Total Maximum Daily Load (TMDL) Status Report
Tongue River TMDL Planning Area

March 14, 2003

Department of Environmental Quality

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Prepared for the Montana Department of Environmental Quality by Tetra Tech, Inc.
Technical support and direction provided by the U.S. Environmental Protection Agency

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ACRONYM LIST

ARM	Administrative Rules of Montana
BEHI	Bank erosion hazard index
BLM	Bureau of Land Management
CBM	Coal bed methane
CFS	Cubic feet per second
CV	Coefficient of variation
DO	Dissolved oxygen
EC	Electrical conductivity
EIS	Environmental Impact Statement
GAP	Gap analysis project
GIS	Geographic information system
MDEQ	Montana Department of Environmental Quality
MLRA	Major land resource area
MRLC	Multi-Resolution Land Characterization
NASS	National Agricultural Statistics Service
NCEPD	Northern Cheyenne Environmental Protection Department
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NTU	Nephelometric turbidity units
NWIS	National Water Information System
SAR	Sodium adsorption ratio
SC	Specific conductance
SDDENR	South Dakota Department of Environment and Natural Resources
STATSGO	State Soil Geographic Database
TDS	Total dissolved solids
TMDL	Total maximum daily load
TN	Total nitrogen
TP	Total phosphorus
TPA	TMDL planning area
TR	Total Recoverable
TRR	Tongue River Reservoir
TRWU	Tongue River Water Users
TSI	Trophic state index
TSS	Total suspended solids
T&Y	Tongue and Yellowstone Irrigation District
USDI	United States Department of Interior
USEPA	United State Environmental Protection Agency
USFS	United States Forest Service
USGS	United States Geological Survey
USLE	Universal Soil Loss Equation
WDEQ	Wyoming Department of Environmental Quality
WRCC	Western Regional Climate Center
WWDC	Wyoming Water Development Commission

1.0 INTRODUCTION

1.1 Background

The Tongue River watershed encompasses approximately 5,400 square miles in the states of Wyoming and Montana. The headwaters originate in north central Wyoming and flow to the northeast into southeastern Montana. Approximately 30 percent of the watershed lies in Wyoming, while 70 percent is in Montana. Major tributaries include Goose Creek, Prairie Dog Creek, Hanging Woman Creek, Otter Creek, and Pumpkin Creek. The Tongue River has a total length of about 305 river miles of which 250 river miles flow through Montana to its confluence with the Yellowstone River near Miles City in Custer County. In Montana, the Tongue River follows a winding course through a relatively narrow valley bounded by rolling benches. The Tongue River is one of four major tributaries to the Yellowstone River and its watershed comprises approximately 8 percent of the total Yellowstone River drainage area.

The focus of this document is on the portion of the Tongue River watershed within the state of Montana. This area is referred to as the Tongue River TMDL Planning Area (TPA) and specifically includes the main stem of the Tongue River, the Tongue River Reservoir, Hanging Woman Creek, Otter Creek, and Pumpkin Creek. Although the focus of this document is on the portion of the Tongue River watershed within the state of Montana, the relevant physical, chemical, and biological characteristics within the entire watershed, including all tributaries, are considered herein.

Stream segments designated as "water quality impaired" or "threatened" are listed on Montana's 303(d) list and require the development of TMDLs. Within the Tongue River TPA, the Tongue River, Tongue River Reservoir, Hanging Woman Creek, Otter Creek, and Pumpkin Creek are all listed as impaired on the 1996 303(d) list (see Section 3.0 for details regarding the 303(d) list status of these waterbodies). On September 21, 2000, the United States District Court of Montana ordered the U.S. Environmental Protection Agency (USEPA) to work with the Montana Department of Environmental Quality (MDEQ) to develop and adopt a schedule to develop all necessary TMDLs for waters on Montana's 1996 Section 303(d) list by May 5, 2007. See, *Friends of the Wild Swan, Inc. et al.,* vs. *U.S. Environmental Protection Agency*, CV 97-35-M-DWM. In accordance with the original schedule, all necessary TMDLs for the Tongue River TPA were to be completed by December 31, 2006. However, the MDEQ has decided to accelerate the schedule for this TPA to facilitate coordination between the TMDL program and ongoing efforts relative to development of coal-bed methane (CBM). As will be described below in Section 1.3, interim, framework TMDLs may be completed as early as June/July 2003. However, the final target date for completion of all necessary TMDLs for this TPA is December 31, 2003.

The TMDL process identifies the maximum load of a pollutant (e.g., sediment, nutrient, metal) a waterbody is able to assimilate and fully support its designated uses, allocates portions of the maximum load to all sources, identifies the necessary controls that may be

COAL-BED METHANE (CBM)

Coal-bed methane production has rapidly increased throughout the United States in the past several years. USGS estimates that methane gas extracted from coal seams now accounts for 7.5 percent of the natural gas production in the U.S. (USGS, 2000). Extracting methane gas from coal seams is a relatively new and simple process. Large quantities of methane gas are found in coal beds. The methane is trapped in the coal beds because of pressure and the coal's high internal surface area. During CBM extraction, water is pumped out of the coal bed to reduce the pressure, thereby allowing methane to escape. The methane is collected and the water is disposed of to either the surface or subsurface.

The Montana Bureau of Land Management (BLM) estimated that 3,067 square miles (81 percent) of land in the Tongue River watershed in Montana has the potential to produce CBM (USDI, 2001). It is estimated that the potential maximum number of wells in this area is 10,989 wells. Assuming that the maximum number of wells are installed, and they operate for 20 years, the BLM estimated that as much as 14.4 billion gallons of water would be discharged into the Tongue River watershed over the life of the wells. This potentially enormous volume of water, as well as the constituents in the water, could have adverse affects on water resources in the Tongue River watershed.

implemented voluntarily or through regulatory means, and describes a monitoring plan and associated corrective feedback loop to insure that uses are fully supported. A TMDL can also be viewed as the total amount of pollutant that a waterbody may receive from all sources without exceeding water quality standards. Montana's approach is to include TMDLs as a part of a comprehensive water quality restoration plan containing seven principal components:

1. Watershed characterization (e.g., hydrology, climate, vegetation, land use, ownership)
2. Description of impairments and applicable water quality standards
3. Pollutant source assessment and estimate of existing pollutant loads
4. Water quality goals (i.e., water quality targets and TMDLs)
5. Allocation
6. Restoration strategy
7. Monitoring Strategy

MDEQ has chosen a phased approach for the establishment of TMDLs in the Tongue River TPA. The phased approach has been selected to accommodate the following issues:

1. The intent of the TMDL program is to attain and maintain compliance with water quality standards. In fact, water quality standards are the basis from which TMDLs are established and the TMDL targets are derived. The Montana Board of Environmental Review (the Board) is considering adoption of numeric water quality standards for sodicity (as sodium adsorption ratio, SAR) and salinity (as electrical conductivity, EC) for the Tongue River, Powder River, Little Powder River and Rosebud Creek watersheds to address current and projected development of CBM within these watersheds. As currently planned, the Board is not scheduled to make their final decision regarding adoption of numeric water quality standards until March 28, 2003, at the earliest. If the Board adopts numeric water quality standards, they will form the basis for establishment of TMDLs in the Tongue River TPA. If the Board does not adopt them, the existing narrative standards will have to be interpreted to derive TMDLs and TMDL numeric targets. Given the above described schedule and the interrelationship between the state's standards and TMDL programs, it is not possible to proceed with a final TMDL until final decisions have been made regarding the adoption of numeric criteria. In addition, the Northern Cheyenne Tribe has adopted standards for SAR and EC in the Tongue River and Rosebud Creek Watersheds. The public reviewed the standards and the Tribe has received both written and oral comments. The Tribe will be submitting the final standards to EPA shortly. EPA is currently reviewing the Tribes application to administer the program. Once this application for authority is approved, EPA must approve or disapprove the standards within 60 days.

2. Typically, in the TMDL process, when numeric water quality standards are available for a pollutant of concern, they are used to make water quality impairment determinations and form the basis for numeric water quality targets. For example, if the numeric water quality standard is exceeded a certain percent of the time, the waterbody is considered impaired.

   MDEQ has proposed the establishment of numeric water quality standards for EC and SAR specific to the Tongue River, Powder River, Little Powder River, Rosebud Creek and their tributaries. While MDEQ's proposal may result in establishment of numeric water quality standards (e.g., 1900 µS/cm EC in the Little Powder River), the provisions of 75-5-306 MCA provide that "*It is not necessary that wastes be treated to a purer condition than the natural condition of the receiving stream so long as the minimum treatment requirements established under this chapter are met*."

Natural refers to "*conditions or materials present in the runoff or percolation over which man has no control or from developed land where all reasonable land, soil and water conservation practices have been employed*."

The provisions of 75-5-306 MCA make it impossible to use MDEQ's numeric criteria for making a Clean Water Act 303(d) water quality impairment determination without first defining the natural condition of the receiving stream.

3. While in most cases sufficient data are available to describe ambient water quality conditions, there are currently insufficient site-specific monitoring data to define the natural condition (i.e., to what extent the existing water quality is a function of natural versus human-caused activities) of the waters within the Tongue River TPA or to derive appropriate TMDL targets that are both protective of beneficial uses and reflect the water quality potential of the subject waterbodies.

4. In most cases, for most non-CBM related pollutants (e.g., nutrients, sediment, pathogens) in most 303(d) listed waters within the Tongue River TPA, insufficient site-specific data exist to determine water quality impairment status and/or establish appropriate TMDL targets.

Each of the above issues necessitates a phased TMDL approach where additional time is provided to collect supplemental water quality data and the Board is provided time to make final decisions regarding the adoption of numeric water quality criteria.

1.2 Document Purpose and Content

This document presents the results of the first phase of TMDL development for the Tongue River TPA. The purpose of this document is to provide a summary and status report of the TMDL-related work that has been performed to date, completes the first component of the TMDL process as defined above (i.e., Watershed Characterization), and preliminarily completes the second component of the process (i.e., Water Quality Impairment Status). This is a status report and comments from all interested parties are welcomed. Although MDEQ will not be preparing a revised version of this status report, all data and comments will be considered during the preparation of the final TMDLs.

This phase began almost two years ago when MDEQ began working with the Carter, Custer, Rosebud, Powder, Bighorn, and Prairie County Conservation Districts, with USEPA funding, for the collection of water quality data in waterbodies within the TPA. The work has been conducted under the direction of MDEQ with technical assistance from USEPA and contractor support from Tetra Tech, Inc. The intent of Phase I is to develop a thorough understanding of the existing environment as it relates to water quality and to compile and evaluate all available water quality data to describe ambient water quality conditions. The physical, chemical, and biological characteristics of the environment in which the subject waterbodies exist are described in Section 2 – Watershed Characterization. A summary and evaluation of all available water quality information is presented in Section 3 – Water Quality Impairment Status. Section 3 also discusses identified data gaps. A monitoring plan to fill the identified data gaps is presented in Section 4 – Monitoring Strategy.

1.3 Future Phases

Phase I will provide the foundation upon which to make water quality impairment determinations and establish all necessary TMDLs for the Tongue River TPA. As such, this Phase I report is a status report and a subset of the final TMDL report. All available information at the time of this report was used in the analyses and conclusions. Additional data and comments applicable to all phases of the TMDL process will continue to be acquired and used. Subsequent phases of the TMDL process will build upon the information presented in this report to establish appropriate targets, and source allocations. Potentially, two additional phases will be initiated. These are described in the following paragraphs.

1.3.1 Phase II – Interim Framework TMDLs

The previously mentioned court order not only stipulated that USEPA and the state work together to develop and implement a schedule for completing all necessary TMDLs, but went on to state that "*Until all necessary TMDLs are established for a particular water quality limited segment, the EPA shall not issue any new permits or increase permitted discharges for any permittee under the National Pollutant Discharge Elimination System permitting program or under the Montana Pollutant Discharge Elimination System*." In other words, this stipulates that the state or USEPA can permit no new or increased discharges until all necessary TMDLs are completed.

Phase II would be optionally implemented at MDEQ's discretion in an attempt to avoid permitting delays that might be forced as a result of this court-ordered stipulation. Phase II could be completed within approximately two to three months of a decision by the Board to adopt, or not adopt, numeric water quality criteria (e.g., a draft Phase II TMDL document completed in June/July 2003 assuming the Board makes a final decision on March 28, 2003).

Phase II would use all currently available information to develop framework TMDLs for CBM-related parameters and would establish interim numeric water quality targets, TMDLs, and allocations that would be "in effect" until Phase III is completed in December 2003. The Phase II process would facilitate immediate protection of beneficial uses using the best available data and may allow for some discharges of CBM-related parameters in some waters while additional data are collected, and analyses are conducted in Phase III to refine final targets and TMDLs.

MDEQ's decision to proceed with Phase II will be based on: (1) permit applications for proposed CBM discharges, and (2) the period of time over which the Phase II interim, framework TMDL would be in effect. If factors other than the TMDL process continue to drive the CBM development issue (e.g., the Environmental Impact Statement or delays in the decision to adopt numeric water quality criteria) there may be no need to proceed with Phase II given that the Phase III process is scheduled for completion by December 31, 2003. On the other hand, if it appears that the court-ordered stipulation would drive the CBM development issue, it may be prudent for the state to proceed with Phase II to avoid permit delays.

1.3.2 Phase III – Final TMDLs

The need for additional data collection is described above in Section 1.1. Phase III has been proposed to facilitate the collection of additional data and to provide additional time to apply the appropriate analytical tools to ultimately complete all seven components of the TMDL process based on the best available, up-to-date water quality data.

Phase III is intended to result in the establishment of all necessary, final TMDLs for all pollutant/ waterbody combinations appearing on the 1996 303(d) list. Phase III will fill data gaps identified in Phase

I through implementation of a rigorous monitoring program, establish final numeric targets based on the newly acquired data and application of appropriate analytical tools (e.g., models), apply the final targets to develop final TMDLs and allocations for CBM-related parameters, and to establish all necessary TMDLs for all of the non-CBM related pollutants appearing on the 1996 303(d) list. The target completion date for Phase III is December 31, 2003, assuming that favorable/representative weather conditions exist in the spring and summer of 2003 for the collection of the necessary supplemental monitoring data.

2.0 WATERSHED CHARACTERIZATION

The intent of this section of the document is to put the subject water bodies into context with the watershed in which they occur. This section provides the reader with a general understanding of the environmental characteristics of the watershed that may have relevance to the 303(d) listed water quality impairments. This section also provides some detail regarding those characteristics of the watershed that may play a significant role in driving pollutant loading (e.g., geographical distribution of soil types, vegetative cover, land use, etc.). The information provided in this section is provided for context. A more detailed consideration of some of this information, at a finer scale, will likely be included in the final TMDL document.

2.1 Physical Characteristics

2.1.1 Location

Tongue River near Birney, Montana
(Photograph by Tetra Tech, Inc.)

The Tongue River watershed traverses the states of Wyoming and Montana, encompassing an area of approximately 5,400 square miles. Bounded by the Big Horn Mountains on the southern margin of the watershed, and the Tongue River watershed on the eastern margin, the headwaters of the Tongue River originate in north central Wyoming, and flow generally to the northeast into southeastern Montana toward its confluence with the Yellowstone River (Figure 2-1). Major tributaries to the Tongue River include Goose Creek, Prairie Dog Creek, Hanging Woman Creek, Otter Creek, and Pumpkin Creek.

The watershed includes portions of Johnson and Sheridan Counties in Wyoming, and Big Horn, Rosebud, Powder River, and Custer Counties in Montana. Seventy percent of the watershed (3,781 square miles) lies in Montana, while roughly 30 percent (1,618 square miles) is located in Wyoming. The watershed includes two USGS 8-digit hydrologic cataloging units, numbers 10090101 and 10090102.

2.1.2 Climate

Climate in the Tongue River watershed is characterized by colder and wetter conditions in mountainous areas and temperate to semi-arid conditions in lower elevation plains regions. Annual precipitation and temperature is largely governed by elevation in the Tongue River watershed. In mountainous areas, typified by elevations of 6,000 to 11,000 feet above mean sea level, total annual average precipitation ranges from 14 to 25 inches and is dominated by snowfall (Lindner-Lunsford, et al., 1992). The continental location of the watershed results in a climate that is marked by seasonal variations and extremes in precipitation and temperature. Average monthly precipitation is greatest from March through July. Significant snowfall begins in October and continues through May. Temperatures reach their maximum in July, while minimum values occur in January.

The National Oceanic and Atmospheric Administration (NOAA) collects data from many climate stations located within the Tongue River watershed as shown in Figure 2-2 and listed in Table 2-1. A graphical summary of the average climatic characteristics at a station is called a climagraph. Figure 2-3 illustrates annual average precipitation and temperature for the Burgess Junction station, Wyoming (NOAA

Cooperative station number 481220). This station typifies mountain climates in the Tongue River watershed, and shows that much of the snowfall occurs from October through April, while rainfall is roughly evenly distributed throughout the year (WRCC, 2002). Total annual average precipitation and total annual average snowfall at this station are 21.28 inches and 242.5 inches, respectively. Average monthly temperatures range from a maximum of 54.7 °F in July to a minimum of 16.0 °F in January.

In plains regions, with elevations from 3,000 to 6,000 feet above mean sea level, annual average precipitation ranges from 10 to 14 inches, and rainfall is a more dominant form of the precipitation (Lindner-Lunsford, et al., 1992). Average monthly precipitation is greatest from April through September, and maximum temperatures occur in July, while minimum values occur in January. Figure 2-4 displays a climagraph of the Miles City, F. Wiley Field station, Montana (NOOA Cooperative station number 245690). This station is located near the confluence of the Tongue River and the Yellowstone River, and is typical of lower elevation plains regions in the watershed. The climagraph shows that much of the precipitation occurs from April through September, with the wettest months in May, June, and July. Much of the snowfall occurs from November through April. Total annual average precipitation is 13.52 inches, while total annual average snowfall is 30.0 inches (WRCC, 2002). Average monthly temperatures range from a maximum of 74.3 °F in July to a minimum of 16.5 °F in January.

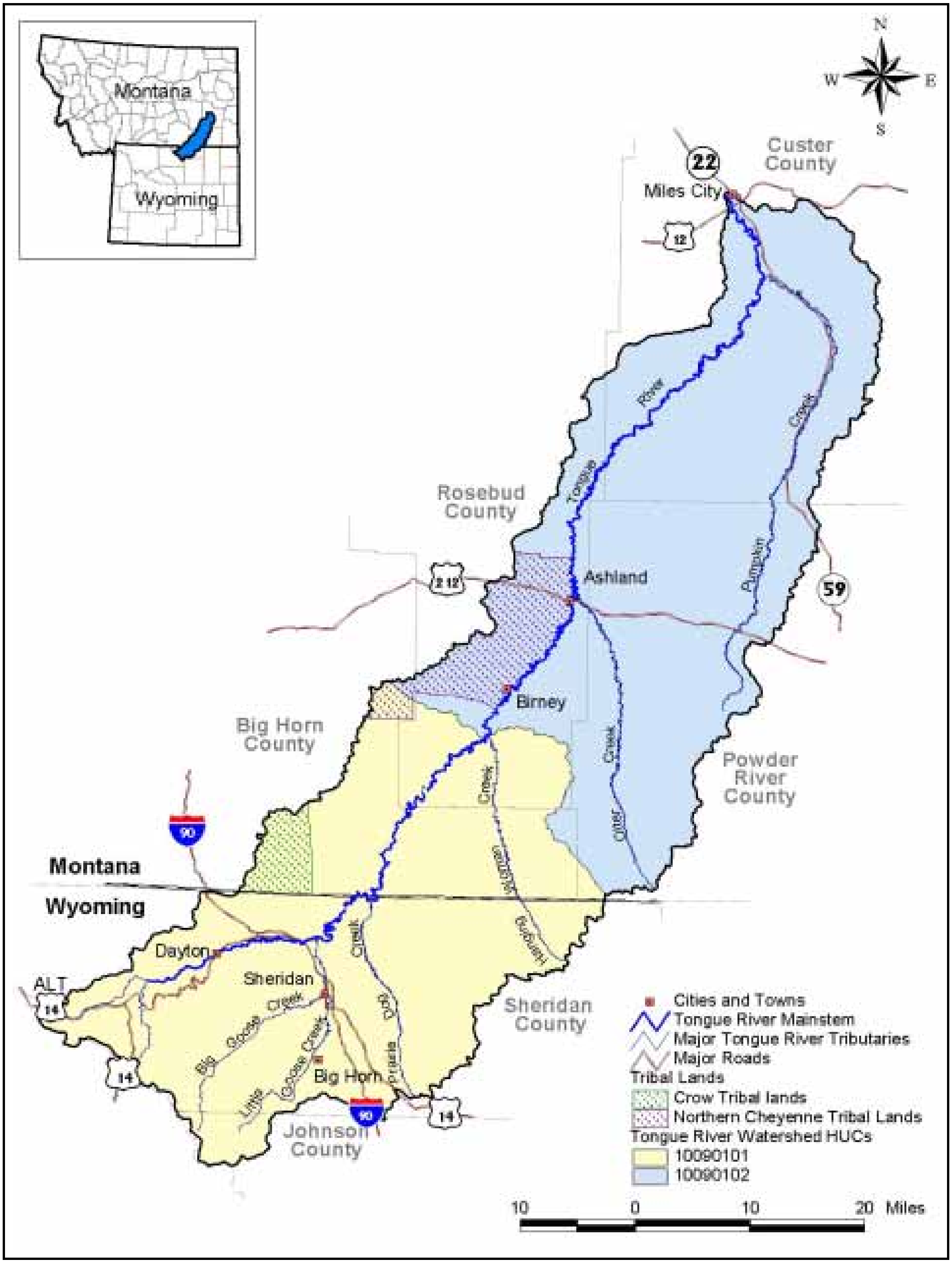

Figure 2-1. Location of the Tongue River watershed.

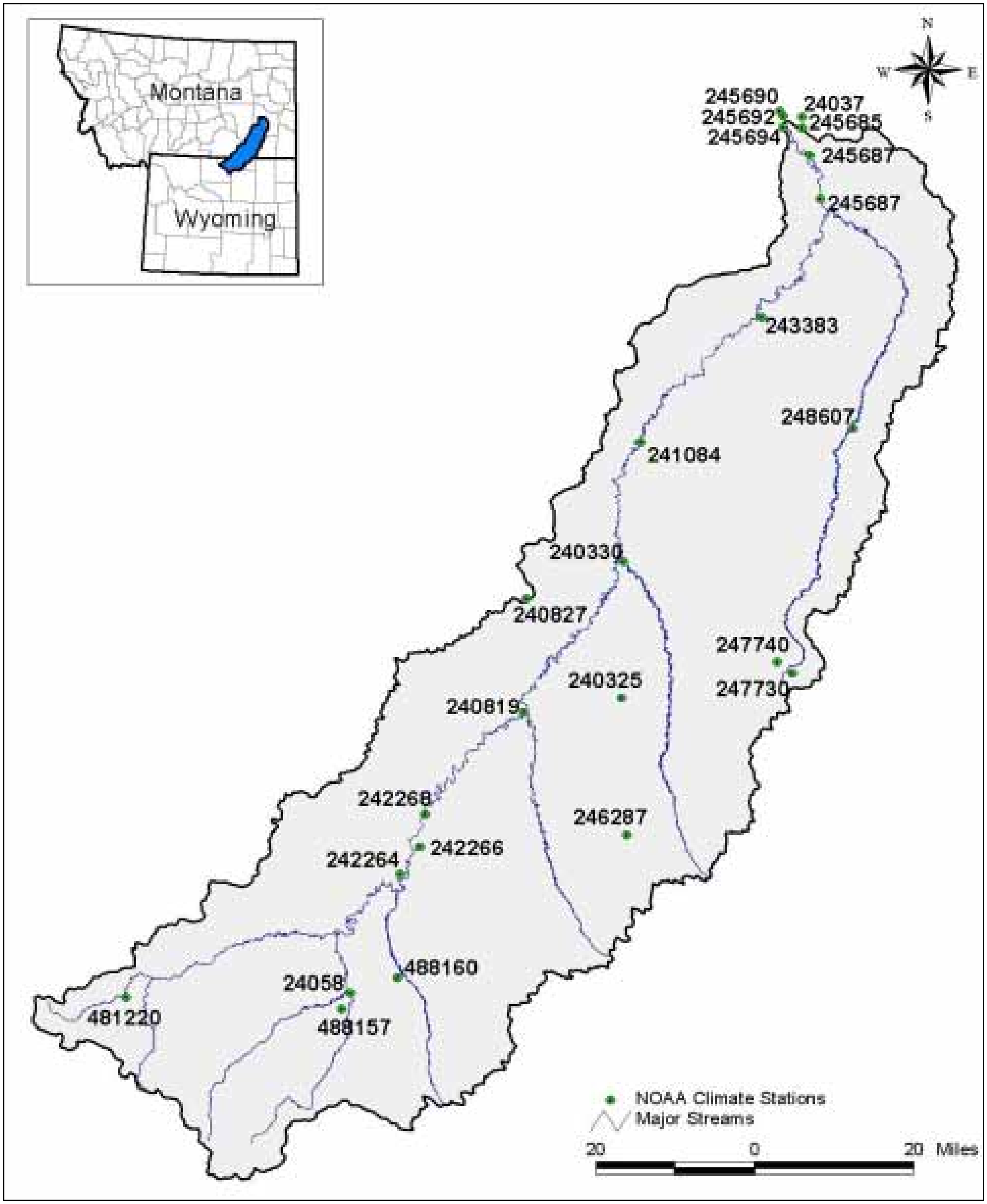

Figure 2-2. Distribution of NOAA climate stations in the Tongue River watershed.

Another important climatic factor for the entire watershed, particularly from a water management perspective, is evaporation rate. Evaporation rate is largely dependent on air temperature, wind speed, and elevation (Reider, 1990). Evaporation is a major water loss from streams and reservoirs, especially in arid and semi-arid climates. Total annual evaporation in the Tongue River watershed averages around 20 inches in mountainous areas, while lower elevation plains regions average approximately 35 inches. In lower elevation areas, evaporation exceeds precipitation on an annual average basis (WRCC, 2002).

Table 2-1. NOAA climate stations located in the Tongue River watershed.

Montana			
Station Name	**Coop-ID**	**Period of Record**	**Elevation (ft)**
Otter 9 SSW	246287	1961-1991	4059.0
Sonnette 2 WNW	247740	1965-present	3898.9
Sonnette	247730	1950-1951	3800.9
Miles City	245685	1948-1982	2361.3
Miles City	24037 (WBAN)	1891-1943	2378.3
Miles City 11 SSE	245687	1976-1987	2240.3
Miles City 4 S	245687	1972-1976	2371.4
Miles City F Wiley Field	245690	1893-present	2623.3
Miles City Hwy Gridge	245692	1956-present	2329.5
Miles City Pumping Plant	245694	1956-1969	2371.4
Volborg	248607	1950-present	2979.2
Garland	243383	1948-1956	2601.4
Decker 2 SE	242264	1990-present	3442.0
Decker 4 NNE	242266	1949-present	3429.2
Decker 8 NE	242268	1956-present	3049.1
Ashland 17 S	240325	1948-1949	3902.9
Ashland Ranger Station	240330	1948-present	3019.2
Birney	240819	1970-2000	3159.3
Birney 15 N	240827	1969-1972	4123.0
Brandenberg	241084	1956-present	2769.3
Wyoming			
Station Name	**Coop-ID**	**Period of Record**	**Elevation (ft)**
Burgess Junction	481220	1960-present	8038.0
Sheridan Field Station	488160	1948-present	3749.0
Sheridan	24058 (WBO)	1907-1940	3782.2
Sheridan County Apt	488155	1934-present	3943.9
Sheridan Girls School	488157	1999-present	3943.9

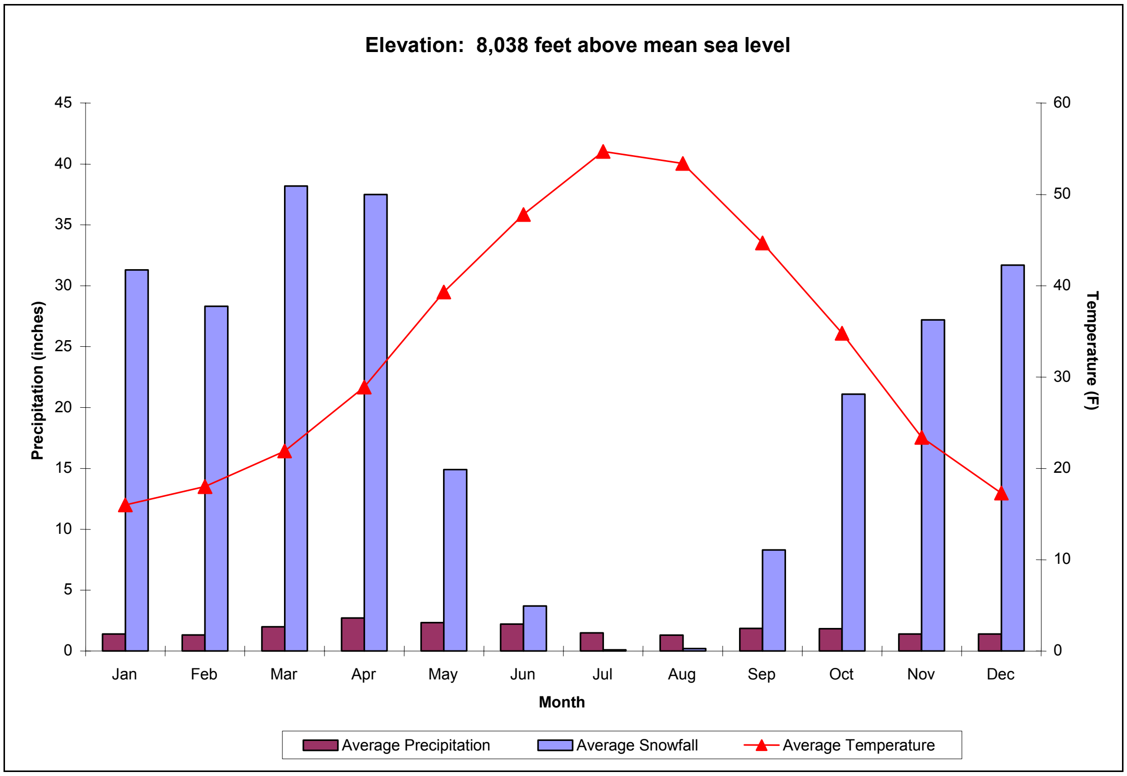

Figure 2-3. Climagraph for Burgess Junction, WY, station 481220.

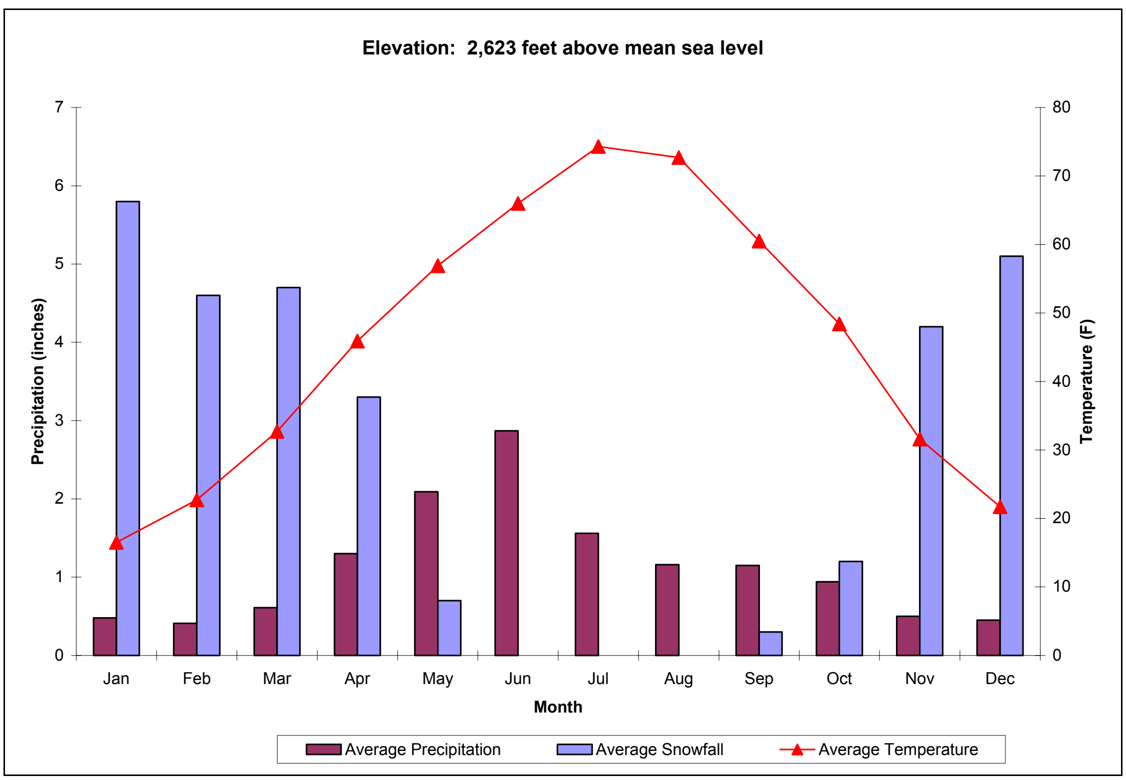

Figure 2-4. Climagraph for Miles City, F. Wiley Field, MT, station 245690.

2.1.3 Hydrology

2.1.3.1 Tongue River Flow Data - Main Stem

The USGS National Water Information System (NWIS) online database lists 50 flow gages with current and historic flow data in the Tongue River watershed. Four of the stations on the main stem of the Tongue River were analyzed to obtain a general understanding of flow from the headwaters to the mouth at the Yellowstone River. These stations were the Tongue River at Miles City, MT; Tongue River at Birney Day School near Birney, MT; Tongue River at State Line near Decker, MT; and the Tongue River near Dayton, WY. These stations are shown in Figure 2-5 and described in Table 2-2.

The flow patterns at the four main stem stations are very similar. Figure 2-6 shows that there is an increase in flow in February and March at the downstream stations. This increase is attributable to snowmelt at lower elevations. Flows then increase at all stations in April and May due to snowmelt and precipitation at higher elevations. By the end of July, flows in the Tongue River have returned to baseflow, which is sustained by yearlong snowmelt and rainfall from the Bighorn Mountains. There is little daily variability in flow because of the continuous flow from the mountain regions. The highest peak flows in the watershed occur at the gage directly upstream of the Tongue River Reservoir (TRR), Tongue River at State Line near Decker, MT (station 06306300). The average yearly flow at this gage is 334,000 acre-feet per year. The average yearly flow at the Tongue River near Miles City (station 06308500) is 309,000 acre-feet per year.

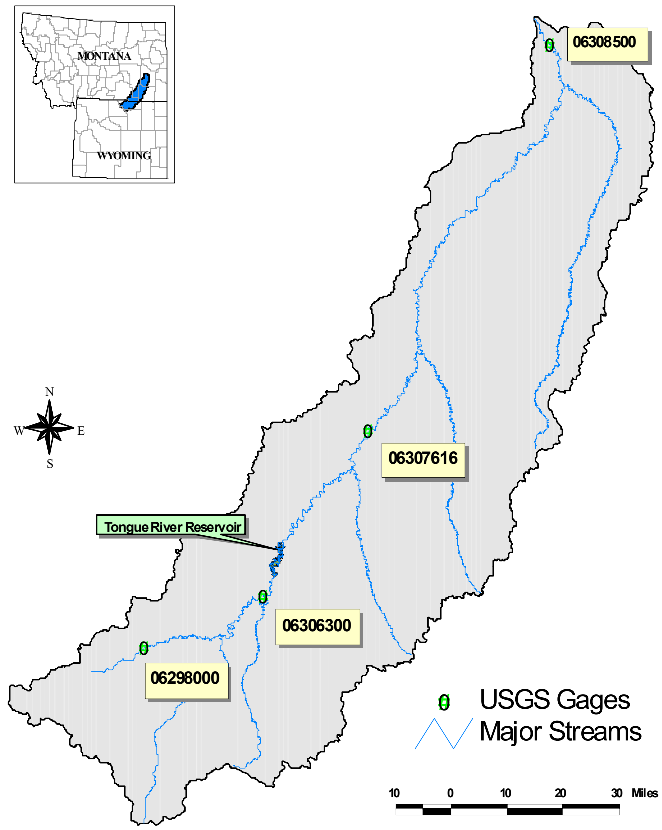

Figure 2-5. Location of selected USGS stations in the Tongue River watershed.

Flows downstream of the reservoir are affected by the release of water from the dam, the Tongue River Diversion Dam, and withdrawals. The Tongue River Diversion Dam (also known as the Tongue/Yellowstone (T/Y) Dam or the Twelve Mile Dam) is located just upstream of the Tongue River confluence with Pumpkin Creek and is approximately 12 miles upstream of Miles City. It diverts water during the irrigation season to the T/Y Ditch. The effect of the dam and diversion dams causes lower flow variability in the downstream Tongue River stations.

Table 2-2. Selected USGS stream gages on the main stem of the Tongue River.

Station ID	Gage Name	Drainage Area (mi²)	Period of Record	
			Start Date[a]	End Date[b]
06308500	Tongue River at Miles City, MT	5,379	1938	Current
06307616	Tongue River at Birney Day School near Birney, MT	2,621	1979	Current
06306300	Tongue River at State Line near Decker, MT	1,477	1960	Current
06298000	Tongue River near Dayton, WY	204	1918	Current

[a]The first year in which continuous flow data are available.
[b]The last year in which continuous flow data are available.

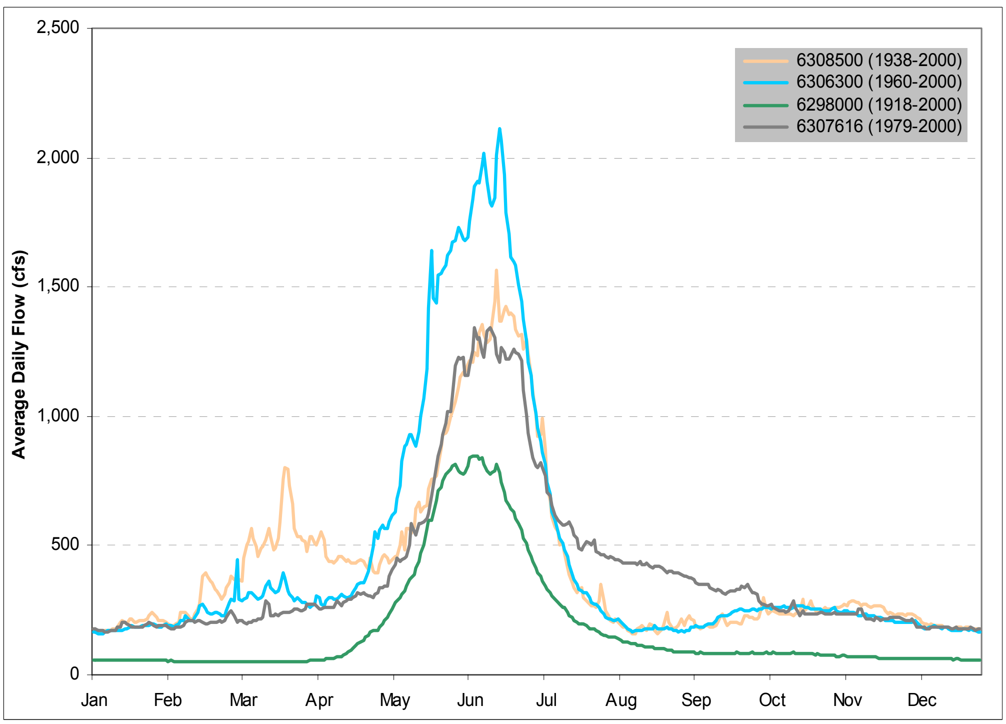

Figure 2-6. Average daily flows at four USGS gages on the main stem of the Tongue River (entire period of record is shown).

2.1.3.2 Tongue River Flow Data - Tributaries

The USGS reports that stream flows in the Tongue River watershed are highly variable (USGS, 1999). Streams that originate in the mountainous regions are generally sustained by snowmelt and precipitation and have consistent perennial flows. Examples of these streams are the headwaters of the Tongue River, Big Goose Creek, and Little Goose Creek. Figures 2-7 and 2-8 show typical hydrographs of streams in these regions, and Table 2-3 summarizes the characteristics of the selected gages. Flows are high during the major snowmelt period of April through July and then taper off into baseflow for the remainder of the year.

Other streams, such as Pumpkin Creek and Hanging Woman Creek, flow entirely through the plains region of the Tongue River watershed. These streams are usually ephemeral in the headwater areas and flow is controlled by snowmelt and intense rainstorms (USGS, 1999). Flows are also strongly influenced by withdrawals and returns. Figures 2-9 and 2-10 show the average daily streamflow at two tributary stations that flow through the plains region. Flows tend to vary from day to day with almost no flow occurring during base flow.

Several of the streams in the Tongue River watershed are influenced by flow from the plains and mountain regions (Goose Creek, Prairie Dog Creek). This combination of both systems results in streamflows that can have significant average daily variability caused by intense rainstorms along with a consistent baseflow maintained by snowmelt from higher elevations. This pattern was observed at the gage located at Prairie Dog Creek (Figure 2-11).

Table 2-3. Selected USGS gages on tributary streams in the Tongue River watershed.

Station ID	Gage Name	Drainage Area (mi^2)	Period of Record	
			Start Date[a]	End Date[b]
06302000	Big Goose Creek near Sheridan, WY	120.0	1930	Current
06303500	Little Goose Creek in Canyon, near Big Horn, WY	51.6	1941	Current
06308400	Pumpkin Creek near Miles City, MT	697.0	1972	1985
06307600	Hanging Woman Creek near Birney, MT	470.0	1973	1995
06306250	Prairie Dog Creek near Acme, WY	358.0	1970	Current

[a]The first year in which continuous flow data are available.
[b]The last year in which continuous flow data are available.

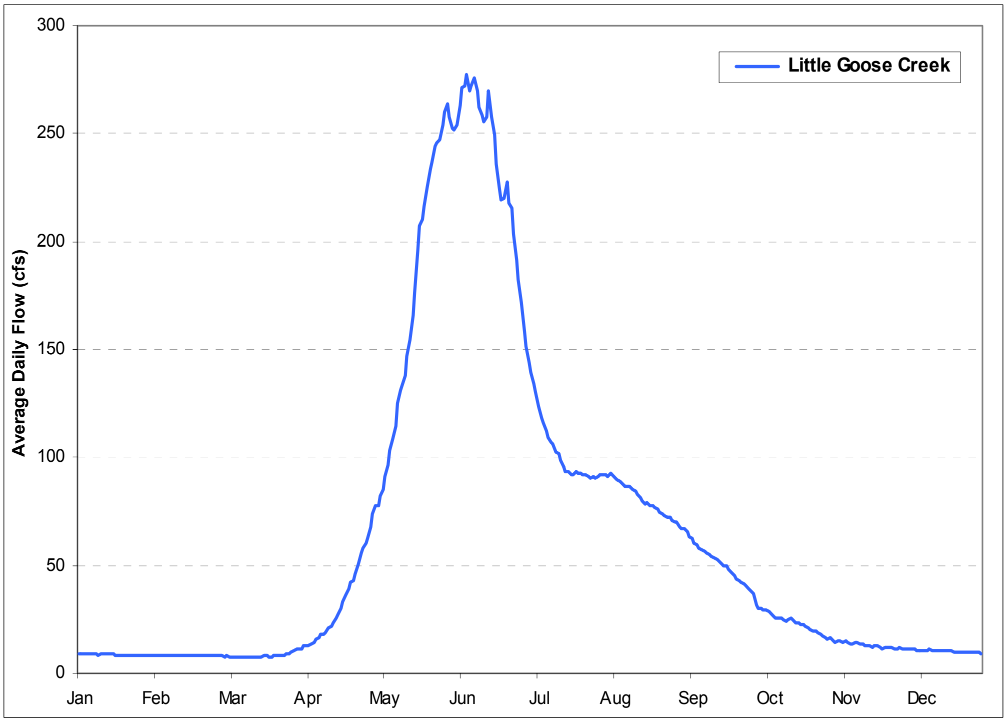

Figure 2-7. Example hydrograph of snowmelt flow regime, Little Goose Creek (1941-2000).

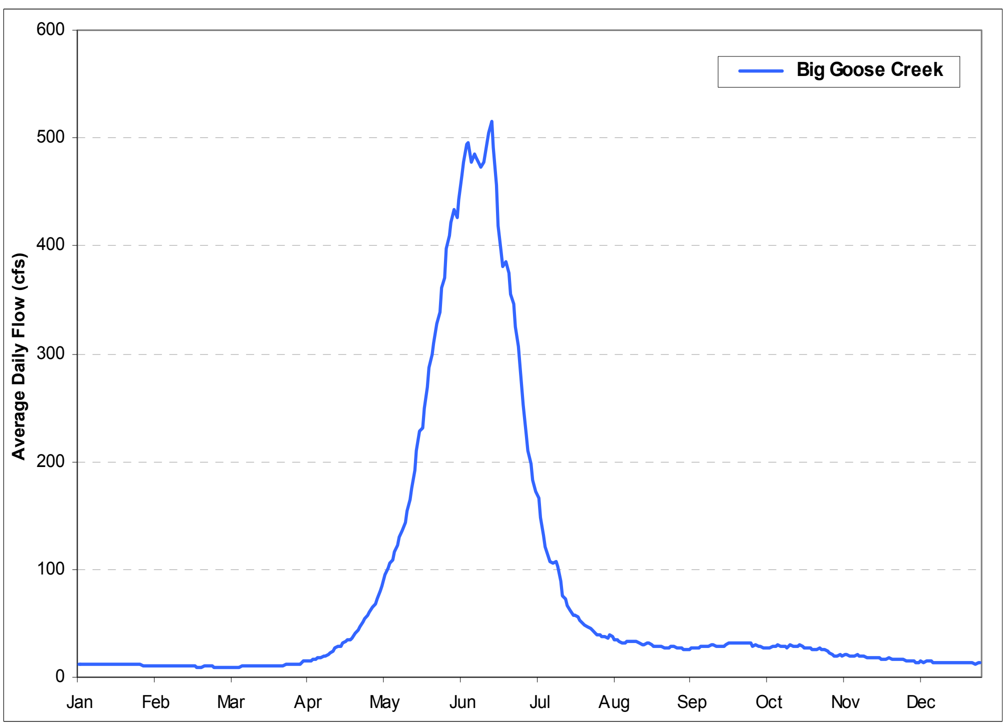

Figure 2-8. Example hydrograph of snowmelt flow regime, Big Goose Creek (1930-2000).

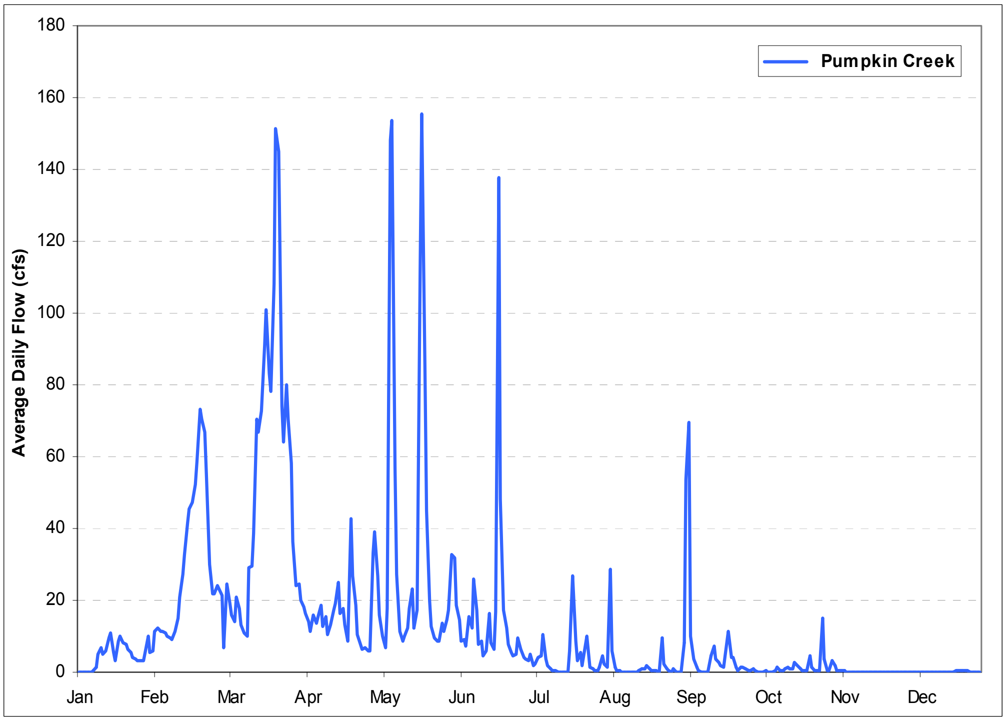

Figure 2-9. Example hydrograph of the plains flow regime, Pumpkin Creek (1972-1985).

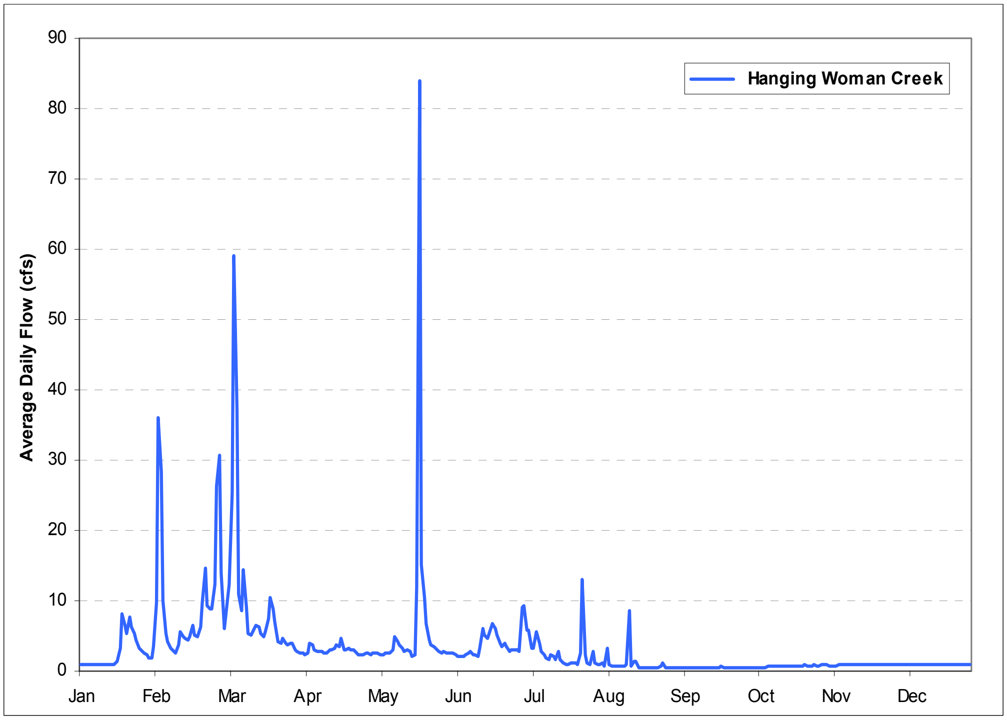

Figure 2-10. Example hydrograph of the plains flow regime, Hanging Woman Creek (1973-1995).

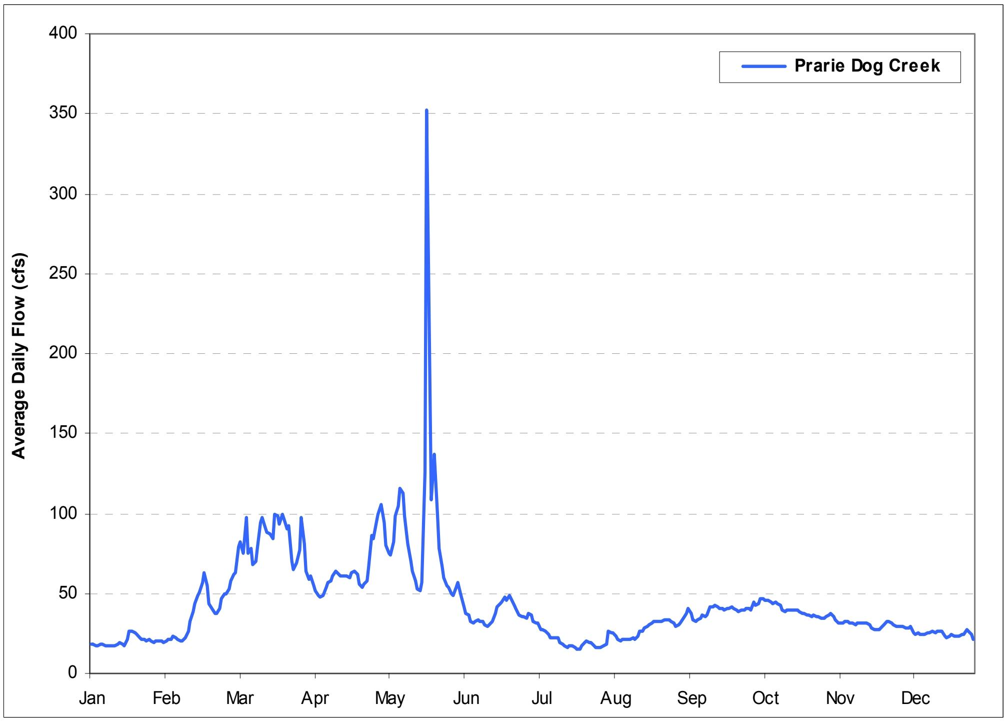

Figure 2-11. Example hydrograph of mixed flow regime, Prairie Dog Creek (1970-2000).

2.1.3.3 Stream Types

The National Hydrography Data (NHD) provided by USEPA and USGS identified three major stream types in the Tongue River watershed. Most of the streams in the Tongue River watershed were classified as intermittent streams (Table 2-4). Intermittent streams have flow only for short periods during the course of a year, and flow events are usually initiated by rainfall. Perennial streamflow was classified only in the main stem of the major rivers (Tongue River, Pumpkin Creek, Otter Creek, Hanging Woman Creek), and in the mountainous region along the southwest border of the Tongue River watershed (Figure 2-12). Mountain streams of varying sizes have perennial flow due to snowmelt and precipitation, while streams located in the plains region are generally intermittent and flow after local rainstorms. Most of the canals and ditches are concentrated along the foothills of the Bighorn Mountains and the main stem of the Tongue River. The T/Y Ditch is identifiable in Figure 2-12 starting near Pumpkin Creek and running alongside the Tongue River towards the Yellowstone River.

Table 2-4. Summary of stream type in the Tongue River watershed.

Stream Type	Stream Length (ft)	Percent
Canal/Ditch/Pipeline	1,677,242	5
Intermittent Stream	29,722,100	79
Perennial Stream	6,179,768	16
Total	37,579,110	100

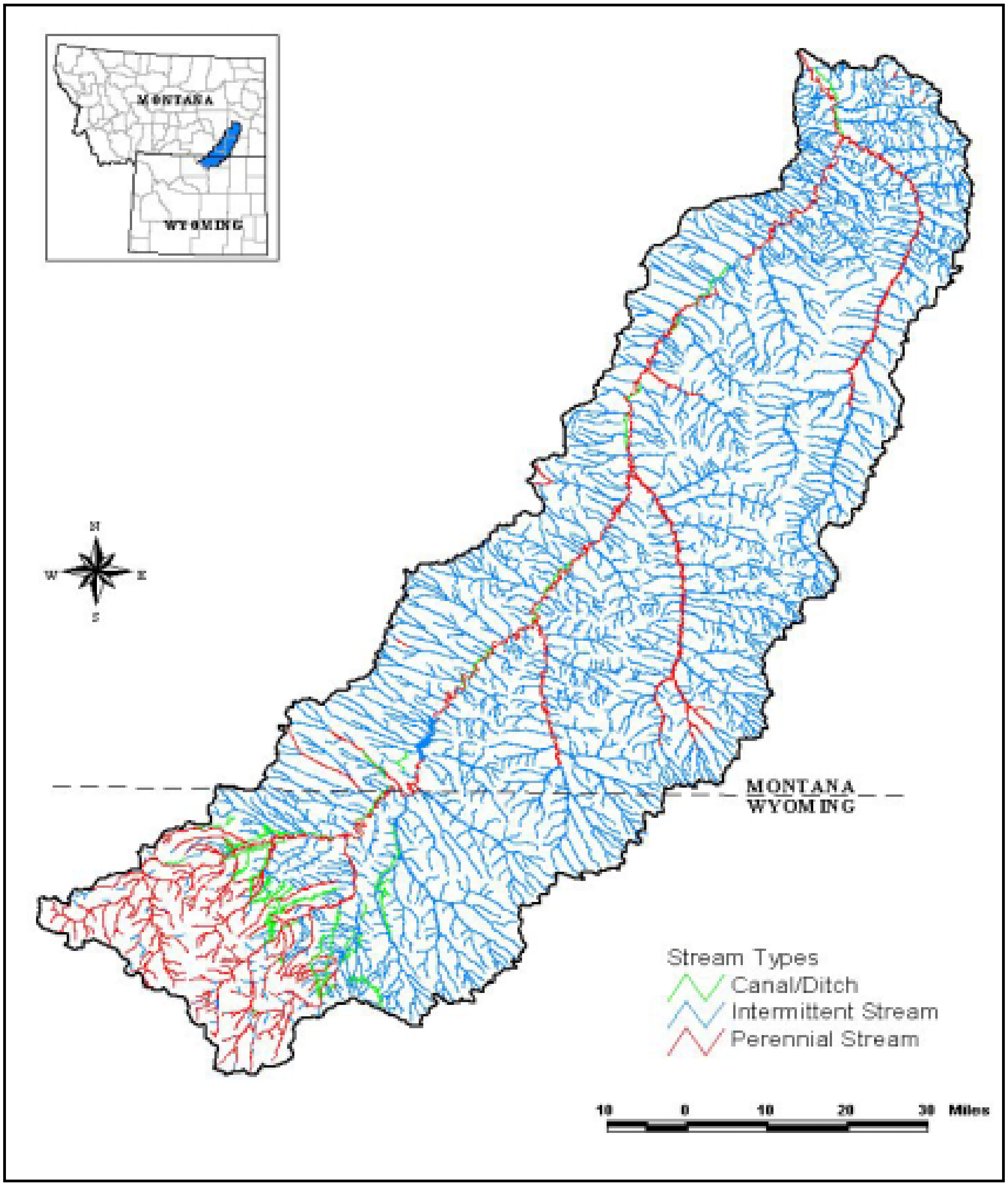

Figure 2-12. Stream types in the Tongue River watershed.

2.1.3.4 Irrigation Practices

Agricultural operations in the Tongue River watershed are heavily dependent on irrigation. In early 2002, DEQ and the Tongue River Water Users (TRWU) sent surveys to landowners in the watershed to obtain better information on irrigation practices. The format of the DEQ and TRWU's surveys were similar but not exactly the same, making it difficult to tabulate the results. The discussion below summarizes some of the key findings. Surveys recently sent to landowners indicate that close to 90 percent of respondents irrigate from these rivers or their tributaries. Most irrigate less than 50 acres of land but some irrigate as many as 9,400 acres. The average land area that is irrigated is 163 acres. Flood irrigation is the most common form of applying the water but sprinkler and spreader dikes are also employed.

Most survey respondents apply water once a week to gardens and lawns. Crops such as alfalfa and small grains are usually watered every two weeks. Table 2-5 summarizes the vegetation that is irrigated.

Table 2-5. Plants most often reported as being irrigated (organized according to category of plant and sensitivity to salt).

	Sensitivity to Salt		
Category	Highly Sensitive	Moderately Sensitive	Somewhat Tolerant
Field crops and forage	red clover, field beans, white dutch clover	alfalfa, brome grass, orchard grass	barley, sugar beets
Vegetables	cucumber, carrots, radish	tomatoes, bell pepper, sweet corn	beets, asparagus, spinach
Fruit crops	apple, crab apple (decorative), strawberry	cantaloupes, grapes	
Deciduous trees	mountain ash, dogwood, silver maple	green ash, american elm	cottonwood, russian olive, chokecherry
Conifer trees		blue spruce, ponderosa pine	

Almost 40 percent of the landowners that responded to the surveys reported that they have experienced crop yield problems due to existing water quality. Slightly more than half of the respondents reported having soil salinization problems.

Assessment of water right information provides another means of determining appropriation and beneficial uses of water in the Tongue River watershed. Water right information acquired from the Montana Department of Natural Resources and Conservation (DNRC) shows that currently there are 5,748,707 acre-feet of water per year in the Tongue River watershed allocated to surface water rights, and 830,244 acre-feet of water per year allocated to groundwater rights. This is the maximum amount of water that can potentially be used throughout the watershed per year, and it does not necessarily reflect water use. Water is primarily used for irrigation, municipal, stock watering, and domestic uses. Most of the water (76 percent) is used for irrigation (Table 2-6).

Table 2-6. Surface water uses designated by water rights.

Water Purpose	Volume (acre-feet/year)	Percentage
Irrigation	4,981,187	75.71%
Municipal	557,562	8.47%
Stock watering	481,647	7.32%
Domestic	401,430	6.10%
Flood control	150,000	2.28%
Other	7,125	0.11%
Total	6,578,951	100.00%

2.1.3.5 Tongue/Yellowstone Ditch

The Tongue River Diversion Dam is located on the Tongue River near the confluence of Pumpkin Creek and approximately 12 miles upstream of Miles City. It diverts a large portion of the Tongue River during the irrigation season (April to October/November) to the T/Y Ditch, which in turn supplies water to fields throughout the lower Tongue River watershed. Flows in the T/Y Ditch are approximately 200 cfs during the irrigation season when the ditch is full (Steven Muggli, personal communications, November 20, 2002). The T/Y Ditch eventually discharges to the Yellowstone River.

2.1.4 Groundwater

A shallow aquifer system underlies the Tongue River watershed and is composed of five hydrogeologic units located above a relatively regionally persistent and highly impermeable lithologic unit called the Upper Cretaceous Bearpaw Shale (Lewis and Hotchkiss, 1981). The uppermost hydrogeologic unit in the shallow aquifer system is the Wasatch-Tongue River aquifer, an extensive aquifer that is up to 3,904 feet thick and is exposed at the land surface throughout most of the watershed (Lewis and Hotchkiss, 1981).

Underlying the Wasatch-Tongue aquifer and extending over much of the watershed is the Lebo confining layer. This confining layer is up to 3,000 feet thick and generally correlates with the Lebo Shale Member of the Fort Union Formation (Lewis and Hotchkiss, 1981). Underlying the Lebo confining layer, except near outcrop areas, is the Tullock aquifer. The Tullock aquifer is up to 1,968 feet thick and is considered an aquifer in most of the watershed (Lewis and Hotchkiss, 1981). The Tullock aquifer is confined by the Upper Hell Creek layer, which underlies much of the watershed. Groundwater may be a potential source of pollutants in the Tongue River watershed, and more information regarding the impact of groundwater on surface water beneficial uses will be presented in the Source Assessment section of the TMDL.

2.1.5 Topography

Figure 2-13 displays the general topography within the Tongue River watershed, and a shaded relief map of the watershed is presented in Figure 2-14. As seen in Figure 2-13, elevations generally range from around 10,997 feet above mean sea level in the southwestern portion of the watershed to 2,338 feet in the northern portion of the watershed.

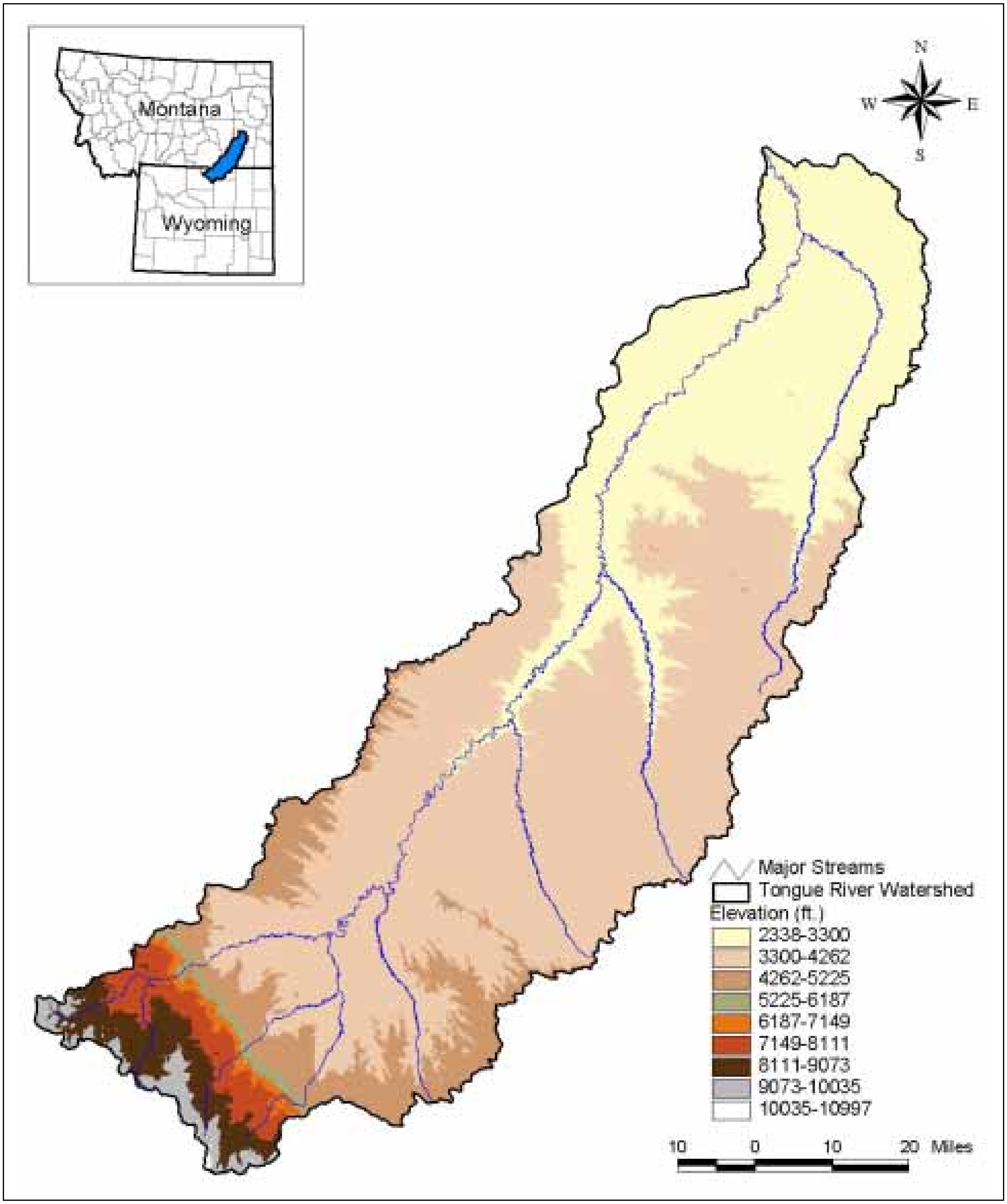

Figure 2-13. Elevation in the Tongue River watershed.

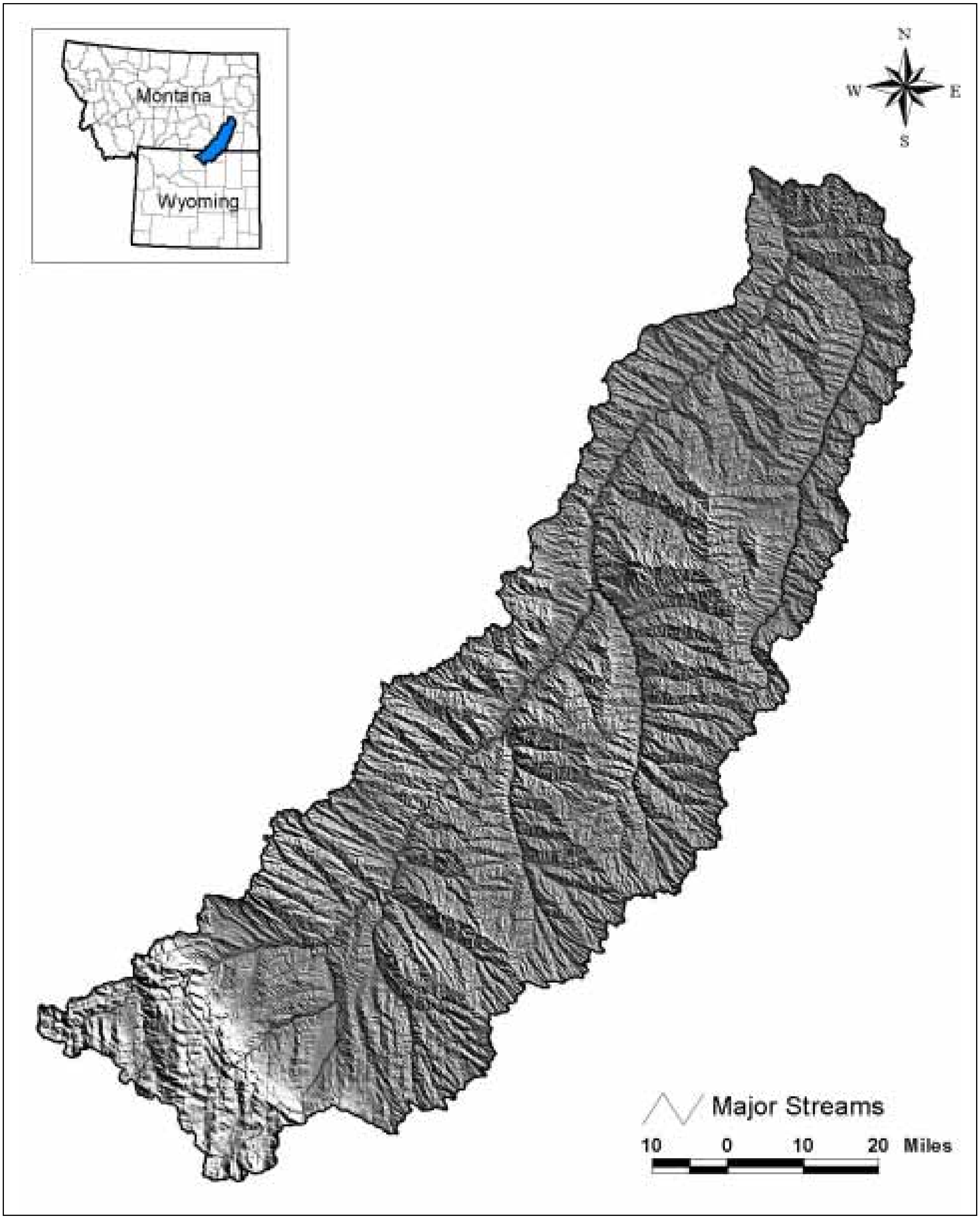

Figure 2-14. Shaded relief in the Tongue River watershed.

2.1.6 Major Land Resource Areas

The U.S. Department of Agriculture (USDA) has identified major land resource areas (MLRAs) within the U.S. (USDA, 1965). The MLRAs are large area land resource units geographically associated according to the dominant physical characteristics of topography, climate, hydrology, soils, land use, and potential natural vegetation. Descriptions of each MLRA are presented in Appendix A. MLRAs have been used in statewide agricultural planning and have value in interstate, regional, and national planning. The distribution of MLRAs in the Tongue River watershed is shown in Figure 2-15, and is summarized in Table 2-7. Figure 2-15 and Table 2-7 show that nearly 86 percent of the Tongue River watershed is classified as northern rolling high plains. Two smaller areas in the southern portion of the watershed are classified as Northern Rocky Mountain Foothills and Northern Rocky Mountains.

Table 2-7. MLRAs of the Tongue River watershed.

MLRA Classification	Area (acres)	Area (miles^2)	Percentage
Northern Rolling High Plains, Northern Part	2,021,109	3158.0	58.5
Northern Rolling High Plains, Southern Part	932,877	1457.6	27.0
Northern Rocky Mountains	279,810	437.2	8.1
Northern Rocky Mountain Foothills	221,362	345.9	6.4
Total Area	3,455,158	5398.7	100.0

2.1.7 Land Use and Land Cover

General land use and land cover data for the Tongue River watershed were extracted from the Multi-Resolution Land Characterization (MRLC) database for the states of Montana and Wyoming (MRLC, 1992) and are shown in Figure 2-16. This database was derived from satellite imagery taken during the early 1990s and is the most current detailed land use data known to be available. Each 100-foot by 100-foot pixel contained within the satellite image is classified according to its reflective characteristics. A complete description of the MRLC land cover categories is given in Appendix B. Table 2-8 summarizes land cover in the Tongue River watershed and shows that grassland is the dominant land cover, comprising approximately 61.9 percent of the total land cover. Evergreen forest and shrubland comprise 18.7 and 11.1 percent, respectively. Other important cover types include pasture/hay (3.0%), small grains (1.3%), and deciduous forest (1.2%). All other individual land cover types compose less than one percent of the total watershed area.

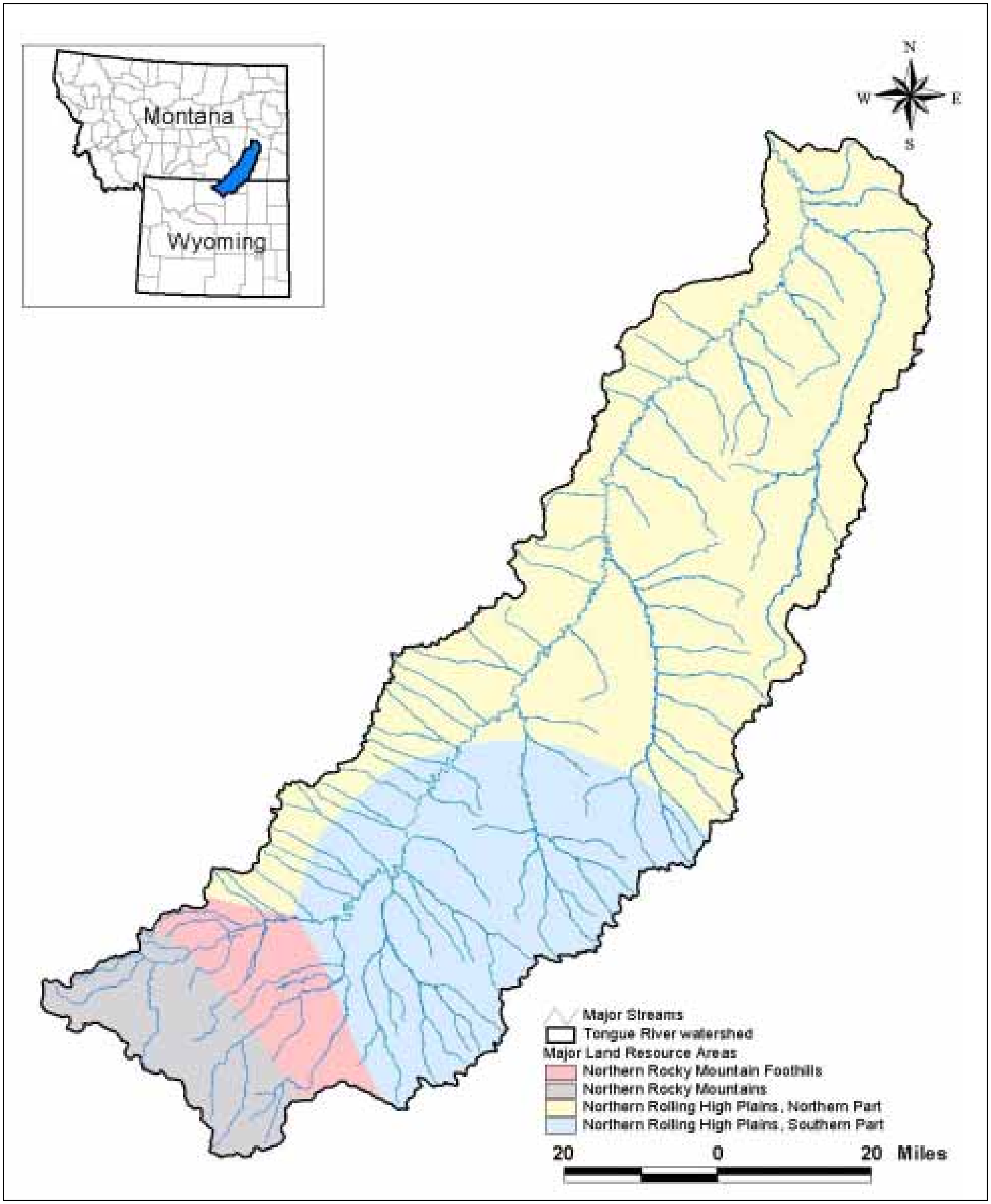

Figure 2-15. MLRAs in the Tongue River watershed.

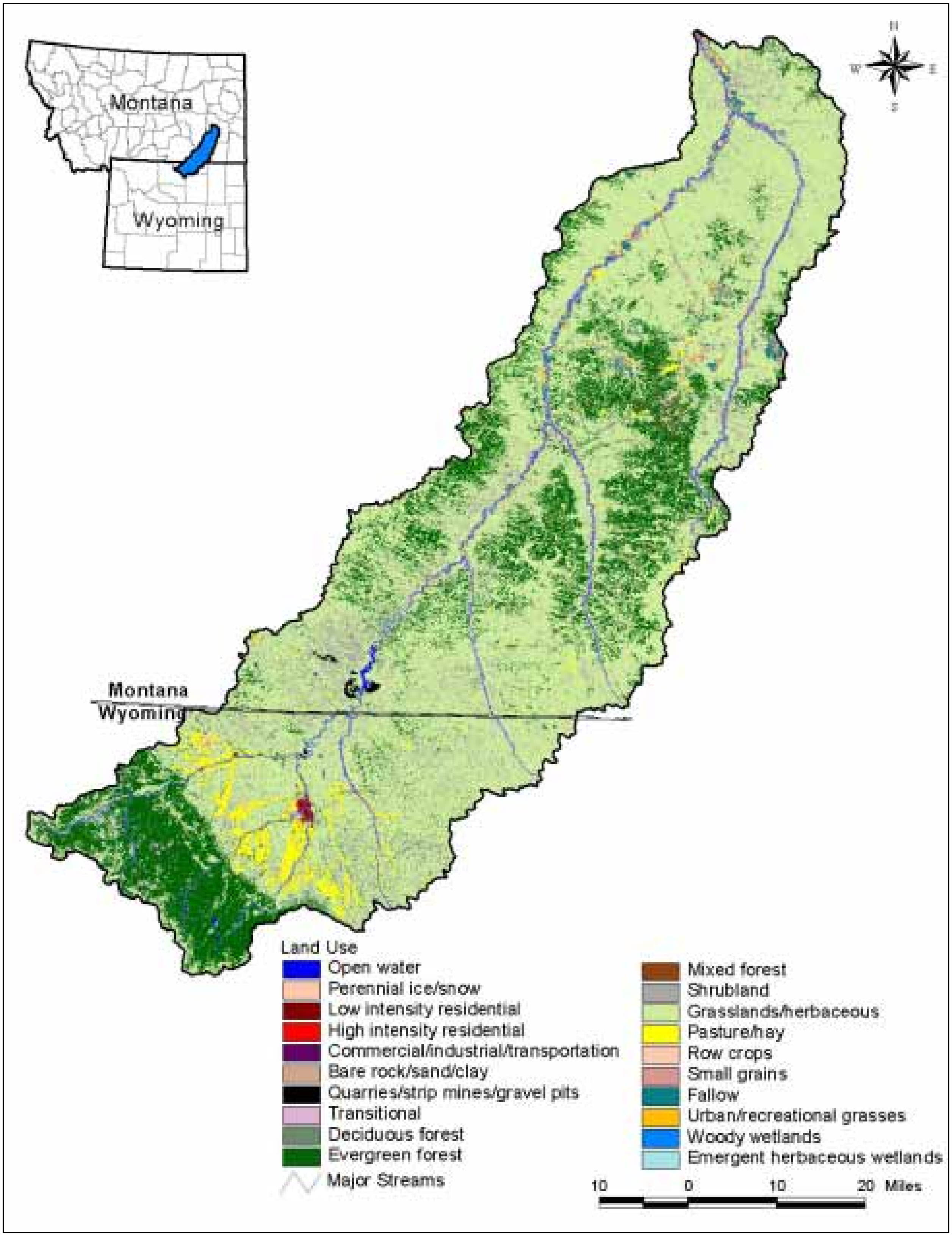

Figure 2-16. Land use and land cover in the Tongue River watershed.

Table 2-8. Land use and land cover in the Tongue River watershed.

Land Use/Land Cover	Area		Percent of Watershed
	Acres	Square Miles	
Grasses/herbaceous	2,139,647	3,343.2	61.92
Evergreen forest	645,156	1,008.1	18.67
Shrubland	384,358	600.6	11.12
Pasture/hay	105,169	164.3	3.04
Small grains	44,820	70.0	1.30
Deciduous forest	40,710	63.6	1.18
Fallow	24,914	38.9	0.72
Emergent herbaceous wetlands	17,119	26.7	0.50
Mixed forest	8,738	13.7	0.25
Open water	8,118	12.7	0.23
Row crops	8,062	12.6	0.23
Woody wetlands	7,881	12.3	0.23
Transitional	6,293	9.8	0.18
Quarries/strip mines/gravel pits	4,693	7.3	0.14
Low intensity residential	3,714	5.8	0.11
Commercial/industrial/transportation	2,368	3.7	0.07
Bare rocks/sand/clay	2,288	3.6	0.07
Urban/recreational grasses	884	1.4	0.03
High intensity residential	445	0.7	0.01
Total	3,455,375	5,399.1	100.00

2.1.8 Vegetative Cover

Vegetative data were gathered from Gap Analysis Projects (GAP) completed for the states of Wyoming and Montana. The GAP is a nation wide program conducted under the guidance of the USGS for the purpose of assessing the extent of conservation of native plant and animal species. Since an important part of the analyses is the identification of habitat, detailed vegetative spatial data are usually available for states that have completed their analyses. Like the MRLC data, the spatial databases for Wyoming and Montana were derived from satellite imagery taken during the early 1990s. However, the vegetative classification is much more detailed than that of the MRLC; the GAP data include vegetative species such as ponderosa pine, rather than general land cover classes like evergreen forest. Furthermore, the vegetation classifications differ between the Wyoming and Montana GAP databases. Therefore, the vegetative cover provided by the GAP data for the Tongue River watershed is shown for the states of Montana and Wyoming in Figures 2-17 and 2-18, respectively, and summarized according to state in Tables 2-9 and 2-10.

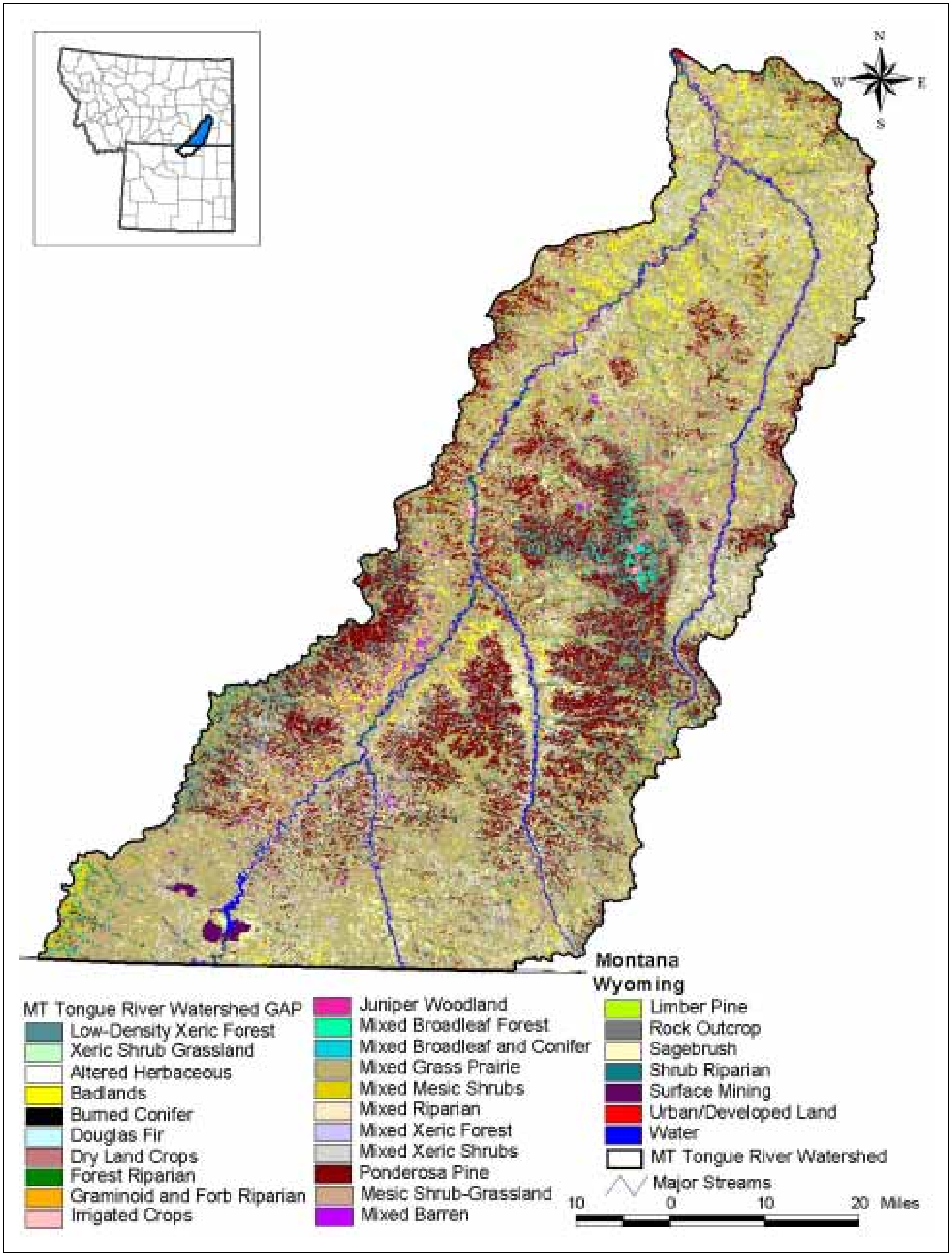

Figure 2-17. Vegetative cover in the Montana portion of the Tongue River watershed.

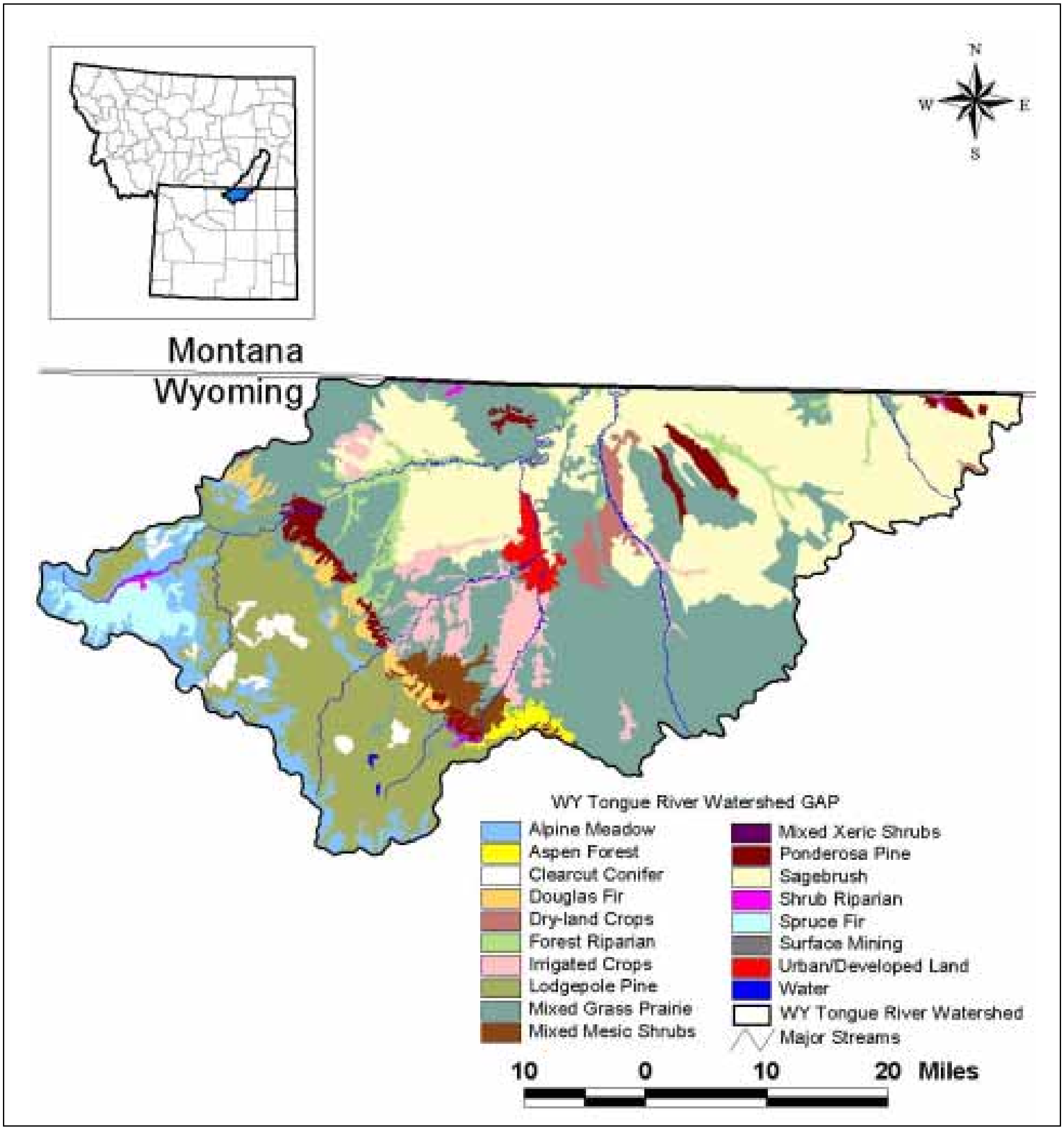

Figure 2-18. Vegetative cover in the Wyoming portion of the Tongue River watershed.

Table 2-9. Vegetative cover according to GAP analysis for the Montana portion of the Tongue River watershed.

Vegetative Cover	Area		Percent of Watershed
	Acres	Square Miles	
Mixed Grass Prairie	1,024,147	1,600.2	42.22
Ponderosa Pine	338,756	529.3	13.97
Mixed Xeric Shrubs	260,223	406.6	10.73
Low Density Xeric Forest	159,791	249.7	6.59
Sagebrush	128,071	200.1	5.28
Badlands	99,151	154.9	4.09
Mesic Shrub-Grassland	61,892	96.7	2.55
Mixed Mesic Shrubs	52,140	81.5	2.15
Dryland Crops	47,859	74.8	1.97
Graminoid and Forb Riparian	41,912	65.5	1.73
Shrub Riparian	39,412	61.6	1.62
Mixed Barren	29,737	46.5	1.23
Forest Riparian	24,501	38.3	1.01
Xeric Shrub Grassland	24,327	38.0	1.00
Irrigated Crops	16,785	26.2	0.69
Mixed Broadleaf Forest	15,100	23.6	0.62
Mixed Broadleaf and Conifer	13,629	21.3	0.56
Rock Outcrop	10,702	16.7	0.44
Mixed Riparian	10,652	16.6	0.44
Water	7,654	12.0	0.32
Altered Herbaceous	6,319	9.9	0.26
Surface Mining	5,798	9.1	0.24
Juniper Woodland	3,931	6.1	0.16
Burned Conifer	1,083	1.7	0.04
Limber Pine	921	1.4	0.04
Urban/Developed Land	616	1.0	0.03
Mixed Xeric Forest	256	0.4	0.01
Douglas Fir	190	0.3	0.01
Total	2,425,556	3,789.9	100.00

Table 2-10. Vegetative cover according to GAP analysis for the Wyoming portion of the Tongue River watershed.

Vegetative Cover	Area		Percent of Watershed
	Acres	Square Miles	
Mixed Grass Prairie	331,478	517.9	32.17
Sagebrush	273,972	428.1	26.59
Lodgepole Pine	164,323	256.8	15.95
Alpine Meadow	55,199	86.2	5.36
Irrigated Crops	44,901	70.2	4.36
Forest Riparian	33,154	51.8	3.22
Ponderosa Pine	25,129	39.3	2.44
Spruce Fir	20,590	32.2	2.00
Mixed Mesic Shrubs	16,787	26.2	1.63
Dryland Crops	15,468	24.2	1.50
Clearcut Conifer	13,753	21.5	1.33
Douglas Fir	13,516	21.1	1.31
Urban/Developed Land	10,402	16.3	1.01
Aspen Forest	6,535	10.2	0.63
Shrub Riparian	3,323	5.2	0.32
Mixed Xeric Shrubs	817	1.3	0.08
Surface Mining	512	0.8	0.05
Water	502	0.8	0.05
Total	1,030,360	1,609.9	100.00

Inspection of Tables 2-9 and 2-10 shows that the proportions of the dominant vegetative cover types are similar in both the Montana and Wyoming portions of the Tongue River watershed. The dominant vegetative cover types in the Montana portion of the watershed are mixed grass prairie, ponderosa pine, and mixed xeric shrubs, comprising 42.22 percent, 13.97 percent, and 10.73 percent of the total vegetative cover, respectively. Dryland crops comprise 1.97 percent of the total vegetative cover in the watershed and are primarily located in the lower portion of the watershed along the main stem of the Tongue River and Pumpkin Creek. Irrigated crops comprise 0.69 percent of the total vegetative cover and are typically located on valley floors along the major tributaries and the main stem of the Tongue River.

In the Wyoming portion of the watershed, mixed grass prairie, sagebrush, and lodgepole pine are the three largest vegetative cover types, comprising 32.17 percent, 26.59 percent, and 15.95 percent, respectively, of the total vegetative cover in the watershed. Dryland crops represent 1.50 percent of the total vegetative cover and most of this cover type is concentrated along Prairie Dog Creek. Irrigated crops account for 4.36 percent of the total vegetative cover and are predominately along the mountain foothills of the Tongue River and the Goose Creek subwatershed.

2.1.9 Soils

Soils data and GIS coverages from the Natural Resources Conservation Service (NRCS) were used to characterize soils in the Tongue River watershed. General soils data and map unit delineations for the United States are provided as part of the State Soil Geographic (STATSGO) database. The STATSGO data set was created to provide a general understanding of soils data to be used with large-scale analyses. Small, site-specific analyses with the STATSGO data are not appropriate. GIS coverages provide accurate locations for the soil map units at a scale of 1:250,000 (USDA, 1995). A map unit is composed of several soil series having similar properties. Identification fields in the GIS coverages can be linked to a database that provides information on chemical and physical soil characteristics. Figure 2-19 shows the general map unit boundaries in the Tongue River watershed, and the following sections summarize relevant chemical and physical soil data.

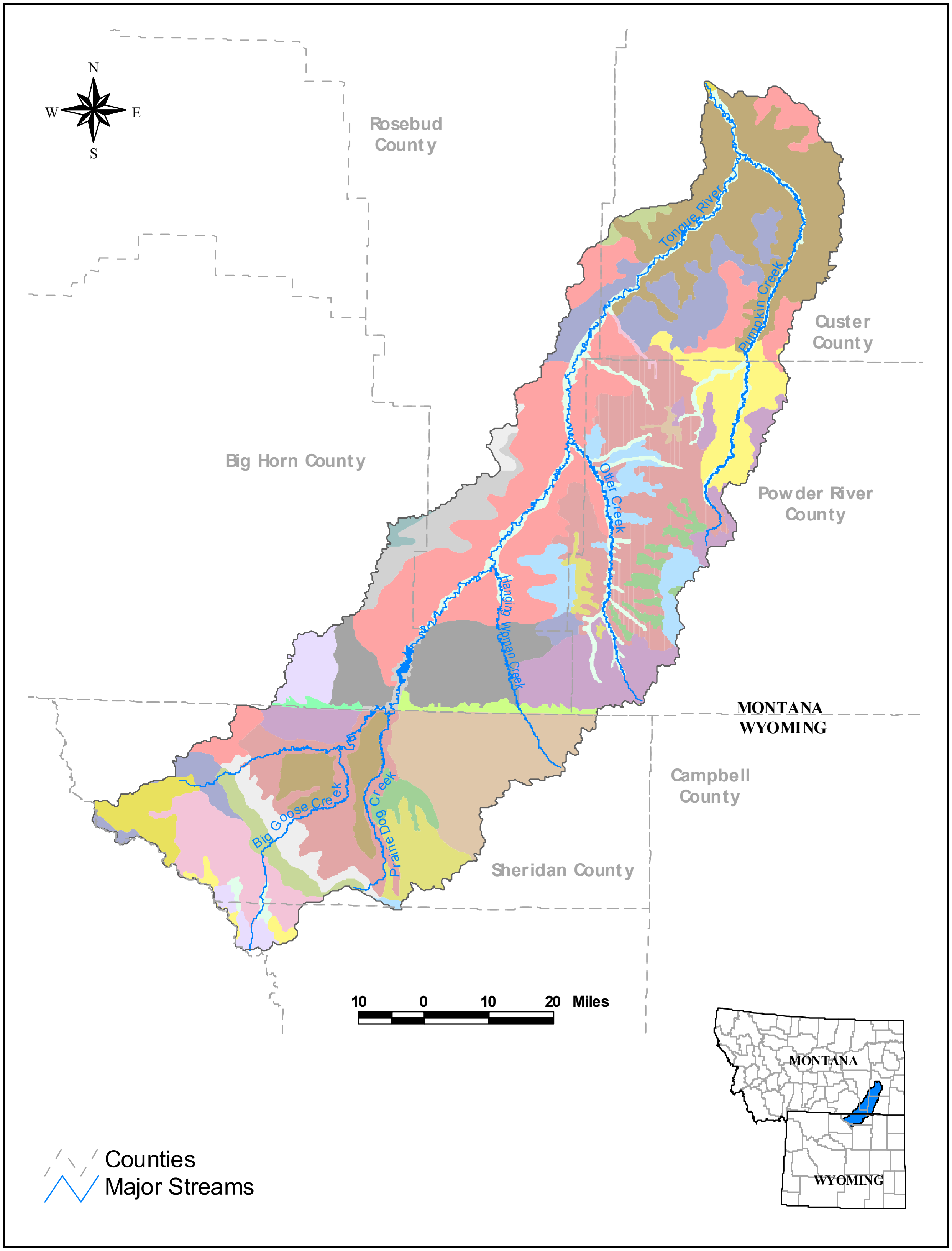

Figure 2-19. General soil units in the Tongue River watershed.

2.1.9.1 Universal Soil Loss Equation (USLE) K-factor

A commonly used soil attribute is the K-factor, a component of the USLE (Wischmeier and Smith, 1978). The K-factor is a dimensionless measure of a soil's natural susceptibility to erosion, and values may range from 0.0 to 1.0 (generally, the maximum values do not generally exceed 0.67). Large K-factor values reflect greater soil erodibility. The distribution of K-factor values in the Tongue River watershed is shown in Figure 2-20. The figure indicates that nearly all of the soils in the watershed have K-factors ranging from 0.2 to 0.4, suggesting moderate soil erosion potential. The figure also shows that soils in the higher end of the moderate erosion susceptibility class (K-factors of 0.3 to 0.4) occur throughout much of the Tongue River watershed.

2.1.9.2 Hydrologic Soil Group

The hydrologic soil group classification is a means for grouping soils by similar infiltration and runoff characteristics during periods of prolonged wetting. Typically, clay soils that are poorly drained have the worst infiltration rates, while sandy soils that are well drained have the best infiltration rates. NRCS has defined four hydrologic groups for soils, and data for the Tongue River watershed were obtained from STATSGO (Table 2-11) (NRCS, 2001). Downloaded data were summarized based on the major hydrologic group in the surface layers of the map unit and are displayed in Figure 2-21.

Soils in the Tongue River watershed show a similar representation of B, C, and D soils and have moderate to very slow infiltration when saturated. This is most likely because soils range from moderately deep and moderately well-drained alluvium to soils containing high amounts of clay. Only a small portion of soils in the Tongue River watershed has high infiltration rates. These are the alluvial soils roughly parallel to Otter Creek. Soils found in the Wyoming headwater region and the low reaches of the Tongue River and Pumpkin Creek are generally classified as C soils. Additionally, group B and D soils dominate the middle portion of the watershed.

Table 2-11. Hydrologic soil groups.

Hydrologic Soil Group	Description
A	Soils with high infiltration rates. Usually deep, well-drained sands or gravels. Little runoff.
B	Soils with moderate infiltration rates. Usually moderately deep, moderately well-drained soils.
C	Soils with slow infiltration rates. Soils with finer textures and slow water movement.
D	Soils with very slow infiltration rates. Soils with high clay content and poor drainage. High amounts of runoff.

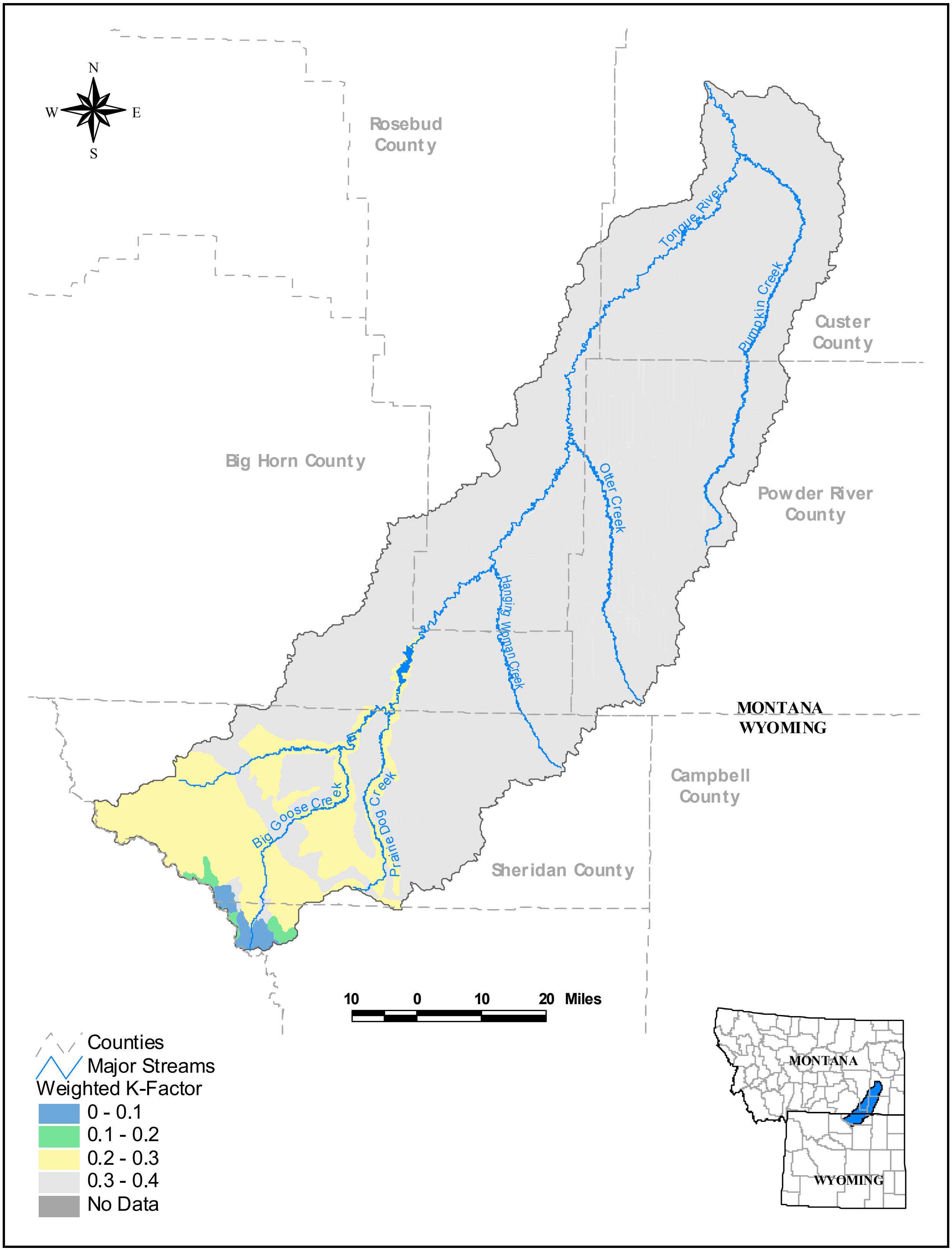

Figure 2-20. Distribution of the USLE K-factor.

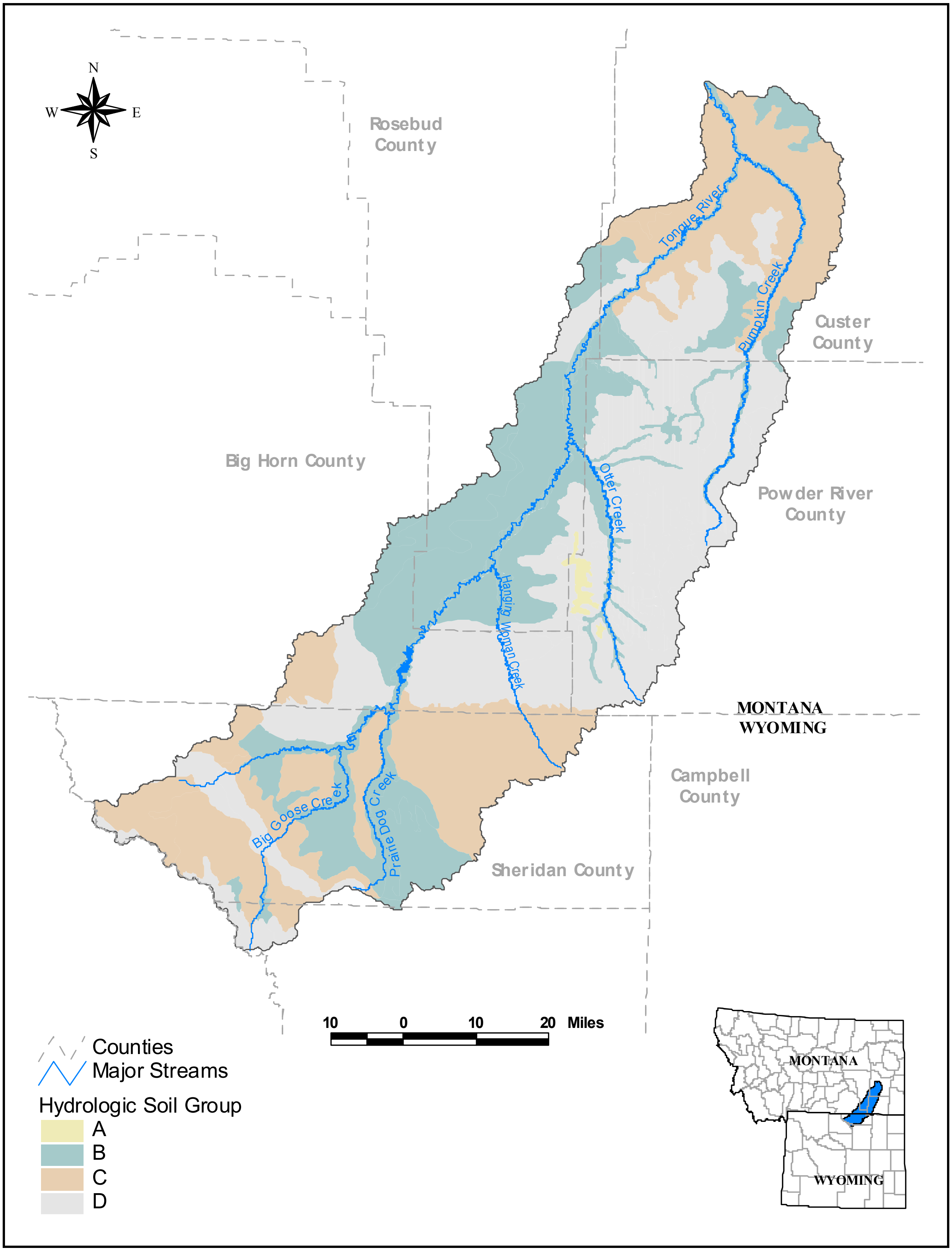

Figure 2-21. Distribution of hydrologic soil groups.

2.1.9.3 Permeability

Permeability is defined as the rate at which water moves through a soil. It is measured in inches per hour and varies with soil texture, structure, and pore size. Water moves slowly through a soil with low permeability, and quickly through a soil with high permeability. Soil uses, such as agriculture, septic systems, and construction, can be limited when permeability is too slow. Clays are usually the least permeable soils and sands and gravels the most permeable. NRCS has provided the minimum and maximum ranges for permeability in the Tongue River watershed in the STATSGO database. For the purpose of this analysis, permeabilities are reported for the surface layers of the dominant soil type in the STATSGO map units.

Figure 2-22 shows that permeability in the Tongue River watershed ranges from impermeable to very rapid. Soils with the lowest permeabilities were found in the Rocky Mountains near the Tongue River and Big Goose Creek headwater regions. Most of the soils in the plains region of the Tongue River watershed had moderate or moderately slow minimum permeabilities, and range from moderately slow to moderately rapid.

2.1.9.4 Salinity

Salts are naturally occurring in the Tongue River watershed due to bedrock materials that are easily weathered. These salts are found in varying concentrations in soils and waters throughout the watershed. In arid regions, salts also accumulate in soils due to evaporation that tends to concentrate salts in the upper soil layers. The term salts refers to several different anions and cations that may or may not be present in solution. The most common salts are calcium, magnesium, sodium, chloride, sulfate, and bicarbonate and they are usually measured in terms of EC or total dissolved solids (TDS). NRCS classifies saline as having an EC greater than 4,000 µS/cm. High salt concentrations in soil can limit the amount of plant available water and cause plant mortality, but this varies depending on the type of plant, soil, root depth, and salt depth.

Figure 2-23 shows the distribution of soil salt concentrations in the Tongue River watershed. Data were obtained from the STATSGO database and represent the maximum salinity reported for the surface layer in the map unit. It should be noted that map units can be highly variable, and Figure 2-23 is meant as a general representation of salinity throughout the watershed. Soils in the Tongue River watershed generally have moderate to high ECs ranging from 2,000 to 4,000 µS/cm. The majority of soils in the Tongue River headwaters have ECs less than 2,000 µS/cm. However, areas around the main stem of the Tongue River, Hanging Woman Creek, Otter Creek, and Pumpkin Creek have high salt concentrations in the soil solution. Furthermore, the upper Tongue River watershed in Montana has two large areas with high soil salinity.

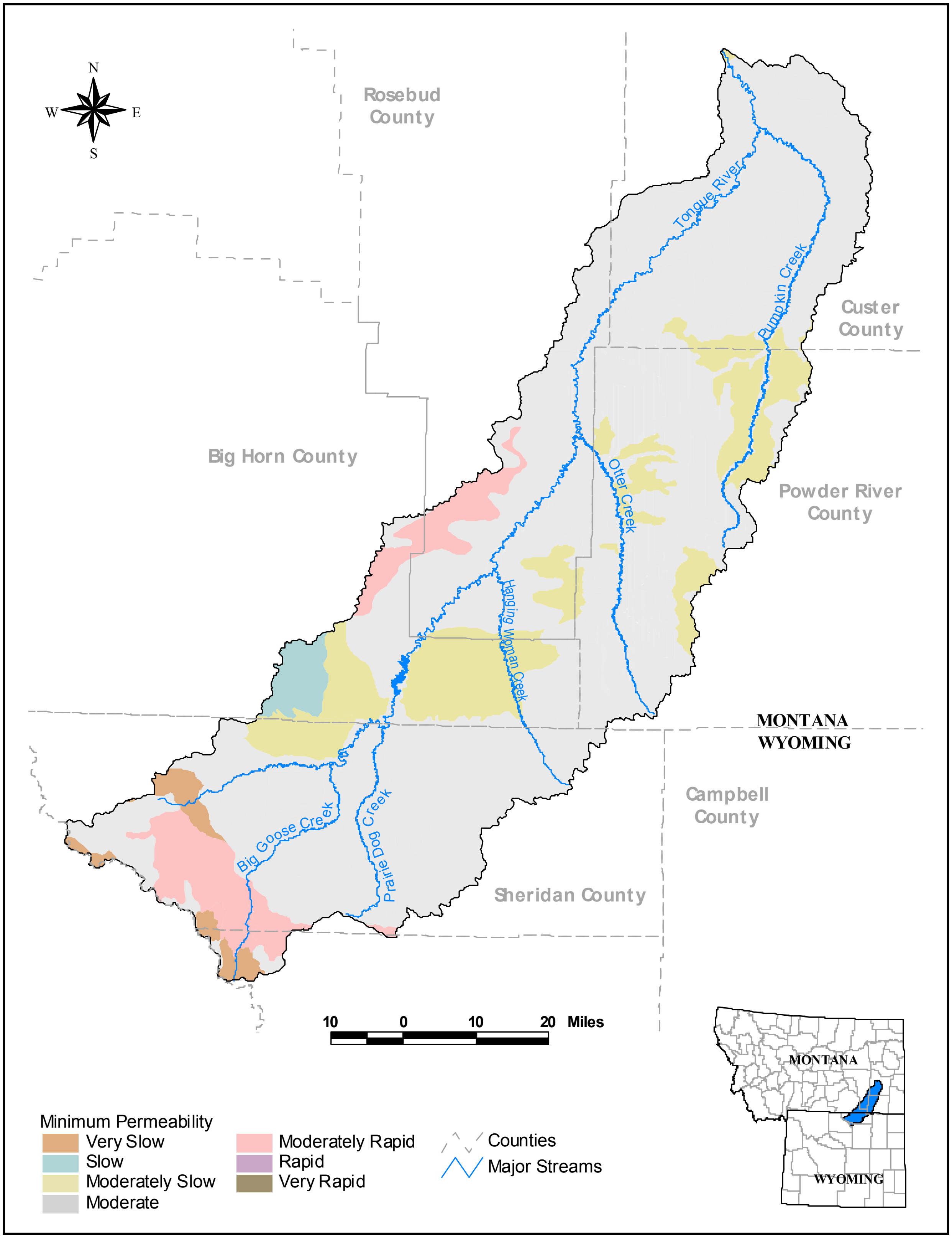

Figure 2-22. Minimum soil permeabilities in the Tongue River watershed.

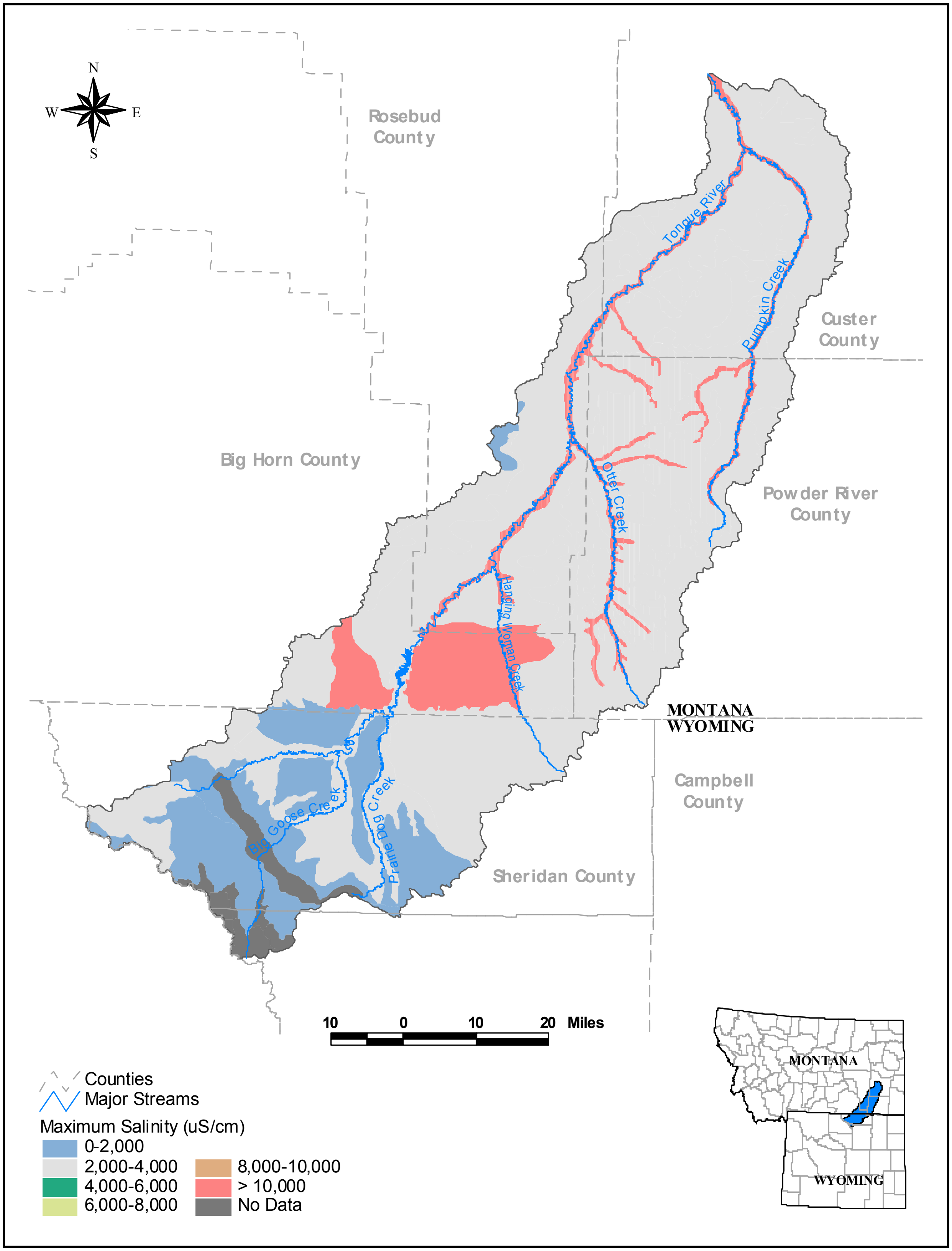

Figure 2-23. Maximum soil salinities in the Tongue River watershed.

2.1.9.5 Sodium Adsorption Ratio

Sodium salts are naturally occurring in the Tongue River watershed due to sodium-rich bedrock in certain areas. These salts make their way into soils through weathering processes and water transport. Due to evaporation, sodium then tends to accumulate in the soil surface layers and can have adverse effects on plants and soils. High sodium concentrations can disperse clay soils, changing the soil structure and rendering the soil hard and resistant to water and aeration. Sodium is also toxic to plants at elevated concentrations and raises the pH of a soil, which can also be toxic to plants.

Calcium and magnesium in the soil solution help to mitigate the effects of high sodium concentrations on soil structure. Because of this, a sodium adsorption ratio (SAR) is often used to determine the potential for sodium-caused impairment. SAR is the ratio of sodium to calcium plus magnesium in water. The units for the ions are milliequivalents per liter (meq/L). The exact ratio is shown below:

$$SAR = \frac{Na^{+}}{\sqrt{\frac{(Ca^{++} + Mg^{++})}{2}}}$$

Figure 2-24 shows the distribution of soil SAR values in the Tongue River watershed. Data were obtained from the STATSGO database and represent the maximum SAR reported for the surface layer in the map unit. It should be noted that map units can be highly variable, and Figure 2-24 is meant as a general representation of the SAR throughout the watershed. SAR values are low in the headwater and upland regions of the watershed with higher values along the Tongue River main stem and lowland areas in the Montana portion of the watershed. The highest ratios are concentrated in two areas in the upper Montana portion of the watershed.

2.1.9.6 Clay Content

The clay content of a soil affects the soil in many ways. Structure, texture, water holding capacity, and the mineral content of clay all help define the use of soil. In the Tongue River watershed, clay content of the soil ranges from 20 to 70 percent (see Figure 2-25). Data for Figure 2-25 were obtained from the STATSGO database and represent the maximum clay content reported for the surface layer in the map unit. It should be noted that map units can be highly variable, and Figure 2-25 is meant as a general representation of the clay content throughout the watershed.

Clay content is an important soil characteristic in the Tongue River watershed because soils with high amounts of clay are more susceptible to the effects of high sodium concentrations. This suggests that the lower Tongue River and Pumpkin Creek watershed soils are the most at risk if sodium concentrations were to increase in this area. Also, most of the soils in the Tongue River watershed have high clay content (40 to 60 percent) and could be susceptible to increased sodium concentrations.

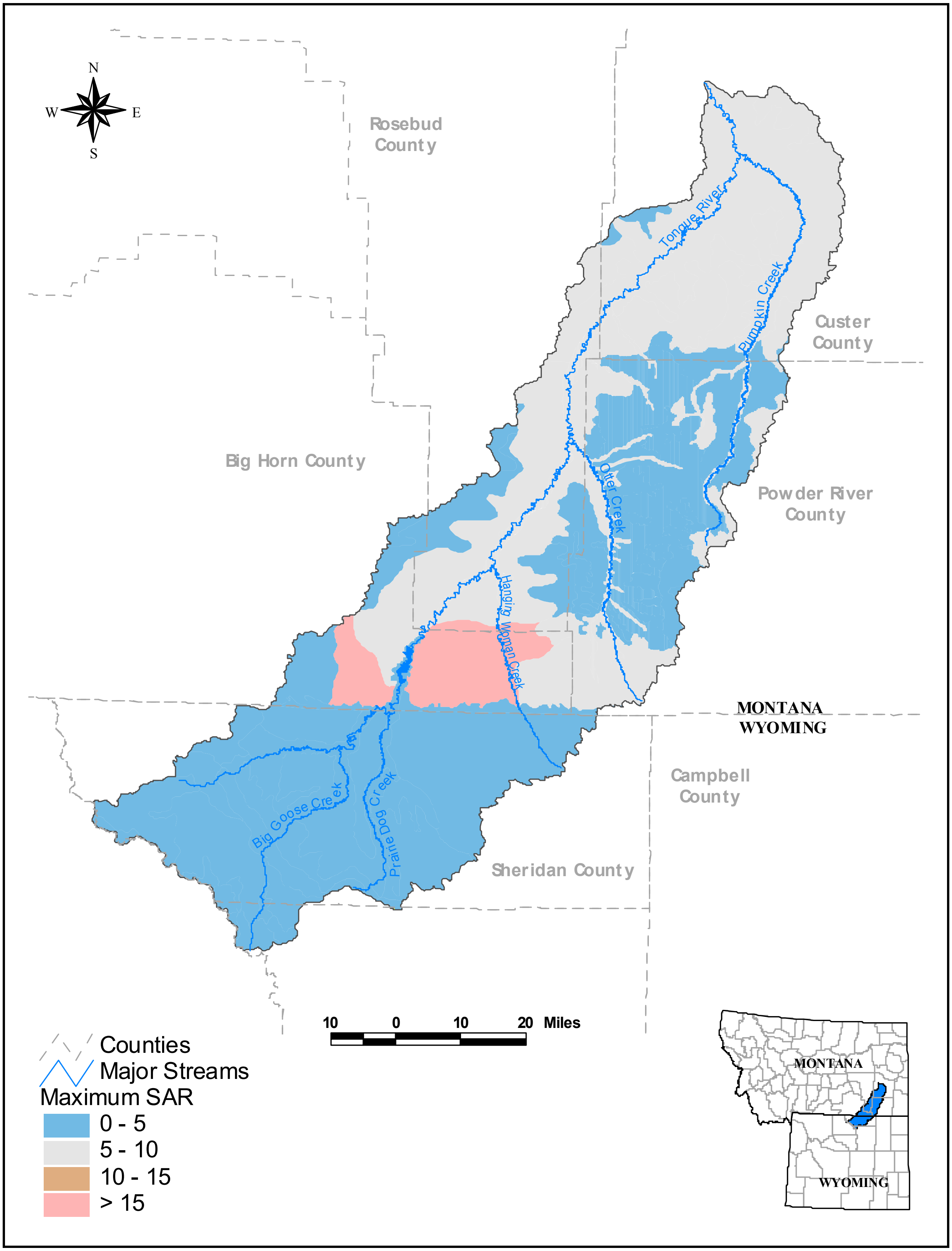

Figure 2-24. Maximum soil SAR values in the Tongue River watershed.

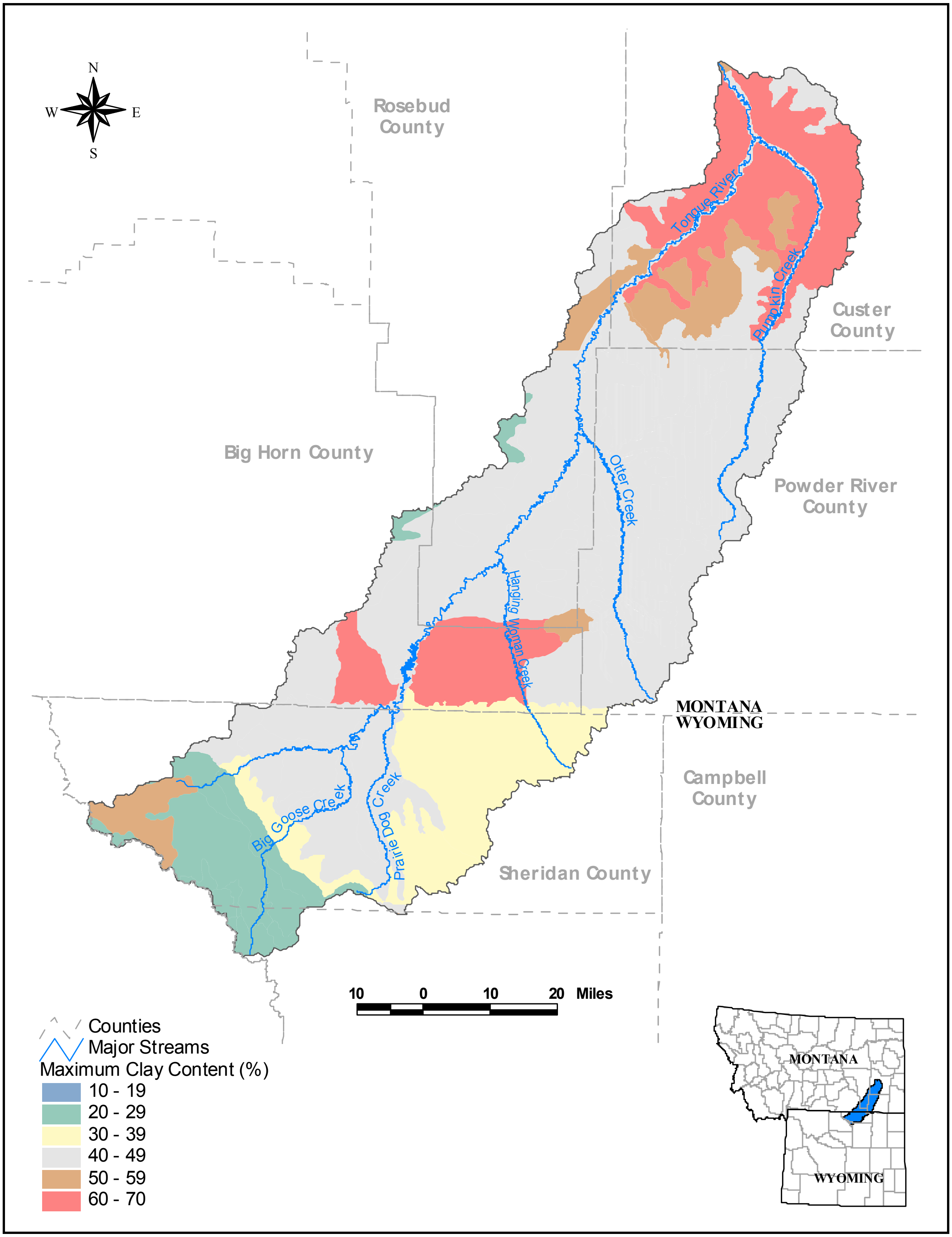

Figure 2-25. Maximum soil clay content in the Tongue River watershed.

2.1.10 Riparian characteristics

2.1.10.1 Vegetation

Vegetative characteristics within the riparian corridor of the Tongue River watershed were examined by creating a 492-foot buffer (150-meter) on either side of the main stem and major tributaries of the Tongue River in ArcView GIS. This buffer was then overlaid on the GAP vegetative cover layers for both the Montana and Wyoming portions of the watershed, and the vegetative classes lying within the buffer were extracted. Since the vegetative classifications differ between the Montana and Wyoming GAP data, the riparian vegetative characteristics are given separately for the buffered areas in each state. Table 2-12 gives the riparian vegetation characteristics for the portion of the watershed in Montana, and Table 2-13 lists the riparian vegetation characteristics for the Wyoming portion of the watershed.

The buffering technique described above yielded 36,673 riparian acres in the Montana portion of the Tongue River watershed (see Table 2-12). Of this area, 10,579 acres (28.85%) are in mixed grass prairie vegetation, 3,710 acres (10.12%) consist of shrub riparian, and another 3,529 acres (9.62%) are in graminoid and forbs vegetation[1]. Additionally, riparian forest, dryland crops, and mixed xeric shrub comprise 2,675 acres (7.30%), 2,632 acres (7.18%), and 2,296 acres (6.26%), respectively, within the riparian corridor.

The NRCS Phase II Stream Corridor Assessment found that the dominant plant communities along the main stem of the Tongue River are eastern cottonwood, green ash, boxelder maple, and peachleaf willows in the overstory, and western snowberry, redosier dogwood, chokecherry, and wild rose in the understory (NRCS, 2002). These plant communities were found in varying combinations throughout the floodplains of the Tongue River, Hanging Woman Creek, Pumpkin Creek, and Otter Creek. Noxious species, including leafy spurge, Canada thistle, Russian olive, and salt cedar, were also observed. NRCS noted that these invasive species appear to be increasing throughout the watershed (NRCS, 2002).

1 Graminoid and forbs refer to grasses and grass-like plants, including sedges and rushes and broad-leaved herbaceous plants, respectively.

Table 2-12. Vegetative characteristics within the riparian corridor of Tongue River watershed: Montana portion of the watershed.

Description	Area (acres)	Sq. Miles	Percent
Mixed Grass Prairie	10,579	16.5	28.85
Shrub Riparian	3,710	5.8	10.12
Graminoid and Forb Riparian	3,529	5.5	9.62
Forest Riparian	2,675	4.2	7.3
Mixed Xeric Shrubs	2,296	3.6	6.26
Ponderosa Pine	2,282	3.6	6.22
Low-Density Xeric Forest	1,433	2.2	3.91
Sagebrush	1,180	1.8	3.22
Mesic Shrub-Grassland	1,098	1.7	2.99
Water	944	1.5	2.57
Mixed Riparian	819	1.3	2.23
Mixed Mesic Shrubs	698	1.1	1.9
Badlands	361	0.6	0.98
Altered Herbaceous	217	0.3	0.59
Mixed Broadleaf Forest	190	0.3	0.52
Xeric Shrub Grassland	180	0.3	0.49
Rock Outcrop	114	0.2	0.31
Mixed Broadleaf and Conifer	69	0.1	0.19
Juniper Woodland	34	0.1	0.09
Burned Conifer	15	0	0.04
Limber Pine	10	0	0.03
Mixed Xeric Forest	3	0	0.01
Urban/Developed Land	6	0.0	0.02
Dryland Crops	2,632	4.1	7.18
Irrigated Crops	1,089	1.7	2.97
Surface Mining	73	0.1	0.20
Mixed Barren	434	0.7	1.18
Total	36,673	57.3	100.00

The proportions of riparian vegetation classes in the Wyoming portion of the watershed are similar to those in Montana, although the forested riparian proportion is a bit greater. This is a reflection of higher elevations and slightly more precipitation in Wyoming. A total of 17,858 riparian acres exist in the Wyoming portion of the watershed, and 5,204 of these acres (29.14%) are in mixed grass prairie vegetations (see Table 2-13). Another 3,144 acres (17.61%) consist of forest riparian, and sagebrush comprises 2,832 acres (15.86%) of the riparian corridor. Additionally, lodgepole pine, irrigated crops, and alpine meadow comprise 2,323 acres (13.01%) and 1,956 acres (10.95%), and 596 acres (3.34%), respectively, within the riparian corridor.

Table 2-13. Vegetative characteristics within the riparian corridor of Tongue River watershed: Wyoming portion of the watershed.

Description	Area (ac)	Sq. Miles	Percent
Mixed Grass Prairie	5,204	8.1	29.14
Forest Riparian	3,144	4.9	17.61
Sagebrush	2,832	4.4	15.86
Lodgepole Pine	2,323	3.6	13.01
Irrigated Crops	1,956	3.1	10.95
Alpine Meadow	596	0.9	3.34
Urban/Developed Land	471	0.7	2.64
Shrub Riparian	304	0.5	1.7
Dryland Crops	259	0.4	1.45
Ponderosa Pine	242	0.4	1.35
Mixed Mesic Shrubs	208	0.3	1.16
Douglas Fir	122	0.2	0.68
Clearcut Conifer	54	0.1	0.3
Mixed Xeric Shrubs	49	0.1	0.27
Water	41	0.1	0.23
Spruce Fir	30	0	0.17
Aspen Forest	12	0	0.06
Surface Mining	12	0	0.06
Total	17,858	27.9	100

2.1.10.2 Channel Morphology

NRCS assessed the conditions of major streams in the Tongue River watershed in Montana in the summer of 2002 (NRCS, 2002). As part of this study, NRCS personnel described the channel morphology of the Tongue River, Pumpkin Creek, Otter Creek, and Hanging Woman Creek in Montana. Overall, streams in the watershed are low gradient, sinuous streams that have localized regions of entrenchment based on site-specific conditions. Descriptions of the channels and floodplains from the NRCS report are summarized below.

> *Tongue River – Above the Tongue River Reservoir, the Tongue River is a low gradient, moderately sinuous system displaying many of the characteristics of both mountain/ foothill and prairie stream systems. Overall, the river corridor appears to be functioning within the range of its inherent potential and capability. The floodplain is relatively accessible to frequent flood events. In the reach below the reservoir, bedrock outcrops within a narrow canyon below the dam controlled the channel. Gradient increased and sinuosity dropped due to the controlling factors as the channel meandered less across the narrow valley floor. The channel was fairly wide with few deep pools, however, boulders provided adequate habitat. Below the confines of the canyon to the mouth of the river, gradient decreased again, and sinuosity increased. The channel has downcut in the past, resulting in high flows having less access to spread out over the floodplain and creating more erosive force on the banks.*
>
> *Otter Creek – Otter Creek was characterized by an ephemeral channel six to eight feet in depth in the headwaters to a low gradient, widely meandering, deeply incised channel at the confluence with the Tongue River. The channel was incised for most of its length to*

an extent of twelve to fifteen feet below the valley floor which somewhat limited the capability of the channel to fulfill natural stream corridor functions. There were only a few places where high water was able to frequently access the historic floodplain.

Pumpkin Creek – Pumpkin Creek was noted as having a low gradient, highly meandering stream flowing through a wide valley. Some reaches of Pumpkin Creek had the highest sinuosity of all stream reaches evaluated in this assessment; stream length being over two and a half times the valley length. This creek is characterized a channel that is incised an average of four to six feet in dept below the valley floor.

Hanging Woman Creek – A variable gradient and moderate to high sinuosity characterized Hanging Woman Creek. The headwater area was a wide, open and rolling plains bounded by hills of shale outcroppings. The uppermost reach was constrained by a headcut, which had downcut the channel some six to eight feet in depth. The headcut in this reach of Hanging Woman Creek was prevented from moving upstream by the presence of a road crossing culvert. Further down, the channel passed through a fairly wide, flat valley where sinuosity increased accordingly. Channel conditions resembled a meadow type stream with slight to moderate incisement and better floodplain access.

2.2 Cultural Characteristics

2.2.1 Population

The total population for the watershed is not directly available but may be inferred from the 2000 U.S. Census data. The 2000 U.S. Census data were downloaded for all towns, cities, and counties whose boundaries lie wholly or partially within the watershed. Urban populations for each county were determined by summing the populations of all towns and cities located within the watershed. Nonurban populations for each county were determined by first subtracting the county urban population totals from the county population total. Since only portions of various counties are found within the watershed, a nonurban population weighting method was used to estimate each county's contribution of nonurban population to the total watershed population. The proportion of county area within the watershed was determined from spatial overlay in a GIS of county boundaries and the watershed boundary. It is assumed that the nonurban population for each county is uniformly distributed within the county. The nonurban county population was multiplied by the county's proportional watershed area and the product was assumed to reflect the county nonurban population.

The analysis found that approximately 25,000 people reside within the Tongue River watershed, and that the Wyoming portion of the watershed has a more urban character. The watershed urban and nonurban population totals by county are given in Table 2-14. Figure 2-1 displays the locations of counties and the larger cities and towns. From the table, it can be seen that 18,158 people (71.4 percent of the population), live in cities and towns, while 7,275 people (28.6 percent) reside in nonurban areas. Sheridan County, Wyoming, has the largest total population in the watershed with 22,408 people (88.1 percent of the watershed total population), and it also has the largest urban population of 17,518 (68.9 percent of the entire urban population) within the watershed. The second largest total county population is found in Custer County, Montana, with 943 people (3.7 percent of the total watershed population).

A review of Table 2-14 reveals that population distribution by state is very dissimilar. The Wyoming portion of the Tongue River watershed is home to 22,460 people, which represents 88.3 percent of the total watershed population. Sheridan County alone represents 99.7 percent of Wyoming's contribution to the watershed's total population. Montana, on the other hand, contributes 2,974 persons, or 11.7 percent, to the total watershed population. Most of the Montana populations are found in Custer, Big Horn, and Rosebud counties, which represent 2,532 people, or roughly 85 percent of Montana's contribution to the total watershed population.

Urban population centers in the Tongue River watershed are listed in Table 2-15. The total urban population in the watershed is 18,158 people and is distributed among seventeen towns. The largest town is Sheridan, in Sheridan County, Wyoming, with 15,804 people, which represents approximately 62 percent of the total watershed population. All other towns have populations less than 1,000 people. The largest urban center in the Montana portion of the watershed is the town of Ashland with a population of 385 people. In general, there is a much larger urban population in the Wyoming portion of the watershed, although there are a greater number of towns in the Montana portion of the watershed. Summarized by state, the Wyoming portion of the watershed has 17,518 persons living in urban places, while the Montana portion has 640 persons in urban places.

Table 2-14. Tongue River watershed population summarized by county.

County	Total Watershed Population	Percent of Total Population	Nonurban Population	Percent Nonurban	Urban Population	Percent Urban
Sheridan, WY	22,408	88.1	4,890	19.2	17,518	68.9
Custer, MT	943	3.7	903	3.5	40	0.2
Big Horn, MT	841	3.3	806	3.2	35	0.1
Rosebud, MT	748	2.9	223	0.9	525	2.1
Powder River, MT	442	1.7	402	1.6	40	0.2
Johnson, WY	52	0.2	52	0.2	0	0.0
Total	25,433	100.0	7,275	28.6	18,158	71.4

Source: U.S. 2000 Census and GIS analysis.

Table 2-15. Urban population centers in the Tongue River watershed.

City/Town	Population	County	State
Sheridan	15,804	Sheridan	WY
Miles City[a]	8,487	Custer	MT
Ranchester	701	Sheridan	WY
Dayton	678	Sheridan	WY
Ashland	385	Rosebud	MT
Big Horn	198	Sheridan	WY
Parkman	137	Sheridan	WY
Birney Day School	100	Rosebud	MT
Decker	30	Big Horn	MT
Birney	20	Rosebud	MT
Brandenberg	20	Rosebud	MT
Garland	20	Custer	MT
Otter	20	Powder River	MT
Beebe	10	Custer	MT
Sonnette	10	Powder River	MT
Stacey	10	Powder River	MT
Volborg	10	Custer	MT
Quietus	5	Big Horn	MT
Total	26,635		

[a]Portions of Miles City are not located in the Tongue River watershed.
Source: U.S. 2000 Census and GIS analysis.

2.2.2 Land Ownership

Various private, tribal, state and federal agencies hold title to portions of the Tongue River watershed, as shown in Figure 2-26. Land ownership is summarized for the watershed as a whole in Table 2-16, and Table 2-17 summarizes land ownership by state. For the watershed as a whole, the majority of land is privately owned, consisting of 2,153,801 acres, or 62.3 percent of the watershed area. Federal land holdings, represented by agencies such as the U.S. Bureau of Land Management (BLM) and the U.S. Forest Service, comprise a total of 868,014 acres, or roughly 25 percent of the watershed area. The Forest Service is the largest federal landowner in the watershed, and represents the second largest land ownership in the watershed overall with responsibility for 690,245 acres, which comprises 20 percent of the total watershed area. Land holdings by tribal lands, the BLM, the state of Montana, and the state of Wyoming represent 5.8 percent, 5.2 percent, 3.5 percent, and 2.7 percent of total watershed area, respectively.

Table 2-16. Land ownership in the Tongue River watershed.

Land Ownership Description	Area (Acres)	Percentage
Private lands	2,124,435	61.5
U.S. Forest Service	690,245	20.0
Tribal Lands	228,504	6.6
U.S. Bureau of Land Management	177,690	5.1
Montana State Lands	120,727	3.5
Wyoming State Lands	93,465	2.7
U.S. Department of Agriculture	19,097	0.6
U.S. Fish and Wildlife Service	499	<0.1
U.S. Department of Defense	496	<0.1
Total	3,455,158	100.00

The watershed-wide characteristics of land ownership given in Table 2-16 are very similar when ownership is examined by state. Table 2-17 presents land ownership for the Montana and the Wyoming portions of the Tongue River watershed. As shown in the table, the majority of land ownership consists of privately held land in Montana and Wyoming, comprising 61.5 percent of the watershed area within each state. The proportion of BLM ownership is much smaller in Wyoming (1.6%) than in Montana (6.6%). Additionally, the proportion of state-owned lands is different in the Montana (5.0%) and the Wyoming (8.7%) portions of the watershed. One major difference in land ownership between the two states can be identified in Table 2-4. Forest Service ownership is much smaller in the Montana portion of the Tongue River watershed (16.7%) compared to Wyoming (27.7%). This is primarily due to topographic differences, mainly lower elevation, and consequently less precipitation and therefore less forested area in Montana. Furthermore, the Northern Cheyenne and Crow Tribal Lands make up almost 10 percent of the land ownership in Montana whereas similar ownership is absent in Wyoming.

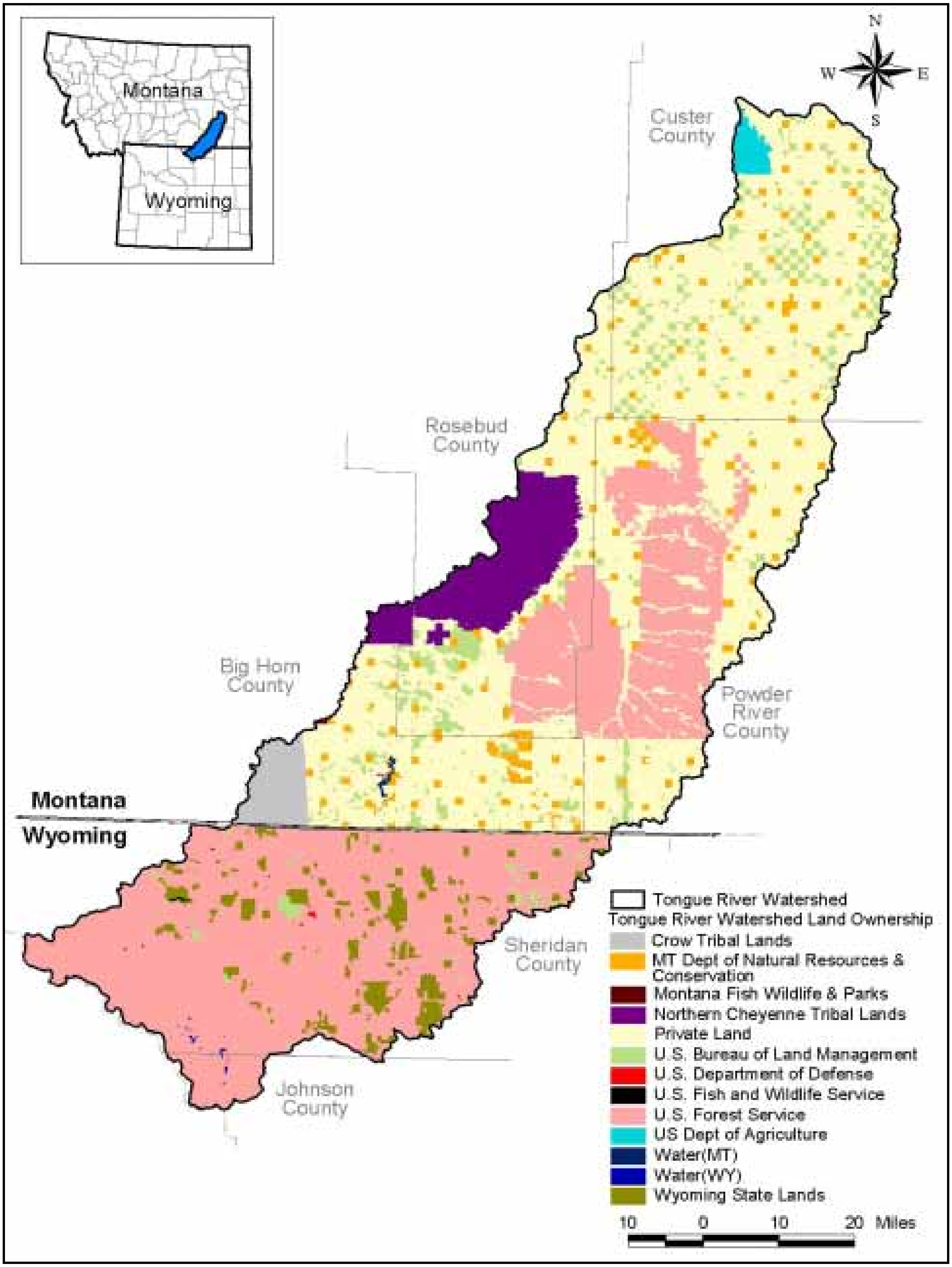

Figure 2-26. Land ownership in the Tongue River watershed.

Table 2-17. Land ownership by state in the Tongue River watershed.

Montana		
Land Ownership Description	**Area (Acres)**	**Percent**
Private land (undifferentiated)	1,490,614	61.5
U.S. Forest Service	405,061	16.7
Northern Cheyenne Tribal Lands	173,747	7.1
U.S. Bureau of Land Management	160,779	6.6
Montana State Lands	120,745	5.0
Crow Tribal Lands	54,757	2.2
Other U.S. Department of Agriculture	19,097	0.9
Total	2,424,800	100.0

Wyoming		
Land Ownership Description	**Acres (Acres)**	**Percent**
Private lands	633,821	61.5
U.S. Forest Service: National Forest	251,184	24.4
Wyoming State Lands	90,158	8.7
U.S. Forest Service: Wilderness Area	33,876	3.3
U.S. Bureau of Land Management	16,911	1.6
Wyoming State Wildlife Habitat Management Unit	3,307	0.3
U.S. Fish and Wildlife Service: National Wildlife Refuge	499	<0.1
U.S. Department of Defense	496	<0.1
U.S. Forest Service: Research Natural Area	124	<0.1
Total	1,030,377	100.0

2.2.3 Economics

The four counties in the Tongue River watershed in Montana – Big Horn County, Custer County, Powder River County, and Rosebud County – all support a primarily rural economy. Big Horn County has the most number of people of the four counties, but it does not have the largest work force (Table 2-18) (U.S. Census Bureau, 2000). Unemployment rates in 2000 were above the state average of 4.9 percent in Big Horn and Rosebud Counties, and below the state average in Custer and Powder River Counties (Table 2-19). Both the Northern Cheyenne and Crow Reservations also had unemployment rates above the Montana state average (MDLI, 2001).

The median income in 2000 for Big Horn, Custer, Powder River, and Rosebud Counties was $30,000, $35,898, $28,398, and $27,684, respectively (U.S. Census Bureau, 2000). Most people in Custer, Rosebud, and Big Horn Counties were employed by the educational, health, and social services sector (U.S. Census Bureau, 2000). The agriculture, forestry, fishing, hunting, and mining industry employed the most people in Powder River County (Table 2-20). A large percentage of people worked in the agriculture, forestry, fishing, hunting, and mining industry in all four counties. Table 2-21 summarizes the agricultural economics data for each county in the Tongue River watershed. On average, almost 40 million dollars in revenue for agricultural products were generated per county in 1997 (NASS, 1997).

Table 2-18. Summary of population and work force data per county.

County	Total Population	Total Population Greater than 15 Years Old	Number of People in the Labor Force	Total Number of Households
Big Horn	12,671	8,680	5,431	3,924
Custer	11,696	9,203	5,869	4,768
Powder River	1,858	1,424	961	737
Rosebud	9,383	6,611	4,288	3,307
Reservation				
Crow Reservation	10,083	NA	3,902	NA
Northern Cheyenne Reservation	7,473	NA	2,437	NA

Sources: U.S. Census Bureau, 2000; USDI, 2003.
Note: Population data are presented for the entire county or tribal area, not just the portion within the Tongue River watershed.

Table 2-19. Unemployment rates by county and reservation.

County	1995 Rate (%)	2000 Rate (%)	% Change
Big Horn	12.7	14.4	1.7
Custer	4.6	4.3	-0.3
Powder River	2.4	3.0	0.6
Rosebud	9.2	7.5	-1.7
Reservation	**1996 Rate (%)**	**1999 Rate (%)**	**% Change**
Crow Reservation	15.5	14.9	0.6
Northern Cheyenne Reservation	26.0	18.7	7.3

Source: MDLI, 2001 (adapted from USDI, 2003).
Note: Unemployment data are presented for the entire county, not just the portion within the Tongue River watershed.

Table 2-20. Percent employment by sector in 2000.

Industry	Custer County	Rosebud County	Powder River County	Big Horn County
Agriculture, forestry, fishing, hunting, and mining	10.6	19.6	43.0	14.6
Construction	5.1	4.8	4.0	6.7
Manufacturing	2.4	1.6	1.6	0.8
Wholesale trade	2.2	0.6	1.2	1.2
Retail trade	14.1	6.6	6.6	8.9
Transportation/warehousing/utilities	4.7	11.6	3.8	3.2
Information	1.4	2.1	1.9	0.5
Finance, insurance, real estate, and rental and leasing	4.0	2.2	2.3	3.5
Professional, scientific, management, administrative, and waste management services	3.6	2.8	1.5	2.9
Educational, health and social services	27.5	28.1	17.2	31.1
Arts, entertainment, recreation, accommodation and food services	10.0	9.2	7.6	9.0
Other services (except public administration)	5.9	3.9	3.5	2.7
Public administration	8.6	6.9	5.8	15

Source: U.S. Census Bureau, 2000.
Note: Employment data are presented for the entire county, not just the portion within the Tongue River watershed.

Table 2-21. Summary of agricultural economics data for 1997.

	Big Horn County	Custer County	Powder River County	Rosebud County	Average (Four Counties)
Farms (number)	530	405	297	362	399
Land in farms (acres)	2,770,118	1,897,536	1,559,222	2,680,844	2,226,930
Total cropland (acres)	407,958	170,277	165,614	122,605	216,614
Market value of agricultural products sold	$61,126,000	$32,586,000	$27,293,000	$37,666,000	$39,667,750
Market value of agricultural products sold, average per farm	$115,332	$80,459	$91,895	$104,049	$97,934

Source: NASS, 1997.
Note: Agricultural data are presented for the entire county, not just the portion within the Tongue River watershed.

2.3 Fisheries

The Montana Fisheries Information System (MFISH) contains information on fish species in Montana's rivers. Fish species in the Tongue River, Hanging Woman Creek, Otter Creek, Pumpkin Creek, and the Tongue River Reservoir are shown in Table 2-22. MFISH classified most of the Tongue River as a high-value fishery (NRIS, 2002). However, periodic dewatering is a concern to fish in the Tongue River between river miles 0.0 and 21.5. Pumpkin Creek, Otter Creek, and Hanging Woman Creek were all classified as substantial fisheries near their mouths, but were generally only moderate or limited fisheries in the middle and headwater segments. In the past, the Tongue River has been stocked with rainbow trout, brown trout, walleye, and shovelnose sturgeon. The Tongue River Reservoir has been stocked with northern pike, white crappie, walleye, and spottail shiner. No information was available for fish stocking in Hanging Woman Creek, Otter Creek, or Pumpkin Creek.

Table 2-22. Fish species in the Tongue River watershed, Montana.

Species	Hanging Woman Creek	Otter Creek	Pumpkin Creek	Tongue River	Tongue River Reservoir
Bigmouth Buffalo				x	
Black Bullhead	x	x	x	x	x
Black Crappie				x	x
Blue Sucker				x	
Brassy Minnow	x	x	x		
Brown Trout				x	
Burbot				x	
Channel Catfish			x	x	x
Common Carp	x	x	x	x	x
Creek Chub		x			
Fathead Minnow	x	x	x		
Flathead Chub		x	x	x	
Golden Shiner	x	x			
Goldeye			x	x	
Goldfish				x	
Green Sunfish	x	x	x	x	x
Lake Chub	x	x	x		
Largemouth Bass					x
Longnose Dace	x		x	x	
Longnose Sucker	x			x	x
Mountain Sucker			x	x	
Mountain Whitefish				x	
Northern Pike	x			x	x
Paddlefish				x	
Pumpkinseed	x	x	x	x	x
Rainbow Trout				x	
River Carpsucker	x	x	x	x	
Rock Bass	x	x		x	x
Sand Shiner	x	x	x		
Sauger	x		x	x	
Shorthead Redhorse	x	x	x	x	x
Shovelnose Sturgeon				x	
Smallmouth Bass	x	x		x	x
Smallmouth Buffalo				x	
Spottail Shiner					x
Stonecat	x	x	x	x	
Sturgeon Chub				x	
Walleye	x	x		x	x
Western Silvery/Plains Minnow			x		
White Crappie	x	x	x	x	x
White Sucker	x	x	x	x	x
Yellow Bullhead				x	x
Yellow Perch	x	x		x	x

Source: NRIS, 2002.

3.0 WATER QUALITY CONCERNS AND STATUS

This section of the document first presents the 303(d) list status of all listed water bodies within the TPA (i.e., which water bodies are listed as impaired or threatened and for which pollutants). This is followed by a description of the parameters of concern, the applicable water quality standards, a water body by water body review of available water quality data, and, finally, an updated water quality impairment status determination for each listed water body.

3.1 Montana 303(d) List Status

The Montana 1996 303(d) list reported that beneficial uses in the Tongue River, Tongue River Reservoir, Hanging Woman Creek, Otter Creek, and Pumpkin Creek were impaired for a variety of reasons. The listing information from the report is shown in Table 3-1. A revised listing for each segment appeared on Montana's 2002 303(d) list (Table 3-2). Figure 3-1 shows the location of the Tongue River watershed, major streams, and the impaired river segments from the 1996 303(d) list.

Table 3-1. 1996 listing information for the Tongue River watershed.

Segment	Size (mi)	Impaired Uses	Probable Cause	Probable Source
Tongue River (WY border to Tongue River Reservoir) (Tongue River Above Reservoir)	4	Agriculture Aquatic life Coldwater fishery	Flow alteration	Agriculture Irrigated crop production Natural sources
Tongue River Reservoir	3,500 acres	Aquatic life Coldwater fishery Swimmable	Nutrients Organic enrichment/ dissolved oxygen Suspended solids	Agriculture Municipal point sources
Tongue River (TRR Dam to the confluence with Hanging Women Creek) (Upper Tongue River)	31	Aquatic life Coldwater fishery	Flow alteration	Agriculture Flow regulation Irrigated crop production
Tongue River (Hanging Women Creek to diversion dam) (Middle Tongue River)	117.6	Agriculture Aquatic life Warmwater fishery	Flow alteration Metals Other inorganics Salinity/TDS/chlorides Suspended solids	Agriculture Flow regulation Irrigated crop production Natural sources
Tongue River (diversion dam to mouth) (Lower Tongue River)	20.4	Agriculture Aquatic life Warmwater fishery	Flow alteration Metals Other inorganics Salinity/TDS/chlorides Suspended solids	Agriculture Flow regulation Irrigated crop production Natural sources
Hanging Woman Creek	30	Agriculture Aquatic life Warmwater fishery	Flow alteration Metals Salinity/TDS/chlorides	Agriculture Irrigated crop production Natural sources
Otter Creek	53	Agriculture Aquatic life Warmwater fishery	Metals Other habitat alterations Salinity/TDS/chlorides Suspended solids	Agriculture Road/bridge construction Land development Natural sources
Pumpkin Creek	87	Agriculture Aquatic life Warmwater fishery	Flow alteration Salinity/TDS/chlorides Thermal modifications	Agriculture Irrigated crop production

Source: MDEQ, 1996.

Table 3-2. Montana 2002 listing information for the Tongue River watershed.

Segment	Size	Use	Use Status[a]	Probable Cause	Probable Source
Tongue River Reservoir	3,500 acres	B-2	Aquatic life (partial) Cold water fish (not assessed) Drinking water (not assessed) Swimming/recreation (partial) Agricultural (full) Industrial (full)	Algal growth/ chlorophyll-*a*	Domestic wastewater lagoon Agriculture
Tongue River from the diversion dam to the mouth	20.4 mi	B-3	Aquatic life (partial) Warm water fish (partial) Drinking Water (not assessed) Swimming/recreation (partial) Agricultural (full) Industrial (full)	Flow alteration	Dam construction Flow regulation/ modification Hydromodification
Hanging Woman Creek from Stroud Creek to the mouth	18.5 mi	C-3	Aquatic life (partial) Warm water fish (partial) Swimming/recreation (not assessed) Drinking water (not assessed) Agricultural (not assessed) Industrial (not assessed)	Siltation	Grazing Agriculture

[a]Not all uses have been assessed.
Source: MDEQ, 2002.

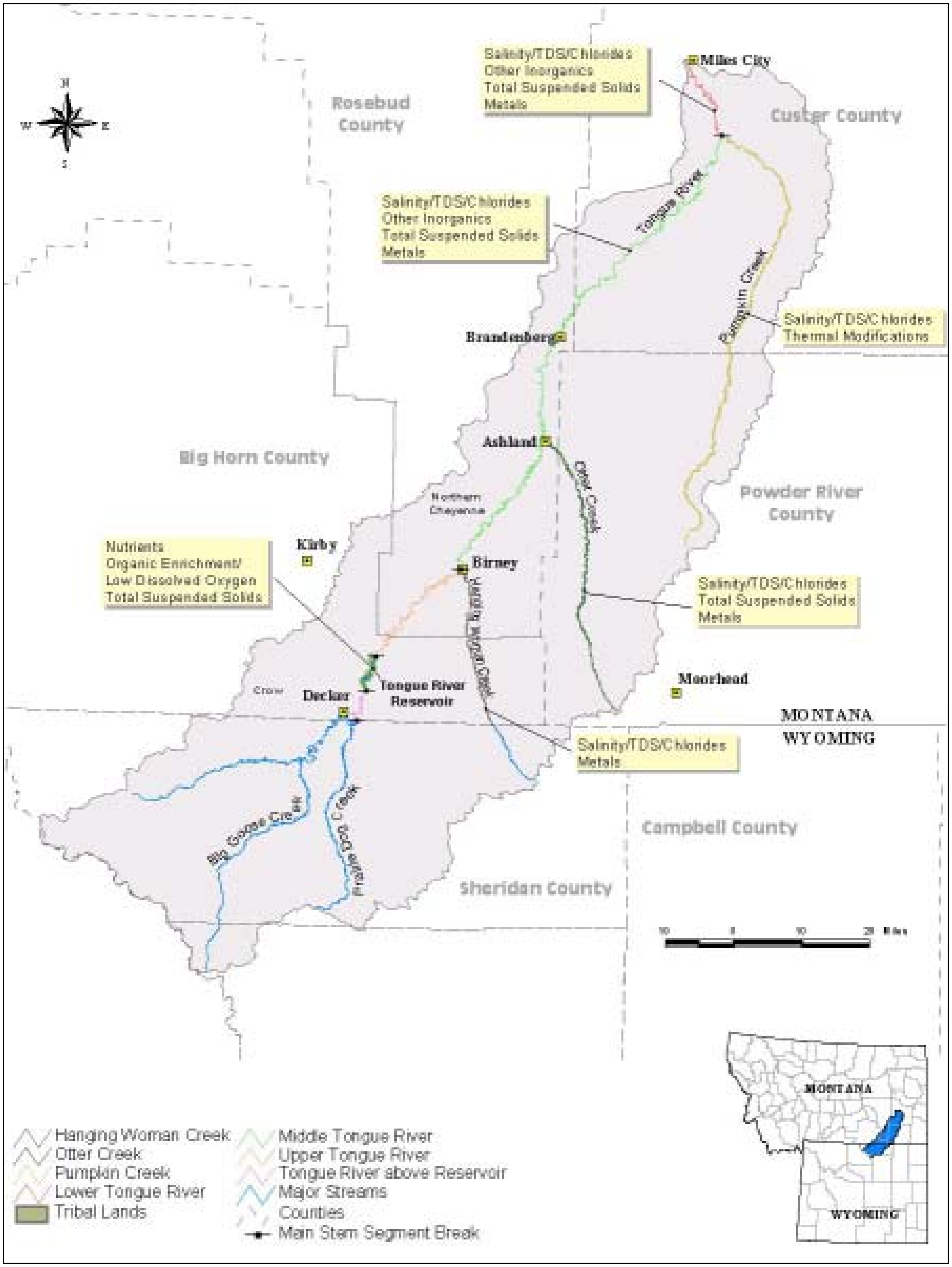

Figure 3-1. Location of the Tongue River and the 1996 303(d) listed streams.

3.2 Parameters of Concern

The following sections provide a summary of the parameters identified on the Montana 1996 303(d) list as causing impairments in the Tongue River watershed. The purpose of these sections is to provide an overview of the parameters, units, sampling methods, and potential sources. The relevance of the parameter to the various beneficial uses is also briefly discussed.

3.2.1 Salinity and Total Dissolved Solids

As water flows through a system, particles of soil, rock, and other materials accumulate in the water. The materials dissolve (or dissociate) in the water to form cations (positively charged ions) and anions (negatively charged ions). The term *salinity* refers to the total amount of dissolved cations and anions in water. Major ions in water are generally sodium, calcium, magnesium, potassium, chloride, sulfate, and bicarbonate. Metals (e.g., copper, lead, and zinc) and other trace elements (e.g., fluoride, boron, and arsenic) are usually only minor components of the total salinity. Salinity is determined by measuring the *conductance* of water, which is the opposite of resistance. This is done by sending an electrical current through the water and measuring the *electrical conductivity* (EC). The conductance of the water is corrected to a water temperature of 25 °C, and is sometimes then called *specific conductivity* (SC). In this report, all EC values are corrected to a water temperature of 25 °C. The units for EC are typically microsiemens per centimeter (µS/cm). EC is an easy and cost efficient measurement that can be performed in the field or the laboratory.

The sum of all of the dissolved substances in water is called *total dissolved solids* (TDS), and is measured in milligrams per liter (mg/L). TDS is a laboratory measurement and cannot be determined in the field. Pure distilled water has a TDS of zero. TDS concentrations in rainfall and snowfall vary, and generally range from zero to 10 milligrams per liter. In comparison, the average TDS for the lower segment of the Tongue River at USGS station 06308500 is 564 mg/L.

The salinity of a waterbody is important to many aquatic organisms because it regulates the flow of water into an out of an organism's cells (osmosis). Increases or decreases in salinity can cause a shift in the composition of the natural aquatic community. In the Tongue River, it is likely that many native aquatic organisms have adapted to the natural moderate salinity. The effects of salinity on non-native species (such as northern pike and rainbow trout) are unknown. Highly saline waters can adversely affect crop production depending on the amount of water applied and the salt tolerance of the crop. Livestock can also be adversely affected by high salinity values.

Natural sources, such as geology and soils, contribute to the salinity of a stream. Watersheds that have easily erodible soils, or parent materials with high salt concentrations, have streams and lakes that have naturally high salinity. However, there are also several potential anthropogenic sources of salinity. Anthropogenic sources of salinity can occur from agricultural irrigation returns, oil and gas returns (e.g., CBM wells and oil wells), disturbed land, road salting, and agricultural runoff. Proposed CBM development in the Tongue River watershed is a major potential source of salinity. Monitoring data reported by one CBM operating facility in Montana indicates a mean salinity of 2,207 µS/cm.

3.2.2 Chlorides

Chloride salts are common in the earth's crust and are easily dissolved in water. Sodium chloride is one such salt, and other major chloride salts are calcium chloride and magnesium chloride. These salts accumulate and dissolve in water as it flows through a watershed. Chloride concentrations are measured in the lab and are typically reported in milligrams per liter. Chloride is one of the many salts measured by salinity and TDS. Therefore any increases or decreases in the chloride concentrations of a waterbody will also cause changes in the salinity and TDS.

Chloride salts are one portion of the salinity of water, and the salinity of a waterbody is important to many aquatic organisms because it regulates the flow of water into an out of an organism's cells (osmosis). In the Tongue River, it is likely that many native aquatic organisms have adapted to the natural moderate chloride concentrations. The effects of chlorides on non-native species (such as northern pike and rainbow trout) are unknown. Chlorides alone can also be toxic to aquatic organisms (USEPA, 1988). Irrigation water with high chloride concentrations can adversely affect crop production depending on the amount of water applied and the salt tolerance of the crop. Livestock can also be adversely affected by high chloride concentrations.

Natural sources, such as geology and soils, contribute to the chloride concentrations of a stream. There are also several potential anthropogenic sources of chlorides. Potential anthropogenic sources of chlorides are irrigation returns, oil and gas returns (e.g., CBM wells, oil wells), road salting, and urban and agricultural runoff.

3.2.3 Sodium Adsorption Ratio

Sodium, magnesium, and calcium salts are naturally occurring in the bedrock and soils of the Tongue River watershed. These salts make their way into streams through weathering processes, runoff, and percolation. The concentrations of calcium, magnesium, and sodium ions in water are of interest because of the way they interact with soils. When high sodium concentrations are present in water with low calcium and magnesium concentrations, the sodium ions can disperse clay soils. This can change the soil structure and eventually render the soil hard and resistant to water and aeration. The relationship between calcium, magnesium, and sodium in streams is monitored to protect the agricultural uses of the waterbody. The relationship is called the sodium adsorption ratio (SAR), and it is the ratio of sodium to calcium plus magnesium in water. It is calculated with the following formula and the units for the ions are milliequivalents per liter (meq/L). The calculated values for SAR are unitless because it is a ratio.

$$SAR = \frac{Na^{+}}{\sqrt{\frac{(Ca^{++} + Mg^{++})}{2}}}$$

The SAR only impacts agricultural uses of a waterbody. The effect of high SAR values on aquatic life, livestock, or drinking water uses is unknown. Individually, calcium, magnesium, and sodium salts all contribute to the salinity of a waterbody.

Natural sources, such as geology and soils, contribute calcium, magnesium, and sodium to waterbodies and therefore affect the SAR. Potential anthropogenic sources of calcium, magnesium, and sodium can occur from agricultural irrigation returns, oil and gas returns (e.g., CBM wells, oil wells), disturbed land, road salting, and urban and agricultural runoff. Anthropogenic sources can increase the SAR by contributing high sodium loads to a waterbody. Proposed CBM development in the Tongue River watershed is a major potential source of SAR. Monitoring data reported by one CBM operating facility in

Montana indicates a mean SAR of approximately 47. For comparison, the average SAR at USGS station 06308500 in the lower Tongue River is 1.54.

3.2.4 Nutrients/Organic Enrichment/Low Dissolved Oxygen

The term *nutrients* usually refers to the various forms of nitrogen and phosphorus found in a waterbody. Both nitrogen and phosphorus are necessary for aquatic life, and both elements are needed at some level in a waterbody to sustain life. The natural amount of nutrients in a waterbody varies depending on the type of system. A pristine mountain spring might have little to almost no nutrients, whereas a lowland, mature stream flowing through wetland areas might have naturally high nutrient concentrations. Various forms of nitrogen and phosphorus can exist at one time in a waterbody, although not all forms can be used by aquatic life. Common phosphorus sampling parameters are total phosphorus (TP), dissolved phosphorus, and orthophosphate. Common nitrogen sampling parameters are total nitrogen (TN), nitrite (NO_2), nitrate (NO_3), total Kjeldahl nitrogen (TKN), and ammonia (NH_3). Concentrations are measured in the lab and are typically reported in milligrams per liter.

Nutrients generally do not pose a direct threat to the beneficial uses of a waterbody. However, excess nutrients can cause an undesirable abundance of plant and algae growth. This process is called eutrophication or organic enrichment. Organic enrichment can have many effects on a stream or lake. One possible effect of eutrophication is low dissolved oxygen concentrations. Aquatic organisms need oxygen to live and they can experience lowered reproduction rates and mortality with lowered dissolved oxygen concentrations. Dissolved oxygen concentrations are measured in the field and are typically reported in milligrams per liter. Ammonia, which is toxic to fish at high concentrations, can be released from decaying organic matter when eutrophication occurs. Recreational uses can be impaired because of eutrophication. Nuisance plant and algae growth can interfere with swimming, boating, and fishing. Nutrients generally do not pose a threat to agricultural uses.

Nitrogen and phosphorus exist in rocks and soils and are naturally weathered and transported into waterbodies. Organic matter is also a natural source of nutrients. Systems rich with organic matter (e.g., wetlands and bogs) can have naturally high nutrient concentrations. Phosphorus and nitrogen are potentially released into the environment through different anthropogenic sources including septic systems, wastewater treatment plants, fertilizer application, and animal feeding operations.

3.2.5 Metals

The metals of concern for the Tongue River watershed are cadmium, chromium, copper, iron, lead, nickel, silver, and zinc. For the purpose of this report, arsenic and selenium are also analyzed with the metals data. The procedures used to sample metals in the field and analyze metals in the laboratory have changed substantially over time. General speculation is that historical metals sampling results are often questionable because of possible contamination during collection and processing. New metals procedures set by USEPA have been implemented to ensure clean sampling results (USEPA, 1996). Analytical procedures in the laboratory now have better accuracy and lower detection limits, and smaller metals concentrations can be detected. Because some data are questionable, only metals data from 1996 to present are analyzed in this report. Metals data are typically reported in micrograms per liter (µg/L).

Metals usually present a threat to the health of aquatic life, animals, and humans because of toxicity. The toxic effects of some metals often change with the hardness of water. The effects on agricultural uses of water are not well known.

Potential sources of metals include natural sources (e.g., geology and soils) and anthropogenic sources such as industrial discharges, CBM, oil, and coal mine discharges, wastewater treatment plants, septic systems, and urban runoff.

3.2.6 Total Suspended Solids/Siltation

Excess total suspended solids (TSS) in a stream can pose a threat to aquatic organisms. Turbid waters created by excess TSS concentrations reduce light penetration, which can adversely affect aquatic organisms. Also, TSS can interfere with fish feeding patterns because of the turbidity. Prolonged periods of very high TSS concentrations can be fatal to aquatic organisms (Newcombe and Jensen, 1996). As TSS settles to the bottom of a stream, critical habitats such as spawning sites and macroinvertebrate habitats can be covered in sediment. This is referred to as *siltation*. Excess sediment in a stream bottom can reduce dissolved oxygen concentrations in stream bottom substrates, and it can reduce the quality and quantity of habitats for aquatic organisms. TSS can also pose a threat to recreational uses because of murky conditions and muddy stream bottoms. High levels of TSS in irrigation waters can clog irrigation ditches and drainage pumps.

Erosion and overland flow contribute some natural TSS to most streams. In watersheds with highly erodible soils and steep slopes, natural TSS concentrations can be very high. Excess TSS in overland flow can occur when poor land use and land cover practices are in place. This potentially includes grazing, row crops, construction activities, road runoff, and mining. Grazing and other practices that can degrade stream channels are other possible sources of TSS.

3.2.7 Thermal Modifications

A thermal modification impairment in a stream generally refers to a condition where some anthropogenic source, or a set of conditions caused by an anthropogenic source, has caused the natural temperature of a stream to increase to undesirable levels. Temperatures in the affected stream are usually compared to a reference stream of similar size and watershed type to determine if there is an impairment. Aquatic life beneficial uses can be impaired if the stream temperatures become detrimental to aquatic organisms. Agricultural uses are generally not affected by thermal modifications. Potential sources of thermal modifications are industrial discharges and urban runoff. The removal of riparian cover (trees and shrubs) can also increase stream temperatures because of reduced shading.

3.2.8 Other Inorganics (Sulfates)

Sulfur is found in the rocks and soils of southeastern Montana. Sulfur compounds from the rocks and soils form sulfate ions (SO_4^{-2}) when dissolved in water. Sulfate concentrations are measured in the lab and are typically reported in milligrams per liter (mg/L). Sulfate is one of the many components measured by salinity and TDS. Therefore any increases or decreases in the sulfate concentrations of a waterbody will also cause changes in the salinity and TDS.

Sulfates are one portion of the salinity of water, and the salinity of a waterbody is important to many aquatic organisms because it regulates the flow of water into an out of an organism’s cells (osmosis). In the Tongue River, it is likely that many native aquatic organisms have adapted to the natural moderate sulfate concentrations. The effects of sulfates on non-native species (such as northern pike and rainbow trout) are unknown. Irrigation water with high sulfate concentrations can adversely affect crop production depending on the amount of water applied and the salt tolerance of the crop. High concentrations of sulfate in water produce unpleasant odors and can have adverse health effects (laxative effect) on humans and livestock.

Natural sources, such as geology and soils, contribute to the sulfate concentrations of a stream. There are also several potential anthropogenic sources of sulfates. Potential anthropogenic sources of sulfates are irrigation returns, oil and gas returns (e.g., CBM wells, oil wells), and agricultural runoff.

3.3 Applicable Water Quality Standards

The Tongue River Watershed is regulated by four jurisdictional entities that could have applicable water quality standards including the State of Montana, the State of Wyoming, the Northern Cheyenne Tribe, and the Crow Tribe. The Crow Tribe does not, at this time, have approved or adopted water quality standards. As necessary, EPA and the Crow Tribe would use established EPA water quality criteria for any regulatory decisions (e.g., permit discharge limits). Wyoming standards are applicable to the Montana border and must be protective of downstream uses. The Northern Cheyenne Tribe has adopted water quality standards, however, these standards are currently pending review by the USEPA. Currently, the only water quality standards applicable to the waters within the Tongue River TPA are those promulgated by the State of Montana. Relative to salinity, the only approved and applicable water quality standards are narrative in form as promulgated by Administrative Rules of Montana Section 17.30.637.

The State of Montana is currently in the process of developing and adopting numeric criteria for EC and SAR to address salinity related issues potentially associated with future CBM discharges. As mentioned above, the Northern Cheyenne Tribal water quality standards for salinity are still pending review by the USEPA.

This section presents the current applicable water quality standards. It also presents the most up to date proposals regarding numeric criteria (as of the time that this report was prepared) including a status report regarding the proposed schedule for, and status of, their adoption.

The uncertainty regarding the timing of review and adoption of both Montana's and the Northern Cheyenne Tribe's water quality standards is acknowledged herein. It is also acknowledged that the standards presented in this section may change. These standards are presented to provide the best indication of water quality metrics available at this time with which to use as a basis for making water quality impairment determinations. All of the proposed standards are within the same relative range of values for protecting agricultural uses and are therefore considered appropriate for an initial screening of impairment. The final TMDL will be updated as appropriate to reflect the water quality standards that apply at that time.

3.3.1 Montana Standards

Waters in the Tongue River watershed are assigned B-2, B-3, and C-3 use classifications (ARM, 2002). Each classification is described below, and stream classes are shown in Figure 3-2. In general, all waters in the Tongue River have similar beneficial uses. Waters classified as B2 are higher quality waters that support salmonid fish species. B3 waters are similar to B2 waters except that non-salmonid species of fish are supported. Waters classified as C3 also support non-salmonid fish species, but only marginally support drinking, agricultural, and industrial water supplies.

- B-2: Waters classified B-2 are to be maintained suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and marginal propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.

- B-3: Waters classified B-3 are to be maintained suitable for drinking, culinary and food processing purposes, after conventional treatment; bathing, swimming and recreation; growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply.
- C-3: Waters classified C-3 are to be maintained suitable for bathing, swimming and recreation, and growth and propagation of non-salmonid fishes and associated aquatic life, waterfowl and furbearers. The quality of these waters is naturally marginal for drinking, culinary and food processing purposes, agriculture and industrial water supply. Degradation which will impact established beneficial uses will not be allowed.

3.3.1.1 Narrative Standards

Montana narrative standards address two basic concepts (1) activities that would result in nuisance aquatic life are prohibited, and (2) no increases are allowed over naturally occurring conditions of sediment, settleable solids, oils, or floating solids, which are harmful to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, and other wildlife (ARM, 2002). A summary of the narrative standards that apply to pollutants of concern in the Tongue River TPA is shown in Table 3-3. Aquatic life in the Tongue River TPA is protected by several different narrative standards that apply to all of the pollutants of concern. Aquatic life may not be harmed by any anthropogenic source of pollution (ARM 17.30.637(d)), and conditions that produce undesirable aquatic life are prohibited (ARM 17.30.637(e)). Agricultural uses are protected by ARM 17.30.637(d), which states that no anthropogenic source of pollution may create conditions that are harmful to plant or animal life. All of the beneficial uses of a waterbody, whether a direct narrative standard exists or not, must be protected.

Table 3-3. Summary of the Montana narrative water quality standards and affected pollutants.

Rule	Text	Affected Pollutants
ARM 17.30.637	No wastes may be discharged and no activities conducted such that the wastes or activities, either alone or in combination with other wastes or activities, will violate, or can reasonably be expected to violate, any of the standards.	All Parameters
ARM 17.30.637(d)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life.	All Parameters
ARM 17.30.637(e)	State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will create conditions which produce undesirable aquatic life.	All Parameters
ARM 17.30.624; 17.30.625; 17.30.629	The maximum allowable increase above naturally occurring turbidity is 10 nephelometric turbidity units except as permitted in ARM 17.30.637.	Total Suspended Solids Siltation
ARM 17.30.624; 17.30.625; 17.30.629	No increases are allowed above naturally occurring concentrations of sediment, settleable solids, oils, or floating solids which will or are likely to create a nuisance or render the waters harmful, detrimental, or injurious to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.	Total Suspended Solids Siltation
ARM 17.30.629	A 3 °F maximum increase above naturally occurring water temperature is allowed within the range of 32 F to 77 °F; within the range of 77 °F to 79.5 °F, no thermal discharge is allowed which will cause the water temperature to exceed 80 °F; and where the naturally occurring water temperature is 79.5 °F or greater, the maximum allowable increase in water temperature is 0.5 °F. A 2 °F per-hour maximum decrease below naturally occurring water temperature is allowed when the water temperature is above 55 °F, and a 2 F maximum decrease below naturally occurring water temperature is allowed within the range of 55 °F to 32 °F (B3 and C3 waters only)	Thermal Modifications

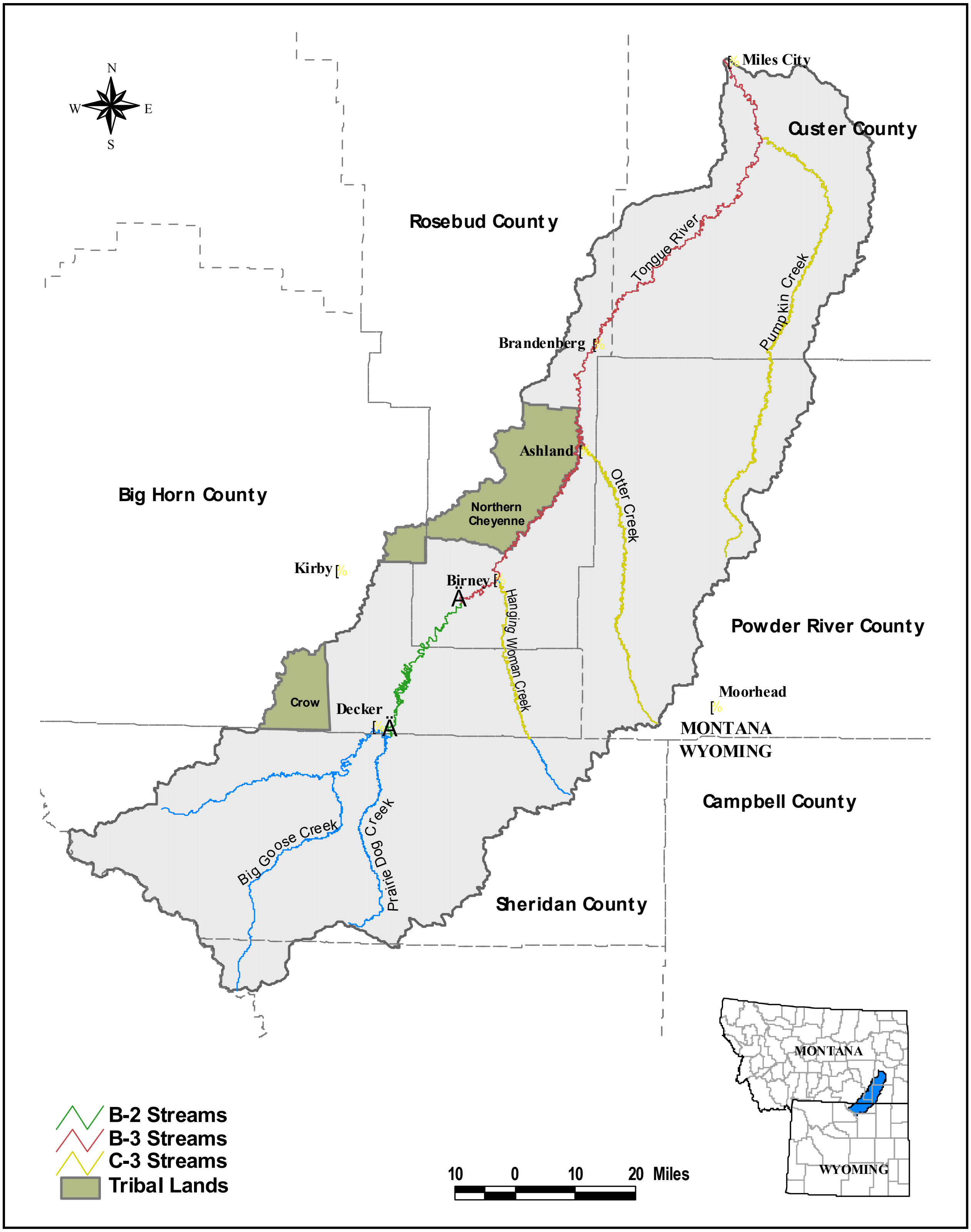

Figure 3-2. Beneficial use classifications in the Tongue River watershed.

3.3.1.2 Numeric Standards

Numeric surface water quality standards have been developed for the protection of beneficial uses. Montana currently has three sets of standards: (1) standards that vary by beneficial use, (2) standards that apply to all surface waters of the state, and (3) standards that apply to specific waters in the state. Numeric standards for all Montana surface waters are summarized in the Montana Department of Environmental Quality (MDEQ) Circular WQB-7 (MDEQ, 2002). The circular contains standards for numerous parameters for the protection of aquatic life and human health. All numeric standards that apply to impaired waters in the Tongue River watershed are summarized in Tables 3-4 and 3-5.

REVISED NUMERIC CRITERIA

On August 29, 2002, the Montana Board of Environmental Review proposed numeric water quality standards for the Tongue River, Powder River, Little Powder River, Rosebud Creek and their tributaries for electrical conductivity (EC) and sodium adsorption ratio (SAR). All available water quality data are compared to these proposed standards in the main text of this document. On December 6, 2002, the Montana Board of Environmental Review instructed DEQ to prepare a supplemental notice of rulemaking regarding the adoption of numeric water quality standards for the Tongue River, Powder River, Little Powder River, Rosebud Creek and their tributaries for EC and SAR. This supplemental notice included a revised set of numeric criteria for EC and SAR. Insufficient time was available to modify this document to include consideration of these revised criteria. DEQ's new standards proposal is presented in Appendix D. A preliminary comparison of the revised numeric criteria to available water quality data for the Rosebud Creek watershed is presented in Appendix E. The forthcoming final TMDL document will be based on consideration of the approved and adopted water quality standards (for all appropriate jurisdictions) available at that time.

The metals standards for Montana are for total recoverable (TR) metals in a waterbody. In some cases, dissolved metals data were collected in the Tongue River watershed. These data were compared to the Montana standards by converting the TR metals standards to dissolved standards using conversion factors developed by EPA (USEPA, 1996b). The conversion factors and the calculated dissolved standards are shown in Appendix F.

Montana has proposed standards for salinity (measured as EC at 25 degrees Celsius) and SAR (see text box) (MDEQ, 2002b, 2002c). Table 3-6 provides a summary of EC standards for the Tongue River watershed. These are the draft salinity standards proposed by MDEQ on August 29, 2002. The proposed SAR standard (August 29, 2002) varies depending on the salinity of the water. Under the proposed standards, the instantaneous SAR in a waterbody may not exceed the value given by the equation [(EC*0.0071) – 2.475]. At an EC of 350 µS/cm or less, the formula indicates that the allowable SAR is less than zero. Because of this nonsensical result, the formula does not apply when the EC is 350 µS/cm or less. When the formula given above for calculating the proposed SAR standard results in a value greater than 5, the SAR standard is 5. The proposed formula and conditions for SAR apply year-round to all waters in the Tongue River watershed. This is a draft SAR standard proposed by MDEQ at the time of this report. SAR standards might change in the future (see text box above). Montana water quality standards do not include numeric criteria for suspended solids, nutrients, or other inorganics.

Table 3-4. Montana numeric surface water quality standards for all waters in the state.

Parameter	Aquatic Life (acute) (μg/L)[a]	Aquatic Life (chronic) (μg/L)[b]	Human Health (μg/L)[a]
Aluminum (dissolved), (pH 6.5-9.0 only)	750	87	—
Arsenic (TR)	340	150	18
Barium (TR)	—	—	2,000
Cadmium (TR)	1.05 @ 50 mg/L hardness[c]	0.16 @ 50 mg/L hardness[c]	5
Chromium (III) (TR)	1,804 @ 100 mg/L hardness[c]	86 @ 100 mg/L hardness[c]	—
Copper (TR)	7.3 @ 50 mg/L hardness[c]	5.2 @ 50 mg/L hardness[c]	1,300
Iron (TR)	—	1,000	—
Lead (TR)	82 @ 100 mg/L hardness[c]	3.2 @ 100 mg/L hardness[c]	15
Nickel (TR)	261 @ 50 mg/L hardness[c]	29 @ 50 mg/L hardness[c]	100
Selenium	20	5	50
Silver (TR)	4.1 @ 100 mg/L hardness[c]	—	100
Zinc (TR)	67 @ 50 mg/L hardness[c]	67 @ 50 mg/L hardness[c]	2,000
Fecal coliforms	The geometric mean of fecal coliforms in waters in the Tongue River must be less than 200 coliforms per 100 mL and no more than 10 percent of the samples during a 30-day period shall exceed 400 coliforms per 100 mL. Numeric standards for fecal coliforms in the Tongue River watershed are only applied when the daily maximum water temperature is greater that 60 °F, and standards for organisms of the coliform group are based on a minimum of 5 samples obtained during separate 24-hour periods during any consecutive 30-day period analyzed by the most probable number or equivalent membrane filter methods.		
pH	Induced variation of hydrogen ion concentration (pH) within the range of 6.5 to 9.0 must be less than 0.5 pH units. Natural pH outside this range must be maintained without change. Natural pH above 7.0 must be maintained above 7.0.		

[a]Maximum allowable concentration.
[b]No 4-day (96-hour) or longer period average concentration may exceed these values.
[c]Standard is dependent on the hardness of the water, measured as the concentration of $CaCO_3$ (mg/L) (see Appendix F for the coefficients to calculate the standard).
Note: TR – total recoverable.

Table 3-5. Aquatic life standards for dissolved oxygen (mg/L).

Time Period	Use Class B-2		Use Classes B-3 and C-3	
	Early Life Stages[a]	Other Life Stages	Early Life Stages	Other Life Stages
30-day average	NA	6.5	NA	5.5
7-day average	9.5 (6.5)	NA	6.0	NA
7-day average minimum	NA	5.0	NA	4.0
1-day minimum	8.0 (5.0)	4.0	5.0	3.0

[a]These are water column concentrations recommended to achieve the required intergravel DO concentrations shown in parentheses. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.

Table 3-6. Proposed EC (µS/cm) standards for agricultural uses.

Waterbody	April 1–October 31 (Growing Season)	November 1–March 31 (Non-growing Season)
Tongue River	1,000	2,000
Tongue River tributaries	500	2,000

3.3.1.3 Petitioner Standards

Several different agencies in the Tongue River, Powder River, and Rosebud Creek watersheds have petitioned the Montana Board of Environmental Review to establish SAR and salinity standards. The agencies are the Tongue River Water Users (TRWU), Tongue and Yellowstone Irrigation District (T&Y), Buffalo Rapids Irrigation District (Buffalo Rapids), and Northern Plains Resource Council (Northern Plains). These four groups are collectively referred to as the Petitioners. Standards have been proposed for the Powder River, Tongue River, and Rosebud Creek (TRWU et al., 2002). Proposed standards are maximum values that are not to be exceeded. Values are shown in Table 3-7. At the time of this report, these standards were presented to the Montana Board of Environmental Review, and they are part of the formal rulemaking process to develop salinity and SAR standards for the Tongue River TPA. They are not to be interpreted as additional or enforceable standards for the watershed, and are simply presented here to illustrate the range of standards currently being considered.

Table 3-7. Petitioner proposed EC and SAR standards[a].

Segment and Season	EC (µS/cm)	SAR
Tongue River at the Wyoming Border		
Growing Season	600	0.5
Non-Growing Season	600	0.5
Tongue River at the Tongue River Reservoir Dam		
Growing Season	800	1.0
Non-Growing Season	800	1.0
Tongue River at the Mouth		
Growing Season	1,000	1.6
Non-Growing Season	1,200	2.5

[a]Maximum values not to be exceeded.
Source: TRWU et al., 2002.

3.3.1.4 Use Support Guidelines

Montana has use support guidelines to determine use impairments based on various sampling parameters. The aquatic life and fisheries use support guidelines for chemistry data consist of narrative and numeric criteria to determine use impairments (MDEQ, 2000). The guidelines for determining the degree of aquatic life use impairment using chemistry data (nutrients, DO, suspended solids, and temperature) are shown below.

> *Unimpaired* – Water quality standards are not exceeded for any pollutant; or the measurements are similar to reference conditions; and/or for one parameter only, the water quality standard is randomly exceeded by no more than 10 percent of the samples in a large dataset.

> *Moderately Impaired* – Water quality standards are exceeded by less than or equal to 50 percent

(parameters that do not have numeric values will be compared to reference conditions), or the water quality standards are exceeded by 11 to 25 percent of the samples from a large dataset.

Severely Impaired – Water quality standards are exceeded by more than 50 percent (parameters that do not have numeric values will be compared to reference conditions), or the water quality standards are exceeded by more than 25 percent of the measurements from a large dataset.

The guidelines for determining the degree of aquatic life use impairment because of metals include specifications for addressing acute and chronic criteria. The metals guidelines are shown below.

Unimpaired – No exceedance of acute or chronic standards, and/or the chronic standards are exceeded by less than 10 percent no more than once for one parameter in a three-year period when measurements were taken at least four times/year (quarterly).

Moderately Impaired – Acute standards are exceeded by less than 25 percent; and/or chronic standards are exceeded by 10-50 percent; and/or water quality standards are exceeded in no more than 10 percent of the measurements from a large data set.

Severely Impaired – Acute standards are exceeded by at least 25 percent; and/or chronic standards are exceeded by more than 50 percent; and/or water quality standards are exceeded in more than 10 percent of the measurements from a large data set.

Chronic Criteria Note – When possible, use the average concentration of samples collected over a 96-hour period and compare directly to chronic standard values; one data point (n=1) is sufficient if no other data were collected within 96 hours.

Use support guidelines also suggest that waterbodies should be compared to reference conditions where available. MDEQ states that reference conditions may be determined through a combination of the following:

- Comparison of the waterbody to a less impaired stream
- Historical data showing the previous condition of the waterbody
- Conditions in a less-impaired upstream or downstream segment of the same waterbody
- Conditions in a paired watershed
- A review of pertinent literature or expert opinion
- Modeling

Streams are not impaired when they are determined to be similar to reference conditions. They are moderately impaired when moderately different from reference conditions, and they are severely impaired when severely different from reference conditions. This narrative comparison is used to determine agricultural impairments due to salinity and SAR, as well as aquatic life impairments due to chemical parameters, habitat modification, and siltation.

3.3.2 Northern Cheyenne Tribal Standards

Based on the tribally adopted water quality standards (currently pending review by USEPA), the Tongue River is a beneficial use Class 1 coolwater stream from Cook Creek to the confluence with Logging Creek. From Logging Creek to the Northern Reservation border, the Tongue River is a Class 1 warmwater stream (NCEPD, 2002). Class 1 coolwater streams "provide for protection, propagation, and growth of coolwater fishes, as well as protection, growth, and propagation of associated aquatic life normally found where summer water temperatures do not often exceed 25 degrees Celsius." Class 1 warmwater streams "provide for protection, propagation, and growth of warmwater fishes, as well as protection, growth, and propagation of associated aquatic life normally found where summer water temperatures do not often exceed 35 degrees Celsius."

The Northern Cheyenne Tribe's narrative standards are similar to Montana's standards and address two basic concepts: (1) activities that would result in nuisance aquatic life are prohibited; and (2) no increases are allowed over naturally occurring conditions of sediment, settleable solids, oils, or floating solids, which are harmful to public health, recreation, safety, welfare, livestock, wild animals, birds, fish, or other wildlife.

Numeric standards for the Tongue River watershed are shown in Tables 3-8 and 3-9. The salinity (EC and TDS) standards are similar to the proposed Montana standards, but the SAR standards for the Tongue River and its tributaries are more stringent.

Table 3-8. Northern Cheyenne surface water quality standards.

Parameter	Aquatic Life (acute) (µg/L)	Aquatic Life (chronic) (µg/L)	Human Health (µg/L)[a]
Aluminum (TR), (pH 6.5-9.0 only)	750	87	
Arsenic	340	150	18
Barium			1,000
Cadmium[b]	2.0	0.025	
Chloride	860,000	230,000	
Chromium (III)[b]	570	74	
Copper[b]	13	9.0	1,300
Iron		1,000	300
Lead[b]	65	2.5	
Nickel[b]	470	52	610
Selenium		5.0	170
Silver[b]	3.4	0.12	
Zinc[b]	120	120	9,100

[a]Maximum allowable concentration.
[b]Standard is dependent on the hardness of the water, measured as the concentration of $CaCO_3$ (mg/L). Values are shown at 100 mg/L hardness (see Appendix F for the coefficients to calculate the standard).
Note: TR – total recoverable.

Table 3-9. Numeric standards for EC, TDS, and SAR for waters in the Northern Cheyenne Reservation.

	EC (µS/cm)	SAR	TDS (mg/L)
Southern Boundary			
Irrigation Period Average[a]	1,000	—	660
Year Round Maximum	2,000	2.0	1,320
Northern Boundary			
Irrigation Period Average[a]	1,500	—	990
Year Round Maximum	2,000	3.0	1,320
Tributaries			
Irrigation Period Average[a]	1,500	3.0	990
Year Round Maximum	2,000	3.0	1,320

[a]An "irrigation period average" is the 30-day average applicable during the period of active irrigation or water spreading, defined by the Tribe as April 1 through November 15, annually.

3.3.3 Wyoming Standards

Wyoming classifies most of the major streams in the Tongue River drainage as Class 2AB streams. These streams are protected for drinking water, game fish, nongame fish, fish consumption, other aquatic life, recreation, wildlife, agriculture, industry, and scenic value uses. The main stem of the Tongue River is a Class 2AB coldwater fishery stream. Other Class 2AB streams in Wyoming are Prairie Dog Creek and Goose Creek. Most of the tributaries to the Tongue River in Wyoming are classified as Class 3B streams and are protected for other aquatic life, recreation, wildlife, agriculture, industry, and scenic value uses.

3.3.3.1 Narrative Standards

Wyoming has narrative standards to protect all beneficial uses assigned to a waterbody, including industrial, agricultural, and aquatic life uses. Aquatic life uses are generally protected under Sections 28 and 32 of the standards which state that waters must be free of substances that "adversely alter the structure and function of indigenous or intentionally introduced aquatic communities", and no conditions may be produced which "cause undesirable aquatic life in a waterbody," (WDEQ, 2001). Agricultural uses of a waterbody are protected so that there shall be no "measurable decrease in crop or livestock production." Wyoming has chosen not to pursue numeric criteria for SAR and EC. SAR and EC impairments are determined by using the narrative standards and implementation procedures for determining those impairments. However, the implementation procedures for determining EC and SAR impairments were not available at the time of this report. A summary of the Wyoming narrative standards is shown in Table 3-10. All Wyoming standards can be accessed on the Internet at http://deq.state.wy.us.

3.3.3.2 Numeric Standards

Numeric surface water quality standards have been developed for the protection of beneficial uses in Wyoming waters. These standards apply to pollutants such as metals, fecal coliforms, pH, and other toxics (WDEQ, 2001). Standards are summarized in Tables 3-11 and 3-12.

Table 3-10. Summary of the Wyoming narrative water quality standards.

Rule	Text	Affected Pollutants
Section 13	Except for those substances referenced in Sections 21 (e) and (f) of these regulations, toxic materials attributable to or influenced by the activities of man shall not be present in any Wyoming surface water in concentrations or combinations which constitute "pollution".	Metals
Section 15	In all Wyoming surface waters, substances attributable to or influenced by the activities of man that will settle to form sludge, bank or bottom deposits shall not be present in quantities which could result in significant aesthetic degradation, significant degradation of habitat for aquatic life or adversely affect public water supplies, agricultural or industrial water use, plant life or wildlife.	Total Suspended Solids Siltation
Section 16	In all Wyoming surface waters, floating and suspended solids attributable to or influenced by the activities of man shall not be present in quantities which could result in significant aesthetic degradation, significant degradation of habitat for aquatic life, or adversely affect public water supplies, agricultural or industrial water use, plant life or wildlife.	Total Suspended Solids Siltation
Section 19	All Wyoming surface waters which have the natural water quality potential for use as an industrial water supply shall be maintained at a quality which allows continued use of such waters for industrial purposes. Degradation of such waters shall not be of such an extent to cause a measurable increase in raw water treatment costs to the industrial user(s). Unless otherwise demonstrated, all Wyoming surface waters have the natural water quality potential for use as an industrial water supply.	All Parameters
Section 20	All Wyoming surface waters which have the natural water quality potential for use as an agricultural water supply shall be maintained at a quality which allows continued use of such waters for agricultural purposes. Degradation of such waters shall not be of such an extent to cause a measurable decrease in crop or livestock production. Unless otherwise demonstrated, all Wyoming surface waters have the natural water quality potential for use as an agricultural water supply.	Salinity SAR
Section 23	In all cold water fisheries and drinking water supplies (classes 1, 2AB, 2A, and 2B), the discharge of substances attributable to or influenced by the activities of man shall not be present in quantities which would result in a turbidity increase of more than ten (10) nephelometric turbidity units (NTUs). (b) In all warm water or nongame fisheries (classes 1, 2AB, 2B and 2C), the discharge of substances attributable to or influenced by the activities of man shall not be present in quantities which would result in a turbidity increase of more than 15 NTUs.	Total Suspended Solids Siltation
Section 28	All Wyoming surface waters shall be free from substances and conditions or combinations thereof which are attributable to or influenced by the activities of man, in concentrations which produce undesirable aquatic life.	All Parameters
Section 32	Class 1, 2 and 3 waters of the state must be free from substances, whether attributable to human induced point source discharges or nonpoint source activities, in concentrations or combinations which will adversely alter the structure and function of indigenous or intentionally introduced aquatic communities.	All Parameters

Table 3-11. Summary of the numeric Wyoming surface water quality standards.

Parameter	Aquatic Life (acute) (μL)	Aquatic Life (chronic) (μL)	Human Health (μL)[b]
Aluminum, *(pH 6.5-9.0 only)*	750	87	
Arsenic	340	150	7
Barium			2,000
Cadmium[c]	4.3	2.2	5
Chloride	860,000	230,000	
Chromium (III)[c]	569.8	74.1	100
Copper[c]	13.4	9	1,000
Iron	1,000	300	
Lead[c]	64.6	2.5	15
Manganese[c]	3,110	1,462	50
Nickel[c]	468.2	52.0	100
Silver[c]	3.4		
Zinc[c]	117.2	118.1	5,000
Fecal coliforms	During the entire year, fecal coliform concentrations shall not exceed a geometric mean of 200 organisms per 100 mL (based on a minimum of not less than 5 samples obtained during separate 24-hour periods for any 30-day period), nor shall the geometric mean of 3 separate samples collected within a 24-hour period exceed 400 organisms per 100 mL in any Wyoming surface water.		
pH	For all Wyoming surface waters, wastes attributable to or influenced by the activities of man shall not be present in amounts which will cause the pH to be less than 6.5 or greater than 9.0 standard units. For all Class 1, 2 and 3 waters, effluent attributable or influenced by human activities shall not be discharged in amounts which change the pH to levels which result in harmful acute or chronic effects to aquatic life, directly or in conjunction with other chemical constituents, or which would not fully support existing and designated uses.		

[a]Metals criteria are for dissolved metals.
[b]No 4-day (96-hour) or longer period average concentration may exceed these values.
[c]Hardness-dependent criteria. Value given is an example only and is based on a $CaCO_3$ hardness of 100 mg/L. Criteria for each case must be calculated using a formula. See Appendix F.

Table 3-12 Minimum DO criteria[a] (mg/L) for Wyoming waters.

Period of Time	Coldwater Criteria		Warmwater Criteria	
	Early Life Stages[b,c]	Other Life Stages	Early Life Stages[c]	Other Life Stages
30-day mean	NA	6.5	NA	5.5
7-day mean	9.5 (6.5)	NA	6.0	NA
7-day mean minimum[d]	NA	5.0	NA	4.0
1-day minimum[d]	8.0 (5.0)	4.0	5.0	3.0

[a]These limitations apply to Class 1, 2A, 2B, and 2C waters only and in no case may be interpreted to require DO concentrations greater than 100 percent saturation at ambient temperature and elevation.
[b]These are water column concentrations recommended to achieve the required intergravel DO concentrations shown in parentheses. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.
[c]Includes all embryonic and larval stages and all juvenile forms to 30 days after hatching.
[d]All minima should be considered as instantaneous concentrations to be achieved at all times.

3.4 Water Quality Impairment Status

This section presents separate summaries and evaluations of all available water quality data for waters appearing on the Montana 1996 303(d) list. A preliminary analysis of the current beneficial use impairment status is also provided. In the absence of current, approved numeric water quality criteria, this section relies on the State's proposed numeric criteria, the Northern Cheyenne Tribe's adopted criteria discussed in Section 3.3.2, or appropriate surrogate targets where applicable. Water quality impairments were determined using the standards and data available at the time this report was written. Causes of impairment from the Montana 1996 303(d) list are analyzed. Also, each segment was evaluated for impairments due to salinity, TDS, chlorides, and SAR. A summary of the current impairment status is presented in Table 3-13, including the determination of whether a TMDL is required for each parameter. In general, impairment decisions cannot be made at this time due to a lack of numeric targets or insufficient data. Final water quality impairment determinations will be made in the future as described in Section 1.3. Supporting documentation is provided on a water body by water body basis in the remainder of this section.

Water chemistry data presented in the following sections were downloaded from the USGS National Water Information System (NWIS) database and from MDEQ's STOREASE database. USGS quality assurance/quality control standards (QA/QC) for data contained in the NWIS database are summarized on the NWIS web site at http://waterdata.usgs.gov/nwis/qwdata?help. These include protocols for sampling and analysis, as well as standards for data input and parameter codes. QA/QC standards for the STOREASE database are available from MDEQ's division of Planning, Prevention, and Assistance.

Additional water chemistry data for the Tongue River watershed were obtained from the Northern Cheyenne Tribe and the TRWU. All of the available data were input into a Microsoft Access database to allow for storage and retrieval on a site specific or watershed basis. Additional reports, such as macroinvertebrate and periphyton studies, NRCS, FWS, and other miscellaneous studies, were used to help determine water quality impairments. These reports are summarized and documented in the following sections where they are applicable.

Table 3-13. Water quality impairment status summary.

Segment	Evaluated Cause of Impairment	1996 303(d) List	2002 303(d) List[a]	TMDL Requirement
Tongue River (WY Border to Tongue River Reservoir) (Tongue River Above Reservoir)	Chlorides			No
	Flow alteration	✔		No
	Metals			Undetermined
	Salinity			Undetermined
	SAR			Undetermined
	TDS			Undetermined
Tongue River Reservoir	Algal growth/chlorophyll-*a*		✔	Undetermined
	Chlorides			No
	Nutrients	✔		Undetermined
	Organic enrichment/DO	✔		Undetermined
	Salinity			Undetermined
	SAR			Undetermined
	Suspended solids	✔		Undetermined
	TDS			Undetermined
Tongue River (TRR Dam to the confluence with Hanging Women Creek) (Upper Tongue River)	Chlorides			No
	Flow alteration	✔		No
	Metals			No
	Salinity			Undetermined
	SAR			Undetermined
	TDS			Undetermined
Tongue River (Hanging Women Creek to diversion dam) (Middle Tongue River)	Chlorides	✔		No
	Flow alteration	✔		No
	Metals	✔		Undetermined
	Other Inorganics	✔		Undetermined
	Salinity	✔		Undetermined
	SAR			Undetermined
	Suspended solids	✔		Undetermined
	TDS	✔		Undetermined
Tongue River (diversion dam to mouth) (Lower Tongue River)	Chlorides	✔		No
	Flow alteration	✔	✔	No
	Metals	✔		No
	Other Inorganics	✔		Undetermined
	Salinity	✔		Undetermined
	SAR			Undetermined
	Suspended solids	✔		Undetermined
	TDS	✔		Undetermined
Hanging Woman Creek	Chlorides	✔		No
	Flow Alteration	✔		No
	Metals	✔		Undetermined
	Salinity	✔		Undetermined
	SAR			Undetermined
	Siltation		✔	Undetermined
	TDS	✔		Undetermined
Otter Creek	Chlorides	✔		No
	Metals	✔		Undetermined
	Other habitat alterations	✔		No
	Salinity	✔		Undetermined
	SAR			Undetermined
	Suspended solids	✔		Undetermined
	TDS	✔		Undetermined

Segment	Evaluated Cause of Impairment	1996 303(d) List	2002 303(d) List[a]	TMDL Requirement
Pumpkin Creek	Chlorides	✔		Undetermined
	Flow alteration	✔		Undetermined
	Salinity	✔		Undetermined
	SAR			Undetermined
	TDS	✔		Undetermined
	Thermal modifications	✔		Undetermined

[a]Not all causes of impairment were evaluated for the 2002 303(d) list.
Source: MDEQ, 1996, 2002.

3.4.1 Tongue River

The sections below describe the available water quality data for streams in the Tongue River watershed. Data include water quality, macroinvertebrate, periphyton, and habitat analyses. The data were obtained from USGS, MDEQ, TRWU, and the Northern Cheyenne Tribe.

The Montana 1996 303(d) list reported that the Tongue River from Hanging Woman Creek to the Tongue River Diversion Dam was impaired because of flow alterations, metals, other inorganics, salinity/TDS/chlorides, and total suspended solids (TSS) (MDEQ, 1996). The Tongue River from the diversion dam to the mouth was also impaired because of flow alterations, metals, other inorganics, salinity/TDS/chlorides, and TSS. Impairments due to other inorganics are believed to refer to sulfates. Agricultural, aquatic life, and fishery uses were impaired by these causes in both segments of the Tongue River.

The Montana 2002 303(d) list reported that the Tongue River from the mouth to the Tongue River Diversion Dam was impaired because of flow alterations (MDEQ, 2002). Aquatic life, fishery, and swimming/recreation beneficial uses were all partially impaired by flow alterations. The middle Tongue River fully supported agricultural uses in 2002. Aquatic life, fishery, drinking water, swimming/recreation, and industrial beneficial uses were not assessed in the middle Tongue River for the 2002 303(d) report because of insufficient credible data. The upper Tongue River and the Tongue River above the Tongue River Reservoir fully supported agricultural and industrial beneficial uses in 2002. Aquatic life, fishery, drinking water, and swimming/recreation beneficial uses were not assessed in the upper Tongue River and the Tongue River above the reservoir for the 2002 303(d) report because of insufficient credible data.

The discussion below provides a review of available data to evaluate the water quality impairment status.

3.4.1.1 Macroinvertebrates and Periphyton

The algae community at six sites in the Tongue River was sampled in August 2001. The analysis indicated cool, fresh waters and good to excellent biological integrity at most sites (Bahls, 2001). However, aquatic life uses were moderately impaired in the Tongue River near Brandenburg due to habitat alterations (Figure 3-3). The siltation index indicated moderate impairment upstream of the Tongue River diversion dam. No other sites with impairments were identified in this study. A periphyton study from 1977 found that algae in the Tongue River on average indicated a moderately enriched, hardwater environment with excessive sediment and salinity near the mouth of the river (Bahls and Bahls, 1977). Biological stress was found immediately below the Tongue River Reservoir Dam and near the mouth at Miles City.

Aquatic invertebrates were sampled at seven sites on the Tongue River on September 21 and 22, 2001 (Figure 3-3) (Bollman, 2002a). The results from the sampling were compared to MDEQ's provisional reference criteria for Montana plains region streams. Site B1 above the Tongue River Reservoir was the only site with both no identified impairments and fully supported beneficial uses. Station B6 was the only other site with fully supported beneficial uses. Slight impairments were identified at stations B2 through B6, and beneficial uses were only partially supported at stations B2, B3, B4, B5, and B7. The conclusions from the Bollman report are shown below and indicate that the only site with truly impaired beneficial uses is site B7 near the mouth of the Tongue River.

> *At most Tongue River sites, good water quality and intact instream habitats are suggested by the taxonomic and functional composition of benthic assemblages, in spite of relatively low bioassessment scores at some sites. High mayfly taxa richness and the presence of sensitive taxa such as Rhithrogena sp. at several sites strongly support the hypothesis of generally good water quality at these sites. The moderate impairment classification assigned to the site at the mouth of the river seems to exaggerate the disturbance there. However, information provided by the project manager (P. Newby, personal communication) suggests that dewatering and resultant elevated water temperatures may be factors in the relatively low score there.*

Station B7 was previously sampled in July 2001 (Bollman, 2002b). Habitat at the time of sampling was ranked as marginal because of monotonous substrate, severe siltation, and poor riffle development. Moderate macroinvertebrate impairments were found at the time of sampling and the site was only partially supporting aquatic life uses. However, a lack of organisms at this site at the time of sampling complicated the impairment determination.

3.4.1.2 Fish

A recent analysis of fish populations in the Tongue River found that the fish populations have been adversely affected by changes in flow due to diversion dams and withdrawals (Trenka, 2000). Trenka found that the Tongue River channel has become narrower and more uniform in depth, and that altered flows have caused shifts in the macroinvertebrate and fish communities.

3.4.1.3 Water Chemistry Assessment

MDEQ, USGS, TRWU, and the Northern Cheyenne Tribe analyzed water chemistry data at stations throughout the Tongue River watershed (Figure 3-3). The different agencies often assigned different station names to similar sites. For the purpose of this report, all data sampled at similar sites were analyzed together and only one station number is reported.

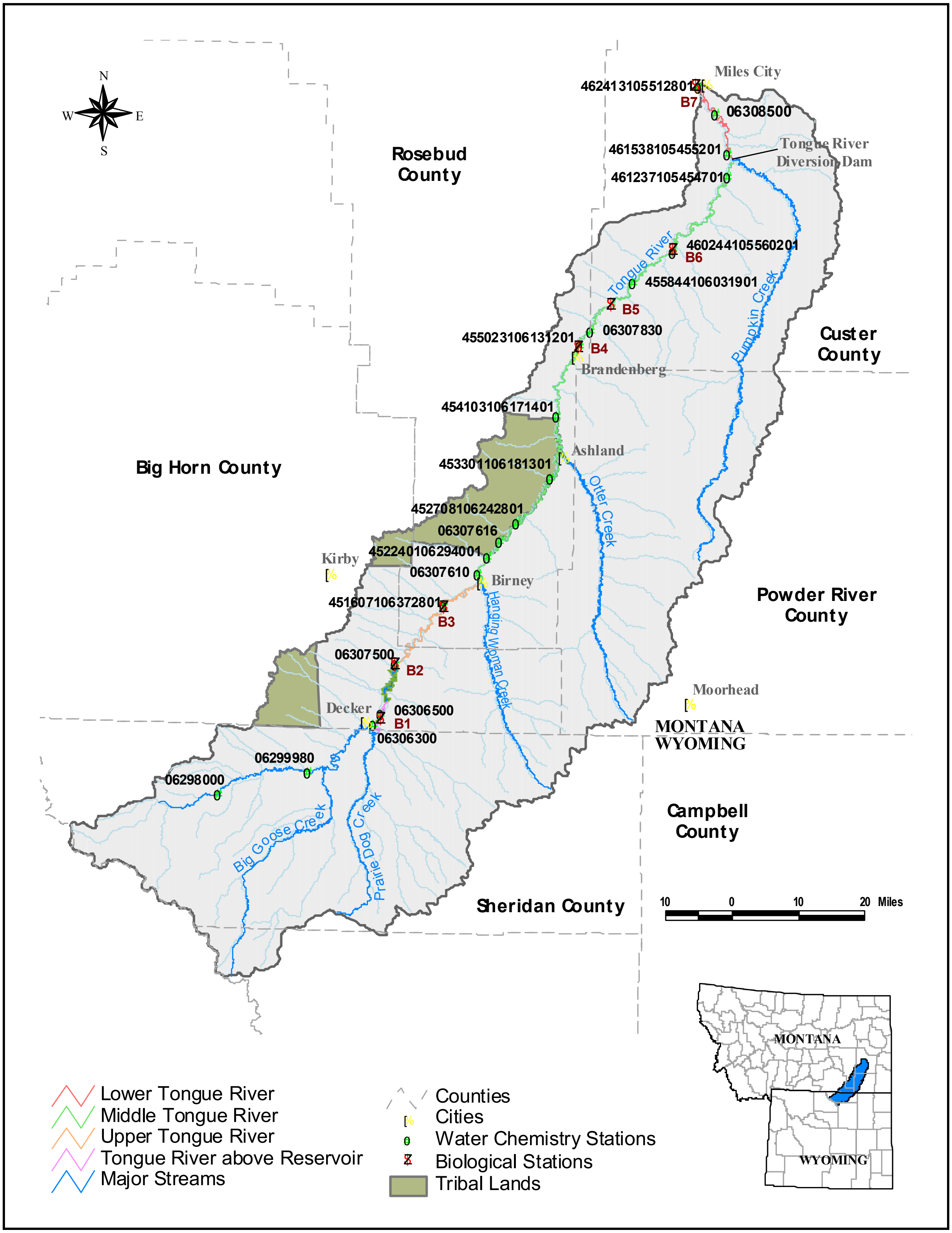

Figure 3-3. Tongue River monitoring stations.

3.4.1.3.1 Salinity

A total of four segments of the Tongue River and the Tongue River Reservoir appeared on the Montana 1996 303(d) list – Tongue River Above the Reservoir, Upper Tongue River, Middle Tongue River, and the Lower Tongue River. As described in Section 3.4.1, two segments of the Tongue River (i.e., the lower and middle Tongue River) were listed as impaired for salinity on the 1996 list. None of the segments of the Tongue River appeared on the 2002 303(d) list as a result of salinity. All four segments were fully supporting agricultural uses in 2002, and salinity was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of all segments of the Tongue River to verify the impairment status relative to salinity.

MDEQ has proposed salinity standards (measured as EC, at 25 °C) for rivers in the Tongue River watershed. Separate standards were proposed for the main stem of the Tongue River and the Tongue River tributaries. Separate standards have also been proposed for the growing season (April 1 through October 31) and the non-growing season (November 1 through March 31). The salinity standards are draft standards proposed at the time of this report. The standards might change in the future.

EC data for all segments of the Tongue River are summarized in Tables 3-14 and 3-15. Figure 3-4 shows that there has been little yearly variation in EC values in the lower Tongue River over a 40-year period. Twenty-four percent of the current samples in the lower Tongue River exceeded the salinity criterion during the growing season (Table 3-16). Declining trends in EC data were apparent in the middle and upper segments of the Tongue River (Figures 3-5 and 3-6). Few EC values exceeded any of the proposed standards in the middle and upper Tongue River (Tables 3-17 and 3-18). The majority of EC values exceeded the Petitioner's criteria in the Tongue River above the reservoir (Table 3-19). However, only 14 percent of the samples exceeded MDEQ's proposed criteria. Most of the data in Tongue River above the reservoir exceeding MDEQ's proposed criteria were sampled in the summer of 2001 (Figure 3-7). EC values in the Tongue River in Wyoming were much lower than in downstream segments (Figure 3-8).

Growing season values were generally lower than non-growing season values; this is partially explained by the relationship between flow and EC. Figure 3-9 shows that EC varies with flow at station 06307616 in the middle Tongue River. Higher EC values were found during low-flow periods, which correspond to the non-growing season in the Tongue River watershed. A weaker relationship between flow and EC was found at station 06308500 in the lower Tongue River (Figure 3-10). This might be explained by the presence of the Tongue River diversion dam and possible irrigation return flows in this segment. Figure 3-11 shows that the average monthly EC values are lowest in May through July.

A final water quality impairment determination will not be made for salinity (EC) until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria (see Section 3.3.1.2).

Table 3-14. Summary of EC data, Tongue River (µS/cm) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
461538105455201	2	970	970	970	0%	11/4/77	11/4/77
462413105512801	1	940	940	940		11/5/77	11/5/77
6308500	247	941	252	2,480	25%	11/1/62	3/28/01
Middle Tongue							
452240106294001	2	810	810	810	0%	11/3/77	11/3/77
452708106242801	2	840	840	840	0%	11/3/77	11/3/77
453301106181301	1	840	840	840	NA	11/3/77	11/3/77
454103106171401	1	890	890	890	NA	11/4/77	11/4/77
455023106131201	7	1,143	910	1,463	19%	11/3/75	3/23/79
455844106031901	1	890	890	890	NA	11/4/77	11/4/77
460244105560201	7	1,144	940	1,475	19%	3/22/74	11/4/77
461237105454701	1	910	910	910	NA	11/4/77	11/4/77
590	6	979	886	1,014	5%	1/17/74	12/4/75
591	7	949	720	1,000	11%	12/5/75	1/29/77
6307610	38	921	368	1,310	16%	1/30/74	3/28/79
6307616	78	808	590	1,080	13%	11/1/77	3/27/01
6307830	51	934	420	1,300	15%	11/19/74	3/18/02
761	1	1,024	1,024	1,024	NA	3/22/74	3/22/74
Upper Tongue							
364	8	913	768	1,109	15%	11/4/75	11/5/79
451607106372801	2	822	810	833	2%	11/3/77	11/3/77
6307500	136	756	485	996	12%	3/25/75	3/7/01
TRWU1	6	551	409	814	33%	11/8/00	11/14/01
TRWU4	10	707	437	821	20%	11/8/98	12/19/01
Tongue River Above Reservoir							
133	2	761	760	761	0%	3/25/75	11/1/77
134	3	982	878	1,061	10%	1/30/74	12/18/75
6306300	63	676	232	991	16%	11/4/85	3/18/02
6306500	1	752	752	752	NA	2/27/02	2/27/02
TRWU2	1	580	580	580	NA	11/14/01	11/14/01
TRWU3	1	291	291	291	NA	11/14/01	11/14/01
TRWU5	1	608	608	608	NA	11/14/01	11/14/01
TRWU7	6	583	542	636	6%	1/28/01	12/19/01
TRWU8	6	758	691	828	6%	1/28/01	12/19/01
Tongue River in Wyoming							
6298000	92	272	200	360	8%	11/14/66	03/07/00
6299980	32	481	310	640	13%	11/13/74	03/15/83

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-15. Summary of EC data, Tongue River (µS/cm) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
1437	2	926	900	951	4%	6/27/77	6/27/77
461538105455201	1	1,506	1,506	1,506	NA	8/17/01	8/17/01
462413105512801	6	977	846	1,082	10%	9/7/78	10/28/01
6308500	480	743	274	1,500	30%	10/1/59	7/23/02
Middle Tongue							
1320	2	876	850	902	4%	6/27/77	6/27/77
452708106242801	2	774	680	868	17%	9/7/78	10/19/78
455023106131201	13	830	429	1,060	22%	9/28/75	10/26/01
455844106031901	3	926	835	1,080	15%	9/7/78	10/27/01
460244105560201	4	1,012	881	1,219	16%	10/20/75	9/22/01
590	4	480	320	776	43%	8/8/74	5/19/77
591	6	633	400	975	35%	4/21/76	10/20/76
6307610	51	643	280	1,130	33%	4/11/74	9/13/79
6307616	165	563	198	1,030	35%	10/2/79	10/26/01
6307830	99	688	260	1,260	32%	4/10/74	8/13/02
679	2	781	750	811	6%	6/24/77	6/24/77
967	2	930	900	960	5%	6/27/77	6/27/77
TR022	1	783	783	783	NA	10/26/01	10/26/01
TR032	1	866	866	866	NA	9/22/01	9/22/01
Upper Tongue							
364	22	609	270	942	33%	10/21/75	7/19/90
451607106372801	3	696	629	750	9%	8/17/01	10/26/01
6307500	243	531	190	958	36%	8/8/74	10/26/01
TRWU1	10	669	587	797	11%	6/8/01	10/27/01
TRWU4	15	666	570	801	11%	5/28/01	10/27/01
Tongue River Above Reservoir							
133	6	611	275	941	40%	4/16/75	6/15/77
134	10	416	196	811	59%	7/1/75	9/24/77
6306300	134	508	163	1,280	51%	10/16/85	8/7/02
6306500	5	885	587	1,354	34%	8/14/85	10/26/01
TRWU2	10	570	419	720	15%	6/8/01	10/27/01
TRWU3	10	327	219	498	21%	6/8/01	10/27/01
TRWU5	9	672	469	940	23%	6/8/01	10/27/01
TRWU6	9	1,739	1,721	1,777	1%	6/8/01	10/27/01
TRWU7	16	636	385	866	20%	5/28/01	10/27/01
TRWU8	16	837	405	1,332	34%	5/28/01	10/27/01
Tongue River in Wyoming							
6298000	153	216	50	310	21%	10/10/66	09/12/00
6299980	59	397	170	660	31%	04/03/74	09/20/83

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-16. Summary of EC exceedances, lower Tongue River.

Season	Salinity Criteria (µS/cm)	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
***MDEQ*[a]**							
Growing Season[b]	1,000	489	63	13%	42	10	24%
Non-Growing Season	2,000	250	1	0%	14	0	0%
Northern Cheyenne – Northern Border							
Irrigation period[c,d] (average)	1,500	270	0	0%	37	0	0%
Year Round Maximum	2,000	739	1	0%	56	0	0%
***Petitioners (Tongue River at the mouth)*[a]**							
Irrigation Season[b]	1,000	489	63	13%	42	10	24%
Non Irrigation Season	1,200	250	19	8%	14	0	0%

[a]Maximum value.
[b]Irrigation season is from April 1 to October 31.
[c]Irrigation period average is the 30-day average applicable during the period of active irrigation or water spreading, defined by the Tribe as April 1 to November 15, annually. Monthly averages are evaluated.
[d]Average values per month per year are evaluated for the purpose of this analysis.

Table 3-17. Summary of EC exceedances, middle Tongue River.

Season	Salinity Criteria (µS/cm)	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
***MDEQ*[a]**							
Growing Season[b]	1,000	355	16	5%	64	1	2%
Non-Growing Season	2,000	203	0	0%	18	0	0%
Northern Cheyenne – Northern Border							
Irrigation period[c,d] (average)	1,500	186	0	0%	36	0	0%
Year Round Maximum	2,000	558	0	0%	82	0	0%
***Petitioners (Tongue River at the mouth)*[a]**							
Irrigation Season[b]	1,000	355	16	5%	64	1	2%
Non Irrigation Season	1,200	203	6	3%	18	0	0%

[a]Maximum value.
[b]Irrigation season is from April 1 to October 31.
[c]Irrigation period average is the 30-day average applicable during the period of active irrigation or water spreading, defined by the Tribe as April 1 to November 15, annually. Monthly averages are evaluated.
[d]Average values per month per year are evaluated for the purpose of this analysis.

Table 3-18. Summary of EC exceedances, upper Tongue River.

Season	Salinity Criteria (µS/cm)	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
MDEQ[a]							
Growing Season[b]	1,000	293	0	0%	54	0	0%
Non-Growing Season	2,000	162	0	0%	24	0	0%
Northern Cheyenne – Southern Border							
Irrigation period[c,d] (average)	1,000	166	0	0%	29	0	0%
Year Round Maximum	2,000	455	0	0%	78	0	0%
Petitioners (Tongue River at the Tongue River Reservoir Dam)[a]							
Irrigation Season[b]	800	293	26	9%	54	3	6%
Non Irrigation Season	800	162	52	32%	24	4	17%

[a]Maximum value.
[b]Irrigation season is from April 1 to October 31.
[c]Irrigation period average is the 30-day average applicable during the period of active irrigation or water spreading, defined by the Tribe as April 1 to November 15, annually. Monthly averages are evaluated.
[d]Average values per month per year are evaluated for the purpose of this analysis.

Table 3-19. Summary of EC exceedances, Tongue River above the reservoir.

Season	Salinity Criteria (µS/cm)	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
MDEQ[a]							
Growing Season[b]	1,000	225	18	8%	130	18	14%
Non-Growing Season	2,000	84	0	0%	43	0	0%
Petitioners (Tongue River at the Montana-Wyoming border)[a]							
Irrigation Season[b]	600	225	103	46%	130	70	54%
Non Irrigation Season	600	84	64	76%	43	26	60%

[a]Maximum value.
[b]Irrigation season is from April 1 to October 31.

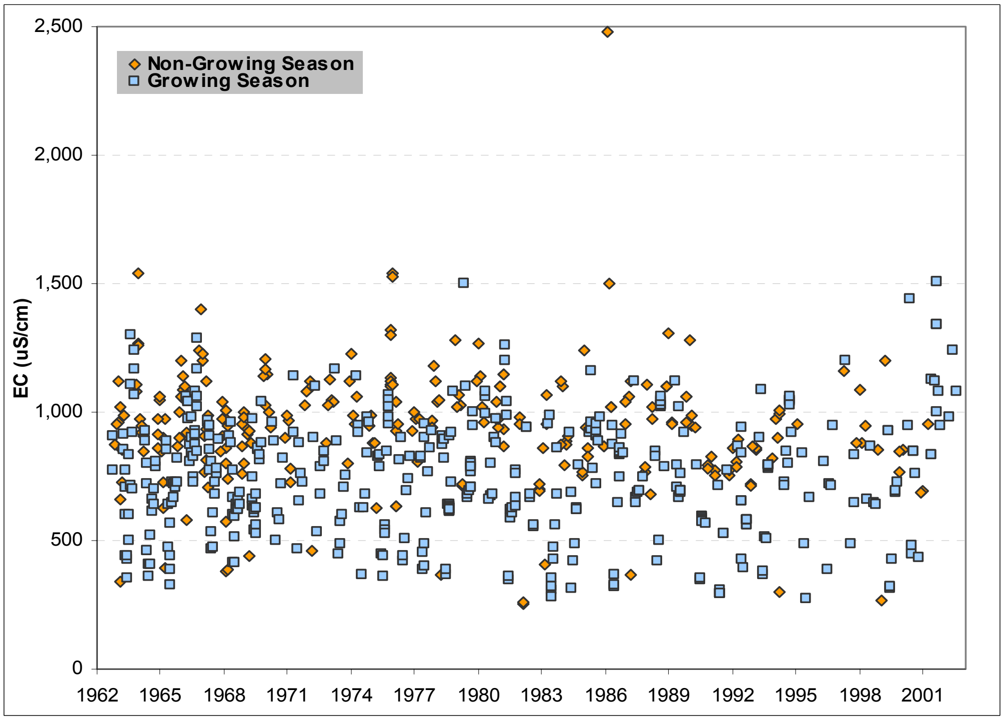

Figure 3-4. EC data for the lower Tongue River (all stations).

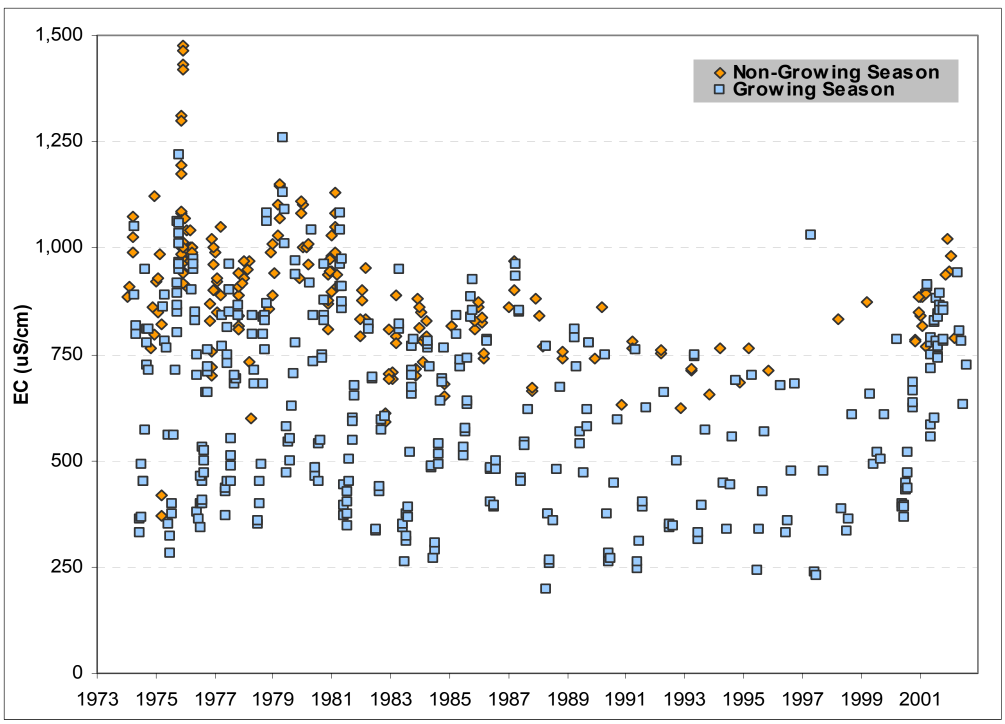

Figure 3-5. EC data for the middle Tongue River (all stations).

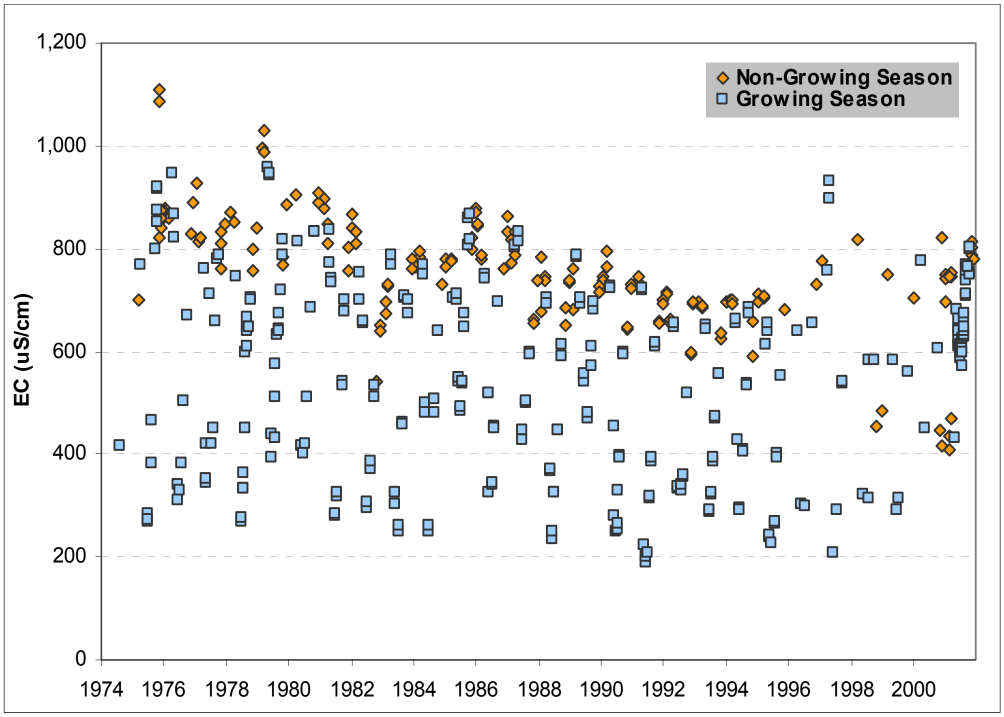

Figure 3-6. EC data for the upper Tongue River (all stations).

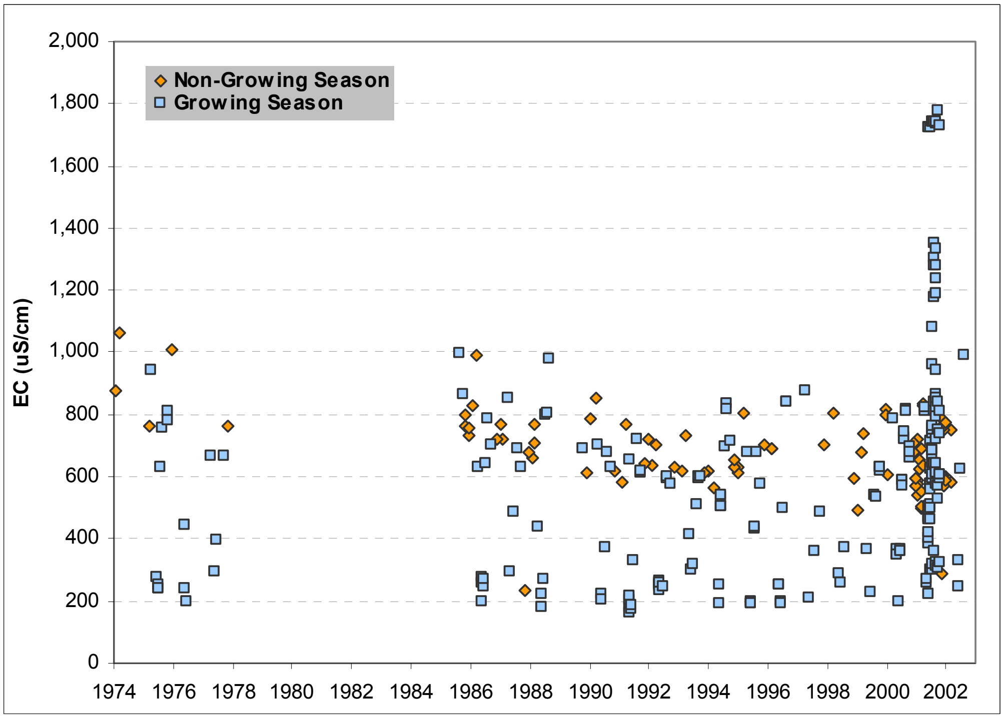

Figure 3-7. EC data for the Tongue River above the reservoir (all stations).

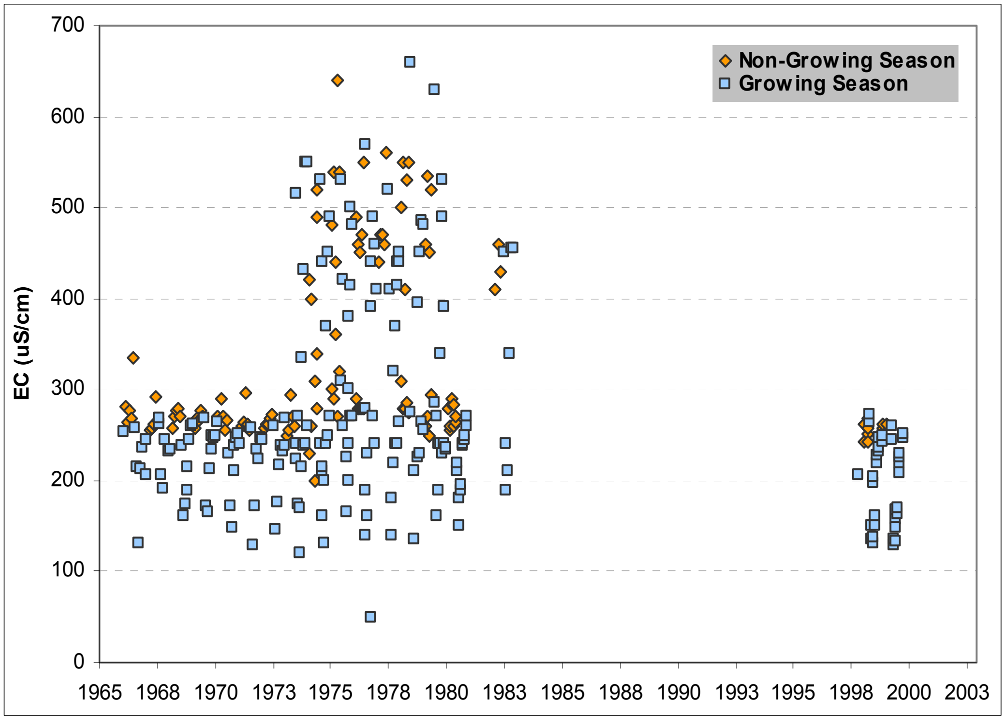

Figure 3-8. EC data for the Tongue River in Wyoming (all stations).

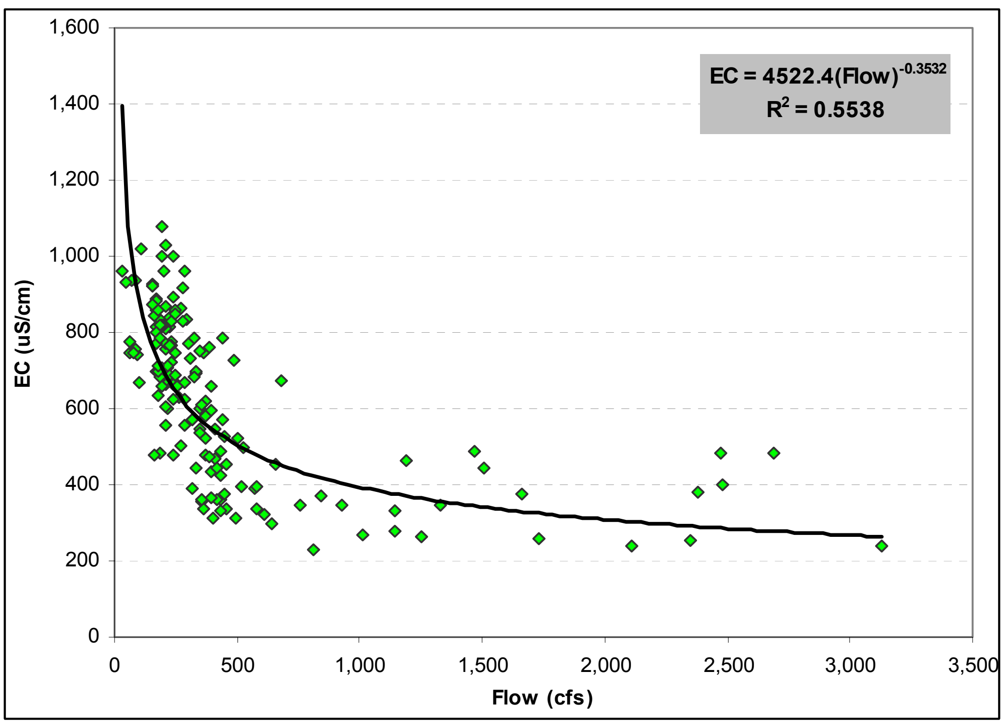

Figure 3-9. Relationship between EC and flow at station 06307616.

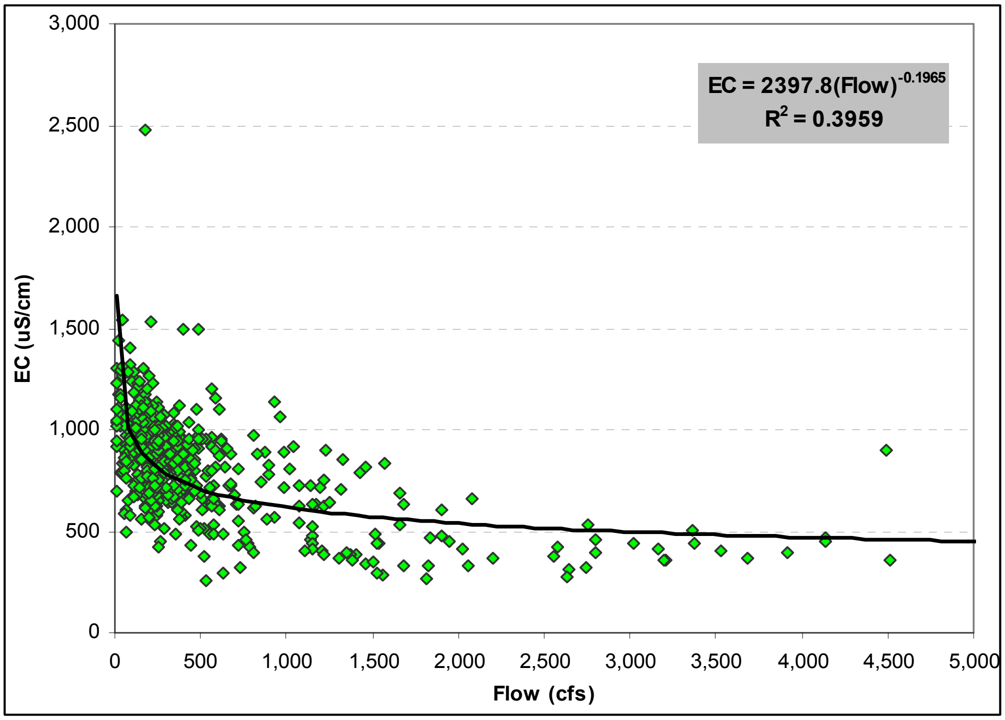

Figure 3-10. Relationship between EC and flow at station 06308500.

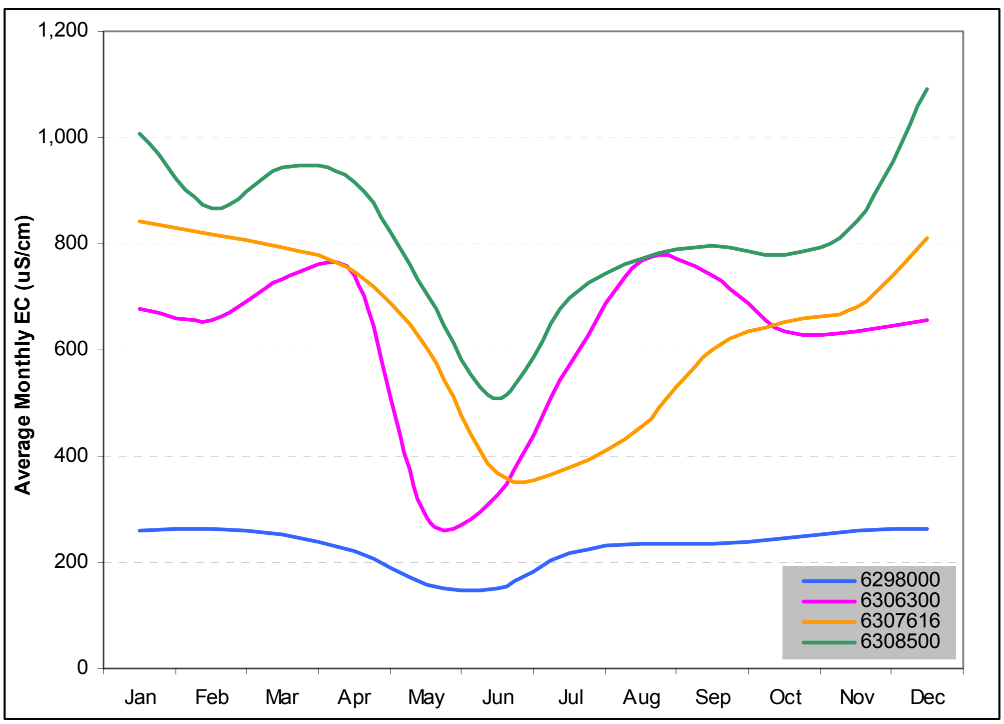

Figure 3-11. Average monthly EC values at four stations in the Tongue River (1986-2001).

3.4.1.3.2 Total Dissolved Solids

A total of four segments of the Tongue River and the Tongue River Reservoir appeared on the Montana 1996 303(d) list – Tongue River Above the Reservoir, Upper Tongue River, Middle Tongue River, and the Lower Tongue River. As described in Section 3.4.1, two segments of the Tongue River (i.e., the lower and middle Tongue River) were listed as impaired for total dissolved solids (TDS) on the 1996 list. None of the segments of the Tongue River appeared on the 2002 303(d) list as a result of TDS. All four segments were fully supporting agricultural uses in 2002, and TDS was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of all segments of the Tongue River to verify the impairment status relative to TDS.

Section 3.4.1.3.1 described salinity (measured as EC) in the Tongue River. EC is an indirect measurement of TDS and salinity. The relationship between TDS and EC is different for each waterbody, and it varies with the type of ions in solution and temperature. Figure 3-12 shows the relationship between EC and TDS in the lower Tongue River. This graph shows EC and TDS data obtained on the same date and location. The relationship between the two parameters is EC = 1.46(TDS). Therefore, an EC standard of 1,000 µS/cm is equivalent to a TDS concentration of 685 mg/L and an EC of 2,000 µS/cm is equivalent to 1,476 mg/L. At station 06308500, the major ions measured by TDS were on average sulfate (40%), sodium (11%), calcium (11%), chloride (1%), and magnesium (7%). A large portion of dissolved solids appears to be bicarbonate ions. Figures 3-13 and 3-14 show the relationships between EC and TDS in the middle and upper segments of the Tongue River. The relationships were similar to the relationship found in the lower Tongue River and all three relationships are approximately EC = 1.5(TDS). The Tongue River above the reservoir had few paired EC and TDS samples, and the relationship is not shown for that reason.

TDS data for the growing and non-growing seasons in the Tongue River are summarized in Tables 3-20 and 3-21. Few recent TDS data were available for all of the segments of the Tongue River. Since 1995, only 2 samples exceeded the calculated TDS targets, and both were in the lower Tongue River. In general, almost all TDS concentrations were lower than the calculated targets.

A final water quality impairment determination will not be made for TDS until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria for salinity (EC) (see Section 3.3.1.2).

Table 3-20. Summary of TDS data, Tongue River (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
461538105455201	2	598	589	607	2%	11/4/77	11/4/77
462413105512801	2	639	630	647	2%	11/5/77	11/5/77
6308500	218	652	155	1,251	23%	11/1/62	3/30/94
Middle Tongue							
452240106294001	2	531	526	535	1%	11/3/77	11/3/77
452708106242801	2	550	548	552	1%	11/3/77	11/3/77
453301106181301	2	554	549	558	1%	11/3/77	11/3/77
454103106171401	2	554	550	557	1%	11/4/77	11/4/77
455023106131201	4	767	567	1,148	36%	11/3/75	11/4/77
455844106031901	2	586	576	596	2%	11/4/77	11/4/77
460244105560201	5	810	590	1,273	34%	3/22/74	11/4/77
461237105454701	2	607	597	617	2%	11/4/77	11/4/77
590	4	786	702	832	7%	1/17/74	12/4/75
591	7	666	480	754	13%	12/5/75	1/29/77
6307610	35	610	226	984	20%	1/30/74	3/28/79
6307616	13	617	527	725	10%	11/14/79	3/3/82
6307830	26	649	225	868	18%	11/19/74	2/3/81
761	1	791	791	791	NA	3/22/74	3/22/74
Upper Tongue							
364	4	771	653	908	16%	11/4/75	3/31/79
451607106372801	3	506	497	514	2%	11/3/77	11/3/77
6307500	31	547	358	722	12%	3/25/75	11/5/82
Tongue River above Reservoir							
133	2	649	599	699	11%	3/25/75	11/1/77
134	3	783	683	852	11%	1/30/74	12/18/75
6306500	3	493	477	505	3%	2/27/02	2/27/02
Tongue River in Wyoming							
6298000	111	152	133	369	15%	11/14/66	03/07/00
6299980	29	306	211	395	11%	11/13/74	02/21/80

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-21. Summary of TDS data, Tongue River (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
1437	1	708	708	708	NA	6/27/77	6/27/77
462413105512801	6	682	589	744	10%	9/7/78	10/28/01
6308500	315	504	192	1,370	33%	10/1/59	9/21/94
Middle Tongue							
1320	1	627	627	627	NA	6/27/77	6/27/77
452708106242801	4	529	461	589	13%	9/7/78	10/19/78
455023106131201	9	618	416	783	20%	9/28/75	10/26/01
455844106031901	5	643	544	729	13%	9/7/78	10/27/01
460244105560201	2	713	624	802	18%	10/20/75	9/22/01
590	2	273	244	301	15%	7/1/75	5/19/77
591	6	430	264	652	35%	4/21/76	10/20/76
6307610	47	409	176	743	38%	4/11/74	9/13/79
6307616	21	424	207	857	38%	10/2/79	10/26/01
6307830	43	459	203	834	35%	10/1/74	9/15/81
679	1	590	590	590	NA	6/24/77	6/24/77
967	1	741	741	741	NA	6/27/77	6/27/77
TR022	1	576	576	576	NA	10/26/01	10/26/01
TR032	1	583	583	583	NA	9/22/01	9/22/01
TRNC001	1	450	450	450	NA	5/25/01	5/25/01
TRNC004	3	483	480	490	1%	5/31/01	6/22/01
Upper Tongue							
364	9	418	196	757	50%	10/21/75	7/19/90
451607106372801	2	517	470	564	13%	9/21/01	10/26/01
6307500	58	389	173	705	38%	4/16/75	10/27/01
Tongue River above Reservoir							
133	5	512	213	710	36%	4/16/75	4/20/77
134	4	307	179	624	69%	7/1/75	5/18/77
6306500	3	534	507	571	6%	9/21/01	10/26/01
Tongue River in Wyoming							
6298000	172	123	66	167	17%	10/10/66	09/12/00
6299980	51	248	93	524	36%	04/03/74	09/09/80

[a]CV – Coefficient of Variation (standard deviation/mean).

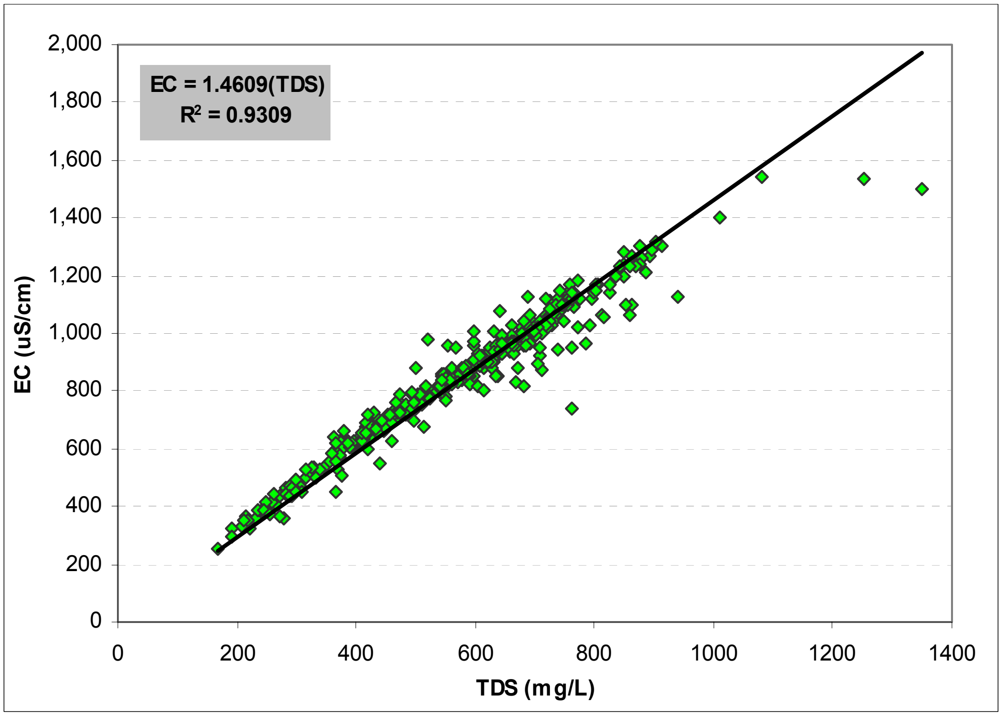

Figure 3-12. Relationship between EC and TDS in the lower Tongue River.

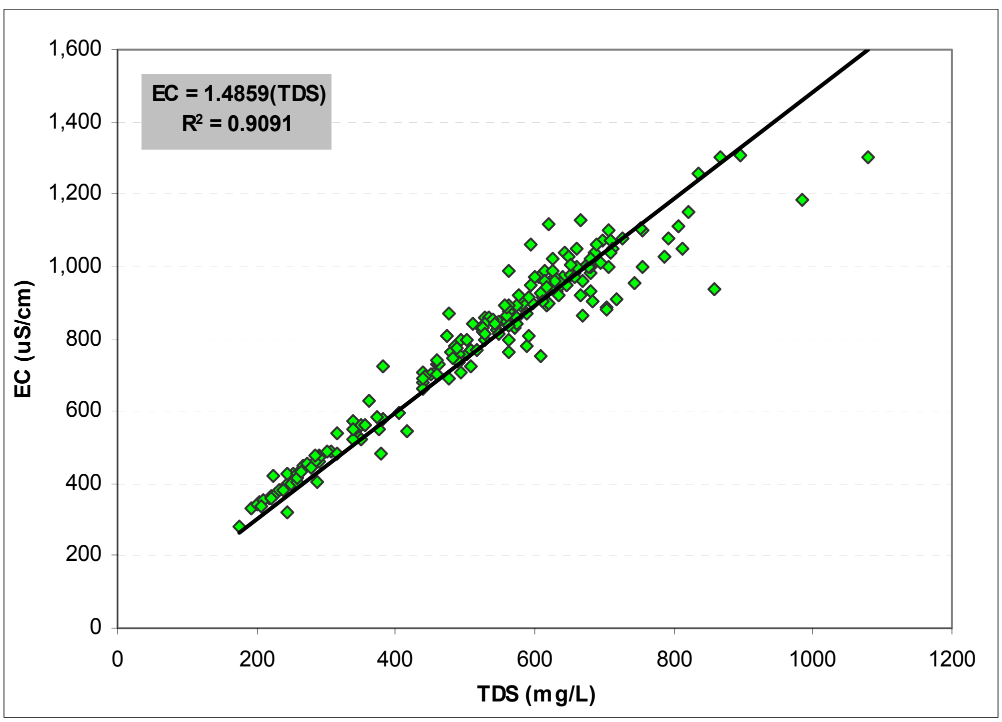

Figure 3-13. Relationship between EC and TDS in the middle Tongue River.

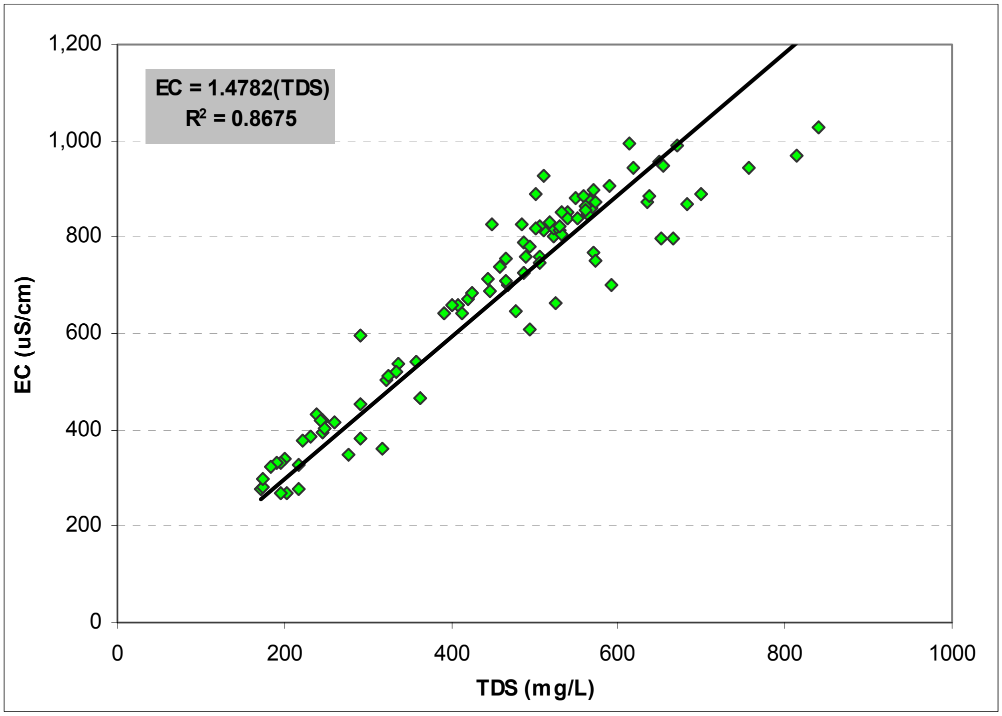

Figure 3-14. Relationship between EC and TDS in the upper Tongue River.

3.4.1.3.3 Chlorides

A total of four segments of the Tongue River and the Tongue River Reservoir appeared on the Montana 1996 303(d) list – Tongue River Above the Reservoir, Upper Tongue River, Middle Tongue River, and the Lower Tongue River. As described in Section 3.4.1, two segments of the Tongue River (i.e., the lower and middle Tongue River) were listed as impaired for chlorides on the 1996 list. None of the segments of the Tongue River appeared on the 2002 303(d) list as a result of chlorides. All four segments were fully supporting agricultural uses in 2002, and chloride was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of all segments of the Tongue River to verify the impairment status relative to chlorides.

USEPA recommended chloride standards for streams and rivers based on the aquatic toxicity of plant, fish, and invertebrate species (USEPA, 1999). USEPA recommends an acute standard of 860 mg/L and a chronic standard of 230 mg/L. These standards were adopted by Wyoming and the Northern Cheyenne Tribe. Montana does not have numeric standards for chlorides.

Chloride data for the Tongue River are summarized in Tables 3-22 and 3-23. Average concentrations were less than USEPA's proposed standards, and no single sample exceeded those standards. There was no apparent increase or decrease in chloride concentrations over time (Figures 3-15 through 3-18). Based on an analysis of the available data, chlorides are not impairing agricultural or aquatic life uses in the Tongue River. Chloride concentrations for all four segments of the Tongue River were much lower than the USEPA recommended standards to protect aquatic life uses. Concentrations were also much lower than the calculated TDS targets to protect agricultural uses (see Section 3.4.1.3.2).

Table 3-22. Summary of chloride data, Tongue River (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
461538105455201	1	4.3	4.3	4.3	NA	11/4/77	11/4/77
462413105512801	1	4.7	4.7	4.7	NA	11/5/77	11/5/77
6308500	107	5.2	2.0	12.0	29%	11/1/62	11/22/99
Middle Tongue							
452240106294001	1	3.5	3.5	3.5	NA	11/3/77	11/3/77
452708106242801	1	3.7	3.7	3.7	NA	11/3/77	11/3/77
453301106181301	1	3.6	3.6	3.6	NA	11/3/77	11/3/77
454103106171401	1	3.8	3.8	3.8	NA	11/4/77	11/4/77
455023106131201	3	5.1	4.0	7.2	36%	11/3/75	11/4/77
455844106031901	1	4.2	4.2	4.2	NA	11/4/77	11/4/77
460244105560201	4	4.6	2.0	6.7	43%	3/22/74	11/4/77
461237105454701	1	4.5	4.5	4.5	NA	11/4/77	11/4/77
590	4	4.3	3.0	6.0	31%	1/17/74	12/4/75
6307610	28	4.3	1.2	7.2	26%	1/30/74	3/28/79
6307616	33	4.5	2.6	6.3	19%	11/14/79	3/24/93
6307830	37	4.9	3.2	6.4	16%	11/19/74	3/18/02
761	1	2.0	2.0	2.0	NA	3/22/74	3/22/74
452240106294001	1	3.5	3.5	3.5	NA	11/3/77	11/3/77
Upper Tongue							
364	4	4.6	4.1	5.2	12%	11/4/75	3/31/79
451607106372801	2	3.5	3.4	3.5	0%	11/3/77	11/3/77
6307500	73	4.1	2.2	16.0	40%	3/25/75	3/14/95
TRWU4	6	4.8	4.0	6.0	20%	2/25/01	3/28/02
Tongue River above Reservoir							
133	2	4.3	3.5	5.0	25%	3/25/75	11/1/77
134	3	2.0	1.0	3.1	52%	1/30/74	12/18/75
6306300	16	4.5	2.8	7.3	27%	11/4/85	3/18/02
6306500	3	5.1	5.0	5.2	2%	2/27/02	2/27/02
TRWU7	7	4.6	3.0	6.0	21%	1/28/01	3/28/02
TRWU8	7	5.4	4.0	8.0	26%	1/28/01	3/28/02
Tongue River in Wyoming							
6298000	82	2.2	0	24	66%	11/14/66	03/07/00
6299980	29	2.3	1.4	5.2	15%	11/13/74	02/21/80

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-23. Summary of chloride data, Tongue River (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
1437	1	3.8	3.8	3.8	NA	6/27/77	6/27/77
462413105512801	4	6.8	4.5	8.0	25%	9/7/78	10/28/01
6308500	149	3.8	0.3	8.9	41%	4/15/63	6/12/02
Middle Tongue							
1320	1	3.9	3.9	3.9	NA	6/27/77	6/27/77
452708106242801	2	3.9	3.0	4.7	31%	9/7/78	10/19/78
455023106131201	7	4.9	2.7	7.0	31%	9/28/75	10/26/01
455844106031901	3	5.2	3.6	6.0	27%	9/7/78	10/27/01
460244105560201	2	5.2	4.4	6.0	22%	10/20/75	9/22/01
590	3	1.7	1.0	2.1	36%	9/24/74	5/19/77
6307610	41	3.0	1.2	5.2	37%	4/11/74	9/13/79
6307616	61	3.1	0.5	6.2	46%	10/2/79	10/26/01
6307830	58	3.7	1.4	6.2	37%	10/1/74	7/10/02
679	1	3.0	3.0	3.0	NA	6/24/77	6/24/77
967	1	4.4	4.4	4.4	NA	6/27/77	6/27/77
TR022	1	5.0	5.0	5.0	NA	10/26/01	10/26/01
TR032	1	7.0	7.0	7.0	NA	9/22/01	9/22/01
NCTR004	2	4.3	4.1	4.4	5%	6/22/01	6/22/01
Upper Tongue							
364	9	2.8	1.3	4.8	39%	10/21/75	7/19/90
451607106372801	2	5.5	5.0	6.0	13%	9/21/01	10/26/01
6307500	124	2.9	0.3	12.0	55%	4/16/75	10/27/01
TRWU1	5	4.4	3.1	9.4	64%	6/8/01	10/27/01
TRWU4	12	4.3	2.0	9.6	43%	5/28/01	6/29/02
Tongue River above Reservoir							
133	5	2.9	0.5	4.1	48%	4/16/75	4/20/77
134	4	1.5	0.2	3.2	100%	7/1/75	5/18/77
6306300	37	2.7	0.2	6.7	68%	5/30/86	8/7/02
6306500	3	4.3	4.0	5.0	13%	9/21/01	10/26/01
TRWU2	5	3.6	1.9	8.7	79%	6/8/01	10/27/01
TRWU3	4	0.5	0.4	0.7	23%	6/8/01	7/19/01
TRWU5	4	4.6	1.5	8.9	68%	6/8/01	10/27/01
TRWU6	5	17.4	9.9	26.0	35%	6/8/01	10/27/01
TRWU7	13	3.9	1.9	8.7	50%	5/28/01	6/29/02
TRWU8	13	4.4	1.8	9.1	58%	5/28/01	6/29/02
Tongue River in Wyoming							
6298000	130	1.8	0	25	166%	10/10/66	09/12/00
6299980	50	1.9	0.6	4.1	45%	04/03/74	09/09/80

[a]CV – Coefficient of Variation (standard deviation/mean).

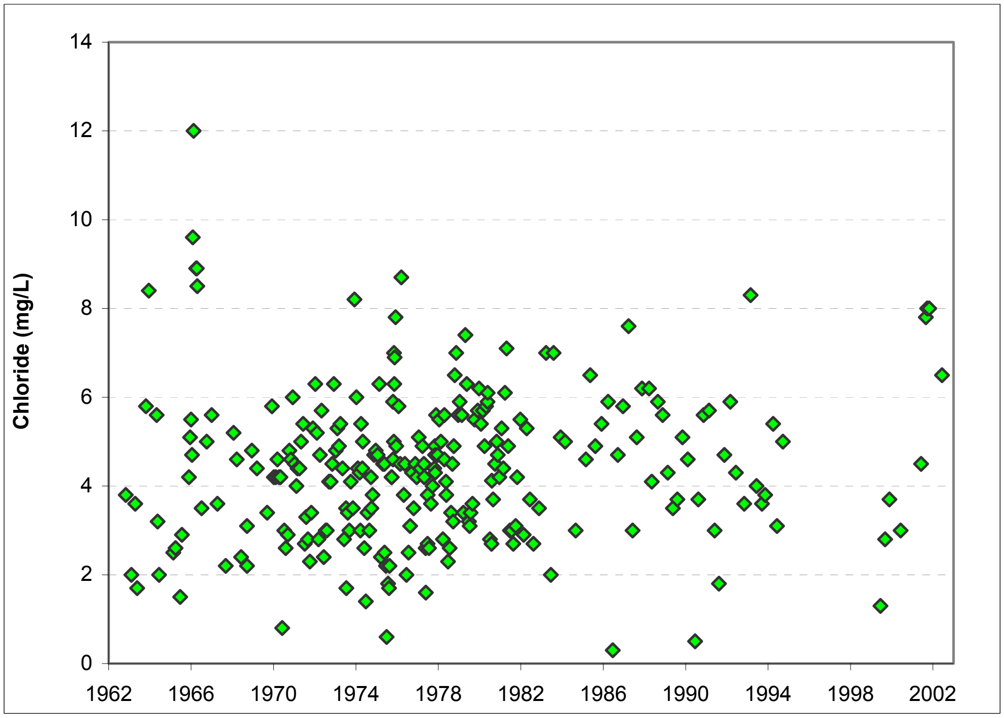

Figure 3-15. Chloride data for the lower Tongue River (all stations).

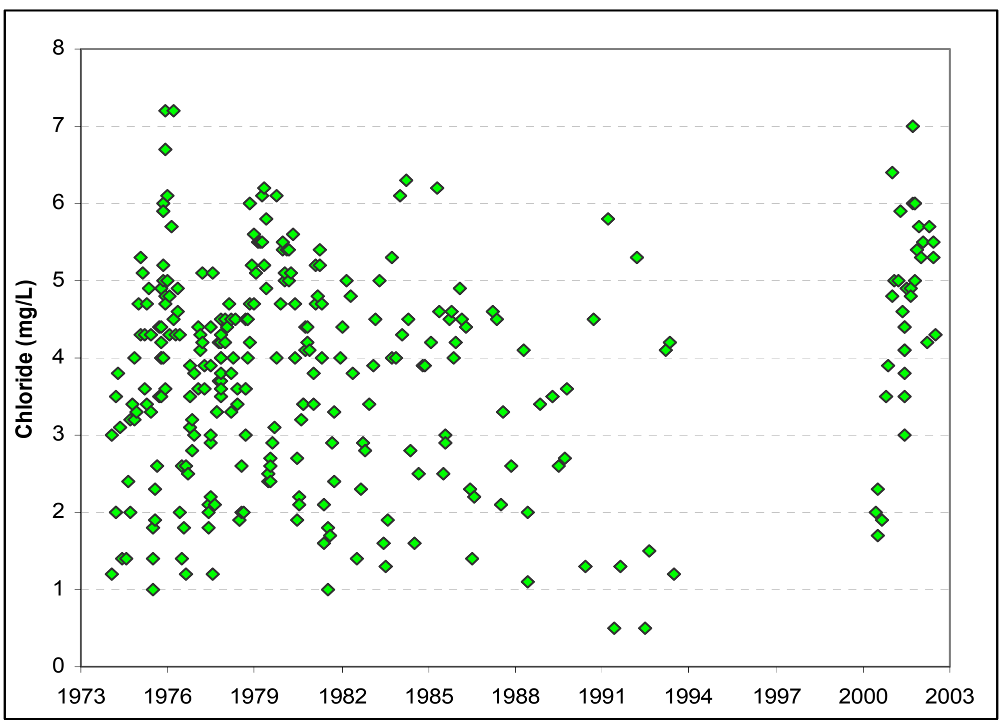

Figure 3-16. Chloride data for the middle Tongue River (all stations).

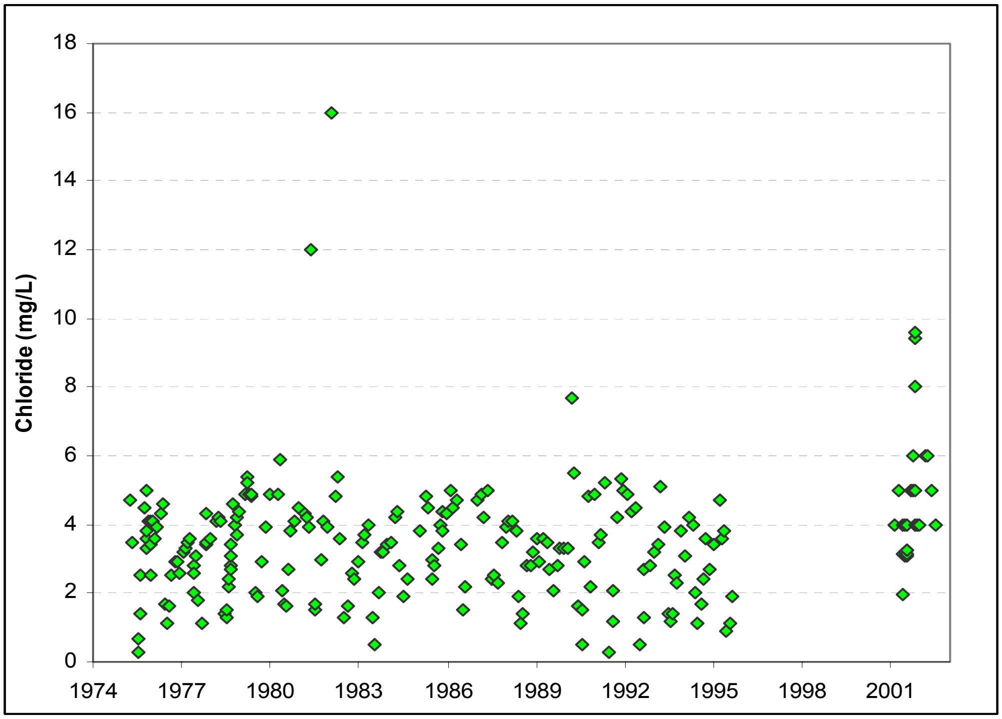

Figure 3-17. Chloride data for the upper Tongue River (all stations).

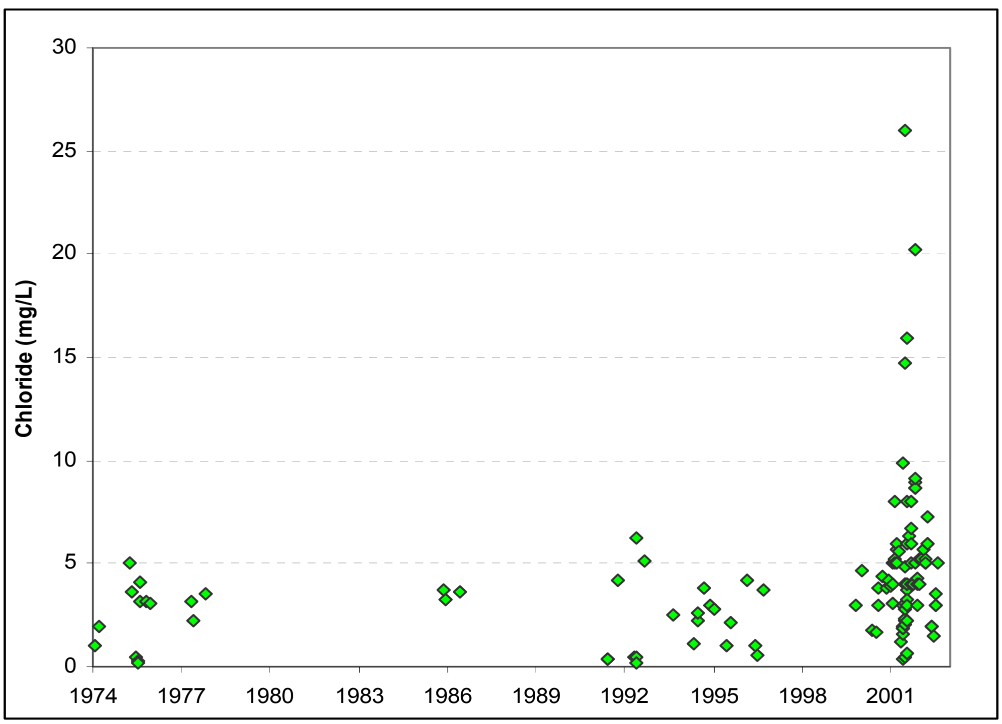

Figure 3-18. Chloride data for the Tongue River above the reservoir (all stations).

3.4.1.3.4 SAR

A total of four segments of the Tongue River and the Tongue River Reservoir appeared on the Montana 1996 303(d) list – Tongue River Above the Reservoir, Upper Tongue River, Middle Tongue River, and the Lower Tongue River. As described in Section 3.4.1, the Tongue River was not listed for SAR in the 1996 or 2002 303(d) lists. All four segments of the Tongue River were fully supporting agricultural uses in the 2002 303(d) list.

SAR data for the Tongue River are summarized in Tables 3-24 and 3-25. The data are compared to the proposed SAR criteria in Tables 3-26 through 3-29. SAR exceedances varied with the three different proposed criteria. The Petitioner's criteria were generally more stringent than MDEQ's or the Northern Cheyenne Tribe's criteria, and samples often exceeded the Petitioner's criteria and not the others. Figures 3-19 through 3-22 show that there appeared to be decreasing trends in the middle and upper segments of the Tongue River and then a large increase in recent values (1999 through 2002). There was no apparent trend in SAR data for the lower Tongue River.

A final water quality impairment determination will not be made for SAR until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria (see Section 3.3.1.2).

Table 3-24. Summary of SAR data, Tongue River (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
461538105455201	1	1.2	1.2	1.2	NA	11/4/77	11/4/77
462413105512801	1	1.7	1.7	1.7	NA	11/5/77	11/5/77
6308500	108	1.6	1.0	3.0	23%	11/1/62	11/22/99
Middle Tongue							
452240106294001	1	0.9	0.9	0.9	NA	11/3/77	11/3/77
452708106242801	1	1.0	1.0	1.0	NA	11/3/77	11/3/77
453301106181301	1	1.0	1.0	1.0	NA	11/3/77	11/3/77
454103106171401	1	1.0	1.0	1.0	NA	11/4/77	11/4/77
455023106131201	3	1.6	1.1	2.3	37%	11/3/75	11/4/77
455844106031901	1	1.2	1.2	1.2	NA	11/4/77	11/4/77
460244105560201	4	1.9	1.3	3.1	46%	3/22/74	11/4/77
461237105454701	1	1.3	1.3	1.3	NA	11/4/77	11/4/77
590	4	1.4	1.1	1.7	16%	1/17/74	12/4/75
6307610	26	1.1	0.6	2.2	26%	1/30/74	3/28/79
6307616	33	1.1	0.8	1.6	18%	11/14/79	3/24/93
6307830	37	1.4	0.8	2.2	18%	11/19/74	3/18/02
761	1	1.5	1.5	1.5	NA	3/22/74	3/22/74
Upper Tongue							
364	4	1.3	1.0	1.7	23%	11/4/75	3/31/79
451607106372801	1	0.9	0.9	0.9	NA	11/3/77	11/3/77
6307500	73	0.8	0.5	1.1	11%	3/25/75	3/14/95
TRWU4	6	1.1	0.9	1.4	17%	2/25/01	3/28/02
Tongue River Above Reservoir							
133	2	0.9	0.8	1.1	24%	3/25/75	11/1/77
134	3	1.0	0.8	1.2	20%	1/30/74	12/18/75
6306300	16	0.7	0.5	1.0	17%	11/4/85	3/18/02
6306500	1	1.0	1.0	1.0	NA	2/27/02	2/27/02
TRWU7	7	0.5	0.4	0.6	14%	1/28/01	3/28/02
TRWU8	7	0.9	0.8	1.0	9%	1/28/01	3/28/02
Tongue River in Wyoming							
6298000	82	0.2	0.0	8.9	572%	11/14/66	3/7/00
6299980	29	0.5	0.4	0.9	27%	11/13/74	2/21/80

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-25. Summary of SAR data, Tongue River (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
1437	1	1.7	1.7	1.7	NA	6/27/77	6/27/77
462413105512801	4	2.3	1.7	3.0	22%	9/7/78	10/28/01
6308500	151	1.5	0.5	3.9	44%	4/15/63	6/12/02
Middle Tongue							
1320	1	1.5	1.5	1.5	NA	6/27/77	6/27/77
452708106242801	2	1.1	1.0	1.3	20%	9/7/78	10/19/78
455023106131201	6	1.4	0.9	1.8	23%	9/28/75	10/26/01
455844106031901	4	1.8	1.3	2.0	19%	9/7/78	10/27/01
460244105560201	2	1.6	1.3	1.9	27%	10/20/75	9/22/01
590	3	0.5	0.5	0.5	3%	9/24/74	5/19/77
6307610	41	0.9	0.5	1.5	30%	4/11/74	9/13/79
6307616	61	0.8	0.3	1.6	33%	10/2/79	10/26/01
6307830	59	1.1	0.6	2.0	33%	10/1/74	7/10/02
679	1	1.3	1.3	1.3	NA	6/24/77	6/24/77
967	1	1.8	1.8	1.8	NA	6/27/77	6/27/77
NCTR004	2	1.3	1.3	1.3	0%	6/22/01	6/22/01
TR022	1	1.7	1.7	1.7	NA	10/26/01	10/26/01
TR032	1	1.8	1.8	1.8	NA	9/22/01	9/22/01
Upper Tongue							
364	9	0.7	0.4	1.2	40%	10/21/75	7/19/90
451607106372801	4	1.5	1.5	1.5	2%	9/21/01	10/26/01
6307500	125	0.7	0.3	2.1	39%	4/16/75	10/27/01
TRWU4	7	1.0	0.8	1.4	18%	5/28/01	6/29/02
Tongue River above Reservoir							
133	6	0.7	0.4	1.3	43%	4/16/75	6/15/77
134	4	0.4	0.3	0.6	32%	7/1/75	5/18/77
6306300	37	0.7	0.2	2.8	87%	5/30/86	8/7/02
6306500	3	1.1	1.0	1.2	10%	9/21/01	10/26/01
TRWU7	8	0.7	0.3	1.4	45%	5/28/01	6/29/02
TRWU8	8	1.3	0.5	2.7	56%	5/28/01	6/29/02
Tongue River in Wyoming							
6298000	125	0.1	0.0	0.31	50%	10/10/66	9/12/00
6299980	50	0.4	0.1	1.1	45%	4/3/74	9/9/80

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-26. Summary of SAR exceedances, lower Tongue River.

Season	SAR Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
MDEQ							
All Seasons	Variable[a]	263	16	6%	9	1	11%
Northern Cheyenne – Northern Border							
All Seasons	3.0	266	5	2%	9	1	11%
Petitioners (Tongue River at the mouth)							
Irrigation Season	1.6	156	51	33%	8	5	63%
Non Irrigation Season	2.5	110	4	4%	1	0	0%

[a]Reported data are from sample dates with both an SAR and salinity measurement, and criteria are based on the formula SAR <= (EC * 0.0071) – 2.475.

Table 3-27. Summary of SAR exceedances, middle Tongue River.

Season	SAR Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
MDEQ							
All Seasons	Variable[a]	293	3	1%	32	0	0%
Northern Cheyenne – Northern Border							
All Seasons	3.0	299	1	0%	34	0	0%
Petitioners (Tongue River at the mouth)							
Irrigation Season	1.6	185	16	9%	24	10	42%
Non Irrigation Season	2.5	114	1	1%	10	0	0%

[a]Reported data are from sample dates with both an SAR and salinity measurement, and criteria are based on the formula SAR <= (EC * 0.0071) – 2.475.

Table 3-28. Summary of SAR exceedances, upper Tongue River.

Season	SAR Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
MDEQ[1]							
All Seasons	Variable[a]	217	0	0%	11	0	0%
Northern Cheyenne – Southern Border							
All Seasons	2.0	229	1	0%	21	1	5%
Petitioners (Tongue River at the Tongue River Reservoir Dam)							
All Seasons	1.0	229	27	12%	21	14	67%

[a]Reported data are from sample dates with both an SAR and salinity measurement, and criteria are based on the formula SAR <= (EC * 0.0071) – 2.475.

Table 3-29. Summary of SAR exceedances, Tongue River above the reservoir.

Season	SAR Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
MDEQ							
All Seasons	Variable[a]	93	1	1%	57	1	2%
Petitioners (Tongue River at the Tongue River Reservoir Dam)							
All Seasons	1.0	102	17	17%	66	14	21%

[a]Reported data are from sample dates with both an SAR and salinity measurement, and criteria are based on the formula SAR <= (EC * 0.0071) – 2.475.

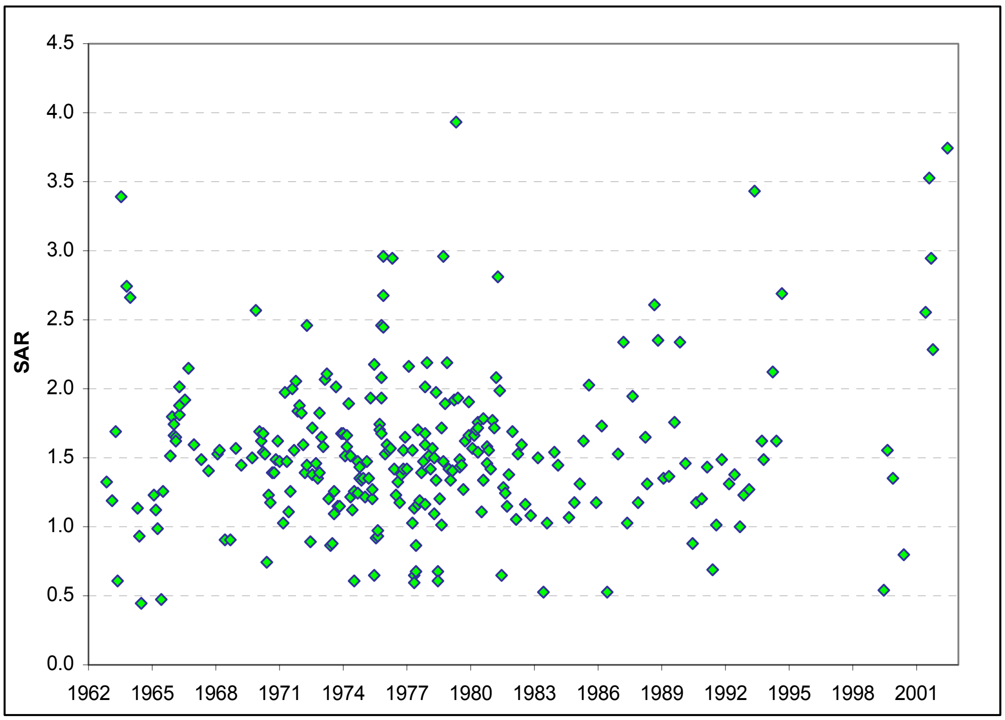

Figure 3-19. SAR data for the lower Tongue River (all stations).

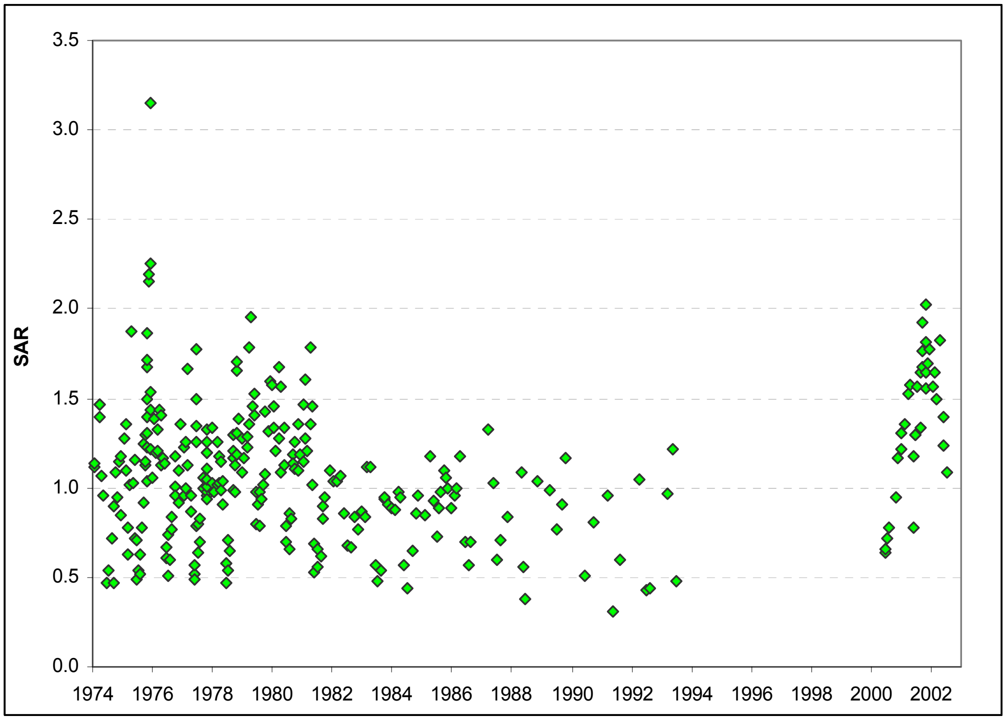

Figure 3-20. SAR data for the middle Tongue River (all stations).

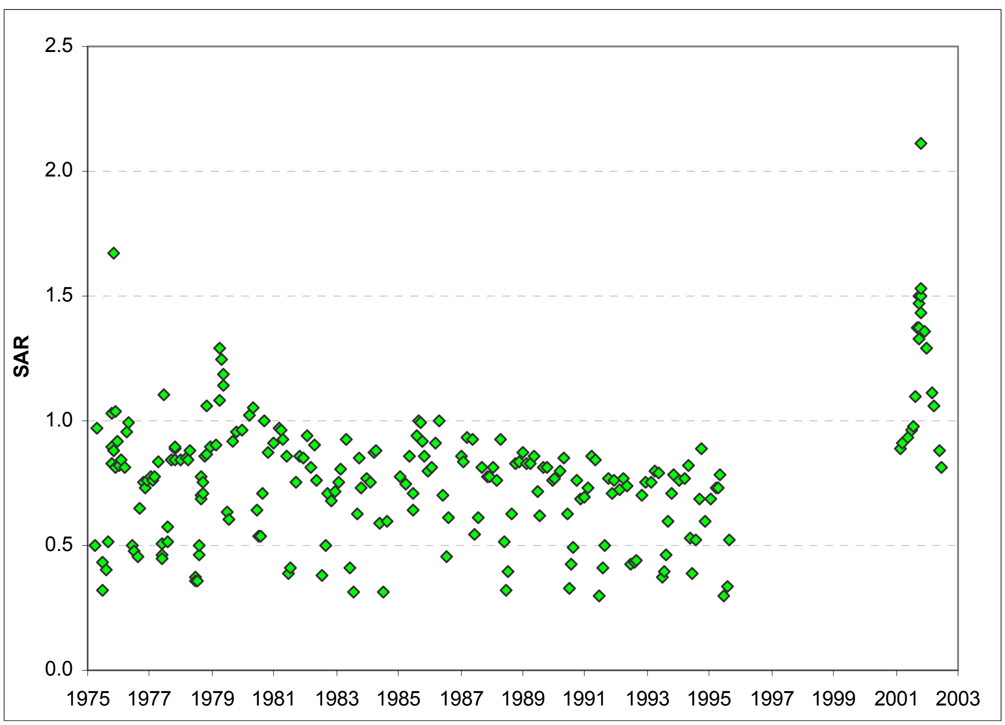

Figure 3-21. SAR data for the upper Tongue River (all stations).

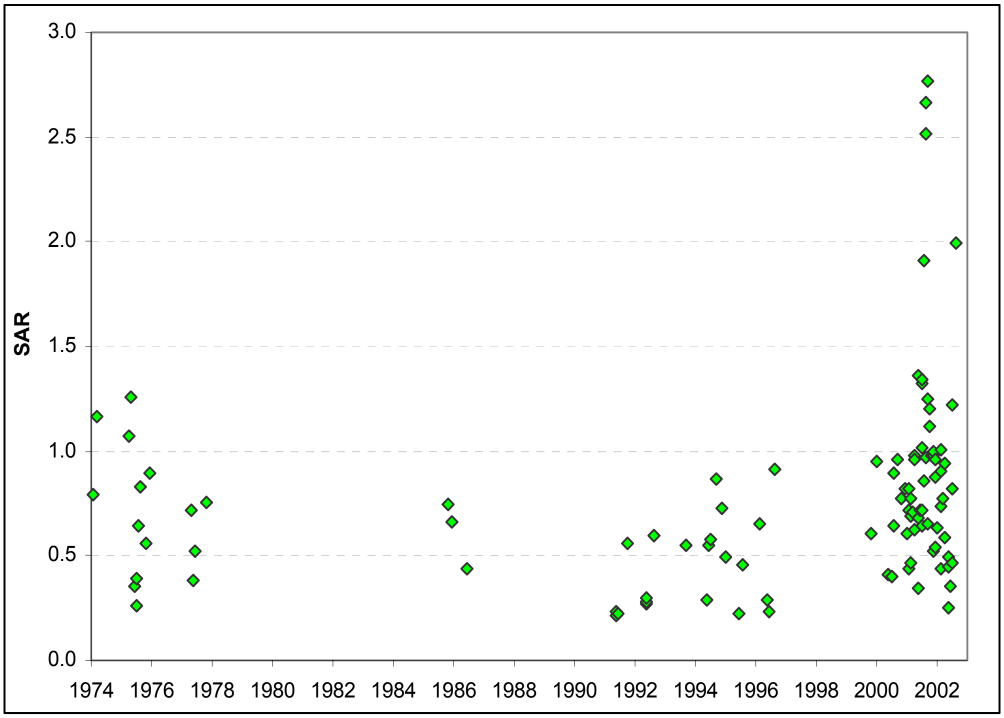

Figure 3-22. SAR data for the Tongue River above the reservoir (all stations).

3.4.1.3.5 Other Inorganics (Sulfate)

A total of four segments of the Tongue River and the Tongue River Reservoir appeared on the Montana 1996 303(d) list – Tongue River Above the Reservoir, Upper Tongue River, Middle Tongue River, and the Lower Tongue River. As described in Section 3.4.1, two segments of the Tongue River (i.e., the lower and middle Tongue River) were listed as impaired for other inorganics on the 1996 list. The other inorganics listing refers to sulfate. None of the segments of the Tongue River appeared on the 2002 303(d) list as a result of sulfates. All four segments were fully supporting agricultural uses in 2002, and sulfate was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of all segments of the Tongue River to verify the impairment status relative to sulfates.

TDS targets for the four segments of the Tongue River are discussed in Section 3.4.1.3.2. These targets were used to help determine sulfate impairments in the Tongue River because TDS is partially composed of sulfates. By definition, the dissolved sulfate concentration in a stream must be equal to or less than the TDS concentration.

Tables 3-30 and 3-31 summarize the sulfate data for the Tongue River, and data are shown in Figures 3-23 through 3-26. Concentrations appeared to increase from upstream to downstream. The lower segment of the Tongue River generally had the highest concentrations of sulfates. Concentrations in all four segments were generally lower during the growing season, and the majority of concentrations were lower than USEPA's secondary drinking water standard of 250 mg/L. Only one sample in the lower Tongue River exceeded the calculated TDS target.

A final water quality impairment determination will not be made for sulfate until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria for salinity (EC) (see Section 3.3.1.2).

Table 3-30. Summary of sulfate data, Tongue River (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
461538105455201	1	250	250	250	NA	11/4/77	11/4/77
462413105512801	1	260	260	260	NA	11/5/77	11/5/77
6308500	172	269	38	508	28%	11/1/62	11/22/99
Middle Tongue							
452240106294001	1	220	220	220	NA	11/3/77	11/3/77
452708106242801	1	230	230	230	NA	11/3/77	11/3/77
453301106181301	1	230	230	230	NA	11/3/77	11/3/77
454103106171401	1	230	230	230	NA	11/4/77	11/4/77
455023106131201	3	303	240	410	31%	11/3/75	11/4/77
455844106031901	1	240	240	240	NA	11/4/77	11/4/77
460244105560201	4	340	250	500	32%	3/22/74	11/4/77
461237105454701	1	250	250	250	NA	11/4/77	11/4/77
590	4	272	230	294	11%	1/17/74	12/4/75
591	7	268	187	315	16%	12/5/75	1/29/77
6307610	38	250	77	420	23%	1/30/74	3/28/79
6307616	33	218	150	330	22%	11/14/79	3/24/93
6307830	37	260	80	400	24%	11/19/74	3/18/02
761	1	290	290	290	NA	3/22/74	3/22/74
Upper Tongue							
364	4	278	211	360	27%	11/4/75	3/31/79
451607106372801	2	210	210	210	0%	11/3/77	11/3/77
6307500	73	188	120	310	21%	3/25/75	3/14/95
TRWU4	6	182	162	200	8%	2/25/01	3/28/02
Tongue River above Reservoir							
133	2	228	185	270	26%	3/25/75	11/1/77
134	3	270	219	330	21%	1/30/74	12/18/75
6306300	16	121	74	180	30%	11/4/85	3/18/02
6306500	3	174	172	178	2%	2/27/02	2/27/02
TRWU7	7	96	86	124	14%	1/28/01	3/28/02
TRWU8	7	160	133	208	15%	1/28/01	3/28/02
Tongue River in Wyoming							
6298000	82	6	0	18	50%	11/14/66	3/7/00
6299980	29	79	57	150	24%	11/13/74	2/21/80

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-31. Summary of sulfate data, Tongue River (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue							
1437	1	214	214	214	0%	6/27/77	6/27/77
462413105512801	4	281	240	330	14%	9/7/78	10/28/01
6308500	257	199	45	730	43%	10/1/62	6/12/02
Middle Tongue							
1320	1	193	193	193	0%	6/27/77	6/27/77
452708106242801	2	220	190	250	19%	9/7/78	10/19/78
455023106131201	7	237	138	320	24%	9/28/75	10/26/01
455844106031901	3	263	220	320	19%	9/7/78	10/27/01
460244105560201	2	271	251	290	10%	10/20/75	9/22/01
590	2	69	58	80	23%	7/1/75	5/19/77
591	6	164	81	286	48%	4/21/76	10/20/76
6307610	48	164	47	340	46%	4/11/74	9/13/79
6307616	61	146	34	270	48%	10/2/79	10/26/01
6307830	58	185	63	430	45%	10/1/74	7/10/02
679	1	189	189	189	0%	6/24/77	6/24/77
967	1	258	258	258	0%	6/27/77	6/27/77
TR022	1	210	210	210	0%	10/26/01	10/26/01
TR032	1	245	245	245	0%	9/22/01	9/22/01
TR001	2	142	142	142	0%	5/25/01	5/25/01
TR002	3	142	138	148	4%	5/29/01	6/22/01
TR004	6	159	149	171	6%	5/31/01	6/22/01
Upper Tongue							
364	9	137	34	308	66%	10/21/75	7/19/90
451607106372801	2	204	202	205	1%	9/21/01	10/26/01
6307500	124	130	23	320	53%	4/16/75	10/27/01
TRWU1	5	168	155	200	11%	6/8/01	10/27/01
TRWU4	12	151	112	198	17%	5/28/01	6/29/02
Tongue River above the Reservoir							
133	6	137	42	230	49%	4/16/75	6/15/77
134	4	76	31	180	93%	7/1/75	5/18/77
6306300	37	99	16	302	80%	5/30/86	8/7/02
6306500	3	173	159	188	8%	9/21/01	10/26/01
TRWU2	5	86	70	107	17%	6/8/01	10/27/01
TRWU3	5	19	9	26	35%	6/8/01	10/27/01
TRWU5	4	93	38	147	48%	6/8/01	10/27/01
TRWU6	4	1	0	2	90%	6/8/01	7/19/01
TRWU7	13	106	30	186	40%	5/28/01	6/29/02
TRWU8	13	143	55	348	56%	5/28/01	6/29/02
Tongue River in Wyoming							
6298000	133	5	0	22	75%	10/10/66	9/12/00
6299980	50	61	11	240	66%	4/3/74	9/9/80

[a]CV – Coefficient of Variation (standard deviation/mean).

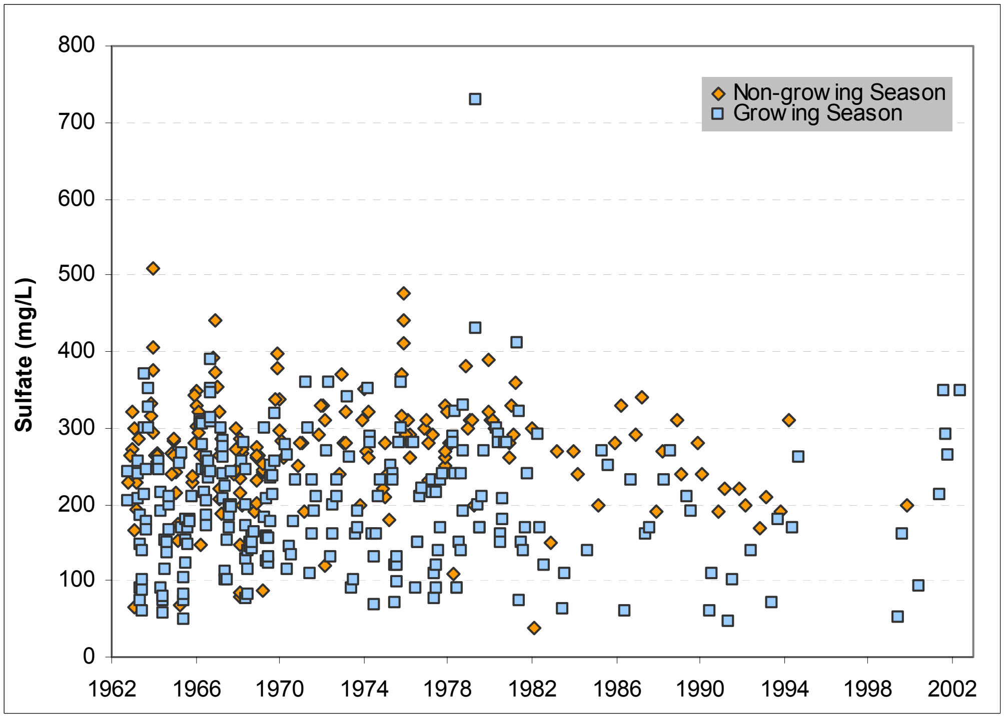

Figure 3-23. Sulfate data for the lower Tongue River (all stations).

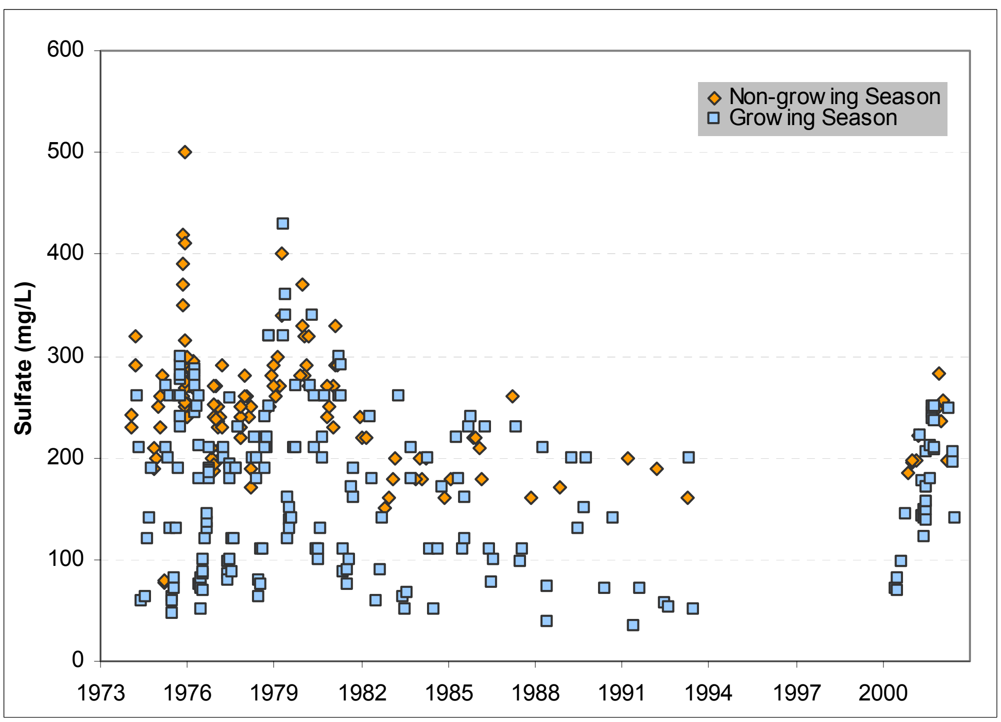

Figure 3-24. Sulfate data for the middle Tongue River (all stations).

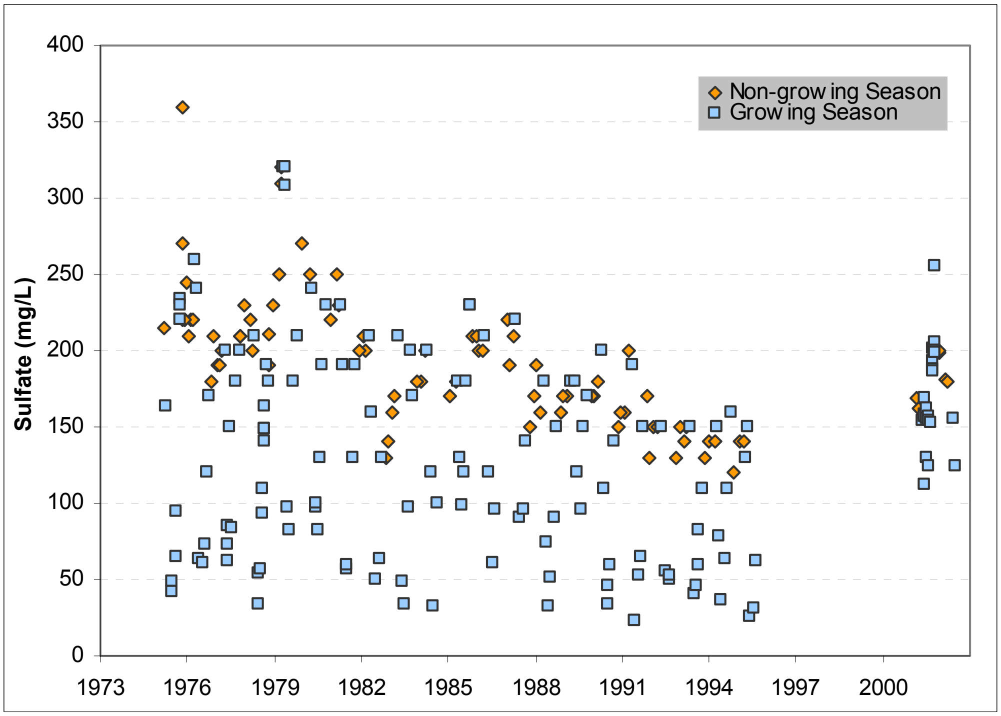

Figure 3-25. Sulfate data for the upper Tongue River (all stations).

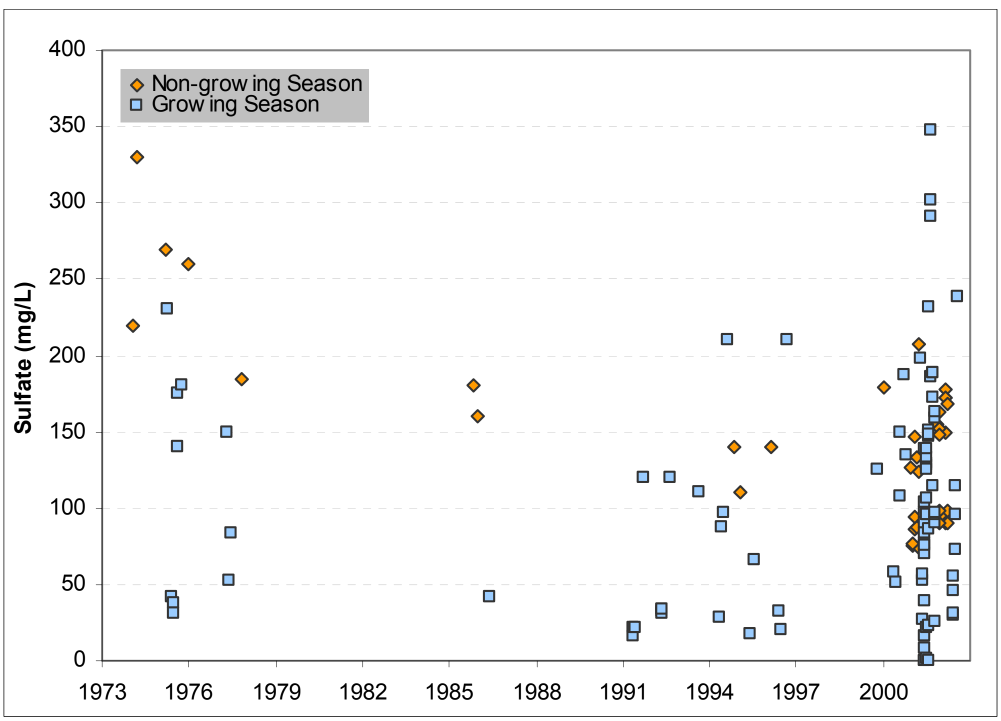

Figure 3-26. Sulfate data for the Tongue River above the reservoir (all stations).

3.4.1.3.6 Metals

A total of four segments of the Tongue River and the Tongue River Reservoir appeared on the Montana 1996 303(d) list – Tongue River Above the Reservoir, Upper Tongue River, Middle Tongue River, and the Lower Tongue River. As described in Section 3.4.1, two segments of the Tongue River (i.e., the lower and middle Tongue River) were listed as impaired for metals on the 1996 list. The 2002 303(d) list reported that metals were not impairing fishery or aquatic life uses in the lower Tongue River. Aquatic life and fishery uses were not evaluated for the other three segments of the Tongue River in 2002 because of insufficient credible data. This section presents an updated evaluation of all segments of the Tongue River to verify the impairment status relative to metals.

In general, stations in the Tongue River were sampled for metals from 1999 through 2002. All recent metals sampling was for total recoverable (TR) metals. Both dissolved metals and TR metals data are available for the Tongue River above the reservoir and the Tongue River in Wyoming. For the middle Tongue River, recent metals data were available from the Northern Cheyenne Tribe. Sampling was performed on June 22, 2001, in the Tongue River at the northern border of the Northern Cheyenne Reservation. The TRWU collected metals samples in the upper Tongue River and the Tongue River above the reservoir.

The lower Tongue River was sampled for most metals seven times at USGS station 06308500 between 1996 and 2002. None of these samples exceeded the acute water quality standards (Table 3-32). Single samples of copper and lead exceeded the chronic standard; however, average and median concentrations did not. No metals impairments were found in the periphyton sampling. These data suggest that aquatic life uses in the lower Tongue River are not impaired because of metals. A water quality impairment determination cannot be made for the middle Tongue River because there was a lack of current data. The only recent (1996-2002) metals data available for the middle Tongue River were single samples of arsenic, cadmium, copper, iron, and lead obtained by the Northern Cheyenne Tribe. There was not enough data to sufficiently determine the beneficial use status. However, none of the metals standards were exceeded at the Northern Cheyenne Tribe's station (Table 3-33).

The TRWU collected TR metals data in 2001 and 2002 at one station in the upper Tongue River (TRWU4). Metals standards were not exceeded at station TRWU4 (Table 3-34). The TRWU also collected TR metals data in 2001 and 2002 at stations TRWU7 and TRWU8 in the Tongue River above the reservoir. USGS collected TR metals data in 2001 and 2002 at station 06306300 for the Tongue River above the reservoir. The chronic iron standard was exceeded eight times by single samples in the Tongue River above the reservoir (Table 3-35). The average iron concentrations for 2001 and 2002 (621 mg/L and 528 mg/L, respectively) did not exceed the chronic iron standard. USGS collected dissolved metals data at station 06306300 for the Tongue River above the reservoir (Table 3-36). None of the dissolved metals data exceeded the calculated standard. Also, none of the dissolved metals data for the Tongue River in Wyoming exceeded the calculated criteria (Table 3-37). Beneficial uses in the upper Tongue River and the Tongue River above the reservoir do not appear to be impaired because of metals.

Table 3-32. Summary of TR metals exceedances in the lower Tongue River, 1996–2002.

Parameter	Total # of Samples	Acute			Chronic		
		Criteria (µg/L)	Total # of Exceedances	Percent Exceeding	Criteria (µg/L)	Total # of Exceedances	Percent Exceeding
Arsenic	7	340	0	0%	150	0	0%
Cadmium[a]	7	Variable	0	0%	Variable	0	0%
Chromium[a]	7	Variable	0	0%	Variable	0	0%
Copper[a]	7	Variable	0	0%	Variable	1	14%
Iron	0	NA	NA	NA	1,000	NA	NA
Lead[a]	7	Variable	0	0%	Variable	1	14%
Nickel[a]	7	Variable	0	0%	Variable	0	0%
Selenium	0	20	NA	NA	5	NA	NA
Silver[a]	0	Variable	NA	NA	NA	NA	NA
Zinc[a]	7	Variable	0	0%	Variable	0	0%

[a]Hardness-dependent criteria (hardness as mg/L of $CaCO_3$). The hardness of the water at the time of sampling is needed to calculate the criteria. Where hardness was not available, the average hardness for the lower Tongue River (329 mg/L) was used.

Table 3-33. Summary of TR metals exceedances in the middle Tongue River, 1996–2002.

Parameter	Total # of Samples	Acute			Chronic		
		Criteria (µg/L)	Total # of Exceedances	Percent Exceeding	Criteria (µg/L)	Total # of Exceedances	Percent Exceeding
Arsenic	1	340	0	0%	150	0	0%
Cadmium[a]	1	Variable	0	0%	Variable	0	0%
Copper[a]	1	Variable	0	0%	Variable	0	0%
Iron	1	NA	NA	NA	1,000	0	0%
Lead[a]	1	Variable	0	0%	Variable	0	0%

[a]Hardness-dependent criteria (hardness as mg/L of $CaCO_3$). The hardness of the water at the time of sampling is needed to calculate the criteria.

Table 3-34. Summary of TR metals exceedances in the upper Tongue River, 1996–2002.

Parameter	Total # of Samples	Acute			Chronic		
		Criteria (µg/L)	Total # of Exceedances	Percent Exceeding	Criteria (µg/L)	Total # of Exceedances	Percent Exceeding
Arsenic	13	340	0	0%	150	0	0%
Cadmium[a]	13	Variable	0	0%	Variable	0	0%
Chromium[a]	0	Variable	0	0%	Variable	0	0%
Copper[a]	13	Variable	0	0%	Variable	0	0%
Iron	13	NA	NA	NA	1,000	0	0%
Lead[a]	12	Variable	0	0%	Variable	0	0%
Nickel[a]	13	Variable	0	0%	Variable	0	0%
Selenium	0	20	NA	NA	5	NA	NA
Silver[a]	13	Variable	0	0%	NA	NA	NA
Zinc[a]	13	Variable	0	0%	Variable	0	0%

[a]Hardness-dependent criteria (hardness as mg/L of $CaCO_3$). The hardness of the water at the time of sampling is needed to calculate the criteria.

Table 3-35. Summary of TR metals exceedances in the Tongue River above the reservoir, 1996–2002.

Parameter	Total # of Samples	Acute			Chronic		
		Criteria (µg/L)	Total # of Exceedances	Percent Exceeding	Criteria (µg/L)	Total # of Exceedances	Percent Exceeding
Arsenic	43	340	0	0%	150	0	0%
Cadmium[a]	44	Variable	0	0%	Variable	0	0%
Chromium[a]	14	Variable	0	0%	Variable	0	0%
Copper[a]	44	Variable	0	0%	Variable	0	0%
Iron	44	NA	NA	NA	1,000	8	18%
Lead[a]	44	Variable	0	0%	Variable	0	0%
Nickel[a]	44	Variable	0	0%	Variable	0	0%
Selenium	14	20	0	0%	5	0	0%
Silver[a]	30	Variable	0	0%	NA	NA	NA
Zinc[a]	30	Variable	0	0%	Variable	0	0%

[a]Hardness-dependent criteria (hardness as mg/L of $CaCO_3$). The hardness of the water at the time of sampling is needed to calculate the criteria.

Table 3-36. Summary of dissolved metals exceedances in the Tongue River above the reservoir, 1996–2002.

Parameter	Total # of Samples	Acute			Chronic		
		Criteria (µg/L)	Total # of Exceedances	Percent Exceeding	Criteria (µg/L)	Total # of Exceedances	Percent Exceeding
Arsenic	14	340	0	0%	150	0	0%
Cadmium[a,b]	14	Variable	0	0%	Variable	0	0%
Chromium[a,b]	20	Variable	0	0%	Variable	0	0%
Copper[a,b]	14	Variable	0	0%	Variable	0	0%
Iron	0	NA	NA	NA	1,000	NA	NA
Lead[a,b]	14	Variable	0	0%	Variable	0	0%
Nickel[a,b]	14	Variable	0	0%	Variable	0	0%
Selenium	14	20	0	0%	5	0	0%
Silver[a,b]	14	Variable	0	0%	NA	NA	NA
Zinc[a,b]	14	Variable	0	0%	Variable	0	0%

[a]Criteria were calculated based on the Montana TR metals standards and the EPA conversion factors shown in Appendix F.
[b]Hardness-dependent criteria (hardness as mg/L of $CaCO_3$). The hardness of the water at the time of sampling is needed to calculate the criteria.

Table 3-37. Summary of dissolved metals exceedances in the Tongue River in Wyoming, 1996–2002.

Parameter	Total # of Samples	Acute			Chronic		
		Criteria (µg/L)	Total # of Exceedances	Percent Exceeding	Criteria (µg/L)	Total # of Exceedances	Percent Exceeding
Arsenic	5	340	0	0%	150	0	0%
Cadmium[a]	5	Variable	0	0%	Variable	0	0%
Chromium[a]	0	NA	NA	NA	Variable	NA	NA
Copper[a]	5	Variable	0	0%	Variable	0	0%
Iron	20	NA	NA	NA	1000	0	0%
Lead[a]	5	Variable	0	0%	0	NA	NA
Nickel[a]	5	Variable	0	0%	Variable	0	0%
Selenium	0	NA	NA	NA	5	NA	NA
Silver[a]	5	Variable	0	0%	NA	NA	NA
Zinc[a]	5	Variable	0	0%	Variable	0	0%

[a]Hardness-dependent criteria (hardness as mg/L of $CaCO_3$). The hardness of the water at the time of sampling is needed to calculate the criteria.

3.4.1.3.7 Total Suspended Solids

A total of four segments of the Tongue River and the Tongue River Reservoir appeared on the Montana 1996 303(d) list – Tongue River Above the Reservoir, Upper Tongue River, Middle Tongue River, and the Lower Tongue River. As described in Section 3.4.1, two segments of the Tongue River (i.e., the lower and middle Tongue River) were listed as impaired for total suspended solids (TSS) on the 1996 list. The 2002 303(d) list reported that TSS were not impairing fishery or aquatic life uses in the lower Tongue River. Aquatic life and fishery uses were not evaluated for the other three segments of the Tongue River in 2002 because of insufficient credible data. This section presents an updated evaluation of all segments of the Tongue River to verify the impairment status relative to TSS.

There are no numeric water quality standards for TSS in Montana, and no reference conditions are available for the Tongue River at this time. Both Utah and South Dakota have a TSS criterion of 90 mg/L for the protection of warmwater fishery streams, and South Dakota also has a criterion of 150 mg/L for the protection of marginal warmwater fishery streams. The TSS data from the Tongue River were compared to Utah's and South Dakota's TSS criteria to provide some insight on use impairment status. However, a better target for prairie streams is needed to make more conclusive decisions.

A general summary of TSS data is provided in Table 3-38. All TSS data for each segment of the Tongue River in Montana are plotted in Figures 3-27 though 3-30. There was a wide range of TSS concentrations at most stations, with some stations having minimum and maximum concentrations differing by three orders of magnitude. This is also shown by the high coefficients of variation (CV) at most stations. All of the stations had median concentrations lower than the 90 mg/L target except station 590. The wide range of TSS concentrations can be partially attributed to flow. Figures 3-31 and 3-32 show that TSS and flow are related: concentrations increase with increasing flow. Periphyton sampling indicated that there is moderate impairment in the middle Tongue River because of siltation (Bahls, 2001).

The lower Tongue River had the largest percentage of concentrations exceeding the TSS targets (Table 3-39). This is expected as TSS loads accumulate in the river moving downstream. Fewer TSS concentrations exceeded the targets in the middle Tongue River. Almost no concentrations exceeded the targets in the segment of the Tongue River just downstream of the Tongue River Reservoir (TRR) Dam (upper Tongue River). The reservoir is most likely trapping sediment, which is causing lower TSS concentrations at stations in the upper Tongue River. Above the TRR, concentrations were higher than the upper segment of the Tongue River.

The NRCS Phase II Stream Channel Assessment found that most of the Tongue River channel (57 percent) had sustainable conditions. Sustainable conditions were defined as "the stream and associated riparian area had certain expected attributes, (e.g., flood plain, adequate riparian vegetation, sufficient soil, and channel characteristics) in place, and that processes such as energy dissipation, sediment trapping, and biotic function were working together to make the system stable," (NRCS, 2002). The other 43 percent of evaluated reaches were "at risk". At risk segments had the necessary characteristics of a sustainable stream, but lacked critical stability or function. Conditions that caused segments of the Tongue River to be classified as at risk included bank erosion, loss of vegetation, lack of sufficient root depth, and the presence of invasive species. NRCS also noted that irrigation and cropping practices were having an effect of bank stability in localized areas, particularly in the middle and lower segments of the Tongue River. These findings indicate that there are potential anthropogenic sources of sediment along the Tongue River. However, it is not clear if these sources are impairing beneficial uses in the river.

A final water quality impairment determination will not be made for suspended solids because appropriate information is not yet available to determine if the elevated concentrations are a result of natural or anthropogenic causes.

Table 3-38. Summary of TSS data, Tongue River (mg/L).

Station	Count	Median	Average	Min	Max	CV[a]	Min Date	Max Date
Lower Tongue								
1437	1	12	12	12	12	0%	6/27/77	6/27/77
462413105512801	2	49	49	17	80	92%	9/22/01	10/28/01
6308500	251	66	343	2	14,000	322%	4/2/74	4/9/02
Middle Tongue								
1320	1	13	13	13	13	0%	6/27/77	6/27/77
455023106131201	9	7	49	2	310	204%	9/28/75	10/26/01
455844106031901	1	10	10	10	10	0%	10/27/01	10/27/01
460244105560201	3	2	25	1	73	164%	10/20/75	9/22/01
590	2	107	107	5	210	135%	12/4/75	5/19/77
6307610	66	21	58	1	812	212%	4/11/74	9/13/79
6307616	70	28	53	3	780	194%	10/2/79	10/26/01
6307830	90	46	402	1	23,100	606%	4/10/74	7/10/02
679	1	11	11	11	11	0%	6/24/77	6/24/77
967	1	11	11	11	11	0%	6/27/77	6/27/77
TR22	1	10	10	10	10	0%	10/26/01	10/26/01
TR32	1	55	55	55	55	0%	9/22/01	9/22/01
NCTR002	2	30	30	24	36	28%	6/22/01	6/22/01
NCTR004	4	58	58	54	62	8%	6/22/01	6/22/01
Upper Tongue								
364	25	4	18	1	135	179%	10/21/75	7/19/90
451607106372801	2	10	10	10	10	0%	9/21/01	10/26/01
6307500	196	16	24	2	213	101%	3/25/75	10/27/01
TRWU4	9	5	5	5	5	0%	2/25/01	10/13/02
Tongue River above Reservoir								
133	7	76	87	8	250	105%	3/25/75	11/1/77
134	10	76	62	4	117	74%	7/1/75	9/24/77
6306300	24	68	70	3	170	60%	6/21/00	7/10/02
6306500	6	16	24	2	57	102%	9/21/01	2/27/02
TRWU7	14	12	17	10	44	68%	1/28/01	10/13/02
TRWU8	14	27	29	10	65	60%	1/28/01	10/13/02
Tongue River in Wyoming								
6298000	65	3	10	0	86	183%	4/3/74	9/12/00
6299980	16	30	58	1	352	153%	4/3/74	7/21/77

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-39. Summary of TSS exceedances.

Segment	Target	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Lower Tongue	90 mg/L	254	104	41%	15	8	53%
Lower Tongue	150 mg/L	254	71	28%	15	5	33%
Middle Tongue	90 mg/L	252	46	18%	37	7	19%
Middle Tongue	150 mg/L	252	30	12%	37	2	5%
Upper Tongue	90 mg/L	232	6	3%	15	0	0%
Upper Tongue	150 mg/L	232	2	1%	15	0	0%
Above Reservoir	90 mg/L	75	12	16%	58	6	10%
Above Reservoir	150 mg/L	75	3	4%	58	1	2%

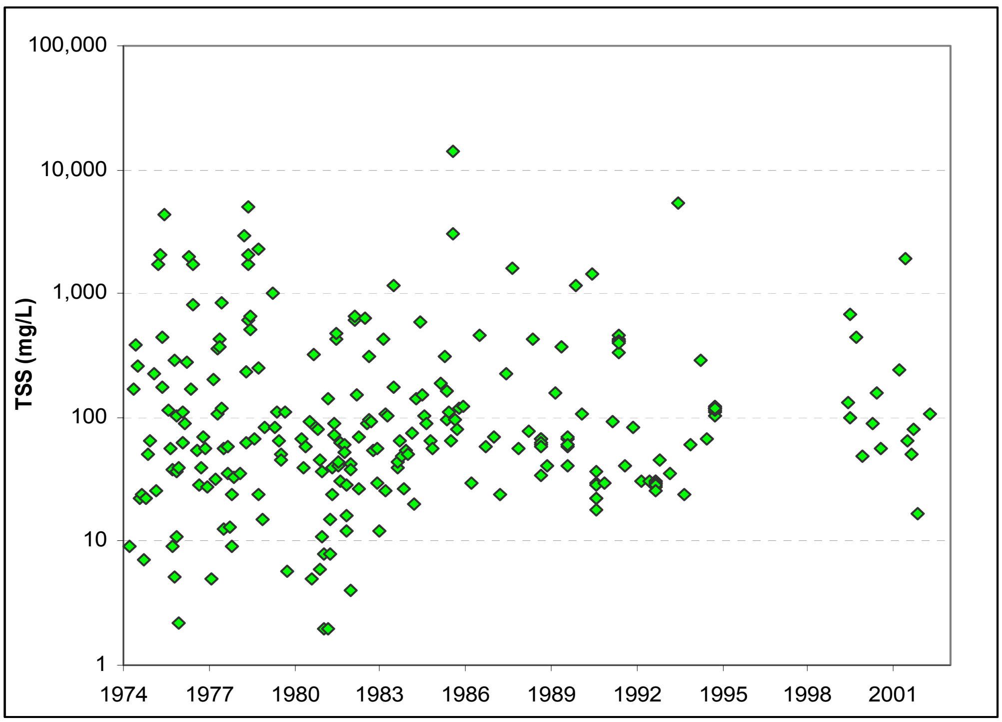

Figure 3-27. TSS data for the lower Tongue River (all stations).

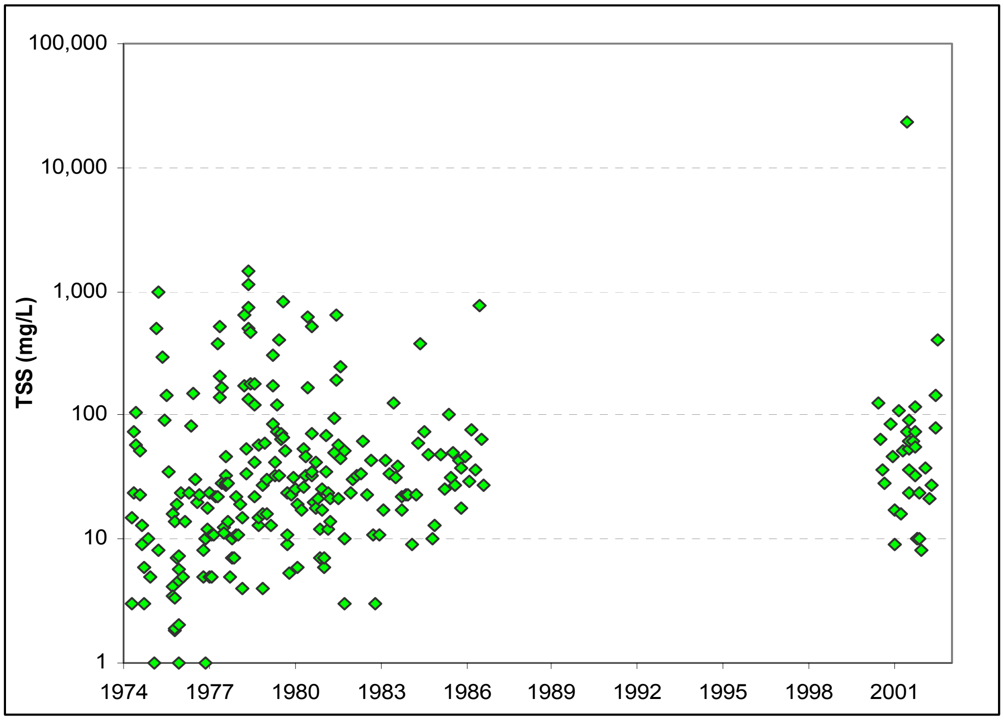

Figure 3-28. TSS data for the middle Tongue River (all stations).

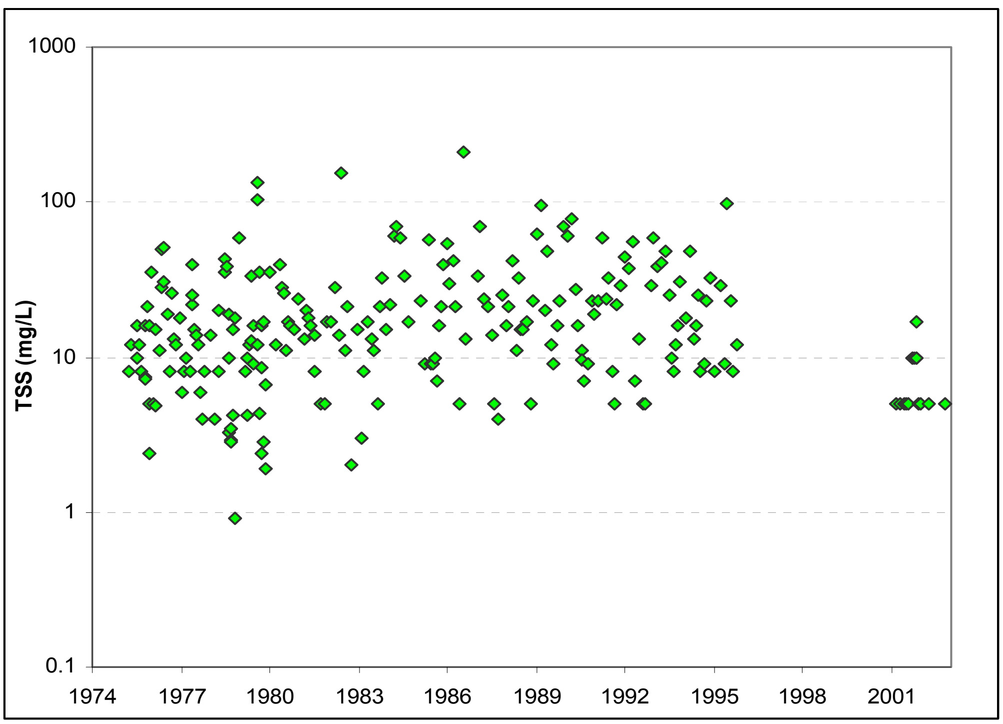

Figure 3-29. TSS data for the upper Tongue River (all stations).

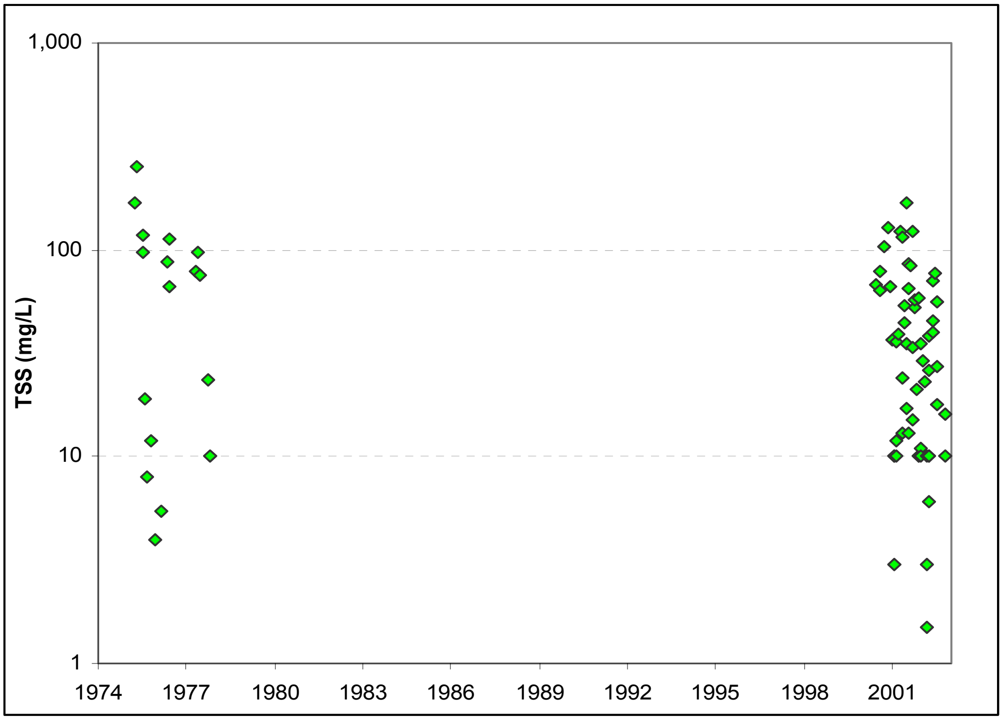

Figure 3-30. TSS data for the Tongue River above the reservoir (all stations).

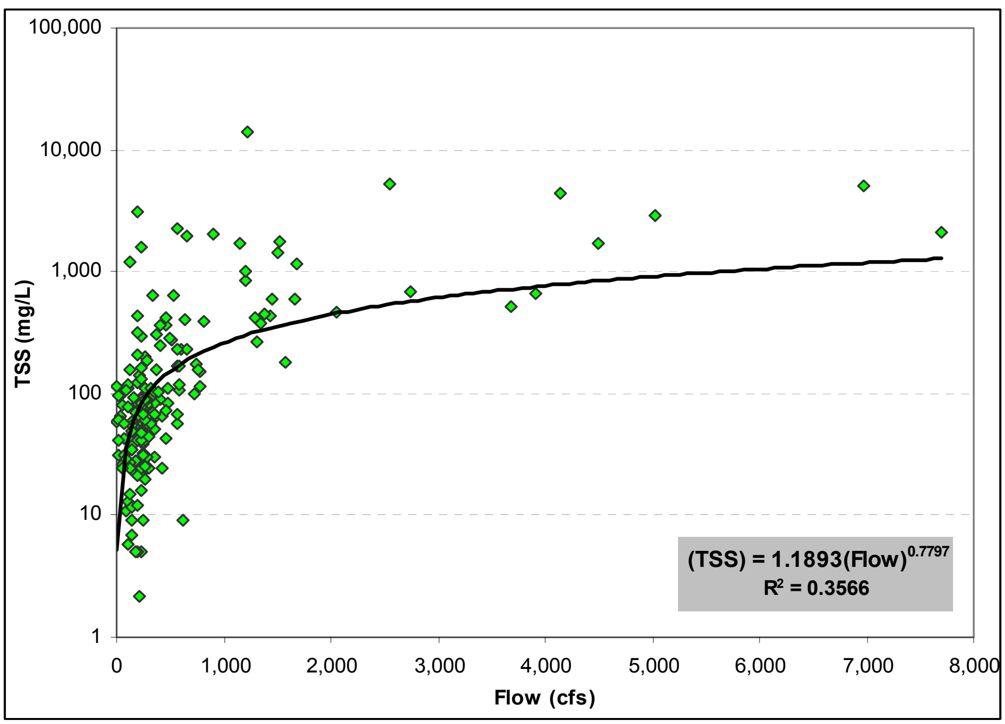

Figure 3-31. Relationship between TSS and flow at station 06308500.

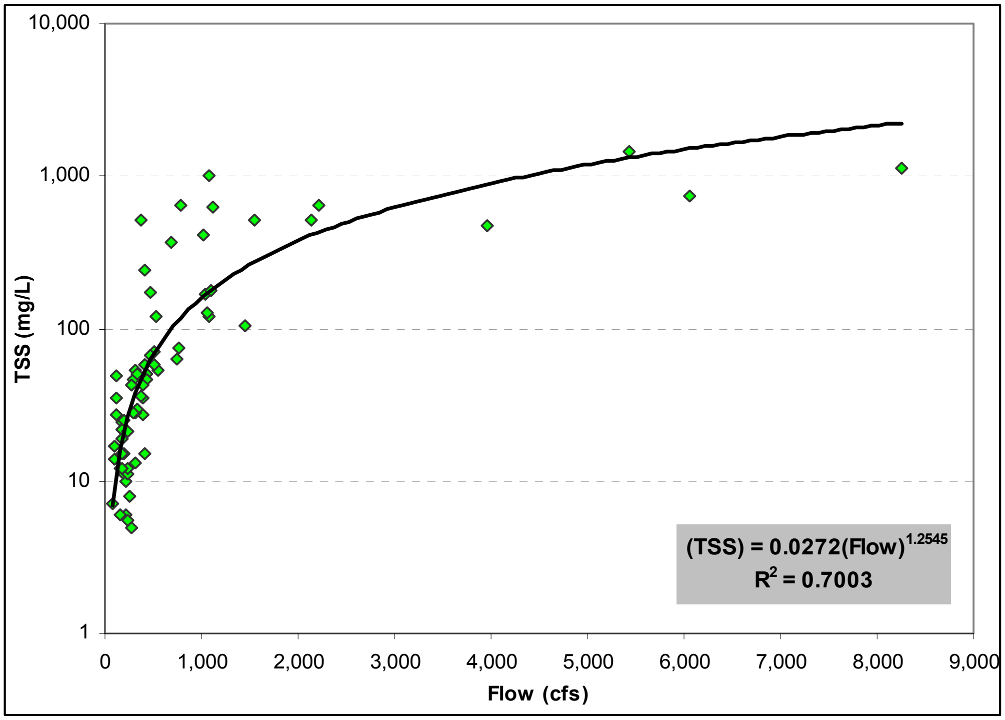

Figure 3-32. Relationship between TSS and flow at station 06307830.

3.4.1.3.8 Water Quality Impairment Status: Tongue River

The Montana 1996 303(d) list reported that the lower and middle segments of the Tongue River were impaired because of salinity/TDS/chlorides, flow alteration, metals, other inorganics, and suspended solids. The upper Tongue River and the Tongue River above the reservoir were impaired because of flow alterations.

In 2002, using additional data and a new listing methodology, MDEQ identified the lower Tongue River as impaired because of flow alterations. Aquatic life, fishery, and recreational uses were all partially impaired because of flow alterations. Agricultural uses were the only beneficial use evaluated for the middle Tongue River in 2002. There was insufficient credible data to determine the use impairment status for other uses for this segment. Agricultural uses were fully supporting in the middle Tongue River. Agricultural and industrial uses were evaluated for the upper Tongue River and the Tongue River above the reservoir in 2002. Both uses were fully supporting in both segments. No other beneficial uses were evaluated for these segments because of insufficient credible data.

In this report, water quality impairment determinations could not be made for several causes of impairment because appropriate site-specific numeric criteria have not been identified, or because there was a lack of recent data. A summary for each evaluated cause of impairment for each segment of the Tongue River is shown in Table 3-40.

Table 3-40. Water quality impairment status summary, Tongue River.

Segment	Evaluated Cause of Impairment	1996 303(d) List	2002 303(d) List	TMDL Requirement
Tongue River (WY Border to Tongue River Reservoir) (Tongue River Above Reservoir)	Chlorides			No
	Flow alteration	✔		No
	Metals			Undetermined
	Salinity			Undetermined
	SAR			Undetermined
	TDS			No
Tongue River (TRR Dam to the confluence with Hanging Women Creek) (Upper Tongue River)	Chlorides			No
	Flow alteration	✔		No
	Metals			No
	Salinity			Undetermined
	SAR			Undetermined
	TDS			Undetermined
Tongue River (Hanging Women Creek to diversion dam) (Middle Tongue River)	Chlorides	✔		No
	Flow alteration	✔		No
	Metals	✔		Undetermined
	Other Inorganics	✔		Undetermined
	Salinity	✔		Undetermined
	SAR			Undetermined
	Suspended solids	✔		Undetermined
	TDS	✔		Undetermined
Tongue River (diversion dam to mouth) (Lower Tongue River)	Chlorides	✔		No
	Flow alteration	✔	✔	No
	Metals	✔		No
	Other Inorganics	✔		Undetermined
	Salinity	✔		Undetermined
	SAR			Undetermined
	Suspended solids	✔		Undetermined
	TDS	✔		Undetermined

3.4.2 Hanging Woman Creek

The Montana 1996 303(d) list reported that Hanging Woman Creek was impaired because of salinity/TDS/chlorides, flow alterations, and metals (MDEQ, 1996). Agricultural, aquatic life, and fishery beneficial uses were impaired by these causes in 1996.

The Montana 2002 303(d) list reported that Hanging Woman Creek from Stroud Creek to the mouth was impaired because of siltation (MDEQ, 2002). Aquatic life and warmwater fishery uses were impaired by this cause. Agricultural, drinking water, industrial, and swimming/recreational uses were not evaluated in Hanging Woman Creek (Stroud Creek to the mouth) in the 2002 303(d) report because of insufficient credible data. Beneficial uses in Hanging Woman Creek from the headwaters to Stroud Creek were also not assessed in the 2002 303(d) report for the same reason.

The discussion below provides a review of available data to evaluate the water quality impairment status.

3.4.2.1 Macroinvertebrates and Periphyton

No recent macroinvertebrate or periphyton data were identified at the time of this report.

3.4.2.2 Fish

No recent fish information was identified at the time of this report.

3.4.2.3 Water Chemistry Assessment

Water chemistry data for Hanging Woman Creek are available from five monitoring stations in Montana (Figure 3-33). These data have been collected by USGS and MDEQ and are summarized in the following sections.

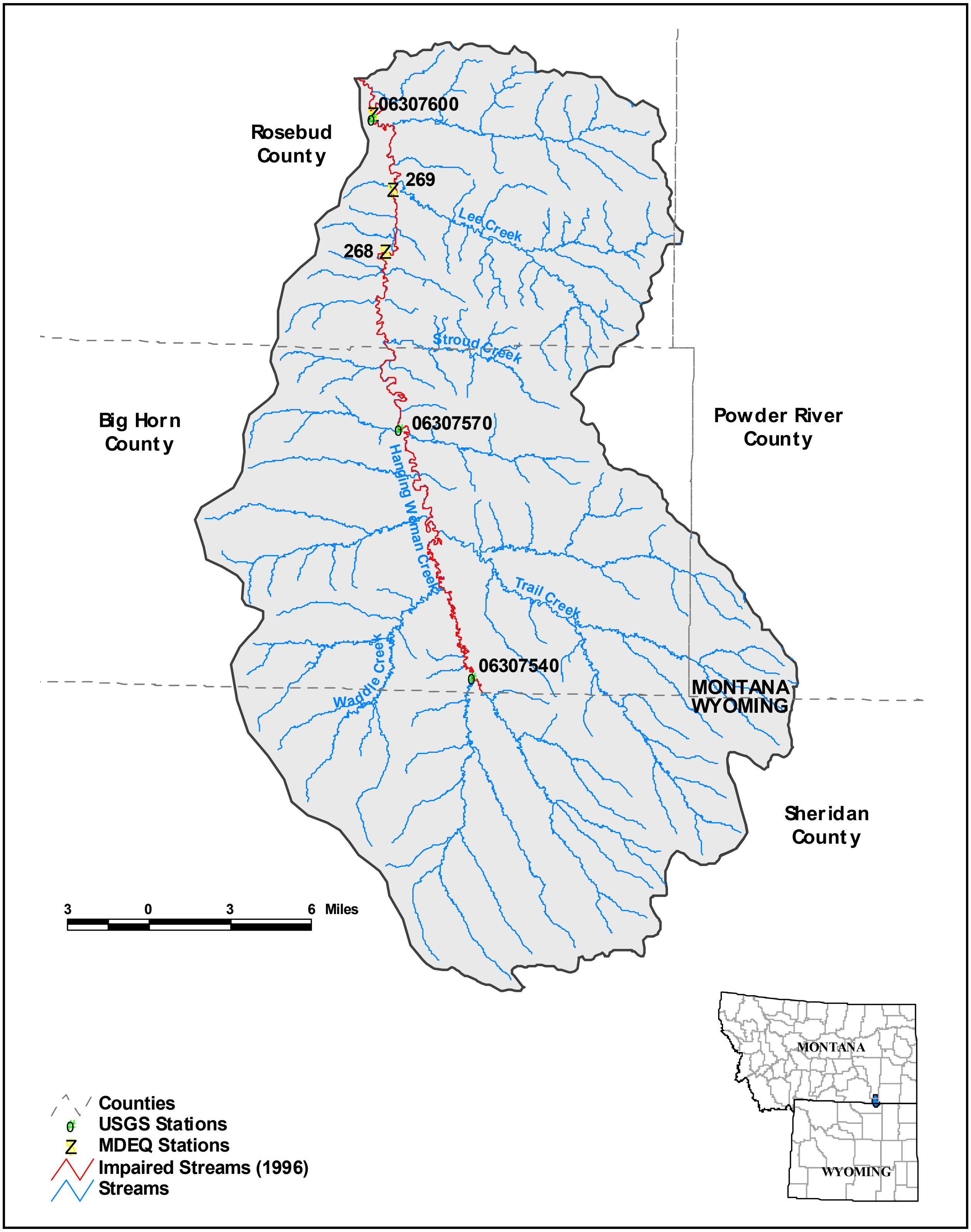

Figure 3-33. Surface water quality monitoring stations in Hanging Woman Creek.

3.4.2.3.1 Salinity

As described in Section 3.4.2, Hanging Woman Creek was listed as impaired for salinity on the 1996 303(d) list. Agricultural uses for Hanging Woman Creek were not evaluated for the 2002 list, and salinity was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of all segments of Hanging Woman Creek to verify the impairment status relative to salinity.

EC data are summarized in Tables 3-41 and 3-42. Figure 3-34 shows that there has been little yearly change in the EC data and that values from the growing season and non-growing season are very similar. EC values are very high in Hanging Woman Creek. All average concentrations are higher than 2,000 µS/cm. However, the latest water quality sampling occurred in 1995 and there are no current EC data. Table 3-43 shows that historically, 100 percent of EC samples exceeded the proposed water quality standard of 500 µS/cm. There was no relationship between EC and flow at USGS station 06307600 (Figure 3-35).

A final water quality impairment determination will not be made for salinity (EC) until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria (see Section 3.3.1.2). Also, a water quality impairment determination cannot be made for Hanging Woman Creek because there is a lack of current data. The most recent EC data were collected in 1995.

Table 3-41. Summary of EC data, Hanging Woman Creek (µS/cm) (November 1– March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
269	1	3,520	3,520	3,520	NA	3/31/79	3/31/79
6307540	7	4,131	785	11,100	108%	2/20/80	2/24/83
6307570	37	3,549	885	5,600	35%	1/30/74	2/10/87
6307600	142	2,242	226	3,590	36%	1/30/74	3/20/95

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-42. Summary of EC data, Hanging Woman Creek (µS/cm) (April 1– October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
268	1	3,590	3,590	3,590	NA	9/14/79	9/14/79
6307540	6	11,650	10,700	13,200	8%	5/19/82	6/8/83
6307570	83	4,207	1,730	7,010	25%	10/20/77	9/15/87
6307600	181	2,619	990	4,220	27%	4/4/74	8/30/95

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-43. Summary of EC exceedances.

Season	Criterion	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season	500 µS/cm	271	271	100%	0	NA	NA
Non-growing Season	2,000 µS/cm	187	138	74%	0	NA	NA

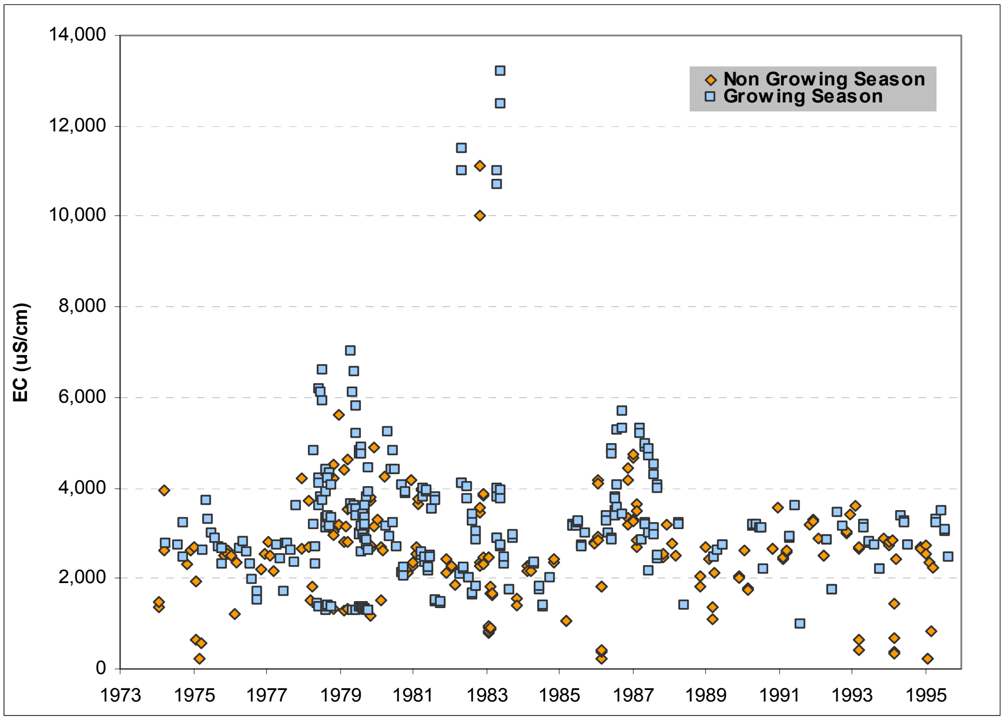

Figure 3-34. EC data for Hanging Woman Creek (all stations).

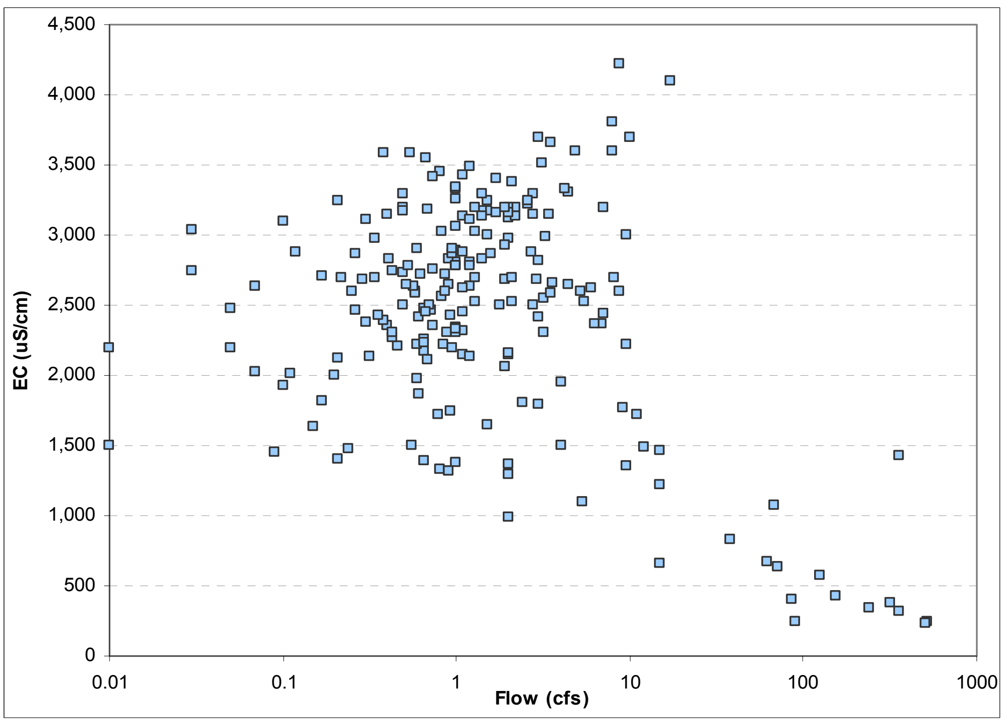

Figure 3-35. Relationship between EC and flow at USGS station 6307600.

3.4.2.3.2 Total Dissolved Solids

As described in Section 3.4.2, Hanging Woman Creek was listed as impaired for total dissolved solids (TDS) on the 1996 303(d) list. Agricultural uses for Hanging Woman Creek were not evaluated for the 2002 list, and TDS was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of all segments of Hanging Woman Creek to verify the impairment status relative to TDS.

Section 3.3.2.3.1 described salinity (measured as EC) in Hanging Woman Creek. EC is an indirect measurement of TDS and salinity. The relationship between TDS and EC is different for each waterbody, and it varies with the type of ions in solution, temperature, and barometric pressure. Figure 3-36 shows the relationship between EC and TDS in Hanging Woman Creek. This graph shows EC and TDS data obtained on the same date and location, and it confirms the strong relationship between EC and TDS. The relationship between the two parameters is EC = 1.29(TDS). Therefore, an EC standard of 500 µS/cm is equivalent to a TDS concentration of 388 mg/L and an EC of 2,000 µS/cm is equivalent to 1,550 mg/L. At station 06307600, the major ions measured by TDS were on average sulfate (53%), sodium (17%), calcium (5%), chloride (1%), and magnesium (7%).

TDS data for the growing and non-growing seasons are summarized in Tables 3-44 and 3-45. Average concentrations during the growing season regularly exceeded calculated TDS targets. Figure 3-37 shows that there was no apparent change in TDS values and there were few recent data available.

A final water quality impairment determination will not be made for TDS until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria for salinity (EC) (see Section 3.3.1.2). Also, a water quality impairment determination cannot be made for Hanging Woman Creek because there is a lack of current data. The most recent TDS data were collected in 1990.

Table 3-44. Summary of TDS data, Hanging Woman Creek (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
269	1	3,034	3,034	3,034	NA	3/31/79	3/31/79
6307540	1	2,020	2,020	2,020	NA	2/20/80	2/20/80
6307570	16	3,025	1,064	4,130	33%	1/30/74	3/26/81
6307600	41	1,677	176	2,583	35%	1/30/74	3/3/82

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-45. Summary of TDS data, Hanging Woman Creek (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
268	1	2,963	2,963	2,963	NA	9/14/79	9/14/79
6307570	34	3,663	1,670	7,682	32%	10/20/77	9/30/82
6307600	70	1,908	985	3,236	31%	4/4/74	7/19/90

[a]CV – Coefficient of Variation (standard deviation/mean).

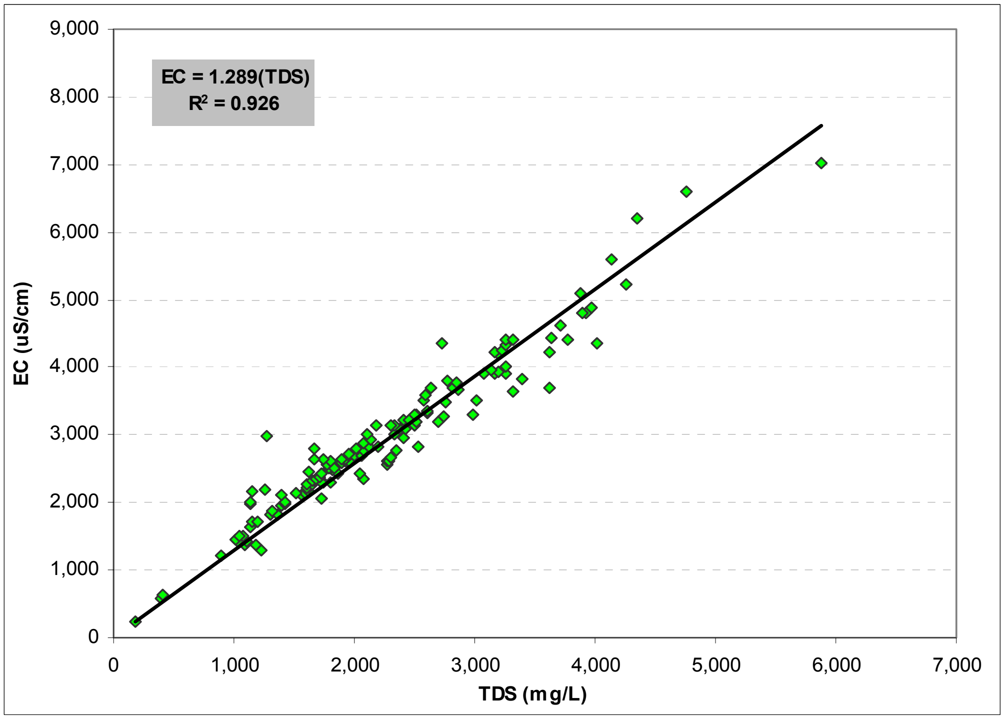

Figure 3-36. Relationship between EC and TDS for Hanging Woman Creek.

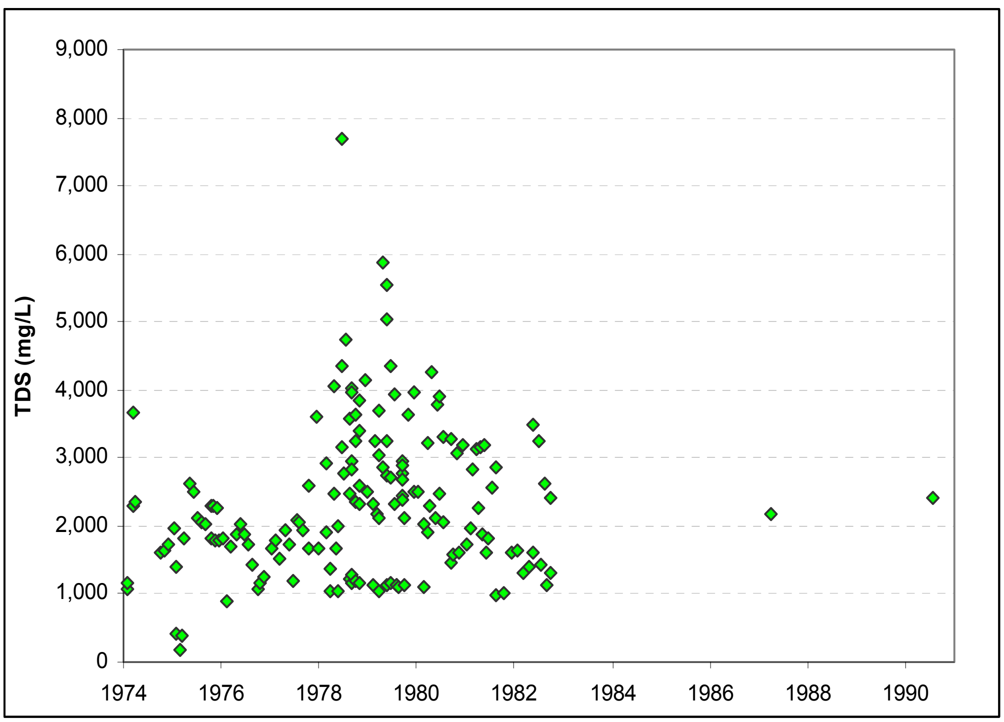

Figure 3-37. TDS data for Hanging Woman Creek (all stations).

3.4.2.3.3 Chlorides

As described in Section 3.4.2, Hanging Woman Creek was listed as impaired for chlorides on the 1996 303(d) list. Agricultural uses for Hanging Woman Creek were not evaluated for the 2002 list, and chloride was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of all segments of Hanging Woman Creek to verify the impairment status relative to chlorides.

USEPA recommended chloride standards for streams and rivers based on the aquatic toxicity of plant, fish, and invertebrate species (USEPA, 1999). USEPA recommends an acute standard of 860 mg/L and a chronic standard of 230 mg/L. These standards were adopted by Wyoming and the Northern Cheyenne Tribe. Montana does not have numeric standards for chlorides.

Chloride data for Hanging Woman Creek are summarized in Tables 3-46 and 3-47. Average concentrations were under USEPA's proposed standards. There was no apparent increase or decrease in chloride concentrations for Hanging Woman Creek, and few recent data were available (Figure 3-38).

Based on an analysis of the available data, chlorides are not impairing agricultural or aquatic life uses in Hanging Woman Creek. Chloride concentrations were much lower than USEPA's recommended standards to protect aquatic life uses. Concentrations were also much lower than the calculated TDS targets to protect agricultural uses (see Section 3.4.2.3.2). Additional data will be collected in the future to verify the beneficial use impairment status.

Table 3-46. Summary of chloride data, Hanging Woman Creek (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
269	1	12.0	12.0	12.0	NA	3/31/79	3/31/79
6307540	4	16.8	5.4	42.0	102%	2/20/80	2/24/83
6307570	25	19.2	4.1	66.0	75%	1/30/74	2/10/87
6307600	73	12.3	3.5	50.0	56%	1/30/74	1/11/95

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-47. Summary of chloride data, Hanging Woman Creek (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
268	1	18.9	18.9	18.9	NA	9/14/79	9/14/79
6307540	3	26.7	23.0	32.0	18%	5/19/82	6/8/83
6307570	48	17.6	4.0	32.0	31%	10/20/77	9/15/87
6307600	101	14.2	1.8	140.0	95%	4/4/74	7/20/95

[a]CV – Coefficient of Variation (standard deviation/mean).

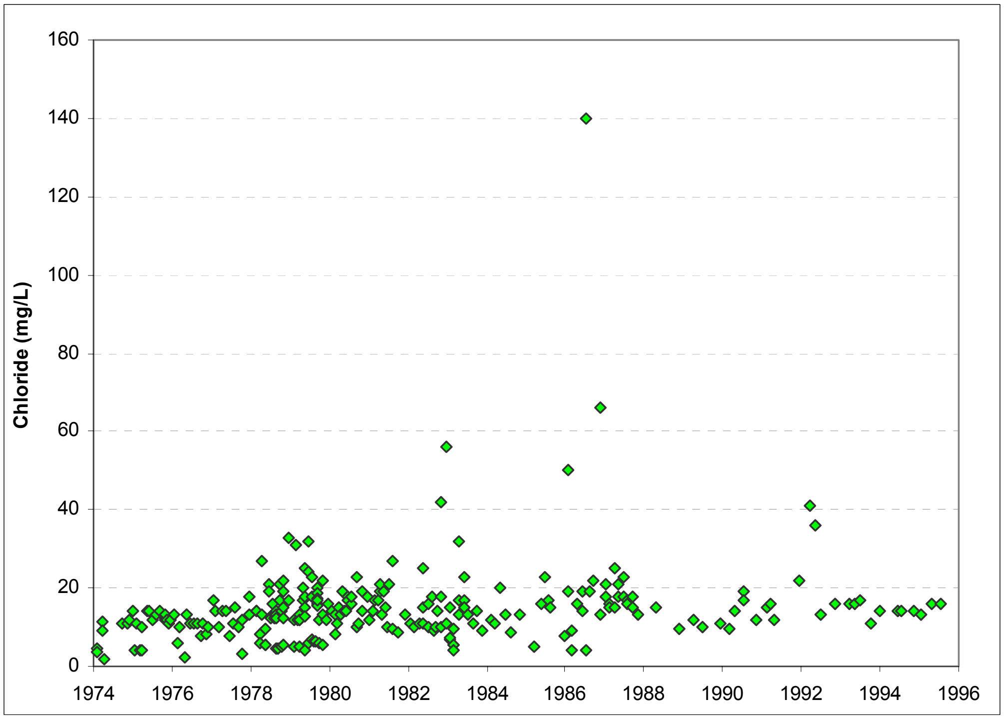

Figure 3-38. Chloride data for Hanging Woman Creek (all stations).

3.4.2.3.4 SAR

As described in Section 3.4.2, Hanging Woman Creek was not listed for SAR in the 1996 or 2002 303(d) lists. Hanging Woman Creek was fully supporting agricultural uses in the 2002 303(d) list. This section presents an updated evaluation of Hanging Woman Creek to verify the impairment status relative to SAR.

SAR data for Hanging Woman Creek are summarized in Tables 3-48 and 3-49. The data are compared to MDEQ's proposed SAR criteria in Table 3-50. There were no recent SAR data for Hanging Woman Creek. Historically, SAR appears to have impaired agricultural uses. SAR values rarely exceeded the calculated SAR criteria but were often greater than 5 (the upper limit for SAR values) (Figure 3-39).

A final water quality impairment determination will not be made for SAR until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria for SAR (see Section 3.3.1.2). Also, a water quality impairment determination cannot be made for Hanging Woman Creek because there is a lack of current data. The most recent TDS data were collected in 1995.

Table 3-48. Summary of SAR data, Hanging Woman Creek (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
269	1	6.5	6.5	6.5	0%	3/31/79	3/31/79
6307540	4	7.2	3.2	15.5	78%	2/20/80	2/24/83
6307570	24	6.5	2.5	8.7	27%	1/30/74	2/10/87
6307600	69	4.7	0.7	6.8	25%	1/30/74	1/11/95

*CV – Coefficient of Variation (standard deviation/mean).

Table 3-49. Summary of SAR data, Hanging Woman Creek (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
268	1	6.4	6.4	6.4	0%	9/14/79	9/14/79
6307540	3	15.9	14.7	17.2	8%	5/19/82	6/8/83
6307570	48	7.7	4.6	11.9	19%	10/20/77	9/15/87
6307600	100	5.4	2.4	8.1	24%	4/4/74	7/20/95

*CV – Coefficient of Variation (standard deviation/mean).

Table 3-50. Summary of SAR exceedances[a].

Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Variable	250	172	69%	0	NA	NA

[a]Reported data are from sample dates with both an SAR and salinity measurement, and criteria are based on the formula SAR <= (EC * 0.0071) – 2.475.

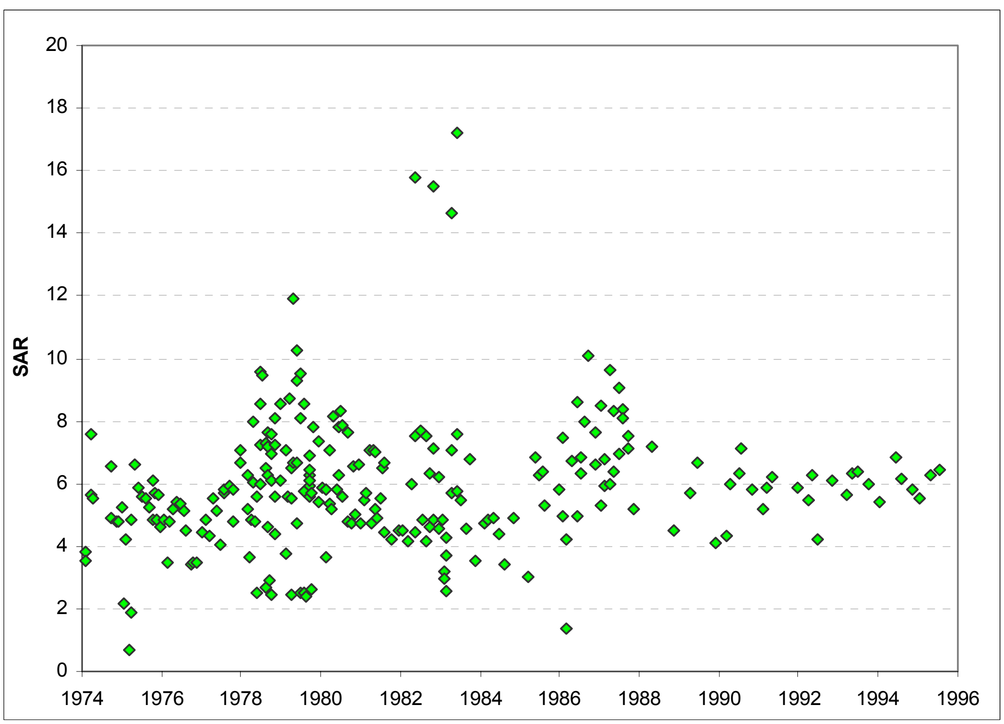

Figure 3-39. SAR data for Hanging Woman Creek (all stations).

3.4.2.3.5 Metals

As described in Section 3.4.2, Hanging Woman Creek was listed as impaired for metals on the 1996 303(d) list. The 2002 303(d) list reported that metals were not impairing fishery or aquatic life uses in Hanging Woman Creek from Stroud Creek to the mouth. It was noted in the Hanging Woman Creek Assessment Record Sheet (Datarev7) that some high metals concentrations were present in this segment, but it was unclear if they were due to natural or anthropogenic causes (MDEQ, 1999). Aquatic life and fishery uses in 2002 were not evaluated for Hanging Woman Creek from the Wyoming border to Stroud Creek because of insufficient credible data. This section presents an updated evaluation of Hanging Woman Creek to verify the impairment status relative to metals.

Hanging Woman Creek was listed for a metals impairment in 1996. The following analysis considers arsenic, cadmium, chromium, copper, iron, lead, nickel, selenium, silver, and zinc. Metals usually present a threat to the health of aquatic life, animals, and humans because of toxicity. The toxic effects of metals often change with the hardness of water, and criteria are calculated based on hardness rather than fixed at one value.

No recent metals data were available for Hanging Woman Creek. An analysis of historical metals data found that most samples had high detection limits and were not reliable sources of data. A water quality impairment determination cannot be made for Hanging Woman Creek because there is a lack of current data. The most recent metals data were collected in 1995.

3.4.2.3.6 Siltation

Hanging Woman Creek was not listed as impaired because of siltation on the 1996 303(d) list. The 2002 303(d) list reported that aquatic life and fishery uses in Hanging Woman Creek from Stroud Creek to the mouth were impaired because of siltation. Grazing and agriculture were cited as the source of the siltation impairment. Aquatic life and fishery uses in 2002 were not evaluated for Hanging Woman Creek from the Wyoming border to Stroud Creek because of insufficient credible data. This section presents an updated evaluation of Hanging Woman Creek to verify the impairment status relative to siltation.

Table 3-51 summarizes TSS data in Hanging Woman Creek and Figure 3-40 shows the data. TSS concentrations were similar to other tributaries in the Tongue River watershed, and there is no evidence from the TSS data that excess sediment and siltation are causes of impairment. The NRCS Stream Corridor Assessment found that there was a high degree of incisement and a lack of stable vegetation in Hanging Woman Creek near the mouth (NRCS, 2002). However, the report also noted that sediment supply and deposition appeared to be in balance in the creek. Nine of the ten reaches evaluated for Hanging Woman Creek were rated “sustainable” by NRCS.

A final water quality impairment determination will not be made for siltation because appropriate information is not yet available to determine if the siltation is a result of natural or anthropogenic causes.

Table 3-51. Summary of TSS data, Hanging Woman Creek.

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
268	1	14.1	14.1	14.1	0%	9/14/79	9/14/79
269	1	11.0	11.0	11.0	0%	3/31/79	3/31/79
6307540	7	37.0	9.0	120.0	555%	2/20/80	6/8/83
6307570	77	50.3	2.4	609.0	99%	10/20/77	9/15/87
6307600	182	74.8	0.4	650.0	49%	10/2/74	7/20/95

*CV – Coefficient of Variation (standard deviation/mean).

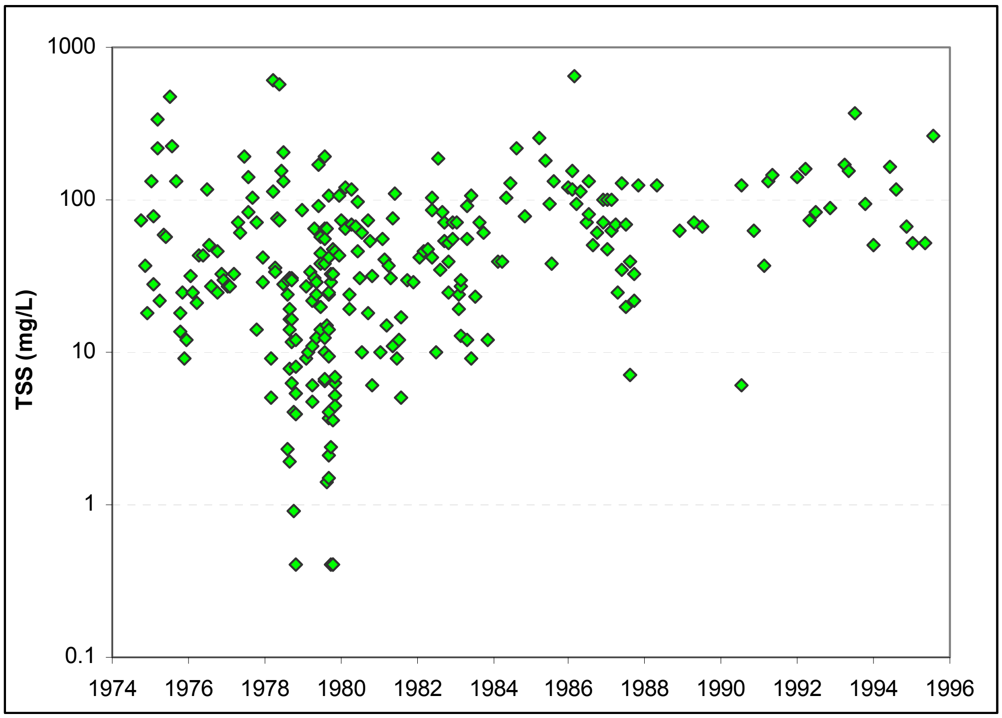

Figure 3-40. TSS data for Hanging Woman Creek (all stations).

3.4.2.3.7 Beneficial Use Support Summary: Hanging Woman Creek

The Montana 1996 303(d) list reported that Hanging Woman Creek was impaired because of salinity/TDS/chlorides, flow alteration, and metals. In 2002, using additional data and a new listing methodology, MDEQ identified Hanging Woman Creek from Stroud Creek to the mouth as impaired because of siltation. Aquatic life and fishery uses were impaired because of siltation. No other causes of impairment for Hanging Woman Creek were identified in the 2002 Section 303(d) report. However, agricultural, industrial, drinking water, and recreation beneficial uses were not evaluated for the 2002 report because of insufficient credible data.

The 1996 and 2002 causes of impairment were analyzed in the previous sections to determine which causes will require TMDLs. Water quality impairment determinations could not be made for several causes of impairment because appropriate site-specific numeric criteria have not been identified, or because there was a lack of recent data. A summary for each evaluated cause of impairment is shown in Table 3-52.

Table 3-52. Water quality impairment status summary.

Segment	Evaluated Cause of Impairment	1996 303(d) List	2002 303(d) List[a]	TMDL Requirement
Hanging Woman Creek	Chlorides	✔		No
	Flow Alteration	✔		No
	Metals	✔		Undetermined
	Salinity	✔		Undetermined
	SAR			Undetermined
	Siltation		✔	Undetermined
	TDS	✔		Undetermined

[a]Not all causes of impairment were evaluated for the 2002 303(d) list.
Source: MDEQ, 1996, 2002.

3.4.3 Otter Creek

The Montana 1996 303(d) list reported that Otter Creek was impaired because of salinity/TDS/chlorides, other habitat alterations, suspended solids, and metals. Agricultural, aquatic life, and fishery beneficial uses were impaired by these causes in 1996. In 2002, beneficial uses and causes of impairment in Otter Creek were not assessed for the 303(d) report because of insufficient credible data. The discussion below provides a review of available data to evaluate the water quality impairment status.

3.4.3.1 Macroinvertebrates and Periphyton

No recent macroinvertebrate or periphyton data were identified at the time of this report.

3.4.3.2 Fish

No recent fish data were available at the time of this report.

3.4.3.3 Water Chemistry Assessment

Water chemistry data for Otter Creek are available from 20 monitoring stations in Montana (Figure 3-41). These data have been collected by USGS and MDEQ and are summarized in the following sections.

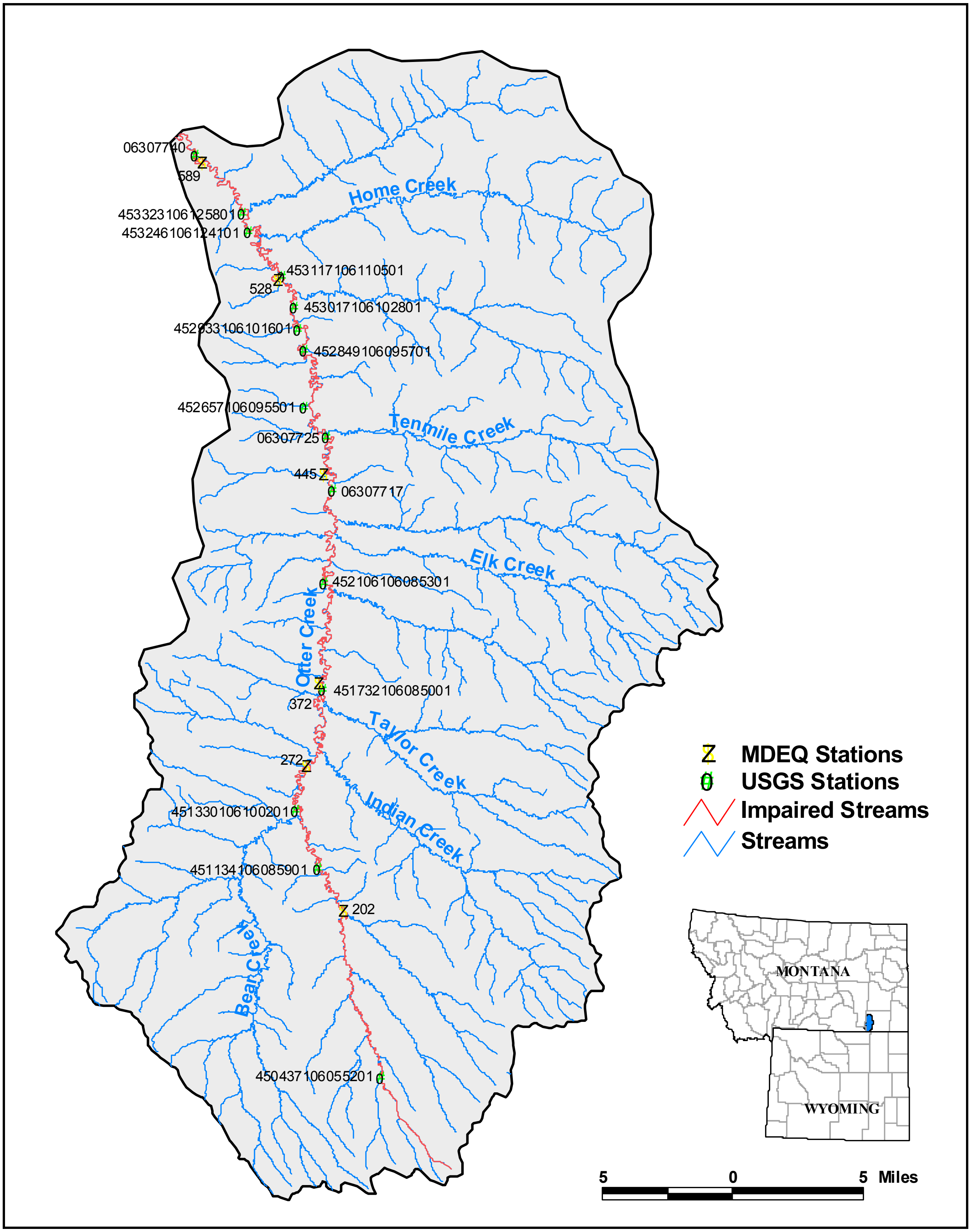

Figure 3-41. Location of Otter Creek and 1996 impaired streams.

3.4.3.3.1 Salinity

As described in Section 3.4.3, Otter Creek was listed as impaired for salinity on the 1996 303(d) list. Agricultural uses for Otter Creek were not evaluated for the 2002 list, and salinity was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Otter Creek to verify the impairment status relative to salinity.

EC data are summarized in Tables 3-53 and 3-54. Figure 3-42 shows that there has been little change in EC concentrations over time and that values from the growing season and non-growing season are very similar. EC values are very high in Otter Creek. All average concentrations are higher than 2,000 µS/cm. However, the latest water quality sampling occurred in 1995 and there are no current EC data. Table 3-55 shows that historically, 100 percent of EC samples during the growing season exceeded the water quality standard of 500 µS/cm. There was a very weak relationship between EC and flow at USGS station 06307740 (Figure 3-43).

A final water quality impairment determination will not be made for salinity (EC) until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria (see Section 3.3.1.2). Also, a water quality impairment determination cannot be made for Otter Creek because there is a lack of current data. The most recent EC data were collected in 1995.

Table 3-53. Summary of EC data, Otter Creek (µS/cm) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
272	1	3,140	3,140	3,140	NA	1/30/74	1/30/74
451732106085001	1	2,776	2,776	2,776	NA	3/22/74	3/22/74
452933106101601	2	3,635	3,490	3,780	6%	3/29/83	3/29/83
453117106110501	1	2,840	2,840	2,840	NA	3/31/79	3/31/79
589	10	2,930	2,359	3,339	8%	1/17/74	11/6/79
6307717	22	3,170	1,440	3,920	17%	11/3/82	3/19/85
6307725	18	3,049	680	3,730	22%	12/20/77	3/6/81
6307740	95	2,599	325	3,900	27%	11/21/74	3/21/95

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-54. Summary of EC data, Otter Creek (µS/cm) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
202	1	6,400	6,400	6,400	NA	9/30/79	9/30/79
272	5	3,142	2,014	3,533	20%	6/27/79	9/30/79
451330106100201	2	3,600	3,450	3,750	6%	10/19/83	10/19/83
451732106085001	8	2,951	2,620	3,210	6%	10/26/77	10/19/83
452106106085301	3	2,577	2,260	2,870	12%	10/26/77	10/19/83
452657106095501	1	1,360	1,360	1,360	NA	5/19/78	5/19/78
452849106095701	2	3,520	3,300	3,740	9%	10/19/83	10/19/83
453117106110501	3	2,646	1,550	3,700	41%	10/18/76	10/20/83
453246106124101	6	3,735	3,250	4,200	9%	10/27/77	10/20/83
453323106125801	3	2,793	2,580	3,200	13%	10/27/77	10/20/83
453557106161401	1	2,950	2,950	2,950	NA	10/20/83	10/20/83
453601106161001	1	2,600	2,600	2,600	NA	10/28/77	10/28/77
589	22	2,913	2,250	3,399	10%	4/18/74	4/21/83
6307717	41	3,310	2,430	3,940	10%	9/30/79	9/11/85
6307725	29	3,240	2,520	4,400	13%	10/18/77	10/19/83
6307740	159	2,832	1,030	3,960	14%	10/2/74	9/1/95

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-55. Summary of EC exceedances.

Season	Salinity Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season	500 µS/cm	287	287	100%	0	NA	NA
Non-growing Season	2,000 µS/cm	150	134	89%	0	NA	NA

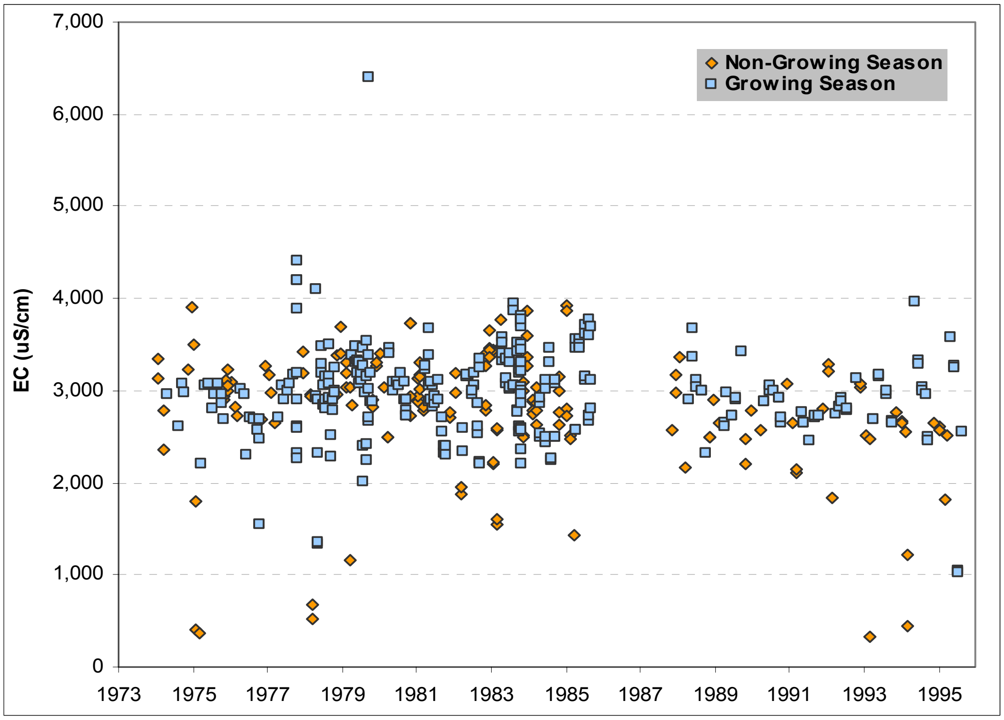

Figure 3-42. EC data for Otter Creek (all stations).

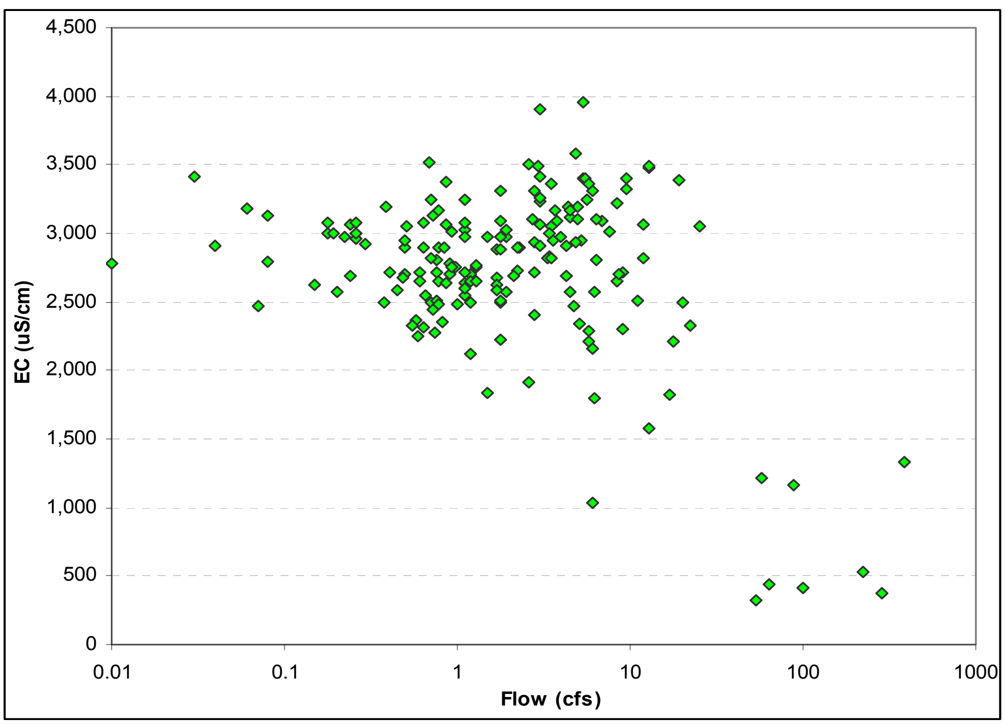

Figure 3-43. Relationship between EC and flow at USGS station 06307740.

3.4.3.3.2 Total Dissolved Solids

As described in Section 3.4.3, Otter Creek was listed as impaired for total dissolved solids (TDS) on the 1996 303(d) list. Agricultural uses for Otter Creek were not evaluated for the 2002 list, and TDS was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Otter Creek to verify the impairment status relative to TDS.

Section 3.4.3.3.1 described salinity (measured as EC) in Otter Creek. EC is an indirect measurement of TDS and salinity. The relationship between TDS and EC is different for each waterbody, and it varies with the type of ions in solution, temperature, and barometric pressure. Figure 3-44 shows the relationship between EC and TDS in Otter Creek. This graph shows EC and TDS data obtained on the same date and location, and it confirms the strong relationship between EC and TDS. The relationship between the two parameters is EC = 1.27(TDS). Therefore, an EC standard of 500 µS/cm is equivalent to a TDS concentration of 394 mg/L and an EC of 2,000 µS/cm is equivalent to 1,575 mg/L. The major ions measured by TDS were on average sulfate (54%), sodium (17%), calcium (4%), chloride (1%), and magnesium (8%).

TDS data for the growing and non-growing seasons are summarized in Tables 3-56 and 3-57. Average values during the growing season regularly exceeded calculated TDS targets. Figure 3-45 shows that there was no apparent change in TDS values although there were few recent data available.

A final water quality impairment determination will not be made for TDS until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria for salinity (EC) (see Section 3.3.1.2). Also, a water quality impairment determination cannot be made for Otter Creek because there is a lack of current data. The most recent TDS data were collected in 1982.

Table 3-56. Summary of TDS data, Otter Creek (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
272	1	2,693	2,693	2,693	0%	1/30/74	1/30/74
451732106085001	1	2,330	2,330	2,330	0%	3/22/74	3/22/74
453117106110501	1	2,352	2,352	2,352	0%	3/31/79	3/31/79
589	4	2,565	2,203	2,834	11%	3/22/74	2/11/79
6307725	14	2,260	444	2,950	28%	12/20/77	3/6/81
6307740	31	1,980	228	2,750	36%	11/21/74	3/8/82

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-57. Summary of TDS data, Otter Creek (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
202	1	6,207	6,207	6,207	0%	9/30/79	9/30/79
272	5	2,678	1,623	3,083	22%	6/27/79	9/30/79
451732106085001	9	2,230	2,000	2,672	10%	10/26/77	10/24/78
452106106085301	2	1,630	1,610	1,650	2%	10/26/77	10/26/77
452657106095501	1	1,350	1,350	1,350	0%	5/19/78	5/19/78
453117106110501	1	2,295	2,295	2,295	0%	10/18/76	10/18/76
453246106124101	7	2,776	2,490	3,060	9%	10/27/77	10/24/78
453323106125801	2	1,970	1,970	1,970	0%	10/27/77	10/27/77
453601106161001	2	2,125	2,110	2,140	1%	10/28/77	10/28/77
589	6	2,503	2,038	2,876	11%	4/18/74	9/30/79
6307717	5	2,476	2,190	2,671	7%	9/30/79	9/22/82
6307725	27	2,543	1,900	3,540	16%	10/18/77	8/13/81
6307740	50	2,118	923	2,790	16%	10/2/74	9/20/82

[a]CV – Coefficient of Variation (standard deviation/mean).

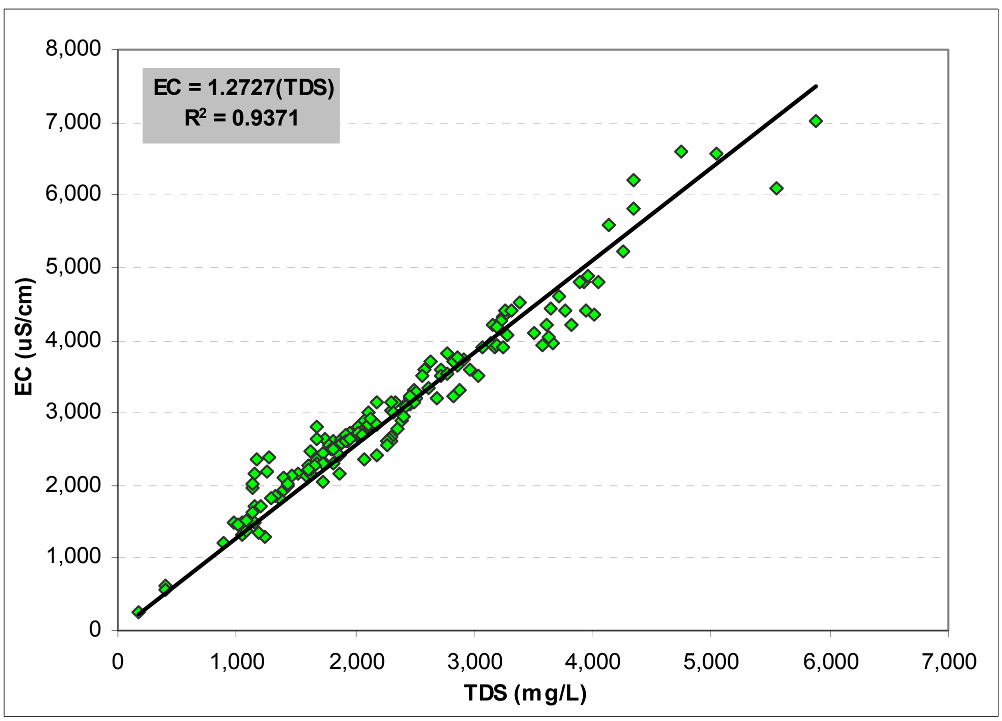

Figure 3-44. Relationship between EC and TDS in Otter Creek.

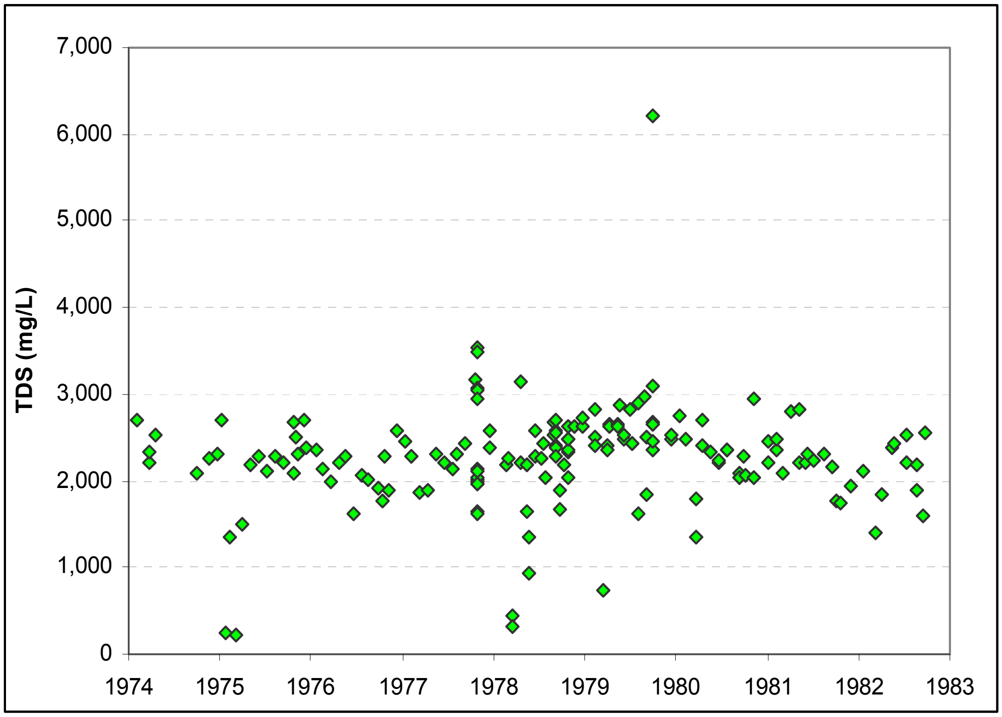

Figure 3-45. TDS data for Otter Creek (all stations).

3.4.3.3.3 Chlorides

As described in Section 3.4.3, Otter Creek was listed as impaired for chlorides on the 1996 303(d) list. Agricultural uses for Otter Creek were not evaluated for the 2002 list, and chlorides were not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Otter Creek to verify the impairment status relative to chlorides.

Chloride data for Otter Creek are summarized in Tables 3-58 and 3-59. Average concentrations were under USEPA's proposed standards. There was no apparent increase or decrease in chloride data for Otter Creek, and few recent data were available (Figure 3-46).

Based on an analysis of the available data, chlorides are not impairing agricultural or aquatic life uses in Otter Creek. Chloride concentrations were much lower than the USEPA recommended standards to protect aquatic life uses. Concentrations were also much lower than the calculated TDS targets to protect agricultural uses (see Section 3.4.3.3.2). Additional data will be collected in the future to verify the beneficial use impairment status.

Table 3-58. Summary of chloride data, Otter Creek (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
272	1	8.6	8.6	8.6	NA	1/30/74	1/30/74
451732106085001	1	10.0	10.0	10.0	NA	3/22/74	3/22/74
452933106101601	1	22.4	22.4	22.4	NA	3/29/83	3/29/83
453117106110501	1	10.1	10.1	10.1	NA	3/31/79	3/31/79
589	5	10.9	8.5	12.0	14%	1/17/74	2/11/79
6307717	10	18.4	12.0	49.0	60%	11/3/82	1/7/85
6307725	14	13.4	3.9	22.0	29%	12/20/77	3/6/81
6307740	50	12.5	2.2	19.0	32%	11/21/74	1/12/95

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-59. Summary of chloride data, Otter Creek (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
202	1	29.1	29.1	29.1	NA	9/30/79	9/30/79
272	5	15.8	10.8	18.5	19%	6/27/79	9/30/79
451330106100201	1	20.0	20.0	20.0	0%	10/19/83	10/19/83
451732106085001	7	11.9	8.0	16.0	24%	10/26/77	10/19/83
452106106085301	2	11.4	9.8	13.0	20%	10/26/77	10/19/83
452657106095501	1	6.4	6.4	6.4	NA	5/19/78	5/19/78
452849106095701	1	20.0	20.0	20.0	NA	10/19/83	10/19/83
453117106110501	1	13.0	13.0	13.0	NA	10/18/76	10/18/76
453246106124101	5	15.8	14.0	17.0	8%	10/27/77	10/20/83
453323106125801	2	13.0	11.0	15.0	22%	10/27/77	10/20/83
453601106161001	1	10.0	10.0	10.0	NA	10/28/77	10/28/77
589	8	9.9	0.0	17.5	63%	4/18/74	4/21/83
6307717	21	15.6	11.0	23.0	20%	9/30/79	9/11/85
6307725	24	17.1	3.1	51.0	50%	10/18/77	8/13/81
6307740	90	15.5	1.3	86.0	59%	10/2/74	7/20/95

[a]CV – Coefficient of Variation (standard deviation/mean).

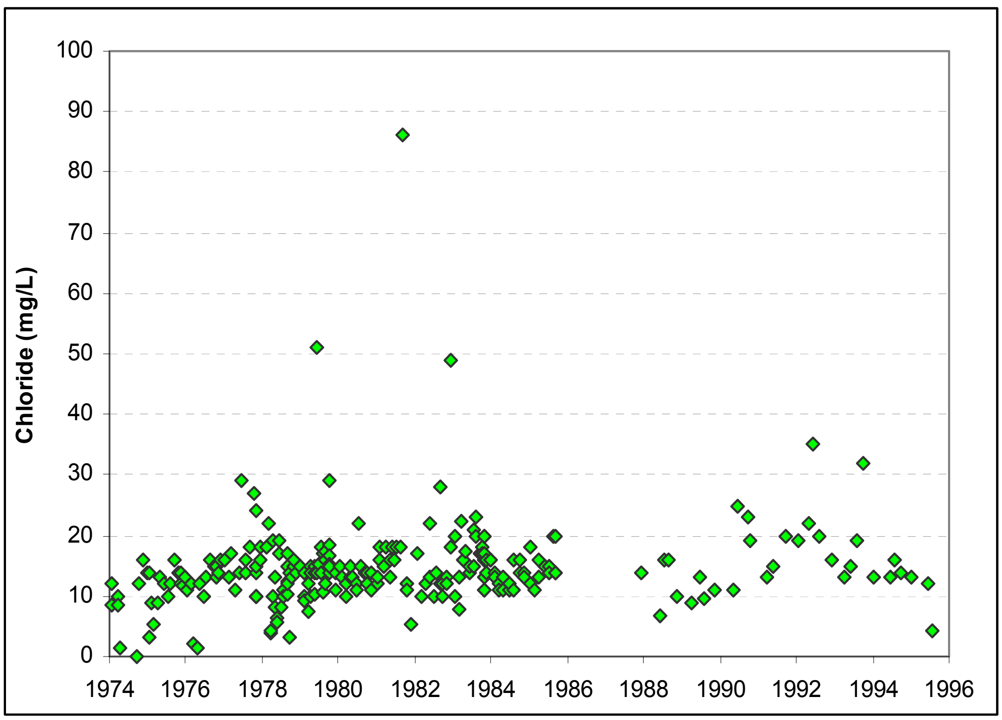

Figure 3-46. Chloride data for Otter Creek (all stations).

3.4.3.3.4 SAR

Otter Creek was not listed as impaired for SAR on the 1996 303(d) list. Agricultural uses for Otter Creek were not evaluated for the 2002 list, and SAR was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Otter Creek to verify the impairment status relative to SAR.

SAR data for Otter Creek are summarized in Tables 3-60 and 3-61. The data are compared to MDEQ's proposed SAR criteria in Table 3-62. There are no recent SAR data for Otter Creek. Historically, SAR appears to have impaired agricultural uses (Figure 3-47). A final water quality impairment determination will not be made for SAR until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria (see Section 3.2.1.2). Also, a water quality impairment determination cannot be made for Otter Creek because there is a lack of current data. The most recent SAR data were collected in 1995.

Table 3-60. Summary of SAR data, Otter Creek (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
272	1	4.9	4.9	4.9	0%	1/30/74	1/30/74
589	5	5.8	5.5	6.2	5%	1/17/74	2/11/79
6307717	10	4.9	4.3	5.8	9%	11/3/82	1/7/85
6307725	13	4.8	1.8	6.7	22%	12/20/77	3/6/81
6307740	50	5.2	1.0	6.5	23%	11/21/74	1/12/95
451732106085001	1	5.1	5.1	5.1	0%	3/22/74	3/22/74
452933106101601	1	5.4	5.4	5.4	0%	3/29/83	3/29/83
453117106110501	1	4.6	4.6	4.6	0%	3/31/79	3/31/79

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-61. Summary of SAR data, Otter Creek (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
202	1	8.1	8.1	8.1	0%	9/30/79	9/30/79
272	5	4.8	3.6	5.4	15%	6/27/79	9/30/79
589	8	5.9	5.4	6.8	8%	4/18/74	4/21/83
6307717	21	5.5	4.2	6.5	10%	9/30/79	9/11/85
6307725	24	5.5	4.4	7.3	13%	10/18/77	8/13/81
6307740	92	5.9	2.7	7.2	12%	10/2/74	7/20/95
451330106100201	1	5.1	5.1	5.1	0%	10/19/83	10/19/83
451732106085001	6	4.5	3.7	5.0	12%	10/26/77	10/19/83
452106106085301	2	4.3	4.1	4.5	6%	10/26/77	10/19/83
452657106095501	1	4.4	4.4	4.4	0%	5/19/78	5/19/78
452849106095701	1	6.6	6.6	6.6	0%	10/19/83	10/19/83
453117106110501	1	5.8	5.8	5.8	0%	10/18/76	10/18/76
453246106124101	4	6.6	5.8	7.5	14%	10/27/77	10/20/83
453323106125801	2	5.9	5.8	5.9	0%	10/27/77	10/20/83
453601106161001	1	5.9	5.9	5.9	0%	10/28/77	10/28/77

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-62. Summary of SAR exceedances[a].

Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Variable	252	198	79%	0	NA	NA

[a]Reported data are from sample dates with both an SAR and salinity measurement, and criteria are based on the formula SAR <= (EC * 0.0071) – 2.475.

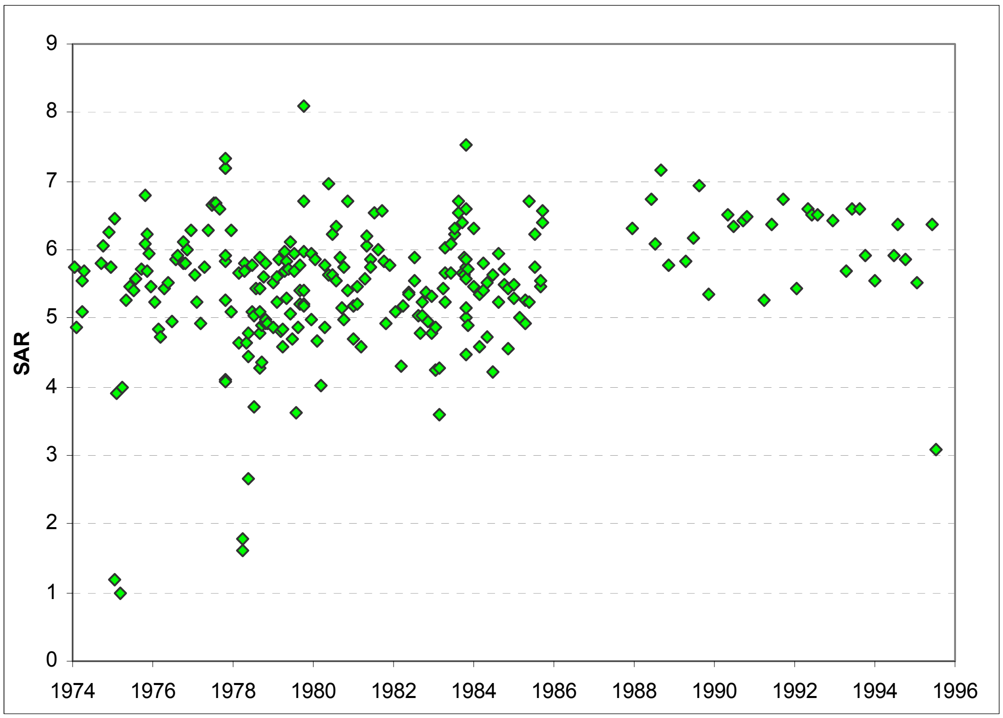

Figure 3-47. SAR data for Otter Creek (all stations).

3.4.3.3.5 Metals

As described in Section 3.4.3, Otter Creek was listed as impaired for metals on the 1996 303(d) list. Aquatic life and fishery uses for Otter Creek were not evaluated for the 2002 list because of insufficient credible data. This section presents an updated evaluation of Otter Creek to verify the impairment status relative to metals. The following analysis is for arsenic, cadmium, chromium, copper, iron, lead, nickel, selenium, silver, and zinc. Metals usually present a threat to the health of aquatic life, animals, and humans because of toxicity. The toxic effects of metals often change with the hardness of water, and criteria are calculated based on hardness rather than fixed at one value.

No recent metals data were available for Otter Creek. An analysis of historical metals data found that most samples had high detection limits and were not reliable sources of data. A metals beneficial use determination cannot be made at this time because of the lack of current, reliable data.

A water quality impairment determination cannot be made for Otter Creek because there is a lack of current data. The most recent metals data were collected in 1995.

3.4.3.3.6 Total Suspended Solids

As described in Section 3.4.3, Otter Creek was listed as impaired for total suspended solids (TSS) on the 1996 303(d) list. Aquatic life and fishery uses for Otter Creek were not evaluated for the 2002 list because of insufficient credible data. This section presents an updated evaluation of Otter Creek to verify the impairment status relative to total suspended solids.

There are no numeric water quality standards for total suspended solids (TSS) in Montana, and no reference conditions are available for Otter Creek at this time. Both Utah and South Dakota have a TSS criterion of 90 mg/L for the protection of warmwater fishery streams, and South Dakota also has a criterion of 150 mg/L for the protection of marginal warmwater fishery streams. The TSS data from Otter Creek were compared to Utah’s and South Dakota’s criteria to provide some insight on use impairment status. However, a better target for prairie streams is needed to make more conclusive decisions.

TSS data are summarized in Table 3-63 and are shown in Figure 3-48. Table 3-64 compares TSS data to the Utah and South Dakota targets. Twenty-nine percent of samples exceeded the 90 mg/L target from 1974 through 1995. Figure 3-49 shows that there is no relationship between TSS and flow in Otter Creek. The NRCS Phase II Stream Channel Assessment found that the majority of Otter Creek had stable banks with deep rooted vegetation (NRCS, 2002). However, 30 percent of the evaluated reaches were classified as at risk because of channel disturbance and altered vegetation. These reaches are potential sources of sediment to Otter Creek because of the resulting bank and channel instability. It was not clear if sediment from these potential sources was impairing beneficial uses in the stream.

A final water quality impairment determination will not be made for suspended solids because appropriate information is not yet available to determine if the elevated concentrations are a result of natural or anthropogenic causes. Also, a water quality impairment determination cannot be made for Otter Creek because there is a lack of current data. The most recent TSS data were collected in 1995.

Table 3-63. Summary of TSS data, Otter Creek (mg/L).

Station	Count	Median	Average	Min	Max	CV[a]	Min Date	Max Date
202	1	1	1	1	1	NA	9/30/79	9/30/79
272	5	12	23	1	61	104%	6/27/79	9/30/79
451732106085001	2	11	11	10	12	10%	7/7/78	8/29/78
453117106110501	1	48	48	48	48	NA	3/31/79	3/31/79
589	20	23	26	7	68	65%	10/20/75	4/21/83
6307717	31	50	56	1	178	86%	9/30/79	9/11/85
6307725	35	24	38	4	132	104%	10/18/77	8/13/81
6307740	143	75	95	2	536	80%	10/2/74	7/20/95

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-64. Summary of TSS exceedances, Otter Creek.

Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
90 mg/L	238	68	29%	0	NA	NA
150 mg/L	238	28	12%	0	NA	NA

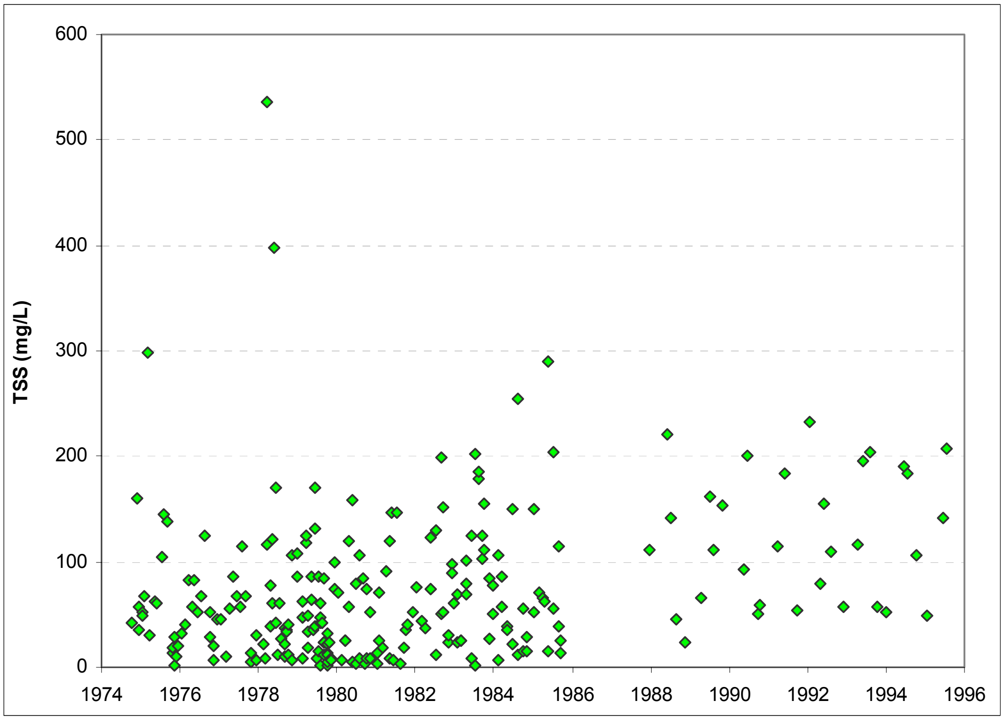

Figure 3-48. TSS data for Otter Creek (all stations).

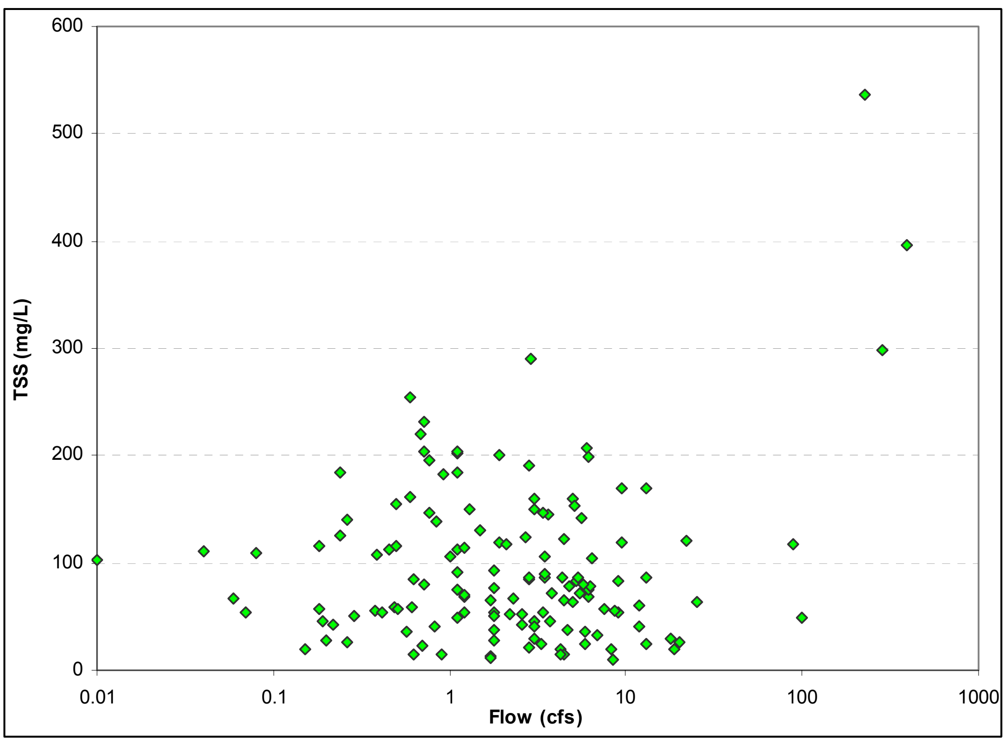

Figure 3-49. Relationship between TSS and flow at USGS station 06307740.

3.4.3.3.7 Beneficial Use Support Summary: Otter Creek

The Montana 1996 303(d) list reported that Otter Creek was impaired because of salinity/TDS/chlorides, other habitat alterations, suspended solids, and metals. Beneficial uses and causes of impairment were not assessed for the 2002 303(d) report because of insufficient credible data. The 1996 causes of impairment were analyzed in the previous sections to determine which causes will require TMDLs. Water quality impairment determinations could not be made for several causes of impairment because appropriate site-specific numeric criteria have not been identified, or because there was a lack of recent data. A summary for each evaluated cause of impairment is shown in Table 3-65.

Table 3-65. Water quality impairment status summary.

Segment	Evaluated Cause of Impairment	1996 303(d) List	2002 303(d) List[a]	TMDL Requirement
Otter Creek	Chlorides	✔		No
	Metals	✔		Undetermined
	Other habitat alterations	✔		No
	Salinity	✔		Undetermined
	SAR			Undetermined
	Suspended solids	✔		Undetermined
	TDS	✔		Undetermined

[a]Not all causes of impairment were evaluated for the 2002 303(d) list.
Source: MDEQ, 1996, 2002.

3.4.4 Pumpkin Creek

The Montana 1996 303(d) list reported that Pumpkin Creek was impaired because of salinity/TDS/ chlorides, thermal modifications, and flow alterations. Agricultural, aquatic life, and fishery beneficial uses were impaired by these causes in 1996. In 2002, beneficial uses and causes of impairment in Pumpkin Creek were not assessed for the 303(d) report because of insufficient credible data. The discussion below provides a review of available data to evaluate the water quality impairment status.

3.4.4.1 Macroinvertebrates and Periphyton

No recent macroinvertebrate or periphyton data were identified at the time of this report.

3.4.4.2 Fish

No recent fish data were available at the time of this report.

3.4.4.3 Water Chemistry Assessment

Water chemistry data for Pumpkin Creek are available from five monitoring stations in Montana (Figure 3-50). These data have been collected by USGS and MDEQ and are summarized in the following sections. However, no current water quality data were identified for the Pumpkin Creek watershed; the most recent sampling was in 1985.

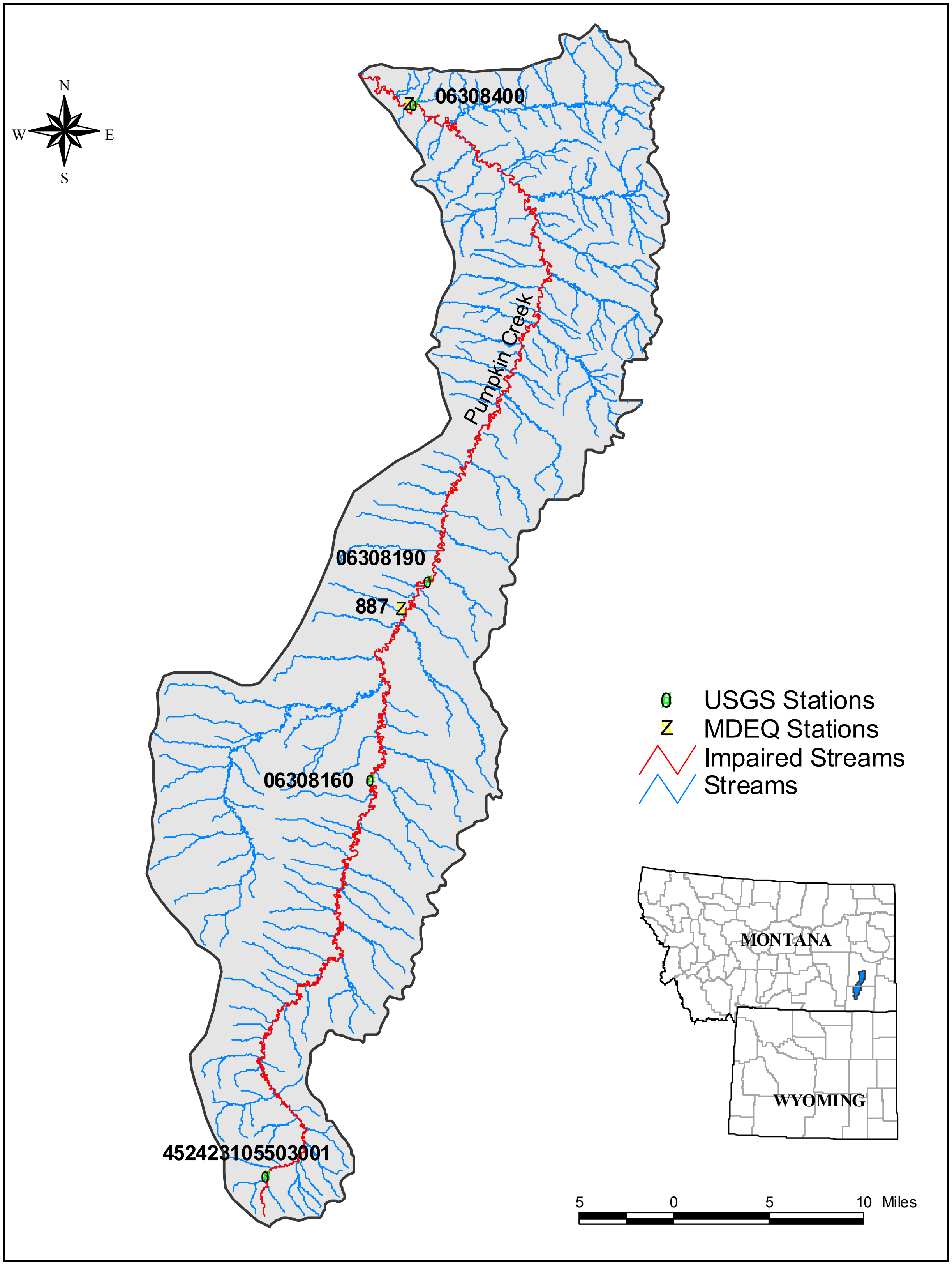

Figure 3-50. Surface water quality monitoring stations in Pumpkin Creek.

3.4.4.3.1 Salinity

As described in Section 3.4.4, Pumpkin Creek was listed as impaired for salinity on the 1996 303(d) list. Agricultural uses for Pumpkin Creek were not evaluated for the 2002 list, and salinity was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Pumpkin Creek to verify the impairment status relative to salinity.

EC data are summarized in Tables 3-66 and 3-67. Figure 3-51 shows that there has been little yearly change in the EC data and that values from the growing and non-growing seasons are very similar. EC values are high in Pumpkin Creek. Almost all average concentrations are higher than 2,000 µS/cm, and maximum concentrations as high as 10,000 µS/cm have been recorded. The latest water quality sampling occurred in 1985 and there are no current EC data. Table 3-68 shows that historically, the majority of samples from the growing season exceeded the EC criterion. Figure 3-52 shows that EC is inversely related to flow.

A final water quality impairment determination will not be made for salinity (EC) until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria (see Section 3.3.1.2). Also, a water quality impairment determination cannot be made for Pumpkin Creek because there is a lack of current data. The most recent EC data were collected in 1985.

Table 3-66. Summary of EC data, Pumpkin Creek (µS/cm) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
6308160	10	5,102	819	10,000	47%	12/10/75	3/17/79
6308190	4	4,900	3,880	7,000	29%	12/10/75	3/2/77
6308400	45	1,786	168	8,700	118%	1/31/74	2/28/85

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-67. Summary of EC data, Pumpkin Creek (µS/cm) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
452423105503001	2	1,915	1,870	1,960	3%	9/6/78	10/24/78
6308160	18	5,170	2,690	7,000	22%	4/14/76	7/30/79
6308190	5	5,130	4,200	5,900	12%	4/15/76	5/3/77
6308400	64	2,095	460	7,030	77%	4/18/74	8/2/85
887	1	5,400	5,400	5,400	NA	4/18/74	4/18/74

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-68. Summary of EC exceedances.

Season	Salinity Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season	500 µS/cm	90	86	96%	0	NA	NA
Non-growing Season	2,000 µS/cm	59	28	47%	0	NA	NA

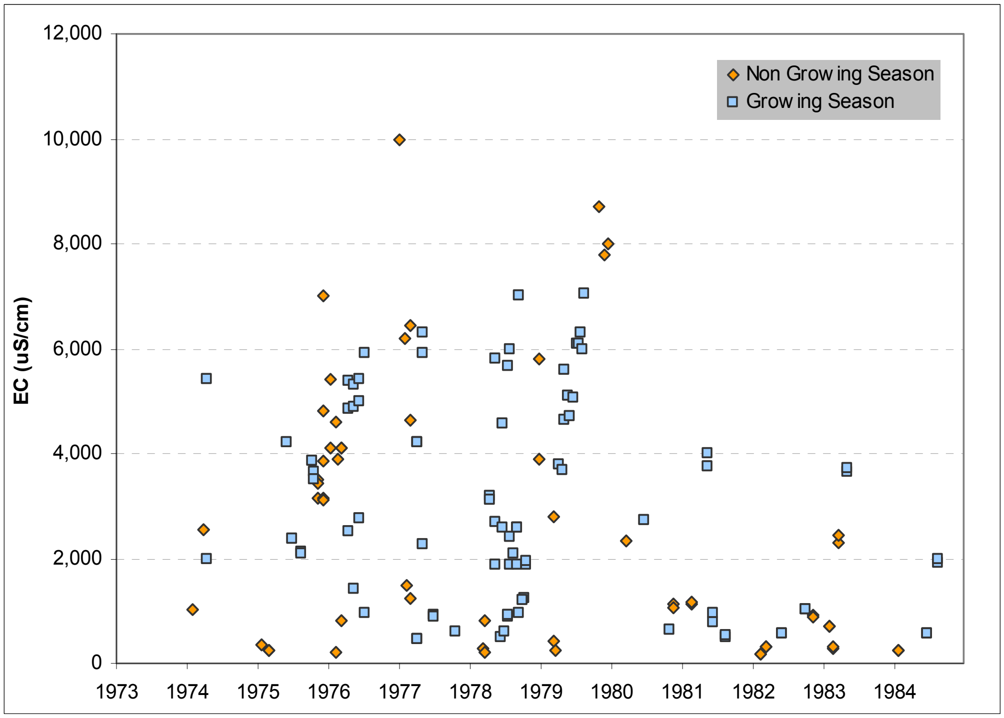

Figure 3-51. EC data for Pumpkin Creek (all stations).

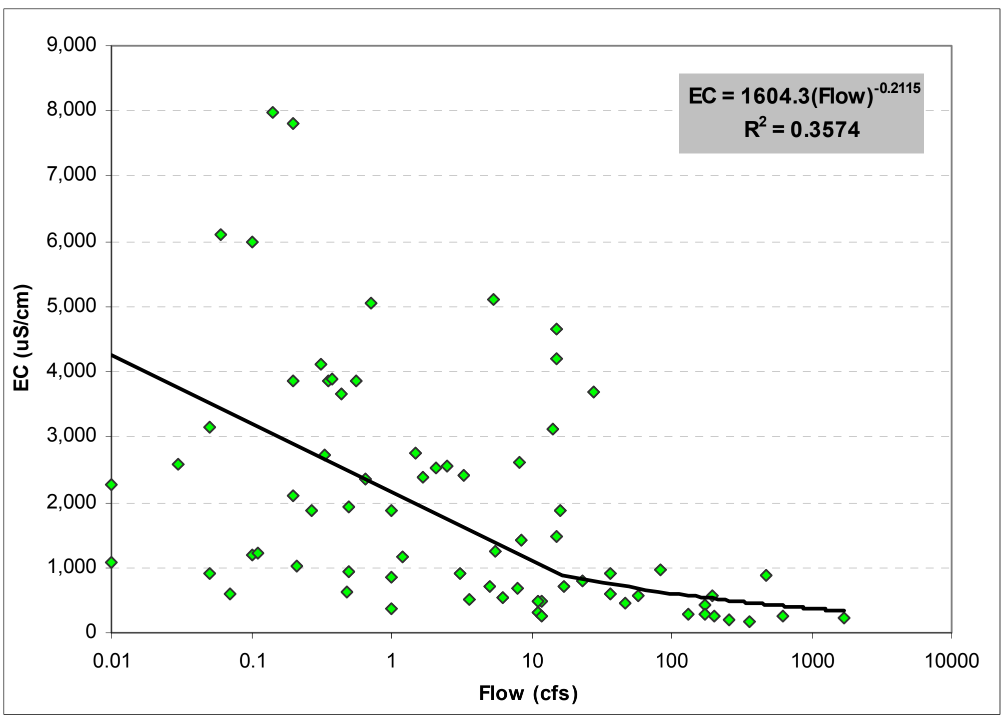

Figure 3-52. Relationship between EC and flow at USGS station 06308400.

3.4.4.3.2 Total Dissolved Solids

As described in Section 3.4.4, Pumpkin Creek was listed as impaired for total dissolved solids (TDS) on the 1996 303(d) list. Agricultural uses for Pumpkin Creek were not evaluated for the 2002 list, and TDS was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Pumpkin Creek to verify the impairment status relative to TDS.

Section 3.3.4.3.1 described salinity (measured as EC) in Pumpkin Creek. EC is an indirect measurement of TDS and salinity. The relationship between TDS and EC is different for each waterbody, and it varies with the type of ions in solution, temperature, and barometric pressure. Figure 3-53 shows the relationship between EC and TDS in Pumpkin Creek. This graph shows EC and TDS data obtained on the same date and location, and it confirms the strong relationship between EC and TDS. The relationship between the two parameters is EC = 1.27(TDS). Therefore, an EC standard of 500 μS/cm is equivalent to a TDS concentration of 394 mg/L and an EC of 2,000 μS/cm is equivalent to 1,575 mg/L. At station 06308400, the major ions measured by TDS were on average sulfate (53%), sodium (22%), calcium (4%), chloride (1%), and magnesium (4%).

TDS data for the growing and non-growing seasons are summarized in Tables 3-69 and 3-70. Average values during the growing and non-growing seasons regularly exceeded calculated TDS targets. Figure 3-54 shows that there was no apparent trend in TDS values and that few recent data are available.

A final water quality impairment determination will not be made for TDS until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria for salinity (EC) (see Section 3.3.1.2). Also, a water quality impairment determination cannot be made for Pumpkin Creek because there is a lack of current data. The most recent TDS data were collected in 1982.

Table 3-69. Summary of TDS data, Pumpkin Creek (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
6308160	10	3,803	523	6,430	44%	12/10/75	3/17/79
6308190	4	3,740	2,750	5,950	40%	12/10/75	3/2/77
6308400	24	1,585	111	6,530	110%	1/31/74	3/15/82

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-70. Summary of TDS data, Pumpkin Creek (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
452423105503001	4	1,480	1,390	1,560	5%	9/6/78	10/24/78
6308160	18	4,224	2,110	5,930	26%	4/14/76	7/30/79
6308190	5	4,058	3,070	4,710	17%	4/15/76	5/3/77
6308400	41	1,939	290	5,798	70%	4/18/74	6/7/82

[a]CV – Coefficient of Variation (standard deviation/mean).

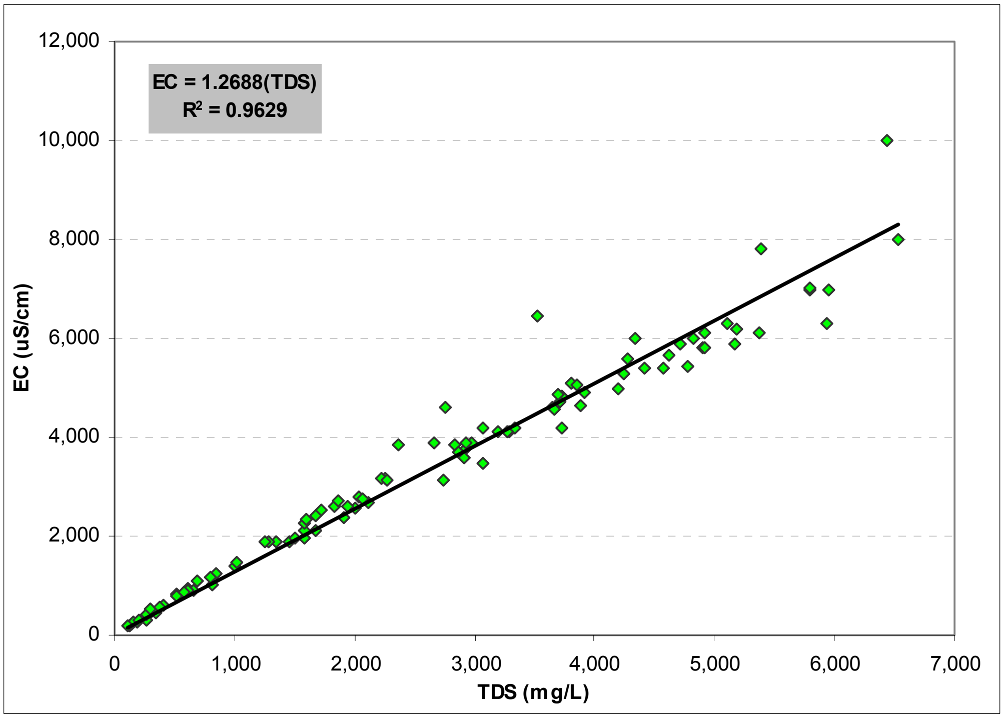

Figure 3-53. Relationship between EC and TDS in Pumpkin Creek.

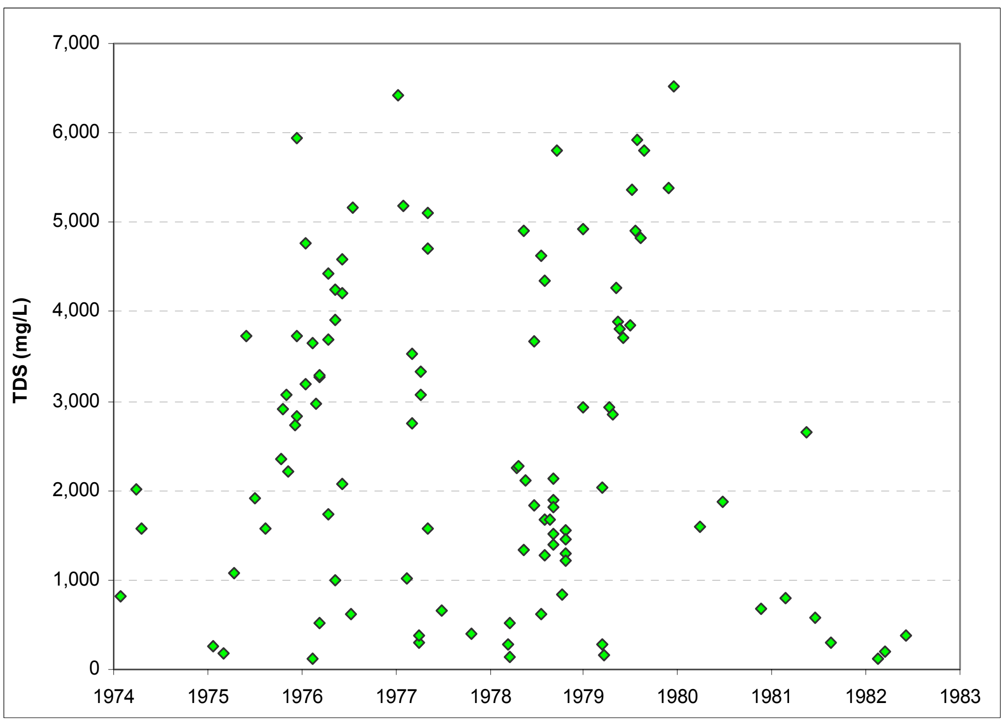

Figure 3-54. TDS data for Pumpkin Creek (all stations).

3.4.4.3.3 Chlorides

As described in Section 3.4.4, Pumpkin Creek was listed as impaired for chlorides on the 1996 303(d) list. Agricultural uses for Pumpkin Creek were not evaluated for the 2002 list, and chloride was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Pumpkin Creek to verify the impairment status relative to chlorides.

Chloride data for Pumpkin Creek are summarized in Tables 3-71 and 3-72. Average concentrations were under USEPA's proposed standards. There was no apparent increase or decrease in chloride data for Pumpkin Creek, and few recent data were available (Figure 3-55).

A final water quality impairment determination for chlorides cannot be made at this time because of a lack of recent data. The most recent chloride data was collected in 1985. Additional data will be collected in the future to determine the beneficial use impairment status.

Table 3-71. Summary of chloride data, Pumpkin Creek (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
6308160	10	15.3	3.0	26.0	44%	12/10/75	3/17/79
6308190	4	18.5	12.0	26.0	38%	12/10/75	3/2/77
6308400	31	7.7	1.2	31.0	100%	1/31/74	2/28/85

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-72. Summary of chloride data, Pumpkin Creek (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
452423105503001	2	6.0	5.9	6.0	1%	9/6/78	10/24/78
6308160	18	16.3	6.7	25.0	29%	4/14/76	7/30/79
6308190	5	15.0	14.0	17.0	8%	4/15/76	5/3/77
6308400	44	9.3	2.3	30.0	71%	4/18/74	4/2/85

[a]CV – Coefficient of Variation (standard deviation/mean).

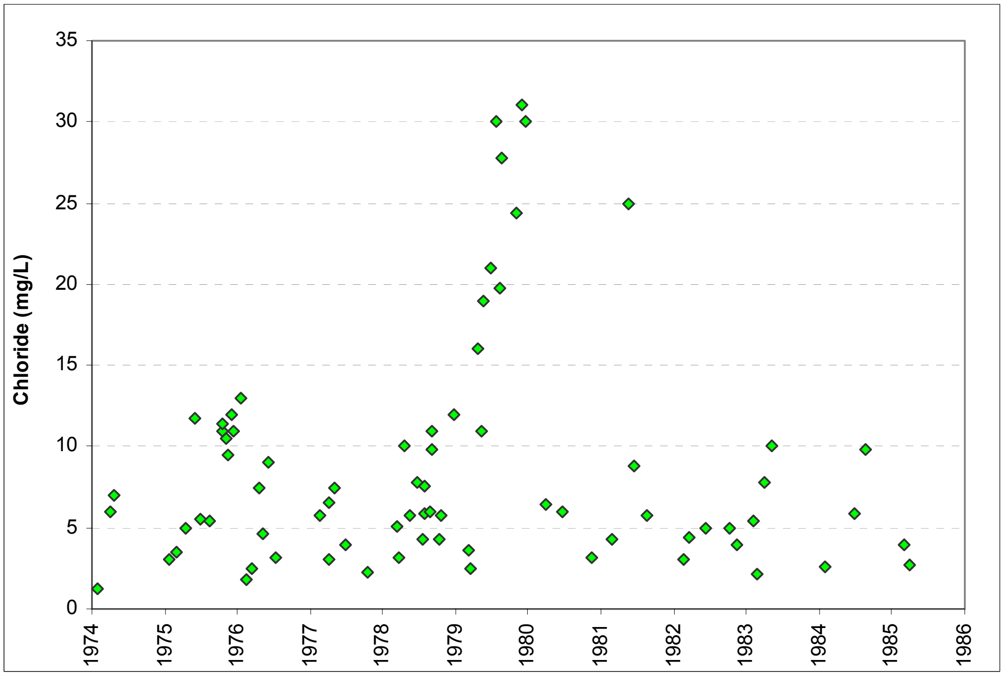

Figure 3-55. Chloride data for Pumpkin Creek (all stations).

3.4.4.3.4 SAR

Pumpkin Creek was not listed as impaired for SAR on the 1996 303(d) list. Agricultural uses for Pumpkin Creek were not evaluated for the 2002 list, and SAR was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Pumpkin Creek to verify the impairment status relative to SAR.

Pumpkin Creek was not listed as impaired for SAR on the 1996 303(d) list. Agricultural uses for Pumpkin Creek were not evaluated for the 2002 list, and SAR was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Pumpkin Creek to verify the impairment status relative to SAR.

SAR data for Pumpkin Creek are summarized in Tables 3-73 and 3-74. The data were compared to MDEQ's proposed SAR criteria in Table 3-75. Historically, 96 percent of the data exceeded the proposed criteria. There are no recent data for Pumpkin Creek. SAR values rarely exceeded the calculated SAR criteria but were often greater than 5 (the upper limit for SAR values) (Figure 3-56).

A final water quality impairment determination will not be made for SAR until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria (see Section 3.3.1.2). Also, a water quality impairment determination cannot be made for Pumpkin Creek because there is a lack of current data. The most recent SAR data were collected in 1985.

Table 3-73. Summary of SAR data, Pumpkin Creek (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
6308160	10	7.0	2.1	9.9	30%	12/10/75	3/17/79
6308190	4	9.1	7.2	13.6	33%	12/10/75	3/2/77
6308400	30	8.2	1.4	24.8	75%	1/31/74	2/28/85

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-74. Summary of SAR data, Pumpkin Creek (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
887	1	11.5	11.5	11.5	0%	4/18/74	4/18/74
6308160	18	8.1	5.3	10.0	17%	4/14/76	7/30/79
6308190	5	9.7	8.5	10.8	9%	4/15/76	5/3/77
6308400	42	9.6	1.7	21.2	42%	4/18/74	4/2/85
452423105503001	2	1.9	1.8	2.1	10%	9/6/78	10/24/78

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-75. Summary of SAR exceedances[a].

Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Variable	112	107	96%	0	NA	NA

[a]Reported data are from sample dates with both an SAR and salinity measurement, and criteria are based on the formula SAR <= (EC * 0.0071) – 2.475.

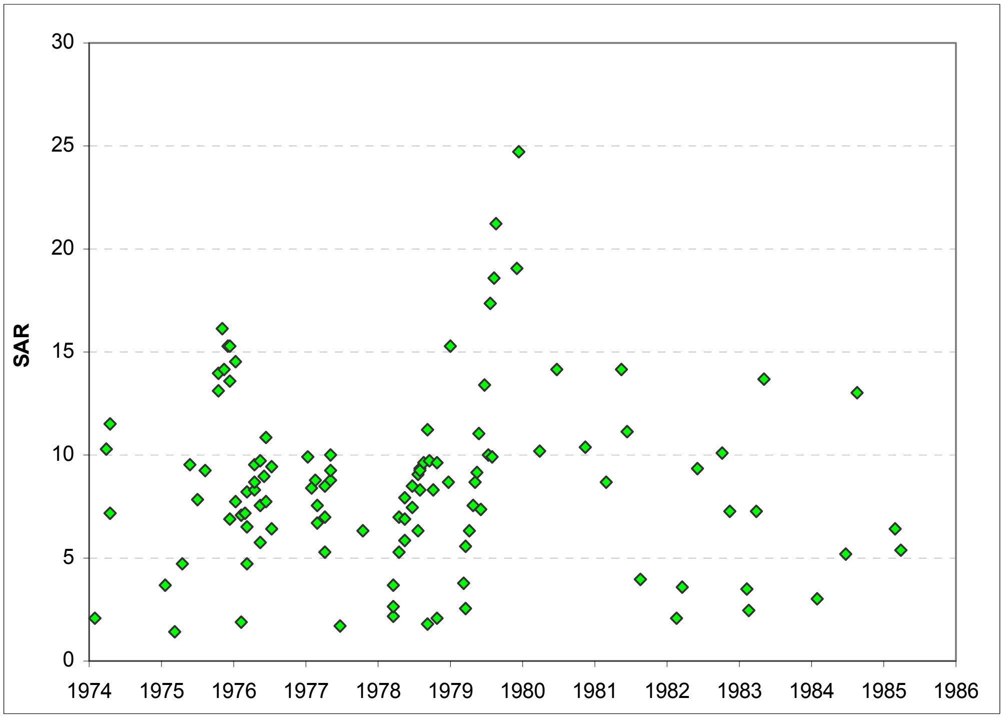

Figure 3-56. SAR data for Pumpkin Creek.

3.4.4.3.5 Thermal Modifications

As described in Section 3.4.4, Pumpkin Creek was listed as impaired for thermal modifications on the 1996 303(d) list. Aquatic life and fishery uses for Pumpkin Creek were not evaluated for the 2002 list, and thermal modifications were not identified as a cause of impairment for any other uses. This section presents an updated evaluation of Pumpkin Creek to verify the impairment status relative to thermal modifications.

The Montana 1996 303(d) list reported that thermal modifications were impairing uses in Pumpkin Creek. High temperatures in streams can impair aquatic life and fishery uses. Montana temperature standards state that a 3-degree maximum increase over naturally occurring water temperature is allowed and that no thermal discharge is allowed to raise the temperature above 80 °F.

Table 3-76 summarizes the available temperature data for Pumpkin Creek, and Figure 3-57 shows the monthly distribution of temperatures. The latest sample date was 1985, and no recent data are available. Available data exceeded 80 °F eight times during the sampling period (Table 3-77). A monthly analysis of the lower Tongue River, Otter Creek, and Pumpkin Creek shows that average monthly temperatures are similar in all four reaches in the Tongue River (Table 3-78). This shows that the stream temperature exceedances could be due to natural conditions and not thermal modifications.

A water quality impairment determination cannot be made for Pumpkin Creek because there is a lack of current data. The most recent temperature data were collected in 1985.

Table 3-76. Summary of water temperature data, Pumpkin Creek (°F).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
452423105503001	2	51.8	41.0	62.6	77%	9/6/78	10/24/78
6308160	28	51.7	32.0	78.8	90%	12/10/75	7/30/79
6308190	9	49.3	32.0	80.6	104%	12/10/75	5/3/77
6308400	85	52.9	32.0	85.1	85%	1/31/74	8/2/85
887	2	54.5	53.6	55.4	6%	4/18/74	4/15/75

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-77. Summary of temperature exceedances.

Criteria	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
80 °F	126	8	6%	0	NA	NA

Table 3-78. Average monthly temperatures for four segments in the Tongue River watershed (°F).

Month	Lower Tongue	Middle Tongue	Otter Creek	Pumpkin Creek
January	32	32	32	32
February	32	32	32	33
March	39	38	36	35
April	52	48	49	50
May	63	59	57	63
June	68	66	69	73
July	75	72	73	72
August	69	70	71	73
September	59	61	61	61
October	50	51	48	48
November	37	39	38	38
December	32	32	32	33

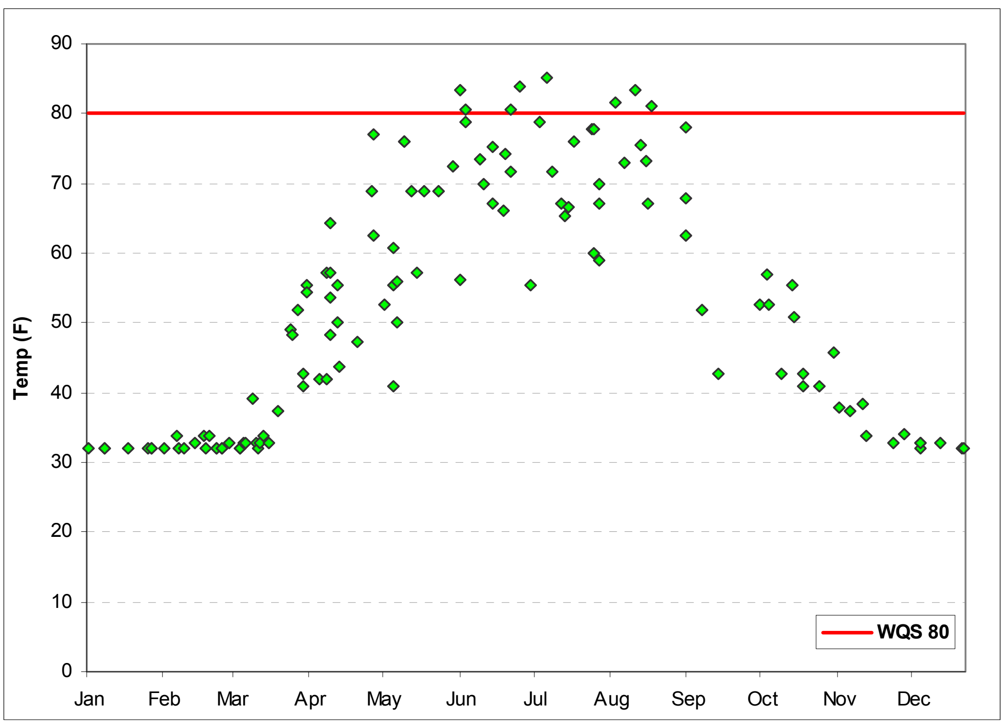

Figure 3-57. Water temperature data distribution by month and day for Pumpkin Creek (1974-1985).

3.4.4.3.6 Beneficial Use Support Summary: Pumpkin Creek

The Montana 1996 303(d) list reported that Pumpkin Creek was impaired because of salinity/TDS/chlorides, thermal modifications, and flow alterations. Beneficial uses and causes of impairment were not assessed for the 2002 303(d) report because of insufficient credible data. The 1996 causes of impairment were analyzed in the previous sections to determine which causes will require TMDLs. Water quality impairment determinations could not be made for several causes of impairment because appropriate site-specific numeric criteria have not been identified, or because there was a lack of recent data. A summary for each evaluated cause of impairment is shown in Table 3-79.

Table 3-79. Water quality impairment status summary.

Segment	Evaluated Cause of Impairment	1996 303(d) List	2002 303(d) List[a]	TMDL Requirement
Pumpkin Creek	Chlorides	✔		No
	Flow alteration	✔		No
	Salinity	✔		Undetermined
	SAR			Undetermined
	TDS	✔		Undetermined
	Thermal modifications	✔		Undetermined

[a]Not all causes of impairment were evaluated for the 2002 303(d) list.
Source: MDEQ, 1996, 2002.

3.4.5 Tongue River Reservoir

The Tongue River Reservoir (TRR) was completed in 1940 by constructing an earthen dam on the Tongue River north of Decker, Montana. The average depth is 6.1 meters and the length of the reservoir is 12.5 kilometers. After the 1996–1999 rehabilitation project, the reservoir has a storage capacity of 79,000 acre-feet of water. The average volume of water in the reservoir (1960–1999) is 38,870 acre-feet and the average residence time is approximately 44 days (MDNRC, 2002). An additional spillway was added during the rehabilitation project so that the total combined discharge is 4,000 cubic feet per second. The reservoir was built for irrigation, recreational, and flood control purposes.

The Montana 1996 303(d) list reported that the Tongue River Reservoir was impaired because of nutrients, organic enrichment/DO, and suspended solids (MDEQ, 1996). Aquatic life, fishery, and recreation/swimmable beneficial uses were impaired by these causes in 1996.

In 2002, MDEQ identified the Tongue River Reservoir as impaired because of algal growth/chlorophyll-*a* (MDEQ, 2002). Aquatic life and recreational uses were all partially impaired because of algal growth/chlorophyll-*a*. Agricultural and industrial uses were found to be fully supporting in the 2002 303(d) report. Drinking water and fishery uses were not assessed in the 2002 303(d) report because of insufficient credible data.

The discussion below provides a review of available data to evaluate the water quality impairment status.

3.4.5.1 Fish

A 1977 study of the Tongue River Reservoir indicated that the reproductive success of largemouth and smallmouth bass in the reservoir was limited by suitable spawning substrate and turbidity. However, fingerling growth did not seem to be affected by differences in turbidity in parts of the lake (Penkal, 1977).

3.4.5.2 Water Chemistry Assessment

Water chemistry data for the Tongue River Reservoir are available from 36 stations in the reservoir. However, the location of several of the stations is unknown. Those stations are reported as “unknown” in the summary tables for the following analyses.

3.4.5.2.1 Salinity

The Tongue River Reservoir was not listed as impaired for salinity on the 1996 303(d) list. Agricultural uses for the Tongue River Reservoir were fully supported in 2002, and salinity was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of the Tongue River Reservoir to verify the impairment status relative to salinity.

Reservoirs can alter the salinity of river systems. Evaporation from the reservoir can lead to increased salinity concentrations because when the water evaporates, the salts are left behind. It is estimated that the salinity of the Colorado River is increased by 26.5 mg/L each year because of the effects of the Powell Reservoir (USDI, 1997). Reservoir releases might help to mitigate high salinity concentrations caused by low-flow conditions.

EC data for the reservoir are summarized in Tables 3-80 and 3-81, and all data are shown in Figure 3-58. No samples exceeded the proposed growing season standard for the Tongue River (1,000 µS/cm). No recent EC data were available.

Data were analyzed at stations 06306300 (Tongue River at the state line near Decker, MT) and 06307500 (Tongue River below the TRR Dam) to help determine the effects of the TRR on salinity in the Tongue River. EC data from 1986 to the present were analyzed. Average values at station 06306300 and 06307500 were 562 µS/cm and 573 µS/cm, respectively. The results from a one-way ANOVA analysis indicated that there was no statistical difference in EC values at the two stations.

Flows in the Tongue River are influenced by spring snowmelt from the Big Horn Mountains. High flows with low salinity concentrations occur during spring snowmelt. The residence time of the reservoir causes a lag in the downstream arrival of the spring snowmelt flows. This is illustrated in Figure 3-59. However, the lag time is minimal and the reservoir does not appear to affect salinity concentrations.

A final water quality impairment determination will not be made for salinity (EC) until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria (see Section 3.3.1.2). Also, a water quality impairment determination cannot be made for the Tongue River Reservoir because there is a lack of current data. The most recent EC data were collected in 1976.

Table 3-80. Summary of EC data, Tongue River Reservoir (µS/cm) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
196	3	848	830	879	3%	12/19/75	12/19/75
197	1	775	775	775	0%	3/21/74	3/21/74

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-81. Summary of EC data, Tongue River Reservoir (µS/cm) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
136	6	298	201	457	41%	5/14/76	6/10/76
137	6	282	254	307	7%	7/1/75	7/1/75
196	11	454	213	822	58%	5/14/76	6/10/76
198	19	418	237	830	52%	7/1/75	6/10/76
9070	3	552	302	700	39%	5/23/75	10/15/75
9101	3	480	280	614	37%	5/23/75	10/15/75
9115	3	566	516	615	9%	5/23/75	10/15/75

[a]CV – Coefficient of Variation (standard deviation/mean).

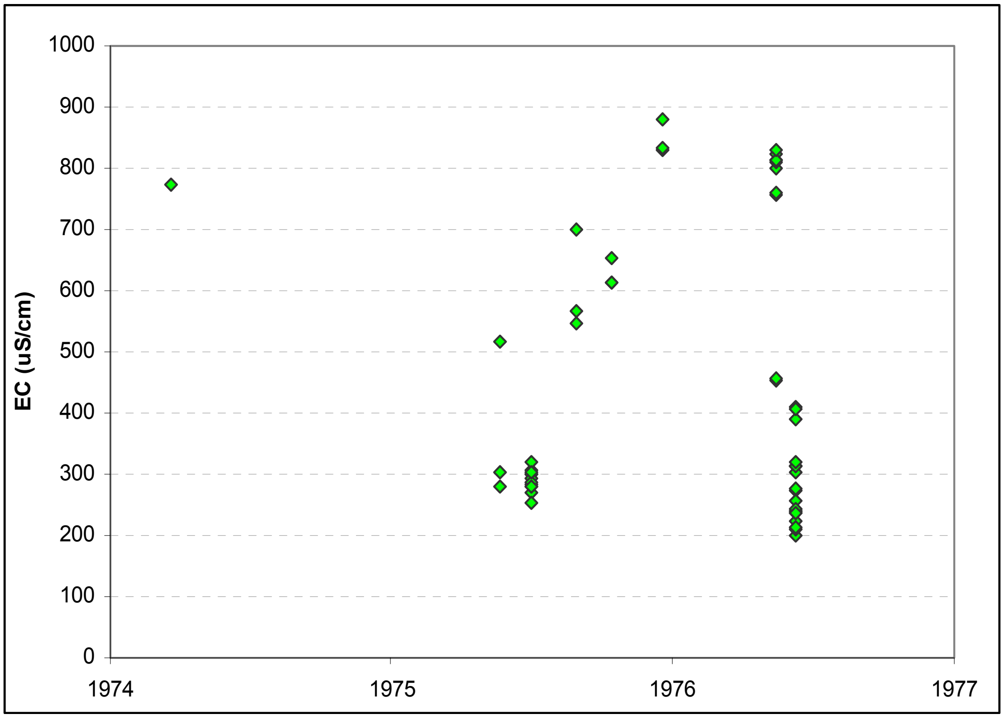

Figure 3-58. EC data for the Tongue River Reservoir (all stations).

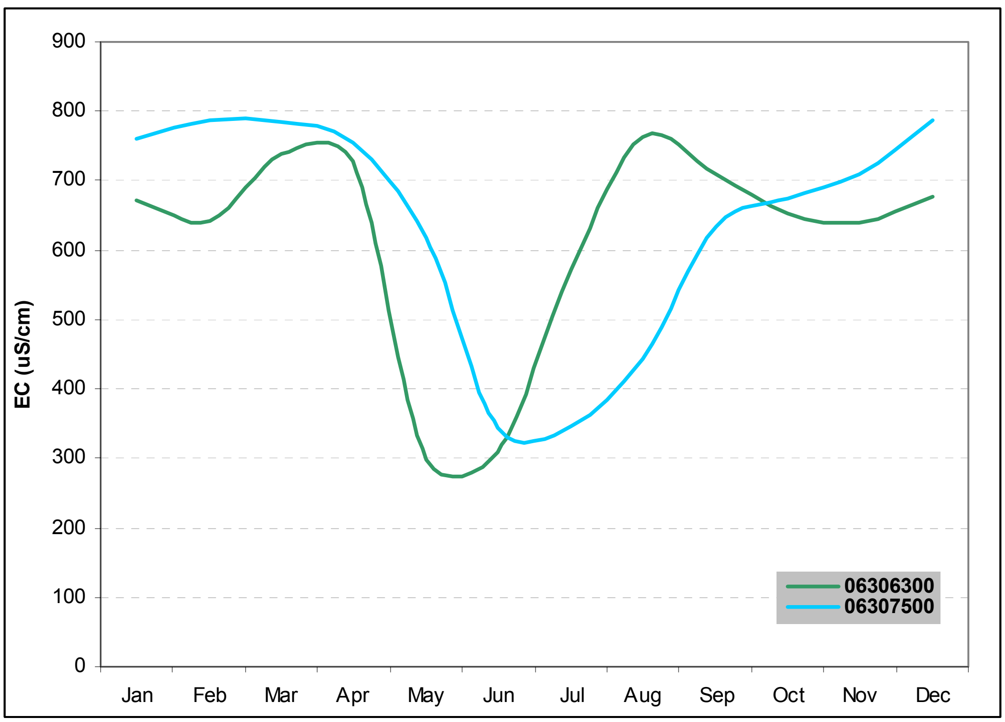

Figure 3-59. Average monthly EC values upstream and downstream of the Tongue River Reservoir (1986-2001).

3.4.5.2.2 Total Dissolved Solids

The Tongue River Reservoir was not listed as impaired for total dissolved solids (TDS) on the 1996 303(d) list. Agricultural uses for the Tongue River Reservoir were fully supported in 2002, and TDS was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of the Tongue River Reservoir to verify the impairment status relative to TDS.

TDS data for the Tongue River Reservoir are summarized in Tables 3-82 and 3-83. Insufficient data are available to evaluate the relationship between EC and TDS in the reservoir. The relationship from the upper Tongue River analysis is EC = 1.48(TDS). This corresponds to a calculated TDS target of 676 mg/L during the growing season and 1,351 mg/L during the non-growing season. None of the current TDS samples exceeded the growing season target (Figure 3-60).

A final water quality impairment determination will not be made for TDS until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria for salinity (EC) (see Section 3.3.1.2).

Table 3-82. Summary of TDS data, Tongue River Reservoir (mg/L) (November 1–March 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
196	3	695	664	740	6%	12/19/75	12/19/75
197	1	601	601	601	NA	3/21/74	3/21/74

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-83. Summary of TDS data, Tongue River Reservoir (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
137	3	215	203	221	5%	7/1/75	7/1/75
198	3	226	218	236	4%	7/1/75	7/1/75
TR028	1	483	483	483	NA	7/26/01	7/26/01
UNKNOWN	18	501	369	604	13%	7/26/01	10/26/01

[a]CV – Coefficient of Variation (standard deviation/mean).

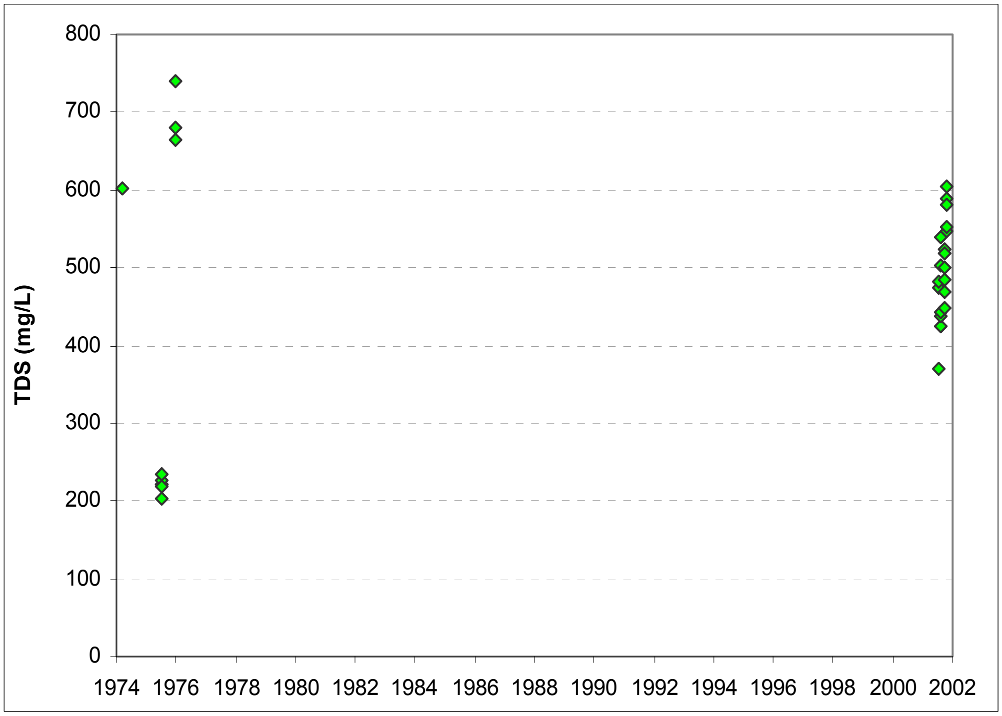

Figure 3-60. TDS data for the Tongue River Reservoir (all stations).

3.4.5.2.3 SAR

The Tongue River Reservoir was not listed as impaired for SAR on the 1996 303(d) list. Agricultural uses for the Tongue River Reservoir were fully supported in 2002, and SAR was not identified as a cause of impairment for any other uses. This section presents an updated evaluation of the Tongue River Reservoir to verify the impairment status relative to SAR.

SAR data for the Tongue River Reservoir are summarized in Table 3-84. Data were not available for the non-growing season. Data could not be compared to the proposed SAR standard for the Tongue River because there were no paired EC data to calculate an SAR target. No samples exceeded the maximum Tongue River SAR criterion of 5 (Figure 3-61). Data were analyzed at stations 06306300 (Tongue River at the state line near Decker, MT) and 06307500 (Tongue River below the TRR Dam) to help determine the effects of the TRR on SAR in the Tongue River. SAR data from 1985 to the present were analyzed. Average values at station 06306300 and 06307500 were 0.71 and 0.74, respectively. The results from a one-way ANOVA analysis indicated that there was no statistical difference in SAR values at the two stations.

A final water quality impairment determination will not be made for SAR until the Montana Board of Environmental Review makes their final decision regarding the adoption of numeric criteria (see Section 3.3.1.2).

Table 3-84. Summary of SAR data, Tongue River Reservoir (mg/L) (April 1–October 31).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
TR028	1	1.3	1.3	1.3	NA	7/26/01	7/26/01
UNKNOWN	18	1.3	0.9	1.6	16%	7/26/01	10/26/01

[a]CV – Coefficient of Variation (standard deviation/mean).

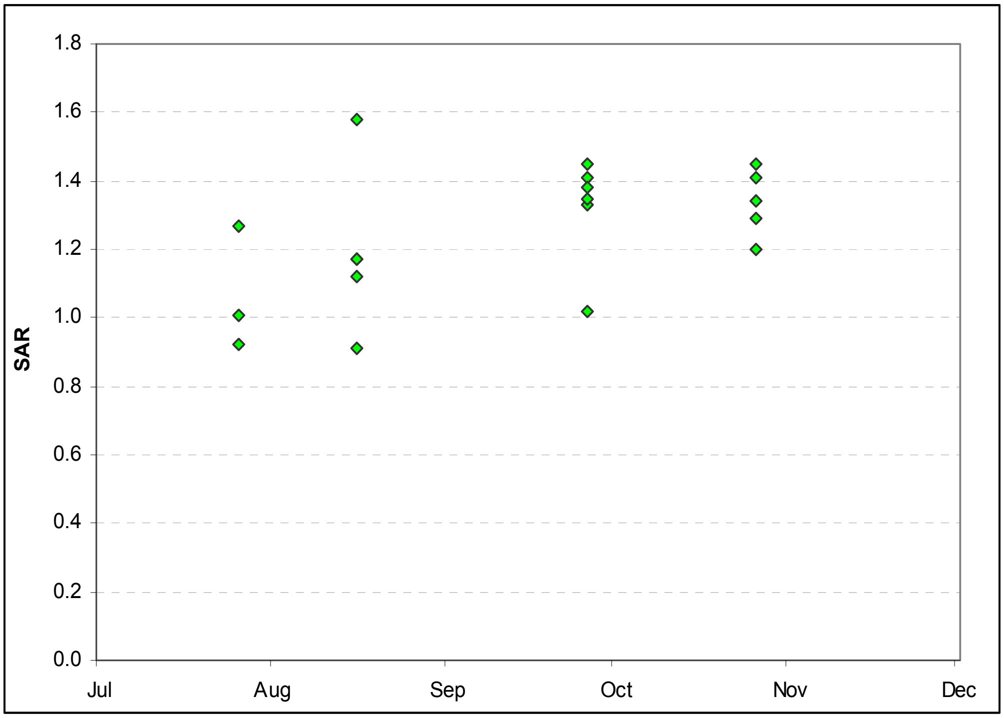

Figure 3-61. SAR data for the Tongue River Reservoir (2001).

3.4.5.2.4 Nutrients

As described in Section 3.4.5, the Tongue River Reservoir was listed as impaired for nutrients on the 1996 303(d) list. In the 2002 303(d) list, nutrients were not identified as a cause of impairment for the reservoir. However, aquatic life and fishery uses in 2002 were impaired because of algal growth and chlorophyll-*a*. This section presents an updated evaluation of the Tongue River Reservoir to verify the impairment status relative to nutrients.

Few states, including Montana, have numeric nutrient standards. This is because natural levels of nutrients vary among streams and lakes. Also, the aquatic life and lake responses to nutrient concentrations vary with different systems. North Dakota nutrient guidelines for lakes are 0.02 mg/L for phosphate (measured as total phosphorus) and 0.25 for nitrate. Utah has a total phosphorus (TP) standard of 0.025 for lakes.

Trophic status is the measure of productivity of a lake or reservoir, and it is directly related to the level of nutrients (phosphorus and nitrogen) entering the lake or reservoir from its watershed. Lakes tend to become eutrophic (more productive) when nitrogen and phosphorus inputs are high. Eutrophic lakes often have nuisance algal blooms, limited clarity, and low DO concentrations, which can result in impaired aquatic life and recreational uses. Carlson's Trophic State Index (TSI) attempts to measure the trophic state of a lake using nitrogen, phosphorus, chlorophyll-*a*, and Secchi disk depth measurements (Carlson, 1977). South Dakota uses Carlson's TSI to determine aquatic life use impairments in lakes from nutrients. TSI values are compared to standard conditions that are specific to an ecoregion. The Tongue River Reservoir is in the Northwestern Great Plains ecoregion (ecoregion 43). South Dakota's impairment determinations for ecoregion 43 are shown in Table 3-85.

Nitrate and phosphorus data for the Tongue River Reservoir are presented in Tables 3-86 and 3-87 and Figure 3-62. Average TP concentrations for the reservoir were higher than the North Dakota and Utah standards at each station. In 2001 all samples except one were greater than 0.025 mg/L (Table 3-88); however, only one sample exceeded the North Dakota nitrate guideline of 0.25 mg/L. The limiting nutrient, or the nutrient that limits plant growth when it is not available in sufficient quantities, appears to be phosphorus (Chapra, 1997). The average ratio of total nitrogen to TP in the reservoir is 10:1.

Table 3-89 shows the average TSI values for chlorophyll-*a* and TP in the Tongue River Reservoir. Only recent data (1996 through 2002) were used for this analysis. The TP TSI value indicates that the reservoir is hypereutrophic, and the chlorophyll-*a* data indicate that it is eutrophic. Both TSI values are in the partially supporting aquatic life beneficial use category using the South Dakota targets.

A final water quality impairment determination will not be made for nutrients because appropriate information is not yet available to determine if the elevated concentrations are a result of natural or anthropogenic causes.

Table 3-85. Aquatic life use support status for lakes in ecoregion 43.

TSI Range	Support Status
<55	Fully Supporting
55.01–70	Partially Supporting
>70	Not Supporting

Table 3-86. Summary of total phosphorus data, Tongue River Reservoir (mg/L).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
137	3	0.03	0.02	0.04	33%	7/1/75	7/1/75
196	5	0.03	0.02	0.05	44%	12/19/75	8/18/93
198	3	0.03	0.02	0.04	33%	7/1/75	7/1/75
9070	3	0.08	0.05	0.11	37%	5/23/75	10/15/75
9101	3	0.05	0.04	0.08	43%	5/23/75	10/15/75
9115	3	0.06	0.02	0.14	105%	5/23/75	10/15/75
TR28	1	0.08	0.08	0.08	NA	7/26/01	7/26/01
UNKNOWN	17	0.14	0.01	0.79	134%	7/26/01	10/26/01

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-87. Summary of nitrite/nitrate data, Tongue River Reservoir (mg/L).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
137	3	0.02	0.01	0.03	50%	7/1/75	7/1/75
196	3	0.16	0.08	0.31	81%	12/19/75	12/19/75
198	3	0.04	0.01	0.07	75%	7/1/75	7/1/75
9070	3	0.07	0.02	0.17	124%	5/23/75	10/15/75
9101	3	0.06	0.02	0.14	115%	5/23/75	10/15/75
9115	3	0.03	0.02	0.04	43%	5/23/75	10/15/75
TR028	1	0.04	0.04	0.04	NA	7/26/01	7/26/01
UNKNOWN	17	0.02	0.01	0.17	188%	7/26/01	10/26/01

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-88. Summary of total phosphorus exceedances using Utah's 0.025 mg/L standard.

Target	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
0.025 mg/L	38	32	84%	18	17	94%

Table 3-89. Carlson's TSI and Tongue River Reservoir values. {tc "Table 13. **Carlson's trophic state indexes and Patterson Lake values.** " \f D }

Parameter	Relationship	Units	TSI Value
Chlorophyll-*a*	TSI (Chl-a) = 30.6 + 9.81[ln(Chl-a)]	μg/L	55.7
TP	TSI (TP) = 4.15 + 14.42[ln(TP)]	μg/L	68.1

TSI < 40 = Oligotrophic (least productive)
40 < TSI < 50 = Mesotrophic
50 < TSI < 60 = Eutrophic
TSI > 60 = Hypereutrophic (most productive)

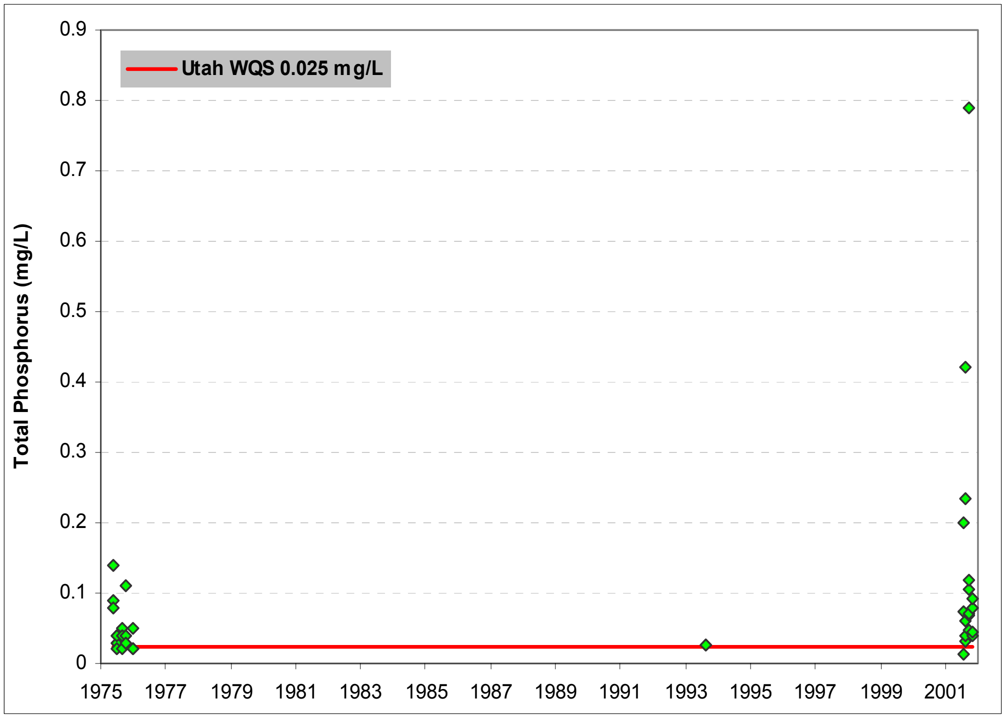

Figure 3-62. TP data in the Tongue River Reservoir.

3.4.5.2.5 Organic Enrichment/Dissolved Oxygen/Algal Growth/Chlorophyll-*a*

As described in Section 3.4.4, the Tongue River Reservoir was listed as impaired for organic enrichment/DO on the 1996 303(d) list. In 2002, aquatic life uses were impaired because of algal growth/chlorophyll-a. This section presents an updated evaluation of the Tongue River Reservoir to verify the impairment status relative to organic enrichment, low dissolved oxygen, algal growth, and chlorophyll-*a*. Excessive algal growth, which is usually caused by excess nutrients, can cause low DO concentrations and fish kills. The Montana DO standard requires that the average 7-day DO concentration not fall below 6.0 mg/L when early life stages are present. The 1-day minimum is 5.0 mg/L.

There are no current DO data for the reservoir. An analysis of historical data showed that in 1975, 2 out of 18 samples (11 percent) were below the 1-day minimum (Table 3-90). Chlorophyll-*a* data generally indicate that the lake is either eutrophic or hypereutrophic (Table 3-91).

There are insufficient data to determine whether the lake is meeting DO standards. Chlorophyll-*a* data and TSI values suggest that excess algal growth and nutrient concentrations are impairing the reservoir. Montana's 2002 303(d) list indicates that the Tongue River Reservoir is impaired because of algal growth and chlorophyll-*a* (MDEQ, 2002).

A final water quality impairment determination will not be made for suspended solids because appropriate information is not yet available to determine if the elevated concentrations are a result of natural or anthropogenic causes. Also, a water quality impairment determination cannot be made for the Tongue River Reservoir because there is a lack of current data. The most recent DO data were collected in 1976.

Table 3-90. Summary of DO data, Tongue River Reservoir (mg/L).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
196	3	10.8	10.1	11.7	7%	2/21/76	2/21/76
9070	3	10.3	9.6	11.4	9%	5/23/75	10/15/75
9092	6	11.2	6.5	14.5	24%	10/1/75	5/1/76
9101	3	7.6	4.2	9.4	39%	5/23/75	10/15/75
9115	3	4.8	1.4	8.8	78%	5/23/75	10/15/75

[a]CV – Coefficient of Variation (standard deviation/mean).

Table 3-91. Summary of chlorophyll-*a* data, Tongue River Reservoir (µg/L).

Station	Count	Average	TSI	Min	Max	CV[a]	Min Date	Max Date
TRR26	1	5.6	47.5	5.6	5.6		7/26/01	7/26/01
TRR28	1	15.0	57.2	15.0	15.0		7/26/01	7/26/01
UNKNOWN	9	20.5	60.2	4.5	54.0	92%	8/16/01	10/26/01

[a]CV – Coefficient of Variation (standard deviation/mean).

3.4.5.2.6 Total Suspended Solids

As described in Section 3.4.5, the Tongue River Reservoir was listed as impaired for total suspended solids (TSS) on the 1996 303(d) list. TSS was not identified as a cause of impairment on the 2002 303(d) list. This section presents an updated evaluation of the Tongue River Reservoir to verify the impairment status relative to TDS.

There are no numeric water quality standards for TSS in Montana, and few states have TSS standards for lakes. The Tongue River Reservoir and the Tongue River upstream of the reservoir are coldwater fishery waterbodies. South Dakota’s standards for coldwater fishery streams are 30 mg/L (average) and 53 mg/L (maximum). Utah also has a 35 mg/L (average) TSS standard for coldwater fishery streams. The TSS data from the Tongue River Reservoir was compared to the 35 mg/L criterion to provide some insight on use impairment status. However, a better target is needed to make more conclusive decisions.

The TSS data are summarized in Table 3-92 and shown in Figure 3-63. Historically, average TSS concentrations were generally lower than the 35 mg/L target. Two out of nineteen samples exceeded 35 mg/L in 2001 (Table 3-93).

A final water quality impairment determination will not be made for suspended solids because appropriate information is not yet available to determine if the elevated concentrations are a result of natural or anthropogenic causes.

Table 3-92. Summary of TSS data, Tongue River Reservoir (mg/L).

Station	Count	Average	Min	Max	CV[a]	Min Date	Max Date
136	6	20.7	5.4	51.3	83%	5/14/76	6/10/76
137	3	22.0	2.0	42.0	91%	7/1/75	7/1/75
196	14	8.8	4.9	13.1	31%	12/19/75	6/10/76
198	15	6.4	2.0	14.4	55%	7/1/75	6/10/76
TRR28	1	10.0	10.0	10.0	0%	7/26/01	7/26/01
UNKNOWN[b]	18	20.6	10.0	73.0	82%	7/26/01	10/26/01

[a]CV – Coefficient of Variation (standard deviation/mean).
[b]Sample locations within the reservoir are unknown.

Table 3-93. Summary of TSS exceedances.

Target	Total # of Samples	Total # of Exceedances	Percent Exceeding	Total # of Samples, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
35 mg/L	57	4	7%	19	2	11%

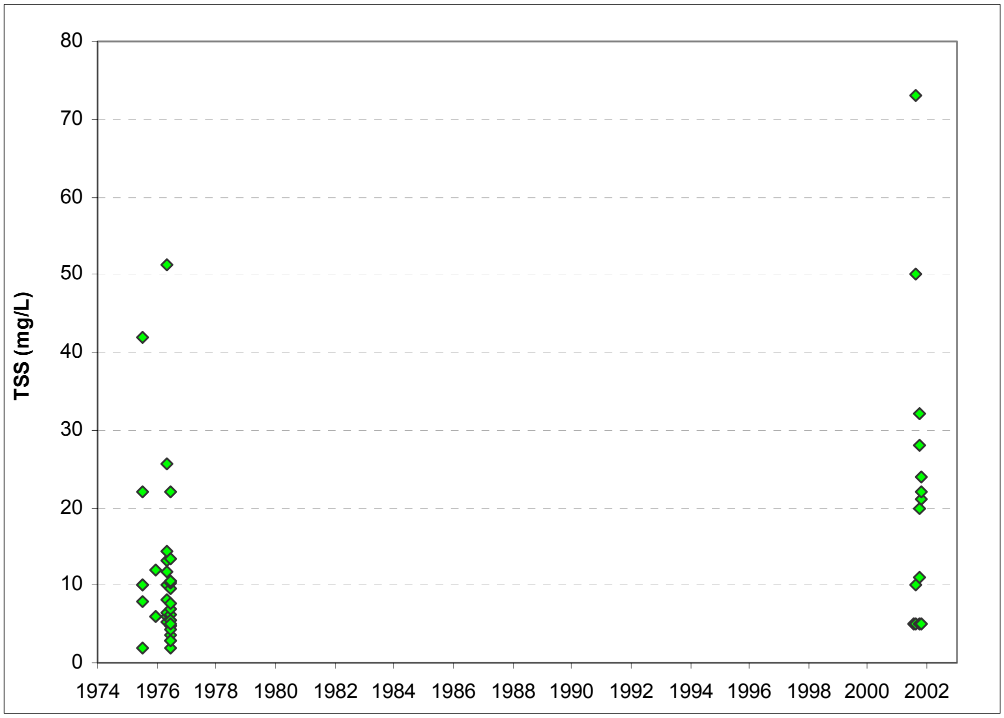

Figure 3-63. TSS data for the Tongue River Reservoir.

3.4.5.2.7 Beneficial Use Support Summary: Tongue River Reservoir

The Montana 1996 303(d) list reported that the Tongue River Reservoir was impaired because of nutrients, organic enrichment/DO, and suspended solids. In 2002, using additional data and a new listing methodology, MDEQ identified the Tongue River Reservoir as impaired because of algal growth/chlorophyll-*a* (MDEQ, 2002). Aquatic life and recreational uses were all partially impaired because of algal growth/chlorophyll-*a*. Agricultural and industrial uses were found to be fully supporting in the 2002 303(d) report. Drinking water and fishery uses were not assessed in the 2002 303(d) report because of insufficient credible data.

The 1996 and 2002 causes of impairment were analyzed in the previous sections to determine which causes will require TMDLs. Water quality impairment determinations could not be made for several causes of impairment because appropriate site-specific numeric criteria have not been identified, or because there was a lack of recent data. A summary for each evaluated cause of impairment is shown in Table 3-94.

Table 3-94. Water quality impairment status summary.

Segment	Evaluated Cause of Impairment	1996 303(d) List	2002 303(d) List[a]	TMDL Requirement
Tongue River Reservoir	Algal growth/chlorophyll-*a*		✔	Undetermined
	Chlorides			Undetermined
	Nutrients	✔		Undetermined
	Organic enrichment/DO	✔		Undetermined
	Salinity			Undetermined
	SAR			Undetermined
	Suspended solids	✔		Undetermined
	TDS			Undetermined

[a]Not all causes of impairment were evaluated for the 2002 303(d) list.
Source: MDEQ, 1996, 2002.

4.0 CONCEPTUAL MONITORING PLAN

The purpose of this section is to identify data gaps and recommend additional monitoring strategies for the Tongue River watershed. The goals of the additional monitoring are to determine beneficial use impairments, obtain data for setting up and calibrating a watershed/water quality model, and better determine sources of impairment. The amount of current, reliable data is directly linked to the level of confidence in the results of the TMDL process. The more data that can be collected, the easier it will be to determine the current impairment status, appropriate water quality targets, and existing and allowable loadings for the Tongue River watershed. The monitoring plan presented below is a *conceptual plan* and provides a preliminary framework for the final monitoring strategy. A more detailed sampling and analysis plan is being prepared.

4.1 Identified Data Gaps

4.1.1 Beneficial Use Determinations

Section 3.0 summarized all available data relative to the water quality limited segments identified on the 1996 303(d) list. In many cases, insufficient data were available to make final water quality impairment determinations. The identified data gaps are summarized in Table 4-1. The purpose of this monitoring section is to develop a detailed strategy to fill these gaps.

Table 4-1. Identified data gaps in the Tongue River watershed.

Water Body	Pollutant	Identified Data Gap
Tongue River	Salinity/TDS/Chlorides	• Lack of final, approved numeric criteria
	SAR	• Lack of final, approved numeric criteria
	Total Suspended Solids	• Lack of comparable reference condition or suitable target
	Metals	• Few recent data in the lower and middle segments
Hanging Woman Creek	Salinity/TDS/Chlorides	• Lack of final, approved numeric criteria • Lack of recent data
	Metals	• Lack of recent data
Otter Creek	Salinity/TDS/Chlorides	• Lack of final, approved numeric criteria • Lack of recent data
	Metals	• Lack of recent data
	Total Suspended Solids	• Lack of recent data • Lack of comparable reference condition or suitable target • Insufficient data to define the natural conditions
Pumpkin Creek	Salinity/TDS/Chlorides	• Lack of recent data • Lack of final, approved numeric criteria
	Thermal Modifications	• Lack of recent data
Tongue River Reservoir	Nutrients	• Insufficient understanding of the limnology of the reservoir (i.e., chemical, physical, and biological characteristics of the reservoir) • Lack of upstream/downstream nutrient data
	Organic Enrichment/DO	• Lack of recent DO data • Insufficient understanding of the limnology of the reservoir (i.e., chemical, physical, and biological characteristics of the reservoir)

Water Body	Pollutant	Identified Data Gap
	Total Suspended Solids	• Lack of recent TSS and/or turbidity data • Insufficient understanding of the limnology of the reservoir (i.e., chemical, physical, and biological characteristics of the reservoir) • Lack of comparable reference condition or suitable target

4.1.2 Model Calibration

As discussed in Section 1.3.2, it is expected that during Phase III some sort of watershed and water quality modeling will need to be performed to establish the relationship between the in-stream water quality targets and the source loadings. Using models allows for the evaluation of management options and the selection of the option that will achieve the desired source load reductions in the most efficient manner. Although a specific model has not yet been identified, one of the purposes of the data collection activities will be to collect the data that are necessary to setup, apply, calibrate, and validate the model. The data that will likely be needed to setup and calibrate whichever model is chosen include the following:

- Hourly precipitation and temperature data for representative areas of the watershed.
- Flow data at multiple main stem and tributary stations for hydrologic calibration and validation of the model.
- Stream cross sections for the upstream, middle, and downstream segments of the Tongue River.
- Water quality data at multiple main stem and tributary stations to calibrate the model. Additional data will be necessary at the same stations for model validation.
- Sampling of significant sources, such as mining, oil and gas development, and irrigation return flows, to better characterize these sources within the model.
- Shallow groundwater sampling to characterize the interaction between groundwater and surface waters.

4.1.3 Source Assessment

TMDLs must consider all significant sources of a pollutant (e.g., the source of excessive algal growth in a stream are nutrients from a municipal wastewater treatment plant and an animal feeding operation). It is necessary to identify and quantify the relative contribution from all potentially significant sources for each pollutant. A summary of the listed pollutants and their associated potential sources in the Tongue River watershed is provided in Table 4-2. To date, little work has been conducted in the Tongue River watershed to identify and estimate loading rates from those pollutants appearing on the 1996 303(d) list.

Table 4-2. Pollutants and their potential sources in the Tongue River watershed.

Water Body	Pollutant	Potential Sources
Tongue River	Salinity/TDS/Chlorides	• Industrial point sources • Mining; oil and CBM development • Natural sources (geology and soils)
	SAR	• Industrial point sources • Mining; oil and CBM development • Natural sources (geology and soils)
	Suspended Solids	• Agriculture • Channel erosion and scouring • Natural sources (geology and soils) • Pasture/range grazing
	Metals	• Industrial point sources • Mining; oil and CBM development • Natural sources (geology and soils)
Hanging Woman Creek	Salinity/TDS/Chlorides	• Industrial point sources • Mining; oil and CBM development • Natural sources (geology and soils)
	Metals	• Industrial point sources • Mining; oil and CBM development • Natural sources (geology and soils)
Otter Creek	Salinity/TDS/Chlorides	• Irrigation • Mining, oil, and CBM development • Natural sources (geology, soils, evaporation)
	Metals	• Industrial point sources • Mining; oil and CBM development • Natural sources (geology and soils)
	Suspended Solids	• Agriculture • Channel erosion and scouring • Natural sources (geology and soils)
Pumpkin Creek	Salinity/TDS/Chlorides	• Irrigation • Mining, oil, and CBM development • Natural sources (geology, soils, evaporation)
	Thermal Modifications	• Industrial point sources • Loss of riparian habitat • Mining, oil, and CBM development
Tongue River Reservoir	Nutrients	• Animal feeding operations • Agriculture • Fisheries • Primary/secondary production • Recreation • Wastewater disposal
	Organic Enrichment/DO	• Animal feeding operations • Agriculture • Fisheries • Primary/secondary production • Recreation • Wastewater disposal
	Suspended Solids	• Agriculture • Channel erosion and scouring • Natural sources (geology and soils) • Pasture/range grazing • Recreation

4.2 Monitoring Strategy

There are four different types of data that need to be collected for the 2003 sampling program:

- Data for listed segments and parameters where there are no current data
- Data to quantify sources in the Tongue River and tributaries
- Data to assess the natural or background conditions of the listed parameters
- Data to run and calibrate a model

All four types of data will help to make beneficial use determinations for the listed segments and to develop TMDLs for those segments that are indeed impaired. This report assumes that USGS will continue monthly monitoring and continuous flow data at stations 06307830 and 06306300 in the Tongue River. The following sections outline the additional monitoring sites and needed data.

4.2.1 Data Gap – No Current Data

4.2.1.1 Tributaries

There are few current data for tributaries in the Tongue River watershed. However, data exist at historic USGS stations throughout the watershed. Salinity (EC), SAR, TDS, DO, turbidity, metals, and TSS data should be collected at or near these historic USGS monitoring sites so that current data (2003) can be compared to the historic data. Metals samples should be collected and analyzed using standard USEPA procedures to obtain the highest levels of quality, accuracy, and precision. Instantaneous flows should be obtained at the time of any sampling. Biological assemblages (macroinvertebrates, fish, algae) should be sampled at these sites as well.

Pumpkin Creek was the only stream in the Tongue River watershed listed for thermal modifications in 1996. However, there are no recent temperature data. Because of this, temperature data should be collected for Pumpkin Creek in 2003. Temperature readings should be obtained at the time of ambient sampling at all of the Tongue River stations.

4.2.1.2 Tongue River Reservoir

Additional data for the Tongue River Reservoir are also needed. Because of the unique characteristics of the reservoir, a modified sampling schedule is recommended. Samples should be obtained at various depths and regions of the lake. A detailed analysis of lake characteristics (depth, volume, residence time, etc.) is currently underway, which will provide guidance for future sampling programs. Recommended sampling parameters are EC, TDS, turbidity, chlorides, SAR, nutrients, DO, chlorophyll-*a*, and TSS. Temperature profiles will be collected to help understand lake stratification, and Secchi depths will be collected to determine lake clarity.

4.2.1.3 Tongue River

There are current data with good spatial coverage on the main stem of the Tongue River for most parameters. However, there are few recent metals samples for the lower Tongue River and middle Tongue River. Current metals samples should be collected for both reaches in 2003. Recommended metals sampling includes arsenic, cadmium, chromium, copper, iron, lead, nickel, selenium, silver, and zinc. Grab samples should be obtained at the recommended stations shown in Table 4-3. Metals samples should be collected and analyzed using standard USEPA procedures to obtain the highest levels of quality, accuracy, and precision.

Table 4-3. 2003 metals sampling sites for the main stem of the Tongue River.

USGS Site Number	Site Name	Latitude	Longitude
06308500	Tongue River at Miles City, MT	46.3456	-105.8028
06307616	Tongue River at Birney Day School Bridge near Birney, MT	45.4117	-106.4572

4.2.2 Data Gap – Sources

There are few data or studies assessing potential sources of impairment in the Tongue River watershed. Potential sources of impairment are irrigation, grazing, animal feeding operations, fisheries, channel erosion, natural sources, industrial sources, and mining/oil/CBM operations. A monitoring approach for quantifying the effect of these sources is outlined below.

- Identify and monitor major irrigation return flows for flow and water chemistry
- Identify and monitor upstream and downstream of major agricultural areas
- Monitor shallow groundwater aquifers for water chemistry
- Monitor downstream of major mining, oil, and gas development activities
- Monitor downstream of major wastewater discharges (treatment plants and areas with high septic system densities)
- Monitor instream erosion using the Bank Erosion Hazard Index (BEHI) methodology

The following sections describe the monitoring approach to help locate and quantify major sources of impairment in the Tongue River watershed.

4.2.2.1 Irrigation Return Flows

Irrigation return flows are a potential source of contaminants and little data are available. Irrigation returns should be identified and monitored for quality and quantity. Returns from different irrigation practices, soil types, and crops should be monitored. Examples include returns from flood irrigation, spreader dike systems, and sprinkler based systems. The NRCS Phase 1 Rapid Aerial Assessment identified major irrigation return flows (Figure 4-1). Each site should be evaluated in the field to determine which sites should be monitored, and monitoring sites should be selected based on site-specific conditions. Other irrigation return flows should be identified as well. The monitoring approach is outlined below.

- Identify all irrigation return flows during a field assessment
- Identify sites with different irrigation practices, soils, and crops
- Locate appropriate water chemistry sampling sites
- Obtain permission from the landowners for sampling

- Perform water chemistry sampling (EC, TDS, SAR, and chlorides) and obtain flow data

Several irrigation return flow sites should be monitored in the Tongue River watershed to determine the salinity contribution from a variety of different conditions. The sites should be monitored during the growing season and specifically after periods of irrigation if possible. All possible irrigation returns should also be identified to quantify the total load contributed by irrigation. Shallow groundwater wells should be identified and monitored where available.

4.2.2.2 Other Agricultural Sources

It is difficult to determine the effects of all agricultural sources on the Tongue River because of the large watershed size and multiple contributions from different sources. It is recommended that a study should be conducted in the headwater areas of the Tongue River near Sheridan, Wyoming. In this area, the low salinity water from the Bighorn Mountains flows into the Tongue River Valley, which is almost entirely used for agriculture. Monitoring upstream and downstream of this high intensity agricultural area would help to quantify the effects of agricultural land use. Table 4-4 summarizes the recommended sites and they are shown in Figure 4-2. Other potential sources of pollution, such as grazing and animal feeding operations, should also be identified and monitored.

Table 4-4. Monitoring sites to evaluate potential agricultural sources of pollution.

Site Number	Site Description	Latitude	Longitude
USGS 06298000	Tongue River near Dayton, WY	44.8494	-107.3039
New Site 1	Tongue River east of Dayton, WY	44.9072	-107.0802
USGS 06302000	Big Goose Creek near Sheridan, WY	44.7022	-107.1808
New Site 2	Big Goose Creek near Sheridan, WY	44.7865	-106.9981
USGS 06303500	Little Goose Creek in canyon, near Big Horn, WY	44.5961	-107.0394
New Site 3	Little Goose Creek near Sheridan, WY	44.7543	-106.9550

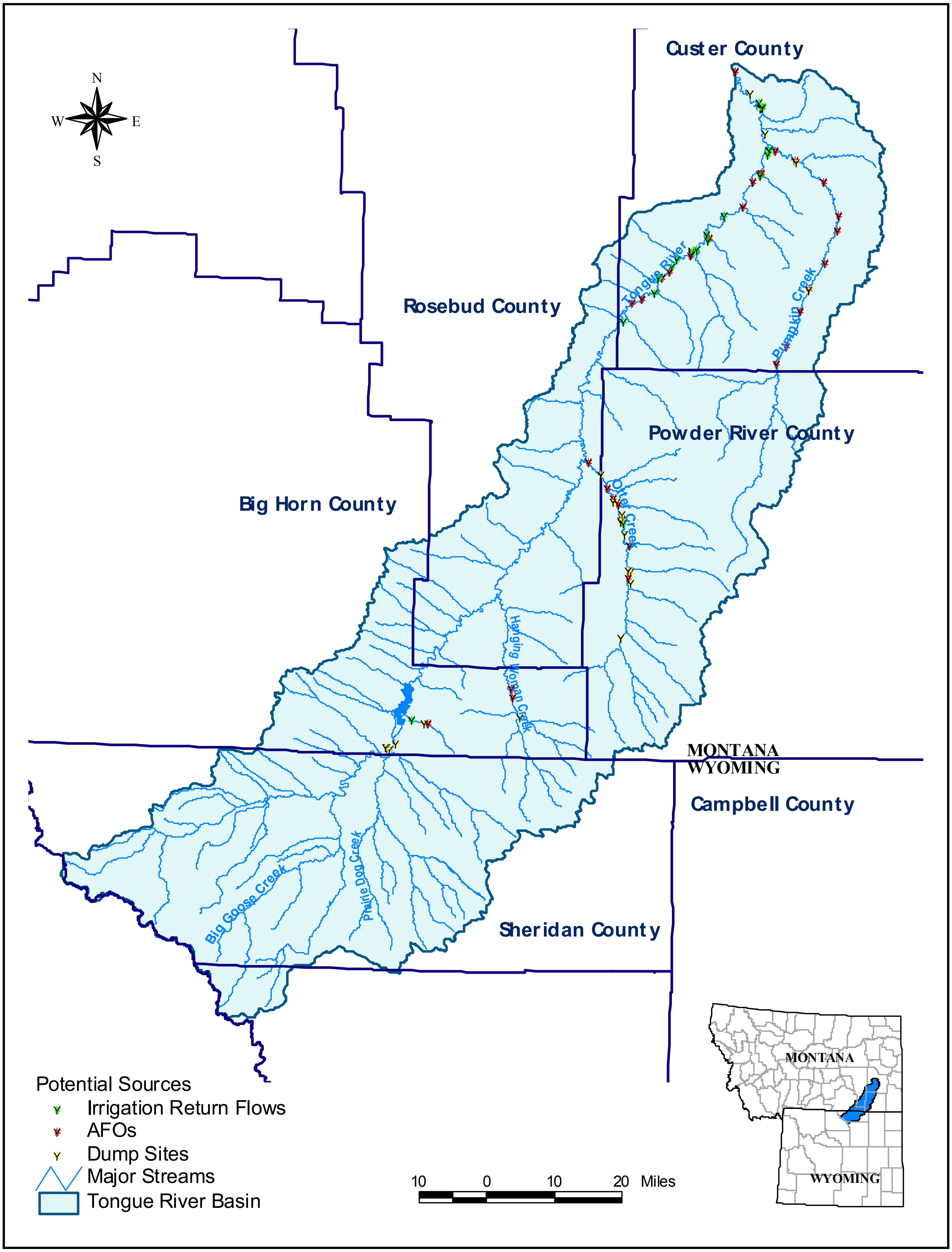

Figure 4-1. Potential sources identified by NRCS.

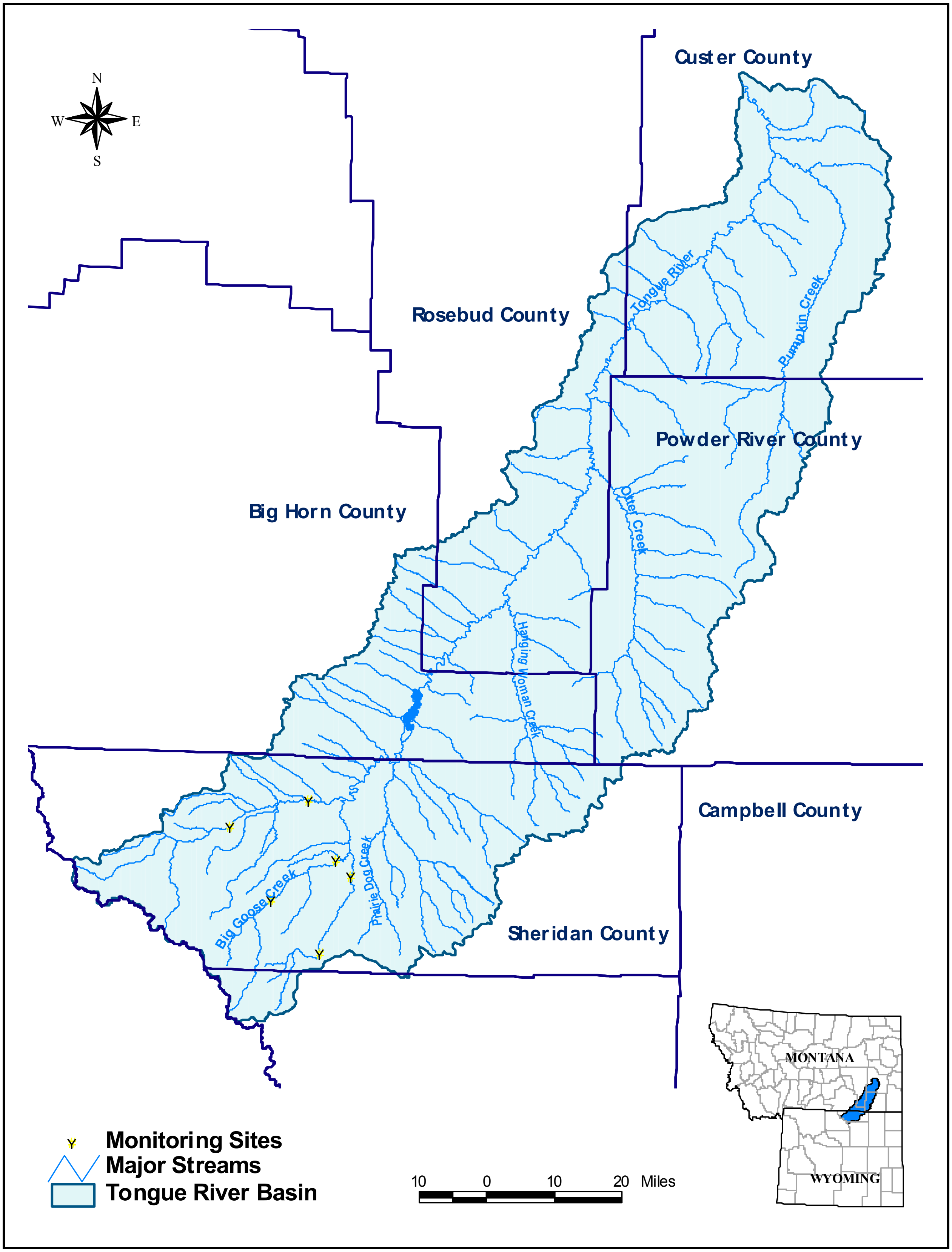

Figure 4-2. Monitoring sites to determine agricultural loads.

4.2.2.3 Mining

There is currently not a good understanding of how mining, oil, and gas development affect water quality in the Tongue River. Also, the location of many of these sites is unknown. The first step to developing a monitoring plan to address these potential sources is to identify all mining-related sources, source types, and locations. Monitoring at or near the potential sources of pollution should occur for EC, TDS, SAR, and chlorides.

4.2.2.4 Streambank Erosion

Streambank erosion is a potential source of sediment in the Tongue River. Several methods exist for measuring and predicting streambank erosion depending on the measured amount of erosion over time and bank stability factors. One such technique is the bank erosion hazard index (BEHI). BEHI measurements should be made along similar reaches of the main stem of the Tongue River and the major tributaries. An approach for quantifying sediment loads from streambank erosion is outlined below.

- Identify unique segments of the Tongue River based on streambanks by rafting or walking portions of the river.
- Partition the river into several similar segments based on the assessment.
- Perform a BEHI measurement for each segment prior to the spring snowmelt season.
- Install bank erosion pins at each BEHI location during the initial BEHI measurement.
- Measure streambank erosion using the bank pins after the snowmelt season (July) and again in the fall (October).

By knowing the BEHI score and the total length of a segment, a total volume of sediment load from streambank erosion can be estimated. Pebble counts should also be performed to determine size of bed material in the channel. This should be performed during the July and October sampling periods. An aerial photograph analysis could also help to quantify streambank erosion and channel movement.

4.2.2.5 Other Potential Sources

Other potential sources, such as industrial sources and municipal sources, should be identified during a field assessment of the Tongue River watershed. If it is suspected during the field assessment that the potential source is contributing a significant amount of pollution to the river, it should be monitored as part of the 2003 monitoring plan.

4.2.3 Data Gap – Background Conditions

4.2.3.1 Reference Streams

Reference streams are used to compare data from a least impaired stream to an impaired stream of concern. This is extremely helpful for determining beneficial use impairments for parameters that have no numeric standards (e.g., nutrients, TSS, TDS, chlorides). The reference stream should have few sources or causes of impairment and it should be relatively similar in size, type, and region to the target stream. It is unlikely that a reference stream could be found for the main stem of the Tongue River because of the unique conditions that occur in the watershed. However, reference streams for the impaired tributaries should be located and monitored. Reference streams outside of the Tongue River watershed, but with similar watershed characteristics, may need to be found. A plan for identifying and monitoring reference streams is shown below.

- Perform a field assessment to identify reference streams for tributaries in the Tongue River watershed. A reference stream outside of the watershed may need to be found, or a least impacted portion of the target stream may be used.
- Sample water chemistry at both the reference stream and target stream at similar time periods once per month during the non-growing season and twice per month during the growing season.
- Monitor fish, macroinvertebrate, and algae communities at both streams at least once per year.

Sampling at both the reference stream and the target stream should be performed at similar intervals and time periods, which would allow for statistical comparisons. The establishment of these reference streams will have to be a site specific process with a detailed investigation of the watershed. Reference streams for Hanging Woman Creek, Otter Creek, and Pumpkin Creek could be established.

4.2.3.2 Continuous Data Monitoring

A data probe, such as a YSI or Hydrolabs sensor, can be used to obtain continuous samples at small specified intervals (e.g., hourly). Data probes generally come with sensors to obtain DO, temperature, turbidity, and EC data. Data from these sensors would help to characterize the water chemistry of the river on a daily basis, and the data would supplement ambient sampling by USGS and MDEQ.

A continuous sample data probe is recommended for the main stem of the Tongue River. The probe would obtain hourly readings for EC, turbidity, and DO. The continuous readings would provide information on conditions during low-flow and high-flow events, which can be used for multiple reasons such as setting up and calibrating a model and obtaining information on background conditions. The probes should be installed at or near current USGS flow gages to ensure that accurate flow readings accompany the data. USGS has a continuous sample data probe for the Tongue River at the state line near Decker, Montana. An additional continuous sample data probe should be installed at USGS gage 06307830 near Brandenburg, Montana, and continuous flow should be monitored at this gage during the sampling period of the data probe. Also, monthly TSS and TDS concentrations should be sampled at these sites so that relationships can be developed between turbidity and sediment, and EC and TDS.

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APPENDIX A: MAJOR LAND RESOURCE AREAS DATA DESCRIPTION

43--Northern Rocky Mountains
Idaho, Montana, Oregon, Washington, and Wyoming

Land use: Nearly all this area is federally owned and administered by the Forest Service, U.S. Department of Agriculture, and the BLM, Department of the Interior. Most of the privately owned land is controlled by large commercial timber companies. All the forested areas are used as wildlife habitat, for recreation and watershed, and for timber production. Meadows on the upper mountain slopes and crests above timberline provide summer grazing for livestock and big game animals. Mining is an important industry in Idaho and western Montana. Dairy and livestock farms are important enterprises in the west. Less than 2 percent of the area is cropped. Forage, grain, peas, and a few other crops are grown in some valleys.

Elevation and topography: Elevation is mainly 400 to 2,400 m, but it is almost 3,000 m on some mountain peaks. Some areas in Montana and Wyoming are at an elevation of 2,100 to 3,000 m, and mountain peaks are almost 4,300 m. High mountains having steep slopes and sharp crests are cut by narrow valleys, most of which have steep gradients. Lakes are common, especially in glaciated areas.

Climate: Average annual precipitation – 625 to 1,525 mm, increasing with elevation, but almost 375 mm in the western part of the area and almost 2,550 mm in high mountains. Most of the precipitation during the fall, winter, and spring is snow. Summers are dry. Average annual temperature—2 to 7 °C in most of the area, but it is 8 °C or more at low elevations. Average freeze-free period – 45 to 120 days, decreasing with elevation, and as long as 140 days in low valleys of Washington. Frost occurs every month of the year on high mountains; some peaks have a continuous cover of snow and ice.

Water: Moderate precipitation and many perennial streams and lakes provide ample water. Streams and reservoirs supply water to adjoining MLRA's for irrigation and other uses. Springs and shallow wells in the valleys provide water for domestic use and livestock. Elsewhere, groundwater supplies are small and mostly untapped.

Soils: Most of the soils are Ochrepts and Andepts. They have a frigid or cryic temperature regime. Shallow to moderately deep, medium textured and moderately coarse textured Cryochrepts (Jughandle and Holloway series) and Xerochrepts (Waits and Moscow series) are on mountain slopes. Cryandepts (Huckleberry, Truefissure, and Coerock series) are on ridges with thin layers of volcanic ash. Stony Cryorthents (Tamely series) and areas of rock outcrop are on peaks and ridges above timberline. Detailed soil survey information is lacking in most of the area.

Potential natural vegetation: This area supports conifer forests. Forests of western white pine, ponderosa pine, lodgepole pine, western redcedar, western larch, hemlock, Douglas fir, subalpine fir, and spruce are common. Alpine grasses, forbs, and shrubs and scattered stands of subalpine fir, spruce, and whitebark pine grow on high mountains of Montana and Wyoming.

46--Northern Rocky Mountain Foothills
Montana and Wyoming

Land use: About one-fifth of this area is federally owned. The remainder is in farms and ranches. One-half or more of the area is a range of short and mid grasses and some shrubs. Many of the valleys are irrigated, but they make up only 1 or 2 percent of the total area. Grain and forage for livestock are the main crops, but potatoes, sugar beets, peas, and some other crops are grown in the warmer valleys. About one-fifth of this area, mainly along the northeastern side, is dry farmed to wheat. Some of the highest hills are forested.

Elevation and topography: Elevation ranges from 1,100 to 1,800 m in the north, increasing gradually to 1,800 or 2,400 m in the south and in central Wyoming. The rugged hills and low mountains are cut by many narrow valleys that have steep gradients. Broad flood plains and fans border a few of the major rivers.

Climate: Average annual precipitation – 300 to 500 mm, but it is 750 mm at the highest elevations and 250 mm in some basins. In the north, minimum precipitation is in spring, and in the south it is early in summer. Winter precipitation is snow. Average annual temperature – 6 to 7 °C. Average freeze-free period – 90 to 125 days, but only 80 days at the highest elevations.

Water: Precipitation is too low for good growth of crops in some parts of the area, but in others it is adequate for grain farming and forage production. The major rivers provide most of the water for irrigation, but small streams furnish local supplies. Groundwater is abundant in the fill in some valleys, but in most of the area groundwater is meager or lacking.

Soils: Soils of this area are mostly Borolls, Orthents, and Fluvents. They are medium textured to fine textured and mainly well drained and have a frigid temperature regime. Moderately deep to deep Argiborolls (Absarokee, Farnuf, and Savage series), Haploborolls (Winifred and Rottulee series), and Natriborolls (Adger series) are on sedimentary uplands, alluvial fans, foot slopes, and terraces. Shallow Argiborolls (Sinnigam and Amherst series), Haploborolls (Castner series), and Ustorthents (Cabba and Wayden series) are on sedimentary uplands. Deep, nearly level to gently sloping Ustifluvents (Havrelon and Lohler series) are on flood plains and low alluvial terraces. Soils in wooded areas are at higher elevations where more rainfall is received.

Potential natural vegetation: This area supports grass vegetation in the valleys and foothills and forest vegetation at higher elevations. Bluebunch wheatgrass, rough fescue, Idaho fescue, and western wheatgrass are the major grass species. Ponderosa pine, Rocky Mountain juniper, common snowberry, and skunkbush sumac are dominant species in forests.

58A—Northern Rolling High Plains, Northern Part
Montana and Wyoming

Land use: Most of this area consists of privately owned ranches. The remainder is federally owned. Most of it is in native grasses and shrubs grazed by cattle and sheep. The rest is mainly dry-farmed to wheat. Narrow strips of land along the Yellowstone River and its main tributaries are irrigated. Sugar beets, alfalfa, other hay crops, and corn for silage are the principal crops. Some of the land is in tame pasture. The upper slopes and tops of some of the higher buttes and mountains are open woodland.

Elevation and topography: Elevation generally ranges from 900 to 1,800 m, increasing from east to west and from north to south, but in a few mountains it is as high as 2,100 m. These dissected plains are underlain by shale, siltstone, and sandstone. Slopes are mostly gently rolling to steep, and wide belts of steeply sloping badland border a few of the larger river valleys. Local relief is mainly in meters to tens of meters. In places, flat-topped, steep-sided buttes rise sharply above the general level of the plains.

Climate: Average annual precipitation – 300 to 500 mm in most of the area and as much as 750 mm in the mountains, but it fluctuates widely from year to year. Maximum precipitation is in spring and early in autumn. Precipitation in winter is snow. Average annual temperature – 4 to 7 °C. Average freeze-free period – 120 to 140 days.

Water: The low and erratic precipitation is the principal source of water for agriculture. Water for livestock is stored in small reservoirs, but supplies are inadequate for significant irrigation. Irrigation water in quantity is available only along the Yellowstone River and one or two of its larger tributaries. Groundwater is scarce in most of the area, but locally sand and gravel deposits and coal beds yield small to moderate amounts.

Soils: Most of the soils are Orthents, Orthids, Argids, Borolls, and Fluvents. They are medium to fine textured, shallow to deep, and mainly well drained. Most of these soils have a frigid temperature regime, but soils in some wide river valleys, such as the Yellowstone River Valley, have a mesic temperature regime. The nearly level to steep Torriorthents (Lisam, Cabbart, and Lambeth series), Camborthids (Yamac, Lonna, and Cambeth series), Calciorthids (Crago and Cargill series), Haplargids (Bonfri series), Natrargids (Absher series), and Argiborolls (Tanna, Ethridge, and Evanston series) are on sedimentary uplands, fans, terraces, and foot slopes. The nearly level Torrifluvents (Havre and Glendive series) are on flood plains and low stream terraces.

Potential natural vegetation: This area supports grassland vegetation. Western wheatgrass, bluebunch wheatgrass, green needlegrass, and needleandthread are dominant species. In the eastern part of the area, little bluestem replaces bluebunch wheatgrass as the dominant species.

58B—Northern Rolling High Plains, Southern Part
Montana and Wyoming

Land use: More than two-thirds of this area is ranches. Most of the remainder is federally owned. Nearly 80 percent of the area consists of native grasses and shrubs grazed by cattle and sheep. Gently sloping deep soils, making up about 4 or 5 percent of the area, are dryfarmed to wheat. Narrow strips of land along the Tongue, Powder, and Platte Rivers and some of their tributaries are irrigated. Alfalfa, other hay crops, and feed grains are the principal crops. Some tracts are in tame pasture. The upper slopes and tops of some of the higher buttes and mountains are open woodland.

Elevation and topography: Elevation generally ranges from 900 to 1,800 m, increasing gradually from north to south, but in a few buttes it is as high as 2,100 m. These dissected plains are underlain by shale and sandstone. Slopes are mostly gently rolling to steep, and wide belts of steeply sloping badland border a few of the larger river valleys. Local relief is mainly in tens of meters. In places, flat-topped, steep-sided buttes rise sharply above the general level of the plain.

Climate: Average annual precipitation – 300 to 475 mm in most of the area but it fluctuates widely from year to year. Maximum precipitation is in spring and early autumn. Precipitation in winter is snow. Average annual temperature—7 to 9 °C. Average freeze-free period – 100 to 130 days.

Water: The low and erratic precipitation is the principal source of water for agriculture. Water for livestock is stored in small reservoirs, but supplies are inadequate for significant irrigation. Irrigation water in quantity is available only along the major rivers and some of their larger tributaries. Groundwater is scarce in most of the area, but in places, sand and gravel deposits and coalbeds yield small to moderate amounts.

Soils: Most of the soils are Orthents, Orthids, Argids, and Fluvents. They are moderately coarse to fine textured, well drained, and have a mesic temperature regime. The nearly level to steep, shallow to deep Tomorthents (Kim, Thedalund, Samsil, Shingle, and Tassel series) and the nearly level to steep, moderately deep to very deep Haplargids (Cushman, Olney, Terry, and Vona series) are on sedimentary uplands. The nearly level to moderately sloping, moderately deep to very deep Camborthids (Zigweid and McRae series) and Paleargids (Bidman and Briggsdale series) are on alluvial fans, foot slopes, and terraces. The nearly level, deep Torrifluvents (Haverson, Glenberg, and Bankard series) are on flood plains and low stream terraces.

Potential natural vegetation: This area supports grassland vegetation. Rhizomatous wheatgrasses, green needlegrass, needleandthread, blue grama, and threadleaf sedge are dominant species on deep soils. Bluebunch wheatgrass and little bluestem are major species on shallow soils on hills and ridges. Basin wildrye, green needlegrass, rhizomatous wheatgrasses, and shrubs are dominant along bottom land and streams. Big sagebrush is the dominant shrub.

APPENDIX B: MULTI-RESOLUTION LAND CHARACTERISTICS (MRLC) CONSORTIUM DATA DESCRIPTION

Land Cover Classes:

Water
11 Open Water
12 Perennial Ice/Snow

Developed
21 Low-Intensity Residential
22 High-Intensity Residential
23 Commercial/Industrial/Transportation

Barren
31 Bare Rock/Sand/Clay
32 Quarries/Strip Mines/Gravel Pits
33 Transitional

Vegetated Natural Forested Upland
41 Deciduous Forest
42 Evergreen Forest
43 Mixed Forest

Shrubland
51 Shrubland

Non-natural Woody
61 Orchards/Vineyards/Other

Herbaceous Upland
71 Grasslands/Herbaceous

Herbaceous Planted/Cultivated
81 Pasture/Hay
82 Row Crops
83 Small Grains
84 Fallow
85 Urban/Recreational Grasses

Wetlands
91 Woody Wetlands
92 Emergent Herbaceous Wetlands

Land Cover Classification System and Land Cover Class Definitions:

Water – All areas of open water or permanent ice/snow cover.

11. Open Water – areas of open water, generally with less than 25 percent or greater cover of water (per pixel).

12. Perennial Ice/Snow – all areas characterized by year long cover of ice or snow.

Developed – Areas characterized by high percentage (approximately 30% or greater) of constructed materials (e.g., asphalt, concrete, buildings).

21. Low-Intensity Residential – areas with a mixture of constructed materials and vegetation. Constructed materials account for 30 to 80 percent of the cover. Vegetation may account for 20 to 70 percent of the cover. These areas most commonly include single-family housing units. Population densities will be lower than in high-intensity residential areas.

22. High-Intensity Residential – heavily built up urban centers where people reside in high numbers. Examples include apartment complexes and row houses. Vegetation accounts for less than 20 percent of the cover. Constructed materials account for 80 to 100 percent of the cover.

23. Commercial/Industrial/Transportation – infrastructure (e.g., roads, railroads) and all highways and all developed areas not classified as High-Intensity Residential.

Barren – Areas characterized by bare rock, gravel, sand, silt, clay, or other earthen material, with little or no "green" vegetation present regardless of its inherent ability to support life. Vegetation, if present, is more widely spaced and scrubby than that in the "green" vegetated categories; lichen cover may be extensive.

31. Bare Rock/Sand/Clay – perennially barren areas of bedrock, desert, pavement, scarps, talus, slides, volcanic material, glacial debris, and other accumulations of earthen material.

32. Quarries/Strip Mines/Gravel Pits – areas of extractive mining activities with significant surface expression.

33. Transitional – areas of sparse vegetative cover (less than 25 percent that are dynamically changing from one land cover to another, often because of land use activities. Examples include forest clearcuts, a transition phase between forest and agricultural land, the temporary clearing of vegetation, and changes due to natural causes (e.g., fire, flood)

Forested Upland – Areas characterized by tree cover (natural or semi-natural woody vegetation, generally greater than 6 meters tall); tree canopy accounts for 25 to 100 percent of the cover.

41. Deciduous Forest – areas dominated by trees where 75 percent or more of the tree species shed foliage simultaneously in response to seasonal change.

42. Evergreen Forest – areas characterized by trees where 75 percent or more of the tree species maintain their leaves all year. Canopy is never without green foliage.

43. Mixed Forest – areas dominated by trees where neither deciduous nor evergreen species represent more than 75 percent of the cover present.

Shrubland – Areas characterized by natural or semi-natural woody vegetation with aerial stems, generally less than 6 meters tall with individuals or clumps not touching to interlocking. Both evergreen and deciduous species of true shrubs, young trees, and trees or shrubs that are small or stunted because of environmental conditions are included.

51. Shrubland – areas dominated by shrubs; shrub canopy accounts for 25 to 100 percent of the cover. Shrub cover is generally greater than 25 percent when tree cover is less than 25 percent. Shrub cover may be less than 25 percent in cases where the cover of other life forms (e.g., herbaceous or trees) is less than 25 percent, and shrub cover exceeds the cover of the other life forms.

Non-natural Woody – Areas dominated by non-natural woody vegetation; non-natural woody vegetative canopy accounts for 25 to 100 percent of the cover. The non-natural woody classification is subject to the availability of sufficient ancillary data to differentiate non-natural woody vegetation from natural woody vegetation.

61. Orchards/Vineyards/Other – orchards, vineyards, and other areas planted or maintained for the production of fruits, nuts, berries, or ornamentals.

Herbaceous Upland – Upland areas characterized by natural or semi-natural herbaceous vegetation; herbaceous vegetation accounts for 75-100 percent of the cover.

71. Grasslands/Herbaceous – areas dominated by upland grasses and forbs. In rare cases, herbaceous cover is less than 25 percent, but exceeds the combined cover of the woody species present. These areas are not subject to intensive management, but are often utilized for grazing.

Planted/Cultivated – Areas characterized by herbaceous vegetation that has been planted or is intensively managed for the production of food, feed, or fiber; or is maintained in developed settings for specific purposes. Herbaceous vegetation accounts for 75 to 100 percent of the cover.

81. Pasture/Hay – areas of grasses, legumes, or grass-legume mixtures planted for livestock grazing or the production of seed or hay crops.

82. Row Crops – areas used for the production of crops, such as corn, soybeans, vegetables, tobacco, and cotton.

83. Small Grains – areas used for the production of graminoid crops such as wheat, barley, oats, and rice.

84. Fallow – areas used for the production of crops that are temporarily barren or with sparse vegetative cover as a result of being tilled in a management practice that incorporates prescribed alternation between cropping and tillage.

85. Urban/Recreational Grasses – vegetation (primarily grasses) planted in developed settings for recreation, erosion control, or aesthetic purposes. Examples include parks, lawns, golf courses, airport grasses, and industrial site grasses.

<u>Wetlands</u> - Areas where the soil or substrate is periodically saturated with or covered with water as defined by Cowardin et al.

91. Woody Wetlands - areas where forest or shrubland vegetation accounts for 25 to 100 percent of the cover and the soil or substrate is periodically saturated with or covered with water.

92. Emergent Herbaceous Wetlands - areas where perennial herbaceous vegetation accounts for 75 to 100 percent of the cover, and the soil or substrate is periodically saturated with or covered with water

APPENDIX C: MONTANA NARRATIVE WATER QUALITY STANDARDS

Montana Narrative Water Quality Standards (ARM 17.30.637)

(1) State surface waters must be free from substances attributable to municipal, industrial, agricultural practices or other discharges that will:

(a) Settle to form objectionable sludge deposits or emulsions beneath the surface of the water or upon adjoining shorelines;
(b) Create floating debris, scum, a visible oil film (or be present in concentrations at or in excess of 10 milligrams per liter) or globules of grease or other floating materials;
(c) Produce odors, colors or other conditions as to which create a nuisance or render undesirable tastes to fish flesh or make fish inedible;
(d) Create concentrations or combinations of materials which are toxic or harmful to human, animal, plant or aquatic life; and
(e) Create conditions which produce undesirable aquatic life.

(2) No wastes may be discharged and no activities conducted such that the wastes or activities, either alone or in combination with other wastes or activities, will violate, or can reasonably be expected to violate, any of the standards.

(3) Leaching pads, tailing ponds, or water, waste, or product holding facilities must be located, constructed, operated and maintained in such a manner and of such materials so as to prevent the discharge, seepage, drainage, infiltration, or flow which may result in the pollution of surface waters. The department may require that a monitoring system be installed and operated if the department determines that pollutants are likely to reach surface waters or present a substantial risk to public health.

(a) Complete plans and specifications for proposed leaching pads, tailing ponds, or water, waste, or product holding facilities utilized in the processing of ore must be submitted to the department no less than 180 days prior to the day on which it is desired to commence their operation.
(b) Leaching pads, tailing ponds, or water, waste, or product holding facilities operating as of the effective date of this rule must be operated and maintained in such a manner so as to prevent the discharge, seepage, drainage, infiltration or flow which may result in the pollution of surface waters.

(4) Dumping of snow from municipal and/or parking lot snow removal activities directly into surface waters or placing snow in a location where it is likely to cause pollution of surface waters is prohibited unless authorized in writing by the department.

(5) Until such time as minimum stream flows are established for dewatered streams, the minimum treatment requirements for discharges to dewatered receiving streams must be no less than the minimum treatment requirements set forth in ARM 17.30.635(2) and (3).

(6) Treatment requirements for discharges to ephemeral streams must be no less than the minimum treatment requirements set forth in ARM 17.30.635(2) and (3). Ephemeral streams are subject to ARM 17.30.635 through 17.30.637, 17.30.640, 17.30.641, 17.30.645 and 17.30.646 but not to the specific water quality standards of ARM 17.30.620 through 17.30.629.

(7) Pollution resulting from storm drainage, storm sewer discharges, and non-point sources, including irrigation practices, road building, construction, logging practices, over-grazing and other practices must be eliminated or minimized as ordered by the department.

(8) Application of pesticides in or adjacent to state surface waters must be in compliance with the labeled direction, and in accordance with provisions of the Montana Pesticides Act (Title 80, chapter 8, MCA) and the Federal Environmental Pesticides Control Act (7 USC 136, et seq., (Supp. 1973) as amended).

Excess pesticides and pesticide containers must not be disposed of in a manner or in a location where they are likely to pollute surface waters.

(9) No pollutants may be discharged and no activities may be conducted which, either alone or in combination with other wastes or activities, result in the total dissolved gas pressure relative to the water surface exceeding 110% of saturation.

APPENDIX D: MDEQ PROPOSED EC AND SAR STANDARDS

August 29, 2002 Standards (Old Proposed Standards)

The proposed SAR standard varies depending on the salinity of the water. Under the proposed standards, the instantaneous SAR in a waterbody may not exceed the value given by the equation [(EC*0.0071) – 2.475]. At an EC of 350 µS/cm or less, the formula indicates that the allowable SAR is less than zero. Because of this nonsensical result, the formula does not apply when the EC is 350 µS/cm or less. When the formula given above for calculating the proposed SAR standard results in a value greater than 5, the SAR standard is 5. The proposed formula and conditions for SAR apply year-round to all waters in the Powder River watershed.

Table D-1. Proposed EC (µS/cm) standards for agricultural uses.

Waterbody	April 1–October 31 (Growing Season)	November 1–March 31 (Non-growing Season)
Tongue River	1,000	2,000
Tongue River Tributaries	500	2,000

December 6, 2002 Standards (New Proposed Standards)

Table D-2. December 6, 2002 proposed EC standards for agricultural uses.

Waterbody	March 2 – October 31 (µS/cm) (Growing Season)	November 1 – March 1 (µS/cm) (Non-growing Season)
Tongue River	1,000	2,000
Tongue River Tributaries	500	500

Table D-3. December 6, 2002 proposed SAR standards for agricultural uses.

Waterbody	March 2 – October 31 (µS/cm) (Growing Season)	November 1 – March 1 (µS/cm) (Non-growing Season)
Tongue River	3.5	5.0
Tongue River Tributaries	5.0	5.0

APPENDIX E: COMPARISON OF THE PROPOSED EC AND SAR STANDARDS

Montana Proposed EC and SAR Criteria

On August 29, 2002, the Montana Board of Environmental Review proposed numeric water quality standards for the Tongue River and the Powder River, Little Powder River, Rosebud Creek and their tributaries for electrical conductivity (EC) and sodium adsorption ratio (SAR). All available water quality data are compared to these proposed standards in the main text of this document. On December 6, 2002, the Montana Board of Environmental Review instructed DEQ to prepare a supplemental notice of rulemaking regarding the adoption of numeric water quality standards for the Tongue River, Powder River, Little Powder River, Rosebud Creek and their tributaries for EC and SAR. This supplemental notice included a revised set of numeric criteria for EC and SAR. Insufficient time was available to modify this document to include consideration of these revised criteria. Major changes included in the December 6 proposed standards are described below.

- The definition of the growing season is now March 2 – October 31. The growing season was previously defined as April 1 – October 31.
- SAR standards are now fixed numbers. SAR standards were previously calculated using a formula that incorporated the EC at the time of sampling.
- The non-growing season EC criterion for tributaries to the Tongue River is now 500 µS/cm.
- Both the EC and SAR standards are now based on monthly averages. Standards were previously treated as maximum allowable values for single samples.

A preliminary analysis of the December 6, 2002 standards is presented in the tables and figures below. These are referred to as the *"new proposed standards"* in the figures. Further analysis and discussion of these results will be presented in the final TMDL document.

Electrical Conductivity (EC)

Table E-1. Summary of EC exceedances, lower Tongue River.

Season	Salinity Criteria (µS/cm)[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	1,000	274	38	51%	40	11	28%
Non-Growing Season	2,000	124	1	1%	9	0	0%

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-2. Summary of EC exceedances, middle Tongue River.

Season	Salinity Criteria (µS/cm)[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	1,000	299	21	7%	54	1	2%
Non-Growing Season	2,000	105	0	0%	8	0	0%

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-3. Summary of EC exceedances, upper Tongue River.

Season	Salinity Criteria (µS/cm)[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	1,000	196	1	1%	42	0	0%
Non-Growing Season	2,000	76	0	0%	16	0	0%

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-4. Summary of EC exceedances, Tongue River above the Reservoir.

Season	Salinity Criteria (µS/cm)[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	1,000	145	11	8%	75	10	13%
Non-Growing Season	2,000	52	0	0%	26	0	0%

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-5. Summary of EC exceedances, Hanging Woman Creek.

Season	Salinity Criteria (µS/cm)[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	500	177	176	99%	0	NA	NA
Non-Growing Season	500	82	81	99%	0	NA	NA

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-6. Summary of EC exceedances, Otter Creek.

Season	Salinity Criteria (µS/cm)[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	500	254	253	100%	0	NA	NA
Non-Growing Season	500	90	90	100%	0	NA	NA

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-7. Summary of EC exceedances, Pumpkin Creek.

Season	Salinity Criteria (µS/cm)[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	500	76	70	92%	0	NA	NA
Non-Growing Season	500	25	21	84%	0	NA	NA

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-8. Summary of EC exceedances, Tongue River Reservoir.

Season	Salinity Criteria (µS/cm)[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	1,000	18	0	0%	0	NA	NA
Non-Growing Season	2,000	1	0	0%	0	NA	NA

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

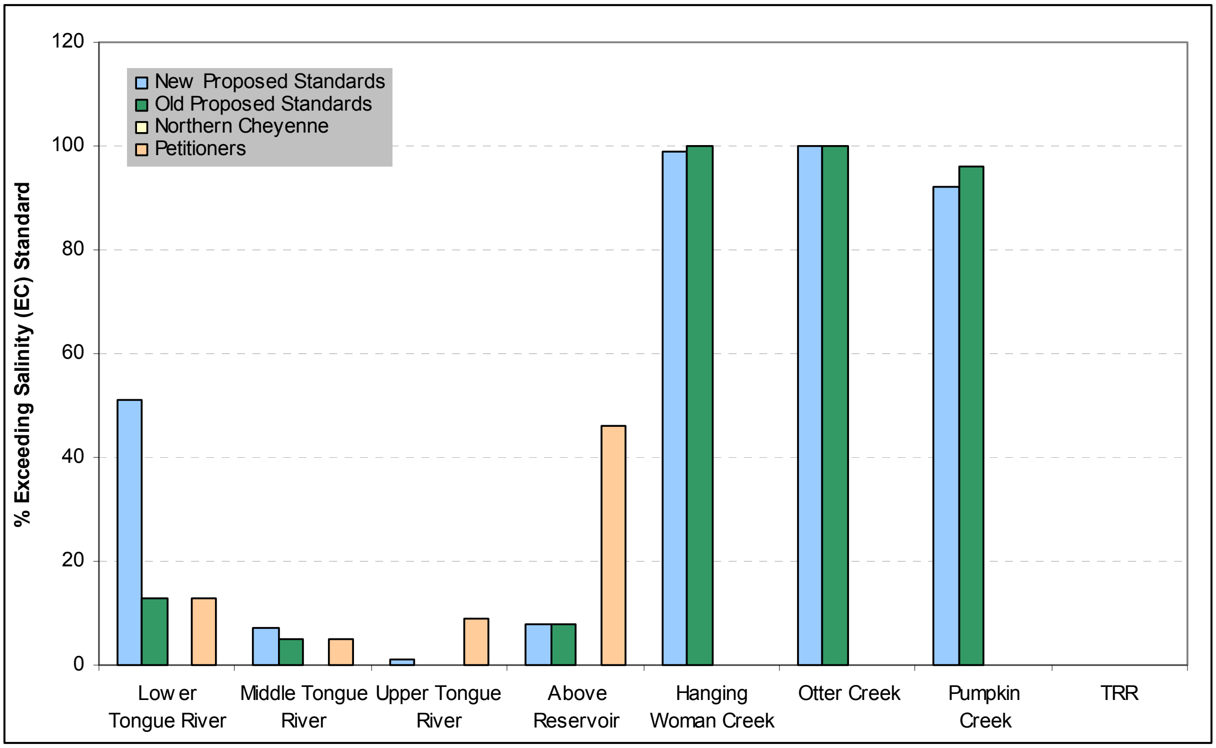

Figure E-1. Summary of salinity (EC) exceedances for the growing season.

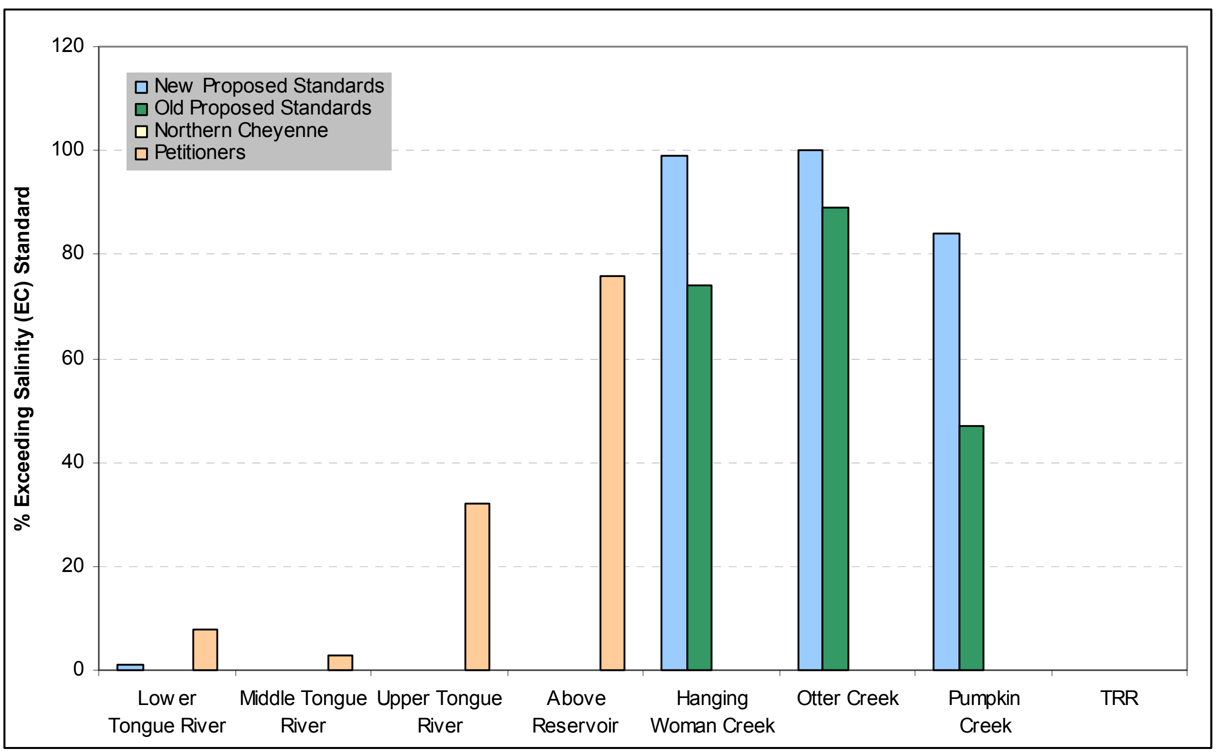

Figure E-2. Summary of salinity (EC) exceedances for the non-growing season.

SAR

Table E-9. Summary of SAR exceedances, lower Tongue River.

Season	SAR Criteria[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	3.5	155	3	2%	8	2	25%
Non-Growing Season	5.0	80	0	0%	1	0	0%

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-10. Summary of SAR exceedances, middle Tongue River.

Season	SAR Criteria[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	3.5	207	0	0%	24	0	0%
Non-Growing Season	5.0	84	0	0%	8	0	0%

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-11. Summary of SAR exceedances, upper Tongue River.

Season	SAR Criteria[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	3.5	143	0	0%	4	0	0%
Non-Growing Season	5.0	55	0	0%	0	NA	NA

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-12. Summary of SAR exceedances, Tongue River above the reservoir.

Season	SAR Criteria[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	3.5	64	0	0%	42	0	0%
Non-Growing Season	5.0	28	0	0%	21	0	0%

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-13. Summary of SAR exceedances, Hanging Woman Creek.

Season	SAR Criteria[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	5.0	153	112	73%	0	NA	NA
Non-Growing Season	5.0	66	38	58%	0	NA	NA

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-14. Summary of SAR exceedances, Otter Creek.

Season	SAR Criteria[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	5.0	181	145	80%	0	NA	NA
Non-Growing Season	5.0	63	45	71%	0	NA	NA

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-15. Summary of SAR exceedances, Pumpkin Creek.

Season	SAR Criteria[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	5.0	74	63	85%	0	NA	NA
Non-Growing Season	5.0	25	19	76%	0	NA	NA

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

Table E-16. Summary of SAR exceedances, Tongue River Reservoir.

Season	SAR Criteria[a]	# of Averaging Periods	Total # of Exceedances	Percent Exceeding	# of Averaging Periods, 1996-2002	Total # of Exceedances, 1996-2002	Percent Exceeding, 1996-2002
Growing Season[b]	5.0	4	0	0%	4	0	0%
Non-Growing Season	5.0	0	NA	NA	0	NA	NA

[a]An average value per month per station not to be exceeded.
[b]Growing season is March 2 – October 31.

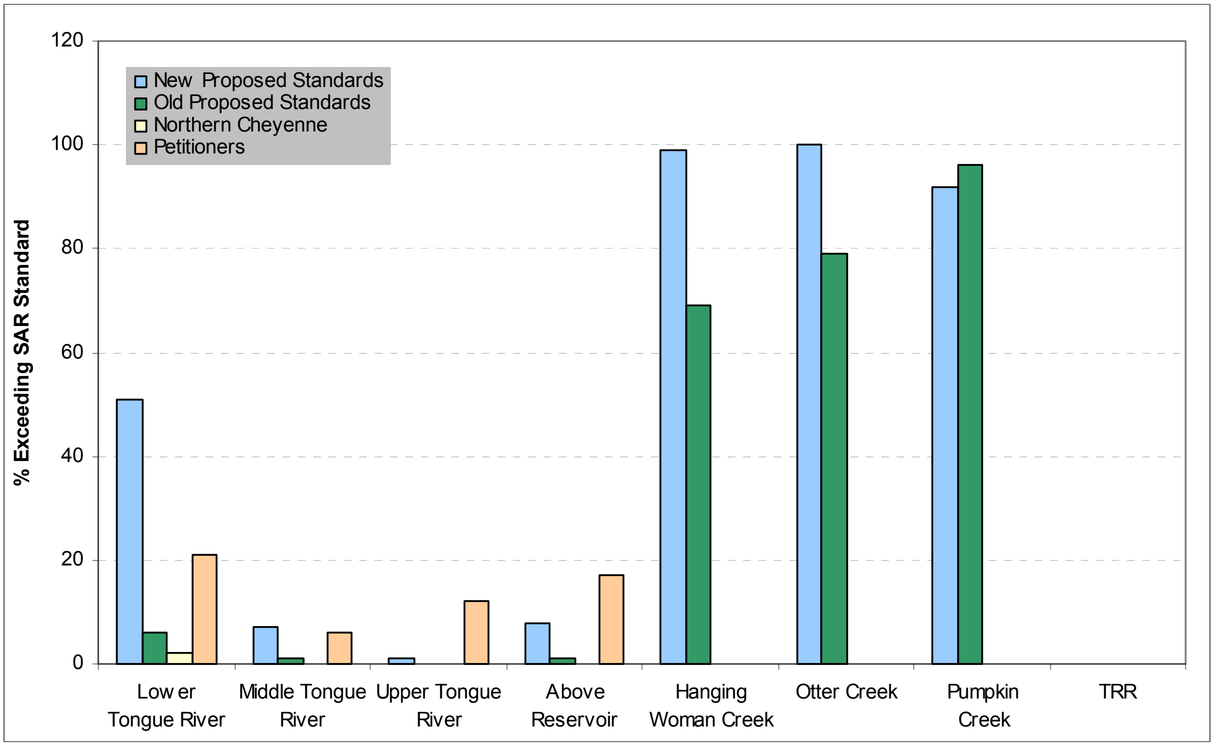

Figure E-3. Summary of SAR exceedances for the Tongue River watershed (all seasons).

APPENDIX F: COEFFICIENTS FOR CALCULATING METALS STANDARDS FOR SURFACE WATERS

COEFFICIENTS FOR CALCULATING METALS STANDARDS FOR SURFACE WATERS IN MONTANA

Table F-1. Coefficients for calculating metals standards in Montana.

Parameter	ma	ba	mc	bc
Cadmium	1.0166	-3.924	0.7409	-4.719
Copper	0.9422	-1.700	0.8545	-1.702
Chromium (III)	0.819	3.7256	0.819	0.6848
Lead	1.273	-1.46	1.273	-4.705
Nickel	0.846	2.255	0.846	0.0584
Silver	1.72	-6.52	—	—
Zinc	0.8473	0.884	0.8473	0.884

Note: If the hardness is < 25 mg/L as $CaCO_3$, the number 25 must be used in the calculation. If the hardness is greater than or equal to 400 mg/L as $CaCO_3$, 400 mg/L must be used in the calculation.

Acute Standard = exp.{ma[ln(Hardness)] + ba}
Chronic Standard = exp.{mc[ln(Hardness)] + bc}

WYOMING

Table F-2. Wyoming metals standards for hardness dependant parameters.*

Parameter	Acute	Chronic
Cadmium	e^ (1.128 [ln(hardness)]-3.6867)(CF)	e^ (0.7852 [ln(hardness)]-2.715)(CF)
Chromium (III)	e^ (0.8190 [ln(hardness)] +3.7256)(0.316)	e^ (0.8190 [ln(hardness)]+0.6848)(0.860)
Copper	e^ (0.9422 [ln(hardness)]-1.700)(0.960)	e^ (0.8545 [ln(hardness)]-1.702)(0.960)
Lead	e^ (1.273 [ln(hardness)]-1.460)(CF)	e^ (1.273 [ln(hardness)]-4.705)(CF)
Manganese	e^ (0.7693[ln(hardness)]+4.4995)	e^ (0.5434[ln(hardness)]+4.7850)
Nickel	e^ (0.8460 [ln(hardness)]+2.255)(0.998)	e^ (0.8460 [ln(hardness)]+0.0584)(0.997)
Silver	e^ (1.72 [ln(hardness)]-6.52)(0.85)	N/A
Zinc	e^ (0.8473 [ln(hardness)]+0.884)(0.978)	e^ (0.8473 [ln(hardness)]+0.884)(0.986)

*Hardness measured as mg/L $CaCO_3$. Hardness values used in these equations must be between 25 mg/L and 400 mg/L. For hardness values less than 25 mg/L, use 25. For hardness values greater than 400 mg/L use 400.

Conversion Factors: Aquatic life values for the following metals are based on dissolved amounts of each substance. Because the National Toxics Criteria (USEPA's Section 304(a) criteria) are expressed as "total recoverable" values, the application of a conversion factor is necessary to convert from "total recoverable" to "dissolved". Furthermore, the toxicity of the associated metals varies with hardness and the total recoverable value must be calculated based on the $CaCO_3$ hardness prior to multiplying by the conversion factor (CF).

Table F-3. Conversion factors for selected metals.

Metal	Acute Value	Chronic Value
Chromium (III)	0.316	0.860
Copper	0.960	0.960
Nickel	0.998	0.997
Silver	0.85	NA
Zinc	0.978	0.986

The CF for cadmium and lead are not constant but vary with hardness ($CaCO_3$). They can be calculated using the following equations:

$$\text{Cadmium Acute: CF} = 1.136672 - [(\ln \text{hardness})(0.041838)]$$

$$\text{Cadmium Chronic: CF} = 1.101672 - [(\ln \text{hardness})(0.041838)]$$

$$\text{Lead Acute and Chronic: CF} = 1.46203 - [(\ln \text{hardness})(0.145712)$$

USEPA STANDARDS

Equations for the calculation of acute and chronic standards:

$$CMC_{(dissolved)} = CF \times e^{m_a(\ln hardness)+b_a}$$

$$CCC_{(dissolved)} = CF \times e^{m_c(\ln hardness)+b_c}$$

Table F-4. USEPA equations and conversion factors for metals.

Parameter	m_a	b_a	m_c	b_c	Conversion Factors (CF)	
					Acute	Chronic
Cadmium	1.128	-3.6867	0.7852	-2.715	1.136672-[ln (hardness)(0.041838)]	1.101672-[ln (hardness)(0.041838)]
Chromium III	0.8190	3.7256	0.8190	0.6848	0.316	0.860
Copper	0.9422	-1.700	0.8545	-1.702	0.960	0.960
Lead	1.273	-1.460	1.273	-4.705	1.46203-[ln (hardness)(0.145712)]	1.46203-[ln (hardness)(0.145712)]
Nickel	0.8460	2.255	0.8460	0.0584	0.998	0.997
Silver	1.72	-6.52	—	—	0.85	—
Zinc	0.8473	0.884	0.8473	0.884	0.978	0.986