek, the sites above Moose Creek and at the water treatment plant were limited primarily because of siltation. The site below Spring Creek showed siltation as the third most important limiting factor (Bahls, 1998). The siltation index was below the threshold for minor impairment at the Chessman Reservoir turnoff and above Minnehaha Creek. The siltation index value was above the threshold for minor impairment below Spring Creek, above the threshold for moderate impairment above Moose Creek, and above the threshold for severe impairment near the Helena water treatment plant.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database and data from the Helena National Forest. Tenmile Creek is managed as a trout fishery. According to MFISH, mottled sculpin are the only fish species thought to be common year-round residents in this segment of Tenmile Creek. The Helena National Forest estimates that both rainbow and brook trout occupy this segment of Tenmile Creek. The overall habitat and sport fishery rating for Tenmile Creek is "moderate."

Metals Concentrations

The project team evaluated a total of 20 in-stream water chemistry samples taken between May 1997 and July 2003. Arsenic concentrations in 18 samples were above the human health criterion. The average concentration in all samples was 71.5 percent higher than the human health criterion. The highest measured concentration was three times the human health criterion. No samples exceeded the aquatic life criteria. This evidence shows this segment does not meet the human health standard for arsenic.

Cadmium concentrations in 17 samples (85 percent of the samples) exceeded the chronic aquatic life criterion. Of those, 8 also exceeded the acute aquatic life criterion. The average value of all samples was 20 percent and 664 percent higher than the acute and chronic aquatic life criteria, respectively. The highest measured value was 19 times the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence shows this segment does not meet the aquatic life water quality standards for cadmium.

Copper concentrations in14 samples (70 percent of the samples) exceeded the chronic aquatic life criterion. All but one of those were also above the acute aquatic life criterion. The average value of all samples was 185 percent and 300 percent higher than the acute and chronic aquatic life criteria, respectively. The highest measured value was 20 times the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence shows this segment does not meet the aquatic life criteria for copper.

Lead concentrations in 12 samples (60 percent of the samples) exceeded the chronic aquatic life criterion for lead. The average value of all samples was 358 percent higher than the chronic aquatic life criterion. The highest measured value was 12 times the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence shows this segment does not meet the aquatic life criteria for lead.

Zinc concentrations in 20 samples (100 percent of the samples) exceeded the acute and chronic aquatic life criteria. The average value of all samples was 231 percent higher than the acute and chronic aquatic life criteria. The highest measured value was 11 times the acute and chronic aquatic life criteria. No samples exceeded the human health criterion. This evidence shows this segment does not meet the aquatic life standards for zinc.

Tenmile Creek Segment MT41I006_142 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediments, macroinvertebrates, periphyton, fisheries, and water chemistry.

Results from the target and supplemental indicator values are mixed. The supplemental indicator values for all channel metrics were met. Macroinvertebrate results were somewhat contradictory, but the value for clinger richness was lower than desired at the water treatment plant. Periphyton indicators suggest impairment by siltation, which increases in a downstream manner. Recent fisheries data suggest that the stream provides habitat for few fish species. The fines values were in excess of both target values.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment, and that impairments to channel condition occurred for most of the length of this segment. Water withdrawals by the City of Helena affect the flow regime and sediment transport capacity of this segment of Tenmile Creek because the stream segment was observed dry or occupying less than half its channel during the summer of 2003. Target values and various biological metrics are not being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Tenmile Creek Segment MT41I006_142 are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

Based on a review of the water chemistry analysis results, Tenmile Creek from the Helena public water supply intake to the Helena water treatment plant is impaired by arsenic, cadmium, copper, lead, and zinc. TMDLs will be developed to address the arsenic, cadmium, lead, and zinc impairments.

3.4.2.3 Tenmile Creek from Helena Water Treatment Plant to the Mouth (MT41I006_143)

Segment MT41I006_143 of Tenmile Creek extends 15.9 miles from the Helena water treatment plant to the mouth where it meets Prickly Pear Creek. In 1996, aquatic life, cold-water fishery, drinking water, and recreational uses were listed as partially supported because of siltation, habitat alterations, flow alterations, metals, and pH. In 2000, the segment was listed as not supporting aquatic life, cold-water fishery, and drinking water uses and as partially supporting recreation. In 2002, the segment was listed as partially supporting aquatic life and cold-water fishery uses and as not supporting drinking water uses. Suspected causes of impairment in 2000 and 2002 included flow alterations, habitat alterations, metals (specifically arsenic, cadmium, lead, copper, mercury, and zinc). Siltation was also a suspected cause of impairment in 2000 but not 2002. Nutrients were added to the causes of impairment in 2002. A typical view of this segment is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), two cross-sectional surveys on the creek above the confluence with Sevenmile Creek and above Green Meadow Drive, including a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from two survey sites, suspended sediment data, macroinvertebrate and periphyton data, fish population information, and a total of 52 in-stream water chemistry samples taken between June1997 and December 2003.

Tenmile Creek from Helena WTP to mouth

Pollution Sources

The 2003 preliminary source assessment identified roads, grazing, and farming practices as the primary sediment sources for this segment of Tenmile Creek. Most of the source assessment inventory sites consisted of road sites. The aerial photography inventory showed 22 road crossings. Stream channelization along 16 percent of the segment occurs from construction of Highway 12 and I-15.

The primary geology of this sub-watershed is the Boulder Batholith, with Quaternary sediments prominent in the floodplain. The aerial photography inventory showed that exposed and eroding stream banks were visible. The beginning and end of the stream segment are predominantly impacted by agricultural practices (straightening for irrigation, grazing, and cultivation in the riparian zone), while the middle segment of the stream is surrounded by dense subdivision development.

In summary, roads and localized sources (grazing, removal of riparian vegetation) are probably the biggest contributors of sediment to this segment of Tenmile Creek. Irrigation diversions and municipal withdrawals severely deplete the flow of this section of Tenmile Creek, and probably inhibit the transport of sediment.

This segment is also affected by nutrients and metals. Irrigation diversions, grazing practices, and upstream sources contribute nutrients. Diffuse nutrient sources from rural housing and subdivisions might also affect the stream. Expected relevant sources of metals to the stream segment are upstream sources and historical mining activities in the immediate drainage area. The segment's upstream reach (Tenmile Creek 142) also contributes metals. The immediate drainage area falls within the Blue Cloud, Helena, and Scratchgravel Hills mining districts. The MBMG Abandoned and Inactive Mines database reports hot springs, mineral location, placer, surface, surface-underground, underground, and other unknown mining activities in the immediate drainage area of the stream. The historical mining types include lode, mill, and placer. In the past these mines produced gold, silver, copper, lead, uranium, arsenic, and zinc. Six mines are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites: Franklin (Scratchgravel), Joslyn Street Tailings (Helena district) , Lower Tenmile Mine (Rimini), Davis Gulch II (Helena), Spring Hill Tailings (Helena), and Lady Luck (Helena).

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted two field investigations along Tenmile Creek: (1) above the confluence with the Sevenmile Creek, and (2) above Green Meadow Drive.

The site above the confluence with Sevenmile Creek was chosen as a "reference" condition for the main stem of Tenmile, but the site is not a true reference reach. The stream's entrenchment ratio and sinuosity were out of balance with the valley type setting, reflecting channel confinement and straightening. Without channel modifications, the stream reach probably would be a Rosgen stream type C4. The width-to-depth ratio was 39.5, which is 86 percent greater than the average for reference stream data for southwestern Montana and Greater Yellowstone Area C-type reference streams (Table 3-56). The BEHI rating was in the mid-range of "moderate," and 27 percent greater than the average for C-type reference streams for southwestern Montana and the Greater Yellowstone Area. D_{50} as determined in a zigzag Wolman pebble count consisted of coarse gravels. The D_{50} was one size-class less than expected based on southwestern Montana and Greater Yellowstone Area C4 reference streams.

Part of the channel survey included a Proper Functioning Condition assessment. The field crew rated the reach above Sevenmile as "Functional – at risk" (FAR), noting that the stream has healthy and diverse riparian vegetation. However, the field crew also noted that the stream was riprapped and that pool infilling was occurring. The riparian land type aggregate assigned to this survey site is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive.

At the site above Green Meadow Drive, the field crew determined the stream to be a straightened Rosgen stream type C4. The width-to-depth ratio was 25, which is about 18 percent greater than the average for southwestern Montana and Greater Yellowstone Area C-type reference streams. The BEHI rating was "high," and 79 percent above the average for C-type reference streams for southwestern Montana and the Greater Yellowstone Area. D_{50} as determined in a zigzag Wolman pebble count consisted of very coarse gravels. The D_{50} was comparable to southwestern Montana and Greater Yellowstone Area C-type reference streams.

The channel survey included a Proper Functioning Condition assessment. The field crew rated the reach below above Green Meadow Drive as "Functional – at risk" (FAR) verging on "Non-functional" (NF). The field crew noted that the stream had eroding banks, excess sediment deposition, and a limited riparian area. The riparian land type aggregate assigned to the survey sites is also 29, Alluvial (Borolls) Floodplains and Terraces.

Table 3-56. Summary of cross-sectional data for Tenmile Creek, Segment MT41I006_143.

Site	Parameter	Result	Comparable to Reference
Above Sevenmile	Width/depth ratio	39.5	No
Above Sevenmile	BEHI	25.7	No
Above Sevenmile	D_{50}	Coarse gravels	No
Above Sevenmile	PFC	FAR	NA, trend not apparent
Above Green Meadow Drive	Width/depth ratio	25	Yes
Above Green Meadow Drive	BEHI	36.4	No
Above Green Meadow Drive	D_{50}	Very coarse gravels	Yes
Above Green Meadow Drive	PFC	FAR/NF	No

McNeil Cores

McNeil core data are available for two sites on this segment of Tenmile Creek—the field survey sites. At the site above Sevenmile Creek, six cores were collected. The riparian aggregate here was determined to be 29, Alluvial Floodplains and Terraces (Table 3-57). The average percentage of fines less than 6.4 mm was 25.1 percent, with average fine fines (less than 0.85 mm) at 7.2 percent. The percentage of fines less than 6.4 mm for this site is 35 percent less than the mean for reference riparian aggregate 29 cores, while the fine fines are 11 percent less.

Six cores were collected above Green Meadow Drive, and the riparian aggregate was determined to be 29. The average percentage of fines less than 6.4 mm was 26.5 percent, with average fine fines at 10.4 percent. The percentage of fines less than 6.4 mm for this site is 22 percent less than the mean for reference riparian aggregate 29 cores, while the fine fines are 28 percent greater.

Table 3-57. Summary of McNeil core data for Tenmile Creek, Segment MT41I006_143.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
29	2003	25.1	7.2	Yes
29	2003	26.5	10.4	Fine fines value is elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Data were available for four sites on this segment of Tenmile Creek, and 35 samples were taken from 1997 to 2003 (Table 3-58). The highest value collected was 1270 mg/L in March 2003 at the sampling site at Green Meadow Drive. The suspended sediment data had an average of 48.7 mg/L with a median of 6.0 mg/L. These values are not comparable to values from selected reference streams for suspended sediment.

Table 3-58. Statistical summary of suspended sediment data for Tenmile Creek, Segment MT41I006_143.

Mean	48.7 mg/L
Median	6.0 mg/L
Standard deviation	213.0 mg/L
Maximum	1,270.0 mg/L
Number of samples	35
Number of sample sites	4

In 2003, two turbidity observations were recorded at Green Meadow Drive. Both observations reported the water clarity as clear. However, the observations were made during the recessional limb of peak flow and also during low flow.

Macroinvertebrates

Macroinvertebrate data were available from three reports. The first report sampled this segment of Tenmile in July 1997 below Colorado Gulch, at the Williams Street Bridge, at Green Meadow Drive, and at Sierra Road East. Sampling results were evaluated using the MDEQ's Rapid Bioassessment Protocols (Eakin, 1998). All sites were rated as non-impaired and fully supporting aquatic life uses. No values for clinger or trichoptera richness were given. Eakin concluded that "poor bank stability and underdeveloped riparian vegetation may be influencing the condition of the macroinvertebrate community in Tenmile Creek below Colorado Gulch" (1998). The 1997 MDEQ macroinvertebrate survey also indicated eutrophication (Eakin, 1998).

The second report sampled this segment of Tenmile over a 3-year period from 1997 to 1999 at the water treatment plant. Sampling results were evaluated using the MDEQ's Rapid Bioassessment Protocols (McGuire, 2000). The 3-year average metric score for this site was non-impairment with full support of aquatic life use. Clinger richness was not given; the 3-year average for trichoptera taxa was 14.3.

The third report sampled macroinvertebrates near the confluence with Sevenmile Creek in July 2001. The habitat rating for this site was "optimal," but points were lost because of sediment deposition and pool variability. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2001). The metric score of 44 percent indicated moderate impairment and partial support of aquatic life use. Eight clinger taxa and five trichoptera taxa were found at the site.

Periphyton

Periphyton data from one report were available. Sampling occurred in July 1997 below Colorado Gulch, at Williams Street Bridge, at Green Meadow Drive, and at Sierra Drive. Diatom metrics varied from minor to severe impairment in a downstream manner. Impairment conclusions were made according to Rocky Mountain Ecoregion protocols (Bahls, 1997). The siltation index was above the threshold for minor impairment below Colorado Gulch. The siltation index was above the threshold for moderate impairment at Williams Street Bridge and at Green Meadow Drive, and above the threshold for severe impairment at Sierra Drive.

The 1997 periphyton assessment also indicated light to heavy algal growth in sites in lower Tenmile Creek (Bahls, 1997). The 2001 MDEQ stream reach assessment form indicated some profuse algal growth in the stream.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database and data from the Helena National Forest. Tenmile Creek is managed as a trout fishery. According to MFISH, mottled sculpin and rainbow trout are the only fish species thought to be common year-round residents in this segment of Tenmile Creek. Sucker, brook trout, and longnose sucker were considered to be rare. The Helena National Forest estimates that both rainbow and brook trout occupy this segment of Tenmile Creek from the beginning of the segment to the confluence with Blue Cloud Creek. The overall habitat and sport fishery rating for Tenmile Creek is "moderate." Montana Fish, Wildlife and Parks lists this segment of Tenmile Creek as a chronic dewatering stream of concern.

Nutrient Concentrations

Numerous analyses for total phosphorus (30 of 43 records), total Kjeldahl nitrogen (13 of 26 records), and total nitrogen (19 of 26 records) from the 1997–2003 period of record exceeded the Lake Helena watershed nutrient target values (Appendix D). The database reflected sampling by the USGS and MDEQ at several locations within this segment of Tenmile Creek.

Metals Concentrations

The project team evaluated a total of 52 in-stream water chemistry samples taken between June1997 and December 2003. Arsenic concentrations in 46 samples were above the human health criterion. The average concentration was 51 percent higher than the human health criterion. The highest measured concentration was three times the human health criterion. No samples exceeded the aquatic life criteria. This evidence suggests this segment does not meet the human health criterion for arsenic.

Cadmium concentrations from 23 samples (44 percent of the samples) exceeded the chronic aquatic life criterion. The highest measured value was 5.2 times the chronic aquatic life criterion. The average value of all samples was 19 percent higher than the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence shows that this segment does not meet the aquatic life water quality standards for cadmium.

Copper concentrations in 12 samples (23 percent of the samples) exceeded the chronic aquatic life criterion. Of those, four were also above the acute aquatic life criterion. The highest measured value was 8.2 times the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence shows that this segment does not meet the aquatic life standards for copper.

Lead concentrations in 14 samples (27 percent of the samples) exceeded the chronic aquatic life criterion. Of those, two samples exceeded the human health criterion. The average value of all samples was 28 percent higher than the chronic aquatic life criterion. The highest measured value was 20 times the chronic aquatic life criterion, and 4.6 times the human health criterion. This evidence shows that this segment does not meet the aquatic life or human health standards for copper.

Zinc concentrations in six samples (12 percent of the samples) exceeded the acute and chronic aquatic life criteria for zinc. The highest measured value was 11 times the acute and chronic aquatic life criteria. No samples exceeded the human health criterion. This evidence shows that this segment does not meet the aquatic life criteria for zinc.

Tenmile Creek Segment MT41I006_143 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediments, fisheries, and water chemistry.

Results from the sediment data assessment are mixed. At the upper channel survey site target values were met, but no supplemental values were met. The elevated width-to-depth ratio and BEHI rating, along with a smaller than expected size-class for median particle size, is probably a reflection of stream aggradation and/or channel alterations from riprap. At the lower sample site, width-to-depth ratio and D_{50} were the only supplemental indicator values within the expected range, but the target value of percentage of fine fines was elevated. Suspended sediment data revealed some extremely high values, as well as a higher than expected mean value. Macroinvertebrate results were somewhat inconclusive, but the one value for clinger richness was lower than desired and comments from two of the reports indicated problems with sediment deposition. Periphyton indicators suggested impairment from siltation, which increases in a downstream manner. Recent fisheries data suggest that the stream provides habitat for few fish species, and chronic dewatering is a problem.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment. Municipal and irrigation diversions affect the flow regime and sediment transport capacity of this segment of Tenmile Creek. The majority of supplemental indicator values were not being met, and target values were not met for fine fines at one of the sample sites.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Tenmile Creek Segment MT41I006_143 are impaired by siltation and suspended solids. A TMDL will therefore be developed to address the sediment impairment.

The weight of evidence suggests that Tenmile Creek (from the Helena water treatment plant to the creek's mouth) is impaired by nutrients. Numerous analyses for total phosphorus, total Kjeldahl nitrogen, and total nitrogen of samples taken from various stations on this stream segment are above the nutrient target values for the entire period of record (May 1997–December 2003). Agricultural operations and sediment have altered stream morphology. Irrigation diversions, grazing practices, and upstream sources contribute nutrients. Dewatering has affected the natural hydrology of the stream. Diffuse and possible nutrient sources associated with rural housing and subdivisions affect the stream. The 1997 and 2001 macroinvertebrate and periphyton surveys indicate eutrophication, and light to heavy algal growths. A 2001 stream reach assessment form indicated profuse algal growths in the stream. Therefore, a TMDL will be developed to address nutrients.

In reviewing the available water chemistry analysis results for metals, the evidence suggests that Tenmile Creek from the Helena water treatment plant to the mouth is impaired by arsenic, cadmium, copper, lead, and zinc. TMDLs will be developed to address the arsenic, cadmium, copper, lead, and zinc impairments.

3.4.2.4 Skelly Gulch (Tributary of Greenhorn Creek) (MT41I006_220)

Skelly Gulch is a tributary of Greenhorn Creek, which drains to Sevenmile Creek. In 1996, the 7.7-mile segment from the headwaters to the confluence with Greenhorn Creek was listed as partially supporting aquatic life and cold-water fishery uses because of siltation. In 2002, metals were added to the suspected causes of impairment. A typical view of Skelly Gulch is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey 2.5 miles above the mouth that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from two sites, suspended sediment data, macroinvertebrate data, fish population information, and a limited total of three in-stream water chemistry samples taken between July 2001 and August 2003.

Skelly Gulch

Pollution Sources

The 2003 preliminary source assessment identified roads and localized sources (including grazing and placer mine-associated alterations) as the primary sediment sources for Skelly Gulch. The Helena National Forest conducted a road sediment survey on the forest portion of the creek and identified a single site that, based on modeling using the Water Erosion Prediction Project (WEPP) model, contributes approximately 0.8 ton of sediment per year to the stream (USDA, 2004). The aerial photography inventory showed11 road crossings and road encroachment along 17 percent of the stream.

The primary geologies of this sub-watershed are Cambrian and pre-Cambrian sedimentary rocks, which consist primarily of shale and argillite. The aerial photography inventory showed old clear-cut timber harvests in the headwaters relatively close to the stream course. Riparian buffer areas were extensive, except where limited by minor road encroachment. For the preliminary source assessment, channel incision, channelization from placer mining, bank trampling, and loss of riparian vegetation due to livestock grazing were recorded on the Helena National Forest portion of the stream. Below the forest boundary, the primary sources affecting the stream were roads, beaver ponds, and housing development.

In summary, roads and localized sources are probably the biggest contributors of sediment to Skelly Gulch. Near the mouth of the stream, a culvert was observed to be plugged by beaver dams, thereby creating an area of excessive sedimentation.

Expected relevant sources of metals to the stream are historical hard rock mining activities in the watershed. The segment's drainage area falls within the Austin mining district. The MBMG Abandoned and Inactive Mines database reports mineral location, placer, underground and other "unknown" mining activities in the drainage area of the stream. The historical mining types include lode and placer. In the past these mines produced gold, silver, copper, lead, iron, manganese, and arsenic. None of the mines in the immediate drainage area of this segment are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites. The Helena National Forest documented evidence of placer mining and one mine waste rock dump within the stream bankfull width during the source assessment.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting staff conducted a field investigation on Skelly Gulch at a location about 2 miles above the mouth. The field crew determined the stream to be a Rosgen stream type C4b. The width-to-depth ratio of 13.6 was about 30 percent less than that for the southwestern Montana and Greater Yellowstone Area C-type streams, but similar to other B-type reference streams in the region (Table 3-59). The BEHI rating was in the mid-range of "moderate," which is about 22 percent greater than the average for southwestern Montana and Greater Yellowstone Area C-type reference streams. However, the higher than expected rating is probably due to the presence of undercut banks, which are important fish habitat components. D_{50} as determined in a zigzag Wolman pebble count consisted of medium gravels. D_{50} was two size-classes less than expected based southwestern Montana and Greater Yellowstone Area C4 reference streams, as well as the one Helena National Forest B4 reference stream inventoried in a similar riparian aggregate.

Part of the channel survey included a PFC assessment. The field crew rated this site as "Proper Functioning Condition" (PFC), but noted some sediment deposition. The riparian land type aggregate assigned to this site is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive.

Table 3-59. Summary of cross-sectional data for Skelly Gulch, MT41I006_220.

Parameter	Result	Comparable to Reference
Width/depth ratio	13.6	Yes
BEHI	24.7	Yes
D_{50}	Medium gravels	No
PFC	PFC	Yes

McNeil Cores

McNeil core data are available for two sites on Skelly Gulch. The oldest cores (four cores) were collected in 1991 in the southeast quarter of Section 24, Township 11N, Range 6W. The riparian aggregate here was determined to be 3, defined as Metasedimentary Rock – Mountain Slopes and Ridges (Table 3-60). The average percentage of fines less than 6.4 mm was 36.4 percent, with average fine fines (less than 0.85 mm) at 14.0 percent. These values are elevated against the means for fines from reference cores for riparian aggregate 3. The percentage of fines less than 6.4 mm for this site is 3 percent greater than the mean for reference cores from riparian aggregate 3, and the fine fines are 65 percent above the mean.

The second set of McNeil cores (six cores) was collected in 2003 at the channel survey site. The riparian aggregate here was determined to be 29, Alluvial (Borolls) Floodplains and Terraces. The average percentage of fines less than 6.4 mm was 41.4 percent, with average fine fines (less than 0.85mm) at 16.0 percent. These values are elevated against the means for fines from reference cores for riparian aggregate 29. The percentage of fines less than 6.4 mm for this site is 22 percent greater than the mean for reference riparian aggregate 29 cores, and the fine fines are 98 percent above the mean.

Table 3-60. Summary of McNeil core data for Skelly Gulch, MT41I006_220.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
3	1991	36.4	14.0	Fine fines value is elevated.
29	2003	41.4	16.0	Both fines values are elevated.

Suspended Sediment Concentrations

Few recent data were available for Skelly Gulch. MDEQ has one sample for total suspended solids collected in July 2001 about one-half mile above the mouth. The reported value was less than 10 mg/L. In 2003, two turbidity observations were recorded at the same sampling site. Both turbidity observations reported the water clarity as clear.

Macroinvertebrates

Macroinvertebrate data were available from one sample taken in July 2001 at a location above the mouth. The habitat rating for this site was "optimal." Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2001). The metric score of 78 percent indicated slight impairment and full support of aquatic life use. Sixteen clinger taxa and eight trichoptera taxa were found at the site, and Bollman concluded that fine sediment did not limit benthic habitat.

Periphyton

No recent data are available.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database and data from the Helena National Forest. Skelly Gulch is managed as a trout fishery. The Helena National Forest has documented genetically pure westslope cutthroat trout, a species of special concern, in the upper 3.5 miles of Skelly Gulch. Eastern brook trout have been documented in the lower 2.5 miles of the creek. The overall habitat and sport fishery rating for this section of the creek is "substantial," which is the next rating below "best."

Metals Concentrations

A limited total of three in-stream water chemistry samples taken between July 2001 and August 2003 were evaluated. No exceedances of either the human health or aquatic life criteria for arsenic, cadmium, copper, lead, or zinc were observed in the samples. The maximum measured concentration for arsenic was right at the human health criterion level. The average was just three percent lower than the human health criterion.

Skelly Gulch MT41I006_220 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediments, macroinvertebrates, fisheries, and water chemistry.

All of the sediment supplemental indicator values for channel metrics, except D_{50} , were met. A smaller than expected D_{50} is probably indicative of excessive deposition of surface fines. Suspended sediment data were inadequate to make a determination. Macroinvertebrate supplemental indicator threshold values were exceeded. Recent fisheries data suggest that there are reaches of valuable westslope cutthroat trout habitat in Skelly Gulch, primarily in the upper 4 miles of the stream. However the percentage of fines from McNeil core samples, taken at two sites, were elevated when compared with the target values.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting this stream segment, and that impairments tended to be localized. Target McNeil core values were exceeded.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Skelly Gulch MT41I006_220 are impaired by siltation. A TMDL will therefore be developed to address the sediment impairment.

The limited water column metals concentration data suggest Skelly Gulch is not impaired by arsenic, cadmium, copper, lead, or zinc. Given the limited number of samples available, it is recommended that this stream be monitored closely to confirm these statements.

3.4.2.5 Sevenmile Creek from the Headwaters to the Mouth (MT41I006_160)

Sevenmile Creek is a tributary of Tenmile Creek. It extends for 7.8 miles from its headwaters to the mouth (MT41I006_160). Montana's 1996 303(d) list rated this stream segment as threatened relative to cold-water fishery use because of siltation and habitat alterations. In 2002, the stream was listed as partially supporting aquatic life and cold-water fishery uses because of siltation, other habitat alterations, riparian degradation, flow alterations, nutrients, and metals. A typical view of Sevenmile Creek is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey on the stream above the confluence with the Tenmile Creek that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core subsurface fines from the channel survey site, suspended sediment data, macroinvertebrate and periphyton data, fish population information, and a total of 21 in-stream water chemistry samples taken between June 1997 and December 2003.

Sevenmile Creek

Pollution Sources

The 2003 preliminary source assessment identified roads and farming practices as the primary sediment sources for Sevenmile Creek. The aerial photography inventory showed five road crossings. Stream channelization along 13 percent of the stream occurs from the railway and Birdseye Road in the upper reaches of the stream.

The primary geologies of this sub-watershed are Cambrian and pre-Cambrian sedimentary rocks, with Quaternary sediments prominent in the floodplain. The aerial photography inventory showed that stream incision and eroding stream banks were visible. The beginning of the stream segment is predominantly affected by channelization from the railroad. Below Birdseye Road, agricultural impacts on the creek are visible (straightening for irrigation, irrigation diversions and return flows, and cultivation in the riparian zone).

In summary, roads and localized sources (cultivation in the riparian zone, eroding stream banks) are probably the biggest contributors of sediment to Sevenmile Creek. Irrigation withdrawals deplete the flow of Sevenmile Creek, and probably inhibit transport of sediment.

Sevenmile Creek is identified as a source of eutrophication in Tenmile Creek. This segment is approximately 8 miles in length and is affected by sediment, habitat and channel alterations, metals, nutrients, and possibly hydromodification/dewatering. Roads, upstream sources, and bare stream banks contribute sediment to the stream. Channelization from roads, railways, and agricultural operations has altered the stream's morphology and possibly its hydrology. Irrigation return flows, grazing practices, and upstream sources contribute nutrients. Irrigation water withdrawals affect aquatic habitat and stream hydrology. Diffuse sediment sources and possibly nutrient sources from rural housing might also affect the stream. Private property borders most of the stream. Intermittent parcels of BLM lands are also present. The primary land uses are a transportation corridor, hay fields and pasture, and rural housing. Stream incisement and eroding stream banks were visible about one and one-quarter miles downstream from the Austin Road crossing. Riparian buffer widths were variable depending on land management practices. Nearer to the stream's mouth, there is a noticeable increase in subdivision developments but none are immediately proximal to the stream. Features that were documented in 2003 using GPS information included road sediment delivery points, an animal confinement area, an irrigation diversion, and suspected wastewater seepage from Fort Harrison's defunct sewage treatment facility. Although healthy riparian vegetation was observed, stream dewatering appears to be a significant problem.

Expected significant contributors of metals to the stream segment are upstream sources and historical mining activities. Skelly Gulch is a tributary stream that might be a relevant source of metals. Most of the drainage area falls within the Scratchgravel Hills and Austin mining districts. The MBMG Abandoned and Inactive Mines database reports mineral location, placer, surface, surface-underground, and underground mining activities in the watershed. The historical mining types include placer, lode, and stockpile. In the past these mines produced gold, iron, lead, silver, and copper. None of the mines in the immediate drainage area of this segment are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation along Sevenmile Creek, above the confluence with the Tenmile Creek. The stream's entrenchment ratio and sinuosity were out of balance with the valley type setting, reflecting channel confinement and straightening. The field crew determined that the stream did not fit a Rosgen stream type classification, but would probably be an E4 or

C4 channel without alterations. The width-to-depth ratio was 9.4, which is typical of E-type channels (Table 3-61). The BEHI rating was in the upper-range of "high," and reflects bank instability. D_{50} as determined in a zigzag Wolman pebble count consisted of medium gravels. The D_{50} was actually greater than expected given the prevalence of sand and silt on the stream bottom.

Part of the channel survey included a Proper Functioning Condition assessment. The field crew rated the reach above the mouth as "Functional – at risk" (FAR), noting that the stream has healthy and diverse riparian vegetation (predominantly on the left bank). However, the field crew noted that the stream was choked with sediment and that cutbanks were prevalent on the right bank of the stream. The riparian land type aggregate assigned to this survey site is 29, Alluvial (Borolls) Floodplains and Terraces. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common but generally not excessive.

Table 3-61. Summary of cross-sectional data for Sevenmile Creek, MT41I006_160.

Site	Parameter	Result	Comparable to Reference
Above mouth	Width/depth ratio	9.4	NA
Above mouth	BEHI	37.1	NA
Above mouth	D_{50}	Medium gravels	NA
Above mouth	PFC	FAR	No, trend not apparent

McNeil Cores

McNeil core data are available for one site on Sevenmile Creek—the field survey site. Spawning size gravels and pool tailouts were sparse, thus only two cores were collected. The riparian aggregate here was determined to be 29, Alluvial Floodplains and Terraces (Table 3-62). The average percentage of fines less than 6.4 mm was 41 percent, with average fine fines (less than 0.85mm) at 15.8 percent. The percentage of fines less than 6.4 mm for this site are 21 percent greater than the mean for reference riparian aggregate 29 cores, while the fine fines are 95 percent greater.

Table 3-62. Summary of McNeil core data for Sevenmile Creek, MT41I006_160.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
29	2003	41	15.8	Both fines values are elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from the USGS National Water Information System. Data were available for one site near the mouth on Sevenmile Creek, with 10 samples taken from 1997 to 2003 (Table 3-63). The highest value collected was 1790 mg/L in March 2003. The suspended sediment data had an average of 197.5 mg/L with a median of 21.5 mg/L. These values are not comparable to values from selected reference streams for suspended sediment.

Table 3-63. Statistical summary of suspended sediment data for Sevenmile Creek, MT41I006_160.

Mean	197.5 mg/L
Median	21.5 mg/L
Standard deviation	559.7 mg/L
Maximum	1,790.0 mg/L
Number of samples	10
Number of sample sites	1

In 2003, four turbidity observations were recorded on Sevenmile Creek at Birdseye Road and near the mouth. All observations reported the water clarity as clear, except for one reading of slight turbidity near the mouth in July. However, the observations were made during the recessional limb of peak flow and also during low flow.

Macroinvertebrates

Macroinvertebrate data were available from two reports. The first report described the results of sampling in July 1997 at a location near the mouth. Sampling results were evaluated using the MDEQ's Rapid Bioassessment Protocols (Eakin, 1998). The site was rated as moderately impaired and partially supporting aquatic life use. No values for clinger or trichoptera richness were given. Eakin concluded that "existing data did indicate that sedimentation was a problem with Sevenmile Creek" (1998).

The second report described the results of a July 2001 sampling effort, also near the stream's mouth on Tenmile Creek. The habitat rating for this site was "optimal," but some points were lost due to sediment deposition and pool variability. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2001). The metric score of 28 percent indicated moderate impairment and partial support of aquatic life uses. Five clinger taxa and eight trichoptera taxa were found at the site. "Sediment tolerant taxa formed a large proportion of the taxa collected" (Bollman, 2001).

The macroinvertebrate assessments also concluded that nutrient enrichment was evident, and the abundance and composition of the macroinvertebrate community was partially a response to increased nutrients and/or organic inputs.

Periphyton

Periphyton data were available from one report. Sampling occurred in July 1997 near the mouth of Sevenmile Creek. Diatom metrics indicated severe impairment and poor biological integrity. Impairment conclusions were made according to Rocky Mountain Ecoregion protocols (Bahls, 1997). The siltation index exceeded the threshold for severe impairment, and was the major limiting factor.

The 1997 MDEQ periphyton assessment for several stations on this stream segment indicated heavy algal growth, and the stream supported algae indicating nutrient enrichment (Bahls, 1997).

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database. Sevenmile Creek is managed as a trout fishery. According to MFISH, no fish species are thought to be common year-round residents of Sevenmile Creek, while brook, brown, and rainbow trout were considered to be rare. The overall habitat and sport fishery rating for Sevenmile Creek is "moderate."

Nutrient Concentrations

Numerous total Kjeldahl nitrogen (7 of 10 records), total nitrogen (8 of 10 records), and total phosphorus (all 14 records) exceedances of Lake Helena watershed target values were documented within the available 1997–2003 period of record (Appendix D). The available data represented sampling by the USGS and MDEQ at various stations within this stream segment.

Metals Concentrations

The project team evaluated a total of 21 in-stream water chemistry samples taken between June 1997 and December 2003. Arsenic concentrations in 18 samples exceeded the human health criterion for arsenic. The average concentration of all samples was 54 percent higher than the human health criterion. The highest measured concentration was 2.8 times the human health criterion. No samples exceeded the aquatic life criteria. This evidence suggests this segment does not meet the human health criterion for arsenic.

The cadmium concentration in five percent of the samples exceeded the chronic aquatic life criterion. The average value of all samples was 77 percent below the chronic aquatic life criterion. The highest measured value was 1.67 times the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence suggests this segment meets the human health and aquatic life water quality standards for cadmium.

Copper concentrations in two samples (10 percent of the samples) exceeded the chronic aquatic life criterion. One of them was also above the acute aquatic life criterion. The highest measured value was four times the chronic aquatic life criterion. No samples exceeded the human health criterion. This evidence suggests this segment does not meet the aquatic life criteria for copper.

The lead concentration in one sample (five percent of the samples) exceeded the chronic aquatic life criterion. This sample also exceeded the human health criterion. The highest measured value was 6.5 times the chronic aquatic life criterion, and 4.5 times the human health criterion. This evidence suggests this segment does not meet the human health or aquatic life standards for lead.

All samples were below the human health and aquatic life criteria for zinc. This evidence shows that this segment meets the aquatic life and human health criteria for zinc.

Sevenmile Creek MT41I006_160 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition), McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediments, macroinvertebrates; periphyton; fisheries; and water chemistry.

No target or supplemental indicator values were met. Channel metrics were not comparable to reference streams, and that in itself signals problems for channel condition. Values for both classes of fines from McNeil cores were above the target values. Suspended sediment data values were higher than expected and extreme values were present. The results from the macroinvertebrate and diatom samples indicate impairment by sedimentation. Recent fisheries data suggest that this segment of the stream provides limited habitat for few fish species.

Results from the 2003 preliminary source assessment revealed that there were actively eroding sediment sources affecting the stream. No targets and few supplemental indicator values were being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Sevenmile Creek Segment MT41I006_160 are impaired by suspended solids and siltation. A TMDL will therefore be developed to address the sediment impairment.

The weight of evidence suggests that Sevenmile Creek (from headwaters to mouth) is impaired by nutrients. Numerous total phosphorus, total Kjeldahl nitrogen, and total nitrogen samples are above nutrient target values throughout the period of record (June 1997–December 2003) at various water quality stations on this stream segment. Sevenmile Creek is a source of eutrophication to Tenmile Creek. Irrigation return flows, grazing practices, and upstream sources contribute nutrients to the stream. Diffuse sediment sources and possible nutrient sources from rural housing may also affect the stream. It is possible that wastewater is seeping from Fort Harrison's defunct sewage treatment facility. Dewatering is significant. The 1997 periphyton report indicated heavy algal growth, and the stream supported algae, indicating nutrient enrichment. The 1997 and 2001 macroinvertebrate surveys indicated partial support of uses, and nutrient enrichment is evident. Therefore, a TMDL will be developed to address nutrients.

The available water chemistry data suggest that Sevenmile Creek is impaired due to copper and lead. TMDLs will be developed to address the copper and lead impairments.

3.4.2.6 Granite Creek from headwaters to mouth (Austin Creek – Greenhorn Creek – Sevenmile Creek) (MT41I006_179)

Granite Creek is a tributary to Austin Creek. It extends for 1.6 miles from its headwaters to the mouth (MT41I006_179). This Granite Creek shares its name with a separate 303(d)-listed segment located further downstream within the same Sevenmile Creek sub-basin (segment MT41I006_230). Figure 3-11 shows the location of both water bodies. Montana's 1996 303(d) list rated the Granite Creek tributary to Austin Creek (segment 179) as threatened relative to cold-water fishery use because of habitat alterations. Additional monitoring of the stream was performed in 2002 and 2003. Based on a detailed review of these data, Granite Creek was listed as fully supporting all of its designated uses on the 2004 303(d) list. A typical view of Granite Creek is shown in the photo below.

A review of the current data for segment 179 is provided below. Available data include results from a 2003 preliminary source assessment survey, macroinvertebrate and periphyton bioassessments for 2002, and a total of three in-stream water chemistry samples taken between September 2002 and August 2003.

Granite Creek (MT41I006_179)

Pollution Sources

Based on 2003 field observations and aerial photo and literature reviews, Granite Creek has sustained at least minor impacts from sediment and from habitat and channel alterations. Periodic runoff from unimproved roads likely contributes some sediment to Granite Creek. The granitic geology of the watershed also is likely to exacerbate sediment delivery rates to the stream. Historical placer mining appears to have altered the stream's natural channel morphology and possibly its hydrology. Most of the stream length is on the Helena National Forest with about one-sixth of a mile of private property located near the stream's mouth. The Helena National Forest manages the area for wildlife, limited timber harvest, and grazing. There is one private residence on the private parcel near the mouth. Rosgen stream type progresses from A to Ba through the 1.6 mile stream reach. The aerial photography assessment showed an extensive riparian area along with minor encroachment from an unimproved road. Small clear-cut operations have occurred in the headwaters area, but these were not in proximity to the stream corridor. Potential pollution sources visible on recent aerial photos were viewed as minor when compared with many of the other 303(d)-listed streams in the Lake Helena watershed.

The Helena National Forest also assessed Granite Creek for potential pollution sources. This assessment documented several road sediment delivery points, placer mine tailings, and an incised stream channel.

During field monitoring activities in 2003, the lower portion of the stream was noted as having rigorous riparian vegetation.

The immediate drainage area of the listed segment falls within the Austin mining district. Despite the present evidence of historical mining activity in this drainage, neither the MBMG Abandoned and Inactive Mines database nor the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites includes any mines in this watershed.

Macroinvertebrates

Macroinvertebrate data were available from one September 2002 sampling event. The evaluation of habitat parameters produced a rating of "optimal." Sampling results were compared to Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2003). Granite Creek supported a diverse and sensitive macroinvertebrate assemblage characteristic of an unimpaired montane stream. A bioassessment score of 94 percent indicated non-impairment and full support of aquatic life uses (Bollman, 2003b). The bioassessment suggested a clean, cold-water environment, and the presence of 20 clinger taxa and 10 caddisfly taxa implied the ample presence of hard substrates unimpaired by sediment deposition. Similarly, the assessment concluded that reach-scale habitat features such as riparian zone function, natural channel morphology, and stream bank integrity were likely intact because six stonefly taxa were collected.

Periphyton

Periphyton data were available from one August 2002 sampling effort (Bahls, 2003). The project evaluated the data using numeric biocriteria developed for reference streams in the Rocky Mountain Ecoregions of Montana. Granite Creek exhibited good biological integrity and full support of its designated aquatic life uses, although both the pollution index and the sedimentation index approached their respective thresholds for minor impairment. The filamentous green alga *Cladophora* was abundant in Granite Creek in 2002, which might have indicated stable flows, firm substrates, and plentiful nutrient concentrations. The presence of *Nostoc*, a bluegreen alga, suggested that nitrogen was likely the limiting nutrient with respect to algal growth potential. This information, together with a predominance of diatom algae species requiring only moderate levels of dissolved oxygen, suggested moderately nutrient enriched conditions in Granite Creek during 2002.

Metals Concentrations

The project team evaluated a total of three in-stream water chemistry samples taken between summer 2002 and summer 2003. All samples were below the human health and aquatic life criteria for arsenic, copper, lead, cadmium, and zinc. Most samples were below detection limits for the metals of concern, and those that were above the detection limits were still well below the human health and aquatic life criteria. This evidence suggests that this segment meets the human health and aquatic life criteria for arsenic, copper, lead, cadmium, and zinc. Because of the data are limited, this segment should be closely monitored in the future to confirm this statement.

Granite Creek MT41I006_179 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, macroinvertebrates, periphyton, and water chemistry. In general, the team's assessment of the available data is consistent with MDEQ's conclusions of full support of all designated water uses in the Granite Creek tributary to Austin Creek. Granite Creek was originally listed as threatened because of habitat alterations. This cause of impairment does not require the development of a TMDL according to EPA guidance and EPA policy. Furthermore, given its 2004 designation of full use support, a TMDL is not warranted. However, this should not preclude the pursuit of voluntary measures to address the existing, though relatively minor, impairments in the Granite Creek drainage as well as periodic monitoring of its water quality status.

3.4.2.7 Granite Creek from the Headwaters to the Mouth (Sevenmile Creek) (MT41I006_230)

This Granite Creek is a direct tributary of Sevenmile Creek, extending for approximately 2 miles from its headwaters to its confluence with Sevenmile Creek (MT41I006_230) (see Figure 3-11). Montana's 1996 303(d) list did not include a listing for this stream segment. MDEQ's 2002 303(d) assessment concluded that this Granite Creek did not support drinking water use because of arsenic, cadmium, and metals. All other designated uses were not assessed. However, due to an erroneous legal description attached to the water analysis data sheet, the assessment results were associated with the Granite Creek tributary to Austin Creek, segment 41I006_179. This error was discovered and corrected on the 2004 303(d) list. Impaired uses and causes remained the same as in 2002.

Available water quality assessment information for Granite Creek segment 41I006_230 is very limited. It consists of a single set of water analysis results from 1983, information from the MBMG Abandoned and Inactive Mines database, correspondence from the BLM, and observations made during an October 2004 field survey. These data are described in the following paragraphs. A typical view of Granite Creek is shown in the photo below.

Granite Creek (MT41I006_230)

<u>Pollution Sources</u>

EPA and Land & Water staff performed a field reconnaissance of the Granite Creek drainage in October 2004 with the goal of examining potential pollution sources and performing chemical, physical, and biological water quality monitoring. The stream was dry for its entire 2-mile length and there was no indication of recent flow. A stock dam located on the lower end of the creek, described as the location where the 1983 water sample had been collected, was breached.

The entire Granite Creek watershed was inspected. Granite Creek did not have surface flow at any location within its entire length during the October 2004 site visit, but a very small quantity of standing water was observed at several locations perhaps corresponding to alluvial groundwater elevations. Much of the Granite Creek channel, especially in its lower reaches and again in the headwaters area, lacked indications of more than brief seasonal flow. Riparian vegetation was not present in these areas. In the middle reaches the riparian zone was populated with aspen and a mixture of other vegetation. The defined stream channel was less than a foot wide. Stock dams had been constructed across the stream corridor in at least two locations and the lowermost of these was breached in its central portion. The dams appeared to have been non-functional for a considerable length of time. The Granite Creek watershed has only a few hundred feet of total elevation and most of the land area is open grassland where a limited snowpack would be expected to melt rapidly each spring season.

Present land use in the Granite Creek watershed is grazing/rangeland and limited recreation. The upper half of the watershed is managed by the BLM and the lower half is private ranchland. The BLM lands are grazed under private grazing leases. The soils are thin, rocky, and arid. In the upper portion of the drainage the geology changes to include outcroppings of the Boulder Batholith formation. A number of granite spires rise up from the valley bottom and adjacent slopes. An abandoned small-scale open-pit mine, a caved adit, and an ore processing facility, most likely a small scale cyanide heap leach operation, are located on BLM lands in the upper third of the Granite Creek drainage. Part of the excavation is located in immediate proximity to the dry creek channel. The facility is described as the Granite Creek Mine in the MBMG Abandoned and Inactive Mines database. This facility was apparently active in the past century but not in recent years. The foundation of a large building with an underdrain system might have been used as an ore leach pad. Several PVC-cased wells are present down-gradient from the mill and above the operation near the stream channel. Obvious processed tailings material was not noted, but it was difficult to differentiate between ore and tailings. Little material appeared to have been crushed or sorted but some granitic sand was noted in a flat area immediately downslope of the concrete foundation. It is not known whether this operation contributed to the original 1996 impaired designation for Granite Creek. BLM is in the process of cleaning up the site as resources become available (Personal communication, 2004, Joan Gabelman)

Other potential sources of impairment in the Granite Creek drainage were limited to agricultural nonpoint sources associated with livestock grazing on BLM and private lands. It was apparent in the 2004 field survey that Granite Creek is an ephemeral water body that sustains only seasonal flow.

Metals Concentrations

The basis for the original 2002 listing was a chemical analysis performed on a single sample collected upstream from a stock water dam in November 1983. The circumstances under which the sample was collected are not known. The agency collecting the sample and the analytical laboratory are also unknown, which may call into question the representativeness and quality of the analytical results. The results showed concentrations of arsenic, lead, and cadmium that were well in excess of the drinking water standards, while the latter two variables also exceeded the aquatic life criteria.

Granite Creek MT41I006_230 Water Quality Impairment Summary

The basis for Granite Creek's 303(d) listing was a single outdated chemical analysis performed by an unknown laboratory, which might not be accurate or representative of the source. MDEQ's stated rationale for retaining Granite Creek on the 303(d) list despite the limited available data is to ensure reassessment (personal communication, 2004, Allan Nixon). Given Granite Creek's ephemeral nature, reassessment will be contingent upon the presence of surface flow. Until monitoring can be conducted to verify the present-day status of this water body and the nature and magnitude of any impairments, TMDL development efforts are not warranted.

3.4.3 Silver Creek Drainage

This section presents summaries and evaluations of all available water quality data for water bodies in the Silver Creek drainage. A map of the Silver Creek drainage area is provided in Figure 3-11.

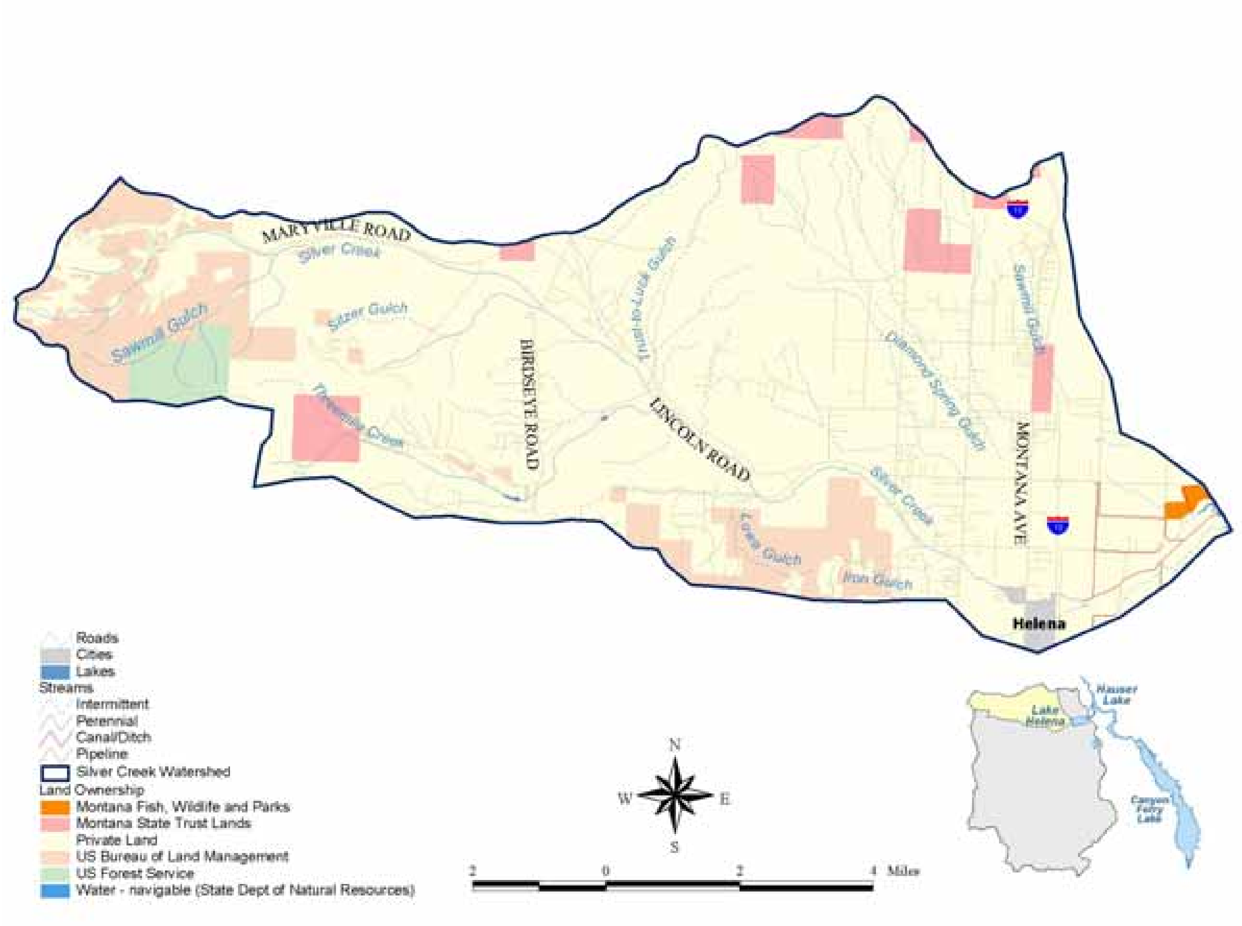

Figure 3-12. Map of the Silver Creek Watershed.

3.4.3.1 Jennie's Fork from the Headwaters to the Mouth (MT41I006_210)

Jennie's Fork is a tributary of Silver Creek. It extends for 1.2 miles from its headwaters to the mouth. In 1996, Jennie's Fork was listed as not supporting its designated aquatic life, cold-water fishery, drinking water, and recreational uses. In subsequent years, it was rated as fully supporting its designated uses, except aquatic life and cold-water fishery uses, which could not be assessed adequate data were lacking. Suspected causes of impairment in Jennie's Fork have included siltation and metals (1996 303(d) list). A typical view of Jennie's Fork is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), a cross-sectional survey below the Great Divide Ski Area that included a Proper Functioning Condition assessment and Wolman pebble counts, McNeil core substrate fines from the reach surveyed in 2003, suspended sediment data, macroinvertebrate and periphyton data, fish population information, and a limited total of four in-stream water chemistry samples taken between August 2001 and August 2003.

Jennie's Fork

<u>Pollution Sources</u>

The 2003 preliminary source assessment identified roads and geology as the primary sediment sources for Jennie's Fork. The aerial photography inventory showed four road crossings and road encroachment along 56 percent of the stream. Source assessment sites consisted primarily of road sites.

The primary geology of this sub-watershed is the Boulder Batholith, which consists of highly erodible quartz monzonite. During the field source assessment, poorly developed soils with gully formations on steep slopes were noted. Deposition of sand was observed in the stream channel at the field sampling sites. The aerial photography assessment showed variable width riparian buffers. There is an extremely high density of roads in the watershed, particularly in the vicinity of the ski resort. The stream flows underground in a series of culverts through most of the ski area. During the field survey it was noted that at least three channels carry flow during spring runoff due to an under-sized culvert. Cattle and horses were observed grazing below the ski area parking lot, and have trampled the stream banks and destroyed riparian vegetation.

In summary, road runoff and erosive geology are probably the biggest contributors of sediment to Jennie's Fork. Land disturbance appears to exacerbate erosion in the Boulder Batholith geology and the poorly developed soils of this sub-watershed.

Expected significant contributors of metals to the stream segment are historical hard rock mining activities in the upper watershed. The watershed falls within the Marysville mining district. The MBMG Abandoned and Inactive Mines database reports mineral location mining activities in the watershed. The historical mining type is lode mining. In the past these mines produced gold, silver, and lead. One mine in the watershed, Bald Mountain, is listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites. During the source assessment, it was learned that Jennie's Fork's point of origin is a mine shaft on Mount Belmont. The state has done significant reclamation work at this location and mining was active at this particular site until the late 1990s.

Channel Survey

In 2003 Tetra Tech and Land & Water Consulting conducted a field investigation on Jennie's Fork below the ski area parking lot. The field crew determined the stream to be a Rosgen stream type A4a+. The width-to-depth ratio was 4.3, which is about half the value for Helena National Forest and southwestern Montana and the Greater Yellowstone Area A4 reference stream (Table 3-64). This is probably a result of the stream leaving its channel during runoff events and/or reduction of flow to fill a cistern at the bottom of the ski hill. The BEHI rating was "moderate." The BEHI score was slightly above the average (less stable) for southwestern Montana and Greater Yellowstone Area A-type reference streams, but within 10 percent of the reference value. D_{50} as determined in a zigzag Wolman pebble count consisted of medium gravels. This median particle size is about two size-classes smaller than the range expected for A4 reference stream, based on data collected for the Helena National Forest and southwestern Montana and the Greater Yellowstone Area.

Part of the channel survey included a Proper Functioning Condition assessment. The field crew rated the reach as "Functional – at risk" (FAR), primarily because of the presence of riparian vegetation and energy dissipating characteristics. But the field crew noted that sand deposition was excessive. The riparian land type aggregate assigned to this site is 10, Granitic Rock – Mountain Slopes and Ridges. According to Helena National Forest data collected for streams occurring in this riparian aggregate, surface and subsurface fines are common and can be excessive.

Table 3-64. Summary of cross-sectional data for Jennie's Fork, MT41I006_210.

Parameter	Result	Comparable to Reference
Width/depth ratio	4.3	No
BEHI	22.7	Yes
D_{50}	Medium gravels	No
PFC	FAR	No

McNeil Cores

McNeil core data are available for one site on Jennie's Fork— the channel survey site. Six cores were collected. The riparian aggregate here was determined to be 10, Granitic Rock – Mountain Slopes and Ridges (Table 3-65). The average percentage of fines less than 6.4 mm was 41.2 percent, with average fine fines (less than 0.85 mm) at 16.3 percent. The percentage of fines less than 6.4 mm for this site is about 15 percent greater than the mean from reference cores for this riparian aggregate, while the fine fines are 60 percent above the mean.

Table 3-65. Summary of McNeil core data for Jennie's Fork, MT41I006_210.

Land Type Aggregate	Year	% Fines < 6.4 mm	% Fines < 0.85 mm	Comparable to Reference
10	2003	41.2	16.3	Both fines values are elevated.

Suspended Sediment Concentrations

Recent suspended sediment data were acquired from MDEQ. Few data were available for Jennie's Fork. Two samples for total suspended solids were collected below the Great Divide Ski Area in 2001 and 2002. The highest value collected was 26.5 mg/L in September of 2002.

In September of 2002, a turbidity observation accompanying the total suspended solids sample reported the water clarity as clear. In 2003, two turbidity observations were recorded on Jennie's Fork below the ski area. One observation reported the water clarity as clear, and the other reported the water clarity as slightly turbid. The observation of slight turbidity was reported in August, and may have been a result of livestock in the creek upstream from the sampling site.

Macroinvertebrates

Macroinvertebrate data from one sample taken in September 2002 below the ski area parking lot were available. Sampling results were compared with Bollman's revised bioassessment metrics for the Montana Valley and Foothill Prairies Ecoregion (Bollman, 2003b). The site was rated as moderately impaired and partially supporting aquatic life uses. Nine clinger taxa and four trichoptera taxa were found at the site, and Bollman concluded that fine sediment deposition might limit benthic habitat.

Periphyton

Periphyton data from one sample taken in August 2002 below the ski area parking lot were available. Sampling results were compared with reference biocriteria metrics established for the Rocky Mountain Ecoregions of Montana (Bahls, 2003). Diatom metrics indicated minor impairment and full support of aquatic life uses. Bahls concluded that the impairment was primarily due to organic loading and secondarily due to siltation. The siltation index exceeded the threshold for minor impairment. Sample notes indicated that the sample was silty.

Fish Populations

The project team examined data were in the Montana Fish, Wildlife and Parks' MFISH database. Montana Fish, Wildlife and Parks has no listing or management strategy for Jennie's Fork.

Metals Concentrations

The project team evaluated a limited total of four in-stream water chemistry samples taken between August 2001 and August 2003. No sample analysis results exceeded either the human health or aquatic life criteria for arsenic, cadmium, copper, or zinc. One sample (25 percent of the samples) exceeded the chronic aquatic life and human health criteria for lead. The average of all lead samples was 19 percent higher than the chronic aquatic life criterion. The highest measured value was 3.5 times the chronic aquatic life criterion, and 1.1 times the human health criterion. This evidence suggests this segment does not meet the human health and aquatic life standards for lead.

Jennie's Fork MT41I006_210 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, channel metrics (width-to-depth ratio, median surface particle size, BEHI, and Proper Functioning Condition) McNeil core subsurface fines less than 6.4 mm and less than 0.85 mm, suspended sediments, macroinvertebrates, periphyton, fisheries, and water chemistry.

No targets and few supplemental indicator values were met. Channel metrics, except for BEHI, were not comparable to reference streams. D_{50} at the survey site was at least one size-class smaller than expected, and is probably a reflection of excessive deposition of fine sediments. Values for both classes of fines from McNeil cores were above the target values. Suspended sediment data were inadequate to make a determination. The results from the macroinvertebrate and diatom samples indicate impairment by sedimentation. The lack of fisheries data suggests that this stream provides limited habitat for few fish species.

Results from the 2003 preliminary source assessment revealed that eroding sediment sources affecting the stream were enhanced by the erosive granitic geology. Best management practices for roads are warranted at the Great Divide Ski Area. No targets and few supplemental values are being met.

Based on the weight of evidence, the cold-water fishery and aquatic life beneficial uses in Jennie’s Fork are impaired by siltation. A TMDL therefore will be developed to address sediment impairment.

The limited water column sample analysis results suggest Jennie’s Fork is impaired by lead. A TMDL will be developed to address the lead impairment.

3.4.3.2 Silver Creek from the Headwaters to the Mouth (MT41I006_150)

Silver Creek is a 21.6-mile-long stream that drains directly to Lake Helena (MT41I006_150). Montana's 1996 303(d) list indicated that Silver Creek did not support aquatic life, cold-water fishery, and recreational uses because of metals, flow alterations, habitat alterations, and priority organics. In 2000 and 2002, drinking water and industrial water uses were added to the list of non-supported or partially supported uses, while the causes of impairment remained essentially the same. A typical view of Silver Creek is shown in the photo below.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), the results of four in-stream water chemistry samples, and fish tissue sampling results from 2003 (Appendix I).

Silver Creek

<u>Pollution Sources</u>

Expected significant contributors of metals to the stream segment are upstream sources and historical hard rock mining activities in the upper watershed. Jennie's Fork is a tributary and contributes to the metals loads. The sub-watershed falls within the Marysville, Scratchgravel Hills, and Austin mining districts. The MBMG Abandoned and Inactive Mines database reports mineral location, placer, prospect, surface, surface-underground, and underground mining activities in the watershed. The historical mining types include lode, mill, and placer. In the past these mines produced gold, silver, manganese, lead, iron, copper, and zinc. Five mine sites in the watershed are listed in the State of Montana's inventory of High Priority Abandoned Hardrock Mine Sites and fall within the Marysville district: Goldsil Mill Site, Drumlummon Mine/Mine Site, Argo Mill Site, Drumlummon Mine/Mill Site, and Belmont.

Metals Concentrations

The project team evaluated a total of four in-stream water chemistry samples taken between August 2001 and August 2003. Arsenic concentrations in three out of four samples exceeded the human health criterion. The average concentration of all samples was 42 percent higher than the human health criterion. The highest concentration was 2.3 times higher than the human health criterion. The evidence suggests that this segment does not meet the human health standard for arsenic.

All samples were below the human health and aquatic life criteria for cadmium, copper, lead, and zinc. The highest measured copper concentration was 80 percent of the chronic aquatic life criterion level. This is a borderline level.

Fish Tissue

Silver Creek was closed to harvest of sport fish in the 1980s because of mercury levels exceeding guidelines for human consumption. Sources of mercury in the watershed were believed to be associated with historical mercury amalgamation operations in the Marysville mining area. Concentrations of mercury ranged from 1.6 to 3.0 micrograms per gram (µg/g) in fish muscle tissue. Published guidelines for human consumption of mercury-contaminated fish recommend that when fish contain from 2.81 to 4.5 µg/g of mercury, no more than one meal per month should be eaten by adult men and adult women above child-bearing age. Women of child-bearing age, children age six and younger, and nursing mothers should not consume any fish containing these levels of mercury (MDPHHS, 2002). In summer 2003, Silver Creek trout were resampled for mercury analysis. Similar results were seen with mercury concentrations ranging from 1.47 to 3.23 µg/g.

Priority Organics

Silver Creek was listed as impaired on the Montana 303(d) list because of priority organics. Additional information from MDEQ identified DDE as the priority organic pollutant of concern. A second sample was collected on Silver Creek for reanalysis of DDE and 18 priority organics on August 21, 2003. The results of this analysis showed that concentrations of DDE and all of the other organic compounds were present in concentrations below the respective limits of analytical detection.

Silver Creek MT41I006_150 Water Quality Impairment Summary

The available water chemistry data suggest that Silver Creek is impaired for arsenic. A TMDL will be developed to address the arsenic impairment.

The available fish tissue data suggest that Silver Creek is impaired for mercury. A TMDL will be developed to address the mercury-related impairments.

Recent analysis data suggest that Silver Creek does not continue to sustain impairments associated with priority organic contaminants. It does not appear that a TMDL will be required for DDE.

3.4.4 Lake Helena (MT41I007_010)

This section presents summaries and evaluations of all available water quality data for Lake Helena proper. The location of Lake Helena is shown in relation to its watershed in Figure 2-1.

Lake Helena is approximately 2,100 acres in size and is the ultimate receiving water body for streams draining the 620-square-mile Lake Helena watershed. The Lake Helena portion of the Helena Valley originally consisted of a wetland complex that ranged in size from 3,600 to 7,800 acres (Wetlands Community Partnership, 2001). In 1907, Hauser Dam and Reservoir were constructed on the Missouri River north of Helena. Water backing up behind the dam inundated the lower reaches of Prickly Pear Creek and the surrounding wetlands, thereby creating Lake Helena. In 1945, an earthen causeway and control structures were installed to allow independent regulation of water levels in Hauser Reservoir and Lake Helena (Shields et al., 1995). The Lake Helena Causeway now separates Lake Helena from what is known as the Causeway Arm of Hauser Reservoir. Each of these two reservoir segments is listed as a separate segment on the Montana 303(d) list.

Lake Helena (MT41I007_010) was listed on the 1996 303(d) list as partially supporting aquatic life and cold-water fishery uses because of suspended solids, nutrients, metals, and thermal modifications. In subsequent 303(d) lists, Lake Helena was listed as not supporting drinking water uses because of metals, including lead and arsenic. Listings for aquatic life, cold-water fisheries, and primary contact recreation were removed because sufficient credible data were lacking.

A review of the current data is provided below. Available data include results from the 2003 preliminary source assessment survey (Appendix C), suspended sediment data, fish population information, synoptic temperature data, a total of 16 water chemistry samples (two additional samples for arsenic only) taken between June 2000 and August 2003, Secchi disc readings, and lake bottom sediment metals data.

<u>Pollution Sources</u>

The primary pollutant sources identified as affecting Lake Helena during a 2003 pollution source assessment were tributary streams, a variety of nonpoint pollution sources, and natural geologic factors. Tributary streams, diffuse nonpoint sources, and natural sources were documented as contributing sediment, nutrients, and metals to Lake Helena. These observations and conclusions were based on literature reviews, interpretation of available aerial photographs, and analysis of a variety of chemical, physical, and biological samples.

The lowest elevations in the Helena Valley are occupied by Lake Helena, which lies over Quaternary alluvial valley bottom sediment deposits. Lake Helena is a very shallow water body with an average depth of 5.2 feet. The surface area is approximately 3.2 square miles, or 2,072 acres. The limnology of the lake is strongly influenced by a large watershed area to lake area (see Appendix E). The water surface elevation of Lake Helena is partly controlled by Hauser Dam on the Missouri River and a control structure at the Lake Helena Causeway. The water level in Hauser Lake upstream from Hauser Dam is managed for power generation, flood control, and recreational uses. Flow from the Missouri River into and out of Hauser Reservoir is coordinated by the operation of upstream and downstream hydroelectric dams (Canyon Ferry Dam and Holter Dam, respectively). Lake Helena does not continuously discharge water to Hauser Reservoir. On occasion, depending on the respective water levels of the two reservoirs, flow direction can reverse, with Hauser Reservoir discharging water to Lake Helena (Shields et. al., 1995).

Hydrologic inputs to Lake Helena include the major tributary streams (Prickly Pear Creek, Tenmile Creek, and to a lesser extent, Silver Creek), groundwater discharge, tile drainage associated with the Helena Valley Irrigation District (HVID), treated wastewater discharges from the cities of Helena and East Helena (discharged to Prickly Pear Creek), and the Missouri River through direct or indirect discharges from the Helena Valley Irrigation Canal and from occasional backflows from Hauser Reservoir to Lake Helena (Kendy et al., 1998). In the summer, the lower reaches of both Prickly Pear and Tenmile Creeks are severely dewatered due to irrigation withdrawals, and their direct discharges to Lake Helena are negligible. Most of Silver Creek's small volume of flow never reaches the Helena Valley because of channel losses to groundwater and irrigation withdrawals. Silver Creek becomes a channelized ditch in its lower reaches and groundwater tile drainage discharging from the west and north portions of the Helena Valley comprise most or all of its flow. During the summer season, when a large volume of Missouri River water is imported into the Helena Valley to irrigate crops, direct discharges from the main Helena Valley Irrigation Canal and an extensive series of lateral canals provide most of the inflow to Lake Helena. An additional but unquantified volume of Missouri River water enters Lake Helena through groundwater discharges from irrigated fields within the Helena Valley Irrigation District. During the 2003 irrigation season (April 1 to September 30), an average daily flow of 231 cfs was discharged from the Missouri River Helena Valley Regulating Reservoir through the HVID canal system (Personal communication, 2004, Jim Foster). Most of this water can be assumed to eventually reach Lake Helena, minus evapotranspiration losses from irrigated fields. In contrast, average daily flows for Prickly Pear Creek (near Clancy), McClellan Creek (near the mouth), and Tenmile Creek (near the mouth) for the April 1 to September 30 time frame total about 143 cfs (USGS, 2004).

Lake Helena is surrounded by private lands, with the exception of a small public waterfowl preserve operated by Montana Fish, Wildlife and Parks that is located along the northwestern shore. Pacific Power and Light (PP&L) has a 603-acre easement along the west and south shoreline areas of the lake to accommodate fluctuating water levels that result from the operations of Hauser Dam. Private parcels along the western and southern edges of the lake consist of ranches and large residential lots with livestock pasture and hay fields that extend to the lake's edge. On the north and east shores of the lake, recent subdivision development has resulted in the construction of many homes on 1-acre (mostly near the causeway) or 20-acre lots. Interestingly, when the Lewis and Clark County cadastral land ownership GIS layer is overlain on a current aerial photo of the area, many of the subdivided lots on the north shore of Lake Helena have half of their parcels inundated by water.

Waterborne contaminants originating within many of the 303(d)-listed stream drainages are ultimately transported to Lake Helena. Diffuse pollution sources associated with rural housing, agricultural practices, and natural sources also affect the lake. Although the area was once a substantial wetland, most of the riparian vegetation is now restricted to the portion of shoreline where Prickly Pear Creek and the Silver Creek Ditch enter the lake. This corresponds to the area protected by the PP&L easement. The Missouri River irrigation water interbasin transfer might contribute to an increase in arsenic loading to Lake Helena, while surplus irrigation water discharges, return flows, and tile drainage might be sources of nutrient loading. During a 2003 pollution source assessment, open drains discharging tile drainage and excess irrigation water to Lake Helena were observed to contain high densities of aquatic plants and large numbers of dead carp. The majority of the Lake Helena watershed drains an area with granitic geology and a naturally high capacity for erosion and production of sediment. Aerial photographs reviewed as part of the 2003 source assessment showed a deltaic formation in Lake Helena where Prickly Pear Creek discharges to it. Field monitoring activities documented a shifting stream substrate composed of granite sands in much of lower Prickly Pear Creek. Other natural sources such as windy conditions contribute to shoreline erosion, especially along the east shoreline near the Lake Helena Causeway. Historical aerial deposition of metals and other contaminants from the ASARCO East Helena lead smelter is another potential but unquantified source of impairment in Lake Helena.

Suspended Sediment Concentrations

Recent total suspended solids data were acquired from PP&L, as well as 2003 field sampling. Data were available for four sites on the lake, and nine samples were taken in 2003. The highest value collected was 45 mg/L in August at the shallowest sampling site on the east (windward) side of the lake (Table 3-66). The total suspended solids data had an average of 24.6 mg/L with a median of 22.0 mg/L. There are no reference data with which to compare these values.

Table 3-66. Statistical summary of suspended sediment data for Lake Helena, MT41I007_010.

Mean	24.6 mg/L
Median	22.0 mg/L
Standard deviation	13.8 mg/L
Maximum	45.0 mg/L
Number of samples	9
Number of sample sites	4

Thirteen turbidity observations were recorded at four sites on Lake Helena from 2002 to 2003. Eight observations reported the water clarity as opaque and five observations reported the water clarity as slightly turbid. The observations of opacity reported during the 2003 sampling were described as being mostly due to algal blooms.

Aquatic Plants

From the August 2002 EPA/MDEQ Lake Helena water quality survey of Lake Helena, *Potamogeton crispusan* (an introduced species) is widespread in the lake and should be considered a co-dominate plant with *Potamogeton pectinatus*. *Potamogeton pectinatus* is clearly the most abundant plant in the lake and was found at virtually every site. All these species are common aquatic plants with wide distribution that are tolerant of slow moving or brackish water. On the western end of the lake where Tenmile and Silver Creeks enter, the aquatic vegetation was the densest. The thick vegetation prevented staff from accessing that area in the lake on a powerboat in 2002. Vegetation was found in the deeper water, but it was more sporadic.

Fish Populations

The project team examined data in the Montana Fish, Wildlife and Parks' MFISH database. Lake Helena is managed as a trout fishery. According to the MFISH database, many fish species, such as mottled sculpin, mountain whitefish, rainbow trout, Utah chub, walleye, kokanee salmon, brown trout, and fathead minnow, are thought to be common year-round residents of the lake. According to MFISH, common carp, longnose, and white sucker, and yellow perch are also abundant in the lake.

Nutrient-related Data

Post-1996 nutrient and nutrient-related data were limited to two sampling occasions (August 9, 2002, and January 21, 2003) until the focused monitoring effort in summer 2003. Land & Water and Montana Fish, Wildlife and Parks staff collected samples at seven stations on Lake Helena from June through August 2003. From these samples, 13 of 14 total phosphorus analyses exceeded the Lake Helena target values. In addition, 67 percent (8 of 12) of lake water chlorophyll-*a* samples collected between August 9, 2002, and August 29, 2003, exceeded the supplemental indicator value (0.0022 mg/L) (Appendix D).

Algal blooms were noted as being present in the lake during lake sampling events in 2003. Field measurements by Land & Water and Montana Fish, Wildlife and Parks in 2002–2003 showed specific conductance readings ranging from 267 to 465 µS/cm during June and August indicating substantial dissolved solids in the water. Dissolved oxygen readings ranged from a low of 1.8 to 11.7 mg/L at the beginning and end of the 2002 and 2003 summer seasons. Dissolved oxygen concentrations exceeded 133 percent of saturation in some samples (Appendix D).

In January 2003, PP&L Montana staff made dissolved oxygen measurements in Lake Helena near the Lake Helena Causeway and 150 yards off the Montana Fish, Wildlife and Parks boat launch near the mouth of the Silver Creek ditch. The readings ranged from 16 to 20 mg/L at the end of January 2003 (Appendix D). MDEQ staff have reported that during winter conditions when there is limited snow cover on the lake ice, supersaturated conditions can occur in Lake Helena. This is due to photosynthesis and a lack of surface turbulence (Personal communication, 2003, A. Horpestad, MDEQ).

Secchi Depth

Montana Fish, Wildlife and Parks and Land & Water Consulting took Secchi disc readings at four stations in Lake Helena in 2003. All Secchi disc readings were low (less than 1.70 feet at all four stations, except one reading of 3.5 feet at a water depth of 7 feet). These Secchi disc readings indicated low visibility in the lake (Appendix D).

Metals Concentrations

The project team evaluated a total of 14 in-inlake water chemistry samples (two more for just arsenic) taken between June 2000 and August 2003. Arsenic concentrations for 15 out of the 16 samples exceeded the human health criterion for arsenic. The average concentration in all samples was 145 percent higher than the human health criterion. The highest measured concentration was 4.6 times the human health criterion. No samples exceeded the aquatic life criteria. This evidence suggests this segment does not meet the human health standard for arsenic.

Lead concentrations in six samples (43 percent of the samples taken) exceeded the chronic aquatic life criterion. The highest concentration was 1.8 times the chronic aquatic life criterion. The average concentration of all samples was just 4.1 percent lower than the chronic aquatic life criterion. This evidence suggests this segment does not meet the chronic aquatic life standard for lead.

No samples exceeded the human health or aquatic life criteria for cadmium, copper, or zinc. The highest measured concentration of cadmium was 75 percent of the chronic aquatic life criterion. This is a borderline value.

Lake Bottom Sediment Data

A single composite core sample of lake bottom sediment material was collected at each of four lake locations in August 2003 and analyzed in the laboratory for total recoverable metals concentrations. The lab analyses indicated that concentrations of some metals were elevated in the lake bottom sediments. Specifically, the maximum concentrations of arsenic observed were in excess of levels linked to sediment toxicity (MacDonald et al., 2000). In addition, cadmium, copper, lead, and zinc all were present in sufficient concentrations to be of concern relative to aquatic life uses (MacDonald et al., 2000). The measured concentrations of aluminum and iron were also elevated, but fewer studies were available to discern the potential for toxic effects. Some research has shown that excessive amounts of iron in sediments actually serve to make other metals more biologically available. The Bureau of Reclamation evaluated Lake Helena bottom sediment data collected by Kendy et al. of the USGS (1998) in their preparation of an environmental assessment for the renewal of the Canyon Ferry water leasing contracts. They concluded that levels of arsenic, chromium, copper, lead, mercury, and zinc were elevated and comparable to sediment metal levels collected in wetlands impacted by mining (USBR, 2004b).

Site-specific conditions play a large role in the bioavailability of metals in the sediments. Without further study, it is difficult to assess the environmental hazard posed by the observed concentrations. The amount of organic material in the sediment (total organic carbon) and acid-volatile sulfide concentrations both affect the bioavailability of metals. Because Lake Helena is fairly shallow and subjected to frequent mixing by wind, it is unlikely that acid-volatile sulfide, which forms under anoxic conditions, is present in significant concentrations. However, measuring these compounds in the sediments would help to evaluate the bioavailability of these metals.

Performing sediment toxicity tests using EPA methods and amphipods or other common toxicity test species is the best method to determine bioavailability and toxicity of sediment metals to aquatic life. A well designed study that samples and tests representative portions of the lake sediment can be a great help in determining which areas of the lake contain toxic sediments. This information can then be used to establish specific management goals for the system.

Thermal Modifications

Temperature data for Lake Helena were limited to synoptic sampling efforts. During the summers of 2002 and 2003, 21 temperature observations were recorded at 11 stations (Table 3-67). The maximum temperature of 68.4 °F was recorded on August 29, 2003, just after 9 a.m. at the sampling site near the lake's center (M09LHLNC01). Some of the data were collected with a Hydrolab™ instrument and temperatures were recorded at various depth intervals. Hydrolab™ data values were averaged to one value per site, and these averages were incorporated into the results of the summary table below, Table 3-67. Hydrolab™ temperature readings ranged over depths of two to seven feet, with as much as a 4.5 °F temperature difference recorded per site.

Table 3-67. Statistical summary of synoptic temperature data for Lake Helena, MT41I007_010.

Mean	64.0° F
Median	62.8° F
Standard deviation	2.7° F
Maximum	68.4° F
Number of samples	21
Number of sample sites	11

"Naturally occurring temperatures" were not assessed in Lake Helena in part due to the unique nature of the lake (the flooded arm of Hauser Lake). SSTEMP modeling performed on other suspected thermally impaired stream segments in the Lake Helena watershed was not an appropriate tool for assessing temperature issues in Lake Helena.

Lake Helena MT41I007_010 Water Quality Impairment Summary

The project team reviewed data on potential pollution sources, suspended sediments, fisheries, lake temperature, and water chemistry (including nutrient, dissolved oxygen, and metals concentrations).

At this time, insufficient information is available to evaluate the degree of potential sediment impairment in Lake Helena, if any. A suitable reference lake would be needed to evaluate the sediment impairment of Lake Helena. Given the lack of suspended sediment data, it is not recommended that a TMDL be prepared at this time.

The weight of evidence suggests that Lake Helena is impaired by nutrients. Numerous total phosphorus, total nitrogen, and chlorophyll-*a* samples collected from various stations in the lake showed concentrations above the nutrient target or supplemental indicator values throughout the period of record. Tributary streams contribute sediment and nutrients. Rural housing and agricultural practices affect the lake. The lake is surrounded by development, and irrigation return ditches that flow into the lake have been documented as being choked with algae. Algal blooms were observed in the lake in June and August 2003. There were also large dissolved oxygen fluctuations ranging from a low of 1.8 mg/L to over 16 mg/L. Secchi disc readings also indicated low light visibility due to suspended materials in the water. A TMDL will be developed to address nutrients in Lake Helena.

The available water chemistry analysis results strongly suggest that Lake Helena is impaired by arsenic and lead. Lake bottom sediment data suggest unnatural metals enrichment, but further confirmation of the magnitude and spatial extent of the problem is warranted. TMDLs will be developed to address the arsenic and lead impairments in Lake Helena.

At this time, insufficient information is available to make a call on thermal impairments in Lake Helena. A suitable reference lake is needed to evaluate the possibility of thermal modifications. It is not recommended that a temperature TMDL be prepared at this time.

3.5 Conclusions of the Lake Helena Watershed Water Quality Impairment Status Review

Table 3-68 below summarizes the conclusions of the Lake Helena watershed water quality impairment status review discussed in the preceding pages. The table describes our interpretation of the present water quality status based on a thorough review of the available data, and lists the stream segments and the pollutant types that will need to be addressed in the forthcoming Lake Helena water quality restoration plan and TMDLs.

Table 3-68. Water quality status of suspected impaired water bodies and required TMDLs in the Lake Helena watershed.

Water Body Name and Number	Suspected Impairment Causes	Conclusions	Proposed Action
Clancy Creek, MT41I006_120	Sediment	Impaired	A TMDL will be written.
	Nutrients	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Corbin Creek, MT41I006_090	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
	Temperature	Unknown	A TMDL will not be written at this time.
	Salinity/total dissolved solids/chlorides	Impaired for salinity and total dissolved solids. Not impaired for chloride.	A TMDL will not be written. Impairments will be addressed by the metals TMDL.
Golconda Creek, MT41I006_070	Sediment	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for cadmium and lead.
Granite Creek, MT41I006_179	Habitat alterations	Not impaired	A TMDL will not be written.
Granite Creek, MT41I006_230	Metals	Unknown	A TMDL will not be written at this time.
Jackson Creek, MT41I006_190	Sediment	Not impaired	A TMDL will not be written.
Jennie's Fork, MT41I006_210	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for lead.

Water Body Name and Number	Suspected Impairment Causes	Conclusions	Proposed Action
Lake Helena, MT41I007_010	Sediment	Unknown	A TMDL will not be written at this time.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for arsenic and lead.
	Temperature	Unknown	A TMDL will not be written at this time.
Lump Gulch, MT41I006_130	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for cadmium, copper, lead, and zinc.
Middle Fork Warm Springs Creek, MT41I006_100	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, lead, and zinc.
North Fork Warm Springs Creek, MT41I006_180	Sediment	Impaired	A TMDL will be written.
	Low dissolved oxygen, organic enrichment	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, and zinc.
Prickly Pear Creek, MT41I006_060	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for lead.
Prickly Pear Creek, MT41I006_050	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for cadmium, lead, and zinc.
Prickly Pear Creek, MT41I006_040	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
	Temperature[a]	Impaired	A TMDL will be written.
Prickly Pear Creek, MT41I006_030	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for arsenic and lead.
	Temperature	Impaired	A TMDL will be written.

Water Body Name and Number	Suspected Impairment Causes	Conclusions	Proposed Action
Prickly Pear Creek, MT41I006_020	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Total Ammonia	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, and lead.
	Temperature	Impaired	A TMDL will be written.
Prickly Pear Creek, MT41I006_010	Metals	Not evaluated	TMDL needs will be addressed as part of the Hauser Reservoir TMDL.
Sevenmile Creek, MT41I006_160	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for copper and lead.
Silver Creek, MT41I006_150	Metals	Impaired	A TMDL will be written for arsenic and mercury.
	Priority organics	Not impaired	A TMDL will not be written.
Skelly Gulch, MT41I006_220	Sediment	Impaired	A TMDL will be written.
	Metals	Not impaired	A TMDL will not be written.
Spring Creek, MT41I006_080	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Tenmile Creek, MT41I006_141	Sediment	Not impaired	A TMDL will not be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Tenmile Creek, MT41I006_142	Sediment	Impaired	A TMDL will be written.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Tenmile Creek, MT41I006_143	Sediment	Impaired	A TMDL will be written.
	Nutrients	Impaired	A TMDL will be written for nitrogen and phosphorus.
	Metals	Impaired	A TMDL will be written for arsenic, cadmium, copper, lead, and zinc.
Warm Springs Creek,	Sediment	Impaired	A TMDL will be written.

Water Body Name and Number	Suspected Impairment Causes	Conclusions	Proposed Action
MT41I006_110	Metals	Impaired	A TMDL will be written for arsenic, cadmium, lead, and zinc.

[a] Impairment causes that have not been reflected on past 303(d) lists but that were identified during this review.

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