# Final - Lower Beaverhead River and Upper Jefferson River Temperature TMDLs

**November 2014**

M08-TMDL-03a-F

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Various versions of sections of this document were sent to stakeholders for review and input. The involvement of all reviewers led to improvements in this document and is greatly appreciated. DEQ would like to thank Kevin Weinner of the Beaverhead Deerlodge National Forest; Ron Spoon and Matt Jaeger of the Montana Department of Fish, Wildlife, and Parks and; the Department of Natural Resources and Conservation for their comments and contributions. Additionally, we would like to thank the Beaverhead, Ruby Valley, and Jefferson Valley Conservation Districts.

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Watershed & Environmental Technologies, a consulting firm, provided significant contributions in the development of **Appendices B** and **C**. Kyle Flynn and Eric Regensburger, with DEQ, provided temperature modeling for the lower Beaverhead River.

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# ACRONYM LIST

| Acronym | Definition |
|---|---|
| ARM | Administrative Rules of Montana |
| BMP | Best Management Practices |
| BOR | Bureau of Reclamation |
| BRDM | Beaverhead River at Dillon, MT sampling site |
| BWC | Beaverhead Watershed Committee |
| CFR | Code of Federal Regulations |
| CWA | Clean Water Act |
| DEQ | Department of Environmental Quality (Montana) |
| DNRC | Department of Natural Resources & Conservation (Montana) |
| DOI | Department of the Interior (federal) |
| EBID | East Bench Irrigation District |
| EPA | Environmental Protection Agency (U.S.) |
| EQIP | Environmental Quality Incentives Program |
| FWP | Fish, Wildlife & Parks (Montana) |
| GIS | Geographic Information System |
| IR | Integrated Report |
| JRWC | Jefferson River Watershed Council |
| LA | Load Allocation |
| MCA | Montana Code Annotated |
| MFISH | Montana's Fisheries Information System |
| MOS | Margin of Safety |
| MPDES | Montana Pollutant Discharge Elimination System |
| MSU | Montana State University |
| NLCD | National Land Cover Dataset |
| NPDES | National Pollutant Discharge Elimination System |
| NPS | Nonpoint Source |
| NRCS | Natural Resources Conservation Service |
| RIT/RDG | Resource Indemnity Trust / Reclamation and Development Grants Program (RIT/RDG) |
| TMDL | Total Maximum Daily Load |
| TPA | TMDL Planning Area |
| USDA | United States Department of Agriculture |
| USGS | United States Geological Survey |
| WLA | Wasteload Allocation |
| WRP | Watershed Restoration Plan |
| WWTF | Wastewater Treatment Facility |
| WWTP | Wastewater Treatment Plant |

# DOCUMENT SUMMARY

This document presents a total maximum daily load (TMDL) and framework water quality improvement plan for two temperature impaired waterbody segments, one on the Beaverhead River (lower) and one on the Jefferson River (upper) (see **Figure 2-1** found in **Section 2.1.1**).

The Montana Department of Environmental Quality (DEQ) develops TMDLs and submits them to the U.S. Environmental Protection Agency (EPA) for approval. The Montana Water Quality Act requires DEQ to develop TMDLs for streams and lakes that do not meet, or are not expected to meet, Montana water quality standards. A TMDL is the maximum amount of a pollutant a waterbody can receive and still meet water quality standards. TMDLs provide an approach to improve water quality so that streams and lakes can support and maintain their state-designated beneficial uses.

This project area encompasses roughly 106 river miles in western Montana and includes portions of the Beaverhead TMDL Planning Area (TPA) and the Upper Jefferson River TPA.

The Beaverhead TPA is located in Beaverhead County, with a small portion in Madison County and includes the towns of Dillon and Twin Bridges **(Section 2.1.1, Figure 2-1)**. The Beaverhead TPA encompasses the Beaverhead River watershed (fourth-code hydrologic unit code 10020002), which begins at the outlet of the Clark Canyon Reservoir and flows northeast 79.5 miles before joining the Big Hole River to form the Jefferson River. The TPA is bounded by the Pioneer Mountains on the west, the Ruby Range to the east, and the Snowcrest Range and Blacktail Mountains to the south.

The Upper Jefferson River TPA is located in Madison, Silverbow, and Jefferson counties and includes the Jefferson River and its tributaries, from Twin Bridges to the Boulder River confluence near Whitehall. The tributaries originate in the Tobacco Root Mountains, located in the southern portion of the watershed, and the Highland Mountains to the north. The watershed drainage area encompasses about 469,994 acres, with federal, state, and private land ownership.

DEQ determined that the two waterbody segments, the lower Beaverhead River and the upper Jefferson River, do not meet the applicable water quality standards for temperature. The scope of the TMDLs in this document addresses problems only with temperature (see **Table DS-1**). Although DEQ recognizes that there are other pollutant listings for these two rivers, this document addresses only temperature and associated non-pollutant listings.

Temperature was identified as impairing aquatic life on the lower Beaverhead River and upper Jefferson River and a TMDL will be written for each. Historic removal of riparian vegetation, which is important for regulating stream temperature by providing shade, is the primary cause of impairment. Water quality restoration goals focus on improving riparian shade, however, maintaining stable stream channel morphology and in streamflow conditions during the hottest months of the summer are also important for meeting the TMDL. DEQ believes that once these water quality goals are met, all water uses currently affected by temperature will be restored given all reasonable land, soil, and water conservation practices.

The Beaverhead and Jefferson River temperature TMDLs indicate that reductions in maximum daily water temperatures ranging from no reduction to 7.9°F are necessary. General strategies for achieving the in-stream water temperature reduction goals are also presented in this plan and include best management practices (BMPs) for managing riparian areas. Sediment TMDLs were developed in 2012 for the 18 stream segments in the Beaverhead TMDL planning area (Montana Department of Environmental Quality, 2012a), including the lower segment of the Beaverhead River addressed in this document. Sediment TMDLs were also developed for four tributaries to the upper Jefferson River (Starr and Kron, 2009), but not the segment included in this document. However, the sediment load allocations and associated BMPs contained in those documents will also help address many of the causes of temperature impairment in the segments discussed here.

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

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

Although most water quality improvement measures are based on voluntary measures, federal law specifies permit requirements developed to protect narrative water quality criteria, a numeric water quality criterion, or both, to be consistent with the assumptions and requirements of wasteload allocations (WLAs) on streams where TMDLs have been developed and approved by EPA. There are 10 permitted point sources in the lower Beaverhead River and 1 in the upper Jefferson River (**Table 5-5**). The wastewater treatment facility in Dillon is the only permitted discharger with reasonable potential to contribute thermal pollution, therefore requiring the incorporation of a wasteload allocation on the lower Beaverhead River.

**Table DS-1. List of Impaired Waterbodies and their Impaired Uses on the Lower Beaverhead and Upper Jefferson Rivers with Completed temperature TMDLs Contained in this Document**

| Waterbody & Location Description | TMDL Prepared | TMDL Pollutant Category | Impaired Use |
|---|---|---|---|
| **Beaverhead River,** Grasshopper Creek to mouth (Jefferson River) | Temperature | Temperature | Aquatic Life |
| **Jefferson River,** headwaters to confluence of Jefferson Slough | Temperature | Temperature | Aquatic Life |

# 1.0 Project Overview

This document presents an analysis of water quality information and establishes total maximum daily loads (TMDLs) for temperature problems in the lower Beaverhead and upper Jefferson Rivers. This document also presents a general framework for resolving these problems. **Figure 2-1**, found in **Section 2.1.1**, shows a map of the area including the lower Beaverhead and upper Jefferson Rivers.

## 1.1 Why We Write TMDLs

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

Montana's water quality designated use classification system includes the following:
- fish and aquatic life
- wildlife
- recreation
- agriculture
- industry
- drinking water

Each waterbody in Montana has a set of designated uses from the list above. Montana has established water quality standards to protect these uses, and a waterbody that does not meet one or more standards is called an impaired water. Each state must monitor their waters to track if they are supporting their designated uses, and every two years the Montana Department of Environmental Quality (DEQ) prepares a Water Quality Integrated Report (IR) that lists all impaired waterbodies and their identified impairment causes. Impairment causes fall within two main categories: pollutant and non-pollutant.

Montana's biennial IR identifies all the state's impaired waterbody segments. The 303(d) list portion of the IR includes all of those waterbody segments impaired by a pollutant, which require a TMDL, whereas TMDLs are not required for non-pollutant causes of impairments. **Table 1-1** in **Section 1.2** identifies all impaired waters for the lower Beaverhead and upper Jefferson Rivers from Montana's 2014 303(d) List, and includes non-pollutant impairment causes in Montana's "2014 Water Quality Integrated Report" (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2014). **Table 1-1** provides the current status of each impairment cause, identifying whether it has been addressed by TMDL development.

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

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

- Determining measurable target values to help evaluate the waterbody's condition in relation to the applicable water quality standards
- Quantifying the magnitude of pollutant contribution from their sources
- Determining the TMDL for each pollutant based on the allowable loading limits for each waterbody-pollutant combination
- Allocating the total allowable load (TMDL) into individual loads for each source

In Montana, restoration strategies and monitoring recommendations are also incorporated in TMDL documents to help facilitate TMDL implementation (see **Sections 7.0** and **8.0** of this document).

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

## 1.2 Water Quality Impairments and TMDLs Addressed by this Document

**Table 1-1** below lists all of the impairment causes from the "2014 Water Quality Integrated Report" (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2014) that are addressed in this document.

TMDLs are completed for each waterbody – pollutant combination, and this document contains two temperature TMDLs (**Table 1-1**). There are several non-pollutant types of impairment that are also addressed in this document. As noted above, TMDLs are not required for non-pollutants, although in many situations the solution to one or more pollutant problems will be consistent with, or equivalent to, the solution for one or more non-pollutant problems. The overlap between the pollutant TMDLs and non-pollutant impairment causes is discussed in **Section 6.0**. **Sections 6.0** and **7.0** provide some basic water quality solutions to address those non-pollutant causes not specifically addressed by TMDLs in this document.

DEQ recognizes that there are other pollutant listings for the upper Jefferson River segment without completed TMDLs (identified in **Table 1-1** below); however, this document only addresses the temperature impairments on the lower Beaverhead and upper Jefferson. This is because DEQ sometimes develops TMDLs in a watershed at varying phases, with a focus on one or a couple of specific pollutant types. Sediment TMDLs were previously completed for the Beaverhead TMDL Planning Area (TPA) in 2012 (Montana Department of Environmental Quality, 2012a) and the Upper Jefferson TPA in 2009 (Starr and Kron, 2009). **Table 1-1** includes impairment causes with completed TMDLs, as well as non-pollutant impairment causes that were addressed by those TMDLs.

**Table 1-1. Water Quality Impairment Causes for the Lower Beaverhead and Upper Jefferson Rivers**

| Waterbody & Location Description [1] | Waterbody ID | Impairment Cause | Pollutant Category | Impairment Cause Status[2] |
|---|---|---|---|---|
| **Beaverhead River**, Grasshopper Creek to mouth (Jefferson River) | MT41B001_020 | Alteration in streamside or littoral vegetative covers | Not Applicable; Non-Pollutant | Addressed by a Sediment TMDL in a previous document (2012) |
| | | Low flow alterations | Not Applicable; Non-Pollutant | Addressed by a Sediment TMDL in a previous document (2012) |
| | | Physical substrate habitat alterations | Not Applicable; Non-Pollutant | Addressed by a Sediment TMDL in a previous document (2012) |
| | | Sedimentation/ Siltation | Sediment | Sediment TMDL contained in a previous document |
| | | Temperature | Temperature | Temperature TMDL contained in this document |
| **Jefferson River**, headwaters to confluence of Jefferson Slough | MT41G001_011 | Low flow alterations | Not Applicable; Non-Pollutant | Addressed within this document (**Section 6.0**); not linked to a TMDL |
| | | Temperature | Temperature | Temperature TMDL contained in this document |
| | | Iron | Metals | Not yet addressed |
| | | Lead | Metals | Not yet addressed |
| | | Physical substrate habitat alterations | Not Applicable; Non-Pollutant | Not yet addressed |
| | | Sedimentation/ Siltation | Sediment | Not yet addressed |
| | | Solids (Suspended/ Bedload) | Sediment | Not yet addressed |

1. All waterbody segments within Montana's Water Quality Integrated Report are indexed to the National Hydrography Dataset
2. Included in 2014 Integrated Report

## 1.3 What This Document Contains

This document addresses all of the required components of a Total Maximum Daily Loads (TMDL) and includes an implementation and monitoring strategy. TMDL components are summarized within the main body of the document. Additional technical details are contained in the appendices. In addition to this introductory section, this document includes:

**Section 2.0** Lower Beaverhead and Upper Jefferson Watershed Descriptions:
Describes the physical characteristics and social profile of the Beaverhead River and Jefferson River corridor.

**Section 3.0** Montana Water Quality Standards
Discusses the water quality standards that apply to the lower Beaverhead and upper Jefferson Rivers.

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

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

**Section 6.0** Other Identified Issues or Concerns:
Describes other problems that could potentially be contributing to water quality impairment and how the TMDLs in the plan might address some of these concerns. This section also provides recommendations for combating these problems.

**Section 7.0** Water Quality Improvement Plan:
Discusses water quality restoration objectives and a strategy to meet the identified objectives and TMDLs.

**Section 8.0** Monitoring for Effectiveness:
Describes a basic water quality monitoring plan for evaluating the long-term effectiveness of the Lower Beaverhead River and Upper Jefferson River Temperature TMDLs.

**Section 9.0** Public Participation & Public Comments:
Describes other agencies and stakeholder groups who were involved with the development of this plan and the public participation process used to review the draft document. Addresses comments received during the public review period.

# 2.0 WATERSHED DESCRIPTIONS

This watershed description provides a general overview of the physical and cultural characteristics of the Beaverhead River and Jefferson River corridor. Unless otherwise noted, geospatial data used for the figures and accompanying discussion is obtained from the Montana GIS Portal (http://gisportal.msl.mt.gov/geoportal/catalog/main/home.page).

## 2.1 PHYSICAL CHARACTERISTICS

The following information describes the physical characteristics of the Beaverhead River and Jefferson River corridor.

### 2.1.1 Location

The project area encompasses roughly 106 river miles in western Montana, extending from the mouth of Grasshopper Creek to the mouth of Jefferson Slough (**Figure 2-1**). This includes the lower 66 miles of the Beaverhead River and approximately 40 miles of the upper Jefferson River. The project is restricted to the mainstem river corridor, although it passes through two existing total maximum daily load (TMDL) planning areas: the Beaverhead and Upper Jefferson. The adjacent upland areas and tributary streams are addressed in separate TMDL projects. Elevation ranges from approximately 4,260 feet at the mouth of Jefferson Slough to approximately 5,300 feet at the mouth of Grasshopper Creek.

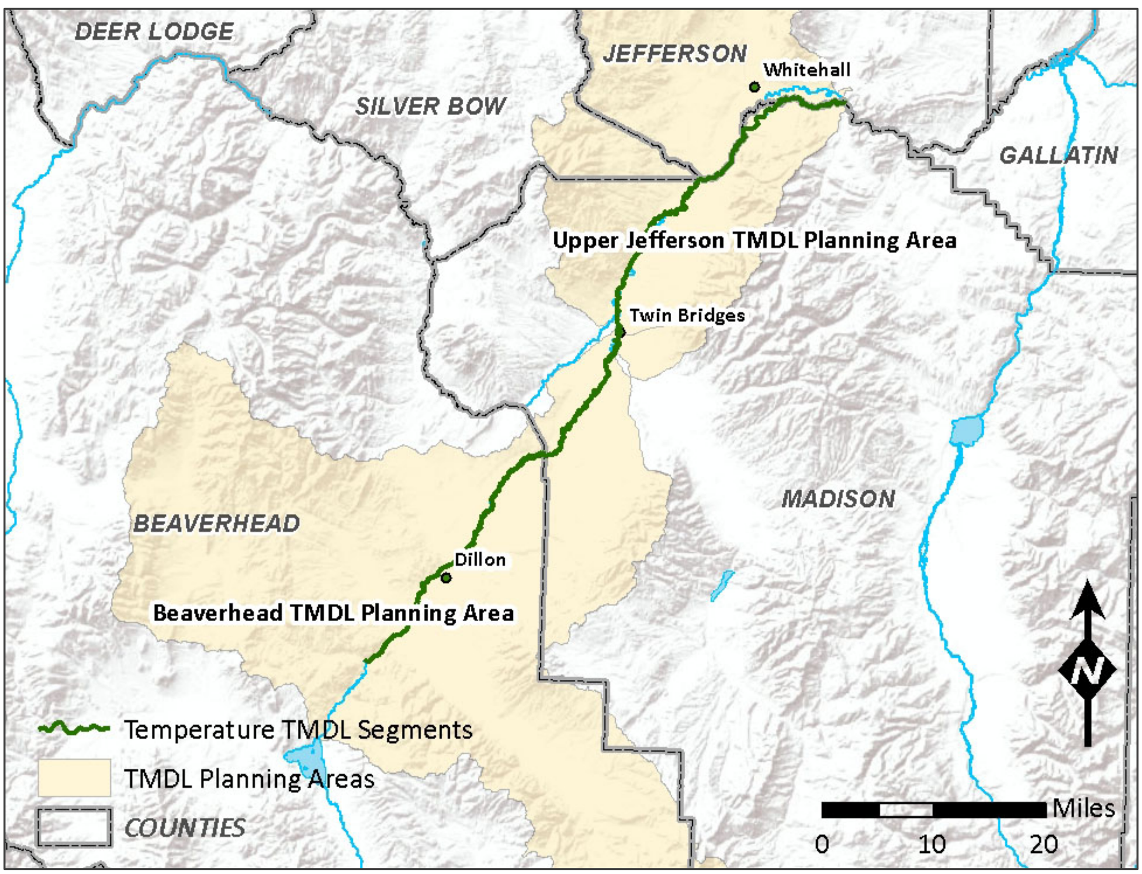



**Figure 2-1. Location of temperature TMDL segments**

### 2.1.2 Hydrology

The Beaverhead River is formed by the confluence of the Red Rock River and Horse Prairie Creek. Since the construction of the Clark Canyon Reservoir in 1964, the Beaverhead River begins at the outlet from the Clark Canyon Dam. The Bureau of Reclamation built the dam and associated irrigation infrastructure in order to irrigate the bench east of Dillon. Below the dam, the Beaverhead River flows about 15 miles through a canyon before entering the Beaverhead Valley near Barretts. Major tributary streams are Grasshopper Creek, Blacktail Deer Creek, Rattlesnake Creek, and the Ruby River. The Ruby River flows into the Beaverhead River slightly over a mile south of Twin Bridges. The Big Hole River meets the Beaverhead River just north Twin Bridges. The confluence of the Beaverhead and Big Hole Rivers marks the start of the Jefferson River. The Jefferson River flows north through the Jefferson Valley and turns eastward south of Whitehall and Cardwell. Tributary streams that flow into the Jefferson River are generally smaller than those flowing into the Beaverhead River. Prominent tributaries to the Jefferson River include Hells Canyon Creek, Beall Creek, Cherry Creek, and Fish Creek. The Beaverhead and Jefferson rivers have distinct mainstems, but there are many anastomosing channels that diverge and converge, the largest of which is Jefferson Slough. Jefferson Slough receives flow from the Boulder River and several smaller streams, and rejoins the Jefferson River at the point where the Jefferson River leaves the valley and enters the canyon. This point is the break between the upper and lower Jefferson River, and represents the downstream end of this project. United States Geological Survey (USGS) gages located in the project area are summarized below in **Table 2-1** and illustrated in **Figure 2-2**.

**Table 2-1. USGS Gage Stations on the Beaverhead River and the Jefferson River**

| Station ID | Station Name | Active? | Area Drained ($miles^2$) |
|---|---|---|---|
| 06015400 | Beaverhead River near Grant | No | 2,322 |
| 06016000 | Beaverhead River at Barretts | Yes | 2,737 |
| 06017000 | Beaverhead River at Dillon | Yes | 2,895 |
| 06018000 | Beaverhead River near Dillon | No | 3,484 |
| 06018500 | Beaverhead River near Twin Bridges | Yes | 3,619 |
| 06023100 | Beaverhead River at Twin Bridges | Yes | 4,779 |
| 06026500 | Jefferson River near Twin Bridges | Yes | 7,632 |
| 06027000 | Jefferson River near Silver Star | No | 7,683 |
| 06027200 | Jefferson River at Silver Star | No | 7,683 |

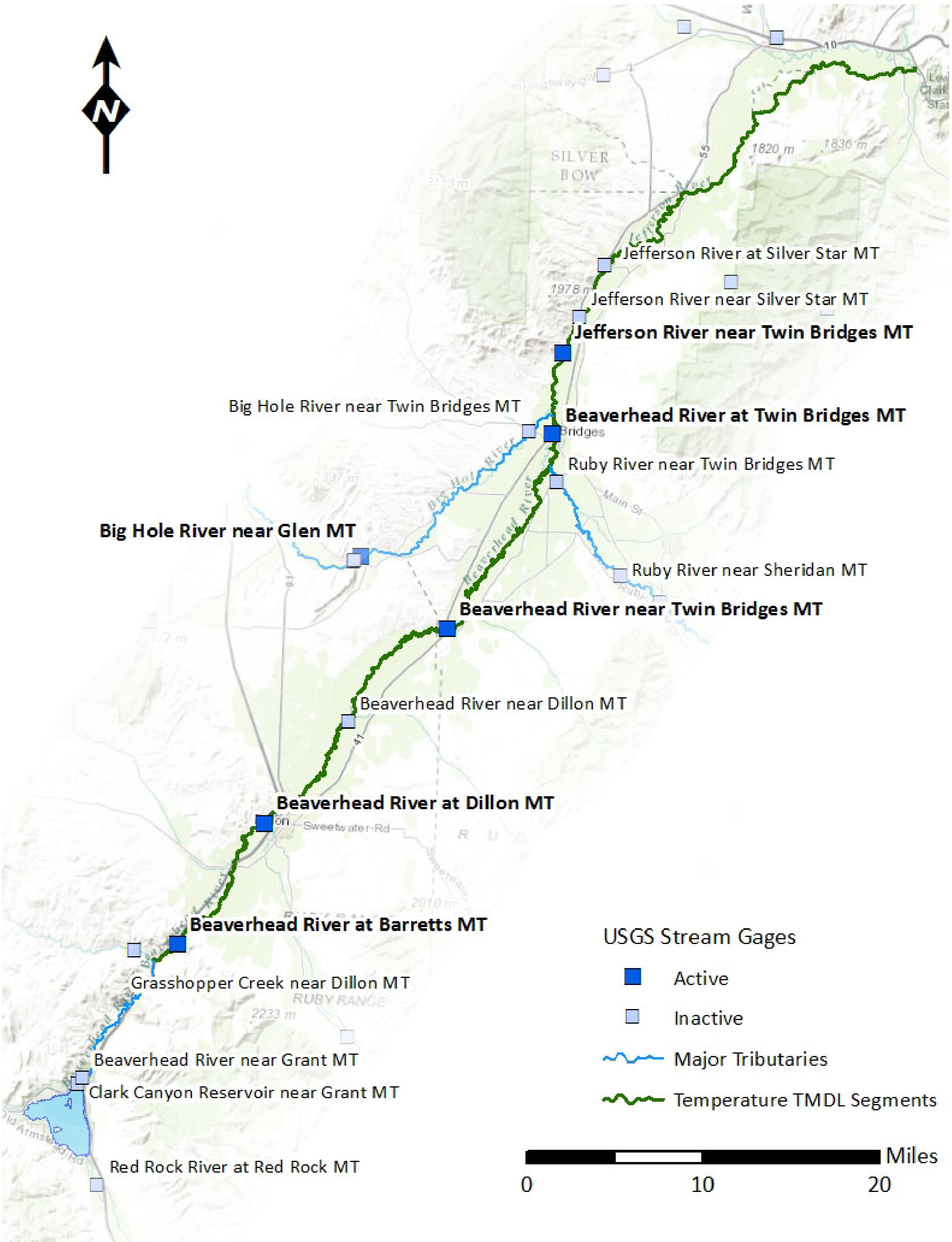
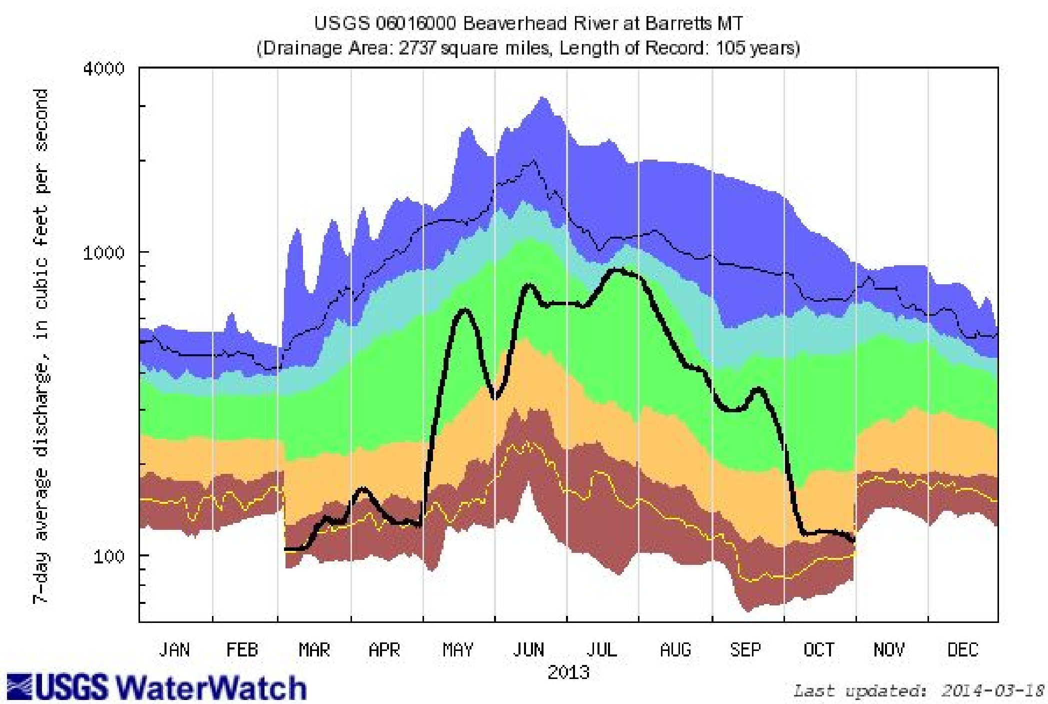



**Figure 2-2. USGS Gages**

Streamflow in the Beaverhead River is strongly influenced by operation of the Clark Canyon Reservoir. This is demonstrated graphically in a hydrograph of Beaverhead River discharge (**Figure 2-3**), measured at USGS gaging station 06016000 (Beaverhead River at Barretts). The peak of the hydrograph is shifted later in the year, reflecting controlled release of stored water that was captured during the spring runoff. The low flow regime is fairly stable, reflecting average low-flow discharge from the reservoir. Diversion of river water to the East Bench Unit irrigation system is reflected at gaging stations further downstream, such as 06017000 (Beaverhead River at Dillon). Reduced flows are distinct between April and November, resulting in an inverted hydrograph. Although the flow at Barretts starts to decrease in late August/September due to reduced irrigation demand, flows in the lower stretches of the Lower Beaverhead River increase as irrigation return flows contribute to flow recovery in the late summer/early fall.

Streamflow in the Jefferson River follows a hydrograph more typical for the region (**Figure 2-4**). This is due to the fact that there are no impoundments on the Big Hole River, and although there is an impoundment on the Ruby River (Ruby Reservoir), the flow in the Ruby River also generally follows a typical hydrograph. Flow in the Jefferson River is highest in June. May and June are the months with the greatest amount of precipitation and snowmelt runoff, but the higher elevations of the Big Hole River watershed melt off later. Streamflow begins to decline in July, reaching minimum flow levels in August and September when many tributary streams go dry. Streamflow generally begins to rebound in October and November when fall storms supplement the base-flow levels. Example hydrographs are provided below, based on the gages at Barretts and near Twin Bridges.




| Explanation - Percentile classes | | | | | | | |
|---|---|---|---|---|---|---|---|
| lowest-10th percentile | 5 | 10-24 | 25-75 | 76-90 | 95 | 90th percentile -highest | Flow |
| Much below Normal | | Below normal | Normal | Above normal | Much above normal | | |

**Figure 2-3. Hydrograph at Beaverhead River at Barretts**

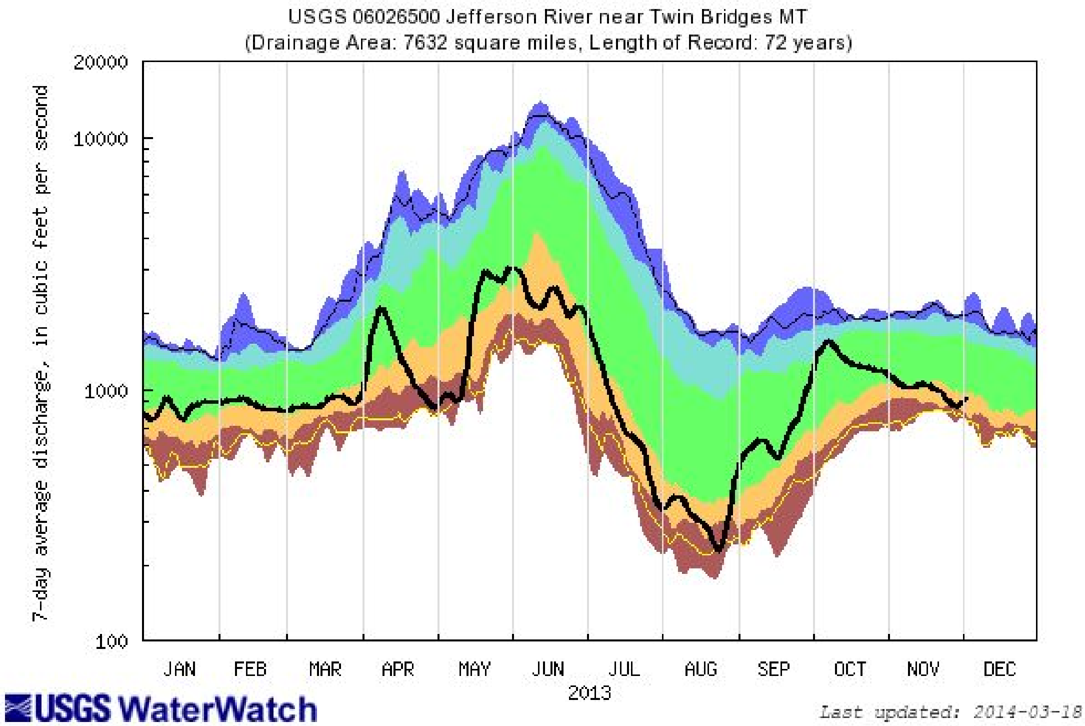



**Figure 2-4. Hydrograph at Jefferson River near Twin Bridges.**

### *2.1.2.2 Impoundments*

Although there are no impoundments located on the temperature-impaired segments of the Beaverhead and Jefferson rivers, there are two reservoirs influencing these segments. One is located upstream on the Beaverhead River (Clark Canyon Reservoir). The other (Ruby Reservoir) is located on the Ruby River, a major tributary.

The Clark Canyon Reservoir was constructed in 1964 and stores roughly 75,000 acre-feet of water. The Bureau of Reclamation operates the Clark Canyon Reservoir for the purposes of irrigating the East Bench Unit south of Dillon. The East Bench Unit irrigates 49,800 acres via the diversion dam at Barretts (Rogers, 2008). Minimum discharges usually occur during late summer and often result in late-season shortages of irrigation water (Kendy and Tresch, 1996).

The Ruby Reservoir stores roughly 37,600 acre-feet of water for irrigation. The dam is owned by Montana Department of Natural Resources Conservation (DNRC). The dam was constructed in 1938, and is operated by the Ruby Water Users Association. Water is distributed via two canals: the West Bench and Vigilante canals.

### *2.1.2.3 Dewatering*

The State of Montana Fish, Wildlife and Parks (MT FWP) maintains a list of Montana streams that support important fisheries or contribute to important fisheries (i.e. provide spawning and rearing habitats) that are significantly dewatered. Dewatering refers to a reduction in streamflow below the point where stream habitat is adequate for fish. The two categories of dewatering are “chronic” – streams where dewatering is a significant problem in virtually all years and “periodic” – streams where dewatering is a significant problem only in drought or water-short years. The list was initially prepared by MT FWP in 1991 and was revised in 1997, 2003, and most recently in December 2011 (Montana

Department of Fish, Wildlife and Parks, Fisheries Division, 2011). The revised list includes a total of 297 streams and 2,921 stream miles that are chronically dewatered and 108 streams and 1,562 stream miles that are periodically dewatered.

The Beaverhead River is classified as periodically dewatered from the Clark Canyon Dam to Rattlesnake Creek. It is classified as chronically dewatered from Blacktail Deer Creek to the mouth. The Statewide Fisheries Management Plan (Montana Fish, Wildlife and Parks, 2013b) states:

> "Clark Canyon Reservoir and irrigation diversions affect the flow pattern of the Beaverhead River. Prior to construction of the reservoir, much of the lower river was severely dewatered during the summer irrigation season. In general, reservoir management has resulted in higher flows in the lower river during the historically low flow months of May, July, August and September. However, much of the lower 64 miles still suffer from dewatering. In recent years, sections of the lower river have been totally dry. Massive withdrawals of irrigation water have virtually eliminated high water flows in the lower river. During periods of drought, the upper river is now severely affected by low flow releases during the non-irrigation season when water is being stored for the following year." (page 215)

The Jefferson River is classified as chronically dewatered from its headwaters to mouth. According to the Statewide Fisheries Management Plan (Montana Fish, Wildlife and Parks, 2013b):

> "Water quality and quantity is severely impaired during drought years when water recedes from structural habitat along the shoreline, and water temperature approaches 80°F. Quality tributaries able to provide suitable trout spawning and rearing habitat are rare.
> Over the past 25 years, priority habitat enhancement efforts have focused on flow improvements during summer irrigation, tributary restoration projects to enhance spawning and rearing habitat, and encouraging sound floodplain function practices during permit review processes. Participation in the implementation of the Jefferson River Drought Plan with the Jefferson River Watershed Council and water users has been the primary tool for preventing acute dewatering of the river." (page 233).

Among major tributaries, the Big Hole River is identified as chronically dewatered. The Ruby River is not included in the list of dewatered streams. However, the habitat narrative in the Statewide Fisheries Management Plan identifies dewatering of the Ruby River downstream of the Ruby Reservoir as a "serious habitat issue" (Montana Fish, Wildlife and Parks, 2013b). In addition to the river mainstems and the major tributaries, some smaller tributaries are identified as dewatered as well. These include Grasshopper Creek, Rattlesnake Creek, Blacktail Deer Creek, and Fish Creek. Dewatered streams are shown on **Figure 2-5**.

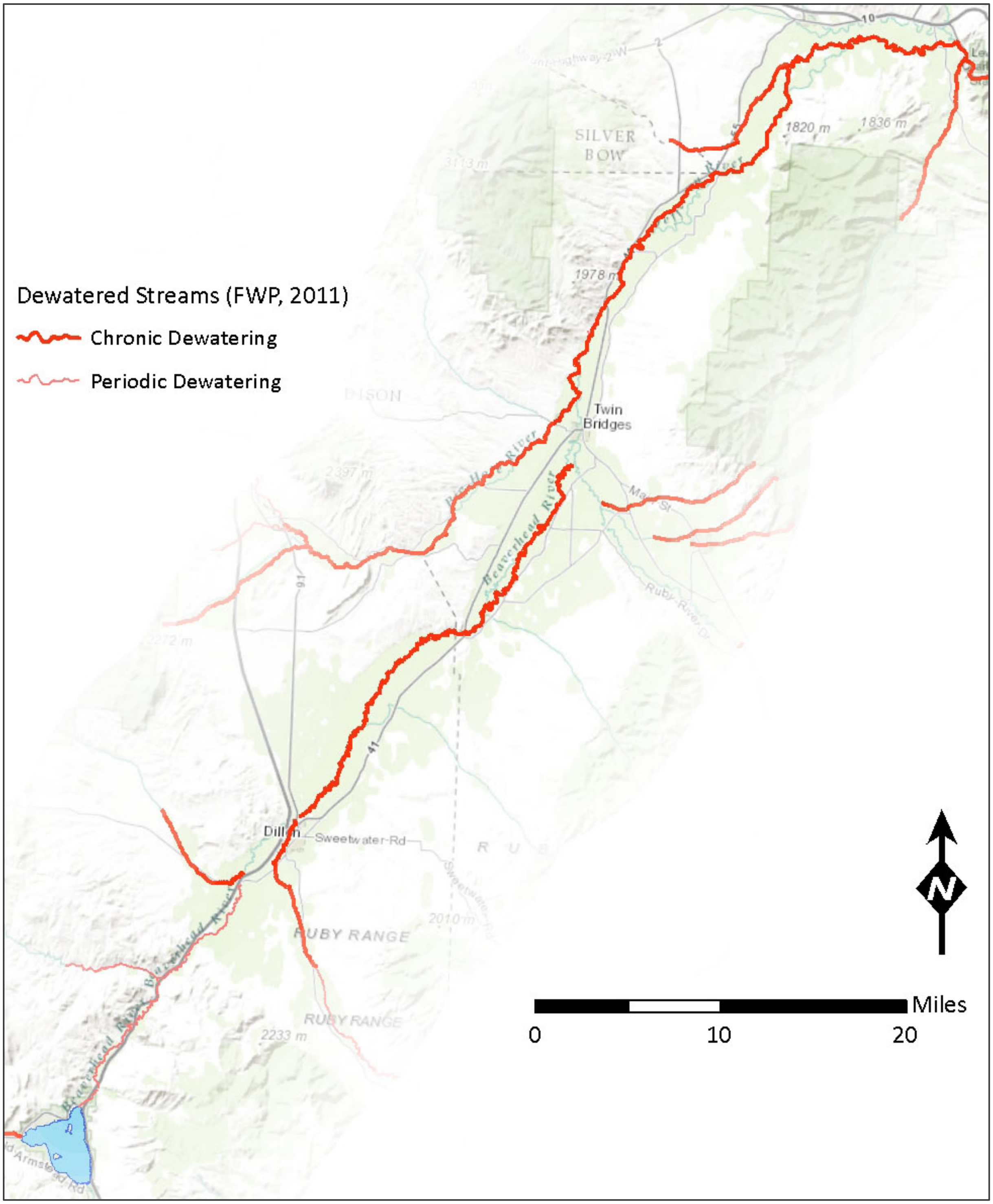



**Figure 2-5. FWP dewatered streams inventory**

## 2.1.3 Climate

The Beaverhead and Jefferson rivers run through contiguous intermontane basins. The climate is typical of higher-elevation intermontane basins east of the Continental Divide, with mild summers and cold winters (Kendy and Tresch, 1996). Average precipitation ranges from just under 10 inches per year at

Dillon to 13.5 inches per year at Cardwell. May and June are consistently the wettest months of the year and winter precipitation is dominated by snowfall. Climate summaries from Dillon, Twin Bridges and Cardwell are provided below in **Table 2-2**.

**Table 2-2. Climate Summaries**

| **Dillon Airport (242404)** | | | | | | | Period of record: 1/1/1940 to 3/31/2013 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Jan** | **Feb** | **Mar** | **April** | **May** | **June** | **July** | **Aug** | **Sept** | **Oct** | **Nov** | **Dec** | **Annual** |
| Ave Max (°F) | 32.2 | 37.5 | 44.3 | 54.5 | 63.8 | 72.2 | 83.2 | 81.4 | 70.5 | 58.3 | 42.4 | 33.3 | 56.1 |
| Ave Min (°F) | 11.1 | 14.9 | 20.3 | 28.4 | 36.4 | 43.4 | 49.1 | 47.4 | 39.4 | 30.9 | 20.2 | 12.7 | 29.5 |
| Ave Total Precip (in.) | 0.25 | 0.23 | 0.51 | 0.93 | 1.72 | 1.91 | 0.97 | 0.93 | 0.99 | 0.62 | 0.38 | 0.26 | 9.69 |
| Ave Total Snow (in.) | 4.9 | 3.8 | 7.1 | 6.2 | 2.3 | 0.1 | 0 | 0 | 1.3 | 2.5 | 4.1 | 4.1 | 36.4 |
| Ave Snow Depth (in.) | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| **Twin Bridges (248430)** | | | | | | | Period of record: 6/1/1950 to 2/28/2013 | | | | | | |
| | **Jan** | **Feb** | **Mar** | **April** | **May** | **June** | **July** | **Aug** | **Sept** | **Oct** | **Nov** | **Dec** | **Annual** |
| Ave Max (°F) | 34.6 | 40.2 | 47.8 | 57.1 | 66.8 | 75 | 84.3 | 82.3 | 72.5 | 60.4 | 44.3 | 35.1 | 58.4 |
| Ave Min (°F) | 11.4 | 14.9 | 20.8 | 27.6 | 35.4 | 42.3 | 45.7 | 43 | 35.4 | 27.5 | 19.2 | 12.2 | 28 |
| Ave Total Precip (in.) | 0.24 | 0.21 | 0.46 | 0.85 | 1.65 | 1.94 | 1.02 | 0.99 | 0.94 | 0.59 | 0.37 | 0.28 | 9.54 |
| Ave Total Snow (in.) | 1.5 | 1.9 | 1.8 | 0.9 | 0.1 | 0 | 0 | 0 | 0 | 0.3 | 1 | 0.8 | 8.3 |
| Ave Snow Depth (in.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Cardwell (241500)** | | | | | | | Period of record: 5/1/1978 to 4/30/1991 | | | | | | |
| | **Jan** | **Feb** | **Mar** | **April** | **May** | **June** | **July** | **Aug** | **Sept** | **Oct** | **Nov** | **Dec** | **Annual** |
| Ave Max (°F) | 37.4 | 43.1 | 50.7 | 60.9 | 68.3 | 78.7 | 86.2 | 84.6 | 73.5 | 63.2 | 45.4 | 36.3 | 60.7 |
| Ave Min (°F) | 12.5 | 15.7 | 23.3 | 29.3 | 37.3 | 43.9 | 48.3 | 45.6 | 37.1 | 28.7 | 20.4 | 11.8 | 29.5 |
| Ave Total Precip (in.) | 0.41 | 0.4 | 1.18 | 1.28 | 2.67 | 1.84 | 1.32 | 1.22 | 1.6 | 0.7 | 0.54 | 0.41 | 13.56 |
| Ave Total Snow (in.) | 3.2 | 2.5 | 7.9 | 1 | 0 | 0 | 0 | 0 | 0.5 | 0.8 | 4.2 | 4.1 | 24.2 |
| Ave Snow Depth (in.) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Climate summaries are provided by the Western Regional Climate Center [http://www.wrcc.dri.edu/]

## 2.2 Ecological Profile

These waterbodies flow through the Middle Rockies Level III ecoregion, and three Level IV ecoregions: dry gneissic-schistose-volcanic hills, dry intermontane sagebrush valleys, and the Townsend Basin. Ecoregions are mapped in **Figure 2-6**.

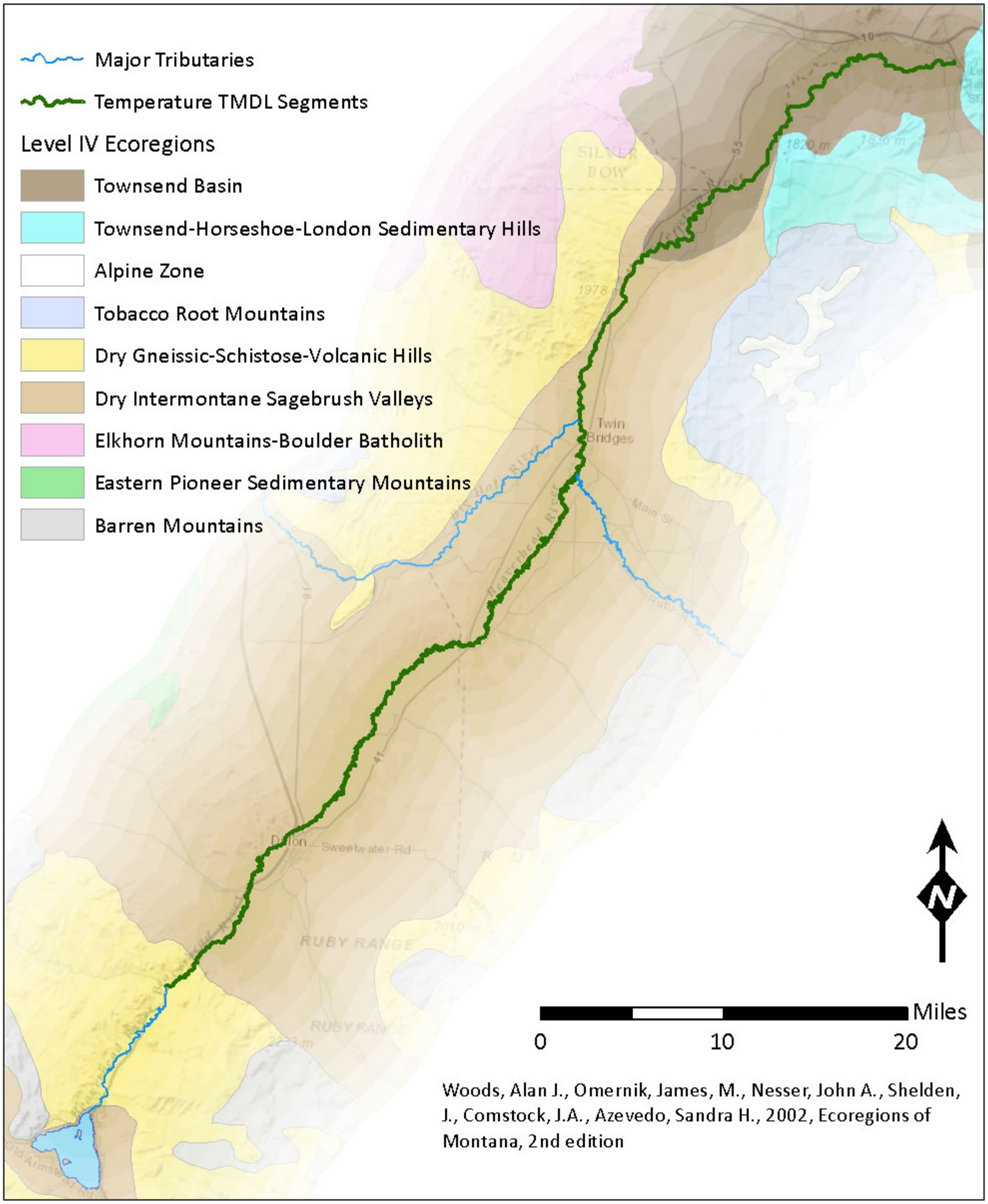



**Figure 2-6. Level IV ecoregions**

## 2.2.1 Land Cover and Land Use

The river corridor includes a wide range of land uses. Since this project addresses only the mainstem river corridor rather than upland areas or tributary watersheds, DEQ queried the 2006 National Land Cover Dataset (NLCD) (Fry et al., 2011) within a 100 meter buffer of the rivers' centerline. Land use and cover excluding the "Open Water" category is summarized below in **Table 2-3**. Pasture and riparian vegetation classes comprise the majority of the land use along the banks.

**Table 2-3 Land Use and Land Cover along the Beaverhead River and the Jefferson River**

| NLCD Cover Type | Acres | Percent of Total |
|---|---|---|
| Pasture/Hay | 3,315.89 | 42.5% |
| Woody Wetlands | 2,285.54 | 29.3% |
| Grassland/Herbaceous | 1,033.69 | 13.2% |
| Evergreen Forest | 290.89 | 3.73% |
| Cultivated Crops | 282.89 | 3.63% |
| Developed, Open Space | 271.32 | 3.48% |
| Developed, Low Intensity | 183.48 | 2.35% |
| Shrub/Scrub | 79.84 | 1.02% |
| Developed, Medium Intensity | 49.82 | 0.64% |
| Barren Land | 5.34 | 0.07% |
| Developed, High Intensity | 2.89 | 0.04% |

The 2006 NLCD is mapped in **Figure 2-7**.

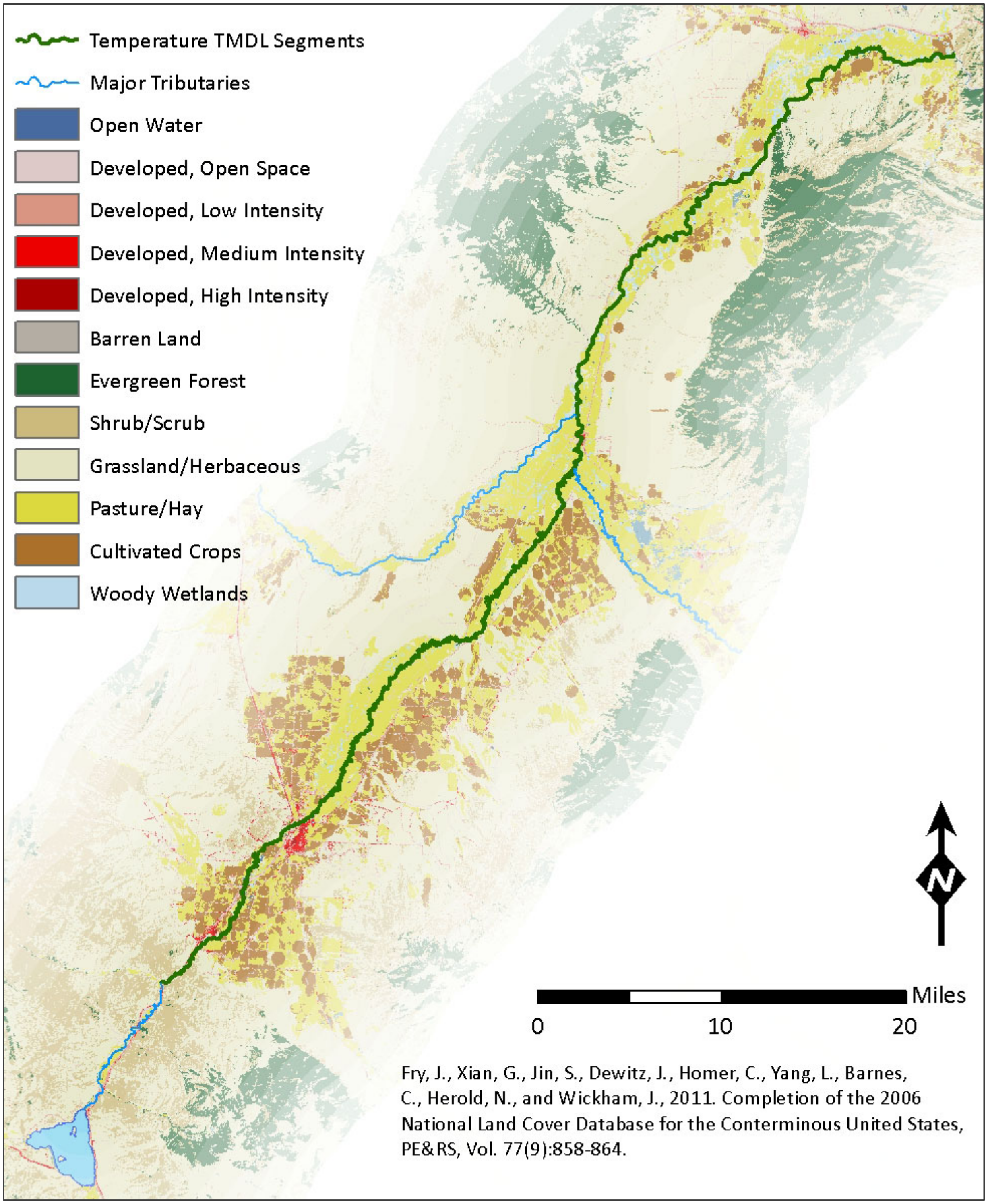



**Figure 2-7. Land use and land cover from the 2006 NLCD**

## 2.2.2 Aquatic Life

Fish distribution is mapped by Montana Fish Wildlife and Parks and reported on the Internet via the Montana's Fisheries Information System (MFISH) site (Montana Fish, Wildlife and Parks, 2013a).

The Beaverhead and Jefferson rivers host fish species common to this part of Montana, including: rainbow trout, brown trout, brook trout, mountain whitefish, burbot, carp, longnose dace, longnose sucker, Rocky Mountain sculpin, and white sucker. Westslope cutthroat trout are mapped in isolated tributaries. Westslope cutthroat trout and arctic grayling are Montana Species of Concern. Westslope cutthroat trout are mapped only in tributary streams, but arctic grayling are reported in the Beaverhead River (miles 11.25 to 26.57). Distribution of selected species is mapped in **Figure 2-8**. These species are selected based on sensitivity to temperature, discussed further in **Section 5.2.2**.

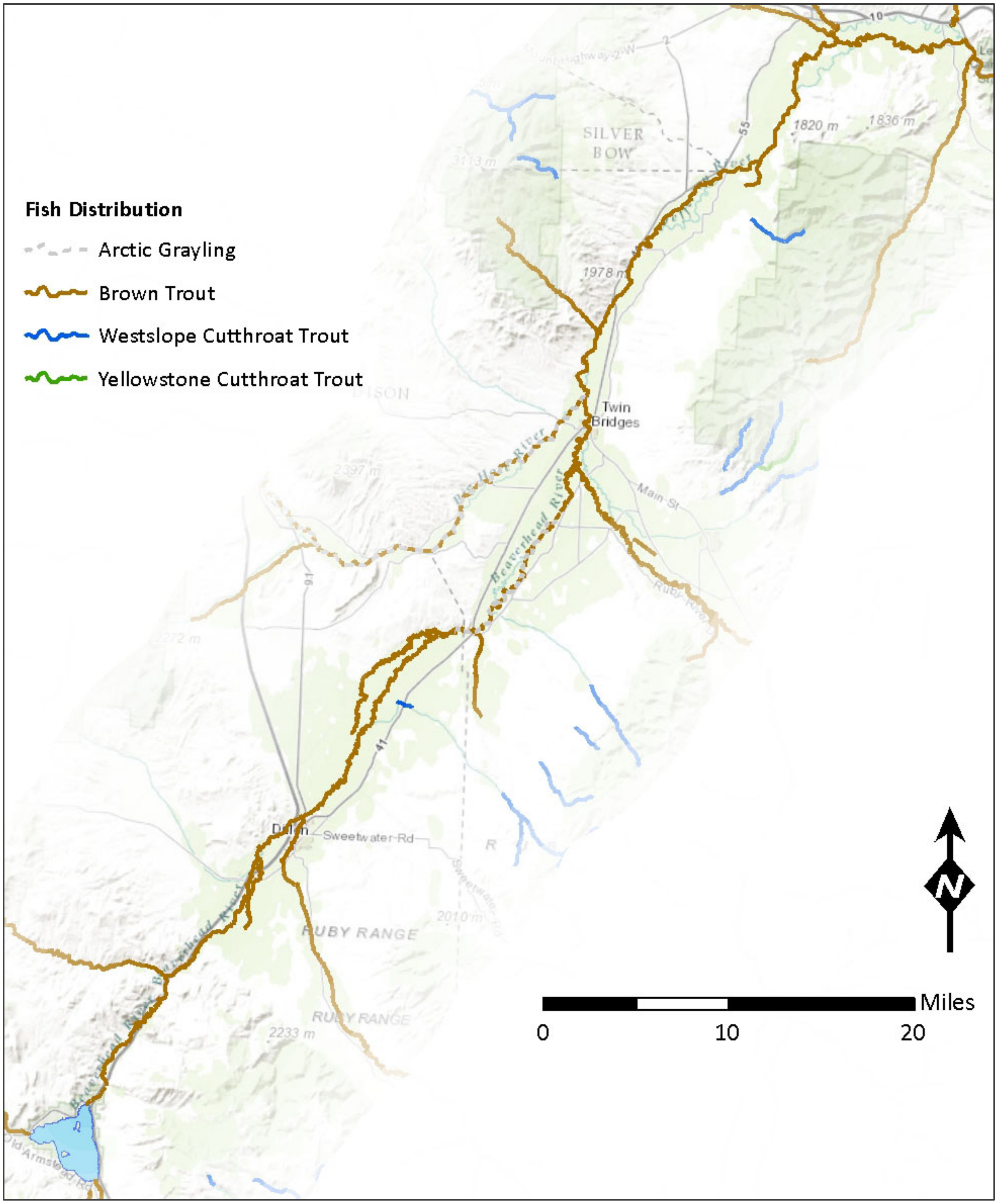


**Figure 2-8. Distribution of selected fish species**

## 2.3 Cultural Profile

The following information describes the social profile of the Beaverhead and Jefferson river corridors.

### 2.3.1 Population

As this project addresses only the mainstems of these rivers, population estimates are problematic. However, populations of communities located along these two valleys are reported in the 2010 Census as:

- Dillon: 4,134
- Twin Bridges: 375
- Silver Star: 141
- Whitehall: 1,038
- Cardwell: 50

### 2.3.2 Land Ownership

The majority of the land that these rivers flow through is privately owned. Exceptions to this include county and state rights-of-way for bridge crossings, Montana Fish, Wildlife and Parks fishing access sites, and isolated State Trust and US Bureau of Land Management lands. Public and ownership is illustrated on **Figure 2-9**.

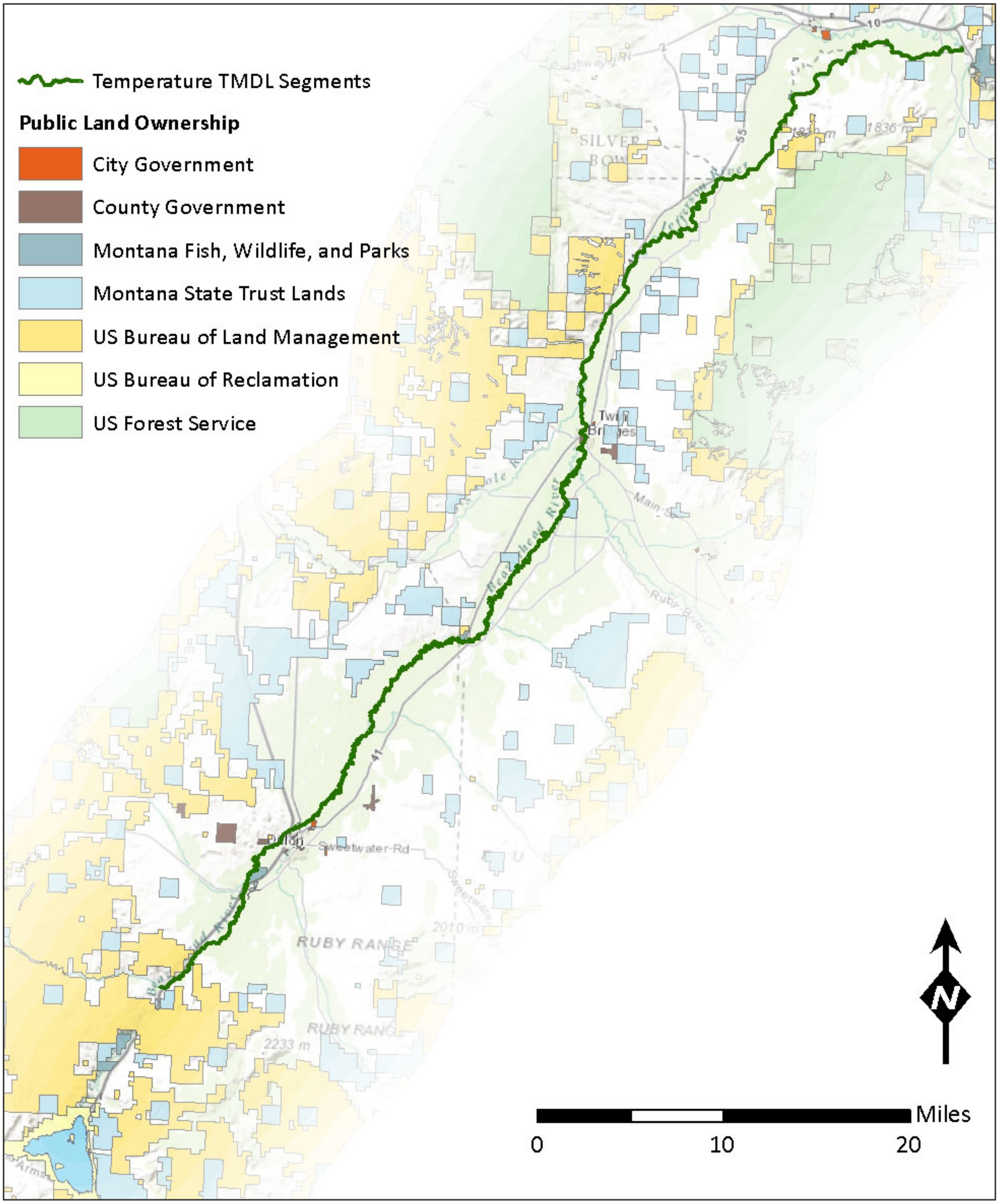



**Figure 2-9. Public land ownership**

## 2.3.3 Transportation Networks

The Beaverhead and Jefferson river corridors host a number of major transportation routes, including Interstate 15, State highways 51 and 44. A rail line is located parallel to the Beaverhead River from Dillon south. These routes parallel and cross the waterbodies in many locations. In some areas, the transportation networks restrict the stream channel. Conversely, there are also reaches along which roads and railroads are set back from the rivers.

### 2.3.4. Permitted Point Sources

Twelve permitted point sources are identified as discharging to the river segments included in this project. They are summarized below in **Table 2-4** and discussed in more detail in **Section 5.5.2**.

**Table 2-4. Permitted Point Source in the lower Beaverhead and upper Jefferson Rivers**

| Facility Name | National Pollutant Discharge Elimination System (NPDES) ID | Permit Type | Waterbody Name |
|---|---|---|---|
| City of Dillon Wastewater Treatment Facility | MT0021458 | Montana Pollutant Discharge Elimination System (MPDES) Individual Permit | Beaverhead River |
| Clark Canyon Hydro US Bureau of Reclamation Beaverhead River Dam Alteration | MTB001814 | Turbidity Related to Construction (318) | Beaverhead River |
| Beaverhead Livestock Auction | MTG010176 | Concentrated Animal Feeding Operation | Beaverhead River |
| City of Dillon - Wastewater Treatment Plant Dewatering | MTG070695 | Construction Dewatering | Beaverhead River |
| Beaverhead County Weed Dist. Beaverhead River Corridor Pesticide | MTG870001 | Pesticides | Beaverhead River |
| Barretts Minerals Incorporated | MTR000508 | Storm Water - Industrial Activity | Beaverhead River |
| Clark Canyon Hydro - Clark Canyon Dam Hydroelectric Facility | MTR104018 | Storm Water - Construction Activity | Beaverhead River |
| Dick Anderson - Dillon Wastewater Treatment Plant | MTR105067 | Storm Water - Construction Activity | Beaverhead River |
| RE Miller and Sons - Montana Center for Horsemanship | MTR104116 | Storm Water - Construction Activity | Beaverhead River and Blacktail Deer Creek |
| Tilstra Ranch | MTG010139 | Concentrated Animal Feeding Operation | Irrigation ditch to Beaverhead River |
| Coronado Resources - Madison Project (SW Mining) | MTR000558 | Storm Water - Industrial Activity | Tom Benton Gulch and Jefferson River |
| Twin Bridges Wastewater Treatment Facility | MT0028797 | Montana Pollutant Discharge Elimination System (MPDES) Individual Permit | Bayers irrigation ditch |

# 3.0 MONTANA WATER QUALITY STANDARDS

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

Montana's water quality standards and water quality standards in general include three main parts:

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

Montana's water quality standards also incorporate prohibitions against water quality degradation as well as point source permitting and other water quality protection requirements.

Nondegradation provisions are not applicable to the TMDLs developed within this document because of the impaired nature of the streams addressed. Those water quality standards that apply to this document are reviewed briefly below. More detailed descriptions of Montana's water quality standards may be found in the Montana Water Quality Act (75-5-301,302 Montana Code Annotated (MCA)), and Montana's Surface Water Quality Standards and Procedures (Administrative Rules of Montana (ARM) 17.30.601-670) and Circular DEQ-7 (Montana Department of Environmental Quality, 2012b).

## 3.1 STREAM CLASSIFICATIONS AND DESIGNATED BENEFICIAL USES

Waterbodies are classified based on their designated uses. All Montana waters are classified for multiple uses. The lower Beaverhead and upper Jefferson Rivers are both classified as B-1.Waters classified as B-1 are to be maintained suitable for the following uses (Administrative Rules of Montana (ARM) (17.30.623(1)):

- Drinking, culinary, and food processing purposes after conventional treatment
- Bathing, swimming, and recreation
- Growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers
- Agricultural and industrial waters supply

While some of the waterbodies might not actually be used for a designated use (e.g., drinking water supply), their water quality still must be maintained suitable for that designated use. More detailed descriptions of Montana's surface water classifications and designated uses are provided in **Appendix A**. Department of Environmental Quality's (DEQ) water quality assessment methods are designed to evaluate the most sensitive uses for each pollutant group, thus ensuring protection of all designated uses (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2011). For streams in Western Montana, the most sensitive use assessed for temperature is aquatic life. DEQ determined that the lower Beaverhead and upper Jefferson Rivers do not meet the temperature water quality standards (**Table 3-1**).

**Table 3-1. Impaired Designated Uses in the Lower Beaverhead River and Upper Jefferson River**

| Waterbody & Location Description | Waterbody ID | Impairment Cause * | Impaired Use(s) |
|---|---|---|---|
| **Beaverhead River**, Grasshopper Creek to mouth (Jefferson River) | MT41B001_020 | Temperature | Aquatic Life |
| **Jefferson River**, headwaters to confluence of Jefferson Slough | MT41G001_011 | Temperature | Aquatic Life |

* Only includes those pollutant impairments addressed by TMDLs in this document

## 3.2 Numeric and Narrative Water Quality Standards

In addition to the use classifications described above, Montana's water quality standards include numeric and narrative criteria that protect the designated uses. Numeric criteria define the allowable concentrations, frequency, and duration of specific pollutants so as not to impair designated uses.

Numeric standards apply to pollutants that are known to have adverse effects on human health or aquatic life (e.g., metals, organic chemicals, and other toxic constituents).

Narrative standards are developed when there is insufficient information to develop numeric standards and/or the natural variability makes it impractical to develop numeric standards. Narrative standards describe the allowable or desired condition. This condition is often defined as an allowable increase above "naturally occurring." DEQ often uses the naturally occurring condition, called a "reference condition," to help determine whether or not narrative standards are being met (see **Appendix A**). For temperature TMDL development in the lower Beaverhead and upper Jefferson Rivers, only narrative standards are applicable; they are summarized in **Appendix A**.

# 4.0 DEFINING TMDLS AND THEIR COMPONENTS

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

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

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

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

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

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

Development of each TMDL has four major components:

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

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

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

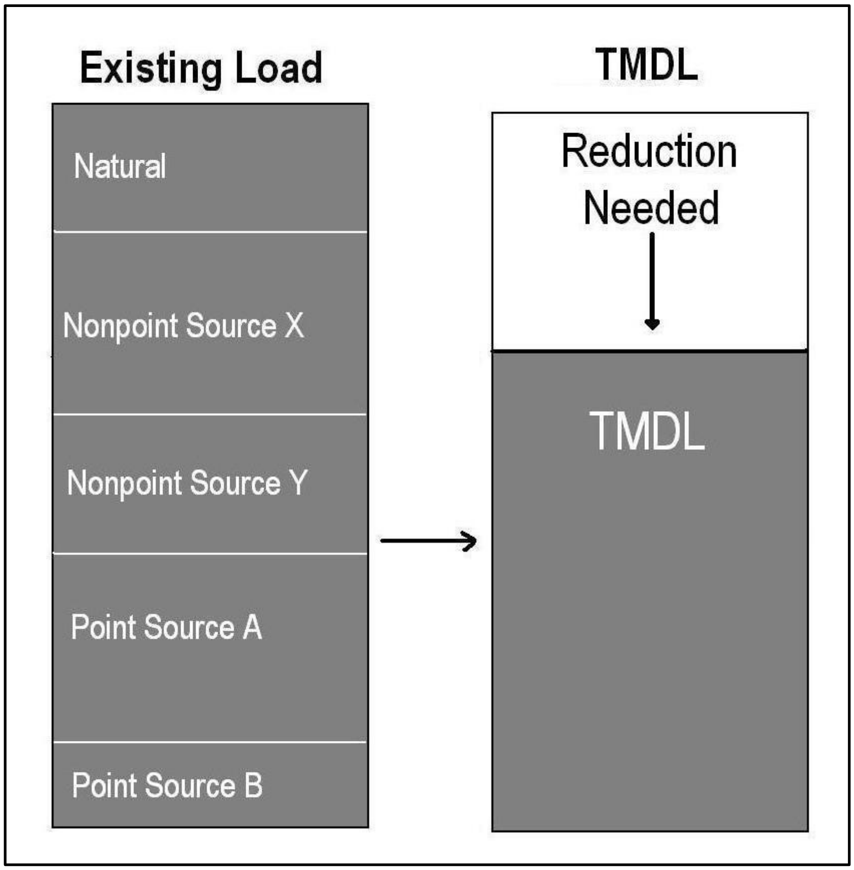



**Figure 4-1. Schematic Example of TMDL Development**

## 4.1 Developing Water Quality Targets

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

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

## 4.2 Quantifying Pollutant Sources

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

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

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

## 4.3 Establishing the Total Allowable Load

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

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

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

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

## 4.4 Determining Pollutant Allocations

Once the allowable load (the TMDL) is determined, that total must be divided among the contributing sources. The allocations are often determined by quantifying feasible and achievable load reductions through application of a variety of best management practices and other reasonable conservation practices.

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

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

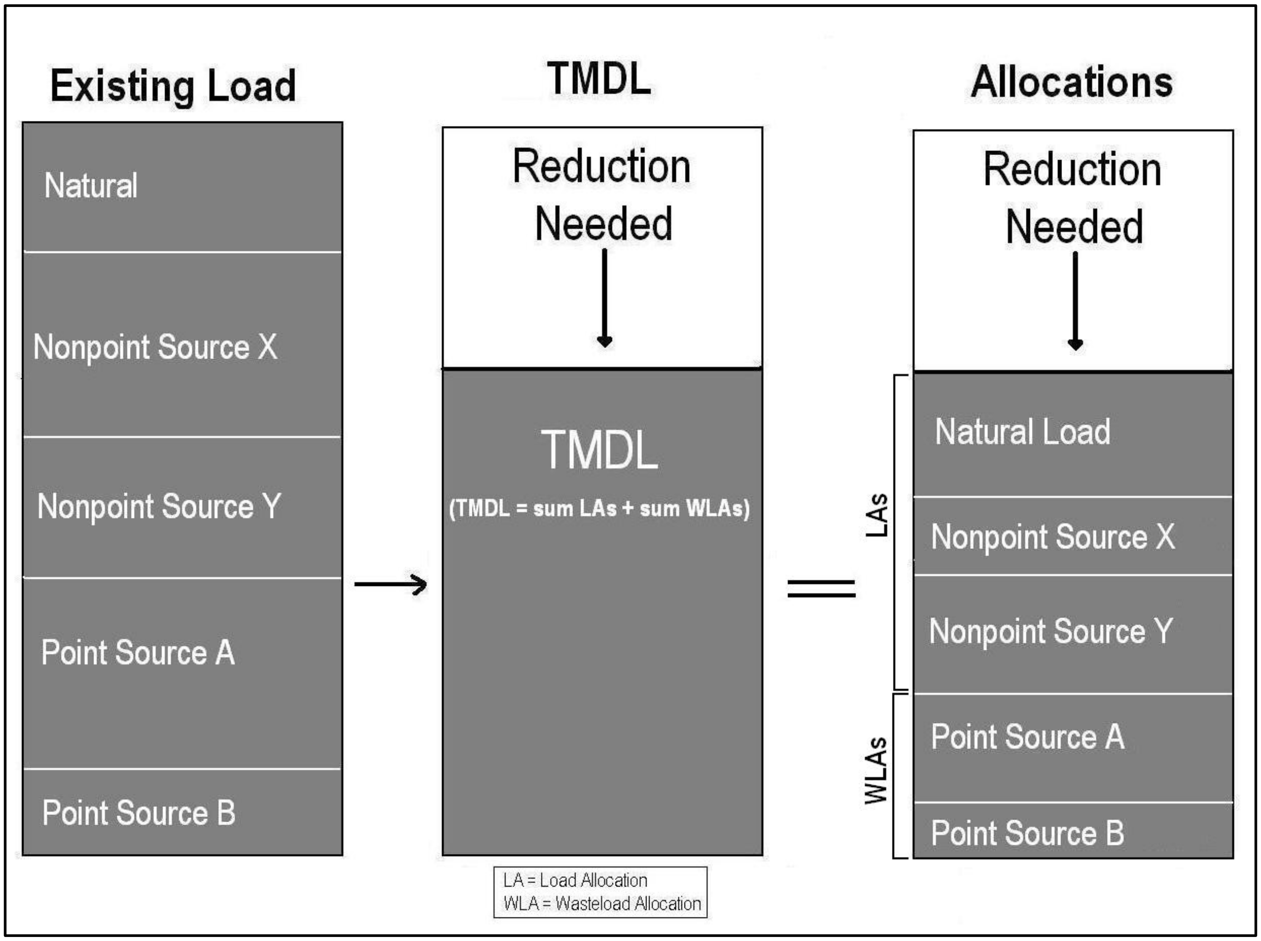



**Figure 4-2. Schematic Diagram of a TMDL and its Allocations**

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

When a TMDL is developed for waters impaired by both point and nonpoint sources, and the WLA is based on an assumption that nonpoint source load reductions will occur, the TMDL should provide reasonable assurances that nonpoint source control measures will achieve expected load reductions. The temperature TMDLs in this document where there is a combination of nonpoint sources and one or more permitted point sources discharging into an impaired stream reach, the permitted point source WLAs are not dependent on implementation of the LAs. Instead, Department of Environmental Quality (DEQ) sets the WLAs and LAs at levels necessary to achieve water quality standards throughout the watershed. Under these conditions, the LAs are developed independently of the permitted point source WLA such that they would satisfy the naturally occurring target conditions within the stream reach immediately above the point source. In order to ensure that the water quality standard is achieved below the point source discharge, the WLA is based on the point source's discharge not exceeding the allowable increase above naturally occurring conditions.

## 4.5 Implementing TMDL Allocations

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

DEQ uses an adaptive management approach to implementing TMDLs to ensure that water quality standards are met over time (outlined in **Section 8.0**). This includes a monitoring strategy and an implementation review that is required by Montana statute (see **Section 8.2**). TMDLs may be refined as new data become available, land uses change, or as new sources are identified.

# 5.0 Temperature TMDL Components

This portion of the document focuses on temperature as an identified cause of water quality impairment in the Beaverhead and Jefferson Rivers. It describes: (1) the mechanisms by which temperature affects beneficial uses of streams; (2) the specific stream segments of concern; (3) information sources used for temperature total maximum daily load (TMDL) development; (4) temperature target development; (5) assessment of sources contributing to excess thermal loading; (6) TMDL development determination; (7) the temperature TMDLs and allocations; (8) seasonality and margin of safety; and (9) uncertainty and adaptive management.

## 5.1 Temperature (Thermal) Effects on Beneficial Uses

Human influences that reduce stream shade, increase stream channel width, add heated water, or decrease the capacity of the stream to buffer solar heat flux all increase stream temperatures. Warmer temperatures can negatively affect aquatic life that depend upon cool water for survival. Coldwater fish species are more stressed in warmer water temperatures, which increases metabolism and reduces the amount of available oxygen in the water. Coldwater fish and other aquatic life may feed less frequently and use more energy to survive in thermal conditions above their tolerance range, which can result in fish kills. Also, elevated temperatures can boost the ability of non-native fish to outcompete native fish if the latter are less able to adapt to warmer water conditions (Bear et al., 2007). Although the TMDL will address increased summer temperatures as the most likely to cause detrimental effects on fish and aquatic life, human influences on stream temperature, such as those that reduce shade, can lead to lower minimum temperatures during the winter (Hewlett and Fortson, 1982). Lower winter temperatures can lead to the formation of anchor and frazil ice which can harm aquatic life by causing changes in movement patterns (Brown, 1999; Jakober et al., 1998), reducing available habitat, and inducing physiological stress (Brown et al., 1993). Addressing the issues associated with increased summer maximum temperatures will also address these potential winter problems. Assessing thermal effects upon a beneficial use is an important initial consideration when interpreting Montana's water quality standard (**Appendix A**) and subsequently developing temperature TMDLs.

## 5.2 Stream Segments of Concern

The lower segment of the Beaverhead River (MT41B001_020, from Grasshopper Creek to the mouth at the Jefferson River) and the upper Jefferson River (MT41G001_011, from the confluence of the Bighole and Beaverhead Rivers to the confluence with the Boulder River/Jefferson Slough) are on the 2014 Montana impaired waters list as having temperature limiting a beneficial use (**Figure 5-1**). As discussed in **Section 3.1** both segments are classified as B-1, which requires that the streams be maintained suitable for several uses, including salmonid fishes and associated aquatic life. To help put monitoring data into perspective and understand how elevated stream temperatures may affect aquatic life, information on fish presence in the lower Beaverhead and upper Jefferson Rivers and temperature preferences for the most sensitive species are described below.

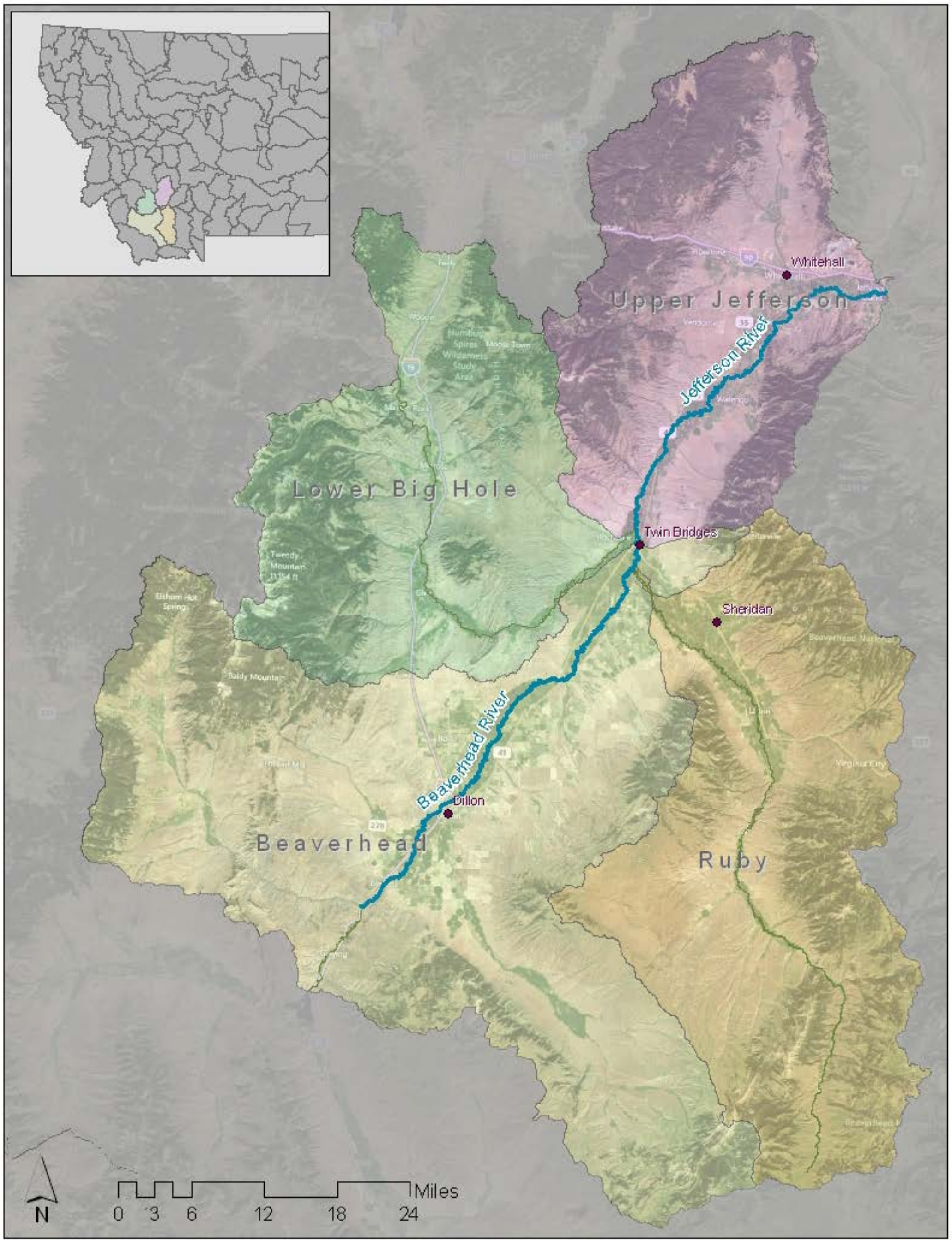



**Figure 5-1. Lower Beaverhead and Upper Jefferson River Segments of Concern**

## 5.2.1 Fish Presence in the Lower Beaverhead and Upper Jefferson Rivers

Because different fish species have varying optimal temperature ranges for survival and some are more sensitive than others to elevated stream temperatures, it is important to identify the fish species within each stream segment of concern.

Based on a query of Montana's Fisheries Information System (MFISH) brown trout, longnose dace, mottled sculpin, mountain whitefish, rainbow trout and white suckers are year-round residents found in abundance in the Beaverhead River. Longnose suckers are common year-round residents. Brook trout, burbot, common carp, and mountain sucker are rare in abundance and are year-round residents. Westslope cutthroat trout are rare and their use type is unknown. Arctic grayling are rare in abundance and their use type in the Beaverhead River is primarily migratory.

According to a query of MFISH, mountain whitefish are abundant year-round residents and brown trout, longnose dace, longnose sucker, mottled sculpin, rainbow trout, and white sucker are all common year-round residents in the Jefferson River. Burbot, mountain sucker, northern pike, redside shiner, and stonecat are rare in abundance and year-round residents. Arctic grayling are rare in abundance and they are a fluvial population that are spawning elsewhere. Brook trout are rare in abundance in the Jefferson River and use type is unknown.

Additional information regarding instream flow recommendations in the Beaverhead and Jefferson Rivers is available from Montana Fish, Wildlife, and Parks (FWP). FWP has provided a 2008 evaluation of fish/streamflow relationships for the Jefferson River (See **Attachment A**). Additionally, FWP completed a Jefferson River invertebrate study in 1979 and repeated that study in recent years. The study provides information related to water temperature and streamflow effects on the aquatic invertebrate community, which is available by contacting FWP (Oswald, 1979).

### 5.2.2 Temperature Levels of Concern in the Lower Beaverhead and Upper Jefferson Rivers

It has been well established that river management has an effect on water temperature (LeBlanc et al., 1997; Meier et al., 2003; Poole and Berman, 2001; Rutherford et al., 1997). For example, healthy riparian areas absorb incoming solar shortwave radiation, reflect longwave radiation, and influence microclimate (i.e., air temperature, humidity, and wind speed). Added streamflow volume (i.e., flow rate) increases the temperature buffering capacity of a waterbody via thermal inertia or assimilative heat capacity. Channel morphology is critical for maintenance of hyporheic flow and minimizes solar gain.

These variables, which are influenced by river management, are important in assessing stream health and associated effects on fish and aquatic life. Critical limits and temperature tolerances of fluvial inhabitants are an effective way to characterize waterbody condition. Temperature tolerances for salmonid fish species present in the Beaverhead River are summarized in **Table 5-1.** Temperatures slightly over 70°F are lethal for 10 percent of the salmonid population ($LC_{10}$) in an exposure lasting 24 hours[1]. Optimum ranges are nearer 60°. Thus given Department of Environmental Quality's (DEQ) knowledge of the current temperature impairment listings on the Beaverhead and Jefferson Rivers, there are potential impacts to most of the trout species.

**Table 5-1. General trout temperature tolerances From DEQ 2011 (R. McNeil, personal communication).[1]**

| Species | Optimum Range (°F) | LC10 for 24 hours (°F) |
|---|---|---|
| Brown trout (adult) | 57 | 75 |
| Rainbow trout (adult) | 57 | 80 |
| Brook trout (adult) | 60 | 77 |
| Cutthroat trout (adult) | 56 | 71 |

[1] It should be noted that coldwater fish species have varied temperature requirements that are dependent on life stage. **Table 5-1** should only be used as a rough guide.

## 5.3 Information Sources and Data Collection

As part of this TMDL project, DEQ used several information and data sources to assess temperature conditions in the Beaverhead and Jefferson Rivers:

- DEQ assessment file information
- Temperature related data collection
    - Beaverhead River
        - 2005 Bureau of Reclamation (BOR) stream temperature and flow
        - 2009 riparian shade and channel geometry data
    - Jefferson River
        - 2009 DEQ stream temperature and flow
        - 2009 riparian shade and channel geometry data
- Meteorological and climatic data from nearby observation stations

As discussed in **Appendix A** and **Section 5.4.1**, Montana defines temperature impairment as occurring when human sources cause a certain degree of change over the naturally occurring water temperature (the combination of natural sources and human sources with all reasonable land, soil, and water conservation practices in place). Interpreting the standard is more complex than just comparing measured temperatures to the temperature levels of concern discussed above (and summarized in **Table 5-1**). A QUAL2K water quality model was needed to determine if human sources are causing the allowable temperature change to be exceeded. Model details are presented in **Appendix B** and **C,** but the model summaries and outcomes are provided in **Section 5.5**.

### 5.3.1 DEQ Assessment Files

DEQ maintains assessment files that provide a summary of available water quality and other existing condition information, along with a justification for impairment determinations.

### 5.3.2 TMDL Data Collection – Lower Beaverhead River

DEQ's methods for temperature TMDL data collection on the lower Beaverhead River included a combination of characterizing water temperatures throughout the summer and collecting additional streamflow, riparian shade, and channel geometry data (**Figure 5-2.**). This information is collectively used within the QUAL2K model to evaluate impairment and the potential for improvement associated with the implementation of all reasonable land, soil, and water conservation practices. The following sections describe the data collected in the lower Beaverhead River for temperature assessment.

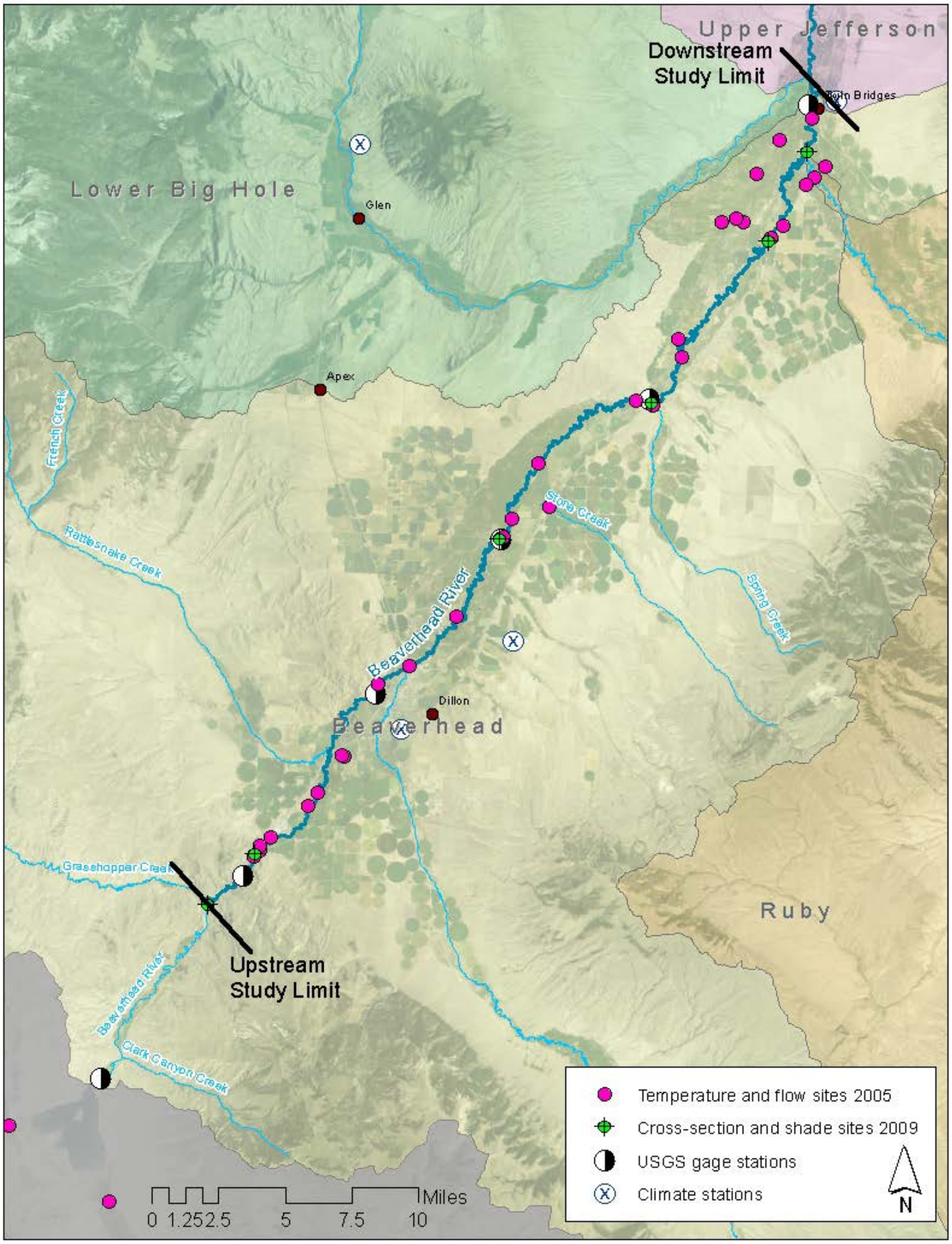



**Figure 5-2. Lower Beaverhead River detailed study reach**

### *5.3.2.1 Temperature and streamflow data collection*

Temperature and flow data were collected for a water balance study by the Bureau of Reclamation (BOR) in 2005, and these data were used to characterize water quality throughout the summer. Thirty-four discharge and temperature monitoring stations were established in 2005 as part of the BOR water balance effort (Sessoms and Bauder, 2005). The flow measurement and temperature monitoring locations used in this study are identified in **Table 5-2**. Additional information regarding the temperature and flow data collected can be found in **Appendix B**.

**Table 5-2. Overview of the monitoring locations on Beaverhead River in 2005**

| Site Type | Agency | Locations |
|---|---|---|
| Mainstem River | USGS | Beaverhead River at Barretts MT |
| | USGS | Beaverhead River at Dillon MT |
| | MSU | Beaverhead River at Anderson Lane Bridge |
| | USGS | Beaverhead River near Twin Bridges MT |
| | MSU/BOR | Beaverhead River at Giem (Silverbow Lane) Bridge |
| | MSU | Beaverhead River at Twin Bridges (Madison County Fairgrounds) |
| Tributaries | MSU | Poindexter Slough |
| | MSU | Stone Creek near Highway 41 bridge |
| | MSU | Trout Creek near Point of Rocks |
| | MSU | California Slough near Silverbow Lane |
| | MSU | Spring Creek near Silverbow Lane |
| | MSU | East Bench 41-2 lateral waste way |
| | MSU | Baker Ditch waste way/Redfield Lane Ditch |
| | MSU | Schoolhouse Slough at Highway 41 crossing |
| | MSU | Owsley Slough at Highway 41 crossing |
| | MSU | Greenhouse Slough at East Bench Road |
| | MSU | Ruby River at East Bench Road bridge |
| | MSU | Jacob's Slough at East Bench Road |
| Diversions | EBID | East Bench Canal |
| | CCWC | Canyon Canal |
| | MSU | Smith-Rebich Canal below Barrett's gauging station |
| | MSU | Outlaw Ditch at Barrett's Diversion Dam |
| | MSU | Perkins Ditch at Barrett's Diversion Dam |
| | MSU | Horton Haines Ditch |
| | MSU | Van Camp Ditch |
| | MSU | Poindexter Slough Diversion |
| | MSU | Westside Canal |
| | MSU | Selway Slough/Ditch |
| | MSU | Horton Haines Ditch |
| | MSU | Bishop Ditch |
| | MSU | 1872 Ditch |
| | MSU | Brown Ditch |
| | MSU | Co-op Ditch near Point of Rocks |
| | MSU | Muleshoe Canal |
| | MSU | Baker Ditch |

BOR = Bureau of Reclamation, CCWC = Canyon Canal Water Company, EBID = East Bench Irrigation District, MSU = Montana State University, USGS = U.S. Geological Survey

### *5.3.2.2 Riparian shading*

Characterization of riparian shade was based on a combination of field data and aerial imagery analysis. Shade was estimated using Shadev3.0.xls. Segmentation identical to the QUAL2K model was used (i.e., 36 reaches) and average conditions for each species type, condition, and age class determined during 2009 (Water & Environmental Technologies, 2009) were used in the analysis. Riparian vegetation was assessed to characterize direct solar radiation losses from topography and vegetative shade. The following measurements were collected at 6 locations (18 transects) to support the modeling efforts: (1) vegetation/canopy height, (2) canopy density, (3) channel overhang, and (4) percent shade using a Solar

Pathfinder™. A fiberglass-tape, range-finder, clinometer, canopy densitometer, and Solar Pathfinder™ were used to acquire these attributes. Values were averaged to provide reach-wide estimates for the QUAL2K model. Simulated and observed shade results are shown in **Appendix B**.

#### *5.3.2.3 Channel geometry*

Channel geometry (i.e., width and depth) can influence the rate of thermal loading and is a necessary input for the QUAL2K model. Wide, shallow streams transfer heat energy faster than narrow, deep streams. Human activities that alter peak flows or disturb the riparian vegetation, streambanks, and/or stream channel have the potential to alter channel geometry. Therefore, channel geometry can be used to identify areas that may be destabilized and more prone to rapid thermal loading, particularly in locations where shading is minimal. Channel width (wetted and bankfull) was collected at 6 locations (18 transects) in 2009 (**Appendix B).**

#### *5.3.2.4 Meteorological and climatic data*

The QUAL2K model requires hourly meteorological data to calculate diurnal heat flux. Four sites had requisite data. These were: (1) Automated Surface Observing Station 242404 Dillon, MT, (2) Dillon Valley Agrimet, (3) Ruby Valley Agrimet, and (4) Jefferson Valley Agrimet. Hourly observations of temperature, wind speed, and dew point were available from each location. Values were averaged to provide mean repeating daily input for the QUAL2K model.

Automated Surface Observing Station number 242404 was closest to the project reach and provides a suitable characterization of long-term climate (Dillon Airport, period of record of 1948-2005). According to site records (Western Regional Climate Center, 2006), July and early August are the most probable time-period when river impairment would occur. Air temperatures approach 80-85°F and coincide with a relatively dry period in the basin.

### 5.3.3 TMDL Data Collection – Upper Jefferson River

DEQ's methods for temperature TMDL data collection on the upper Jefferson River included a combination of characterizing water temperatures throughout the summer and collecting additional streamflow, riparian shade, and channel geometry data (**Figure 5-3**). This information is collectively used within the QUAL2K model to evaluate impairment and the potential for improvement associated with the implementation of all reasonable land, soil, and water conservation practices. The following sections describe the data collected in the upper Jefferson River for temperature assessment.

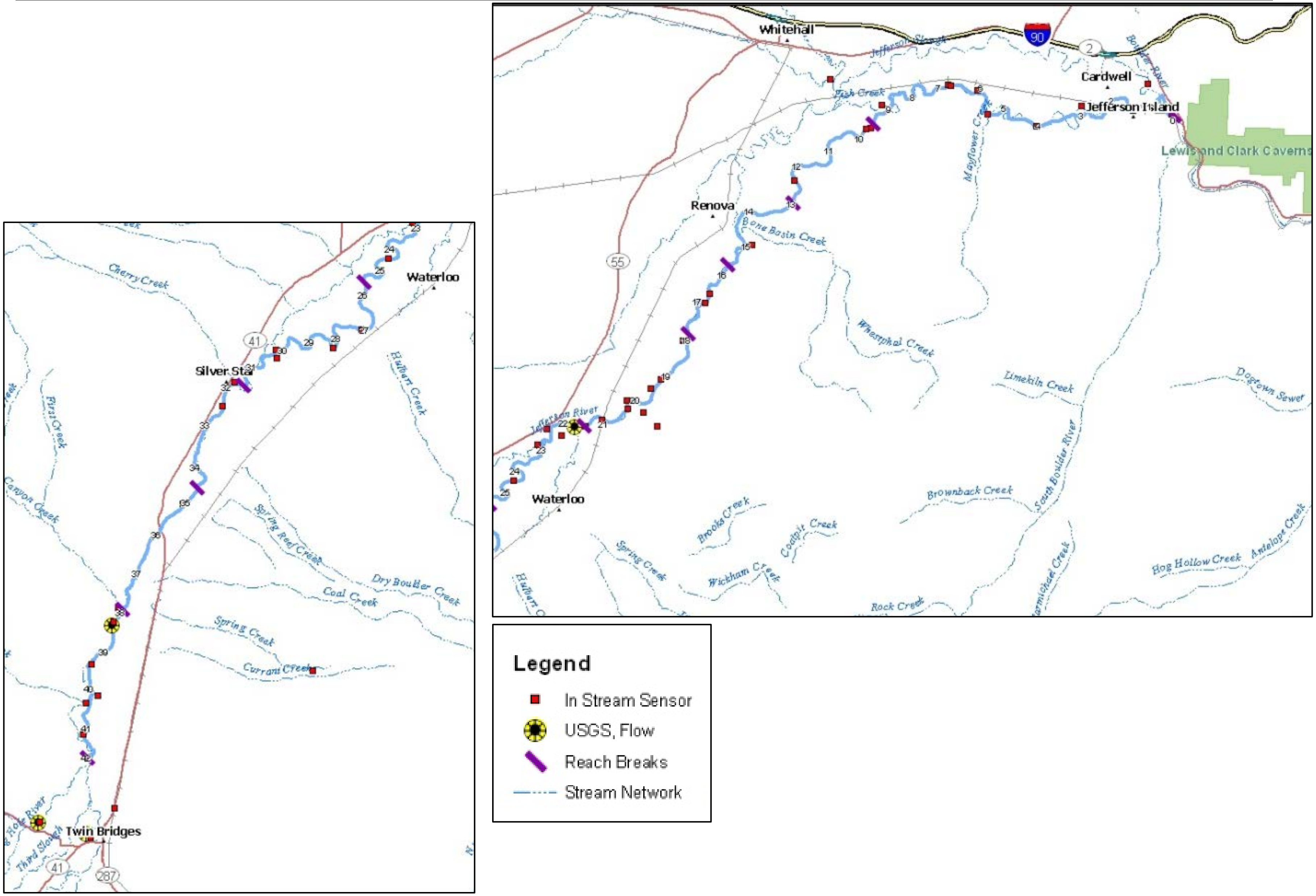



**Figure 5-3. Upper Jefferson River detailed study reach**

#### *5.3.3.1 Temperature and streamflow data collection*

DEQ and Water and Environmental Technologies (WET) collected temperature and flow data in 2009 to characterize water quality throughout the summer. Continuous temperature dataloggers were used to record diurnal variations in water temperature. Forty-nine (49) temperature loggers were deployed in the field; this included 20 mainstem locations, 26 tributaries and irrigation return flows, and three headwater rivers. Of the total deployed, 48 dataloggers were retrieved.

Instantaneous flow was measured at 63 locations (19 mainstem locations, 26 tributaries and irrigation return flows, and 18 irrigation withdrawals). Due to higher than anticipated streamflows during the field effort, it was necessary to adjust pre-selected locations to wadeable sections of the river. A more detailed description of the 2009 data collection effort can be found in **Appendix C.**

#### *5.3.3.2 Riparian shading*

Characterization of riparian shade was based on a combination of field data and aerial imagery analysis. Shade was estimated using Shadev3.0.xls. Segmentation identical to the QUAL2K model was used and average conditions for each species type, condition, and age class determined during 2009 (Water & Environmental Technologies, 2009) were used in the analysis. Riparian vegetation was assessed at 24 sites to characterize direct solar radiation losses from topography and vegetative shade. The following measurements were collected to support the modeling efforts: (1) vegetation/canopy height, (2) canopy density, (3) channel overhang, and (4) percent shade using a Solar Pathfinder™ (at 12 of the 24 sites). A fiberglass-tape, range-finder, clinometer, canopy densitometer, and Solar Pathfinder™ were used to acquire these attributes. Values were averaged to provide reach-wide estimates for the QUAL2K model. Simulated and observed shade results are shown in **Appendix C**.

#### *5.3.3.3 Channel geometry*

As stated previously, channel geometry (i.e., width and depth) can influence the rate of thermal loading and is a necessary input for the QUAL2K model. Channel width (wetted and bankfull) was collected at 5 locations in 2009 (**Appendix C**).

#### *5.3.3.4 Meteorological and climatic data*

The QUAL2K model requires hourly meteorological data to calculate diurnal heat flux within the model. HOBO weather stations collected meteorological data within the river corridor, which were utilized within the model. The hourly air temperature (°C), wind speed (m/s), and dew point (°C) data were compared to the surrounding AGRIMET and RAWS stations located in Whitehall, MT for the model input data (average of hourly results from 8/20/09 – 8/22/09) (**Appendix C**).

## 5.4 Target Development

The following section describes 1) the framework for interpreting Montana's temperature standard; 2) the selection of target parameters and values used for target TMDL development; and 3) a summary of the temperature target values for the lower Beaverhead and upper Jefferson Rivers.

### 5.4.1 Framework for Interpreting Montana's Temperature Standard

Montana's water quality standard for temperature is narrative in that it specifies a maximum allowable increase above the naturally occurring temperature to protect fish and aquatic life. Under Montana water quality law, naturally occurring temperatures incorporate both natural sources and human sources that are applying all reasonable land, soil, and water conservation practices. Naturally occurring temperatures can be estimated for a given set of conditions using QUAL2K or other modeling approaches, but because water temperature changes daily and seasonally, no single temperature value can be identified to represent standards attainment. Therefore, in addition to evaluating if human sources are causing the allowable temperature change to be exceeded, a suite of temperature TMDL targets were developed to translate the narrative temperature standard into measurable parameters that collectively represent attainment of applicable water quality standards at all times. The goal is to set the target values at levels that occur under naturally occurring conditions but are conservatively selected to incorporate an implicit margin of safety that helps account for uncertainty and natural variability. The target values are protective of the use most sensitive to elevated temperatures, aquatic life; as such, the targets are protective of all designated uses for the applicable waterbody segments.

For the lower Beaverhead and upper Jefferson Rivers, a QUAL2K model was used to estimate the extent of human influence on temperature by evaluating the temperature change between existing conditions and naturally occurring conditions. The models used the data described in **Sections 5.3.2** and **5.3.3** to simulate existing conditions, and then the models were re-run with riparian shade and water use altered to reflect naturally occurring conditions. If the modeled temperature change between the two scenarios (i.e., existing and naturally occurring) is greater than allowed by the water quality standard (i.e., 0.5-1.0°F, depending on the naturally occurring temperature), this verifies the existing temperature impairments for the lower Beaverhead and Upper Jefferson rivers. Model scenario details and impairment determinations are presented are presented in **Sections 5.5.1** and **5.5.2**, **Source Assessment,** and **Appendices B and C.**

## 5.4.2 Temperature Target Parameters and Values

The primary temperature target is the allowable human-caused temperature change (i.e., 0.5-1.0°F, depending on the naturally occurring temperature), and the other targets are those parameters that influence temperature and can be linked to human causes (riparian shade, improved streamflow conditions, and lower headwater temperatures; where applicable). All targets are described in more detail below.

### *5.4.2.1 Allowable human-caused temperature change*

The target for allowable human-caused temperature change for the lower Beaverhead and upper Jefferson Rivers links directly to the numeric portion of Montana's temperature standard for B-1 rivers (Administrative Rules of Montana (ARM) 17.30.623(e)): When the naturally occurring temperature is less than 66°F, the maximum allowable increase is 1°F. Within the naturally occurring temperature range of 66–66.5°F, the allowable increase cannot exceed 67°F. If the naturally occurring temperature is greater than 66.5°F, the maximum allowable increase is 0.5°F. As stated above, naturally occurring temperatures incorporate natural sources, yet also include human sources that are applying all reasonable land, soil, and water conservation practices.

### *5.4.2.2 Riparian shade*

Increased shading from riparian vegetation reduces sunlight hitting the stream and, thus, reduces the heat load to the stream. Riparian vegetation also reduces near-stream wind speed and traps air against the water surface, which reduces heat exchange with the atmosphere (Poole and Berman, 2001). In addition, lack of established riparian areas can lead to bank instability, which can result in an overwidened channel.

As stated in **Section 5.3**, shade was estimated using Shadev3.0.xls. The river was segmented into different vegetative reaches, identical to those used in the QUAL2K model, and average conditions were applied for each species type, condition, and age class determined during 2009 field work in both the lower Beaverhead and upper Jefferson Rivers. Measured shade, along with dominant vegetation type, height, offset/overhang, canopy density, and channel dimensions were used to validate the model. Values from each vegetation type were averaged to provide reach-wide estimates for the modeling. Simulated shade results are shown in **Appendices B** and **C.** In the shade scenarios (**Section 5.5**), areas with presently diminished shade conditions were changed to a reference condition by increasing all open/grassed sites, barren areas, and any other area with diminished shading vegetation to a reference shade condition based on field measured shade values and Geographic Information System (GIS) analysis.

**Lower Beaverhead River**

For the lower Beaverhead River, two reference riparian conditions were considered for a target value: where reference willow complex was present along the entire reach and where vigorous cottonwood stands were present due to natural conditions (i.e. no human impacts or native hydrology). Dense willow complex was chosen as the target condition for the lower Beaverhead River because it is likely the best possible condition under the existing hydrology, which is regulated by outflows from the Clark Canyon Reservoir (downstream flow regulation can inhibit the dispersal, germination, and recruitment of cottonwoods). Dense willow complex has an average daily effective shade of 22% (with an average height of approximately 9 feet, overhang of approximately 1.5 feet, density of 73%)**.**

**Jefferson River**

For the upper Jefferson River, two reference riparian conditions were considered. The first reference condition was defined as improvement to a mixed low level vegetation type. The second reference condition was run as a mixed high level (inclusion of cottonwoods) in which grass/bare areas as well as willow areas and mixed low level areas were increased. The target for the upper Jefferson River was determined to reside between these two reference conditions because some cottonwood recruitment is possible in the Jefferson River. Therefore, mixed low and high level vegetation is considered the reference condition with an average daily effective shade ranging between 16-21% (an average vegetation height of approximately 25.5 feet, overhang of approximately 1.5 feet, density of 42%).

DEQ realizes most healthy riparian buffers are comprised of more than a single category of vegetation, but these riparian vegetation categories were used for two reasons 1) the actual composition of the riparian zone under target shade conditions will vary over time and is too complex to model with QUAL2K, and 2) based on existing vegetation in the watershed and what is known of historical conditions, the effective shade provided by high density willows in the lower Beaverhead River and medium density mixed low and high level vegetation in the upper Jefferson River, were determined to be a reasonable targets. Considering the variability in potential vegetation and shade, these densities were used as a surrogate to represent the average achievable shade condition; effective shade is the result of topography and vegetative height and density, so the target shade condition could be achieved by a combination of vegetation types and densities. Additionally, the effective shade potential at any given location may be lower or higher than the target depending on natural factors such as fire history, soil, topography, and aspect but also because of human alterations to the near-stream landscape including roads and riprap that may not feasibly be modified or relocated. The targets are provided as a quantitative guide for meeting the standard and are intended to represent all reasonable land, soil, and water conservation practices (RLSWCPs). Therefore, if all RLSWCPs are being implemented, then the lower Beaverhead River and the upper Jefferson River will be meeting the riparian shade targets. The targets do not apply to portions where the riparian zone is already at potential or is dominated by vegetation not likely to attain great heights at maturity (e.g., wetland shrub community).

In addition to target vegetation types and densities, the DEQ recommends a buffer width of a minimum of 50 feet to improve effective shade. To help minimize the influence of upland activities on stream temperature, a riparian buffer close to 100 feet is commonly recommended (Ledwith, 1996; Knutson and Naef, 1997; Ellis, 2008). However, several studies have shown that most (85-90%) of the maximum shade potential is obtained within the first 50 feet (Brazier and Brown, 1973; Broderson, 1973; Steinblums et al., 1984) or 75 feet of the channel (CH2M, 2000; Castelle and Johnson, 2000; Christensen, 2000). The Natural Resources Conservation Service (NRCS) Conservation Practice Standard recommends a minimum buffer width of 35 feet, and also includes recommendations to use species with a medium or high shade value and to meet the minimum habitat requirements of aquatic species of concern (Natural Resources Conservation Service, 2011a; 2011b). Based on several literature sources finding that most shade is obtained within a buffer width of 50 feet and that 50 feet is the minimum buffer width for the Montana Streamside Management Zone (Montana Department of Natural Resources and Conservation, 2006), the DEQ recommends a buffer width of a minimum of 50 feet.

### *5.4.2.3 Instream flow (water use)*

Because larger volumes of water take longer to heat up during the day, the ability of a stream to buffer incoming solar radiation is reduced as instream water volume decreases. In other words, a channel with little water will heat up faster than an identical channel full of water, even if they have identical shading and are exposed to the same daily air temperatures.

The effect of water use on instream flow and water temperature was considered. Although Montana standards do not necessarily apply to existing water rights, it is important to assess the cumulative effect of these practices on the overall thermal regime of the river. The simple relationship presented by Brown (1969) suggests that large volume streams are less responsive to temperature changes than low flow streams and will also exhibit smaller diel fluctuations.

**Lower Beaverhead River**

The modeling scenario (**Section 5.5.1.3**) consisted of a 20% water savings gained through improved irrigation delivery and allowing that water savings to flow down the lower Beaverhead River (any voluntary water savings and subsequent instream flow augmentation must be done in a way that protects water rights).

The goal is to have improved irrigation delivery through best management practices (BMPs) from all water users on the Beaverhead River (BOR, East Bench Irrigation District (EBID), Clark Canyon Water Supply, and others). Some users are already implementing BMPs and there are existing proposals for upgrades for irrigation delivery. The 20% water savings assumption was based on three grant proposals submitted to the state of Montana by the East Bench Irrigation District (EBID). Two of the grants were for lining 2,000 (Montana Department of Natural Resources and Conservation, 2007) and 1,175 (Montana Department of Natural Resources and Conservation, 2009) feet of main canal respectively, which were estimated by EBID to reduce annual leakage by 3,600 and 2,585 acre-feet. The third grant was to replace slide gates at three existing check structures (Montana Department of Natural Resources and Conservation, 2011), which was expected to conserve another 7,855 acre-feet. Hence the total annual water savings by the three proposals was 14,040 acre-feet or 20.8% of the 67,260 acre-feet diverted annually between 1996 and 2005 (except for 2004 when no water was diverted). This value was rounded to 20% for the scenario and reflects the potential improvement through implementing reasonable BMPs. Additional reductions may be feasible through other canal improvements or improvement in irrigation delivery and efficiency in other areas of the watershed, but it is unknown whether these are reasonable or feasible at this time.

**Upper Jefferson River**

The modeling scenario (**Section 5.5.2.3**) assumes that irrigation delivery improvement and voluntary water reductions during summer low flow conditions by Jefferson River water users could create a water savings of 15% and that the conserved water could be allowed to flow down the upper Jefferson River, thereby increasing instream flow (any voluntary water savings and subsequent instream flow augmentation must be done in a way that protects water rights). The 15% water savings is recommended annually during summer low flow conditions.

For drought years, the Jefferson River Watershed Council (JRWC) and other stakeholders have put together a Drought Management Plan to reduce resource damage and to aid in the equitable distribution of water resources during water critical periods. Implementation of the plan should provide sufficient flow to maintain and potentially improve fish population numbers and is a voluntary effort involving local interests including agriculture, conservation groups, anglers, municipalities, businesses, and government agencies. The first Drought Management Plan was prepared and approved by the Jefferson River Watershed Council in 2000 and revised in 2005. The plan aims to increase flow at the Waterloo Gage (below Fish Creek Canal). The drought management plan goal of maintaining at least 50 cfs at Waterloo has not always been met since the implementation of the plan, but cooperation by water users helped improve flows at this critical location. The Drought Management Plan established flow triggers for directing actions of anglers, water users, and government agencies. The triggers were revised in 2005 based on observations of the previous 5 years of plan implementation. In 2006, a study was prepared for the JRWC and Trout Unlimited (Van Mullem, 2006) to show where additional water savings were possible through changes in canal upgrades and improved canal management. The objective of the JRWC is to continue implementation of the Drought Management Plan in cooperation with Montana FWP, Trout Unlimited, and local irrigators.

Water users in the Beaverhead and Jefferson watersheds are encouraged to work with the United States Department of Agriculture (USDA) Natural Resource Conservation Service, the Montana Department of Natural Resources & Conservation, the local conservation district, and other local land management agencies to review their systems and practices.

#### *5.4.2.4 Headwater Temperature Reduction*

Instream water temperature generally tends to increase in the downstream direction from headwaters to lowlands. Increasing temperature in the downstream direction reflects systematic tendencies in parameters critical to water temperature (including width to depth ratios, air temperature, groundwater inflow, and changes in riparian vegetation and topography) (Moore et al., 2005). For example, as streams widen, riparian canopy provides less shade until some point in a river system it provides insignificant shading. Therefore, it is important to maintain cooler naturally occurring temperatures from headwater streams as they provide the base temperatures for the receiving larger order stream.

Effects of headwater inflow depend on the temperature and discharge of each stream and can be characterized by a simple mixing equation. Naturally occurring temperatures for the headwater streams of the Jefferson River were determined using a QUAL2K model for the Beaverhead River (as described in this document), a SNTEMP model for the Ruby River (see Ruby River Temperature TMDL document (2006)), and a Heat Source model for the Big Hole River (see Middle and Lower Big Hole River TMDL document, (2009)). SNTEMP is a simpler model than the QUAL2K, and Heat Source is more complex like the QUAL2K model; however, all three models provide minimum, maximum, and mean temperature outputs for existing conditions and scenario development. Based on these models, naturally occurring headwater temperature targets for the Jefferson River are as follows: Ruby River at mouth = 66.70°F, Beaverhead River at mouth = 72.29°F, Big Hole River at mouth = 77.00°F.

#### *5.4.2.5 Wastewater Treatment Facilities*

Wastewater treatment facilities (WWTFs) may influence a stream's water temperature. The temperature TMDL target is performance based for WWTFs and other point source effluents. This target requirement states that these point sources shall not warm the stream individually or in combination by more than the allowable increase in temperature under Montana's temperature standard, which applies to the WWTF in Dillon and any future WWTF that discharge to the lower Beaverhead and upper Jefferson Rivers. This translates to no more than a 1.0°F increase when the receiving water is cooler than 66.5°F, no increase above 67°F when the receiving water is 66 – 66.5°F and no more than a 0.5°F increase under conditions where the receiving water is greater than 66.5°F.

### 5.4.3 Target Values Summary

The allowable human-caused temperature change is the primary target that must be achieved to meet the standard. Alternatively, compliance with the temperature standard can be attained by meeting the two temperature-influencing targets (i.e., riparian shade and width/depth ratio). In this approach, if all reasonable land, soil, and water conservation practices are installed or practiced, water quality standards will be met. **Table 5-3** summarizes the temperatures targets for the lower Beaverhead and upper Jefferson Rivers.

**Table 5-3. Temperature Targets for the lower Beaverhead and upper Jefferson Rivers**

| Target Parameter | Target Value |
|---|---|
| ***Primary Target*** | |
| Allowable Human-Caused Temperature Change | If the naturally occurring temperature is less than 66°F, the maximum allowable increase is 1°F. Within the naturally occurring temperature range of 66–66.5°F, the allowable increase cannot exceed 67°F. If the naturally occurring temperature is greater than 66.5°F, the maximum allowable increase is 0.5°F. |
| ***Temperature-Influencing Targets: Meeting both will meet the primary target*** | |
| Riparian Health – Shade | **Beaverhead River**<br>Dense willow complex with an average daily effective shade of 22% (an average height of around 9 ft., overhang of around 1.5 ft., and density of 73%)<br>**Jefferson River**<br>Mixed low and high level vegetation with an average daily effective shade ranging between 16-21% (an average height of around 25.5 ft., overhang of around 1.5 ft., and density of 42%) |
| Instream flow (water use management) | **Beaverhead River**<br>20% increase in flow from improved irrigation delivery<br>**Jefferson River**<br>15% increase in flow from voluntary reductions in use |
| Reduce headwater temperatures | **Jefferson River**<br>Decrease headwater temperature using the naturally occurring maximum temperature from the three headwaters streams (Ruby River at mouth= 66.70°F, Beaverhead River at mouth = 72.29°F, Big Hole River at mouth = 77.00°F). |
| Wastewater Treatment Facilities | Individually or in combination no more than a 1.0°F increase when the receiving water is cooler than 66.5°F, no increase above 67°F when the receiving water is 66 – 66.5°F and no more than a 0.5°F increase under conditions where the receiving water is greater than 66.5°F |

## 5.5 Source Assessment

The source assessment describes the most significant natural, non-permitted, and permitted sources of temperature. As discussed above, the source assessment for the lower Beaverhead and upper Jefferson Rivers largely involved QUAL2K temperature modeling.

### 5.5.1 Source Assessment Using QUAL2K

QUAL2K is a one-dimensional river and stream water quality model that assumes the channel is well-mixed vertically and laterally. The QUAL2K model uses steady state hydraulics that simulates non-uniform steady flow. Within the model, water temperatures are estimated based on climate data, riparian shading, and channel conditions. Each stream is segmented into reaches within the model that are assigned the same channel and shade characteristics. Segmentation is largely based on the location of field data, tributaries, irrigation withdrawal/returns, and changes in channel conditions or shading. Temperature outputs from the model are given at river station miles that correspond with the end of each modeled reach. Both watersheds have been affected by present and historical grazing in the riparian area, land development/redevelopment, irrigated crop production, streambank modification and destabilization, historical mining, and impacts from flow regulation and modification. Instead of focusing on the potential contribution of all of these sources, the source assessment focused on two factors that can be influenced by human activities and are drivers of stream temperature: instream flow and riparian shade.

#### *5.5.1.2 Lower Beaverhead Assessment Using QUAL2K*

A QUAL2K model was used to determine the extent that human-caused disturbances within the lower Beaverhead River have increased the water temperature above the naturally occurring level. The evaluation of model results focuses on the maximum daily water temperatures in the lower Beaverhead River during the summer because those are conditions mostly likely to harm aquatic life, the most sensitive beneficial use.

Within the model, the lower Beaverhead River was segmented into 36 modeled reaches and 3 generalized hydraulic reaches. The water temperature and flow data collected by the BOR in 2005, along with channel measurements, irrigation data, and climate data (**Section 5.3**), were used to calibrate and validate the model. Features of significance were the diversion at Barretts, which withdrew approximately half of the flow in the river, and then numerous smaller diversions that incrementally deplete flow until a minimum is reached near Silver Bow (Giem) Bridge. Gains occur thereafter from sloughs out of the Big Hole River and the Ruby River. Simulated minimum, mean, and maximum daily water temperatures are shown in **Appendix B**. Model error (RE and RMSE) were quite good at 0.01% and 0.91°F. Overall, the river generally increases in temperature (and diurnal flux) from the headwater boundary to mile 12, and then has a short region of cooling coincident with increased flow volume. The addition of the Wastewater Treatment Plant (WWTP) discharge was found to have a very small effect in the middle river.

A baseline scenario and three additional scenarios were modeled to investigate the potential influences of human activities on temperatures in the lower Beaverhead River. The following sections describe those modeling scenarios. Although channel width and depth can influence stream temperatures, the existing channel dimensions were not changed for any of the scenarios because targets for channel width/depth were difficult to ascertain because of a lack of reference data for a system like the

Beaverhead River. A more detailed report of the development and results of the QUAL2K model are included in **Appendix B.**

#### 5.5.1.2.1 Baseline scenario (existing conditions)

The baseline scenario represents stream temperatures under existing shade and channel conditions in August on a hot, dry year and is the scenario that all others are compared against to evaluate the influence of human sources. The simulation results are documented in **Appendix B** and indicate reasonably good calibration for water temperature based on performance statistics of RE and RMSE. Water temperature was shown to increase from the upstream boundary near Barretts until Silver Bow (Giem) Bridge and then decrease thereafter.

Under the baseline scenario, maximum daily temperatures ranged from 71°F at Barretts to 69.9°F at the Westside Canal and then up to 77.1°F at Giem Bridge (**Figure 5-4**). Temperatures generally increase in a downstream direction but reset somewhat by decreasing by approximately 4°F near the mouth at Madison Co. Fairgrounds. The area where temperatures decrease corresponds with where sloughs from the Big Hole River enter into the Beaverhead.

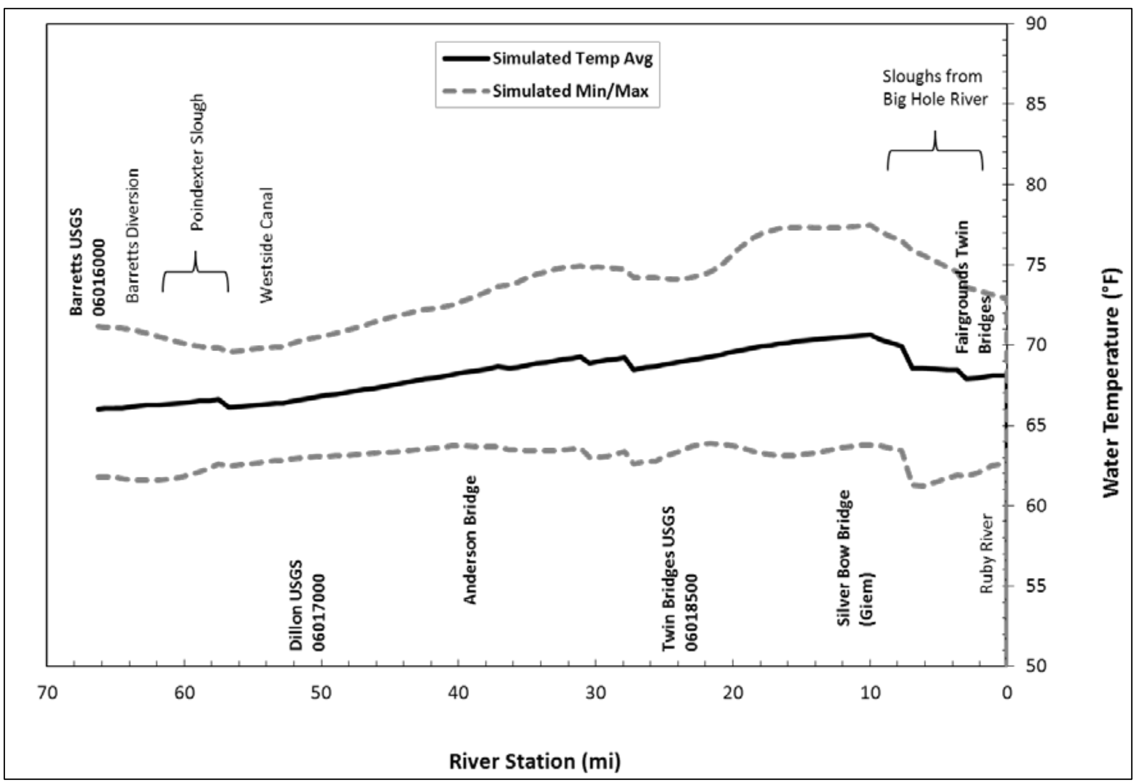



**Figure 5-4. Modeled temperatures for the lower Beaverhead River baseline scenario**

#### 5.5.1.2.2 Shade scenario

For the shade scenario, the effective shade inputs to the model were set to represent the target shade condition. Two different shade conditions were evaluated: (1) where reference willow canopy was present along the entire reach (which is likely the best possible condition under reservoir hydrology) and (2) where vigorous cottonwood stands were present due to natural conditions (i.e. no human impacts or native hydrology).

Simulations were implemented by simply changing riparian cover conditions in the model. The first shade scenario was changed to "dense willow complex" and the second scenario was done identically, but with "cottonwoods". The results of these scenarios are shown in **Figure 5-5**. Relative to baseline conditions, the temperature effect of both scenarios decreases the maximum and minimum temperatures over the entire modeling reach. The cottonwood shade scenario, with an effective shade of approximately 43%, resulted in a significant decrease of river temperatures of 5.2$^o$ F compared to the willow shade scenario, with an effective shade of 22%, which decreased temperatures less than 1$^o$F. This shows that under the current reservoir regulated hydrology, riparian enhancements will provide limited temperature improvement to the river if implemented (unless continuous cottonwood-planting programs are instated). Tabular results for this scenario (and all others) are shown in **Appendix B**.

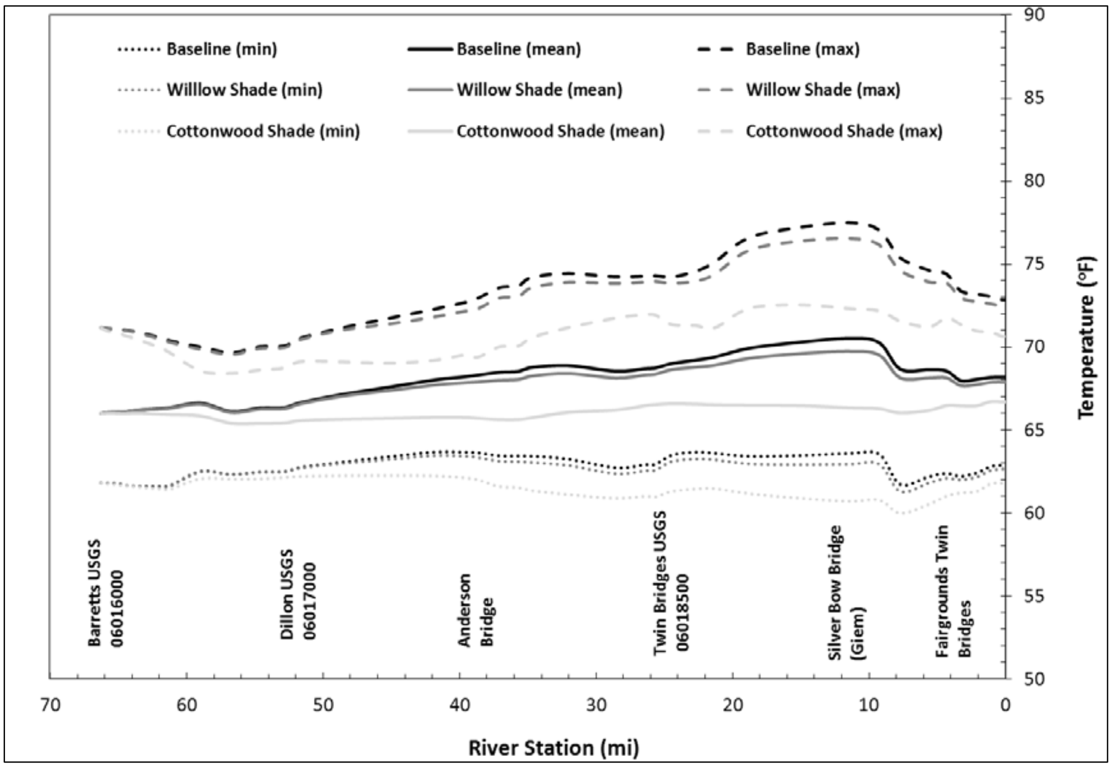



**Figure 5-5. Shade scenarios on the lower Beaverhead River**

#### 5.5.1.2.3 Increased flow (water use) scenario

The increased flow scenario is used to describe the potential thermal effect of water savings and flow augmentation on water temperatures in the lower Beaverhead River. This scenario assumes that improved water delivery could create a water savings of 20% and that the conserved water could be allowed to flow down the lower Beaverhead River, thereby increasing instream flow. For modeling purposes, the diversion flow rate was reduced by 20%, and the additional water was allowed to flow down the Beaverhead River. Based on model simulations, the 20% savings would lead to maximum reductions of 3$^o$F between miles 10 and 20 (**Figure 5-6**). Minimum temperatures actually increased nearly the same (2.6$^o$F) due to added thermal inertia.

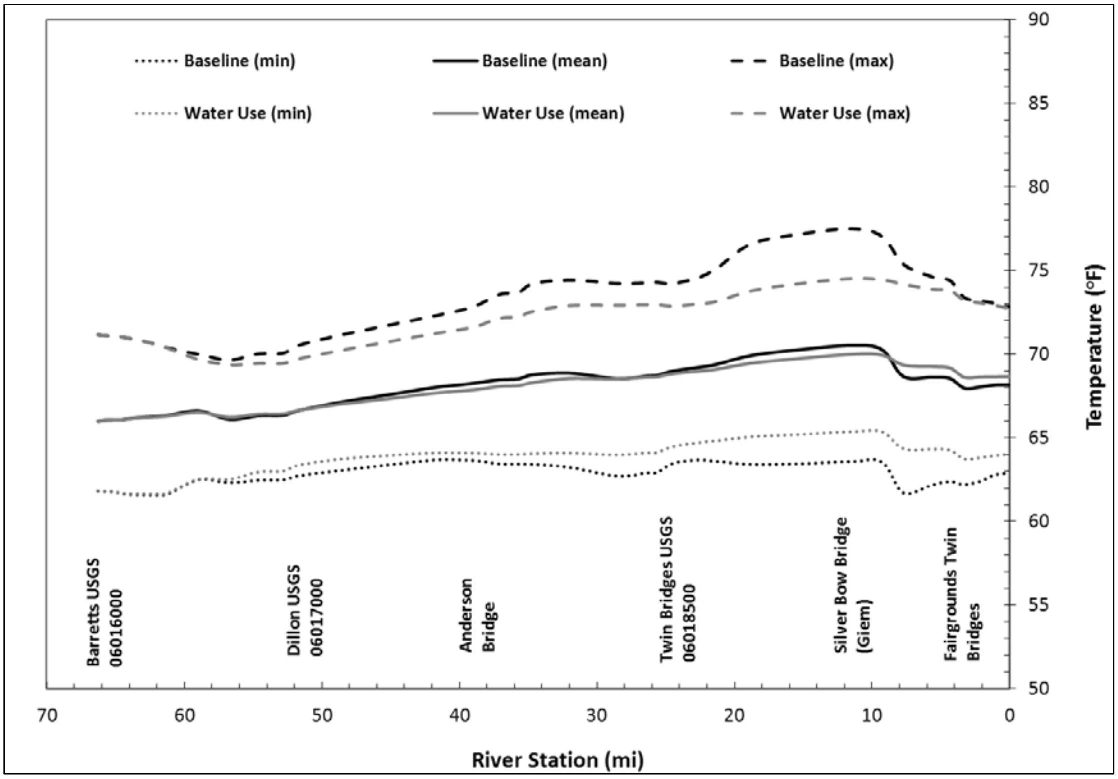



**Figure 5-6. Increased flow (water use) scenario on the lower Beaverhead River**

#### 5.5.1.2.4 Naturally occurring scenario (full application of BMPs with current land use)

The naturally occurring scenario represents lower Beaverhead River water temperatures when all reasonable land, soil, and water conservation practices are implemented (ARM 17.30.602). Pursuant to 75-5-306, Montana Code Annotated (MCA) "Conditions resulting from the reasonable operation of dams at July 1, 1971" are also considered natural. Thus, this scenario establishes the bar for which the allowable 0.5°F temperature increase is compared (refer to **Section 5.4.2.1**). Assumptions used in the development of the naturally occurring scenario include the following: (1) shade conditions as described in the shade scenario (willow complex) and (2) a 20% reduction in the rate of diverted flow as described in the water use scenario.

Results of the naturally occurring scenario are shown in **Figure 5-7**. The scenario indicates the river is impaired extending from approximately mile 56 downstream to the confluence with the Big Hole River (mile 0). The largest temperature increase over baseline condition is 3.7°F at mile 11.4. The impairment is believed to be primarily related to irrigation based on evaluation of the previous scenarios.

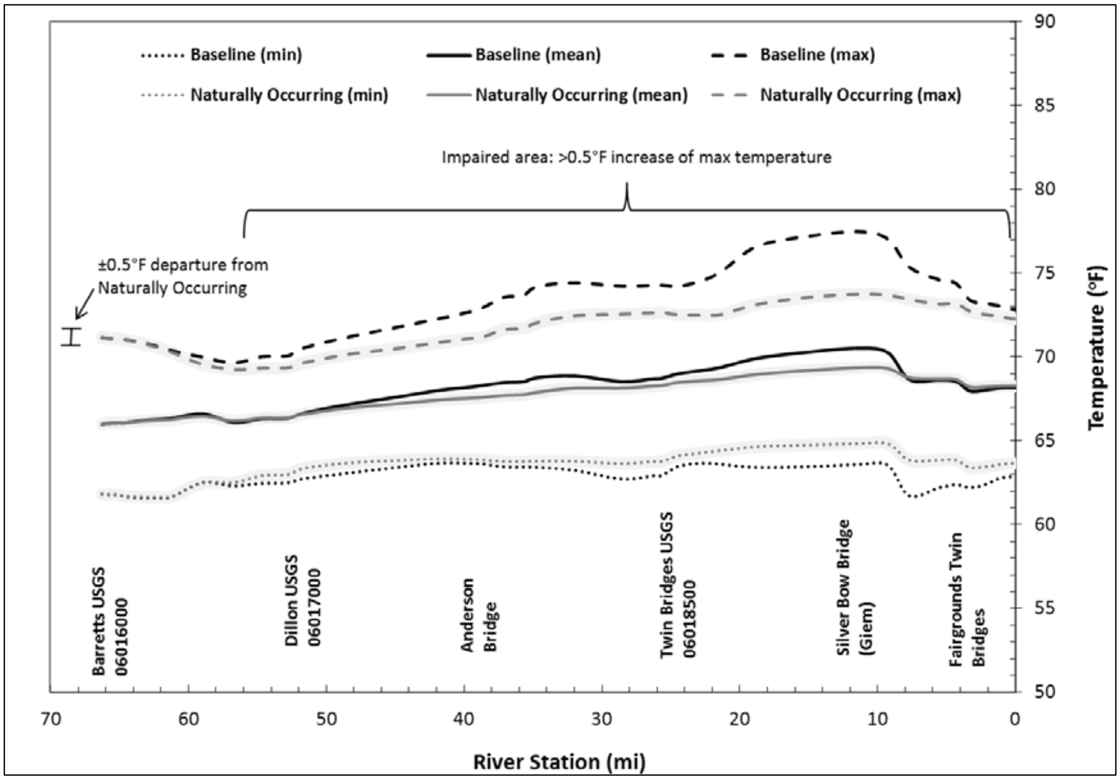



**Figure 5-7. The maximum naturally occurring temperature relative to the existing condition (baseline scenario) and the allowed temperature**

### *5.5.2.2 Upper Jefferson Assessment Using QUAL2K*

A QUAL2K model was used to determine the extent that human-caused disturbances within the upper Jefferson River have increased the water temperature above the naturally occurring level. The evaluation of model results focuses on the maximum daily water temperatures in the upper Jefferson River during the summer because those are conditions mostly likely to harm aquatic life, the most sensitive beneficial use.

Within the model, the upper Jefferson River was segmented into 10 hydraulic reaches. The water temperature and flow data collected by WET for the DEQ in 2009, along with channel measurements, irrigation data, and climate data (**Section 5.3**), were used to calibrate and validate the model. Examination of the longitudinal temperature profile of the 2009 calibrated model (**Figure 5-8**) of the upper Jefferson River provides important information regarding instream water temperatures and associated river dynamics. Beginning at the upstream boundary (mile 41.2), temperature remains relatively constant until reaching river mile 27, where an increasing trend is noted. This area shows significant off-stream agricultural development on both sides of the river. This area is also a losing stretch of the river. Maximum temperatures reach 73.0°F in this section. The warming trend continues as additional irrigation withdrawals occur and flows decrease until reaching the Willow Springs confluence near mile 19.6. The spring fed tributaries and groundwater inflow through this reach lower the average, maximum, and minimum temperatures. Also, the Point of Rocks geologic outcrop provides topographic shade through this reach, which may also affect river temperatures. Temperatures remain relatively constant for approximately the next 15 miles, but a second increasing trend is noted near the end of the study area, starting at mile 3.9.

The maximum simulated river temperature occurs at mile 21.2 (73°F) where there is significant agricultural development and a losing stretch of the river. A second temperature maximum is at mile 0.0 (73°F) where there is significant agricultural development, as well as several backwater sloughs and oxbow channels. The river enters the LaHood Canyon just downstream of the end of the study area. Overall, the model shows a very consistent temperature profile. This constant profile is a function of the high water year. Overall, a good surface water temperature calibration was achieved based on model statistical efficiency. However, the study was conducted during high flows, which resulted in some hydraulic calibration variations. Once sufficient calibration of the existing condition model was achieved, scenarios for TMDL planning and analysis were developed. The flows used for model calibration represented a relatively high flow condition compared to those experienced over the past decade; as a result, a baseline scenario that simulates low flow conditions was included. Also, several potential land and water management scenarios (modeled from the low flow scenario) are described in the following sections. A more detailed report of the development and results of the QUAL2K model are included in **Appendix C.**

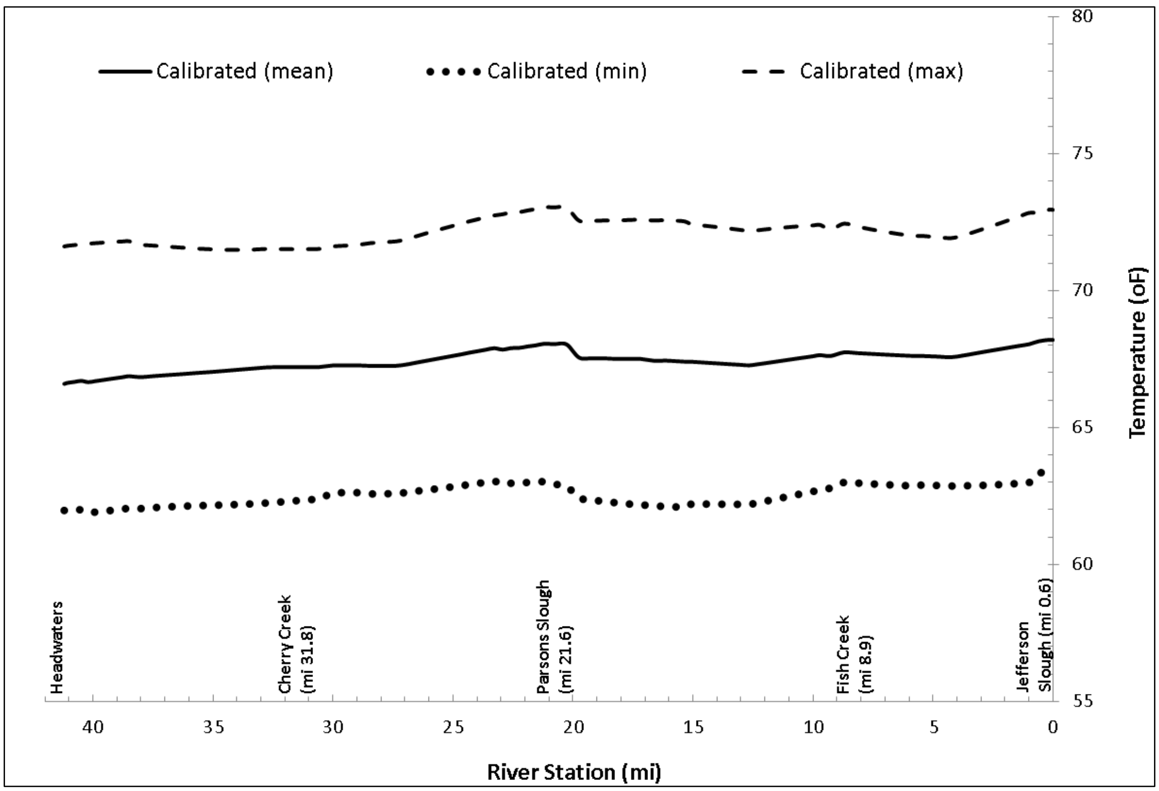



**Figure 5-8. Modeled temperatures for the upper Jefferson River calibration**

#### 5.5.2.2.1 Baseline scenario using 7Q10 water year (low flow)

The baseline scenario represents stream temperatures under existing shade and channel conditions. The goal of this modeling study was to collect data and model the typical summer time low flow or baseline condition of the upper Jefferson River. However, the 2009 water year experienced significantly higher flows during the model period than the several years preceding the temperature model. As a result, the DEQ developed a baseline scenario that simulated summer time low flow conditions using a 7-day 10-yr low flow or 7Q10 flow condition (**Figure 5-9**). The 7Q10 flow is the lowest 7-day average flow that occurs (on average) once every ten years. More details regarding the 7Q10 flow scenario can be found in **Section C6.1 in Appendix C.**

Under the baseline scenario, maximum temperatures above 77°F occur from above Fish Creek/Jefferson ditch to Willow Springs. The spring fed surface water and groundwater inflow in this reach (around mile 20) reduce average and maximum temperatures at a critical location. Temperatures above 80°F occur between miles 11 to 9, where flow in the river goes down around 12 cfs in a 7Q10 year. Temperatures rise above 77°F again, in the reach above the confluence with the Jefferson Slough. The 7Q10 water year scenario is used as the baseline model for the remaining scenarios, as this flow condition will better show the impact of management scenarios on temperature.

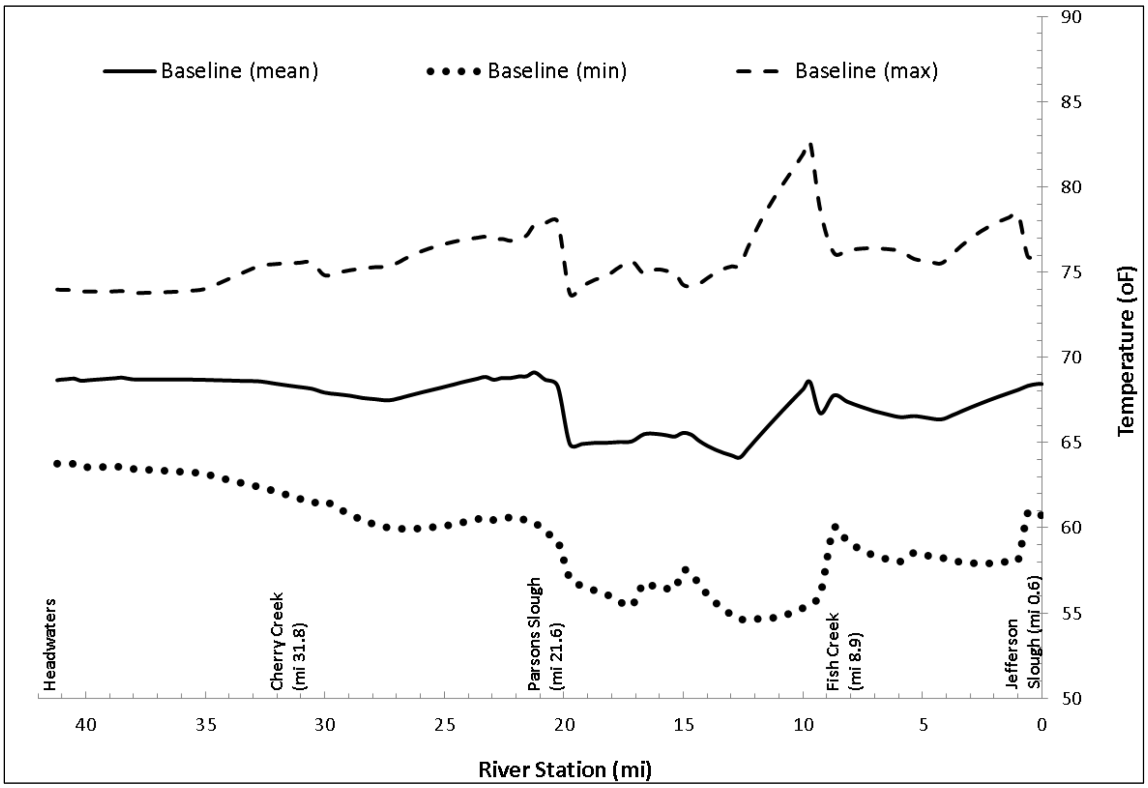


**Figure 5-9. Modeled temperatures for the upper Jefferson River baseline scenario**

#### 5.5.2.2.2 Shade scenario

For the shade scenario, the effective shade inputs to the model were set to represent the target shade condition based on field measured shade values and GIS analysis. Two different shade conditions were evaluated: (1) where reference mixed low level vegetation is present along the entire reach (all open/grassed sites, barren areas, and any other area with diminished shading vegetation were increased to a reference shade condition) and (2) where reference mixed high level (inclusion of cottonwoods) and mixed low level areas are was present along the entire reach. The potential temperature reduction due to naturally occurring increased shade is somewhere between these two shade conditions with a potential for low level shrubs/willows in some areas and cottonwoods in other areas throughout the upper segment of the river.

Simulations were implemented by simply changing riparian cover conditions in the model. The shade scenario used the averaged shade values (from the two evaluated conditions) to reflect a mix of high and low level vegetation (cottonwoods and shrubs/willows). Existing cottonwoods or mixed high level conditions were not adjusted. The results of these scenarios are shown in **Figure 5-10**. The upgrade from bare, native grass and irrigated grass to a mixed high and low level vegetation shows that the greatest temperature reduction (.71°F) would occur at mile 9.7. Results show that shade is not a major temperature influencing factor unless it is of significant height, due to the wide river channel.

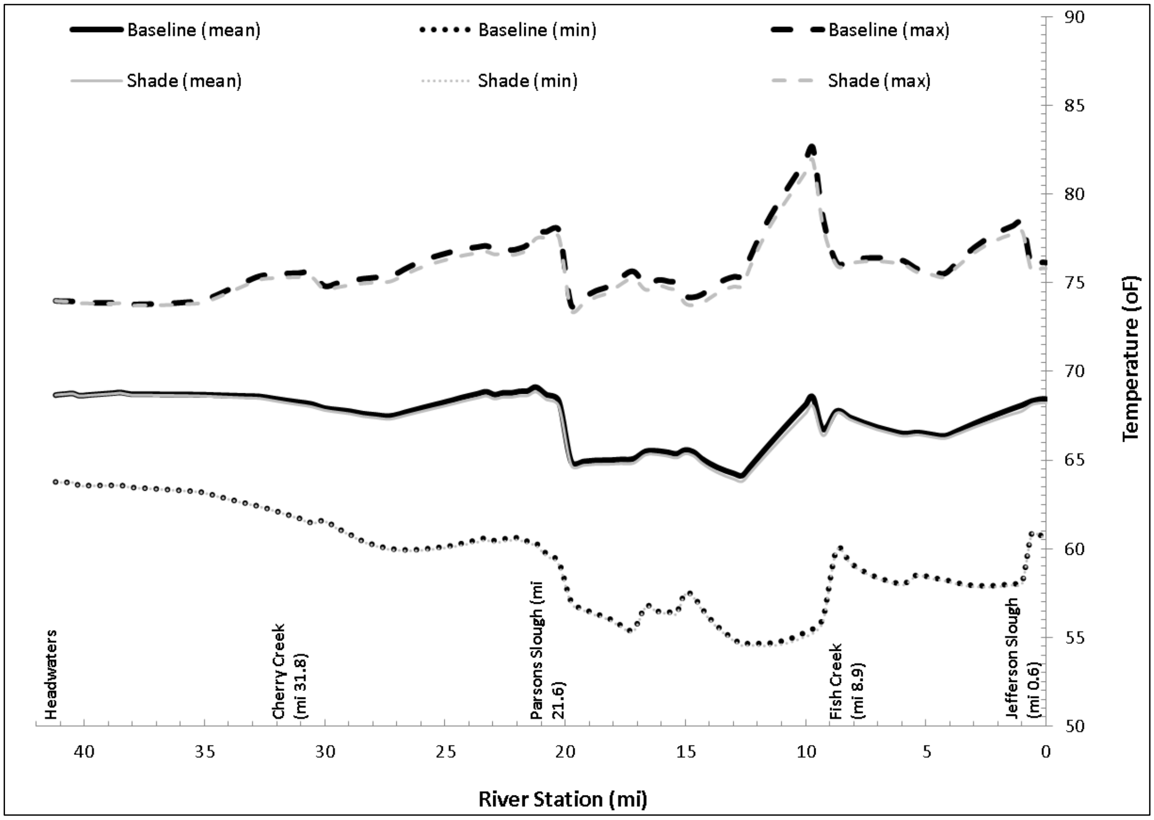


**Figure 5-10. Shade scenario on the upper Jefferson River**

### 5.5.2.2.3 Increased flow (water use) scenario

The increased flow scenario is used to describe the potential thermal effect of water savings and flow augmentation on water temperatures in the upper Jefferson River. This scenario assumes that private land owners' voluntary water restrictions during the low flow could create a water savings of 15% and that the conserved water could be allowed to flow down the upper Jefferson River, thereby increasing instream flow. For modeling purposes, the diversion and return flow rates were reduced by 15%, and the additional water was allowed to flow down the upper Jefferson River.

A 15% increase in stream flow shows that the greatest temperature reduction (7.42°F) would occur at mile 9.7 (**Figure 5-11**). The increased flow scenario shows that reducing the amount of water diverted during low flow is a significant contributing factor to maximum temperature reductions. Based on model results, irrigation water savings are an important means to achieve state temperature regulations. However, compliance would be on a voluntary basis by landowners. In addition to these results, water temperatures in the upper Jefferson River would also be beneficially affected by similar improvements in the Ruby, Beaverhead, and Big Hole Rivers.

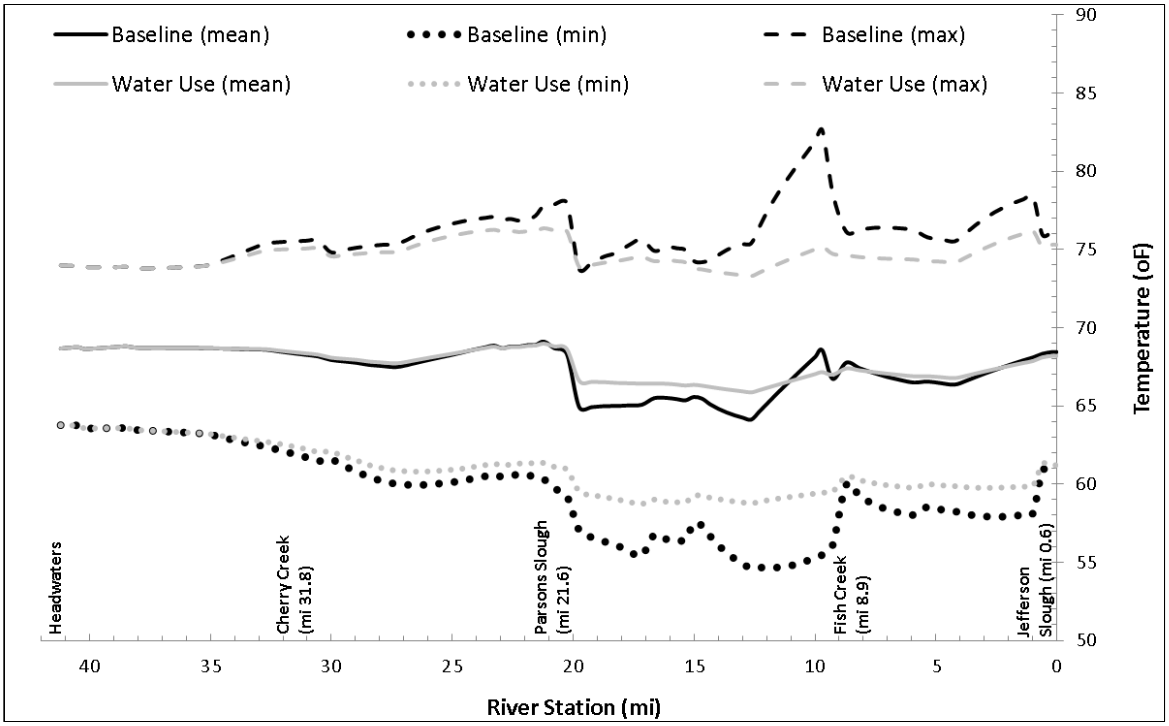



**Figure 5-11. Increased flow (water use) scenario on the upper Jefferson River**

### 5.5.2.2.4 Naturally occurring scenario (full application of BMPs with current land use)

The naturally occurring scenario represents upper Jefferson River water temperatures when all reasonable land, soil, and water conservation practices are implemented (ARM 17.30.602). Thus, this scenario establishes the bar for which the allowable 0.5°F temperature increase is compared (refer to **Section 5.4.2.1**). Assumptions used in the development of the naturally occurring scenario include the following: (1) decrease in headwater temperatures (**Table 5-4**), (2) shade conditions as described in the shade scenario (mixed low and high level vegetation type), and (3) a 15% reduction in the rate of diverted flow as described in the water use scenario.

**Table 5-4. Parameters used in Headwater Mixing Calculations – Naturally Occurring**

| River Name | (Q, cfs) | Source data for Q | Tavg °F | Source data for Tavg | Tmax °F | Source data for Tmax |
|---|---|---|---|---|---|---|
| Ruby River | 94 | * | N/A | Tavg not provided | 66.70** | DEQ model, naturally occurring |
| Beaverhead River | 89 | * | 68.41 | DEQ model, naturally occurring scenario | 72.14*** | DEQ model, naturally occurring |
| Big Hole River | 135 | * | 71.67 | DEQ model, naturally occurring scenario | 77.00** | DEQ model, naturally occurring |
| Jefferson Headwater | | | | | **72.59** | **Mixing Calculation** |

*Headwater flows were determined as a contributing ratio to the Jefferson River USGS gage at Twin Bridges. Available data for all four USGS gage sites when the Jefferson River was below 600 cfs were from 8/3/2008 through 8/31/2008.
USGS gages:

- 06023000 Ruby River near Twin Bridges, MT
- 06018500 Beaverhead River near Twin bridges, MT
- 06026420 Big Hole R blw Hamilton Ditch nr Twin Bridges, MT
- 06026500 Jefferson River near Twin Bridges MT

**Naturally occurring temperatures for the Ruby and Big Hole Rivers were calculated using models for TMDL development of those rivers (completed in 2006 and 2009 respectively)
***Naturally occurring temperature for the Beaverhead River used in the Jefferson River temperature model was calculated before the completion of the Beaverhead River temperature model. The resulting maximum naturally occurring temperature at the mouth from the Beaverhead River temperature model is 0.15°F above the maximum naturally occurring temperature used in the Jefferson model, which means that the temperature used in the mixing equation results in a slightly more conservative estimate of the naturally occurring temperature of the Jefferson River.

The mixing calculation is as follows:

$$\mathrm{T}_{\max,BeaverheadaboveBigholeRiver} = \frac{Q_{Beaverhead}T_{Beaverhead} + Q_{Ruby}T_{Ruby}}{Q_{Beaverhead} + Q_{Ruby}}$$

$$\mathrm{T}_{\max,JeffersonHeadwater} = \frac{Q_{Beaverhead+Ruby}T_{\max,BeaverheadaboveBigHoleRiver} + Q_{BigHole}T_{BigHole}}{Q_{Beaverhead} + Q_{Ruby} + Q_{BigHole}}$$

Results of the naturally occurring scenario (**Figure 5-12)** suggest that maximum temperatures could be reduced by an average of 1.93°F. Of the 102 output locations within the model, only 1 location met the state of the Montana temperature standard during the baseline (7Q10) scenario (e.g. within the 0.5°F allowable increase). Areas with the greatest potential for improvement occur in several locations: 1) the upper reach as a result of implementation of all reasonable land, soil, and water conservation practices in the Ruby, Beaverhead, and Big Hole (41.2 - 35.08 miles); and 2) various lower reaches largely as a result of water management practices (miles 27-20, 18-15.4, and 14.3-0), with the greatest temperature reduction of 7.91°F at mile 9.7. More information regarding this scenario can be found in **Appendix C.**

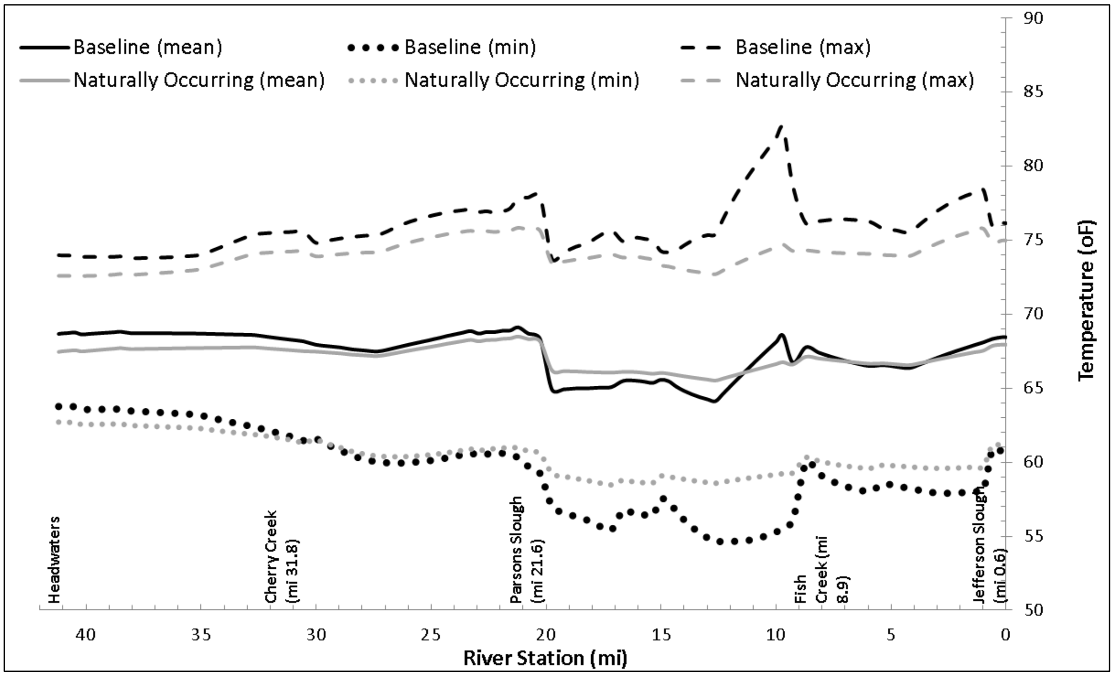


**Figure 5-12. The maximum naturally occurring temperature relative to the existing condition (baseline scenario)**

### *5.5.2.3 QUAL2K Model Assumptions*
The following is a summary of the significant assumptions used during the QUAL2K model development:

- The lower Beaverhead and upper Jefferson Rivers can be divided into distinct segments, each considered homogeneous for shade, flow, and channel geometry characteristics. Monitoring site locations were selected to be representative of segments of both the lower Beaverhead and upper Jefferson Rivers.
- Stream meander and subsurface flow paths (both of which may affect depth-velocity and temperature) are inherently represented during the estimation of various parameters (e.g., stream slope, channel geometry, and Manning's roughness coefficient) for each segment.
- Weather conditions at the chosen climate stations, which were elevation-corrected, are representative of local weather conditions along the lower Beaverhead and upper Jefferson Rivers. Adjustments made to streamflow and climate for the baseline scenario adequately represent existing conditions on a hot, dry summer.
- Shade Model results are representative of riparian shading along segments of the lower Beaverhead and upper Jefferson Rivers.
- Application of some water conservation measures resulting in a decrease in water withdrawn is reasonable and consistent with the definition of the naturally occurring condition.
- The effective shade provided by the recommended riparian densities is achievable and consistent with the definition of the naturally occurring condition.
- The only tributaries accounted for in the naturally occurring condition scenario were the three major contributors to the Jefferson River: the Big Hole, Ruby, and Beaverhead Rivers. Uncertainties in the models lie within the consideration of improvement to Beaverhead River tributaries and other tributaries to the upper Jefferson, besides the three headwater rivers. The potential for decreasing water temperatures in these streams and the effect the decreased temperatures would have on the lower Beaverhead and upper Jefferson Rivers was not evaluated as part of the model simulations. As such, the QUAL2K modeled naturally occurring

scenarios have the potential for further decreasing the lower Beaverhead and upper Jefferson River temperatures.

## 5.5.2 Source Assessment of Permitted Point Sources

There are 10 point sources with Montana Pollutant Discharge Elimination System (MPDES) permits in the lower Beaverhead River and 2 in the upper Jefferson River (**Table 5-5**). The majority of the permits listed are either construction permits which are temporary, or permits not in the scope of temperature issues (pesticides), or discharge only in storm events (stormwater and concentrated animal feeding operations permits). The Twin Bridges WWTF discharges to Bayers ditch, which runs for several miles into a series of ditches, therefore having no direct influence on the upper Jefferson River. The only facility with reasonable potential to contribute thermal pollution is the City of Dillon Waste Water Treatment Facility and is examined below (**Section 5.5.2.1**).

**Table 5-5. Permitted Point Source in the lower Beaverhead and upper Jefferson Rivers**

| Facility Name | National Pollutant Discharge Elimination System (NPDES) ID | Permit Type | Waterbody Name |
|---|---|---|---|
| City of Dillon WWTF | MT0021458 | MPDES Individual Permit | Beaverhead River |
| Clark Canyon Hydro US BOR Beaverhead River Dam Alteration | MTB001814 | Turbidity Related to Construction (318) | Beaverhead River |
| Beaverhead Livestock Auction | MTG010176 | Concentrated Animal Feeding Operation | Beaverhead River |
| City of Dillon - Wastewater Treatment Plant Dewatering | MTG070695 | Construction Dewatering | Beaverhead River |
| Beaverhead County Weed Dist. Beaverhead River Corridor Pesticide | MTG870001 | Pesticides | Beaverhead River |
| Barretts Minerals Incorporated | MTR000508 | Storm Water - Industrial Activity | Beaverhead River |
| Clark Canyon Hydro - Clark Canyon Dam Hydroelectric Facility | MTR104018 | Storm Water - Construction Activity | Beaverhead River |
| Dick Anderson - Dillon Wastewater Treatment Plant | MTR105067 | Storm Water - Construction Activity | Beaverhead River |
| RE Miller and Sons - Montana Center for Horsemanship | MTR104116 | Storm Water - Construction Activity | Beaverhead River and Blacktail Deer Creek |
| Tilstra Ranch | MTG010139 | Concentrated Animal Feeding Operation | Irrigation ditch to Beaverhead River |
| Coronado Resources - Madison Project (SW Mining) | MTR000558 | Storm Water - Industrial Activity | Tom Benton Gulch and Jefferson River |
| Twin Bridges Wastewater WWTF | MT0028797 | MPDES Individual Permit | Bayers irrigation ditch |

**Dillon WWTF (MT0021458) Point Source Discharge Assessment**

The City of Dillon WWTF discharges to the lower Beaverhead River 49.98 miles from the mouth and has a design flow of .750 million gallons per day (1.16 cfs). To evaluate the effects of temperature, an instantaneous thermal load (in kilocalories per second) can be calculated for the streamflow and WWTF discharge flows per **Equation 5-1** below. Note that this loading equation is applicable to water at a temperature greater than the freezing point of 32°F. The effects of the WWTF discharge can then be calculated by mixing the discharge water with the flow of the Beaverhead River under differing conditions.

To examine the effects of the Dillon WWTF on the Beaverhead River, temperature changes were calculated for two different examples; one on measured instream temperatures and the other on the modeled naturally occurring scenario. The first uses the average August 2004 temperature (61.92°F) measured by the temperature data logger at sampling site BRDM (Beaverhead River at Dillon, MT) upstream of the WWTF and is considered the measured existing conditions example. The second example uses the average naturally occurring scenario temperature (66.6°F) in model reach 12 (where BRDM is located) and is called the modeled naturally occurring scenario example. The temperature value from the naturally occurring scenario is greater than the current condition temperature value because the model was constructed to examine source effects on the period of the month with the warmest stream temperatures. Both examples use the measured maximum August (2010 – 2013) effluent temperature of 69.8°F (**Appendix D**) and effluent design discharge of 1.16 cfs from the WWTF and the measured average August 2005 Beaverhead River streamflow of 164 cfs (flow at station BRDM – **Appendix D**). **Equation 5-1** and a basic mixing equation were used to calculate the effects of the WWTF on instream temperatures in the Beaverhead River.

**Equation 5-1: Total Existing Load $_{(instantaneous)}$ = (($T_{meas}$) - 32)*(5/9) * Q * 28.3**

Where:

*$T_{meas}$ = measured or modeled existing water temperature (°F)*
*Q = streamflow (cfs)*
*28.3 = conversion factor*

**Measured Existing Conditions Example:**
For this example, the thermal load of the Beaverhead River at station BRDM was:

(61.92°F – 32) * (5/9) * 164 cfs * 28.3 = 77,147 kcal/s

The thermal load of the WWTF was:

(69.8°F – 32) * (5/9) * 1.16 cfs * 28.3 = 689 kcal/s

The total thermal load of the Beaverhead River below the WWTF would therefore be:

77,147 kcal/s + 689 kcal/s = 77,836 kcal/s

And the water temperature would be:

(9/5) * ((77,836 kcal/s) / (165.16 cfs * 28.3)) + 32 = 61.98°F

In this case, the WWTF causes an increase of 0.06°F (61.98°F – 61.92°F) in the temperature of the Beaverhead River.

**Modeled Naturally Occurring Scenario Example:**
For this example, the thermal load of the Beaverhead River at station BRDM was:

(66.6°F – 32) * (5/9) * 164 cfs * 28.3 = 89,214 kcal/s

The thermal load of the WWTF was:

(69.8°F – 32)*(5/9) * 1.16 cfs * 28.3 = 689 kcal/s

The total thermal load of the Beaverhead River below the WWTF would therefore be:

89,214 kcal/s + 689 kcal/s = 89,903 kcal/s

And the water temperature would be:

(9/5) * ((89,903 kcal/s) / (165.16 cfs * 28.3)) + 32 = 66.62°F

In this case, the WWTF causes an increase of 0.02°F (66.62°F – 66.6°F) in the temperature of the Beaverhead River. This value is well below the 0.5°F increase allowed by the standard at the naturally occurring average temperature of 66.6°F.

Because the Dillon WWTF discharges a small amount of effluent relative to the discharge of the Beaverhead River, it has a negligible effect on instream temperatures below the effluent discharge. Maintaining operation of this facility at current levels would appear to cause no significant increase in Beaverhead River temperatures.

## 5.6 Existing Conditions and Comparison to Targets – Lower Beaverhead and Upper Jefferson Rivers

This section includes a comparison of existing data with water quality targets, along with a TMDL development determination for the lower Beaverhead and upper Jefferson Rivers. QUAL2K model results will be compared to the allowable human-caused temperature change to determine if the target is being exceeded.

To evaluate whether attainment of temperature targets has been met, the existing water quality conditions in the lower Beaverhead and upper Jefferson River waterbody segments are compared to the conditions when water quality targets are met. This is done using the QUAL2K model and different scenarios that represent the implementation of all reasonable land, soil, and water conservation practices. This approach provides DEQ with updated impairment determinations used for TMDL development.

### 5.6.1 Lower Beaverhead River Existing Conditions and Comparison to Targets

The QUAL2K model results indicate that maximum naturally occurring summer temperatures ≥ 66.5°F occur at all Beaverhead River sites (**Figure 5-13**), which means that when water temperatures are the warmest, the allowed increase above the naturally occurring temperature is 0.5°F. Temperature differences between maximum temperatures under the baseline condition and the naturally occurring condition (**Section 5.5.1.2.4**) range from 0.0 to 3.7°F and average 1.3°F (**Figure 5-14**). The allowed increase is being exceeded at 75% of the sites on the Beaverhead River.

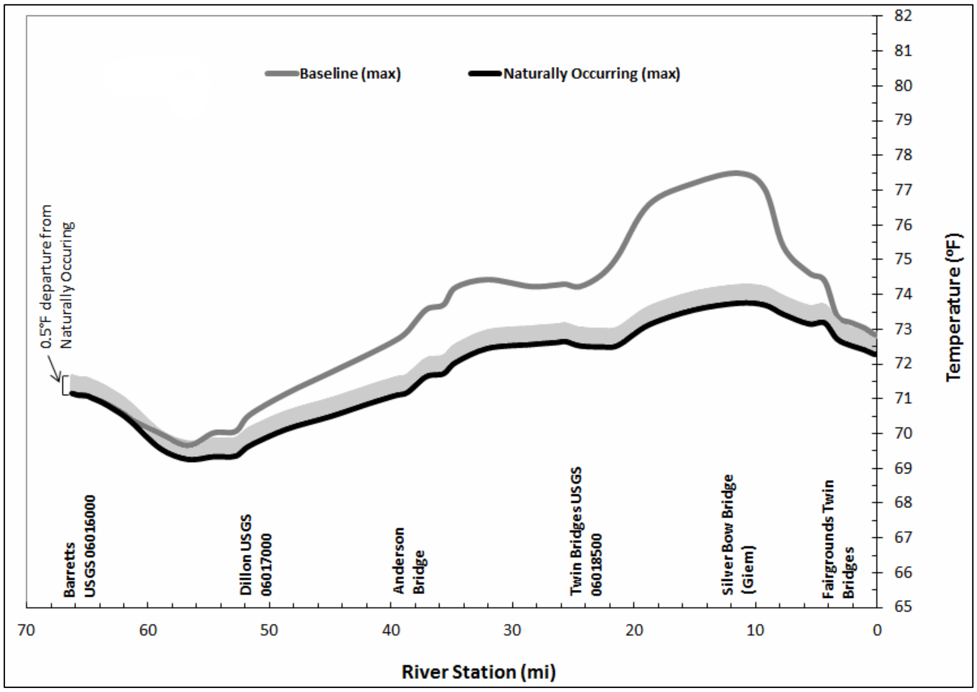



**Figure 5-13. Maximum temperatures for QUAL2K Baseline and Naturally Occurring scenarios**

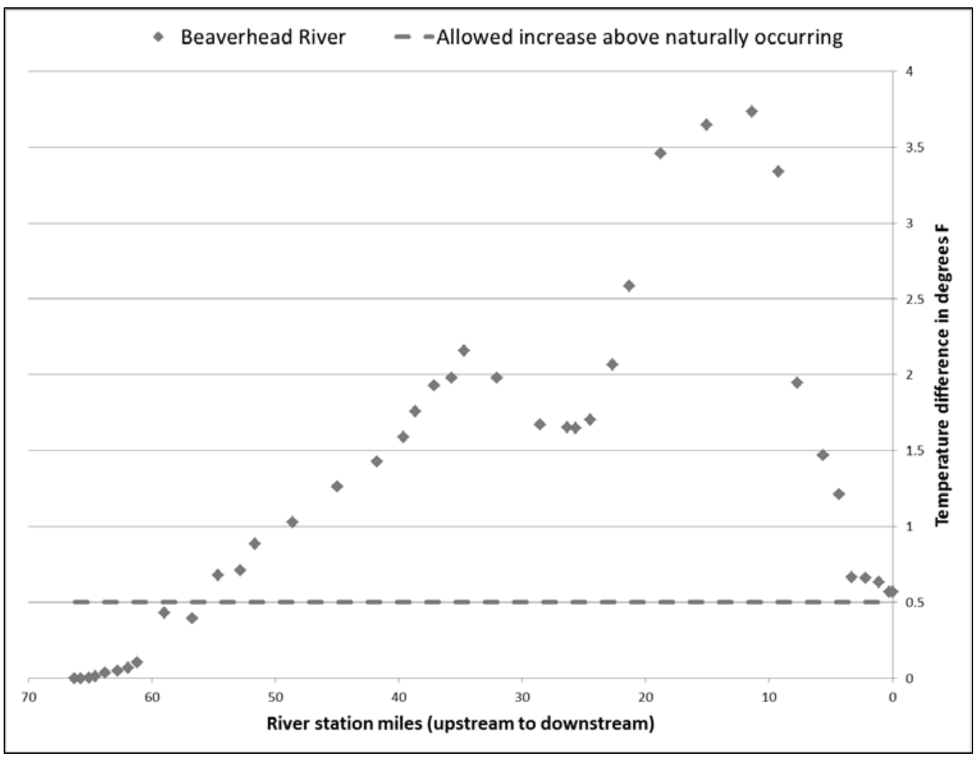



**Figure 5-14. Difference between the baseline (existing) condition and the naturally occurring condition (implementation of all reasonable land, soil and water conservation practices) maximum temperatures at river station miles on the Beaverhead River**

Aerial photographs were used to identify vegetation breakout reaches, determine the potential riparian vegetation condition for each reach, and determine the reference vegetation category for the

Beaverhead River. Sites were then analyzed in the field in a selected number of study reaches and average effective shade for those sites was assessed. About 20% of the vegetation along the Beaverhead River consists of dense willows, cottonwoods, and small conifers; all of which have effective shade at or above target levels. The other 80% of the river corridor consists of sparse willows, grasses, and sedges (**Table 5-6** and **Appendix B**). The estimated existing average daily effective shade for the Beaverhead River is 14%. For modeling purposes, the average of the results for sites in the dense willows category was then applied to those reaches that were not sampled and were not already at target conditions. Average daily effective shade for the dense willow vegetation classification is 22%.

As described in **Section 5.5.1.2.3.**, the 20% water savings for the increased flow scenario was based on grant proposals submitted by the East Bench Irrigation District regarding irrigation delivery improvements (**Table 5-6**). Based on model simulations, the 20% savings would result in an additional 117 cfs of water in the river and would lead to maximum reductions of 3°F between miles 10 and 20. This scenario indicates that reasonable irrigation delivery improvements can have a significant effect on the overall temperature regime in the river.

Point sources of thermal load to the Beaverhead River are required to meet temperature discharges that are consistent with the appropriate water quality standards. The City of Dillon WWTF (MT0021458) discharge is currently satisfying this target as evaluated in **Section 5.5.2 (Table 5-6)**.

**Table 5-6. Existing conditions and comparison to targets**

| Target Parameter | Existing Condition | Target Value |
|---|---|---|
| **Allowable Human-Caused Temperature Change** | Max Δ of 3.7°F | Δ of <0.5°F (under current maximum temperatures) |
| **Riparian Health - Shade** | 14% | 22% |
| **Instream flow (water use)** | Proposals for irrigation delivery improvement | 20% water savings kept in the Beaverhead River |
| **WWTF** | Δ of <0.05°F | Δ of <0.5°F |

**Summary and TMDL Development Determination**

The human-influenced allowable temperature change target is being exceeded in the Beaverhead River. The riparian vegetation is generally not meeting the shade target, which causes increases in temperature and although there have been proposals for instream flow improvement, the target of a 20% water savings has not yet been met. This information supports the existing impairment listing for the lower Beaverhead River. A temperature TMDL will be developed for this segment.

## 5.6.2 Upper Jefferson River Existing Conditions and Comparison to Targets

The QUAL2K model results indicate that maximum naturally occurring summer temperatures ≥ 66.5°F occur at all upper Jefferson River sites (**Figure 5-15**), which means that when water temperatures are the warmest, the allowed increase above the naturally occurring temperature is 0.5°F. Temperature differences between maximum temperatures under the baseline condition and the naturally occurring condition (**Section 5.5.2.2.4**) range from 0.3 to 7.9°F and average 1.93°F. The allowed increase is being exceeded at 99% of the modeled output locations on the upper Jefferson River (**Figure 5-16**).

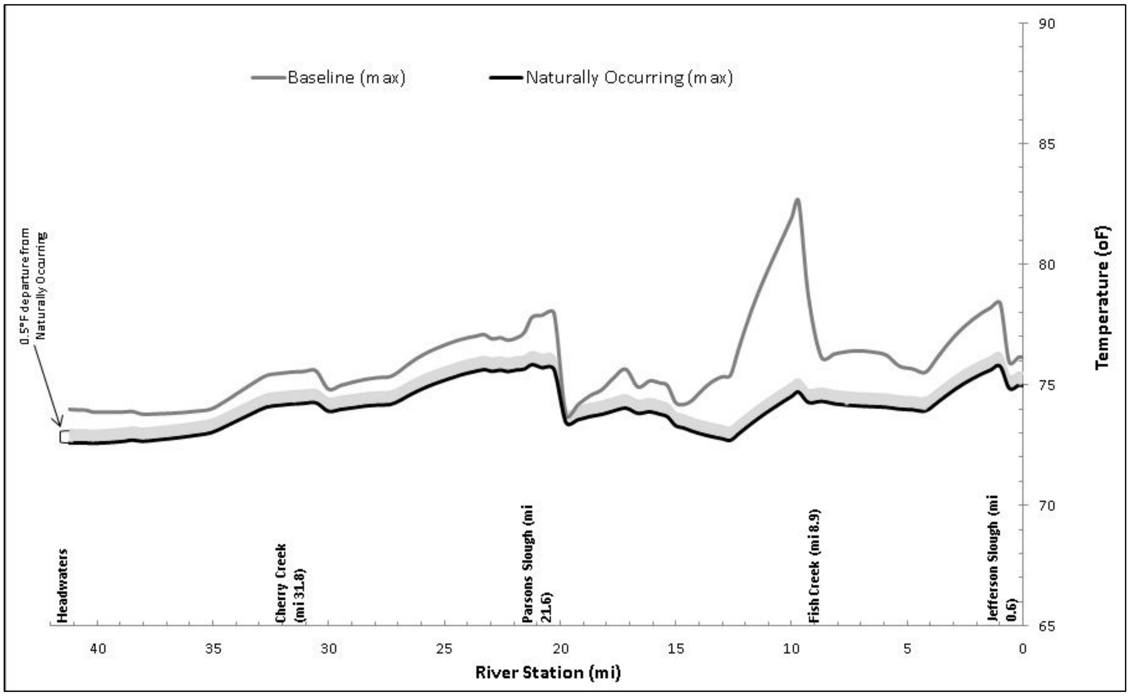



**Figure 5-15. Maximum temperatures for QUAL2K Baseline and Naturally Occurring scenarios**

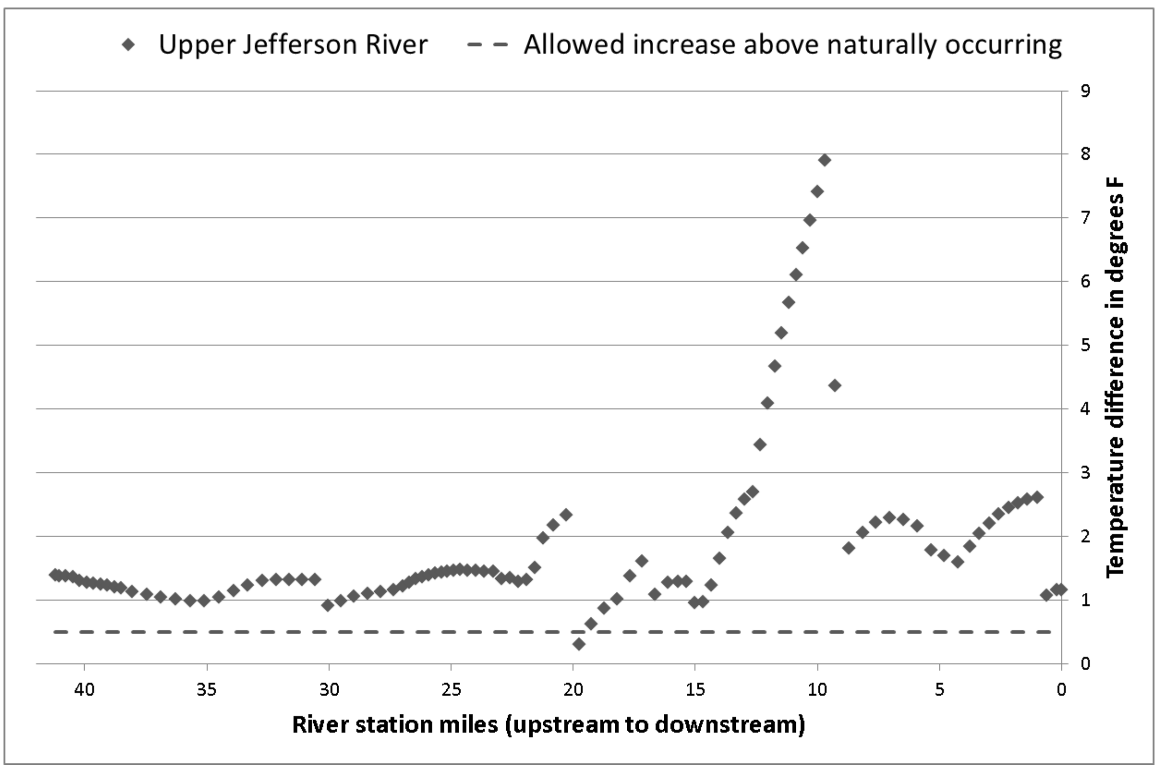



**Figure 5-16. Difference between the baseline (existing) condition and the naturally occurring condition (implementation of all reasonable land, soil and water conservation practices) maximum temperatures at river station miles on the upper Jefferson River.**

As described in **Section 5.5.2.2.2**, shade parameters were input into ShadeV3.xls at every kilometer and then all nodes within each model reach were averaged into a single average hourly value for the entire reach. The upper Jefferson River has varied vegetation conditions, and aerial photography and field reconnaissance did not show significant vegetation breaks. The estimated existing average daily effective shade for mixed low and high level vegetation is 15%. The upgrade from bare, native grass and irrigated grass to a mix of high and low level vegetation would lead to a maximum temperature reduction of 0.71°F. The target range for average daily effective shade is between 16% and 20% (**Table 5-7** and **Appendix C**).

As described in **Section 5.5.2.2.3.**, the 15% water savings for the increased flow scenario is based on private land owners' voluntary water restrictions during summer low flow conditions (and during drought conditions, as suggested in the Jefferson River drought management plan). According to the plan, when the river drops below 600 cfs, the JRWC encourages voluntary conservation measures by water users and awareness among anglers about stress on fish. When the streamflow drops below 280 cfs at the Twin Bridges gage, FWP will evaluate the need for mandatory fishing closures on the Jefferson. At this level irrigators and municipal water users will be asked to voluntarily reduce their water consumption, and weekly meetings will be coordinated by the JRWC with users to keep people informed and updated about the water flows so as to maintain a minimum of 50 cfs at the Waterloo gage. Fishing closures may remain in effect until the flow at Twin Bridges reaches or exceeds 300 cfs for seven consecutive days. Based on model simulations, a 15% savings would result in an average additional 54.4 cfs in the river and would lead to a maximum reduction of 7.42°F around mile 10. This scenario indicates that reasonable irrigation delivery improvements can have a significant effect on the overall temperature regime in the river.

The naturally occurring scenario includes a reduction in the thermal loads from the three headwaters of the Jefferson River (the Big Hole, Ruby, and Beaverhead Rivers). All three rivers have completed temperature models and the temperature targets for each river are presented below in **Table 5-7**. The Big Hole, Ruby, and Beaverhead Rivers are all currently exceeding target conditions at the mouth. Implementation of all reasonable land, soil, and water conservation practices in these three rivers would significantly reduce headwater temperatures coming into the upper Jefferson River (**Section 5.5.2.2.4)**.

**Table 5-7. Existing conditions and comparison to targets**

| Target Parameter | | Existing Condition | Target Value |
|---|---|---|---|
| **Allowable Human-Caused Temperature Change** | | Max Δ of 7.9°F | Δ of <0.5°F (under current maximum temperatures) |
| **Effective Shade** | | 15% | 16-20% |
| **Water Use** | | Drought management plan in place | 15% water savings kept in the upper Jefferson River |
| **HEADWATER TEMPERATURE** | **Ruby River** | 69.96°F (Tmax at mouth) | 66.70°F (Tmax at mouth) |
| | **Beaverhead River** | 72.86°F (Tmax at mouth)* | 72.29°F (Tmax at mouth) |
| | **Big Hole River** | 78.06°F (Tmax at mouth) | 77.00°F (Tmax at mouth) |

*Note that temperatures at the mouth of the Beaverhead are reduced from upstream temperatures near Giem bridge because of added flow from the Ruby River and Big Hole sloughs.

### Summary and TMDL Development Determination

The human-influenced allowable temperature change target is being exceeded in the upper Jefferson River. Riparian vegetation is not meeting the lower end of the shade target range. And, the upper Jefferson River continues to record declining flows during hot and dry summer conditions, even with the drought management plan that is in place calling for voluntary reductions in water use. This information supports the existing impairment listing for the upper Jefferson River. A temperature TMDL will be developed for this segment.

## 5.7 Temperature TMDLs and Allocations

Total maximum daily loads (TMDLs) are a measure of the maximum load of a pollutant a particular waterbody can receive and still maintain water quality standards (**Section 4.0**). A TMDL is the sum of wasteload allocations (WLAs) for point sources and load allocations (LAs) for nonpoint sources. A TMDL includes a margin of safety (MOS) to account for the uncertainty in the relationship between pollutant loads and the quality of the receiving stream. Allocations represent the distribution of allowable load applied to those factors that influence loading to the stream. In the case of temperature, thermal loading is assessed.

### 5.7.1 Temperature TMDL and Allocation Framework

Because stream temperatures change throughout the course of a day, the temperature TMDL is expressed as the instantaneous thermal load associated with the stream temperature when in compliance with Montana's water quality standards. As stated earlier, the temperature standard for the lower Beaverhead and upper Jefferson Rivers is defined as follows: The maximum allowable increase over the naturally occurring temperature is 1°F, when the naturally occurring temperature is less than 66°F. Within the naturally occurring temperature range of 66–66.5°F, the allowable increase cannot exceed 67°F. If the naturally occurring temperature is greater than 66.5°F, the maximum allowable increase is 0.5°F. Montana's temperature standard that applies to the lower Beaverhead and upper Jefferson Rivers, relative to naturally occurring temperatures, is depicted in **Figure 5-17**. As stated in **Section 5.5**, maximum daily temperatures in the lower Beaverhead and upper Jefferson Rivers during the baseline scenario are typically greater than 66.5°F, which means the allowable increase caused by human sources during the hottest part of the summer is typically 0.5°F for both rivers.

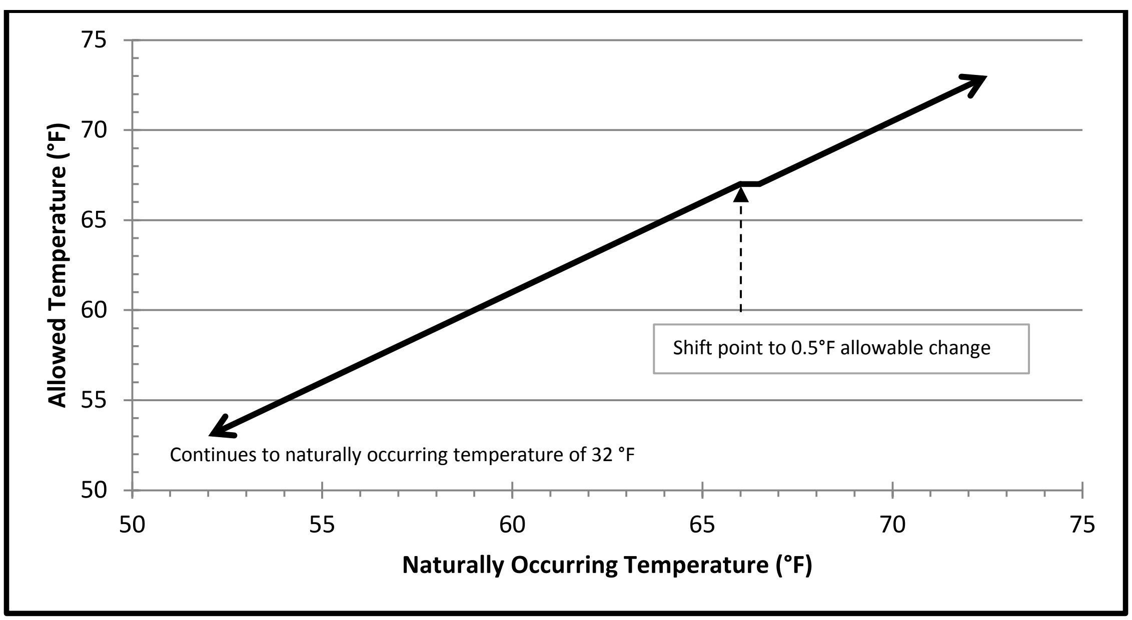



**Figure 5-17. Line graph of the temperature standard that applies to lower Beaverhead and upper Jefferson Rivers**

An instantaneous load is computed by the second and applied at all times. The allowed temperature can be calculated using Montana's B-1 classification standard and using a modeled, measured, or estimated naturally occurring instantaneous temperature. The allowable instantaneous total maximum load (per second) at any location in the waterbody is provided by **Equation 5-2**. This equates to the heat load (kcal/s) increase associated with the warming of the water from 32°F (i.e., water's freezing point) to the temperature that represents compliance with Montana's temperature standard, as determined from **Figure 5-17**.

**Equation 5-2: TMDL** $_{\text{(instantaneous)}}$ **=** $((T_{NO} + \Delta) - 32)*(5/9) * Q * 28.3$

Where:

*$T_{NO}$ = naturally occurring water temperature (°F)*
*Δ = allowable increase above naturally occurring temperature (°F)*
*Q = streamflow (cfs)*
*28.3 = conversion factor*

The instantaneous load is most appropriate expression for a temperature TMDL because water temperatures fluctuate throughout the day and an instantaneous load allows for evaluation of human - caused thermal loading during the daytime when fish are most distressed by elevated water temperatures and when human-caused thermal loading would have the most effect. Although Environmental Protection Agency (EPA) encourages TMDLs to be expressed in the most applicable timescale, it also requires TMDLs to be presented as daily loads (Grumbles, Benjamin, personal communication 2006). Any instantaneous TMDL calculated using **Equation 5-2**, which provides a load per second, can be converted to a daily load (kcal/day) by multiplying by 86,400 (which is the number of seconds in a day).

Because calculation of the TMDL on any timescale relies on the identification of the naturally occurring condition, which fluctuates over time and within a stream, it generally requires a water quality model. However, the shade, flow, point source, and headwater temperature targets that will be met when all reasonable land, soil, and water conservation practices are applied, and the water conservation efforts that fall under the definition of naturally occurring, are also measurable components of meeting the TMDLs and water quality standard. Meeting the targets described above and applying all reasonable water conservation measures, collectively provide an alternative method for meeting and evaluating the TMDL that more directly translates to implementation than an instantaneous or daily thermal load.

## 5.7.2 Temperature TMDL and Allocations for the lower Beaverhead River

The numeric temperature TMDL for the lower Beaverhead River is **Equation 5-2.** The load allocation to nonpoint sources is based on **Equation 5-3.** An explicit MOS will be based on the remaining temperature change allowed by the standard after the LA to nonpoint sources is calculated to meet the naturally occurring temperature and the WLAs are calculated based on the design flow (1.16 cfs) of the facilities and the maximum August temperature (69.8°F) of effluent discharge (2010 – 2013). The following example[2] TMDL for the lower Beaverhead River uses the average August flow (164 cfs) measured at station BRDM (at Dillon, MT above the WWTF **Appendix D**) and the modeled naturally occurring average

[2] The example TMDL provides a load for one point on the river using that specific point's flow and naturally occurring temperature as input to the equation. The load will vary at any given point on the river as flows and temperatures change. Therefore there is not one single, definitive, daily load to provide for the river segment; rather, we provide an example TMDL at a given point on the river using the TMDL equation.

temperature of 66.6°F at this same location. At this temperature, the allowable increase above the naturally occurring temperature is 0.5°F based on the water quality standard for temperature (ARM 17.30.624(e)).

**Equation 5-2** is the TMDL.

An example of how to calculate the TMDL at a given point on the river using the parameters described in the paragraph at the beginning of **Section 5.7.2** is provided below:

**TMDL (instantaneous) = ((66.6 + 0.5) - 32)*(5/9) * (164 + 1.16) * 28.3 = 91,144 kcal/s**

Converted to a daily load the TMDL is:

**TMDL = 91,144 kcal/s * 86,400 s/day = 7,874,802,374 kcal/day***
*resulting daily load is from unrounded instantaneous load

**Equation 5-3** is the load allocation.

***Equation 5-3: LA (instantaneous) = ($T_{NO}$ - 32)*(5/9) * Q * 28.3***

Where:

*$T_{NO}$ = naturally occurring water temperature (°F)*
*Q = streamflow (cfs)*
*28.3 = conversion factor*

An example of how to calculate a composite load allocation at a given point on the river using the same parameters as described above (naturally occurring temperature of 66.6°F and flow of 164 cfs (leaving out the discharges from the Dillon WWTF), is provided below:

**LA (instantaneous) = (66.6 - 32)*(5/9) * 164 * 28.3 = 89,214 kcal/s**

Converted to a daily load the LA is:

**LA = 89,214 kcal/s * 86,400 s/day = 7,708,104,960 kcal/day***
*resulting daily load is from unrounded instantaneous load

In the case of the Beaverhead River, the Dillon WWTF does not appear to have a significant effect on stream temperature (see **Sections 5.5.2**). The WLA for this discharger will be written based on the design flow of the facility (1.16 cfs) and a maximum recorded August effluent temperature (69.8°F) per **Equation 5-4**.

***Equation 5-4: WLA (instantaneous) = ($T_{max}$ - 32)*(5/9) * Q * 28.3***

Where:

*$T_{max}$ = maximum temperate of discharge (°F)*
*Q = design flow discharge in cubic feet per second*
*28.3 = conversion factor*

The WLA is:

$$\mathbf{WLA_{DILLONWWTF\ (instantaneous)} = (69.8 - 32)*(5/9) * 1.16 * 28.3 = 689\ kcal/s}$$

Converted to a daily load the WLA is:

$$\mathbf{WLA_{DILLONWWTF} = 689\ kcal/s * 86{,}400\ s/day = 59{,}563{,}123\ kcal/day^{*}}$$

*resulting daily load is from unrounded instantaneous load

Using **Equation 5-5,** the resulting explicit MOS for this example is:

***Equation 5-5: MOS** $_{(instantaneous)}$ **= TMDL - LA - WLA***

$$\mathbf{MOS_{(instantaneous)} = 91{,}144\ kcal/s - 89{,}214\ kcal/s - 689\ kcal/s = 1240\ kcal/s}$$

Converted to a daily load the MOS is:

$$\mathbf{MOS = 1240\ kcal/s * 86{,}400\ s/day = 107{,}134{,}291\ kcal/day^{*}}$$

*resulting daily load is from unrounded instantaneous load

The temperature TMDL, load allocation, wasteload allocation, and MOS (based on parameters at a given point on the river) are summarized in **Table 5-8**. The targets in **Section 5.4.3** (**Table 5-3**) serve as surrogates to the numeric allocations. Meeting these targets will result in meeting the numeric allocations under all conditions including the examples in **Table 5-8**. Implementation of BMPs is necessary to meet the water quality targets for temperature. The source assessment for the lower Beaverhead River indicates that the low instream flow during the time period of concern contributes the most human-caused temperature loading; load reductions should focus on potential improvements to irrigation delivery and efficiency through implementing reasonable BMPs. Meeting load allocations for the lower Beaverhead River may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

**Table 5-8. Lower Beaverhead River instantaneous and daily load allocations**

| Category | Temperature (°F) | Flow (cfs) | Temperature change from baseline (°F) | Allocation (instantaneous load in kcal/s) | Allocation (daily load in kcal/day) |
|---|---|---|---|---|---|
| Nonpoint sources and background (LA) | 66.60 | 164 | 0.00 | 89,214 | 7,708,104,960 |
| Dillon WWTF (WLA) | 69.80 | 1.16 | 0.02 | 689 | 59,563,123 |
| Explicit MOS | NA | NA | 0.48 | 1240 | 107,134,291 |
| Total | NA | 165.16 | 0.50 | 91,144** | 7,874,802,374** |

**These values reflect the TMDL expressed as instantaneous (kcal/s) and daily (kcal/day) loads

## 5.7.3 Temperature TMDL and Allocations for the upper Jefferson River

The numeric temperature TMDL for the upper Jefferson River is **Equation 5-2.** The load allocation to nonpoint sources is based on **Equation 5-3**. An explicit MOS of either 0.5 or 1.0 °F will be used in this waterbody segment depending on the naturally occurring temperature. The following example[3] TMDL for the upper Jefferson River uses a flow of 101 cfs, the modeled 7Q10 flow used in the baseline condition (**Appendix D**), just above Jefferson Slough (mile 0.79) between August 20-22 (the modeled time period) and the modeled naturally occurring average temperature of 67.53°F (just above Jefferson Slough at mile 0.79). At this temperature, the allowable increase above the naturally occurring temperature is 0.5°F based on the water quality standard for temperature (ARM 17.30.624(e)).

**Equation 5-2** is the TMDL.

An example of how to calculate the TMDL at a given point on the river using the parameters described in the paragraph at the beginning of **Section 5.7.3** is provided below:

$$\textbf{TMDL}_{\text{(instantaneous)}} = ((67.53 + 0.5) - 32)*(5/9) *101 * 28.3 = 57,214 \text{ kcal/s}$$

Converted to a daily load the TMDL is:

$$\textbf{TMDL} = 57,214 \text{ kcal/s} * 86,400 \text{ s/day} = 4,943,258,352 \text{ kcal/day}^{*}$$

*resulting daily load is from unrounded instantaneous load

**Equation 5-3** is the load allocation.

An example of how to calculate a composite load allocation at a given point on the river using the same parameters as described above (naturally occurring temperature of 67.53°F and flow of 101 cfs) is provided below:

$$\textbf{LA}_{\text{(instantaneous)}} = (67.53- 32)*(5/9) * 101 * 28.3 = 56,420 \text{ kcal/s}$$

Converted to a daily load the LA is:

$$\textbf{LA} = 56,420 \text{ kcal/s} * 86,400 \text{ s/day} = 4,874,659,152 \text{ kcal/day}^{*}$$

*resulting daily load is from unrounded instantaneous load

The resulting explicit MOS at 101 cfs is:

$$\textbf{MOS}_{\text{(instantaneous)}} = 57,214 \text{ kcal/s} – 56,420 \text{ kcal/s} = 794 \text{ kcal/s}$$

Converted to a daily load the MOS is:

$$\textbf{MOS} = 794 \text{ kcal/s} * 86,400 \text{ s/day} = 68,599,200 \text{ kcal/day}^{*}$$

*resulting daily load is from unrounded instantaneous load

The temperature TMDL, load allocation, and MOS (based on parameters at a given point on the river) are summarized in **Table 5-9**. The targets in **Section 5.4.3** (**Table 5-3**) serve as surrogates to the numeric

[3] The example TMDL provides a load for one point on the river using that specific point's flow and naturally occurring temperature as input to the equation. The load will vary at any given point on the river as flows and temperatures change. Therefore there is not one single, definitive, daily load to provide for the river segment; rather, we provide an example TMDL at a given point on the river using the TMDL equation.

allocations. Meeting these targets will result in meeting the numeric allocations under all conditions including the example in **Table 5-9**. Implementation of BMPs is necessary to meet the water quality targets for temperature. The source assessment for upper Jefferson River indicates that the low in streamflow during the time period of concern contributes the most human-caused temperature loading; load reductions should focus on potential improvements to irrigation delivery and efficiency through implementing reasonable BMPs. Meeting load allocations for the upper Jefferson River may be achieved through a variety of water quality planning and implementation actions and is addressed in **Section 7.0**.

**Table 5-9. Upper Jefferson River instantaneous and daily load allocations**

| Category | Temperature (°F) | Flow (cfs) | Temperature change from baseline (°F) | Allocation (instantaneous load in kcal/s) | Allocation (daily load in kcal/day) |
|---|---|---|---|---|---|
| Nonpoint sources and background (LA) | 67.53 | 101 | 0.00 | 56,420 | 4,874,659,152 |
| Explicit MOS | NA | NA | 0.50 | 794 | 68,599,200 |
| Total | NA | 101 | 0.50 | 57,214** | 4,943,258,352** |

**These values reflect the TMDL expressed as instantaneous (kcal/s) and daily (kcal/day) loads

### 5.7.4 Achieving Temperature Allocations

Improvement in riparian health needs significant time before changes can be seen. DEQ does not expect these targets to be met in the short-term; however, changes in land management practices would need to be implemented to meet goals for temperature in the lower Beaverhead and upper Jefferson Rivers. A commitment to those practices is necessary to maintain them. In addition, the targets and allocations presented represent the desired conditions that would be expected in most areas along a stream, but DEQ acknowledges that all sites may not be able to achieve them. The targets and allocations are not intended to be specific to every given point on the river; the intent, rather, is to achieve the TMDLs as a typical condition throughout the lower Beaverhead and upper Jefferson River segments. Note that some areas may also be able to achieve conditions greater than the targets, and the management should strive for the best possible condition given all reasonable land, soil, and water conservation practices in all circumstances.

## 5.8 Seasonality and Margin of Safety

Seasonality and margin of safety are both required elements of TMDL development. This section describes how seasonality and margin of safety (MOS) were applied during development of the lower Beaverhead and upper Jefferson temperature TMDLs.

Seasonality addresses the need to ensure year-round beneficial-use support. Seasonality is addressed for temperature in this TMDL document as follows:

- Temperature monitoring and modeling occurred during the summer, which is the warmest time of the year when instream temperatures are most stressful to aquatic life.
- Effective shade for the lower Beaverhead and upper Jefferson Rivers were based on the August solar path, which is typically the hottest month of the year.
- The maximum daily temperatures were used for the source assessment and impairment characterization because they are most likely to stress aquatic life; however, sources affecting maximum stream temperatures can also alter daily minimum temperatures year-round.

Addressing the sources causing elevated summer stream temperatures will also address sources that could lower the minimum temperature throughout the year.
- Temperature targets, the TMDL, and load allocations apply year round, but it is likely that exceedances occur mostly during summer conditions.

The MOS is included to account for uncertainties in pollutant sources and other watershed conditions, and ensure (to the degree practicable) that the TMDL components and requirements are sufficiently protective of water quality and beneficial uses. The MOS is addressed in several ways for temperature as part of this document:
- Although there is an allowable increase from human sources beyond those applying all reasonable land, soil, and water conservation practices, the surrogate allocations are expressed so human sources must apply all reasonable land, soil, and water conservation practices.
- Montana's water quality standards are applicable to any timeframe and any season. The temperature modeling analysis for the lower Beaverhead and upper Jefferson Rivers investigated stream temperatures during the summer, when effects of increased water temperatures are most likely to have a detrimental effect on aquatic life. Additionally, flow and climatic conditions were slightly adjusted for the upper Jefferson River from the sampling years to represent stream temperatures under more critical conditions than those observed in 2009.
- Compliance with targets and refinement of load allocations are all based on an adaptive management approach (**Section 5.9**) that relies on future monitoring and assessment for updating planning and implementation efforts.

## 5.9 Uncertainty and Adaptive Management

Uncertainties in the accuracy of field data, source assessments, water quality models, loading calculations, and other considerations are inherent when evaluating environmental variables for TMDL development. While uncertainties are an undeniable fact of TMDL development, mitigation and reduction of uncertainty through adaptive management approaches is a key component of ongoing TMDL implementation activities. Uncertainties, assumptions, and considerations are applied throughout this document and point to the need for refining analyses when needed.

The process of adaptive management is predicated on the premise that TMDLs, allocations, and their supporting analyses are not static, but are processes subject to periodic modification and adjustment as new information and relationships are better understood. As further monitoring and assessment is conducted, uncertainties with present assumptions and consideration may be mitigated via periodic revision or review of the assessment that occurred for this document. As part of the adaptive management approach, changes in land and water management that affect temperature should be tracked. As implementation of restoration projects that reduce thermal input, or as new sources that increase thermal loading arise, tracking should occur. Known changes in management should be the basis for building future monitoring plans to determine if the thermal conditions meet state standards.

Uncertainty was minimized during data collection because temperature and field data were collected following DEQ sampling protocols (Montana Department of Environmental Quality, 2005a; 2005b). A quality assurance project plan (QAPP) was also completed for the Jefferson and Beaverhead QUAL2K models, but there was more uncertainty associated with the model than with the field data because numerous assumptions had to be made to help simulate existing and naturally occurring conditions. Modeling assumptions are described in in **Appendices B and C.**

The TMDLs and allocations established in this section are meant to apply to recent conditions of natural background and natural disturbance. Under some periodic but extreme natural conditions, it may not be possible to satisfy all targets, loads, and allocations because of natural short term affects to temperature. The goal is to ensure that management activities are undertaken to achieve loading approximate to the TMDLs within a reasonable time frame and to prevent significant longer term excess loading during recovery from significant natural events.

Any influencing factors that increase water temperatures, including global climate change, could impact thermally sensitive fish species in Montana. The assessments and technical analysis for the temperature TMDLs considered a worst case scenario reflective of current weather conditions, which inherently accounts for any global climate change to date. Allocations to future changes in global climate are outside the scope of this project but could be considered during the adaptive management process if necessary.

Uncertainties in environmental assessments should not paralyze, but should point to the need for flexibility in our understanding of complex systems and to adjust our current thinking and future analysis. Implementation and monitoring recommendations presented in **Section 8.2** and **8.3** provide a basic framework for reducing uncertainty and further understanding of the complex issues TMDLs undertake.

# 6.0 NON-POLLUTANT IMPAIRMENTS

Water quality issues are not limited simply to those streams where total maximum daily loads (TMDLs) are developed. In some cases, streams have not yet been reviewed through the water quality assessment process and do not appear Montana's list of impaired waters, even though they may not be fully supporting all of their beneficial uses. In other cases, a stream may be listed as impaired, but does not require TMDL development because it is determined not to be impaired for a pollutant, but for a non-pollutant (TMDLs are only required for pollutant causes of impairment). Non-pollutant causes of impairment, such as "alteration in streamside or littoral vegetation covers," are often associated with temperature, sediment, or nutrient issues, but may be having a deleterious effect on a beneficial use without a clearly defined quantitative measurement or direct linkage to a pollutant.

Non-pollutant impairments have been recognized by Department of Environmental Quality (DEQ) as limiting their ability to fully support all beneficial uses and are important to consider when improving water quality conditions in both individual streams and watershed areas as a whole. **Table 6-1** shows the non-pollutant impairments in the lower Beaverhead and upper Jefferson Rivers on Montana's 2014 list of impaired waters. They are being summarized in this section to increase awareness of the non-pollutant impairment definitions and typical sources. Additionally, the restoration strategies discussed in **Section 7.0** inherently address some of the non-pollutant listings and many of the best management practices (BMPs) necessary to meet TMDLs will also address non-pollutant sources of impairment. As mentioned above, these impairment causes should be considered during planning of watershed scale restoration efforts.

**Table 6-1. Lower Beaverhead and Upper Jefferson Non-pollutant (Pollution) Listings on the 2014 303(d) List**

| Waterbody ID | Stream Segment | 2014 Probable Causes of Impairment |
|---|---|---|
| **Beaverhead River**, Grasshopper Creek to mouth (Jefferson River) | MT41B001_020 | Alteration in streamside or littoral vegetative covers |
| | | Low flow alterations |
| | | Physical substrate habitat alterations |
| **Jefferson River**, headwaters to confluence of Jefferson Slough | MT41G001_011 | Low flow alterations |
| | | Physical substrate habitat alterations |

## 6.1 NON-POLLUTANT CAUSES OF IMPAIRMENT DETERMINATION

Non-pollutant listings are often used as a probable cause of impairment when available data at the time of assessment does not necessarily provide a direct quantifiable linkage to a specific pollutant. In some cases the pollutant and non-pollutant categories are linked and appear together in the cause listings, however a non-pollutant category may appear independent of a pollutant listing. The following discussion provides some rationale for the application of the identified non-pollutant causes to a waterbody, and thereby provides additional insight into possible factors in need of additional investigation or remediation.

**Alteration in Streamside or Littoral Vegetation Covers**

Alteration in streamside or littoral vegetation covers refers to circumstances where practices along the stream channel have altered or removed riparian vegetation and subsequently affected channel geomorphology and/or stream temperature. This may include riparian vegetation removal for a road or utility corridor, effects of streamside mine tailings or placer mining remnants, or overgrazing by livestock along the stream. As a result of altering the streamside vegetation, destabilized banks from loss of vegetative root mass could lead to overwidened stream channel conditions and elevated sediment loads, in addition to elevated stream temperature from loss of canopy shade.

**Physical Substrate Habitat Alterations**
Physical substrate habitat alterations generally describe cases where the stream channel has been physically altered or manipulated, such as through the straightening of the channel or from human-influenced channel downcutting, resulting in a reduction of morphological complexity and loss of habitat (riffles and pools) for fish and aquatic life. For example, this may occur when a stream channel has been straightened to accommodate roads, agricultural fields, or through placer mine operations.

**Low Flow Alterations**
Streams are typically listed for low flow alterations when local water use management leads to flows that would not be typical under naturally occurring flow conditions. This could be related to irrigation practices, dam release operations, or even groundwater use that has subsequently altered stream recharge; which could result in dry channels or extreme low flow conditions harmful to fish and aquatic life.

It should be noted that while Montana law states that TMDLs cannot impact Montana water rights and thereby affect the allowable flows at various times of the year, the identification of low flow alterations or other flow regime alterations as a probable source of impairment does not violate any state or federal regulations or guidance related to stream assessment and beneficial use determination. Subsequent to the identification of this as a probable cause of impairment, it is up to local users, agencies, and entities to improve flows through water and land management.

## 6.2 Monitoring and BMPs for Non-Pollutant Affected Streams

In the lower Beaverhead River, two forms of habitat alteration (alteration in streamside or littoral vegetation covers and physical substrate habitat alterations) were linked to the sediment TMDL developed in 2012. The low flow alteration was also addressed in that 2012 document. It is likely that meeting those sediment targets will also equate to addressing the habitat impairment conditions in the lower Beaverhead River. For the upper Jefferson River, which has no developed sediment TMDL (but does have a sediment listing), applying the sediment targets from the Beaverhead River will likely begin to address the habitat impairment condition. Additionally, groundwater protection may be an effective measure to avoid complete dewatering and provide thermal refuge for aquatic life, especially throughout the Upper Jefferson River segment.

Streams listed for *non-pollutants* as opposed to a pollutant should not be overlooked when developing watershed management plans. Attempts should be made to collect sediment, nutrient, and temperature information where data is minimal and the linkage between probable cause, non-pollutant listing, and effects to the beneficial uses are not well defined. Watershed management planning should also include strategies to help increase streamflows, particularly during summer low flow periods for those streams with low flow alteration impairment causes. The monitoring and restoration strategies that follow in **Sections 7.0** and **8.0** are presented to address both pollutant and non-pollutant issues for streams in the lower Beaverhead and Upper Jefferson Rivers, and they are equally applicable to streams listed for the above non-pollutant categories.

# 7.0 Water Quality Improvement Plan

## 7.1 Purpose of Improvement Strategy

This section describes a general strategy and specific on-the-ground measures designed to restore water quality beneficial uses and attain water quality standards in the lower Beaverhead and upper Jefferson Rivers. The strategy includes general measures for reducing loading from each identified significant pollutant source.

This section should assist stakeholders in developing a watershed restoration plan (WRP) that will provide more detailed information about restoration goals within the watershed. The WRP may also encompass broader goals than the water quality improvement strategy outlined in this document. The intent of the WRP is to serve as a locally organized "road map" for watershed activities, prioritizing types of projects, sequences of projects, and funding sources towards achieving local watershed goals. Within the WRP, local stakeholders identify and prioritize streams, tasks, resources, and schedules for applying best management practices (BMPs). As restoration experiences and results are assessed through watershed monitoring, this strategy could be adapted and revised by stakeholders based on new information and ongoing improvements.

## 7.2 Role of DEQ, Other Agencies, and Stakeholders

The Montana Department of Environmental Quality (DEQ) does not implement total maximum daily load (TMDL) pollutant-reduction projects for nonpoint source activities, but may provide technical and financial assistance for stakeholders interested in improving their water quality by doing such activities. Successful implementation of TMDL pollutant-reduction projects requires collaboration among private landowners, land management agencies, and other stakeholders. DEQ will work with participants to use the TMDLs as a basis for developing locally-driven WRPs, administer funding specifically to help support water quality improvement and pollution prevention projects, and help identify other sources of funding.

Because most nonpoint source reductions rely on voluntary measures, it is important that local landowners, watershed organizations, and resource managers work collaboratively with local and state agencies to achieve water quality restoration goals and to meet TMDL targets and load reductions. Specific stakeholders and agencies that will likely be vital to restoration efforts for streams discussed in this document include:

- Beaverhead Watershed Committee
- Jefferson River Watershed Council
- Beaverhead Conservation District
- Ruby Valley Conservation District
- Jefferson Valley Conservation District
- Water Users on the Beaverhead River (East Bench Irrigation District, Clark Canyon Water Supply Company, and Others)
- Water Users on the Jefferson River (Jefferson Canal Co., Fish Creek Ditch, and Others)
- Natural Resources and Conservation Service (NRCS)
- U.S. Fish & Wildlife Service (USFWS)
- U.S. Environmental Protection Agency (EPA)

- Montana Department of Natural Resources and Conservation (DNRC)
- Montana Fish, Wildlife and Parks (FWP)
- Montana Department of Environmental Quality (DEQ)
- Bureau of Reclamation (BOR)
- Montana Trout Unlimited
- U.S. Army Corp of Engineers
- Montana Department of Transportation
- Montana Bureau of Mines and Geology
- Montana Water Center (at Montana State University)
- University of Montana Watershed Health Clinic
- Montana Aquatic Resources Services
- Montana State University Extension Water Quality Program

## 7.3 Water Quality Restoration Objectives

The water quality restoration objective for the lower Beaverhead and upper Jefferson Rivers is to reduce pollutant loads as identified throughout this document in order to meet the water quality standards and TMDL targets for full recovery of beneficial uses for all impaired streams. Meeting the TMDLs provided in this document will achieve this objective for both temperature impaired river segments. Based on the assessment provided in this document, the TMDLs can be achieved through proper implementation of appropriate BMPs.

A WRP can provide a framework strategy for water quality restoration and monitoring, focusing on how to meet conditions that will likely achieve the TMDLs presented in this document, as well as other water quality issues of interest to local communities and stakeholders. WRPs identify considerations that should be addressed during TMDL implementation and should assist stakeholders in developing a more detailed adaptive plan in the future. A locally developed WRP will provide more detailed information about restoration goals and spatial considerations but may also encompass broader goals than this framework includes. A WRP would serve as a locally organized “road map” for watershed activities, sequences of projects, prioritizing of projects, and funding sources for achieving local watershed goals, including water quality improvements. The WRP is intended to be a living document that can be revised based on new information related to restoration effectiveness, monitoring results, and stakeholder priorities.

The EPA requires nine minimum elements for a WRP. A complete description can be found at http://www.epa.gov/region9/water/nonpoint/9elements-WtrshdPlan-EpaHndbk.pdf and are summarized here:

1. Identification of the causes and sources of pollutants
2. Estimated load reductions expected based on implemented management measures
3. Description of needed nonpoint source management measures
4. Estimate of the amounts of technical and financial assistance needed
5. An information/education component
6. Schedule for implementing the nonpoint source management measures
7. Description of interim, measurable milestones
8. Set of criteria that can be used to determine whether loading reductions are being achieved over time
9. A monitoring component to evaluate effectiveness of the implementation efforts over time

This document provides, or can serve as an outline, for many of the required elements. Water quality goals for temperature are detailed in **Section 5.0**. These goals include water quality and habitat targets as measures for long-term effectiveness monitoring. These targets specify satisfactory conditions to ensure protection and/or recovery of beneficial uses of waterbodies in the lower Beaverhead and upper Jefferson Rivers. It is presumed that meeting all water quality and habitat targets will achieve the water quality goals for each impaired waterbody. **Section 8.0** identifies a general monitoring strategy and recommendations to track post-implementation water quality conditions and measure restoration successes.

## 7.4 Overview of Management Recommendations

A temperature TMDL was completed for both the lower Beaverhead and upper Jefferson Rivers in this document. A temperature TMDL was written for the Big Hole River (Kron et al., 2009) and for the Ruby River (Montana Department of Environmental Quality, Planning, Prevention and Assistance Division, Water Quality Planning Bureau, 2006), among TMDLs for other EPA-approved TMDLs in those watersheds. Eighteen sediment TMDLs were approved in the Beaverhead watershed in 2012. Seven sediment TMDLs were approved for tributaries in the upper Jefferson watershed in 2006. The Beaverhead, Ruby, and Upper Jefferson watersheds all have additional listed waterbody-pollutant combinations that are in need of TMDLs or re-assessment. Other streams in the project areas may be in need of restoration or pollutant reduction, but insufficient information about them precludes TMDL development at this time. The following sub-sections describe some generalized recommendations for implementing projects to achieve the TMDLs. Details specific to each river and therefore which of the following strategies may be most appropriate, are found within **Section 5.0.**

In general, restoration activities can be separated into two categories: active and passive. Passive restoration allows natural succession to occur within an ecosystem by removing a source of disturbance. Fencing off riparian areas from cattle grazing is a good example of passive restoration. Active restoration, on the other hand involves accelerating natural processes or changing the trajectory of succession. For example, historic placer mining often resulted in the straightening of stream channels and piling of processed rock on the streambank. These impacts would take so long to recover passively that active restoration methods involving removal of waste rock and rerouting of the stream channel would likely be necessary to improve stream and water quality conditions. In general, passive restoration is preferable for sediment, temperature, and nutrient problems because it is generally more cost effective, less labor intensive, and will not result in short term increase of pollutant loads as active restoration activities may. However, in some cases active restoration is the only feasible mechanism for achieving desired goals; these activities must be assessed on a case by case basis (Nature Education, 2013).

### 7.4.1 Temperature Restoration Approach

The goal of the temperature restoration approach is to reduce water temperatures where possible to be consistent with naturally occurring conditions. The most significant mechanism for reducing water temperatures in the lower Beaverhead and Upper Jefferson Rivers is using water conservation measures to maximize water left in the stream. Other factors that will help are: increasing riparian shade, improving overwidened portions of the stream, working with reservoir operations, groundwater protection, tributary flow enhancement, creating seasonal flow objectives, and maintaining conditions where theses creeks are currently meeting the targets. Identification of water sources with relatively high water temperature could also result in developing a prioritized project list of inflows that elevate water temperature.

Increasing instream summer flows can be achieved through a thorough investigation of water use practices and water conveyance infrastructure, and a willingness and ability of local water users to keep more water instream. This TMDL document cannot, nor is it intended to, prescribe limitations on individual water rights owners and users. However, it is understood that increased summer instream flows could improve summer water temperatures, and in addition improve quality and connectivity among instream features used by aquatic life. Local water users should work collectively and with local, state, and federal resource management professionals to review water use options and available assistance programs to create seasonal flow objectives.

Increase in shade can be accomplished through the restoration and protection of shade-providing vegetation within the riparian corridor. This type of vegetation can also have the added benefit of serving as a stabilizing component to streambanks to reduce bank erosion, slow lateral river migration, and buffer pollutants from upland sources from entering the stream. In some cases, this can be achieved by limiting activities in the riparian area (such as grazing, near stream cropping, development, and other near stream activities) or through application of BMPs for those activites. Other areas may require planting, active bank restoration, and protection to establish vegetation.

Recovery of stream channel morphology in most cases will occur slowly over time following the improvement of riparian condition, stabilization of streambanks, and reduction in overall sediment load.

The above approaches give only the broadest description of activities to help reduce water temperatures. The temperature assessment described in **Section 5.0** looked at possible scenarios based on limited information at the watershed scale. Those scenarios showed that improvements in stream temperatures can primarily be made by increasing instream flow during summer months. It is strongly encouraged that resource managers and land owners continue to work to identify all potential areas of improvement and develop projects and practices to reduce stream temperatures in the lower Beaverhead and upper Jefferson Rivers.

### 7.4.2 Non-Pollutant Restoration Approach

Although TMDL development is not required for non-pollutant listings, they are frequently linked to pollutants, and addressing non-pollutant causes, such as flow and habitat alterations, is an important component of TMDL implementation. Non-pollutant listings within the lower Beaverhead and upper Jefferson Rivers are described in **Section 6.0**. Typically, habitat impairments are addressed during implementation of associated pollutant TMDLs. Therefore, if restoration goals within the two rivers are not also addressing non-pollutant impairments, additional non-pollutant related BMP implementation should be considered.

## 7.5 Restoration Approaches by Source

General management recommendations are outlined below for the major sources of human caused pollutant loads in the lower Beaverhead and upper Jefferson Rivers: riparian and wetland vegetation removal, agricultural sources, and residential development. Applying BMPs is the core of the nonpoint source pollutant reduction strategy, but BMPs are only part of a watershed restoration strategy. For each major source, BMPs will be most effective as part of a comprehensive management strategy. The WRP developed by local watershed groups should contain more detailed information on restoration goals and specific management recommendations that may be required to address key pollutant sources. BMPs are usually identified as a first effort and further monitoring and evaluation of activities and outcomes, as part of an adaptive management approach will be used to determine if further restoration approaches are necessary to achieve water quality standards. Monitoring is an important part of the restoration process, and monitoring recommendations are outlined in **Section 8.0**.

### 7.5.1 Riparian Areas, Wetlands, and Floodplains

Healthy and functioning riparian areas, wetlands, and floodplains are critical for wildlife habitat, groundwater recharge, reducing the severity of floods and upland and streambank erosion, and filtering pollutants from runoff. The performance of the above named functions is dependent on the connectivity of riparian areas, wetlands, and floodplains to both the stream channel and upland areas. Human activities affecting the quality of these transitional habitats or their connectivity can alter their performance and greatly affect the transport of water, sediments, and contaminants (e.g., channelization, increased stream power, bank erosion, and habitat loss or degradation). Therefore, restoring, maintaining, and protecting riparian areas, wetlands, and floodplains within the watershed should be a priority of TMDL implementation in the lower Beaverhead and upper Jefferson Rivers.

Reduction of riparian and wetland vegetative cover by various land management activities is a principal cause of water quality and habitat degradation in watersheds throughout Montana. Although implementation of passive BMPs that allow riparian and wetland vegetation to recover at natural rates is typically the most cost-effective approach, active restoration (i.e., plantings) may be necessary in some instances. The primary advantage of riparian and wetland plantings is that installation can be accomplished with minimum impact to the stream channel, existing vegetation, and private property.

Factors influencing the appropriate riparian and wetland restoration would include severity of degradation, site-potential for various species, and availability of local sources for native transplant materials. In general, riparian and wetland plantings would promote establishment of functioning stands of native species. The following recommended restoration measures would allow for stabilization of the soil, decrease sediment delivery to the stream, and increase absorption of nutrients from overland runoff:

- Harvesting and transplanting locally available sod mats with an existing dense root mass provides immediate promotion of bank stability and filtering nutrients and sediments
- Seeding with native graminoids (grasses and sedges) and forbs is a low cost activity at locations where lower bank shear stresses would be unlikely to cause erosion
- Willow sprigging expedites vegetative recovery, but involves harvest of dormant willow stakes from local sources
- Transplanting mature native shrubs, particularly willows (*Salix* sp.), provides rapid restoration of instream habitat and water quality through overhead cover and stream shading, as well as uptake of nutrients

***Note***: Before transplanting *Salix* from one location to another it is important to determine the exact species so that we do not propagate the spread of non-native species. There are several non-native willow species that are similar to our native species and commonly present in Montana watersheds.

In addition to the benefits described above, it should be noted that in some cases, wetlands act as areas of shallow subsurface groundwater recharge and/or storage areas. The captured water via wetlands is then generally discharged to the stream later in the season and contributes to the maintenance of base flows and stream temperatures. Restoring ditched or drained wetlands can have a substantial effect on the quantity, temperature, and timing of water returning to a stream, as well as the pollutant filtering capacity that improved riparian and wetlands provide.

## 7.5.2 Agriculture

The main agricultural BMP recommendations for the lower Beaverhead and upper Jefferson Rivers focus on maintaining riparian shade through grazing and cropland BMPs; and also through improving instream flow through irrigation management.

### *7.5.2.1 Grazing*

Grazing has the potential to increase temperatures by altering channel width and riparian vegetation, but these effects can be mitigated with appropriate management. Development of riparian grazing management plans should be a goal for any landowner who operates livestock and does not currently have such plans. Private land owners may be assisted by state, county, federal, and local conservation groups to establish and implement appropriate grazing management plans. Riparian grazing management does not necessarily eliminate all grazing in riparian corridors. In some areas however, a more limited management strategy may be necessary for a period of time in order to accelerate reestablishment of a riparian community with the most desirable species composition and structure.

Every livestock grazing operation should have a grazing management plan. The NRCS Prescribed Grazing Conservation Practice Standard (Code 528) recommends the plan include the following elements (Natural Resources Conservation Service, 2010):

- A map of the operation showing fields, riparian and wetland areas, winter feeding areas, water sources, animal shelters, etc.
- The number and type of livestock
- Realistic estimates of forage needs and forage availability
- The size and productivity of each grazing unit (pasture/field/allotment)
- The duration and time of grazing
- Practices that will prevent overgrazing and allow for appropriate regrowth
- Practices that will protect riparian and wetland areas and associated water quality
- Procedures for monitoring forage use on an ongoing basis
- Development plan for off-site watering areas

Reducing grazing pressure in riparian and wetland areas and improving forage stand health are the two keys to preventing nonpoint source pollution from grazing. Grazing operations should use some or all of the following practices:

- Minimizing or preventing livestock grazing in riparian and wetland areas
- Providing off-stream watering facilities or using low-impact water gaps to prevent ‘loafing’ in wet areas
- Managing riparian pastures separately from upland pastures
- Installing salt licks, feeding stations, and shelter fences in areas that prevent ‘loafing’ in riparian areas and help distribute animals
- Replanting trodden down banks and riparian and wetland areas with native vegetation (this should always be coupled with a reduction in grazing pressure)
- Rotational grazing or intensive pasture management that takes season, frequency, and duration into consideration

The following resources provide guidance to help prevent pollution and maximize productivity from grazing operations:

- United States Department of Agriculture (USDA), Natural Resources Conservation Service Offices serving Beaverhead, Jefferson, and Madison Counties are located in Dillon, Whitehall, and Sheridan (find your local USDA Agricultural Service Center listed in your phone directory or on the Internet at www.nrcs.usda.gov )
- Montana State University Extension Service (www.extn.msu.montana.edu)
- DEQ Watershed Protection Section (Nonpoint Source Program): Nonpoint Source Management Plan (http://deq.mt.gov/wqinfo/nonpoint/NonpointSourceProgram.mcpx)

The key strategy of the recommended grazing BMPs is to develop and maintain healthy riparian and wetland vegetation and minimize disturbance of the streambank and channel. The primary recommended BMPs for the lower Beaverhead and upper Jefferson Rivers are limiting livestock access to streams and stabilizing the stream at access points, providing off-site watering sources when and where appropriate, planting native stabilizing vegetation along streambanks, and establishing and maintaining riparian buffers. Although bank revegetation is a preferred BMP, in some instances bank stabilization may be necessary prior to planting vegetation.

### *7.5.2.2 Flow and Irrigation*

Flow alteration and dewatering are commonly considered water quantity rather than water quality issues. However, changes to streamflow can have a profound effect on the ability of a stream to flush sediment and attenuate other pollutants, especially nutrients, metals, and heat. Flow reduction may increase water temperature, reduce available habitat for fish and other aquatic life, and may cause the channel to respond by changing in size, morphology, meander pattern, rate of migration, bed elevation, bed material composition, floodplain morphology, and streamside vegetation if flood flows are reduced (Andrews and Nankervis, 1995; Schmidt and Potyondy, 2004). Restoration targets and implementation strategies recognize the need for specific flow regimes, and may suggest flow-related improvements as a means to achieve full support of water quality beneficial uses. However, local coordination and planning are especially important for flow management because state law indicates that legally obtained water rights cannot be divested, impaired, or diminished by Montana's water quality law (Montana Code Annotated (MCA) 75-5-705).

Irrigation management is a critical component of attaining both coldwater fishery conservation and TMDL goals. Understanding irrigation water, groundwater, and surface water interactions is an important part of understanding how irrigation practices will affect streamflow during specific seasons.

Some irrigation practices in western Montana are based on flood irrigation methods. Occasionally head gates and ditches leak, which can decrease the amount of water in diversion flows. The following recommended activities could potentially result in notable water savings:

- Install upgraded head gates for more exact control of diversion flow and to minimize leakage when not in operation
- Develop more efficient means to supply water to livestock
- Determine necessary diversion flows and timeframes that would reduce over watering and improve forage quality and production
- Where appropriate, redesign or reconfigure irrigation systems
- Upgrade ditches (including possible lining, if appropriate) to increase ditch conveyance efficiency

Some water from spring and early summer flood irrigation likely returns as cool groundwater to the streams during the heat of the summer. These critical areas could be identified so that they can be preserved as flood irrigation areas. Other irrigated areas which do not contribute to summer groundwater returns to the river should be identified as areas where year round irrigation efficiencies could be more beneficial than seasonal management practices. Winter baseflow should also be considered during these investigations.

## 7.5.3 Residential/Urban Development

There are multiple sources and pathways of pollution to consider in residential and urban areas. Destruction of riparian areas and stormwater generated from impervious areas and construction sites are discussed below.

### *7.5.3.1 Riparian Degradation*

Residential development adjacent to streams can affect the amount and health of riparian vegetation, the amount of large woody debris available in the stream, and might result in placement of riprap on streambanks (see **Section 7.5.4**). As discussed in the above section on riparian areas, wetlands, and floodplains, substantially degraded riparian areas can affect channel width and shade and do not effectively filter pollutants from upland runoff. Riparian areas that have been converted to lawns or small acreage pastures for domestic livestock may suffer from increased contributions of nutrients, sediment, and bacteria, as well as increased summer stream temperatures, increased channel erosion, and greater damage to property from flooding.

For landowners, conservation easements can be a viable alternative to subdividing land and can be facilitated through several organizations such as The Nature Conservancy, the Trust for Public Land, and FWP. Further information on conservation easements and other landowner programs can be obtained from FWP (http://fwp.mt.gov/fishAndWildlife/habitat/wildlife/programs/landownersGuide.html).

DEQ encourages the consideration of adopting local zoning or regulations that protect the functions of floodplains and riparian and wetland areas where future growth may occur. Requirements for protecting native vegetation riparian buffers can be an effective mechanism for maintaining or improving stream health. Local outreach activities to inform new residential property owners of the effects of riparian degradation may also prevent such activities from occurring, including providing information on: appropriate fertilizer application rates to lawns and gardens, regular septic system maintenance, preserving existing riparian vegetation, native vegetation for landscaping, maintaining a buffer to protect riparian and wetland areas, and practices to reduce the amount of stormwater originating from developed property. Montana's Nonpoint Source Management Plan contains suggested BMPs to address the effects of residential and urban development, and also contains an appendix of setback regulations that have been adopted by various cities and counties in Montana (Montana Department of Environmental Quality, 2012c). Planning guides and informational publications related to wetlands and native plant species in Montana can be found on DEQ's Wetlands Conservation website at: http://deq.mt.gov/wqinfo/Wetlands/default.mcpx.

### *7.5.3.2 Stormwater*

Where precipitation from rain or snowmelt events does not infiltrate soils in urban areas and at construction sites, it drains off the landscape as stormwater, which can potentially increase base temperatures of the receiving waterbody (and can carry pollutants as well). As the percentage of impervious surfaces (e.g., streets, parking lots, roofs) increases, so does the volume of stormwater and pollutant loads delivered to waterbodies. Although stormwater is not currently identified as a significant source of pollutant contributions for the two rivers discussed in this document, stormwater management could be a consideration when identifying water quality improvement objectives within the watershed restoration plan. The primary method to control stormwater discharges is the use of BMPs. Additional information can be found in Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, 2012c). A guide to stormwater BMPs can be found on EPA's National Menu of Stormwater Best Management Practices at: http://cfpub.epa.gov/npdes/stormwater/menuofbmps/index.cfm. The Montana Water Center also has a website dedicated to stormwater control for construction activities: http://stormwater.montana.edu/.

## 7.6 Potential Funding and Technical Assistance Sources

Prioritization and funding of restoration or water quality improvement projects is integral to maintaining restoration activities and monitoring project successes and failures. Several government agencies and also a few non-governmental organizations fund or can provide assistance with watershed or water quality improvement projects or wetlands restoration projects. Below is a brief summary of potential funding sources and organizations to assist with TMDL implementation.

### 7.6.1 Section 319 Nonpoint Source Grant Program

DEQ issues a call for proposals every year to award Section 319 grant funds administered under the federal Clean Water Act. The primary goal of the 319 program is to restore water quality in waterbodies whose beneficial uses are impaired by nonpoint source pollution and whose water quality does not meet state standards. 319 funds are distributed competitively to support the most effective and highest priority projects. In order to receive funding, projects must directly implement a DEQ-accepted watershed restoration plan and funds may either be used for the education and outreach component of the WRP or for implementing restoration projects. The recommended range for 319 funds per project proposal is $10,000 to $30,000 for education and outreach activities and $50,000 to $300,000 for implementation projects. All funding has a 40% cost share requirement, and projects must be administered through a governmental entity such as a conservation district or county, or a nonprofit organization. For information about past grant awards and how to apply, please visit http://deq.mt.gov/wqinfo/nonpoint/319GrantInfo.mcpx.

### 7.6.2 Future Fisheries Improvement Program

The Future Fisheries grant program is administered by FWP and offers funding for projects that focus on habitat restoration to benefit wild and native fish. Anyone ranging from a landowner or community-based group to a state or local agency is eligible to apply. Applications are reviewed annually in December and June. Projects that may be applicable to the lower Beaverhead and upper Jefferson watersheds include restoring streambanks, improving fish passage, and restoring/protecting spawning habitats. For additional information about the program and how to apply, please visit http://fwp.mt.gov/fishAndWildlife/habitat/fish/futureFisheries/.

### 7.6.3 Watershed Planning and Assistance Grants

The DNRC administers Watershed Planning and Assistance Grants to watershed groups that are sponsored by a conservation district. Funding is capped at $10,000 per project and the application cycle is quarterly. The grant focuses on locally developed watershed planning activities; eligible activities include developing a watershed plan, group coordination costs, data collection, and educational activities. For additional information about the program and how to apply, please visit http://dnrc.mt.gov/cardd/LoansGrants/WatershedPlanningAssistance.asp.

Numerous other funding opportunities exist for addressing nonpoint source pollution. Additional information regarding funding opportunities from state agencies is contained in Montana's Nonpoint Source Management Plan (Montana Department of Environmental Quality, 2012c) and information regarding additional funding opportunities can be found at http://www.epa.gov/nps/funding.html.

### 7.6.4 Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) is administered by NRCS and offers financial (i.e., incentive payments and cost-share grants) and technical assistance to farmers and ranchers to help plan and implement conservation practices that improve soil, water, air and other natural resources on their land. The program is based on the concept of balancing agricultural production and forest management with environmental quality, and is also used to help producers meet environmental regulations. EQIP offers contracts with a minimum length of one year after project implementation to a maximum of 10 years. Each county receives an annual EQIP allocation and applications are accepted continually during the year; payments may not exceed $300,000 within a six-year period. For additional information about the program and how to apply, please visit http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/.

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

The Resource Indemnity Trust / Reclamation and Development Grants Program (RIT/RDG) is an annual program administered by DNRC that can provide up to $300,000 to address environmental related issues. RIT/RDG program funds can be used for conducting site assessment/characterization activities such as identifying specific sources of water quality impairment. RIT/RDG projects typically need to be administered through a non-profit or local government such as a conservation district, a watershed planning group, or a county. For additional information about the program and how to apply, please visit: http://dnrc.mt.gov/cardd/ResourceDevelopment/rdgp/ReclamationDevelopmentGrantsProgram.asp .

### 7.6.6 Montana Partners for Fish and Wildlife

Montana Partners for Fish and Wildlife is a program under the U.S. Fish & Wildlife Service that assists private landowners to restore wetlands and riparian habitat by offering technical and financial assistance. For additional information about the program and to find your local contact for the Beaverhead and Jefferson watersheds, please visit: http://www.fws.gov/mountain-prairie/pfw/montana/.

### 7.6.7 Wetlands Reserve Program

The Wetlands Reserve Program is a voluntary conservation program administered by the NRCS that offers landowners the means to restore, enhance, and protect wetlands on their property through permanent easements, 30 year easements, or Land Treatment Contracts. The NRCS seeks sites on agricultural land where former wetlands have been drained, altered, or manipulated by human. The landowner must be interested in restoring the wetland and subsequently protecting the restored site. For additional information about the program and how to apply, please visit http://www.nrcs.usda.gov/wps/portal/nrcs/main/mt/programs/easements/wetlands/

### 7.6.8 Montana Wetland Council

The Montana Wetland Council is an active network of diverse interests that works cooperatively to conserve and restore Montana's wetland and riparian ecosystems. Please visit their website to find dates and locations of upcoming meetings, wetland program contacts, and additional information on potential grants and funding opportunities: http://deq.mt.gov/wqinfo/wetlands/wetlandscouncil.mcpx.

### 7.6.9 Montana Natural Heritage Program

The Montana Natural Heritage Program is a valuable resource for restoration and implementation information including maps. Wetlands and riparian areas are one of the 14 themes in the Montana Spatial Data Infrastructure. The Montana Wetland and Riparian Mapping Center (found at: http://mtnhp.org/nwi/) is creating a statewide digital wetland and riparian layer as a resource for management, planning, and restoration efforts.

### 7.6.10 Montana Aquatic Resources Services, Inc.

Montana Aquatic Resources Services, Inc. (MARS) is a nonprofit organization focused on restoring and protecting Montana's rivers, streams and wetlands. MARS identifies and implements stream, lake, and wetland restoration projects, collaborating with private landowners, local watershed groups and conservation districts, state and federal agencies, and tribes. For additional information about the program, please visit http://montanaaquaticresources.org/.

# 8.0 Monitoring Strategy and Adaptive Management

## 8.1 Monitoring Purpose

The monitoring strategies discussed in this section are an important component of watershed restoration, and a requirement of total maximum daily load (TMDL) implementation under the Montana Water Quality Act (Montana Code Annotated (MCA) 75-5-703(7)), and the foundation of the adaptive management approach. Water quality targets and allocations presented in this document are based on available data at the time of analysis. The scale of the watershed analysis, coupled with constraints on time and resources, often result in necessary compromises that include estimations, extrapolation, and a level of uncertainty in TMDLs. The margin of safety (MOS) is put in place to reflect some of this uncertainty, but other issues only become apparent when restoration strategies are underway. Having a monitoring strategy in place allows for feedback on the effectiveness of restoration activities, the amount of reduction of instream pollutants (whether TMDL targets are being met), if all significant sources have been identified, and whether attainment of TMDL targets is feasible. Data from long-term monitoring programs also provide technical justifications to modify restoration strategies, targets, or allocations where appropriate.

The monitoring strategy presented in this section provides a starting point for the development of more detailed planning efforts regarding monitoring needs; it does not assign monitoring responsibility. Monitoring recommendations provided are intended to assist local land managers, stakeholder groups, and federal and state agencies in developing appropriate monitoring plans to meet the water quality improvement goals outlined in this document. Funding for future monitoring is uncertain and can vary with economic and political changes. Prioritizing monitoring activities depends on funding opportunities and stakeholder priorities for restoration. Once restoration measures have been implemented for a waterbody with an approved TMDL and given time to take effect, Department of Environmental Quality (DEQ) will conduct a formal evaluation of the waterbody's impairment status and determine whether TMDL targets and water quality standards are being met.

## 8.2 Adaptive Management and Uncertainty

In accordance with the Montana Water Quality Act (MCA 75-5-703 (7) and (9)), DEQ is required to assess the waters for which TMDLs have been completed and restoration measures, or best management practices (BMPs), have been applied to determine whether compliance with water quality standards has been attained. This aligns with an adaptive management approach that is incorporated into DEQ's assessment and water quality impairment determination process.

Adaptive management as discussed throughout this document is a systematic approach for improving resource management by learning from management outcomes, and allows for flexible decision making. There is an inherent amount of uncertainty involved in the TMDL process, including: establishing water quality targets, calculating existing pollutant loads and necessary load allocations, and determining effects of BMP implementation. Use of an adaptive management approach based on continued monitoring of project implementation helps manage resource commitments and achieve success in meeting the water quality standards and supporting all water quality beneficial uses. This approach further allows for adjustments to restoration goals, TMDLs, and/or allocations, as necessary.

For an in-depth look at the adaptive management approach, view the U.S. Department of the Interior's (DOI) technical guide and description of the process at: http://www.doi.gov/archive/initiatives/AdaptiveManagement/. DOI includes **Figure 8-1** below in their technical guide as a visual explanation of the iterative process of adaptive management (Williams et al., 2009).

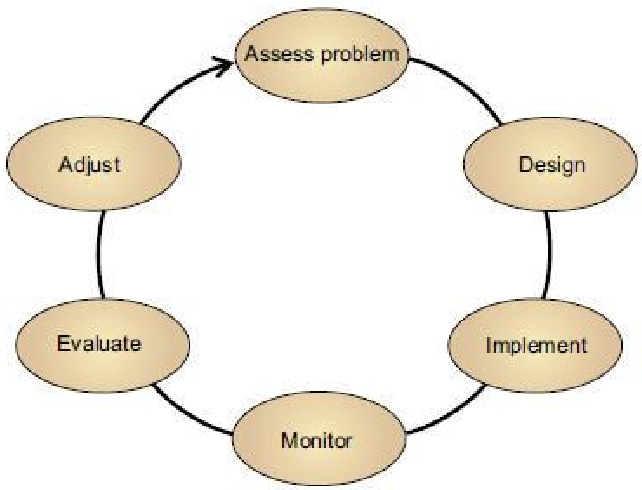



**Figure 8-1. Diagram of the adaptive management process**

## 8.3 Future Monitoring Guidance

The objectives for future monitoring in the lower Beaverhead and upper Jefferson Rivers include:

- Strengthen the spatial understanding of sources for future restoration work, which will also improve source assessment analysis for future TMDL review
- Gather additional data to supplement target analysis, better characterize existing conditions, and improve or refine assumptions made in TMDL development
- Gather consistent information among agencies and watershed groups that is comparable to the established water quality targets and allow for common threads in discussion and analysis
- Expand the understanding of streams and nonpoint source pollutant loading throughout the project area beyond those where TMDLs have been developed and address issues
- Track restoration projects as they are implemented and assess their effectiveness

### 8.3.1 Strengthening Source Assessment

In the lower Beaverhead and upper Jefferson Rivers, the identification of pollutant sources was conducted largely through tours of the watershed, assessments of aerial photographs, the incorporation of geographic information system information, reviewing and analyzing available data, and the review of published scientific studies. In many cases, assumptions were made based on known watershed conditions and extrapolated throughout the project area. As a result, the level of detail often does not provide specific areas on which to focus restoration efforts, only broad source categories to reduce pollutant loads from both of the river segments. Strategies for strengthening source assessments for temperature are outlined below:

- Field surveys to better identify and characterize riparian area conditions and potential for improvement
- Identification of possible areas for improvement in shading along the river corridor, major tributaries, and headwater streams
- Investigation of groundwater influence on instream temperatures, and relationships between groundwater availability and water use
- Assessment of irrigation practices and other water use in and potential for improvements in water use that would result in increased instream flows
- Use of additional collected data to evaluate and refine the temperature targets

### 8.3.2 Increasing Available Data

While the lower Beaverhead and upper Jefferson Rivers have been studied and monitored over the years, data are still often limited depending on the pollutant of interest. Infrequent sampling events at a small number of sampling sites may provide some indication of overall water quality and habitat condition. However, regularly scheduled sampling at consistent locations, under a variety of seasonal conditions is the best way to assess overall stream health and monitor change. Increasing the number of data logger locations and the number of years of data, including collection of associated flow and shade data, would improve our understanding of instream temperature changes and better identify influencing factors on those changes. Collecting additional stream temperature data in sections with the most significant temperature changes and/or largest spatial gaps between loggers will also help refine the characterization of temperature conditions.

### 8.3.3 Consistent Data Collection and Methodologies

Data has been collected throughout the lower Beaverhead and upper Jefferson Rivers for many years and by many different agencies and entities; however, the type and quality of information is often variable. Wherever possible, it is recommended that the type of data and methodologies used to collect and analyze the information be consistent so as to allow for comparison to TMDL targets and track progress toward meeting TMDL goals.

DEQ is the lead agency for developing and conducting impairment status monitoring; however, other agencies or entities may work closely with DEQ to provide compatible data. Water quality impairment determinations are made by DEQ, but data collected by other sources can be used in the impairment determination process. The information in this section provides general guidance for future impairment status monitoring and effectiveness tracking. Future monitoring efforts should consult DEQ on updated monitoring protocols. Improved communication between agencies and stakeholders will further improve accurate and efficient data collection.

It is important to note that monitoring recommendations are based on TMDL related efforts to protect water quality beneficial uses in a manner consistent with Montana’s water quality standards. Other regulatory programs with water quality protection responsibilities may impose additional requirements to ensure full compliance with all appropriate local, state, and federal laws.

Data loggers should be deployed at the same locations through the years to accurately represent the site-specific conditions over time, and recorded temperatures should at a minimum represent the hottest part of the summer when aquatic life is most sensitive to warmer temperatures. Data loggers should be deployed in the same manner at each location and during each sampling event, and follow a consistent process for calibration and installation. Any modeling that is used should refer to previous modeling efforts (such as the QUAL2K analysis used in this document) for consistency in model development to ensure comparability. In addition, flow measurements should also be conducted using consistent locations and methodology.

### 8.3.4 Effectiveness Monitoring for Restoration Activities

As restoration activities are implemented, monitoring is valuable to determine if restoration activities are improving water quality, instream flow, and aquatic habitat and communities. Monitoring can help attribute water quality improvements to restoration activities and ensure that restoration activities are functioning effectively. Restoration projects will often require additional maintenance after initial implementation to ensure functionality. It is important to remember that degradation of aquatic resources happens over many decades and that restoration is often also a long-term process. An efficiently executed long-term monitoring effort is an essential component to any restoration effort.

Due to the natural high variability in water quality conditions, trends in water quality are difficult to define and even more difficult to relate directly to restoration or other changes in management. Improvements in water quality or aquatic habitat from restoration activities will most likely be evident in changes in channel cumulative width/depths, improvements in bank stability and riparian habitat, increases in instream flow, and changes in communities and distribution of fish and other bio-indicators. Specific monitoring methods, priorities, and locations will depend heavily on the type of restoration projects implemented, landscape or other natural setting, the land use influences specific to potential monitoring sites, and budget and time constraints.

As restoration activities begin throughout the project area, pre and post monitoring to understand the change that follows implementation will be necessary to track the effectiveness of specific projects. Monitoring activities should be selected such that they directly investigate those subjects that the project is intended to effect, and when possible, linked to targets and allocations in the TMDL.

### 8.3.5 Watershed Wide Analyses

Recommendations for monitoring in the lower Beaverhead and upper Jefferson Rivers should not be confined to only those streams addressed within this document. The water quality targets presented in this document are applicable to all streams in the watershed, and the absence of a stream from the state’s impaired waters list does not necessarily imply that the stream fully supports all beneficial uses. Furthermore, as conditions change over time and land management changes, consistent data collection methods throughout the watershed will allow resource professionals to identify problems as they occur, and to track improvements over time.

# 9.0 Stakeholder and Public Participation

Stakeholder and public involvement is a component of total maximum daily load (TMDL) planning supported by Environmental Protection Agency (EPA) guidelines and required by Montana state law (Montana Code Annotated (MCA) 75-5-703, 75-5-704) which directs Department of Environmental Quality (DEQ) to consult with watershed advisory groups and local conservation districts during the TMDL development process. Technical advisors, stakeholders and interested parties, state and federal agencies, interest groups, and the public were solicited to participate in differing capacities throughout the TMDL development process in the lower Beaverhead and upper Jefferson Rivers.

## 9.1 Participants and Roles

Throughout completion of the lower Beaverhead and upper Jefferson TMDLs, DEQ worked to keep stakeholders apprised of project status and solicited input from a TMDL advisory group. A description of the participants in the development of the TMDLs in the Thompson Project Area and their roles is contained below.

**Montana Department of Environmental Quality**
Montana state law (MCA 75-5-703) directs DEQ to develop all necessary TMDLs. DEQ has provided resources toward completion of these TMDLs in terms of staff, funding, internal planning, data collection, technical assessments, document development, and stakeholder communication and coordination. DEQ has worked with other state and federal agencies to gather data and conduct technical assessments. DEQ has also partnered with watershed organizations to collect data and coordinate local outreach activities for this project.

**United States Environmental Protection Agency**
EPA is the federal agency responsible for administering and coordinating requirements of the Clean Water Act (CWA). Section 303(d) of the CWA directs states to develop TMDLs (see **Section 1.1**), and EPA has developed guidance and programs to assist states in that regard. EPA has provided funding and technical assistance to Montana's overall TMDL program and is responsible for final TMDL approval.

**Conservation Districts**
The lower Beaverhead and upper Jefferson Rivers fall within Beaverhead, Madison, Silverbow, and Jefferson counties. DEQ provided both the Conservation Districts with consultation opportunity during development of TMDLs. This included opportunities to provide comment during the various stages of TMDL development, and an opportunity for participation in the advisory group discussed below.

**TMDL Advisory Group**
The Beaverhead and Jefferson TMDL Advisory Groups consisted of selected resource professionals who possess a familiarity with water quality issues and processes in the lower Beaverhead and upper Jefferson Rivers, and also representatives of applicable interest groups. All members were solicited to participate in an advisory capacity per Montana state law (75-5-703 and 704). DEQ requested participation from the interest groups defined in MCA 75-5-704 and included municipalities and county representatives; livestock-oriented and farming-oriented agriculture representatives; timber and mining industry representatives; watershed groups; state and federal land management agencies, tribal representatives; and representatives of fishing-related business, recreation, and tourism interests. The

advisory groups also include additional stakeholders with an interest in maintaining and improving water quality and riparian resources.

Advisory group involvement was voluntary and the level of involvement was at the discretion of the individual members. Members had the opportunity to provide comment and review of technical TMDL assessments and reports and to attend meetings organized by DEQ for the purpose of soliciting feedback on project planning. Typically, draft documents were released to the advisory group for review under a limited timeframe, and their comments were then compiled and evaluated. Final technical decisions regarding document modifications resided with DEQ.

Communications with the group members was typically conducted through e-mail and draft documents were made available through DEQ's wiki for TMDL projects (http://montanatmdlflathead.pbworks.com). Opportunities for review and comment were provided for participants at varying stages of TMDL development, including opportunity for review of the draft TMDL document prior to the public comment period.

## 9.2 Response To Public Comments

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

The formal public comment period for the Lower Beaverhead River and Upper Jefferson River Temperature TMDLS was initiated on July 9, 2014 and ended on August 7, 2014. DEQ held two public meetings; the first in Dillon, MT on July 15, 2014 and the second in Whitehall on July 17, 2014. At these two meetings, DEQ provided an overview of the TMDLS, made copies of the document available to the public, and solicited public input and comment on the document. The announcement for those meetings was distributed among the Watershed Advisory Groups and advertised in the following newspapers: the Montana Standard, the Dillon Tribune, and the Whitehall Ledger. This section includes DEQ's response to all public comments received during the public comment period.

Formal written comments were received from two organizations. DEQ evaluates all comments and related information to ensure no critical information was excluded from the document. Excerpts of the public comment letters are provided below. The original comment letters are located in the project files at DEQ and may be reviewed upon request. The response prepared by DEQ follows the comment.

### 9.2.1 Public Comment Letter 1

**Comment 1.1**:

<u>Summary</u>

The undersigned are pleased to see the breadth and intensity of scientific diligence conducted in drafting the instant TMDLs. Extensive modeling and site-specific data was used to document existing, baseline, and target TMDL project area conditions. On the whole, we agree with and support the science used in modeling and estimating needed reductions in water segment temperatures in order for the Lower Beaverhead and Upper Jefferson to meet their designated and existing uses.

However, we are concerned that the draft TMDLs fail to provide adequate Margins of Safety or Reasonable Assurances that additional, needed reductions will actually be achieved.

**Response 1.1**:
Thank you for taking the time to review and comment on the Lower Beaverhead River and Upper Jefferson River Temperature TMDLs. We are pleased that you agree with and support the science used in modeling and estimating needed reductions in the Lower Beaverhead and Upper Jefferson Rivers. **Section 4.4** describes reasonable assurance. In regard to how reductions will be achieved, please see response 1.3.

**Comment 1.2:**
Specific Concerns
On the whole, the two river segments for which Temperature TMDLs have been prepared evidence the need for extensive riparian buffers and land use improvement, as well as the need to improve seasonal flow. In both the Lower Beaverhead and Upper Jefferson, DEQ analyses made clear that, depending on the relevant river segment, riparian improvements may or may not result in significant improvements and conversely, that increases in river flow would almost always result in temperature improvements.

From the 30,000' perspective, we are concerned that the Lower Beaverhead TMDL shows that the allowable temperature standard is being exceeded at 75% of all sites. Apparently only 20% of existing riparian vegetation meets or exceeds needed target levels (and conversely 80% fails to approach necessary targets). Statistical analysis in the TMDL points to the inescapable conclusion that the best manner by which temperature may be decreased in the Lower Beaverhead is via water efficiency/higher flows, where maximum flow increases could result in a maximum benefit of 3% temperature reduction.

Similarly, but even more disturbing, is the data proffered that shows that 99% of the Upper Jefferson is exceeding its target temperature condition. Data there, similar to the Lower Beaverhead, shows that improvements in riparian vegetation will be even less effective in meeting temperature goals (maximum of a .71% reduction for total implementation of riparian BMPs), while water savings BMPs would optimally result in a maximum of a 7.42% reduction in temperature.

On the whole we agree with the science supporting these findings of needed reductions. However, when it comes time to explain how those reductions are realized, DEQ's draft document relies on an inscrutable, mathematically complex and, in a bizarre twist, TMDLs called "example" TMDLs.[4]

**Response 1.1**:
In respect to your first comment regarding the use of example TMDLs in the document, your footnote alludes to the fact that an equation is the TMDL, which is correct. This is stated in **Section 5.7.1** and shown in **Equation 1** below. The example TMDL provides a load for one point on the river using that specific point's flow and naturally occurring temperature as input to the equation. The load will vary at any given point on the river as flows and temperatures change. Therefore there is not one single, definitive, daily load to provide for the river segment; rather, we provide an example TMDL at a given point on the river using the TMDL equation. In order to avoid confusion to other stakeholders regarding the language of an "example TMDL", clarifying language has been added in the document (see **Sections 5.7.2** and **5.7.3**).

[4] Anecdotally, we've never encountered a TMDL named an "example" TMDL. Whereas there is no other equation providing Load Allocations, Waste Load Allocations and Margin of Safety in the draft document, we are forced to assume that those equations are in reality the basis by which the DEQ is rationalizing its TMDLs. We encourage DEQ to clarify its nomenclature and confirm that those equations in **Section 5-34** et seq. are indeed the salient, required TMDLs.

An instantaneous load is computed and applied at all times. The allowed temperature can be calculated using Montana's B-1 classification standard and using a modeled, measured, or estimated naturally occurring instantaneous temperature. The allowable instantaneous total maximum load (per second) at any location in the waterbody is provided by **Equation 1**. This equates to the heat load (kcal/s) increase associated with the warming of the water from 32°F (i.e., water's freezing point) to the temperature that represents compliance with Montana's temperature standard.

**Equation 1:** $\mathbf{TMDL_{(instantaneous)} = ((T_{NO} + \Delta) - 32)*(5/9) * Q * 28.3}$

Where:

*$T_{NO}$ = naturally occurring water temperature (°F)*
*$\Delta$ = allowable increase above naturally occurring temperature (°F)*
*Q = streamflow (cfs)*
*28.3 = conversion factor*

**Comment 1.3:**
Specific Concerns (cont.)
These TMDLs' load allocations (LAs) and margins of safety (MOS) are respectively huge, and strain credulity as one reads that all improvements relied upon to achieve necessary reductions are voluntary. In fact, the TMDL relies 100% on voluntary efforts to achieve needed reductions, particularly in terms of the only means that the TMDL document shows has the capacity to make a significant improvement in decreasing temperature violations, e.g. increasing flow.

Therein lies our concern: TMDLs with complete reliance on voluntary, future actions to achieve necessary reductions do not possess sufficient reasonable assurances that load reductions will occur to satisfy water quality standards.

While we understand that DEQ is not statutorily given full authority over non point source management, it and other, partner agencies do possess authority to ratchet down certain controls on land uses which the TMDL documents admits directly affect riverine temperature (e.g. grazing, E&S controls, buffers, etc.) Therefore it is incumbent on DEQ to think outside the box and consider what actions it and partner agencies or authorities may take to enforce the intent of the TMDLs. It is unconscionable and, as experience has shown often unrealistic to rely, on nonbinding, unenforceable mandates to achieve water quality mandates.

We strongly encourage the DEQ to revise the Lower Beaverhead/Upper Jefferson Draft TMDL to incorporate some measure of accountability in lieu of the present, completely voluntary approach.

**Response 1.3:**
Regarding comments on ensuring that riparian and water quantity goals are met instream, the department supports a voluntary program, per State law (75-5-703, MCA), of reasonable land, soil, and water conservation practices to achieve compliance with water quality standards for nonpoint source (NPS) activities for water bodies that are subject to a TMDL. Because local irrigation management and any subsequent flow alterations are not regulated point sources and there are essentially no applicable

nonpoint source regulations for these temperature TMDL's[5], they fall under the nonpoint source program and any subsequent water savings by local stakeholders is realized on a voluntary basis.

However, DEQ does provide technical and financial support to local stakeholders to help carry out these best management practices. DEQ recommends a voluntary approach to water savings, as water quality assessments may not divest, impair, or diminish any water right recognized pursuant to Title 85, according to State law (75-5-705, MCA). DEQ encourages and supports the efforts of local watershed groups and conservation districts to develop Watershed Restoration Plans (WRPs) to achieve these objectives. DEQ will implement TMDLs by providing staff support and providing (where possible) Section 319 funding of the Clean Water Act to those local watershed efforts that pursue NPS controls by developing their own WRPs and using adaptive management strategies. Watershed Restoration Plans can be viewed as a locally developed "road map," complete with identified priority areas and/or activities, as well as timelines for achieving milestones.

### 9.2.2 Public Comment Letter 2

**Comment 2.1:**
Page 2-2
The map on this page does not include the USGS gage for the Beaverhead at Twin Bridges. This site was added in recent years to better understand inflows from sloughs and springs originating from the Big Hole and Ruby Watersheds.

**Response 2.1:**
Site was added to **Figure 2-2**, **Table 2-1**, and **Figure 5-2**.

**Comment 2.2:**
Page 2-2 (cont)
Clarification of whether the TMDL analysis for the Beaverhead River practically evaluates conditions at the mouth (including numerous diffuse water sources from the Ruby and Big Hole) or the Beaverhead upstream of the Ruby and other water sources would help the reader understand the situation more accurately.

**Response 2.2:**
**Table B3-1** in **Appendix B**, *Beaverhead River Temperature Model*, displays locations of sampling sites for flow and temperature on the Beaverhead River, tributaries, and diversions (including several return flows from the Big Hole River). The DEQ agrees that conditions at the lower end of the impaired segment are complex. The model used the existing calibrated data to estimate what is happening at any given point on the river. Therefore, even though an in-depth study was not performed on irrigation and groundwater return flow, the model does use the existing data along the lower stretch of the Beaverhead River along with monitored irrigation return flow to interpret general conditions of the segment, which is appropriate for the scope of the TMDL.

**Comment 2.3:**
Page 2-4

[5] DEQ's voluntary approach is in recognition that there are some regulatory requirements for nonpoint sources. For example, the streamside management zone (SMZ) law provides important riparian protection from commercial timber harvest in forested watersheds, although that particular law has little potential impact for the temperature TMDLs within this document.

The draft discusses flow recovery in early fall related to storms and precipitation. We believe it is important to briefly discuss the relative contribution of reduced irrigation demand, and perhaps more importantly, timing of irrigation return flows related to flow recovery in late summer/early fall. Quantitative data is likely insufficient to provide detailed trends, but more discussion of seasonal irrigation returns related to water temperature might be informative.

**Response 2.3:**
A very general description of late season irrigation return flows was added to **Section 2.1.2**.

**Comment 2.4:**
Page 2-5
Impoundments. Although a basic description of impoundments was provided, management of impoundments offer a significant opportunity to influence streamflow and water temperature in a watershed. Two examples of impoundment management to address flow and temperature issues are Painted Rocks Reservoir on the Bitterroot River and Hebgen Lake on the Madison River. For example, Painted Rocks water was purchased for flow and temperature enhancement and pulsed releases from Hebgen are used to reduce water temperature in the lower Madison River. In addition, contrasting Ruby Reservoir management with operation of Clark Canyon Reservoir may offer future management examples that may help improve summer flow and temperature issues.

**Response 2.4:**
The DEQ agrees that reservoir management in conjunction with irrigation management from water users may help improve summer flow and temperature issues, and has outlined this as a suggestion for meeting targets in **Section 5.4.2.3** and as part of the temperature restoration approach in implementation in **Section 7.4.1**.

**Comment 2.5:**
Section 5.2.1
Fish Species information is provided, but some detailed reports may also be good references to include in this document. For example, FWP's instream flow recommendation document contains detailed information for recommending desirable streamflow using the wetted perimeter methodology in the Beaverhead and Jefferson Rivers. In addition, an evaluation of fish/streamflow relationships for the Jefferson River is available in a 2008 report. A Jefferson River invertebrate study conducted in 1979 and repeated in recent years provides information related to water temperature and streamflow effects on the aquatic invertebrate community. We believe these types of data have potential to make the TMDL document more effective and we would be happy to provide this information to you.

**Response 2.5:**
These references were added into **Section 5.2.1** and the 2008 report was added as an attachment to the TMDL.

**Comment 2.6:**
Page 5-32
The table showing maximum temperature of the Ruby, Beaverhead and Big Hole has the potential to be misleading. Beaverhead at mouth presumably includes a variety of inflows from sloughs and springs below the Ruby River, which could give the impression that the Beaverhead has cooler water than the Big Hole. Comparing the Beaverhead above the Ruby to the Big Hole probably provides a more accurate assessment of thermal sources for the upper Jefferson River. Understanding these sources accurately

may be important for identifying future remedies. Table B6-1 shows maximum water temperature of the lower Beaverhead near Giem's in 2005 at 77 F (above the Ruby River and Big Hole Sloughs) and maximum temperature of 73 F at the Madison County Fairgrounds. Hence, significant cooling apparently occurs due to inflows to the lower Beaverhead River.

**Response 2.6:**
The temperatures displayed in **Table 5-7** are the conditions as they come into the Jefferson River, which are the appropriate conditions to input into the model. Temperatures will vary throughout the river, depending on inflows, outflows, changes in riparian vegetation, etc. No changes were made to the table, but a note was added to emphasize that temperature in the Beaverhead River at the mouth is reduced because of added flow from the Ruby River and Big Hole sloughs.

**Comment 2.7:**
Page 6-2
Low Flow Alteration. The document states that TMDL's cannot impact water rights, but identification of low flow alterations as a probable source of impairment does not violate state or federal regulations. At least for the Jefferson River, we agree that identifying low flow alteration as a source of elevated water temperature is appropriate. For example, the Jefferson River at Twin Bridges USGS gage exceeds 73 F (daily maximum) frequently during drought years, and only occasionally during years with more normal flow conditions. Daily maximum water temperature at Twin Bridges Gage only exceeded 73 F a total of seven days in the five years from 1995 to 1999. During the severe drought of 2000 to 2007, 73 F daily maximum was exceeded between 7 and 30 days per year.

Your recommendation to encourage a 15% voluntary reduction of withdrawals during periods of water shortage might be a positive step to improve water temperature, but potentially including the concept of seasonal flow objectives might be a better method to attempt to manage flows in the system. For example, 4 major canals in the Jefferson have voluntarily reduced diversion of water by over 15% during several years of drought plan implementation, but these efforts can be negated by changes with upstream water sources. Flow is often less than 300 cfs at Twin Bridges, and withdrawals from major canals between Twin Bridges and Waterloo is often near 300 cfs. A 15% reduction of withdrawals (45 cfs) is common during drought years due to difficulty diverting water and due to attempts to maintain a target flow of 50 cfs at Waterloo.

And finally regarding low flow alterations, your data clearly shows water temperature recovery in areas with groundwater recharge (especially in the area downstream of Parson's Bridge). Groundwater protection may be one of the most effective measures to attempt to avoid complete dewatering and to provide thermal refuge for aquatic life throughout the Jefferson River TMDL reach.

**Response 2.7:**
The 15% voluntary reduction is a starting point with which to run scenarios in the model. Additional savings may be possible through flow management (in all years, not just drought years), especially with seasonal flow objectives. However, performing a detailed study on possible water savings with seasonal management objectives was outside of the scope of this TMDL document. This suggestion however was put into **Section 7.4.1**, as part of the temperature restoration approach. Language regarding groundwater protection was added to **Section 6.2**.

**Comment 2.8:**
Page 7-3

The document states that water conservation measures may be the best means to reduce water temperature. We agree this is important, but other water management actions might also be included in this discussion such as: reservoir operation, groundwater protection, and tributary flow enhancement. Identification of water sources with relatively high water temperature could also result in developing a prioritized project list of inflows that elevate water temperature. We agree with your statement that increased shade and recovery of channel morphology can provide positive effects for cooling water temperature. We believe this is important for both the mainstem rivers and associated tributaries.

**Response 2.8:**
These additional management actions were added to the discussion in **Section 7.4.1**.

**Comment 2.9**
We appreciate the extensive effort needed to develop this TMDL. Water temperature in the Upper Missouri Basin plays a critical role for maintaining high quality fisheries and for preventing the need for frequent fishing closures during periods of high temperature, which reduces angling opportunity.

**Response 2.9**
Thank you for taking the time to review the document.

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