St. Joe River Subbasin Assessment and Total Maximum Daily Loads

July 2003

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Cover picture by Bijay Adams.

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Abbreviations, Acronyms, and Symbols

303(d) Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section

µ micro, one-one thousandth

µg/L micrograms per liter

§ Section (usually a section of federal or state rules or statutes)

BURP Beneficial Use Reconnaissance Program

C Celsius

CFR Code of Federal Regulations (refers to citations in the federal administrative rules)

cfs cubic feet per second

cm centimeters

CWA Clean Water Act

CWE cumulative watershed effects

DEQ Department of Environmental Quality

E. coli *Escherichia coli* bacteria

EPA United States Environmental Protection Agency

GIS Geographical Information Systems

IDAPA Refers to citations of Idaho administrative rules

IDL Idaho Department of Lands

INFISH The federal Inland Native Fish Strategy

KEA Kootenai Environmental Alliance

L liter

LA load allocation

LC load capacity

mg milligram

mi mile

mi^2 square miles

mg/L milligrams per liter

mL milliliter

mm millimeter

MOS margin of safety

MWMT maximum weekly maximum temperature

NB natural background

NTU nephlometric turbidity unit

PCR primary contact recreation

RASI Riffle Armor Stability Index

RUSLE Revised Universal Soil Loss Equation

SCR secondary contact recreation

SFI DEQ's stream fish index

SHI DEQ's stream habitat index

SMI DEQ's stream macroinvertebrate index

SS salmonid spawning

TMDL total maximum daily load

U.S. United States

USC United States Code

USFS United States Forest Service

USGS United States Geological Survey

WAG Watershed Advisory Group

WBAGII *Water Body Assessment Guidance*, Version II

WET whole effluence toxicity

WLA waste load allocation

WQLS water quality limited segment

WQS water quality standard

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters (33 USC § 1251.101). States and tribes, pursuant to Section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the water bodies in the St. Joe River subbasin that have been placed on what is known as the "303(d) list."

This subbasin assessment and TMDL analysis has been developed to comply with Idaho's TMDL schedule. This assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the St. Joe River subbasin located in the Idaho Panhandle. The first part of this document, the subbasin assessment, is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's current 303(d) list of water quality limited water bodies. Seventeen segments of the St. Joe River subbasin were listed on this list. The subbasin assessment portion of this document examines the current status of 303(d) listed waters. It also defines the extent of impairment as well as causes of water quality limitation throughout the subbasin. The loading analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance

Hydrologic Unit Code 17010304

Water Quality Limited Segments..17

Beneficial Uses Affected................Cold water, salmonid spawning, primary and secondary contact recreation

Pollutants of Concern...................Sediment, nutrients, bacteria, dissolved oxygen, temperature

Known Land Uses..........................Forestry, agriculture, recreation

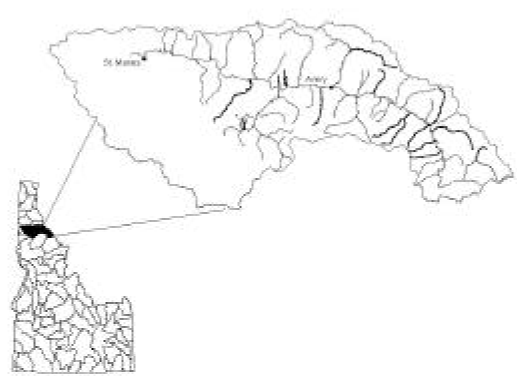

Figure A. St. Joe River Subbasin Location and Listed Segments

Key Findings

The St. Joe River watershed remained in a relatively natural condition until the early twentieth century when miners, loggers, and ranchers began to settle in the area. The watershed has a history of timber harvest and some grazing, which, in recent years, has been restricted to the floodplain of the lower river. Seventeen streams of the subbasin are 303(d) listed for sediment, temperature, habitat alteration, nutrients, bacteria, and dissolved oxygen. Twelve of the seventeen listed segments are listed for temperature, eight segments are listed for sediment, five segments are listed for bacteria, three segments are listed for dissolved oxygen, and one segment each are listed for plant growth nutrients and habitat alteration. The sediment in the subbasin is primarily from road crossing and encroachment. Temperature can be most affected by stream shading. Nutrients and bacteria come mainly from livestock, while dissolved oxygen is affected by discharge of oxygen demanding materials that, in the St. Joe River subbasin, would come from livestock wastes. Impairment of cold water use was assessed using composite scores of fish, macroinvertebrate, and habitat indices. These scores generally indicate full support in most streams assessed in the subbasin, but they also indicate use impairment in some tributaries to the river. Fishhook, Bear, Blackjack, Bond, and Norton Creeks, and tributaries to Marble Creek have index scores below the threshold of full support. The St. Joe River itself was not listed nor was it found to be impaired in this assessment.

An assessment of temperature data indicates that all streams assessed exceed at least one of the temperature standards. Dissolved oxygen and bacteria were not found limiting in Blackjack, Harvey, or Tank Creeks, while bacteria were also not found to be limiting in Bear and Little Bear Creeks. These listings were likely made 15 years ago when grazing was practiced in these watersheds. Habitat alteration is not an effect that can be allocated in a TMDL. Nutrient data from Gold Creek remains to be assessed after control areas are monitored. Sediment yield monitoring indicates that Mica, Bear, and Fishhook Creeks are at sediment yield levels above that expected to cause water quality impairment, as are Hugus, Eagle, Boulder, and Lower Marble Creeks. The low pool volumes in the Marble Creek tributaries may be the result of splash dam log transport and the low index scores may be the result of temperature impairments. These issues require additional assessment. The assessment resulted in temperature TMDLs for all the segments listed for temperature (Table A). Sediment TMDLs were completed for Mica, Fishhook, and Bear Creeks (Table A). Recommendations for the delisting of streams and pollutants is provided in Table B.

Table A. Streams and pollutants for which TMDLs were developed.

Stream	Segment ID Number	Assessment Unit	1998 303(d) Boundaries	Pollutant(s)
Bear/Little Bear Creeks	7606/7607	PN033_02	Headwaters to Toles Creek	Sediment/ Temperature
Beaver Creek	5619	PN025_02/ PN048_02	Headwaters to St. Joe River	Temperature
Blackjack Creek	7577	PN027_02	Headwaters to St. Joe River	Temperature
Bluff Creek	5022	PN045_02	Headwaters to St. Joe River	Temperature
Fishhook Creek	3608	PN039_04	Lick Creek to St. Joe River	Sediment/ Temperature
Fly Creek	2016	PN041_02	Headwaters to St. Joe River	Temperature
Gold Creek	3622	PN053_02	East Fork Gold Creek to St. Joe River	Temperature
Harvey Creek	7576	PN027_02	Lick Creek to St. Joe River	Temperature
Heller Creek	2017	PN041_02	Headwaters to St. Joe River	Temperature
Loop Creek	5620	PN060_02/03	Headwaters to St. Joe River	Temperature
Mica Creek	3601	PN030_03	Headwaters to St. Joe River	Sediment
Mosquito Creek	2020	PN046_02	Headwaters to St. Joe River	Temperature
Simmons Creek	2022	PN052_02/03	Headwaters to St. Joe River	Temperature
Tank Creek	7575	PN027_02	Headwaters to St. Joe River	Temperature

Table B. Summary of assessment outcomes.

Water Body Segment	Pollutant	TMDLs Completed/ Required	Recommended Changes to 303(d) List	Recommended Schedule Changes	Justification[1]
Bear/ Little Bear Creeks	bacteria	0	delist for bacteria	none	bacteria monitoring results
Bear/Little Bear Creeks	sediment	1	none	none	N/A
Bear/ Little Bear Creeks	temperature	1	none	none	N/A
Bird Creek	sediment	0	delist for sediment	none	WBAGII and sediment model results
Blackjack Creek	dissolved oxygen	0	delist for dissolved oxygen	none	dissolved oxygen monitoring results
Blackjack Creek	bacteria	0	delist for bacteria	none	bacteria monitoring results
Blackjack Creek	sediment	0	delist for sediment	none	SHI and sediment model results
Blackjack Creek	temperature	1	none	none	N/A
East Fork Bluff Creek	sediment	0	delist for sediment	none	WBAGII and sediment model results
Fishhook Creek	sediment	1	none	none	N/A
Fishhook Creek	temperature	1	none	none	N/A
Gold Creek	habitat alteration	0	none	none	TMDLs not developed for habitat alteration
Gold Creek	nutrients	0	delist for nutrients	none	nutrient monitoring results
Gold Creek	sediment	0	delist for sediment	none	WBAGII and sediment model results
Gold Creek	temperature	1	none	none	N/A
Harvey Creek	dissolved oxygen	0	delist for dissolved oxygen	none	dissolved oxygen monitoring results
Harvey Creek	bacteria	0	delist for bacteria	none	bacteria monitoring results
Harvey Creek	sediment	0	delist for sediment	none	WBAGII and sediment model results
Harvey Creek	temperature	1	none	none	N/A
Loop Creek	sediment	0	delist for sediment	none	SFI and sediment model results

Table B, continued.

Water Body Segment	Pollutant	TMDLs Completed/ Required	Recommended Changes to 303(d) List	Recommended Schedule Changes	Justification
Loop Creek	unknown	0	delist for unknown	none	no evidence of unknown pollutant found
Mica Creek	sediment	1	none	none	N/A
Tank Creek	dissolved oxygen	0	delist for dissolved oxygen	none	dissolved oxygen monitoring results
Tank Creek	bacteria	0	delist for bacteria	none	bacteria monitoring results
Tank Creek	sediment	0	delist for sediment	none	sediment model results
Tank Creek	temperature	1	none	none	N/A

[1]WBAGII – *Water Body Assessment Guidance*, Version II; SFI – stream fish index; SHI – stream habitat index.

1. Subbasin Assessment – Watershed Characterization

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters (33 USC § 1251.101). States and tribes, pursuant to Section 303 of the CWA are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list of impaired waters, currently every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the water bodies in the St. Joe River subbasin that have been placed on what is known as the "303(d) list."

The overall purpose of this subbasin assessment and TMDL is to characterize and document pollutant loads within the St. Joe River subbasin. The first portion of this document, the subbasin assessment, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Chapters 1 – 4). This information will then be used to develop a TMDL for each pollutant of concern for the St. Joe River subbasin (Chapter 5).

1.1 Introduction

In 1972, Congress passed public law 92-500, the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Pollution Control Federation 1987). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt, with EPA approval, water quality standards and to review those standards every three years. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish TMDLs for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses. These requirements result in a list of impaired waters, called the "303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. A subbasin assessment and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the 303(d) list. *St. Joe River Subbasin Assessment and TMDLs* provides this summary for the currently listed waters in the St. Joe River subbasin.

The subbasin assessment section of this report (Chapters 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the St. Joe River subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (40 CFR, Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also includes individual pollutant allocations among various sources discharging the pollutant. The EPA considers certain unnatural conditions, such as flow alteration, a lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." A TMDL is not required for a water body impaired by pollution, but not specific pollutants. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards and include:

-- Aquatic life support – cold water, seasonal cold water, warm water, and salmonid spawning

-- Contact recreation – primary (swimming), secondary (boating)

-- Water supply – domestic, agricultural, industrial

-- Wildlife habitats, aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitat, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water and primary contact recreation are used as additional default designated uses when water bodies are assessed.

A subbasin assessment entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data to address several objectives:

-- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).

-- Determine the degree of achievement of biological integrity.

-- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.

-- When water bodies are not attaining water quality standards, determine the causes and extent of the impairment.

The St. Joe River subbasin (Hydrologic Unit Code 17010304) is a large watershed composed of both the St. Joe River and the St. Maries River. The primary land uses of the St. Joe River subbasin are forestry and recreation, while considerably more agriculture and garnet mining occur along the St. Maries River. The lower St. Joe River watershed lies within the Coeur d'Alene Reservation boundary. For the purposes of scheduling, assessment of the St. Joe River portion of the watershed was begun in 2000, while the assessment of the St. Maries River portion occurred in the year 2001. The current assessment deals with those water quality limited segments that are tributaries to the St. Joe River, except the St. Maries River and Benewah Creek. Benewah Creek is located within the boundary of the Coeur d'Alene Reservation. Development of a TMDL for Benewah Creek falls under the jurisdiction of the EPA. The St. Maries River is addressed in St. Maries River Subbasin Assessment and Total Maximum Daily Loads (DEQ 2002).

1.2 Physical and Biological Characteristics

The St. Joe River and its tributaries drain the entire watershed above the confluence with the St. Maries River at the city of St. Maries (Figure 1; section 303(d) listed water bodies are highlighted in blue). The river drains the southern slopes of the St. Joe Mountains, the western slope of the Bitterroot Range and the northern slopes of the Clearwater Mountains. The watershed encompasses 1,192 square miles above St. Maries, Idaho.

Climate

Northern Idaho is located in the Northern Rocky Mountain physiographic region to the west of the Bitterroot Range. The St. Joe and Clearwater Mountains, which the St. Joe River drains, are a part of the Bitterroot Range. The local climate is influenced by Pacific maritime air masses from the west, as well as continental air masses from Canada to the north and the Great Basin to the south. The annual weather cycle generally consists of cool to warm summers with cold and wet winters. The relative warmth of winters depends on the dominance of the warmer, wetter Pacific or cooler dryer continental air masses. The relative warmth of summers depends on the dominance of the warmer, dryer Great Basin or cooler wetter Pacific air masses. Precipitation is greatest during the winter months.

For the city of St. Maries for a period of record from 1897 to 2001, the average annual maximum temperature was 59.6 ^{o}F and the average annual minimum temperature was 35.5 ^{o}F (Inside Idaho 2002). For the same time period, the month with the lowest average maximum (49.3 ^{o}F) and lowest average minimum (22.2 ^{o}F) temperature was January. July had the highest average annual minimum temperature (34.8 ^{o}F) and the highest average annual maximum temperature (84.8 ^{o}F). For the town of Avery for a period of record from 1968 to 2001, the average annual maximum temperature was 57.0 ^{o}F and the average annual minimum temperature was 35.6 ^{o}F (Inside Idaho 2002). These temperatures were recorded at the United States Forest Service's Avery Ranger Station, built in 1968. For the same time period, the month with the lowest average maximum (30.2 ^{o}F) and lowest average minimum (20.6 ^{o}F) temperature was January. July had the highest average annual minimum temperature (49.4 ^{o}F) and August the highest average annual maximum temperature (83.7 ^{o}F). The Ranger station built in 1968 replaced an earlier ranger station at a different location. A weather station operated at the earlier Avery Ranger Station from 1913 to 1968. The average annual maximum temperature recorded at that station was 60.1 ^{o}F and the average annual minimum temperature was 34.2 ^{o}F. For the same time period, the month with the lowest average maximum (34.0 ^{o}F) and lowest average minimum (20.3 ^{o}F) temperature was January. July had the highest average annual minimum temperature (47.6 ^{o}F) and the highest average annual maximum temperature (80.0 ^{o}F).

Although intervening mountain ranges progressively dry the Pacific maritime air masses, these air masses deposit appreciable moisture primarily as snow on the St. Joe River watershed. Maritime air masses originating in the mid-Pacific are relatively warm, often yielding their precipitation as rain. The watershed is generally between 3,000 and 6,000 feet (915 and 1829 meters) in elevation with 47% of the watershed in the rain-on-snow elevation range of 3,300 to 4,500 feet (1006 and 1372 meters). Below 3,300 feet, the snow pack is transitory, while above 4,500 feet the snow pack is sufficiently cool that warming by a maritime front is insufficient to cause a significant thaw. In the rain-on-snow elevation range (3,300 - 4,500 feet), a heavy snow pack accumulates each winter. A warm maritime front can sufficiently warm the snow pack making it isothermal and capable of yielding large volumes of water to a runoff event. With 47% of the watershed in the rain-on-snow elevation range, it is less sensitive to high discharge episodes than watersheds with higher percentage of slopes in this zone.

Weather data from the city of St. Maries show that the 105-year average annual precipitation from 1897 to 2001 was 28.4 inches (Inside Idaho 2002). December exhibited the largest amount of precipitation at 3.93 inches and July the lowest amount of precipitation at 0.98 inches. Data from Avery show that the 34-year average annual precipitation from 1968 to 2001 was 37.6 inches. January exhibited the largest amount of precipitation at 5.83 inches and August the lowest amount of precipitation at 1.33 inches.

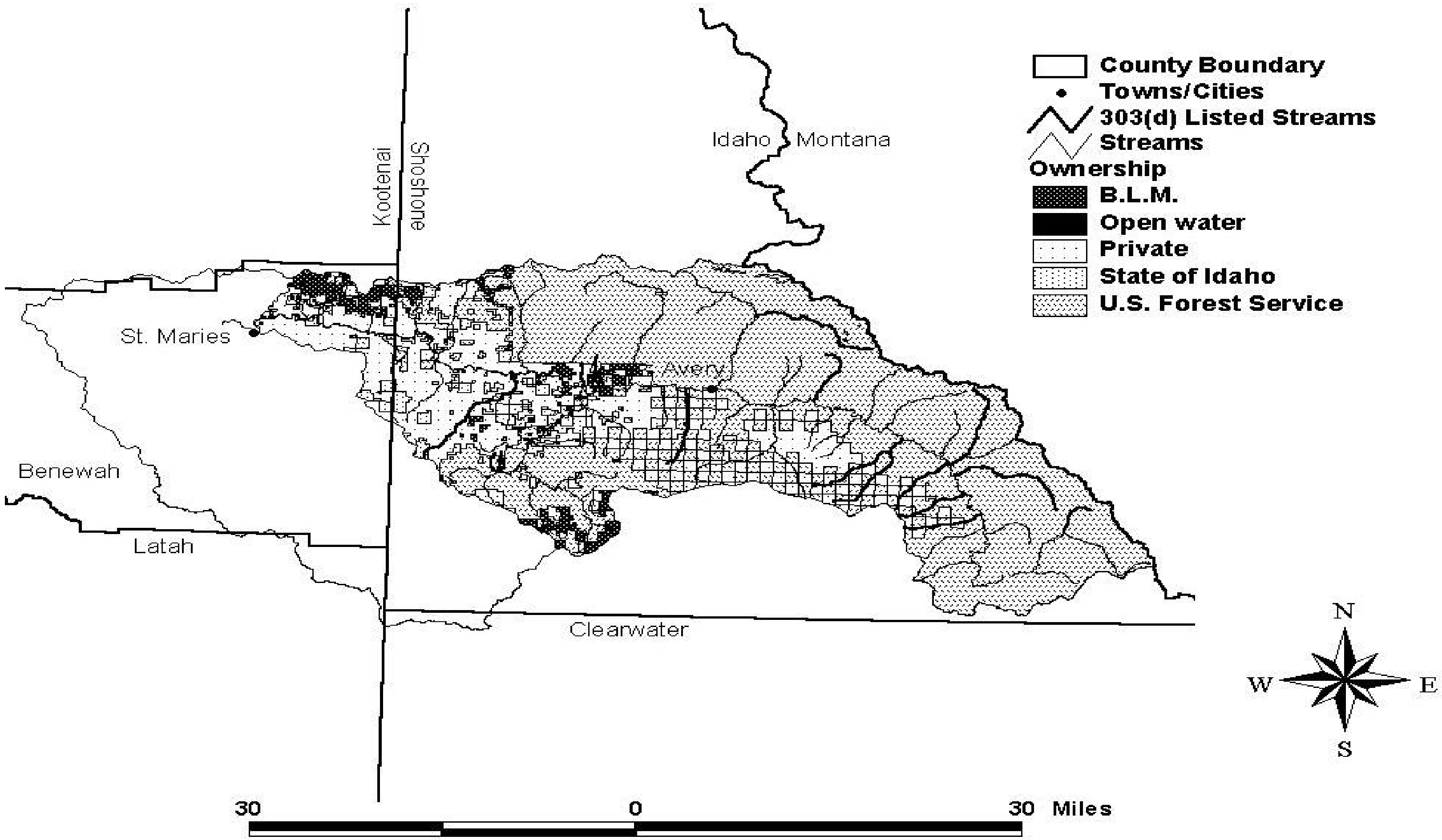

Figure 1. St. Joe River Subbasin

Subbasin Characteristics

The St. Joe River and its tributaries drain the entire watershed above the confluence with the St. Maries River at the city of St. Maries (Figure 1). The river drains the southern slopes of the St. Joe Mountains, the western slope of the Bitterroot Range, and the northern slopes of the Clearwater Mountains. The watershed encompasses 1,192 square miles above St. Maries, Idaho.

-- Hydrography

The U.S. Geological Survey (USGS) has continuously operated the Calder Gaging Station since July 1920. Weather stations have operated at the St. Maries Ranger Station in the city of St. Maries since 1897 and at two ranger stations near the town of Avery, one from 1913 to 1968 and the other since 1968 (Figure 2).

-- Geology and Soils

The St. Joe River drains the St. Joe and Clearwater Mountains, subsets of the Bitterroot Mountains. The mountains are primarily composed of metasedimentary rocks of the Proterozoic Belt Supergroup. Granitic intrusions exist in some areas. The largest of these is the Roundtop pluton located in the Fishhook and Sisters watersheds. Bottoms of steep valleys and gulches are composed of colluvial deposits. Unlike the Coeur d'Alene Mountains to the north, the St. Joe, Clearwater, and Bitterroot Mountains were glaciated, but not covered by ice sheets. In the broader floodplain of the lower St. Joe River, alluvial materials worked by the river comprise the valley bottoms. The lower reaches of the St. Joe River are located on lacustrine deposits of the Miocene Coeur d'Alene Lake. Several wetlands and a few lateral lakes occur in the lower river valley above the city of St. Maries.

The mountain slopes are generally underlain by silty to silt loam podsolic soils developed under cool conditions. Sandy granitic soils occur in the Roundtop area. Volcanic ash deposits are variably found in the soil mantle. The soil mantle is generally thin on slopes, with A and B horizons (topsoil and subsoil layers) of 3 to 4 inches. The soil mantle generally decreases with altitude. Soils in the bottom lands are commonly silty to sandy podsols developed under upland forests. Near streams and in some pockets, black mucky soils exist where red cedar (*Thuja plicata*) stands are the dominant vegetation.

-- Topography

The St. Joe River flows from east to the west to enter Coeur d'Alene Lake near Conkling Point. The ranges have high, massive mountains, and deep, dissected intermountain valleys. Valleys reach down to 2,200 feet while most mountains reach over 5,000 feet. Peaks on the Bitterroot Divide, and some Clearwater Mountains, range to well over 6,000 feet. The land is steep, but generally stable. Mass failures are not a typical feature of the land in this area, but are specific to a few land types located primarily on granitic land forms and in the valley bottoms. The aspect of the St. Joe River valley is generally west facing. Tributary valleys have a predominance of north and south facing aspects.

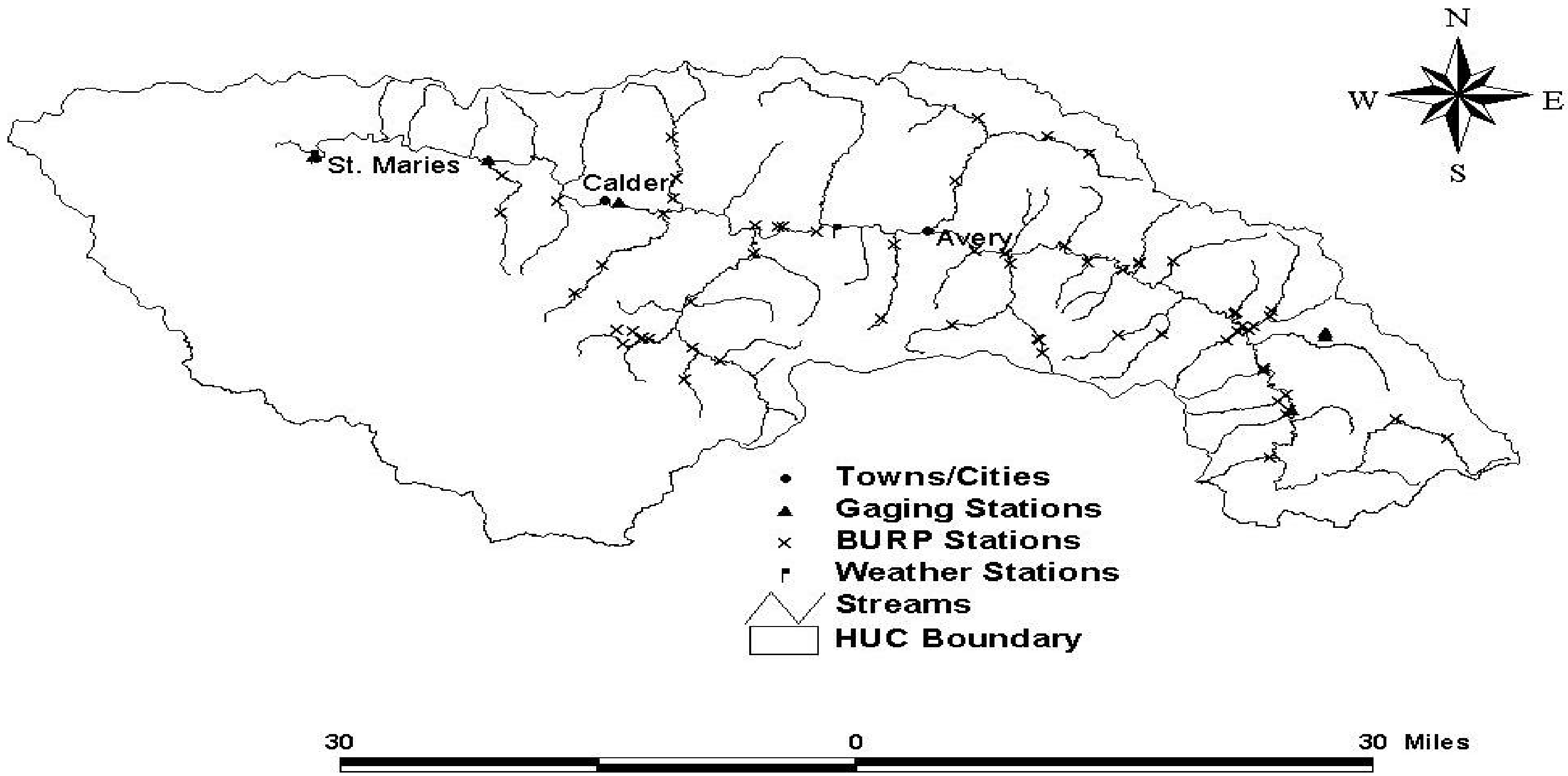

Figure 2. St. Joe River Subbasin Showing Locations of Gaging, BURP, and Weather Stations

-- Vegetation

The mountain slopes are mantled with mixed coniferous forest of true fir (*Abies spp.*), Douglas fir (*Pseudotsuga menziesii*), larch (*Larix spp.*), and pine (*Pinus spp.*). Forest harvest has occurred at significant levels in all watersheds of the basin. Rivers and streams are flanked by riparian stands dominated by cottonwood (*Populus spp.*) at lower elevations and alder (*Alnus spp.*) in the higher valleys. The lower St. Joe River valley floor is comprised of lacustrine deposits. These lands have been converted to pasture to varying degrees. Lateral wetlands are found in the lower river floodplain. Aquatic vegetation, such as rush (*Juncus spp.*), sedge (*Carex spp.*), and cattail (*Typha latifolia*), are common in these wetlands. Some floodplain fields have been converted to the cultivation of wild rice (*Zizania spp.*).

-- Fisheries and Aquatic Fauna

The native salmonids of the subbasin's streams are cutthroat trout (*Oncorhynchus clarki*), bull trout (*Salvelinus confluentus*), and mountain whitefish (*Prosopium williamsoni*). The upper St. Joe River above Prospector Creek has the last self-sustaining bull trout population in the Coeur d'Alene Basin. Sculpin (C*ottus spp.*) and shiners (*Notropis spp.*) are non-salmonid natives. The tailed frog (*Ascaphus truei*), Idaho giant salamander (*Dicamptodon aterrimus*), and painted turtle (*Chrysemys picta*) complete the vertebrate species. Fish populations in the river and some of its tributaries have been altered by the introduction of rainbow trout (*Oncorhynchus mykiss*) and brook trout (*Salvelinus fontinalis*), as well as Chinook salmon (*Oncorhynchus tshawytscha*) and Kokanee salmon (*Oncorhynchus nerka*). Pike (*Esox lucius*) and small mouth bass (*Micropterus dolomieu*) are present in the lower St. Joe River. Introduced species have been able to establish in some habitats at lower elevations, while higher elevation water bodies tend to retain native trout. Fish composition and abundance appear stable in the headwaters.

Idaho considers cutthroat trout a sensitive species. Bull trout are federally listed as a threatened species. Bull trout are present in a self-sustaining population in the subbasin. A bull trout recovery area was delineated in 1996. It extends from the headwaters of the St. Joe River to the mouth of Mica Creek (Batt 1996). No other sensitive, threatened, or endangered aquatic species are known to exist in the subbasin.

The salmonids of the St. Joe subbasin spawn in both the spring and the fall. Cutthroat trout spawn after peak snowmelt runoff in the spring. While actual spawning dates vary from year to year, cutthroat spawning generally occurs from March through late July. Bull trout and mountain whitefish are spawn in the fall. As designated in the State of Idaho Bull Trout Conservation Plan (Batt 1996), the fall spawning period is September 1 through October 31.

Subwatershed Characteristics

The subwatershed characteristics are summarized in Table 1.

Table 1. Watershed characteristics of the fifth order watersheds of the St. Joe River subbasin.

Fifth Order Watershed	Area (acres)	Land Form	Dominant Aspect	Relief Ratio[1]	Mean Elevation (meters)	Dominant Slope	Hydrologic Regimes	Estimated Water Yield (acre-feet/year)	Mass Wasting Potential
Bond-Falls	69,844	Mountainous	West	0.014	1,010	40%	Spring snowmelt; Rain-on-snow	1,806,511	Low
Hugus-Trout	41,716	Mountainous	West	0.016	1,023	40%	Spring snowmelt; Rain-on-snow	1,078,965	Low
Big	36,251	Mountainous	South	0.013	1,210	40%	Spring snowmelt; Rain-on-snow	937,635	Low
Black Prince	29,600	Mountainous	South	0.003	1.057	40%	Spring snowmelt; Rain-on-snow	765,586	Low
Mica	26,108	Mountainous	East	0.013	1,182	20-30%	Spring snowmelt; Rain-on-snow	675,266	Low
Slate	42,824	Mountainous	West	0.011	1,335	40%	Spring snowmelt; Rain-on-snow	1,107,626	Low
Upper Marble	38,580	Mountainous	East	0.007	1,520	20-30%	Spring snowmelt	997,864	Low
Marble	53,300	Mountainous	East	0.008	1,279	20-30%	Spring snowmelt; Rain-on-snow	1,378,592	Low
Fishhook	58,830	Mountainous	East	0.009	1,248	40%	Spring snowmelt; Rain-on-snow	1,521,616	Low
North Fork St. Joe	73,071	Mountainous	South	0.015	1,384	40%	Spring snowmelt; Rain-on-snow	1,889,955	Low
Sisters	43,621	Mountainous	West	0.010	1,401	40%	Spring snowmelt; Rain-on-snow	1,128,251	Low/ Moderate
Prospector-Eagle	36,850	Mountainous	West	0.009	1,355	40%	Spring snowmelt; Rain-on-snow	953,109	Low
Bluff-Gold	81,811	Mountainous	South	0.014	1,470	40%	Spring snowmelt; Rain-on-snow	2,116,026	Low
Beaver-Simmons	80,830	Mountainous	South	0.009	1,498	40%	Spring snowmelt; Rain-on-snow	2,090,50	Low
Upper St. Joe	49,331	Mountainous	West	0.011	1,684	40%	Spring snowmelt; Rain-on-snow	1,275,925	Low

[1] $R_h = H/L$, where H is the difference between the highest and lowest point in the basin and L is the horizontal distance along the longest dimension of the basin parallel to the main stream line.

Stream Characteristics

Tributaries to the St. Joe River generally have V-shaped valleys as a result of the deeply dissected nature of the topography in their upper reaches. Near the valley bottoms, the tributaries are even higher in gradient as they plunge to meet the St. Joe River. The tributary valleys accommodate primarily Rosgen A and high gradient B channels in the upper watersheds and often Rosgen A channels near their mouths. The tributaries are generally bound by boulder-bedrock substrate. The Belt Supergroup bedrock underlies much of the subbasin. Soils are fairly rich in coarse fragments (65%) and rather poor in fine materials (35%) in most watersheds assessed. However, some watersheds with soils evenly divided between coarse and fine materials were found and a few had a preponderance of fine materials. As a result of the soil composition and the steep tributary gradients, boulders and cobble comprise the majority of the stream sediment particles. Width to depth ratios are low in these streams. Floodplains are narrow in uppermost tributary channels. Riparian communities, correspondingly, are narrow in the narrow valleys.

The upper reaches of the St. Joe River valley have U-shaped valleys resulting from glacial activity. The river valley narrows in the vicinity of the Marble Creek confluence. Width to depth ratios are generally low above this point. As the stream passes from Marble Creek to Pollard Creek the valley widens and deposits of sediment bars become apparent in the river. A lower gradient allows the deposition of coarse sediments through this reach. The river valley widens progressively as the river moves west towards the city of St. Maries and its confluence with the St. Maries River. The hydraulic influence of the Post Falls Dam on the Spokane River outlet of Coeur d'Alene Lake occurs at St. Joe City. The channel is a very low gradient Rosgen F channel that meanders through a broad floodplain with some lateral wetlands. The channel is 15 feet deep in most locations and 30 to 40 feet deep in meander bends. Silts dominate the sediment of the river throughout its lower course. Along most of the river, floodplains are broad with broad corresponding riparian communities. The river channel and floodplain morphology remains unchanged below the city of St. Maries. The lateral lakes of the river (Benewah, Round, Chatcolet, and Hidden) are commingled much of the year with Coeur d'Alene Lake as a result of the Post Falls impoundment.

1.3 Cultural Characteristics

The St. Joe River subbasin has timber and some range land resources. These natural resources have been developed since the early 1900s.

Additionally, the Coeur d'Alene Tribe's aboriginal territory takes in all of the St. Joe and St. Maries watersheds. Today, the Coeur d'Alene Tribal people return to this land just like their ancestors did to hunt, gather, and practice cultural traditions. The Coeur d'Alene's used these waters for subsistence living in the past and will continue to do so in the future.

Land Use

Land use of the St. Joe River subbasin is shown in Figure 3. Land use is divided between the uplands and the valley bottoms of the lower river. The uplands are forested, while the valley bottoms of the lower river are used for grazing and a small amount of rice growing.
The forested land is in multiple ownership with varying management directions. National Forest land is managed for multiple resource outputs (timber, water, and recreation). State forestland is managed for timber to support the state School Trust Fund. Commercial forestland is managed primarily for timber production. A considerable amount of forestland is in private ownership. These lands are managed for several resource outputs.

Grazing lands are located in the bottomlands along the St. Joe River below Calder.

Land Ownership, Cultural Features, and Population

Management of the 762,766-acre (1,192 square mile) watershed, is divided among United States Forest Service (USFS) managed land (521,398 acres; 68.2%); private owners, which are primarily timber companies of Idaho, (192,977 acres; 25.3%); Bureau of Land Management (29,485 acres; 3.9%); state (18,074 acres; 2.4%); open water (1,095 acres; 0.1%); and Bureau of Indian Affairs (478 acres; <0.1%) (IDL GIS Database). Private property, exclusive of those owned by timber companies, is primarily bottomlands along the lower St. Joe River near St. Joe City and the town of Calder, plus a few scattered parcels that are typically patented mining claims. The majority of the upper watershed is part of the St. Joe National Forest. The Mica, Marble, and Fishhook Creek watersheds supported large logging operations during the early part of the twentieth century.

The St. Joe River subbasin is in Benewah and Shoshone Counties. The population of Benewah County is approximately 9,200. Roughly half of its residents live in the subbasin. St. Maries is the largest town in the subbasin and is the Benewah county seat. It has a population of 2,500. The Shoshone County population is 13,771. Relatively few people reside in the Shoshone County part of the subbasin. The population of the subbasin is stable. Three small towns, St. Joe City, Calder, and Avery, are located in the St. Joe River subbasin. None of these has a population in excess of 50. Resident and seasonal populations are sparse in the remainder of the watershed. The subdivision of pastures along the lower St. Joe River into summer recreational vehicle parks has increased summer occupancy in these areas in recent years.

Seasonal and permanent homes, as well as recreational vehicle camps, are located in bottomlands along the lower river. Sixteen recreation areas (primarily picnic areas and campgrounds) and five national recreational trails are located in the watershed. The Milwaukee-Chicago-St. Paul railroad grade near Loop Creek has been converted into a bicycle trail. The St. Joe River above the Spruce Tree campground is designated as a wild river, while the entire river is designated a scenic river.

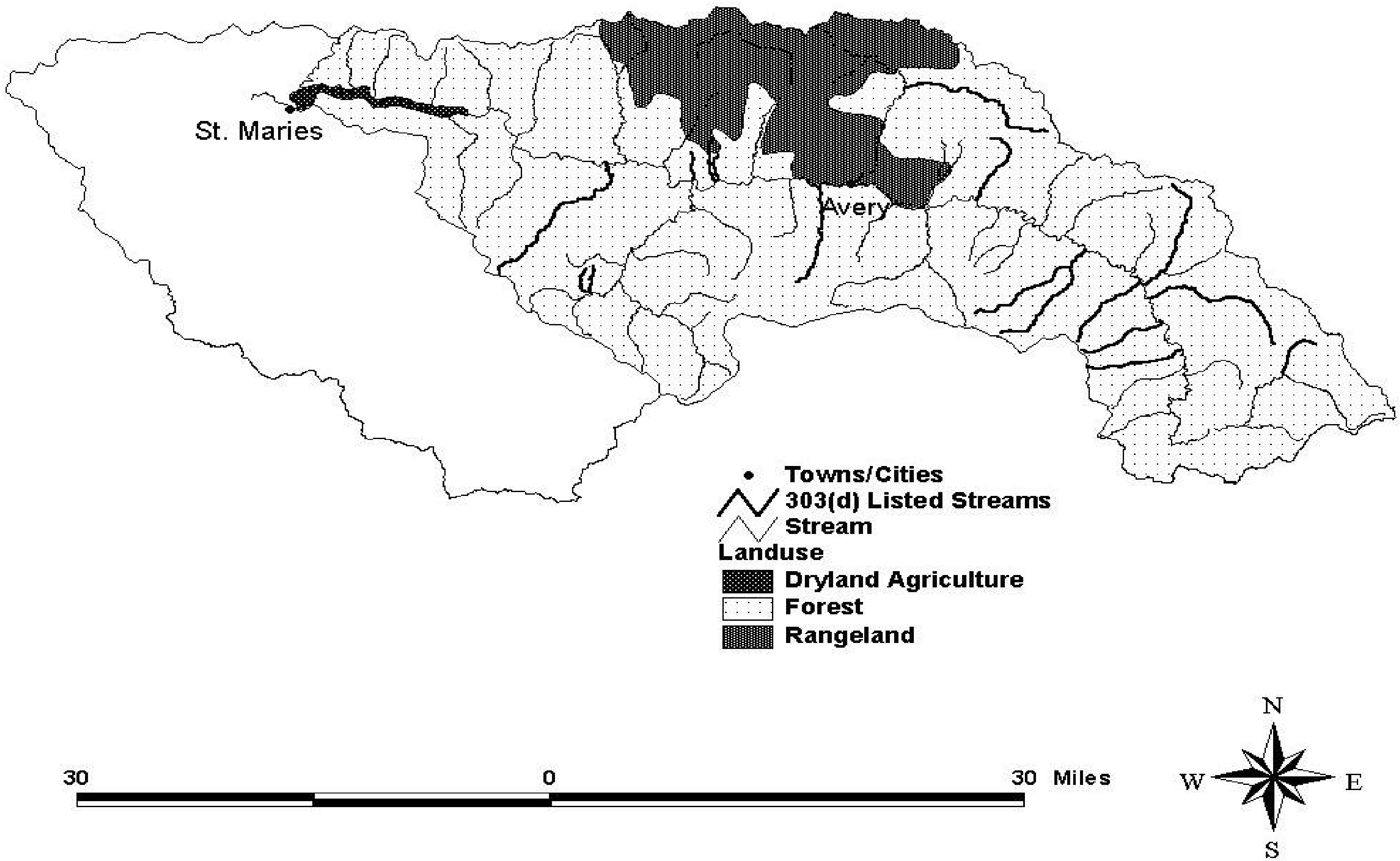

Figure 3. Land Use in the St. Joe River Subbasin

History and Economics

The St. Joe River subbasin was settled and developed during the early decades of the twentieth century (Russell 1979). Grazing is now restricted to the lower river valley. Minor grazing impacts occurred in the watershed in the past. Mineral extraction occurs at some sites throughout the watershed. The upper portion of the St. Joe River subbasin was heavily burned in the fire of 1910. Some unburned watersheds within the subbasin have sustained appreciable timber harvest during the twentieth century. Mica, Marble, and Fishhook Creeks, in particular, were logged heavily in the past. Logging companies initially used the waterways as the log transport system. A system of log flumes, splash dams, and log drives was used to move logs to mills near the city of St. Maries. The splash dams and log drives caused severe structural disruptions to the streams. Railroad logging was also practiced in some watersheds. Later, roads were built in the stream bottoms, fundamentally altering stream gradient and stability.

From the 1940s to the 1970s, timber harvest depended on an extensive road network. Logging with early jammer systems necessitated roads at approximately 100-yard intervals on slopes. The result is a network of roads that intercepts the subbasin's natural drainage system at numerous locations (Figure 4). The mid-century harvests also relied heavily on clear-cut prescriptions. Despite this, impacts from old road systems and logging are not widespread.

The Benewah Soil and Water Conservation District has been active in addressing soil and water conservation issues in the subbasin for many years. The agency has also been active in stream bank stabilization efforts. They have recently formed the core of the St. Joe River subbasin Watershed Advisory Group (WAG) along with representatives of the Coeur d'Alene Tribe, Idaho Department of Fish and Game, Idaho Department of Lands (IDL), Potlatch Company, Emerald Creek Garnet Company, and the USFS. The St. Joe WAG is providing input regarding the St. Joe River and St. Maries River subbasin assessments and will advise DEQ on required TMDLs and implementation plans.

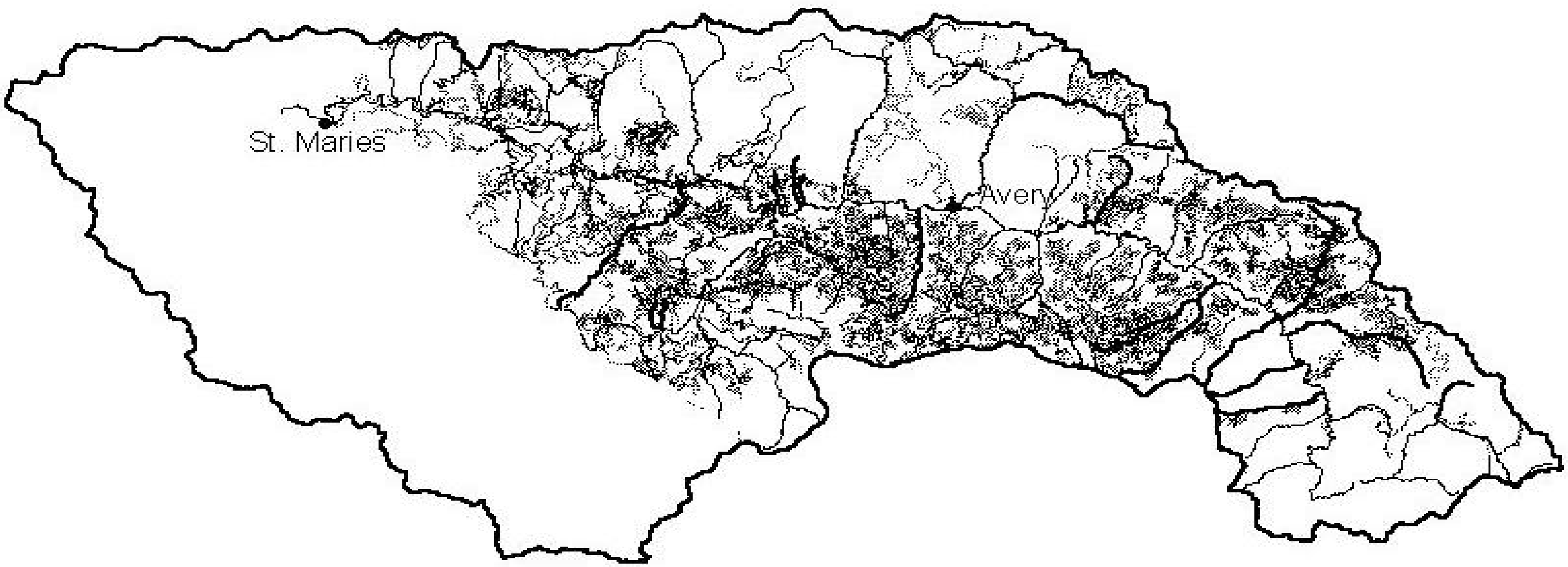

Figure 4. Roads and Road Crossings of Streams in the St. Joe River Subbasin

2. Subbasin Assessment – Water Quality Concerns and Status

The St. Joe River and most of the stream segments in its watershed are not listed as water quality limited under Section 303(d) of the CWA. Seventeen water bodies of the subbasin are listed under Section 303(d) of the CWA.

2.1 Water Quality Limited Segments Occurring in the Subbasin

The St. Joe River subbasin has 17 water quality limited 303(d) listed stream segments according to the 1998 303(d) list. These segments are listed in Table 2, including their segment ID numbers, designated boundaries, and reasons for listing. Listed segments are mapped in Figure 1.

Sediment and temperature are the two most prevalent pollutants listed. Sediment is listed for eight segments. Temperature is listed for 12 segments. Bacteria and dissolved oxygen are listed for five and three segments, respectively. Nutrients responsible for aquatic plant growth are listed as the pollutant for one segment. Habitat alteration is also listed for one segment; however, habitat alteration is not an impact that can be addressed by a TMDL.

2.2 Applicable Water Quality Standards

The water quality standards designate beneficial uses and set water quality goals for the waters of the state. The designated uses for the St. Joe River subbasin and the applicable water quality standards appear below.

Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and "presumed" uses as briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (Grafe et al. 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

-- Existing Uses

Existing uses under the CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.003.35, .050.02, and 051.01 and .053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists. Practical application of this concept would be when a waterbody could support salmonid spawning, but salmonid spawning is not yet occurring.

Table 2. 303(d) listed segments in the St. Joe River subbasin.

Water Body Name	Segment ID Number	Assess-ment Unit	1998 303(d) Boundaries	Pollutants	Listing Basis[1]
Bear Creek	7606	PN033_02	Headwaters to Toles Creek	Bacteria, sediment, temperature	Appendix A, 305(b)
Beaver Creek	5619	PN025_02 PN048_02	Headwaters to St. Joe River	Temperature	EPA addition
Bird Creek	3614	PN057_02	Headwaters to St. Joe River	Sediment	Appendix A, 305(b)
Blackjack Creek	7577	PN027_02	Headwaters to St. Joe River	Dissolved oxygen, bacteria, sediment, temperature	Appendix A, 305(b)
Bluff Creek	5022	PN045_02	Headwaters to St. Joe River	Temperature	EPA addition
East Fork Bluff Creek	5022	PN045_02	Headwaters to St. Joe River	Sediment	Appendix A, 305(b)
Fishhook Creek	3608	PN039_04	Lick Creek to St. Joe River	Sediment, temperature	Appendix A, 305(b); EPA addition
Fly Creek	2016	PN041_02	Headwaters to St. Joe River	Temperature	EPA addition
Gold Creek	3622	PN053_02	East Fork Gold Creek to St. Joe River	Habitat alteration, nutrients, sediment, temperature	Appendix A 305(b)
Harvey Creek	7576	PN027_02	Headwaters to St. Joe River	Dissolved Oxygen, bacteria, sediment, temperature	Appendix A, 305(b)
Heller Creek	2017	PN041_02	Headwaters to St. Joe River	Temperature	EPA addition
Little Bear Creek	7607	PN033_02	Headwaters to Bear Creek	Bacteria, sediment, temperature	Appendix A, 305(b)
Loop Creek	5620	PN060_02	Headwaters to North Fork St. Joe River	Sediment, unknown, temperature	Appendix A, 305(b); BURP Data; EPA addition
Mica Creek	3601	PN030_03	Headwaters to St. Joe River	Sediment	Appendix A, 305(b)
Mosquito Creek	3621	PN046_02	Headwaters to St. Joe River	Temperature	EPA addition
Simmons Creek	2022	PN052_02 /03	Headwaters to St. Joe River	Temperature	EPA addition
Tank Creek	7575	PN027_02	Headwaters to St. Joe River	Dissolved Oxygen, bacteria, sediment, temperature	Appendix A, 305(b)

[1] "EPA addition" refers to EPA additions to the 1ist created in 1998 of water bodies in Idaho that did not fully support at least one beneficial use.

-- Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state. In Idaho these include things like aquatic life support, recreation in and on the water, domestic water supply, and agricultural use. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in the state water quality standards (see IDAPA 58.01.02.003.22 and .100, and IDAPA 58.01.02.109-160 in addition to citations for existing uses).

The St. Joe River (Unit P-41, Source to North Fork St. Joe River; and Unit P-27, North Fork St. Joe River to St. Maries River) has designated beneficial uses of cold water, salmonid spawning, primary contact recreation, domestic water supply, and special resource water (Table 3). Beneficial uses have not been designated for the other listed tributaries of the St. Joe River.

-- Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called "presumed uses," DEQ will apply the numeric criteria cold water and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature). However, if, for example, cold water is not found to be an existing use, an use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria. (IDAPA 58.01.02.101.01).

Table 3. St. Joe River subbasin designated beneficial uses.

Unit	Water Body	Designated Uses[1]			303(d) Listed
		Aquatic Life	Recreation	Other	
P-27	St. Joe River	CW, SS	PCR	DWS, SRW	no
P-41	St. Joe River	CW, SS	PCR	DWS, SRW	no

[1]CW – Cold Water, SS – Salmonid Spawning, PCR – Primary Contact Recreation, DWS – Domestic Water Supply, SRW – Special Resource Water

Table 4. St. Joe River subbasin beneficial uses of impaired streams without standard designated uses.

Unit	Water Body	Designated Uses[1]		303(d) Listed
		Aquatic Life	Recreation	
P-33	Bear Creek	CW, SS	SCR	yes
P-48	Beaver Creek	CW, SS	SCR	yes
P-57	Bird Creek	CW, SS	SCR	yes
P-27	Blackjack Creek	CW, SS	SCR	yes
P-45	Bluff	CW, SS	SCR	yes
P-45	East Fork Bluff Creek	CW, SS	SCR	yes
P-39	Fishhook Creek	CW, SS	SCR	yes
P-47	Fly Creek	CW, SS	SCR	yes
P-53	Gold Creek	CW, SS	SCR	yes
P-27	Harvey Creek	CW, SS	PCR	yes
P-41	Heller Creek	CW, SS	SCR	yes
P-33	Little Bear Creek	CW, SS	PCR	yes
P-60	Loop Creek	CW, SS	SCR	yes
P-30	Mica Creek	CW, SS	SCR	yes
P-52	Simmons	CW, SS	SCR	yes
P-46	Mosquito	CW, SS	SCR	yes
P-27	Tank Creek	CW, SS	SCR	yes

[1]CW – Cold Water Aquatic Life, SS – Salmonid Spawning, PCR – Primary Contact Recreation, SCR – Secondary Contact Recreation

Water Quality Standards

Water quality criteria supportive of the beneficial uses are stated in the Idaho Water Quality Standards and Wastewater Treatment Requirements (DEQ 2000). The standards supporting the beneficial uses are outlined in Table 5. In addition to these standards, cold water and salmonid spawning are supported by two narrative standards. The narrative sediment standard states:

Sediment shall not exceed quantities specified in section 250 and 252 or, in the absence of specific sediment criteria, quantities, which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Subsection 350 (IDAPA 58.01.02.200.08).

The excess nutrients standard states:

Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other aquatic growths impairing designated beneficial uses (IDAPA 58.01.02.200.06).

Table 5. Water quality standards supportive of beneficial uses (IDAPA 58.01.02.250) [1].

Designated Use	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Use	Salmonid Spawning
Coliforms and pH	126 EC/100 mL geometric mean over 30 days	126 EC/100 mL geometric mean over 30 days	pH between 6.5 and 9.5	pH between 6.5 and 9.5
Dissolved gas			dissolved gas not exceeding 110%	dissolved gas not exceeding 110%
Chlorine			total chlorine residual less than 19 ?g/L/hr or an average 11 ?g/L/4-day period	total chlorine residual less than 19 ?g/L/hr or an average 11 ?g/L/4-day period
Toxic substances			less than toxic substances set forth in 40 CFR 131.36(b)(1) Columns B1, B2, D2	less than toxic substances set forth in 40 CFR 131.36(b)(1) Columns B1, B2, D2
Dissolved oxygen			exceeding 6 mg/L D.O.	exceeding 5 mg/L intergraval D. O.; exceeding 6 mg/L surface
Temperature			less than 22°C (72°F) instantaneous; 19°C (66°F) daily average or natural background, if greater	less than 13°C (55°F) instantaneous; 9°C (48°F) daily average or natural background, if greater
Ammonia			low ammonia (formula/tables for exact concentration)	low ammonia (formula/tables for exact concentration)
Turbidity			less than 50 NTU instantaneous; 25 NTU over 10 days greater than background[2]	

[1]pH – negative logarithm of the hydrogen ion concentration; EC - *Escherichia coli;* ?g/L – micrograms per liter; D.O. – dissolved oxygen; mg/L – milligrams per liter; °C – degrees centigrade; °F – degrees Fahrenheit; NTU – nephlometric turbidity units.
[2]The turbidity standard is a standard applied to the mixing zones of point discharges in the water quality standards (IDAPA 58.01.02.250.01.d). However, the standard is technically based on the ability of salmonids to sight feed, thereby making it applicable through the narrative sediment standard (IDAPA58.01.02.200.08) to impacts on salmonids (cold water aquatic use) wherever these may occur.

2.3 Summary and Analysis of Existing Water Quality Data

Existing data for the St. Joe River subbasin are restricted to relatively few sources. The USGS has operated a discharge gage on the St. Joe River near Calder (12414500) since July 1920 and a discharge gage at the Red Ives Ranger Station (12413875) since 1997. Water quality data have been collected at the Calder station intermittently since the late 1980s. These data include temperature, pH, dissolved oxygen, and aquatic plant growth nutrient measurements. No additional data other than discharge are collected at the Red Ives station. The USGS operated a gage at the city of St. Maries during water year 1992. Physical and water chemistry data were collected. DEQ staff collected aquatic plant growth nutrients, dissolved oxygen, and bacteria data at various sites on the impaired segments of the St. Joe River subbasin during water year 2000. Beneficial Use Reconnaissance Program (BURP) data were collected on all water quality limited streams. These data include temperature, habitat, macroinvertebrate, and fisheries data. Sediment source data were collected during the summers of 2000 and 2001 through the Idaho Department of Lands Cumulative Watershed Effects (CWE) program.

Discharge Characteristics

The USGS has continuously operated the Calder Gaging Station (12414500) since July 1920. The average annual discharge hydrograph of the station indicates the spring snowmelt event dominates the pattern of stream discharge (Figure 5)(USGS 1996-2000). The mean high flow discharge for 1996-2000 occurred in April at 1,213 cubic feet per second (cfs) and the mean low flow discharge in September at 64 cfs. Bank full discharge is in the range of 1,200 cfs. Rain-on-snow conditions can result in large discharge (flood) events as occurred during winter 1995-1996 (Figure 6)(USGS 1997). The St. Joe watershed has less than half its slopes in the 3,330 to 4,500 feet elevation range. Peak discharges during the third largest flood on record (February 1996) were estimated at 34,000 cfs.

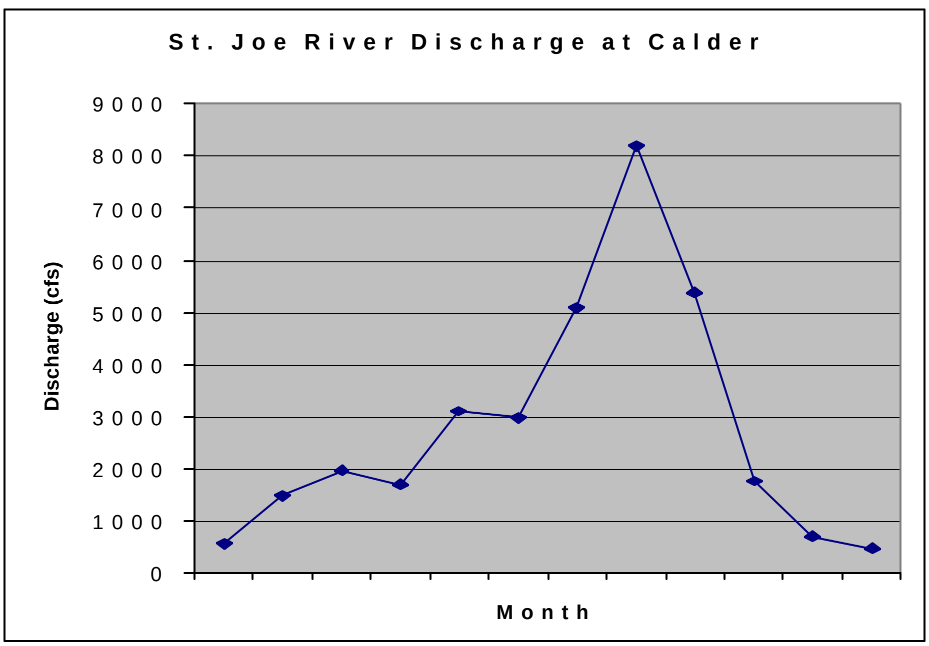

Figure 5. Annual Discharge Hydrograph of the St. Joe River at Calder, Based on Five-Year (1996-2000) Monthly Averages

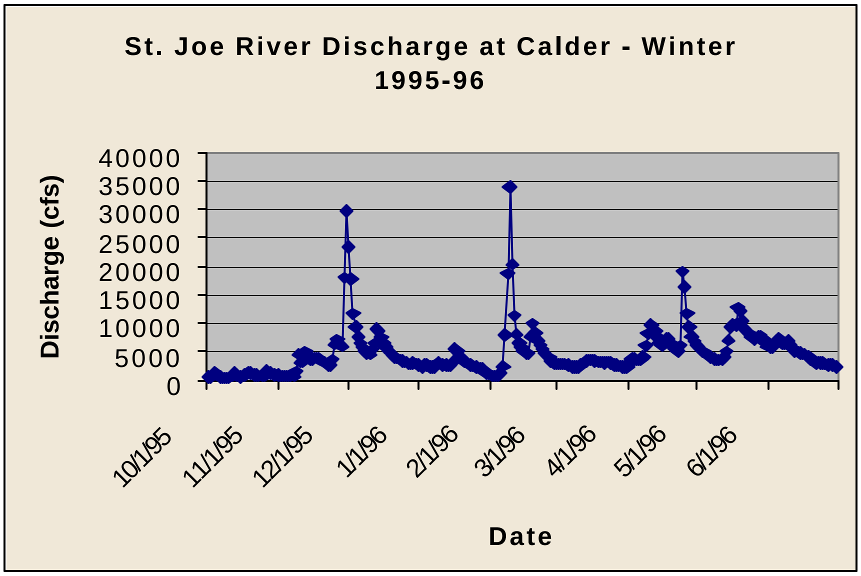

Figure 6. Discharge Hydrograph of the St. Joe River at Calder During Winter 1995-1996

Water Quality Data

Water quality data have been collected at the Calder and St. Maries gages by the USGS under contract to DEQ and EPA. DEQ collected aquatic plant growth nutrient and dissolved oxygen data at four locations in the subbasin. DEQ has collected temperature data with data loggers from several streams in the St. Joe River subbasin.

-- General data from the Calder and St. Maries gage stations

Selected water quality data collected by the USGS at the Calder gage between 1994 and 2000 are summarized in Table 6. The entire data set is provided in Appendix B. The data in Table 6 indicate no exceedences of water quality standards. The Calder gage data are limited, but indicate generally high water quality.

Averages of selected water quality data collected at the St. Maries gage operated by the USGS during water years 1991 and 1992 are provided in Table 7. These data indicate that the St. Joe River is low in plant growth nutrients. The entire data set is available in Appendix B. Data from the Calder and St. Maries stations indicate the water of the St. Joe River is of high quality

Table 6. Water quality of the St. Joe River at the Calder gaging station.

Sample Date	Water Temp (?C)	Inst. Discharge (cubic feet per second)	Specific Conductance (? s/cm) [1]	pH (standard Units)	Nitrogen, Ammonia Dissolved (mg/L as N)	Nitrogen, Ammonia + Organic Total (mg/L as N)	Nitrogen, Nitrate + Nitrite Dissolved (mg/L as N)	Phosphorus Total (mg/L as P)	Phosphorus Ortho Dissolved (mg/L as P)
09/04/96	14.7	436	65.0	7.72	0.015	0.20	0.050	0.01	0.010
04/27/98	6.2	5,010	42.0	7.05	0.035	0.10	0.050	0.01	0.010
05/11/98	7.3	6,360	34.0	7.25	0.068	0.10	0.050	0.01	0.010
06/15/98	10.4	2,980	46.0	7.37	0.053	0.10	0.057	0.019	0.014
07/08/98	17.9	1,380	57.0	6.72	0.054	0.10	0.050	0.01	0.020
08/10/98	19.7	607	66.0	8.02	0.046	0.10	0.050	0.01	0.010
09/14/98	16.0	413	69.0	7.76	0.028	0.10	0.050	0.01	0.010
10/21/98	7.00	357	61.0	7.51	0.002	0.10	0.0050	0.002	0.001
11/19/98	5.00	531	53.0	7.9	0.003	0.10	0.018	0.004	0.001
12/09/98	2.00	688	56.0	7.35	0.002	0.10	0.005	0.003	0.002
01/26/99	0.00	1,100	51.0	7.65	0.003		0.010	0.0048	0.003
02/09/99	1.00	952	52.0	7.36	0.003	0.10	0.007	0.0054	0.003
03/10/99	2.00	1,140	54.0	6.86	0.002	0.10	0.005	0.004	0.002
04/14/99	3.10	2,470	53.0	7.06	0.003	0.10	0.005	0.007	0.003
05/10/99	3.90	4,320	45.0	7.57	0.004	0.10	0.005	0.004	0.002
06/08/99	6.00	6,990	34.0	7.44	0.004	0.11	0.018	0.009	0.004
07/14/99	11.6	2,790	38.0	7.28	0.002		0.005	0.005	0.002
08/10/99	18.7	929	54.0	7.68	0.011		0.005	0.004	0.002
09/09/99	11.1	546	61.0	7.45	0.013		0.005	0.004	0.002
Mean	8.6	2,105	52.0	7.42	0.018	0.10	0.024	0.007	0.006

[1] microsiemens per centimeter

Table 7. Select water quality data from the St. Maries Gage (12415075).

Water Year	Specific Conductance (Microsiemens/cm at 25 ?C)	Nitrogen Ammonia Total (mg/L as N)	Nitrogen Nitrite Total (mg/L as N)	Nitrogen Ammonia plus Organic Total (mg/L as N)	Nitrogen Nitrite plus Nitrate Total (mg/L as N)	Phosphorus Total (mg/L as P)	Phosphorus O-Phosphate Total (mg/L as P)
1991 Mean	46	0.021	0.005	0.339	0.061	0.012	0.003
1992 Mean	51	0.016	0.006	0.204	0.014	0.013	0.006

-- Dissolved Oxygen

Blackjack, Harvey, and Tank Creeks are listed for dissolved oxygen limitation. The dissolved oxygen concentrations of the three streams were measured in late August 2000 after a prolonged period of warm weather without precipitation. If oxygen deficiency occurs, it would be expected under these conditions. The dissolved oxygen concentrations and percent saturation measured are provided in Table 8. The values are higher than the minimum standard of 6 milligrams per liter (mg/L) dissolved oxygen (Table 5) or 90% saturation, which is expected in steams with high gradients. Based on these data, Blackjack, Harvey, and Tank Creeks are not limited by dissolved oxygen concentration.

Table 8. Dissolved oxygen and percent saturation measured in Blackjack, Harvey, and Tank Creeks.

Stream	Dissolved Oxygen (mg/L)	Percent Saturation
Blackjack Creek	10.0	98.5
Harvey Creek	10.3	100.2
Tank Creek	9.9	97.7

-- Nutrients

Gold Creek is listed for nutrients. No obvious sources of nutrients were observed in the Gold Creek watershed. Water samples collected on three dates during summer 2000 from two locations on Gold Creek were analyzed for total phosphorous, nitrite-nitrate, and total Kjeldahl nitrogen. The analytical results are provided in Tables 9 a and b. Nutrient concentrations were slightly higher on the upstream segment than the lower segment, which is listed on the1998 303(d) list. Total Kjeldahl nitrogen data indicated that nearly all nitrogen was in the nitrite and nitrate forms. Concentrations measured in Gold Creek are below the nitrite-nitrate and total phosphorous guidelines. The results demonstrate that Gold Creek is not water quality limited by nutrients and is visibly free from slime and other aquatic growths.

Table 9. Plant growth nutrient concentrations at two locations on Gold Creek.

a) Total phosphorous (mg/L)

Location	6/26/00	7/26/00	8/24/00	Mean
Near mouth	0.008	0.011	0.009	0.009
Above East Fork	0.012	0.012	0.010	0.011

b) Total nitrate-nitrite (mg/L)

Location	6/26/00[1]	7/26/00	8/24/00	Mean
Near mouth	<0.100	0.164	0.150	0.105
Above East Fork	0.035	0.165	0.156	0.125

[1]Less than .100 treated as .005 mg/L in means.

-- Temperature

Bear, Blackjack, Gold, Harvey, Little Bear, and Tank Creeks are listed as limited by temperature standard exceedences. Except for Tank Creek, summer/fall temperatures were continuously monitored on these and several other tributaries to the St. Joe River. Temperature data are not available for Tank Creek because it was dry in the summers of 1997 and 1998, when the data were collected. Blackjack and Harvey Creeks are located very near to Tank Creek. These streams can be used as temperature surrogates for Tank Creek. The temperature profile, as well as the analysis of the data for exceedences of federal and state bull trout standards and cutthroat and bull trout spawning standards, is provided in Appendix B.

The bull trout temperature standard exceedence was assessed as the percentage of seven-day average maximum temperature exceedences during the period from May 1 to October 31. This value is plotted with the average stream temperature on the graph in Appendix B. The individual bull trout and spawning standards are plotted for the periods these apply. Where the temperature recording trace did not start and/or end within the standard, the slope of the temperature trend line was measured and applied to estimate the number of days of temperature exceedence prior to or following the record. The cutthroat trout spawning standard was assessed from seven days after the peak of the spring discharge hydrograph through July 31. Discharge peaks were determined using the Calder gage for the down stream tributaries to the river and the Red Ives gage for the up stream tributaries. These gages were cross-referenced against the peaks at the Bird, Skookum, and Marble Creek gages operated by the USFS (Patten 2000). The cutthroat standard was compared to the average water temperature. The bull trout spawning standard was assessed from September 1 to October 31. After October 31, it is unlikely that water temperatures in any streams would exceed the 9 ?C standard. The standards were assessed against the average water temperature. In those cases that temperatures exceeded the spawning standards at the start and/or end of the temperature record, the extrapolation method described above was applied to estimate the number of days of exceedence beyond the period of record.

The percentage standard exceedence in each stream is provided in Table 10. The federal bull trout temperature standard was exceeded in the streams listed for temperature and in all other streams assessed in the subbasin. The state bull trout temperature standard was exceeded in all streams assessed except Little Bear Creek. None of the streams listed for temperature in the subbasin are designated bull trout streams in the proposed federal rule. However, Beaver, California, Fishhook, Gold, Heller, Marble, Medicine, Sherlock, and Yankee Bar Creeks, and the main stem and North Fork St. Joe River are all listed in the federal rule. None of these streams meets the federal or state temperature standards for bull trout, even though California, Heller, and Yankee Bar have no roads or development and very little placer mining. The entire Upper St. Joe River has very limited development. The cutthroat trout and bull trout spawning standards are exceeded in all streams listed for temperature as well as all other streams, except Medicine Creek. Standard exceedences are for substantial periods. The BURP results employed to develop the 1998 303(d) list indicated that many of these streams fully support their cold water aquatic life and salmonid spawning uses. This result is supported by analyses conducted according to the *Water Body Assessment Guidance, Second Edition* (Grafe *et al*. 2002). The nearly uniform exceedence of the state and federal temperature standards during July, August, and early September, even in undeveloped watersheds, suggests the standards may not be realistic.

Based on the current temperature monitoring results and temperature standards, listed streams Beaver, Bluff, Fishhook, Heller, and Loop Creeks are limited by temperature. Given the results from unlisted streams, it is reasonable to assume that Fly, Mosquito, and Simmons are limited by temperature as well.

Table 10. Percentage exceedence of federal and state bull trout and spawning standards during the period for which the standard applies.

Stream	Federal Bull Trout (May 1 to Oct 31)	State Bull Trout (May 1 to Oct 31)	Cutthroat Trout Spawning (week post hydrograph peak to July 31)	Bull Trout Spawning (Sept 1 to Oct 31)
Bear Creek	33.2	1.1	29.9	9.8
Little Bear Creek	23.4	0.0	19.5	9.8
Blackjack Creek	44.6	33.2	46.0	42.6
Harvey Creek	48.4	32.1	43.7	41.0
Big Creek	56.0	46.2	68.3	52.5
E. F. Big Creek	63.0	54.3	64.6	54.1
Boulder Creek	54.9	45.7	58.5	41.0
Marble Creek	56.5	47.3	53.7	52.5
Fishhook Creek	54.9	48.4	56.1	52.5
Loop Creek	52.7	45.7	29.9	42.6
N. F. St. Joe River	58.2	51.1	53.7	55.7
Bluff Creek	48.4	38.6	28.7	24.6
Gold Creek	42.9	33.7	29.4	23.0
Beaver Creek	47.3	41.3	45.6	24.6
Heller Creek	45.6	32.6	21.8	24.6
Sherlock Creek	44.6	40.8	37.2	27.9
Yankee Bar Creek	45.1	33.2	23.1	19.7
California Creek	38.0	16.3	21.8	18.0
Medicine Creek	33.4	0.5	0.0	0.0
Upper St. Joe River	43.5	37.0	33.3	27.9

Biological and Other Data

The existing biological data include bacteria, macroinvertebrate, and fisheries data. Bacteria data were collected by DEQ.

-- Bacteria

Five streams (Bear, Little Bear, Blackjack, Harvey, and Tank Creeks) are listed for bacteria. An assessment of *Escherichia coli* (*E. coli*) was conducted during June, July, and August 2000. As part of the assessment, the presence of significant livestock concentrations in the watersheds was assessed. No significant concentrations of livestock were found in any of the five watersheds. Results of *E. coli* tests of water samples are provided in Table 11. As shown in Table 11, none of the monitoring sites exceeded the geometric mean standard of 126 organisms/100 mL for primary or secondary contact recreation.

Table 11. *Escherichia coli* (colonies per 100 mL) presence measurements during summer 2000.

Stream	6/27/00	7/26/00	8/2/00	Mean
Bear Creek	<1[1]	2	<1	1
Little Bear Creek	1	5	3	3
Blackjack Creek	3	<1	<1	2
Harvey Creek	4	4	2	3
Tank Creek	8	9	<1	6

[1]Quality assurance/quality control blank samples <1; less than one treated as 0.5 in means

-- Macroinvertebrate and habitat index data

Stream macroinvertebrate, stream fish, and stream habitat scores for water bodies in the St. Joe River subbasin are provided in Table 12. As described in DEQ's *Water Body Assessment Guidance* (WBAGII) (Grafe *et al*. 2002), the indices are based on the northern mountains ecoregion. The index values are averaged to develop the WBAGII score for the available indices. At least two indices are necessary to make a determination. Average values of 2 or greater indicate support of the cold water use, while values lower than 2 indicate nonsupport.

Table 12. Stream macroinvertebrate, fish, and habitat indices data for the St. Joe subbasin.

a) Listed streams

Stream	SMI[1]	SMI Score	SFI[2]	SFI Score	SHI[3]	SHI Score	WBAGII Score (Average SMI + SFI + SHI)	Support Status[4]
Bear Creek	41.21	1	88	3	53	1	1.7	NFS
Beaver Creek	72.10	3	-	-	88	3	3	FS
Bird Creek	-	-	95	3	30	1	2	FS
Blackjack Creek	45.57	1	53	1	82	3	1.7	NFS
East Fork Bluff Creek	45.08	1	92	3	75	3	2.3	FS
Fishhook Creek	45.25	1	82	3	45	1	1.7	NFS
Fly Creek	81.87	3	-	-	55	1	2	FS
Gold Creek	73.51	3	91	3	68	3	3	FS
Harvey Creek	72.88	3	-	-	78	3	3	FS
Little Bear Creek	40.16	1	80	2	58	3	2	FS
Loop	-	-	83	3	-	-	-	ND
Mica Creek	63.72	3	82	3	55	2	2.0	FS
Mosquito Creek	74.03	3	87	3	52	1	2.3	FS
Tank Creek	-	-	-	-	16	1	-	ND

b) Unlisted streams

Stream	SMI[1]	SMI Score	SFI[2]	SFI Score	SHI[3]	SHI Score	WBAG II Score (Average SMI + SFI + SHI)	Support Status[4]
Bond Creek	59.62	2	61	1	45	1	1.3	NFS
Hugus Creek	72.00	3	-	-	55	1	2	FS
Marble Creek	48.01	1	-	-	60	2	1.5	NFS
Toles Creek	48.19	1	-	-	56	2	1.5	NFS
Norton Creek	61.06	2	87	3	82	3	2.7	FS
Hobo Creek	71.22	3	74	2	86	3	2.7	FS
DaVeggio Creek	61.97	2	88	3	73	3	2.7	FS
Sisters Creek	48.72	1	95	3	64	2	2	FS
Alpine Creek	64.41	3	90	3	76	3	3	FS
Prospector Creek	53.29	1	96	3	73	3	2.3	FS
Copper Creek	76.76	3	-	-	58	2	2.5	FS
Bruin Creek	78.28	3	96	3	76	3	3	FS
Quartz Creek	63.45	3	89	3	77	3	3	FS
Eagle Creek	67.80	3	97	3	75	3	3	FS
Nugget Creek	-	-	97	3	66	3	3	FS
Timber Creek	51.58	1	89	3	84	3	2.3	FS
Skookum Creek	-	-	95	3	79	3	3	FS
Upper St. Joe River	85.47	3	-	-	53	1	2	FS
Big Creek	48.92	1	72	3	56	1	1.7	NFS

[1]Stream Macroinvertebrate Index
[2]Stream Fish Index
[3]Stream Habitat Index
[4]FS – full support; NFS – not full support; ND – not determined

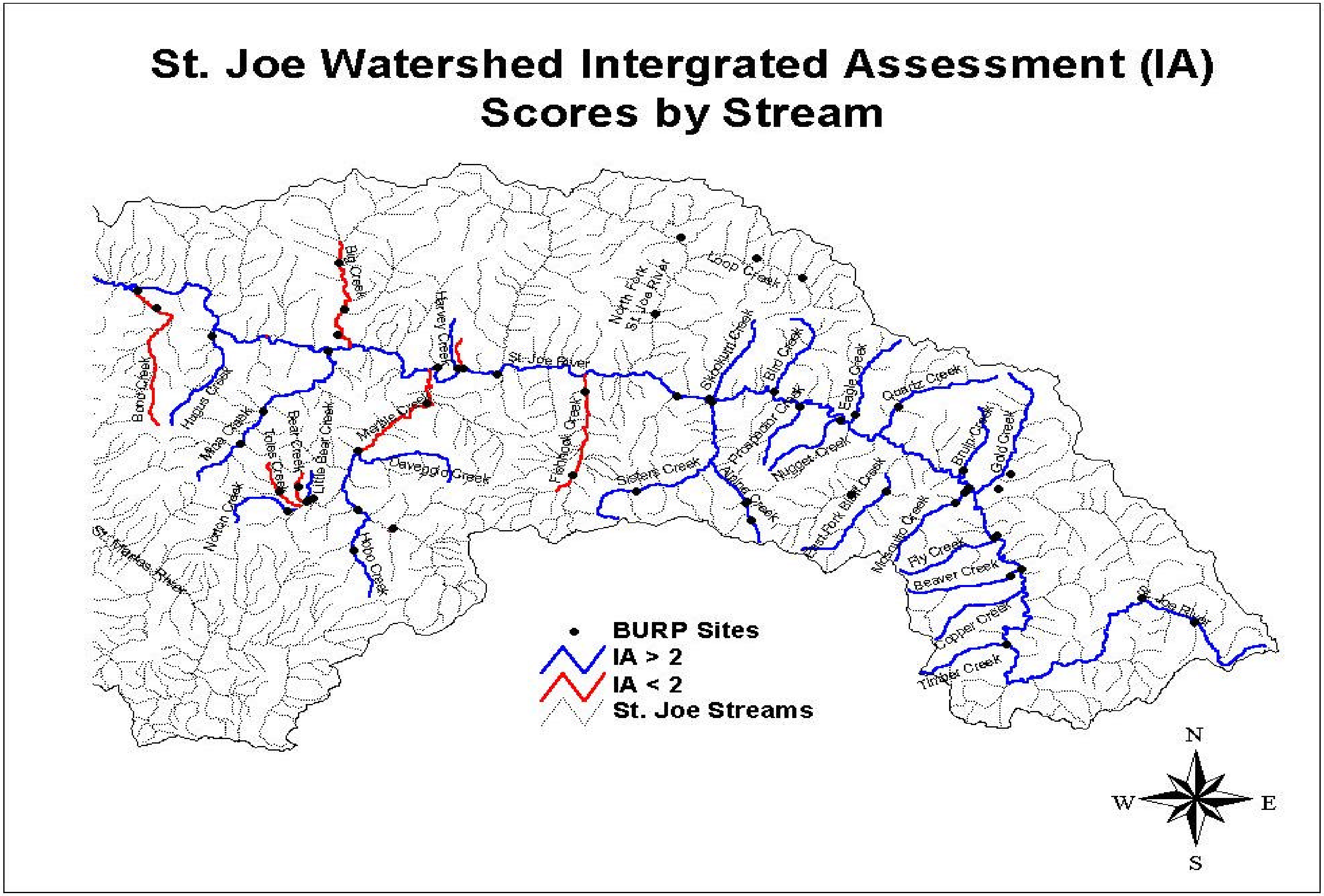

Figure 7. Stream Macroinvertebrate and Habitat Indices Scores at BURP Stations in the St. Joe River Subbasin

-- Additional fisheries data

Electrofishing data from subbasin streams that are either not developed or have little development indicate that between 0.1 and 0.5 fish per square meter per hour of electrofishing effort are typical (Table 13). Fishhook, Gold, Loop, and Mica Creeks are well below this range, while the remaining listed streams are in the range. No data are available for Harvey and Tank Creeks. These are high gradient tributaries to the river where electrofishing is difficult. All streams for which data were collected had at least two age classes present. Most streams had representatives of three age classes. Young of the year were present in all streams where DEQ data were collected. Sculpin are present in most streams in numbers ranging from 0.2 to 0.5 fish per square meter per hour of electrofishing effort. Sculpin were not present in Blackjack Creek, which, like Harvey and Tank Creeks, is a high gradient stream. Tailed frogs were found in all streams where data were collected, while salamanders were present in most of the streams.

Many unlisted streams had the expected number of trout and sculpin per square meter per hour of electrofishing effort (Table 13). Exceptions include Bond, Hobo, DaVeggio, Copper, Quartz, and Big Creeks. Most of the streams had three age classes, including young of the year. Hobo and Big Creeks each had a single age class, while Hobo, DaVeggio, and Big Creeks did not have young of the year detected. Sculpin were typically measured in the range of 0.2 to 0.5 fish per square meter per hour of electrofishing effort. A few streams had slightly lower numbers, but in Big Creek sculpin numbers were extremely low. Tailed frogs were detected in many streams and salamanders in a few.

The results indicate that many of the listed and unlisted streams have numbers of trout and sculpin typically found in streams of the Northern Rocky Mountain Ecosystem. The presence of three age classes and young of the year in most streams indicates salmonid spawning is supported. Fishhook, Gold, Loop and Mica Creeks have low fish numbers that could suggest water quality impairment. The streams of Marble Creek also appear to have low trout numbers, fewer age classes and the absence of young of the year. Boulder Creek is an exception. Big Creek has exceptionally low trout and sculpin numbers. Since this watershed has a very low level of development, these values are either a measurement artifact or the result of some natural impact.

Table 13. Fish population per unit stream area of the streams of the St. Joe River subbasin.

a) Water quality limited streams[1]

Stream	HUC Number	Salmonids (fish/m^2/hr effort)	Number of Salmonid Age Classes and Young of the Year	Sculpin (fish/m^2/hr effort)	Presence of Salamanders and/or Tailed Frogs
Bear Creek	17010304 7606	0.478	2 - YOY	0.517	Yes (TF)
Beaver Creek	17010304	0.21	2 – YOY	0.17	Yes (TF)
Bird Creek	17010304 3614	0.117	3 - YOY	0.285	Yes (TF, S)
Blackjack Creek	17010304 7577	0.734	3 - YOY	0.000	Yes (TF, S)
East Fork Bluff Creek	17010304 5022	0.117	3 - YOY	0.165	Yes (TF)
Fishhook Creek	17010304 3608	0.054	2 - YOY	0.271	Yes (TF, S)
Gold Creek	17010304 3622	0.036	3 - YOY	0.229	Yes (TF)
Harvey Creek	17010304 7576	N.D.	N.D.	N.D.	N.D.
Little Bear Creek	17010304 7607	0.137	2 - YOY	1.096	Yes (TF, S)
Loop Creek	17010304 5620	0.046	3 - YOY	0.396	Yes (TF, S)
Mica Creek	17010304 3601	0.042	3 - YOY	0.355	Yes (TF, S)
Mica Creek[2]	17010304 3601	0.201	3	0.734	N.D.
WF Mica Creek[2]	17010304 3601	0.190	2 - YOY	0.513	N.D.
Mosquito Creek	17010304 3621	0.12	3 – YOY	0.28	Yes (TF, S)
Tank Creek	17010304 7575	N.D.	N.D.	N.D.	N.D.

[1]Data from DEQ Beneficial Use Reconnaissance Program except where otherwise noted; N.D. - no data; YOY – young of the year; TF – tailed frogs; S – salamanders
[2] Average of Potlatch Corporation data collected four separate years 1995-2000

b) Streams not listed as water quality limited[1]

Stream	HUC Number	Salmonids (fish/m^2/hr effort)	Presence of Three Salmonid Age Classes	Sculpin (fish/m^2/hr effort)	Presence of Tailed Frogs and/or Salamanders
Bond Creek	17010304 3598	0.06	3 – YOY	0.24	Yes (TF)
Hugus Creek[2]	17010304	0.03	2 - YOY	0.12	N.D.
Norton Creek	17010304 7604	0.06	2 – YOY	0.30	Yes (TF)
Hobo Creek	17010304	0.02	1	0.14	Yes (TF)
DaVeggio Creek	17010304 3609	0.09	3	0.15	Yes (TF)
Boulder Creek	17010304	0.51	2 – YOY	N.D.	Yes (TF)
Sisters Creek	17010304 3613	0.25	3 – YOY	0.70	Yes (TF)
Prospector Creek	17010304 3615	0.10	3 – YOY	0.24	None
Nugget Creek	17010304	0.30	3 – YOY	0.33	Yes (TF)
Copper Creek	17010304	0.07	3 – YOY	0.39	None
Timber Creek	17010304	0.04	2 – YOY	0.14	Yes (TF)
Bruin Creek	17010304 3620	0.10	3 – YOY	0.15	None
Quartz Creek	17010304 3618	0.06	4 – YOY	0.25	Yes (S)
Eagle Creek	17010304 3617	0.10	3 – YOY	0.11	Yes (TF, S)
Skookum Creek	17010304	0.10	3 – YOY	0.25	Yes (TF)
Big Creek	17010304 3602	0.01	1	0.07	None

[1]Data from DEQ Beneficial Use Reconnaissance Program except as otherwise noted; N.D. - no data; YOY – young of the year; TF – tailed frogs; S – salamanders
[2] Potlatch Corporation data collected one time in 1995

-- Sedimentation data

Available sedimentation data include measurements of riffle armor stability and residual pool volume. Sedimentation model data are also available.

Riffle Armor Stability Indices

A quantitative index of streambed instability is the Riffle Armor Stability Index (RASI) (Kappesser 1993). The measurement consists of a 200 particle count and size measurement on a transect across a stream riffle using the methods of Wolman (1954). With this information, a particle size distribution curve is developed for the riffle. A RASI involves an additional measurement of the 30 largest particles found deposited on the point deposition bar located immediately downstream of the riffle. The RASI value is the percentage of particles in the distribution curve smaller than the mean size of the largest particles deposited on the point bar.

Since the largest particles on the point bar represent the largest stream bed particles moved by the stream during the most recent channel altering event, the RASI provides an assessment of the percentage of the stream bed materials mobilized during the event. A RASI value provides an assessment of relative streambed stability. Values in the range of 28-60 with a mean of 44 have been found in unmanaged streams of the upper St. Joe River basin, which are believed to have high relative stability. These watersheds have very few or no roads and the last general disturbance of the area was the 1910 wildfire (Cross and Everest 1995). Additional RASI scores have not been developed for managed streams of the St. Joe River watershed. A mean RASI score of 44 indicates that an average of 44% of the stream bed particles move during a two-year channel forming discharge event. A high score of 60 means that, at most, 60% of the particles are mobilized. These streambeds are composed primarily of coarse gravel and larger particles. These results from unmanaged watersheds suggest high bed mobility is a natural feature of the dominant Belt terrain. Since the channel-forming events, which move the bed materials, occur in winter or spring, fall spawning fish would be at a disadvantage spawning in streams in which 44-60% of the riffle moves at least every other year.

Residual Pool Volume

Residual pool volume is a measure of the amount pools in a stream channel. In theory, it is an estimate of the amount of the stream bed that would hold water at zero discharge. Residual pool volume can be estimated from stream channel measurements collected by survey crews. The estimates are typically standardized on a volume per stream mile basis. Since the stream width affects the amount of pool volume possible, residual pool volume data are typically ordered based on the bank full width of the stream. Bank full width is the best measure of the typical stream discharge and ability to scour pools (DEQ 1989).

The residual pool data for the water quality limited listed segments of the St. Joe River subbasin are provided in Table 14. The residual pool volumes of several additional streams of the St. Joe River subbasin are provided in Table 15. Streams in both tables are listed in order of increasing bank full width.

Table 14. Residual pool volume of the water quality limited segments of the St. Joe River subbasin.[1]

Stream	HUC Number	Bank Full Width (feet)	Residual pool Volume (cubic feet/mile)
Bear Creek	17010304 7606	7.1	4,531
Tank Creek	17010304 7575	7.2	N.D. (dry)
Little Bear Creek	17010304 7607	9.2	9,446
Blackjack Creek	17010304 7577	11.7	5,190
Harvey Creek	17010304 7576	15.0	4,417
Fly Creek	17010304	19.4	61,098
Beaver Creek	17010304	21.7	180,003
Bird Creek	17010304 3614	23.9	5,070
Mosquito Creek	17010304 3621	26.0	55,136
East Fork Bluff Creek	17010304 5022	33.2	26,614
Fishhook Creek	17010304 3608	33.3	17,329
Gold Creek	17010304 3622	35.7	79,910
Mica Creek	17010304 3601	38.8	14,526
Loop Creek	17010304 5620	41.3	39,521

[1]Data from DEQ Beneficial Use Reconnaissance Program; N.D. - no data

Table 15. Residual pool volume of the unlisted stream segments of the St. Joe River subbasin.[1]

Stream	HUC Number	Bank Full Width (feet)	Residual Pool Volume (cubic feet/mile)
Norton Creek	17010304 7604	19.2	12,462
Bruin Creek	17010304 3620	19.4	14,905
Copper Creek	17010304	20.2	87,743
Nugget Creek	17010304	24.6	0
Siwash Creek	17010304	25.0	81,279
DaVeggio Creek	17010304 3609	25.5	0
Bussel Creek	17010304	25.9	92,586
Prospector Creek	17010304 3615	27.1	15,112
Timber Creek	17010304	27.6	27,259

Table 15, continued.

Skookum Creek	17010304	28.5	31,852
Sisters Creek	17010304 3613	31.8	25,228
Quartz Creek	17010304 3618	32.1	96,726
Eagle Creek	17010304 3617	33.2	46,782
Bond Creek	17010304 3598	33.3	22,601
Hobo Creek	17010304	34.3	7,663
Upper St. Joe River	17010304	39.7	191,768
Boulder Creek	17010304	45.1	92,373
N. F. St. Joe River	17010304	46.3	110,951
Hugus Creek	17010304 3600	48.9	0
Big Creek	17010304 3602	62.8	60,595
Marble Creek	17010304 3604	72.3	143,821

[1]Data from DEQ Beneficial Use Reconnaissance Program

Point Sources of Sediment

There are no point sources of sediment on the sediment-listed segments of the St. Joe River subbasin. There are no point discharges of sediment to the St. Joe River above the St. Maries River confluence. The St. Maries Wastewater Treatment Plant discharges to the river within the Coeur d'Alene Reservation.

Sediment Modeling

Sediment monitoring in-stream is a very time consuming and costly undertaking. In-stream sediment data collection costs estimated by URS Greiner for the Spokane River in 2001 show that in-stream sediment monitoring completed quarterly at five sites would cost $400,000 (URS Greiner 2001a). Sediment monitoring should be conducted at least annually at a site for seven years to develop a database that accounts for the variance of discharge effects on sediment yield and transport from year to year. From the URS Greiner figures, the investment required to conduct annual sediment monitoring for seven years is estimated at $140,000 per site. The time necessary and costs involved do not make sediment monitoring a viable approach for DEQ. A sediment modeling approach uses coefficients developed over long periods in paired watersheds. A sediment modeling approach is the most time and cost efficient approach to estimating sediment for the purposes of TMDLs.

Land Use Data

Sediment yield is estimated from land use data developed from USFS, IDL, and Potlatch Corporation Geographical Information Systems (GIS). Timber stand coverage was assessed for fully stocked and non-stocked lands. Fire coverage developed by the USFS was used to develop data on areas that experienced two wildfires. Forest road coverage developed by USFS, IDL, Potlatch Corporation, and the Bureau of Land Management was used to develop the forest road mileage, road density, road crossings, and encroaching roads data. Cumulative watershed effects (CWE) analyses provide road scores and mass wasting data for all the 303(d) listed watersheds. Road scores and mass wasting data are not available for the Bond, Hugus, and Marble Creek watersheds where CWE analysis will not be completed. In these cases, average road scores and mass wasting data were used from adjacent watersheds for the purpose of assessing sedimentation. These values are reported on Tables 16a and 16b.

Sediment Yield and Export

Sediment yields were developed separately for forestlands, forest roads, and stream bank erosion. No significant agricultural land or highway corridor acreage occurs in the subject watersheds. Sediment export to the stream system was assumed to be 100%. Additional assumptions and documentation of the sediment model are provided in Appendix C. Sediment yield values for 303(d) listed segments and streams draining to the St. Joe River are reported in Tables 18a and 18b, respectively.

Forestland Sediment Yield

Forestland sediment yield was based on mean sediment production coefficients developed from in-stream sediment measurements on Belt geologies of northern and north central Idaho (Patten 1999). The coefficient is 15 tons per square mile per year with a range from 12-17 for the Belt Supergroup geology, which predominate in the St. Joe River watershed. The mean values were used for conifer and sparse conifer forests. The highest values in the range were used for stands that were not fully stocked with trees. Areas twice burned by wildfires were assigned values to reflect sedimentation from burned areas. All of the mean values were divided by 640 acres per square mile. Sediment yield from forestland was estimated by applying the sediment yield coefficients (Table 17) to the land area in each forest category (Table 16).

Table 16. Land use.

a) 303(d) listed streams

Sediment –303(d) listed watersheds in the St. Joe River subbasin

Land Use

Subwatershed	Bear[1]	Bird	Blackjack	East Fork Bluff	Fishhook[2]	Gold	Harvey	Loop[3]	Mica	Tank
Forest land (acres)	1,693.70	8,540.13	733.20	9,281.86	21,835.00	14,972.11	473.80	19,018.28	23,291.75	969.10
Unstocked forest (acres)	371.10	706.79	602.30	583.34	4,092.38	2,914.53	1,161.90	1,320.99	2,874.16	438.80
Total forested acreage	**2,064.80**	**9,246.92**	**1,335.50**	**9,865.20**	**25,927.38**	**17,886.64**	**1,635.70**	**20,339.27**	**26,165.91**	**1,407.90**
Double fires (acres)	0.00	1.23	0.00	0.00	295.58	0.00	33.70	3,926.79	0.00	0.00
Road Data										
Forest roads (miles)	17.10	42.99	4.60	30.46	239.28	65.01	3.50	55.22	157.12	6.00
Ave. road density (miles/mile^2)	5.30	2.98	2.20	1.98	5.91	2.33	1.37	1.74	3.84	2.73
Road crossing number	65.00	27.00	1.00	30.00	184.00	65.00	1.00	41.00	400.00	2.00
Road crossing frequency	3.80	0.63	0.22	0.98	0.77	1.00	0.29	0.74	2.55	0.33
Mass Failure (tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	219.90	0.00	0.00
Encroaching forest roads (miles)	2.30	1.22	0.09	0.86	9.07	2.13	0.11	2.32	12.31	0.02
Mean bankfull width + two 3' banks	14.20	29.90	17.70	39.20	39.20	41.70	21.00	47.30	44.80	13.20
CWE[4] score	14.00	10.00	10.00	12.00	18.00	11.00	10.00	17.00	12.00	10.00
tons/mi CWE	3.03	2.23	2.23	2.61	4.07	2.42	2.23	3.78	2.61	2.23
Miles CWE	5.70	14.29	4.60	7.70	31.76	33.38	3.50	28.10	27.30	0.01

[1]Bear Watershed includes Little Bear Watershed.
[2]Fishhook Creek includes Lick Creek; CWE score for Fishhook Creek used.
[3]Loop Watershed includes Loop Creek + Loop Creek sidewalls. CWE score from Loop Creek was used.
[4]Cumulative Watershed Effects, Idaho Department of Lands.

b) Streams draining to the St. Joe River

Sediment -Bond, Hugus and Marble Watersheds

Land Use

Subwatershed	Bond	Hugus	Marble (upper)	Eagle	Homestead	Bussel	Hobo	DaVeggio	Boulder	Marble (lower)
Forest land (acres)	15,542.90	8,717.40	16,139.90	4,798.00	6,605.90	11,435.10	6,242.10	6,586.80	10,036.10	19,967.10
Unstocked forest (acres)	790.00	410.90	786.50	940.80	314.40	1,143.70	186.30	528.20	1,488.30	1,915.10
Total forested acreage	**16,332.90**	**9,128.30**	**16,926.40**	**5,738.80**	**6,920.30**	**12,578.80**	**6,428.40**	**7,115.00**	**11,524.40**	**21,882.20**
Double fires (acres)	0.00	0.00	1,193.60	68.40	1,107.70	410.30	272.20	281.50	2.90	3,769.20
Road Data										
Forest roads (miles)	116.90	106.30	164.50	79.70	27.10	90.20	34.40	47.70	124.00	164.50
Ave. road density (miles/mile^2)	4.58	7.45	6.22	8.89	2.51	4.59	3.42	4.29	6.89	4.81
Road crossing number	97.00	81.00	18.00	90.00	34.00	71.00	20.00	36.00	82.00	174.00
Road crossing frequency	0.83	0.76	0.11	1.13	1.25	0.79	0.58	0.75	0.66	1.06
Mass Failure (tons/year)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Encroaching Forest Roads (mi)	4.20	2.60	0.42	4.00	0.90	2.30	0.50	0.80	2.90	5.90
Mean Bankfull width + two 3' banks	39.30	54.90	78.30	40.30	40.30	31.90	40.30	31.50	51.10	78.30
CWE score (extrapolated)	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00
tons/mile CWE[1]	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26	3.26

[1]Values extrapolated; CWE not performed on these streams.

Table 17. Estimated sediment yield coefficients for forestland uses based on the geology of the watersheds (Belt Supergroup).

Land Use Type Sediment Export Coefficient	Sediment Export Coefficient
Conifer forest (tons/acre/year)	0.023
Non-stocked Forest (tons/acre/year)	0.027
Double fire Burn (tons/acre/year)	0.004

-- Road Surface Sediment

Forest road fine sediment yield was estimated using a relationship between CWE score and the sediment yield per mile of road (Appendix C). The relationship was developed for roads on a Kaniksu granite geology in the LaClerc Creek watershed (McGreer 1998). Its application to roads on Belt geology overestimates sediment yields from these systems. The watershed CWE score was used to develop a sediment yield in tons per mile, which was multiplied by the estimated road mileage within 200 feet of a road crossing (Table 18). It was assumed that all road surface sediment was delivered to the stream system. These are conservative over-estimates of actual delivery.

-- Road failure sediment

Forest roads can fail into streams. Delivery from road failures is estimated directly in the CWE assessments. Sediment delivery was applied directly for the watersheds where CWE analysis was applied. In those watersheds where CWE data are not available (Bond and Hugus Creeks and most of Marble Creek), average values from adjacent watersheds were applied. Road sediment yield was annualized based on high discharge events with an estimated 10 years return time.

-- Road encroachment sediment

Sediment yield resulting from road encroachment (Tables 18a and b) was modeled based on a set cross-section for each watershed. The cross-section is based on the mean channel bankfull width. The model assumes 0.25-inch erosion from the channel and the banks of stream reaches where roads encroach within 50 feet of the stream. The sediment contribution from these sources was annualized based on large discharge events every 10 years.

Stream Bank Erosion

Stream bank erosion yields sediment to the streams where such erosion occurs. The bank recession rate and height and length of eroding banks were measured using Natural Resource Conservation Service methods for streams with significant bank erosion. The sedimentation rate from eroding banks was estimated based on these measurements (Sampson 1999). Bank erosion was found only in the Loop and Mica Creek watersheds.

Sedimentation Estimates

Sedimentation estimates were developed by totaling the various sediment yields annualized for delivery to the channels based on a 10-year event (Tables 18a and b).

Estimated total sediment delivery from individual streams is compared in Table 19, which shows the percent above background sedimentation rates expected from each watershed. Background sedimentation rates reflect a watershed entirely vegetated with coniferous forest and devoid of roads (0.023 tons/acre/year multiplied by the total acreage of the watershed). The small Bear/Little Bear watershed was incorporated into the Bussel Creek watershed for the purposes of this analysis. Sediment model results indicate that Bear, Fishhook, and Mica Creeks exceed background sediment yield by greater than 50%. Sediment yield greater than 50% above background is used as a coarse filter to segregate streams in which sediment may be impairing water quality (Washington Forest Practices Board 1995). Analyses of the model outputs (Table 18) indicate that it is the encroachment of roads into the floodplain, and to a lesser extent, road crossings, that are responsible for the excess sedimentation.

Additional unlisted streams in the St. Joe River subbasin were modeled for sedimentation. Sediment modeling in these watersheds required some assumptions because CWE data was not collected for these streams. It was assumed the streams would have CWE road scores and mass failure rates similar to those of adjacent watersheds that received CWE analysis. The comparison of the modeled sedimentation rates with the estimated background sedimentation is provided in Table 19. Hugus, Eagle, Boulder, and Lower Marble Creeks have sedimentation rates above the threshold value of 50%. The Boulder Creek watershed is only slightly above the threshold, while the Eagle Creek watershed is substantially above the threshold (>100%), and above the rate at which water quality problems are expected (Washington Forest Practices Board 1995).

The watersheds of Bird, East Fork Bluff, Gold, Harvey, Hobo, and DaVeggio Creeks have sedimentation rates well below the threshold of concern and have WBAGII scores (? 2) indicating full support of beneficial uses. The Mica and Eagle watersheds have sedimentation rates at which water quality problems are expected. Hugus, Boulder, Bear, and Fishhook Creeks have modeled sedimentation rates in the gray area where the impact to water quality is uncertain. Combined, the entire Marble Creek watershed provided a modeled sedimentation rate of 3,150.4 tons per year, while the estimated background rate would be 2,213.1 tons per year. The entire watershed is 42.4% above the background sedimentation rate, and is below the threshold of concern. The Boulder, Eagle, Lower Marble, and Hugus watersheds should be the subject of further investigation before additional decisions are made concerning the water quality of these streams.

Table 18. Estimated sediment yield.

a) 303(d) listed segments

Sediment Yield -St. Joe River Subbasin 303(d) Listed Segments

Subwatershed	Bear	Bird	Blackjack	East Fork Bluff	Fishhook	Gold	Harvey	Loop	Mica	Tank
Conifer forest (tons/yr)(fine)	23.4	135.5	5.1	87.5	231.0	241.1	2.9	286.5	235.7	6.7
(coarse)	15.6	60.9	11.8	126.0	271.2	103.3	8.0	150.9	300.0	15.6
Unstocked forest (tons/yr)(fine)	6.0	13.2	4.9	6.5	50.8	55.1	8.5	23.4	34.1	3.6
(coarse)	4.0	5.9	11.4	9.3	59.7	23.6	22.9	12.3	43.5	8.3
Double fires (tons/yr)(fine)	0.0	0.0	0.0	0.0	0.5	0.0	0.0	10.3	0.0	0.0
(coarse)	0.0	0.0	0.0	0.0	0.6	0.0	0.1	5.4	0.0	0.0
Total yield (tons/yr)(fine)	**29.4**	**148.7**	**10.0**	**94.0**	**282.3**	**296.2**	**11.4**	**320.2**	**269.8**	**10.3**
(coarse)	**19.6**	**66.8**	**23.2**	**135.3**	**331.5**	**126.9**	**31.0**	**168.6**	**343.5**	**23.9**
County, Forest, and Private Road Sediment Yield										
Subwatershed	Bear	Bird	Blackjack	East Fork Bluff	Fishhook	Gold	Harvey	Loop	Mica	Tank
Surface fine sediment (tons/year)	14.9	4.6	0.2	5.9	56.7	11.9	0.2	11.7	79.2	0.3
Road failure fines (tons/year)[1]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.3	0.0	0.0
Road failure coarse (tons/year)[1]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.9	0.0	0.0
Encroachment fines (tons/year)[2]	17.5	22.4	0.9	12.3	145.9	55.5	0.6	64.1	216.4	0.1
Encroachment coarse (tons/yr)[2]	11.7	10.1	2.2	17.7	171.2	23.8	1.5	33.8	312.3	0.2
Forest Roads										
Total fine yield (tons/year)	**32.4**	**27.0**	**1.1**	**18.2**	**202.6**	**67.4**	**0.8**	**104.1**	**295.6**	**0.4**
Total coarse yield (tons/year)	**11.7**	**10.1**	**2.2**	**17.7**	**171.2**	**23.8**	**1.5**	**48.7**	**312.3**	**0.2**
Total sediment (tons/year)	93.1	252.6	36.5	265.2	987.6	514.3	44.7	641.6	1221.2	34.8
Percent Fines[3]	0.66	0.69	0.30	0.42	0.49	0.71	0.27	0.66	0.46	0.31
Percent Coarse	0.34	0.31	0.70	0.58	0.51	0.29	0.73	0.34	0.54	0.69

[1]Uses mass failure and delivery rates developed from Cumulative Watershed Effects protocol prorated for road miles and annualized;

Tons delivered x (road mileage/road mileage assessed)/10 years

[2]Assume: 0.25-inch from 3 feet banks; density = 2.6 grams per cubic centimeter

[3]from weighted average of fines and stones in soils groups

b) Streams draining to St. Joe River

Sediment Yield-Bond, Hugus, and Marble Subwatersheds

Subwatershed	Bond	Hugus	Upper Marble	Eagle	Homestead	Bussel	Hobo	DaVeggio	Boulder	Lower Marble
Conifer forest (tons/year)(fine)	175.2	98.2	133.6	62.9	53.2	157.8	58.9	56.1	85.4	169.9
(coarse)	182.3	102.3	237.6	47.5	98.8	105.2	84.7	95.4	145.4	289.3
Unstocked forest (tons/year)(fine)	0.0	5.4	7.6	14.5	3.0	18.5	2.1	5.3	14.9	19.1
(coarse)	10.9	5.7	13.6	0.0	5.5	12.4	3.0	9.0	25.3	32.6
Double fires (tons/year)(fine)	0.0	0.0	1.7	0.2	1.6	1.0	0.4	0.4	0.0	5.6
(coarse)	0.0	0.0	3.1	0.1	2.9	0.7	0.6	0.7	0.0	9.5
Total yield (tons/year)(fine)	**175.2**	**103.6**	**142.9**	**77.6**	**57.8**	**177.3**	**61.4**	**61.8**	**100.3**	**194.6**
(coarse)	**193.2**	**108.0**	**254.3**	**47.6**	**107.2**	**118.3**	**88.3**	**105.1**	**170.7**	**331.4**

Forest and Private Road Sediment Yield

Subwatershed	Bond	Hugus	Upper Marble	Eagle	Homestead	Bussel	Hobo	DaVeggio	Boulder	Lower Marble
Forest road										
Surface fine sediment (tons/year)	24.0	20.0	4.4	22.2	8.4	17.5	4.9	8.9	20.3	43.0
Road failure fines (tons/year)[1]	5.4	4.9	5.6	4.3	0.9	5.1	1.3	1.7	4.3	5.7
Road failure coarse (tons/year)[1]	5.6	5.1	9.9	3.2	1.7	3.4	1.9	2.8	7.3	9.7
Encroachment fines (tons/year)[2]	72.1	62.4	10.6	82.0	11.3	39.3	7.4	8.3	48.9	152.5
Encroachment coarse (tons/year)[2]	75.1	64.9	18.9	61.8	21.0	26.2	10.6	14.2	83.3	259.6
Total fine yield (tons/year)	**101.5**	**87.3**	**20.6**	**108.5**	**20.6**	**61.9**	**13.6**	**18.9**	**73.5**	**201.2**
Total coarse yield (tons/year)	**80.7**	**70.0**	**28.8**	**65.0**	**22.7**	**29.6**	**12.5**	**17.0**	**90.6**	**269.3**
Total sediment (tons/year)	550.6	368.9	446.6	298.7	208.3	387.1	175.8	202.8	435.1	996.5
Percent Fines[3]	0.50	0.52	0.37	0.62	0.38	0.62	0.43	0.40	0.40	0.40
Percent Coarse	0.50	0.48	0.63	0.38	0.62	0.38	0.57	0.60	0.60	0.60

[1]Uses mass failure and delivery rates developed from Cumulative Watershed Effects protocol prorated for road miles and annualized; Tons delivered x (road mileage/road mileage assessed)/10 years
[2]Assume: 0.25-inch from 3 feet banks; density = 2.6 grams per cubic centimeter
[3]from weighted average of fines and stones in soils groups

Table 19. Estimated background and sediment export.

a) 303(d) listed segments

Sediment Export - St. Joe River 303(d) Listed Segments

Subwatershed	Bear[1]	Bird	Blackjack	East Fork Bluff	Fishhook	Gold	Harvey	Loop	Mica	Tank
Land use fines export (tons/year)	29.4	148.7	9.9	94.0	282.4	296.1	11.4	320.2	269.9	10.2
Land use coarse export (tons/year)	19.6	66.8	23.2	135.2	331.5	126.9	31.0	168.6	343.5	23.9
Road fines export (tons/year)	32.4	27.0	1.1	18.3	202.6	67.4	0.7	104.1	295.6	0.4
Road coarse export (tons/year)	11.7	10.1	2.2	17.7	171.2	23.8	1.5	48.7	312.3	0.2
Bank erosion fines (tons/year)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank erosion coarse (tons/year)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total fines export (tons/year)	61.8	175.7	11.0	112.3	485.0	363.5	12.1	424.3	565.5	10.6
Total coarse export (tons/year)	31.3	76.9	25.4	152.9	502.7	150.7	32.5	217.3	655.8	24.1
Total (tons/year)	**93.1**	**252.6**	**36.4**	**265.2**	**987.7**	**514.2**	**44.6**	**641.6**	**1,221.3**	**34.7**
Natural Background	**47.5**	**212.7**	**30.7**	**226.9**	**596.3**	**411.4**	**37.6**	**467.8**	**601.8**	**32.4**
Percent above background	**96.0**	**18.8**	**18.6**	**16.9**	**65.6**	**25.0**	**18.6**	**37.2**	**102.9**	**7.1**

[1]Bear watershed includes Little Bear watershed.

b) Streams draining to the St. Joe River

Sediment Export - Bond, Hugus, and Marble Subwatersheds

Subwatershed	Bond	Hugus	Upper Marble	Eagle	Homestead	Bussel	Hobo	DaVeggio	Boulder	Lower Marble
Land use fines export (tons/year)	175.2	103.7	143.0	77.5	57.7	177.3	61.4	61.7	100.3	194.6
Land use coarse export (tons/year)	193.2	107.9	254.2	47.6	107.2	118.2	88.3	105.1	170.7	331.4
Road fines export (tons/year)	101.5	87.3	20.6	108.4	20.6	61.9	13.6	18.9	73.5	201.1
Road coarse export (tons/year)	80.7	70.0	28.7	65.0	22.7	29.6	12.5	17.0	90.6	269.3
Bank erosion fines (tons/year)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bank erosion coarse (tons/year)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total fines export (tons/year)	276.7	191.0	163.6	185.9	78.3	239.2	75.0	80.6	173.8	395.7
Total coarse export (tons/year)	273.9	177.9	282.9	112.6	129.9	147.8	100.8	122.1	261.3	600.7
Total (tons/year)	**550.6**	**368.9**	**446.5**	**298.5**	**208.2**	**387.0**	**175.8**	**202.7**	**435.1**	**996.4**
Natural background	**375.7**	**210.0**	**389.3**	**132.0**	**159.2**	**289.3**	**147.9**	**163.6**	**265.1**	**503.3**
Percent above background	**46.6**	**75.7**	**14.7**	**126.1**	**30.8**	**33.8**	**18.9**	**23.9**	**64.1**	**98.0**

Sedimentation Mechanisms

A thorough discussion of the potential sedimentation mechanisms in forested and harvested watersheds is provided in the North Fork Coeur d'Alene River Subbasin Assessment (section 2.3.2.5.3)(DEQ 2001). The discussion will not be repeated for the St. Joe River subbasin, but the mechanisms most active in this watershed will be briefly discussed.

Approximately 47% of the St. Joe watershed is subject to rain-on-snow events, and 47% of the watershed is in the stable snow zone. Although the St. Joe watershed is subject to rain-on-snow discharge events, these are uncommon and not very intense due to its topography. Forestland that is not fully stocked with trees is scarce in the St. Joe watershed, as is land that has been affected by two wildfires in succession. In those watersheds where sedimentation rates are greater than the threshold of concern, roads that encroach on the floodplains, and to a lesser extent, road crossings, are the agents of sediment yield. This appears to cause the exceedences.

Status of Beneficial Uses

The assessed support status of the listed water bodies based on the data available is provided in Table 20. The need for development of a TMDL is noted.

The bacteria limitations of Bear, Little Bear, Blackjack, Harvey and Tank Creeks were disproved. The dissolved oxygen limitations of Blackjack, Harvey, and Tank Creeks were disproved. The nutrient limitation of Gold Creek was disproved. Exceedence of the temperature standard for salmonid spawning was found to occur for significant periods in Bear, Little Bear, Blackjack, and Harvey Creeks. It is probable Tank Creek exceeds the standard as well. Significant exceedences of temperature standards for salmonid spawning and bull trout were found throughout the subbasin. Significant temperature standard exceedences were found in the highest elevation tributaries of the subbasin. These tributaries are known to harbor excellent trout populations. The temperature data indicate that temperature standards may not adequately reflect the requirements of trout. These standards are currently under review by the DEQ. Until the standards issues have been resolved, the temperature TMDLs for the St. Joe River subbasin will be developed.

Sedimentation modeling results indicate that Fishhook, Hugus, and Boulder Creeks have values greater than the 50% above background sedimentation rate threshold of concern, but below the threshold at which water quality impairment is expected (>100%) (Washington Forest Practices Board 1995).

Sediment modeling also indicated that Bear and Lower Marble Creeks are approaching the 100% above background threshold criteria, while Eagle and Mica Creeks are beyond the 100% above background threshold criteria. Sediment TMDLs are recommended for all listed watersheds (Fishhook, Bear, Mica) exceeding the 50% above background threshold. Watersheds that are not listed, but have modeled sediment levels beyond the 50% above background threshold, require further investigation to determine if sediment is adversely affecting aquatic life use.

Table 20. Results of the St. Joe River subbasin assessment based on application of the available data.

Water Body Name and HUC Number	Assessed Support Status	Reasons Segment to be Delisted for Pollutant
Bear/ Little Bear Creeks 17010304 7606 17010304 7607	Sediment modeling indicates cold water use may not be supported by sediment levels; sediment TMDL required. Bacteria monitoring indicates full support of contact recreation. Temperature standard exceeded; temperature TMDL required.	Monitoring of *E.coli* indicates full support of contact recreation standard.
Beaver Creek 17010304 5619	Temperature standard exceeded; temperature TMDL required	N/A
Big Creek 17010304	WBAGII assessment indicates cold water aquatic life not supported, waterbody to be addressed by the 2002-2003 303(d) List.	N/A
Bird Creek 17010304 3614	Sediment modeling indicates cold water use supported by sediment levels.	Sediment modeled at < 50% of background rate; WBAGII score ? 2.
Blackjack Creek 17010304 7577	Sediment modeling indicates cold water use supported by sediment levels. Monitoring of bacteria indicates full support of contact recreation. Dissolved oxygen standard supported. Temperature standard exceeded; temperature TMDL required.	Monitoring of *E.coli* indicates full support of contact recreation standard. Dissolved oxygen above cold water aquatic life standard. Sediment modeled at < 50% of background rate and SHI score ? 2.
Bluff Creek 17010304 5022	Temperature standard exceeded; temperature TMDL required.	N/A
Bond Creek 17010304	WBAGII assessment indicates cold water aquatic life not supported, waterbody to be addressed by the 2002-2003 303(d) List.	N/A
Boulder Creek 17010304	Sediment modeling indicates cold water use may not be supported by sediment levels; further investigation required to determine if aquatic life use is adversely affected.	N/A
Eagle Creek 17010304 3617	WBAGII assessment indicates cold water aquatic life supported, but sediment modeling indicates sediment yield high; further investigation required to determine if aquatic life use is adversely affected.	N/A
East Fork Bluff Creek 17010304 5022	Sediment modeling indicates cold water use supported by sediment levels.	Sediment modeled at < 50% of background rate; WBAGII score ? 2.
Fishhook Creek 17010304 3608	Sediment modeling indicates cold water use may not be supported by sediment levels; sediment TMDL required. Temperature standard exceeded; temperature TMDL required.	N/A
Fly Creek 17010304 2016	Temperature standard exceeded; temperature TMDL required.	N/A
Gold Creek 17010304 3622	WBAGII assessment indicates cold water aquatic life supported. Sediment modeling indicates cold water use supported by sediment levels. Nutrient level indicates weed growth standard not exceeded. Temperature standard exceeded; temperature TMDL required.	Sediment modeled at < 50% of background rate; WBAGII score ? 2. Nutrients not present in concentrations causing nuisance weed or algae growth.
Harvey Creek 17010304 7576	WBAGII assessment indicates cold water aquatic life supported. Sediment modeling indicates cold water use supported by sediment levels. Monitoring of bacteria indicates full support of contact recreation. Dissolved oxygen standard supported. Temperature standard exceeded; temperature TMDL required.	Monitoring of *E.coli* indicates full support of contact recreation standard; Dissolved oxygen above cold water aquatic life standard. Sediment modeled at < 50% of background rate; WBAGII score ? 2.
Heller Creek 17010304 2017	Temperature standard exceeded; TMDL required	N/A
Hugus Creek 17010304 3600	WBAGII assessment indicates cold water aquatic life supported, but sediment modeling indicates sediment yield high; further investigation required to determine if aquatic life use is adversely affected.	N/A

Table 20, continued.

Water Body Name and HUC Number	Assessed Support Status	Reasons Segment to be Delisted for Pollutant
Loop Creek 17010304 5620	Sediment modeling indicates cold water use supported by sediment levels. Temperature standard exceeded; temperature TMDL required.	Sediment modeled at < 50% of background rate. Stream Fish Index scores high. No evidence of unknown pollutant found.
Marble Creek (Lower) 17010304 3604	WBAGII assessment indicates cold water aquatic life not supported. Sediment modeling indicates sediment yield high. Waterbody to be addressed by the 2002-2003 303(d) List.	N/A
Mica Creek 17010304 3601	WBAGII score ? 2, however, sediment modeling indicates sediment more than twice the 50% above background threshold; sediment TMDL required.	N/A
Mosquito Creek 17010304 2020	Temperature standard exceeded; temperature TMDL required.	N/A
Simmons Creek 17010304 2022	Temperature standard exceeded; temperature TMDL required.	N/A
Tank Creek 17010304 7575	Sediment modeling indicates cold water use supported by sediment levels. Monitoring of bacteria indicates full support of contact recreation. Dissolved oxygen standard supported. Temperature standard exceeded; temperature TMDL required.	Sediment modeled at < 50% of background rate; trout density and habitat index high; monitoring of *E.coli* indicates full support of contact recreation standard. Dissolved oxygen above cold water aquatic life standard.
Toles Creek	WBAGII assessment indicates cold water aquatic life not supported, waterbody to be addressed by the 2002-2003 303(d) List.	N/A

Conclusions

The TMDLs currently required in the St. Joe River subbasin are listed in Table 21. The Big, Bond, Boulder, Eagle, Hugus, Lower Marble, and Toles Creeks are not currently on the 303(d) list. Of these watersheds, those with unsatisfactory WBAGII scores will be addressed by the 2002-2003 303(d) List, while those with high sediment levels will require further investigation to determine if aquatic life use is adversely affected by excess sediment.

Table 21. TMDLs required for the St. Joe River subbasin.

Watershed	TMDL Required	Critical Flow	Boundaries of Exceedence	Critical Reaches	Key indicator
Bear/Little Bear	Sediment	Episodic high flow	Headwaters to Toles Creek	Rosgen B and C channels	Tons/year
Bear/Little Bear	Temperature	Low summer flow	Headwaters to Toles Creek	Entire length	Full potential shade
Beaver	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade
Blackjack	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade
Bluff	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade
Fishhook	Sediment	Episodic high flow	Headwaters to St. Joe River	Rosgen B and C channels	Tons/year
Fishhook	Temperature	Low summer flow	Lick Creek to St. Joe River	Entire length	Full potential shade
Fly	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade

Table 21, continued.

Watershed	TMDL Required	Critical flow	Boundaries of Exceedence	Critical Reaches	Key indicator
Gold	Temperature	Low summer flow	East Fork Gold to St. Joe River	Entire length	Full potential shade
Harvey	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade
Heller	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade
Loop	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade
Mica	Sediment	Episodic high flow	Headwaters to St. Joe River	Rosgen B and C channels	Tons/year
Mosquito	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade
Simmons	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade
Tank	Temperature	Low summer flow	Headwaters to St. Joe River	Entire length	Full potential shade

2.4 Data Gaps

Cumulative watershed effects data or data from an equivalent procedure for Bear, Fishhook, Harvey, and Mica Creeks would be beneficial to the sediment modeling. These data are required to better model sediment yields.

Additional temperature data is important to better understand the temperature status of all of the segments of the subbasin. Spatial temperature data would better improve the scope of temperature exceedences.

3. Subbasin Assessment – Pollutant Source Inventory

Sources of nutrients, bacteria, and dissolved oxygen demanding materials are not apparent in the St. Joe River subbasin. Sources of sediment exist in the St. Joe River watershed, including approximately 14.7 tons per square mile per year of natural background sediment. All sources of sediment are nonpoint sources. Sources of thermal input are restricted to loss of stream canopy cover.

3.1 Sources of Pollutants of Concern

Pollutant sources of sediment are discussed in the following sections. Sediment is yielded to the subbasin from a large number of sources, including natural erosion. Cattle are sources of bacteria and nutrients, but grazing is limited in the subbasin to flat fields in the lower river floodplain. Sources of dissolved oxygen demanding materials are not apparent.

Point Sources

No point sources have been permitted or found in the subbasin. The city of St. Maries wastewater treatment plant and Potlatch Corporation discharges are downstream of the subbasin.

There are no Superfund or Resource Conservation Recovery Act (RCRA) sites in the subbasin. Petroleum spills have been addressed at several sites including Avery and Red Ives.

Nonpoint Sources

The primary disturbance causing stream temperatures to rise is non-natural canopy modification by silvicultural and agricultural practices. Attainment of natural full potential canopy shade is the most that can be done to lower stream temperatures.

Nonpoint sources of sediment are primarily from silvicultural practices, especially forest roads. The majority of the land use of the subbasin is forestlands. Silvicultural features, such as road crossings and encroaching roads, are accounted for in the sediment model and are documented in the GIS coverages that were used to load the model.

Sediment sources can be described by land use category as follows:

-- The meta-sedimentary rocks of the Proterozoic Belt Supergroup yield a natural sediment rate of 0.023 tons per acre per year (14.7 tons per square mile per year). Mass wasting is not a typical feature of the terrain, but it does occur on tertiary glacial deposits. Mass wasting is directly estimated in the CWE process.

-- Timber harvest is a source of sediment, especially in the first year following the harvest, while the cut area is void of cover. Forest ground cover regenerates rapidly in open areas where new plants are not competing with mature trees. Ground cover has been observed to return to 28-50% cover the first year after a harvest and near 75% in the second year (Elliot and Robichaud 2001). Once vegetative cover is reestablished, the excess sedimentation from the harvest does not occur.

-- Timber harvest roads are a significant source of sediment. These can yield surface sediment, trigger mass wasting, or constrain streams and accelerate erosion. County and state roads, railroads, and highways can also constrain streams and accelerate erosion.

No significant sources of bacteria, nutrients, or dissolved oxygen requiring substances were found in the St. Joe River subbasin.

Pollutant Transport

Pollutant transport is only relevant to sediment. Sediment is delivered to the stream system primarily during high precipitation-high discharge events or rapid snowmelt events. These are episodic events. Under these conditions, large volumes of sediment move in the stream systems. These conditions develop stream power and stage heights capable of channel alteration. Sediment trapped in upper low order watersheds moves quickly to the higher order streams of the subbasin. Areas with a stream gradient constrained by roads have rapid erosion from the bed and/or banks. The gradient of the St. Joe River is insufficient to flush sediment larger than gravel and cobble from the stream channel below Calder. A sediment transport model is not available for the St. Joe River.

3.2 Data Gaps

The major data gap in temperature pollution is monitoring data from the entire length of the stream. The major data gap in sediment pollution is not related to the sources, but is related to in-stream measurements of load and transport of sediment.

Point Sources

No point discharges of sediment, heat, nutrients, bacteria, or oxygen demanding materials have been documented.

Nonpoint Sources

Nonpoint sources of sediment have been modeled rather than measured. In-stream monitoring of the sediment load would be of value. Such monitoring is quite expensive (see Section 2.3, page 28 in DEQ 2001). It is unlikely that this data gap will be filled. Model results are the best available information.

Current temperature data are from in-stream monitoring at set locations. Thermal imaging that provides a view of stream wide temperatures would be of value. Such imaging is expensive.

4. Subbasin Assessment – Summary of Past and Present Pollution Control Efforts

The Idaho Forest Practices Act governs the harvest and reforestation of all timberlands in Idaho. These rules are, in part, best management practices designed to abate erosion and retard sediment delivery to the streams. The IDL has implemented the act's rules and regulations aggressively over the past 14 years. The timber industry and state have worked cooperatively to acquire the Milwaukee Railroad grade and convert the grade into a high quality road along the St. Joe River. Upgrading and paving the road has lessened sediment delivery to the river from this source.

All USFS harvests must meet INFISH (the federal Inland Native Fish Strategy) guidelines. These guidelines prescribe 300-foot wide buffers for streams with fishery uses. The USFS has relocated and obliterated roads in the subbasin. The USFS also decommissioned 50 miles of road in the Bird and Eagle Creek watersheds. An additional 26 miles of roads have been decommissioned in the North Fork St. Joe, Marble, and Fishhook watersheds. Another 20 miles of road decommissioning or removal is currently planned for the Marble, Loop, Bird, and Eagle Creek watersheds. In the past six years, 155 miles of road removal, decommissioning, and closure has occurred in the Simmons, Gold, Loop, Boulder, and Marble Creek watersheds.

The primary land managers of the St. Joe watershed are the USFS and the timber companies, Potlatch Corporation and Forestry Capital, Inc. Road inventories have been developed in and around timber sale areas for several years. The USFS and Potlatch Corporation have inventoried timber stands and the road systems. This information is available in interactive GIS format. In this form, the stand and road inventory information is available to pinpoint problem sites. Road removal projects and stream crossings requiring remediation can be given priority.

Potlatch has a watershed study in Mica Creek designed to identify impacts of past and current timber harvest. The study has been in progress for nearly nine years. Specific road removals and road crossing projects have been implemented to assess the benefit of these actions on the watershed.

Agricultural practices in the subbasin are livestock grazing and some hay land harvest. These occur almost exclusively in the bottomland along the lower St. Joe River. This land is essentially flat. The Benewah Soil and Water Conservation District has completed 14,790 feet of stream bank erosion abatement projects on the St. Joe River between the towns of Calder and St. Maries. The district has another 8,560 feet ready for implementation.

The USFS has completed 10 acres of riparian enhancement through vegetation planting. Stream enhancement structures have been placed at 115 locations in Heller, Big, Loop, Cedar, and Eagle Creeks. Petroleum spills have been addressed at several sites with leaking underground storage tanks, including Avery and Red Ives. All known petroleum spill sites in the St. Joe River subbasin have been addressed.

5. Total Maximum Daily Loads

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a waste load allocation (WLA); and nonpoint sources, which receive a load allocation (LA). Natural background (NB), when present, is considered part of the load allocation, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (40 CFR part 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the MOS is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First the LC is determined. Then the LC is broken down into its components: the necessary MOS is determined and subtracted; then NB, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation are completed we have a TMDL, which must equal the LC.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. Also, a required part of the loading analysis is that the LC be based on critical conditions – the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both LC and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for "other appropriate measures" to be used when necessary. These "other measures" must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads, and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

Some streams in the St. Joe River subbasin are impaired due to habitat alteration. While degraded habitat is evidence of impairment, the EPA does not consider a waterbody to be polluted if the pollution is not a result of the introduction or presence of a pollutant. Since

TMDLs are not required to be established for waterbodies impaired by pollution but not pollutants, a TMDL has not been established for these streams for habitat alteration.

5.1 Fishhook Creek Sediment TMDL

This TMDL addresses sediment in Fishhook Creek, which is listed for sediment as well as for temperature. Since the creek is physically isolated from the remaining streams requiring sediment TMDLs, a separate TMDL was developed. Fishhook Creek's temperature TMDL is discussed in Section 5.3.

5.1.1 In-Stream Water Quality Targets

The in-stream water quality target for the Fishhook Creek sediment TMDL is full support of the cold water designated use (Idaho Code 39.3611, .3615). Specifically, sedimentation must be reduced to a level where full support of beneficial uses is demonstrated using the current assessment method accepted by DEQ at the time the water body is reassessed.

The TMDL will develop loading capacities in terms of mass per unit time. The interim goals will be set based on conditions in watersheds supporting the cold water use and the final goals will be established when biomonitoring demonstrates full support of the cold water use. The sources yielding sediment to the system can be reduced, but a substantial period (20-30 years) will be required for the stream to clear its current sediment bed load and create pools.

Design and Conditions

All sources of sediment to Fishhook Creek are nonpoint sources. The TMDL addresses the nonpoint sediment yield to the watershed. Sediment from nonpoint sources is loaded episodically, primarily during high discharge events. These critical events coincide with critical conditions. These events occur during November through May, but may not occur for several years. The typical return time of the largest events is 10-15 years (DEQ 2001). The critical stream reaches are the Rosgen B channel types that naturally harbor the most robust cold water communities, but have gradients sufficiently low for coarse bedload to accumulate and fill pools. The key to nonpoint source sediment management is to implement remedial activities prior to the advent of a large discharge event. Large discharge events are the only mechanism of transporting coarse sediments downstream.

Target Selection

The TMDL applies sediment allocations in tons per year and calculates sediment reduction goals. The middle and lower reaches of Fishhook Creek are impaired by sediment, but sediment yield reduction will be required from the entire watershed to meet full support status.

The load capacity rate at which full support is exhibited has been set at various levels within TMDL documents developed by DEQ. These have ranged from setting an interim load capacity at the background level for some watersheds in the Coeur d'Alene Lake Subbasin and the Pend Oreille basin, to over 200% above background in some areas of the state. Evidence is beginning to support that a target of 50% above background is protective of the beneficial uses. This target has already been used in the North Fork Coeur d'Alene TMDL (DEQ 2001) and the Priest River TMDL (Rothrock 2002). The rationale supplied in those TMDLs in support of the target was based on several premises (DEQ 2001):

-- Sediment yield below 50% above background will fully support the beneficial uses of cold water aquatic life and salmonid spawning.

-- The stream has some finite yet not quantified ability to process a sediment yield rate greater than 50% above background rates.

-- Beneficial uses (cold water aquatic life and salmonid spawning) will be fully supported when the finite yet not quantified ability of the stream system to process (attenuate) sediment is met.

Data collected within the St. Joe River subbasin appear to support the target of 50% above background. A comparison of WBAG II scores of watersheds to the modeled percent above background estimates is shown in Figure 8. Only watersheds that had WBAGII scores based on all three of the major components (macroinvertebrates, fish, and habitat) were included in the analysis. The green shaded area indicates the area of the graph where both the WBAGII score is full support and the modeled percent above background is less than 50%. The red area is the portion of the graph is where the WBAGII scores shows that a stream is impaired and the modeled percent above background is greater than 50%.

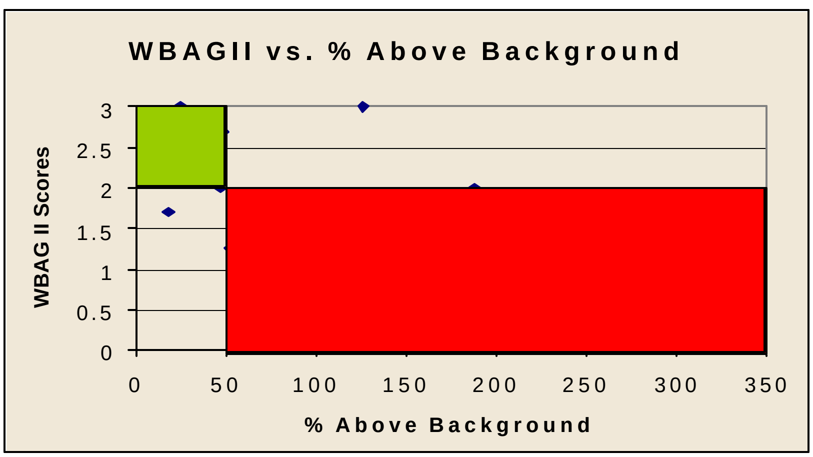

Figure 8. WBAGII Scores Versus Modeled Percent Sediment Above Background

In all but two instances, the WBAGII score and the target of 50% above background coincide. The two watersheds that do not conform may be affected by conditions other than sediment and are therefore unresponsive to changes in sediment delivery to the stream. For instance, Blackjack Creek is a watershed that has a WBAGII score of less than 2, but has very little sediment being delivered to it. This is a first order watershed that is very small with a steep gradient. The low WBAGII scores are a result of poor macroinvertebrate and fish populations. Blackjack Creek's habitat score was one of the highest in the subbasin. The poor macroinvertebrate score could be the result of the small watershed size and relatively little disturbance, making the system nutrient poor and unable to support a good macroinvertebrate community. This low nutrient scenario could also affect the fish community due to a poor food base. The fish community may also be affected by the steep gradient of this watershed, which could make available fish habitat limited.

According to the evidence outlined above, the 50% above background target appears to be reasonable and very protective of the beneficial uses of the watersheds in the St. Joe River subbasin. Therefore, the target load capacity for Fishhook Creek, and the remaining sediment TMDLs in this document, is set at 50% above background.

The goal should be attained following three high flow events after implementation plan actions are in place. Based on the average recurrence of high flow events, this should take about 30 years. This time is necessary to have the channel forming events to export sediment and to create pool structures.

Monitoring Points

The point of compliance for Fishhook Creek is one mile above its mouth (BURP Site # 95NIRO 0A25). The sediment load reduction from the current level (65.6% above background) toward the goal (50% above background) is expected to reduce sediment to a load that, although not yet quantified, will fully support beneficial use (cold water aquatic life). Beneficial use support status will be determined using the current assessment method accepted by DEQ at the time the water body is monitored. Monitoring will be completed using BURP protocols. When the final sediment load capacity is determined by these appropriate measures of full cold water aquatic life support, the TMDL will be revised to reflect the established supporting sediment yield.

5.1.2 Load Capacity

The load capacity for a TMDL designed to address a sediment-caused limitation to water quality is complicated by the fact that the state's water quality standard is a narrative rather than a quantitative standard. In the waters of Fishhook Creek, the sediment interfering with the beneficial use (cold water) is most likely large bed load particles. Adequate quantitative measurements of the effect of excess sediment have not been developed. Given this difficulty, an exact sediment load capacity for the TMDL is difficult to develop.

The natural background sedimentation rate is the sediment yield prior to development of the watershed. It was calculated by multiplying the watershed acreage (26,152 acres) by the sediment yield coefficient for Belt Supergroup terrain vegetated by coniferous forests (0.023 tons/acre/year). The estimate assumes the entire watershed was vegetated by coniferous forest prior to development. As shown in Table 22, the calculated estimated value for the entire Fishhook Creek watershed is 601 tons per year. Thus, the 50% above background sediment yield goal is 902 tons per year for the entire watershed. The load capacity was developed by calculating background sedimentation based on acreage above the point of compliance, then adding an additional 50% to the value. The goal is an estimated goal that will be replaced by the final sediment goal when the criteria for full support of cold water use are met.

Table 22. Fishhook Creek sediment load, background, and load capacity at the point of compliance.

Load Type	Location (BURP[1] Site ID Number)	Acreage of Watershed	Estimated Existing Load (tons/year)	Natural Background (tons/year)	Load Capacity at 50% Above Background (tons/year)	Estimation Method
Sediment	Fishhook Creek (95NIRO 0A25)	26,152	988	601	902	Model

[1]Beneficial Use Reconnaissance Program

Seasonality and Critical Conditions

Sediment from nonpoint sources is not loaded seasonally. It is loaded episodically, primarily during high discharge events. These critical events coincide with the critical conditions and occur during November through May. However, such events may not occur for several years. The return time of the largest events is usually 10-15 years (DEQ 2001).

Critical conditions are part of the analysis of load capacity. The beneficial uses in this subbasin are impaired due to chronic sediment conditions. Due to the chronic condition, this TMDL deals with yearly sediment loads. The concept of critical conditions is difficult to reconcile with the impact caused by sediment. The critical condition concept assumes that under certain conditions, chronic pollution problems become acute pollution problems. Therefore, it is important to ensure that acute conditions do not occur. The proposed sediment reductions in the TMDL will reduce the chronic sediment load and will also reduce the likelihood that an acute sediment loading condition will exist. It is in this way that critical conditions are accounted for in the TMDL.

5.1.3 Estimates of Existing Pollutant Loads

Point sources of sediment do not exist in the Fishhook Creek watershed.

Nonpoint sources of sediment yield were estimated in Section 2.3 (Table 18). These estimates were made using the assumptions and model approach fully documented in Appendix C. Loading rates were based on land use and road impacts (see Section 2.3). The estimated sediment load from the watershed above the point of compliance was shown in Table 22.

The loading area of various sources is entirely forestland. Roads are the single largest source of sediment in the watershed. The percentage of sediment delivery estimated by the miles of forest road based on land ownership is provided in Table 23. Graphic representation of the Fishhook Creek road mileage is available in Appendix D, Figure D-1.

Table 23. Fishhook Creek sediment loading proportion based on ownership.

Owner	Fishhook Creek	
	Acreage	% of Sediment Load
Bureau of Land Management	24	0
U.S. Forest Service	14,464	55
Private	11,664	45
Total	26,152	100

5.1.4 Pollutant Load Allocation

The pollutant allocation is the load capacity minus the margin of safety and the background. A pollutant allocation is comprised of the waste load allocation of point sources and the load allocation of nonpoint sources. Since there are no point sources, this sediment TMDL has a load allocation only.

Margin of Safety

The margin of safety is implicit in the model used. The model is estimated to be 231% conservative when applied on the Belt terrain (Appendix C). This level of conservative assumptions provides an over-estimation of sediment yield. The over-estimation is the implicit margin of safety. Given the conservatively high estimations developed by the model, no additional explicit margin of safety is deemed necessary.

Background

The background sediment load for the watershed is 601 tons per year, as shown in Table 22. The background is treated as part of the load capacity and is allocated as part of the load capacity below. Any unknown unallocated point sources would be included in the background portion of the allocation.

Reserve

No part of the load allocation is held for additional load. All new infrastructure should be constructed or mitigated to allow no net increase in sediment yield to the watershed.

Remaining Available Load

The remaining available load is allocated between the nonpoint sources (load allocation), since no point sources of sediment exist or are expected to exist in the watershed.

Load Allocation

The load allocation and reduction is shown in Table 24. The allocation is based on the modeled estimate of nonpoint source sediment contribution of 988 tons per year and a reduction to 50% above background. The allocation includes the background sediment yield of 601 tons per year, and the margin of safety is applied at the point of compliance. The load reduction required for each land owner is based on the difference between the existing sediment contribution and the load capacity at 50% above background. After implementation, 30 years have been allotted for meeting load allocations. This time frame will permit two or three large channel forming events to occur in the stream.

Table 24. Sediment load allocations and load reductions required for land owners along Fishhook Creek.

Owner/Manager	Percent of load source (%)	Load allocation (tons/year)	Load reduction required (tons/year)	Time frame for meeting allocations
Bureau of Land Management	0	0	0	-
U.S. Forest Service	55	496	47	30 years
Private	45	406	39	30 years
Total	100	902	86	-

Reasonable Assurance of TMDL Implementation

The model identifies forest roads as the primary source of sediment. The federal government manages 55% of the roads in the Fishhook Creek watershed. The large federal ownership should assure implementation plan development and implementation. Road erosion issues on private land can be addressed by incentives provided to private land owners by the Benewah Soil and Water Conservation District. The plan will be implemented based primarily on the budgetary constraints of this incentive program and federal agencies.

Monitoring Provisions

In-stream monitoring of the beneficial uses (cold water and salmonid spawning) support status during and after implementation of sediment abatement projects will establish the final sediment load reduction required by the TMDL. In-stream monitoring, which will determine if the threshold values have been met, will be completed every year on randomly selected sites on each stream order of the subbasin after 70% of the plan has been implemented. Monitoring will be conducted using the DEQ-approved monitoring procedure at the time of sampling. Identical measurements will be made in appropriate reference streams where beneficial uses are supported.

Feedback Provisions

When beneficial use (cold water) support meets the full attainment level, further sediment load reducing activities will not be required in the watershed. The interim sediment load capacity will be replaced in a revised TMDL with the ambient sediment load. Best management practices for forest and mining will be prescribed by the revised TMDL with provisions to maintain erosion abatement structures. Regular monitoring of the beneficial use will be continued for an appropriate period to document maintenance of the full support of the beneficial use (cold water aquatic life).

5.1.5 Conclusions

The assessment of the St. Joe River subbasin indicates that WBAGII scores and sediment modeling reveal sediment impairment of the cold water use in Fishhook Creek.

A sediment TMDL has been prepared for Fishhook Creek. The TMDL sets a goal of 50% above natural background sediment yield based on sediment yield from watersheds of the subbasin fully supporting the cold water beneficial use. A load capacity was set based on this goal. An implicit margin of safety of 231% was applied in the sediment model. No point sources of sediment exist or are expected. The load capacity was allocated to land owners based on the percent of land owned.

5.2 Bear, Little Bear, and Mica Creeks Sediment TMDL

These three watersheds are contiguous and have been combined into a single sediment TMDL.

5.2.1 In-Stream Water Quality Targets

The in-stream water quality target for the Bear, Little Bear, and Mica Creeks TMDL is full support of the cold water designated use (Idaho Codes 39.3611 and .3615). Specifically, sedimentation must be reduced to 50% or less above background and the watersheds must achieve WBAGII scores of two or greater. The TMDL will develop loading capacities in terms of mass per unit time. The interim goals will be set based on watersheds supporting the cold water use and final goals set when biomonitoring establishes full support of the cold water use. The sources yielding sediment to the system can be reduced, but a substantial period (20-30 years) will be required for the stream to clear its current sediment bed load and create pools.

Design Conditions

All sources of sediment to Bear, Little Bear, and Mica Creeks are nonpoint sources. The TMDL addresses the nonpoint sediment yield to the watershed. Sediment from nonpoint sources is loaded episodically, primarily during high discharge events. These critical events coincide with the critical conditions and occur during November through May. However, such events may not occur for several years. The typical return time of the largest events is

10-15 years (DEQ 2001). The critical stream reaches are the Rosgen B and C channel types that naturally harbor the most robust cold water communities, but have gradients sufficiently low for coarse bed load to accumulate and fill pools. The key to nonpoint source sediment management is implementing remedial activities prior to the advent of a large discharge event. Large discharge events are the primary mechanism for transporting coarse sediments downstream.

Target Selection

The TMDL applies sediment allocations in tons per year and calculates sediment reduction goals. The lower reaches of Bear and Little Bear Creeks are impaired by sediment. The lower reaches of Mica Creek have sediment yield in a range expected to affect water quality. Sediment yield reduction will be required from the entire watershed in each case. The implementation plan may apply surrogate measures of success.

As stated in the Fishhook Creek TMDL, a 50% above background target will be used throughout the St. Joe River subbasin (pages 56-57).

Several watersheds adjacent to Bear, Little Bear, and Mica Creeks (DaVeggio, Hobo, and Gold) have levels of sediment contribution that are 50% or less above background. These watersheds also have WBAGII scores of two or greater. This data appears to support the target of 50% above background. Therefore, as in the Fishhook Creek TMDL, the target load capacity for Bear, Little Bear, and Mica Creeks is set at 50% above background. The goal should be attained following two to three high flow events after implementation plan actions are in place. This should take about 30 years. This time is necessary to have the channel forming events to export sediment and to create pool structures.

Monitoring Points

Four points of compliance are set. These points are at Bear Creek near its mouth (BURP Site # 95NIRO 0A61), Little Bear Creek near its mouth (BURP Site # 95NIRO 0A60), Mica Creek near its mouth (BURP Site # 96NIRO 0B11), and Mica Creek below Mica Meadows (BURP Site # 96NIRO 0B08). Due to the small size of Little Bear Creek, the watershed has been combined with the Bear Creek watershed for sediment calculations. Monitoring will occur at the points of compliance on each creek. Sediment load reduction from the current levels (Bear/Little Bear, 95.9% above background; Mica, 102.9% above background) toward the goal (50% above background) is expected to attain a sediment load that is not yet quantified, but will fully support the beneficial use (cold water aquatic life). This sediment load will be recognized through monitoring and by determining beneficial use support using the current assessment method accepted by DEQ at the time the water body is reassessed. Monitoring will be completed using the BURP protocols. When the final sediment load capacity is determined by these appropriate measures of full cold water aquatic life support, the TMDL will be revised to reflect the established supporting sediment yield.

5.2.2 Load Capacity

The load capacity for a TMDL designed to address a sediment-caused limitation to water quality is complicated by the fact that the state's water quality standard is a narrative rather than a quantitative standard. In the waters of Bear, Little Bear, and Mica Creeks, the sediment interfering with the beneficial use (cold water) is most likely large bed load particles. Adequate quantitative measurements of the effect of excess sediment have not been developed. Given this difficulty, an exact sediment load capacity for the TMDL is difficult to develop.

The natural background sedimentation rate is the sediment yield prior to development of the watershed. It was calculated by multiplying the watershed acreage (Bear/Little Bear, 2,074 acres; Mica, 26,170 acres) by the sediment yield coefficient for Belt Supergroup terrain vegetated by coniferous forests (0.023 tons/acre/year). The estimate assumes the entire watershed was vegetated by coniferous forest prior to development. The calculated estimated yield for the entire Bear/Little Bear and Mica Creek watersheds are 48 and 602 tons per year, respectively. Thus, the 50% above background sediment yield goal is 72 and 903 tons per year, respectively for the entire watersheds. Loading capacities were developed by calculating background sedimentation based on acreage above the point of compliance, then adding 50% to the value. The goals are estimated targets that will be replaced by the final sediment goals when the criteria for full support of the cold water use are met. The loading capacities based on the projected goal at the points of compliance are provided in Table 25.

Table 25. Bear/Little Bear and Mica Creeks sediment loads, backgrounds, and loading capacities at the points of compliance.

Load Type	Location (BURP Site ID #)	Acreage of Watershed	Estimated Existing Load (tons/year)	Natural Background (tons/year)	Load Capacity at 50% Above Background (tons/year)	Estimation Method
Sediment	Bear Creek (95NIRO 0A61) and Little Bear Creek (95NIRO 0A60)	2,074	93	48	72	Model
Sediment	Mica Creek (96NIRO 0B11) and (96NIRO 0B08)	26,170	1,221	602	903	Model

Seasonality and Critical Conditions

Sediment from nonpoint sources is not loaded seasonally. It is loaded episodically, primarily during high discharge events. These critical events coincide with the critical conditions and occur during November through May. However, such events may not occur for several years. The typical return time of the largest events is 10-15 years (DEQ 2001).

Critical conditions are part of the analysis of load capacity. The beneficial uses in this subbasin are impaired due to chronic sediment conditions. Due to the chronic condition, this TMDL deals with yearly sediment loads. The concept of critical conditions is difficult to reconcile with the impact caused by sediment. The critical condition concept assumes that under certain conditions, chronic pollution problems become acute pollution problems. Therefore, it is important to ensure that acute conditions do not occur. The proposed sediment reductions in the TMDL will reduce the chronic sediment load and also reduce the likelihood that an acute sediment loading condition will exist. It is in this way that critical conditions are accounted for in the TMDL.

5.2.3 Estimates of Existing Pollutant Loads

Point sources of sediment do not exist in the Bear, Little Bear, or Mica Creek watersheds.

Nonpoint sources of sediment yield were estimated in Section 2.3 (Table 18). These estimates use made using the assumptions and model approach fully documented for land use and road impacts (see Section 2.3). Estimated sediment loads from the watershed above the points of compliance are shown in Table 25.

The loading area of various sources is entirely forestland. Roads are the single largest source of excess sediment in the watershed. The percentage of sediment delivery estimated by the miles of forest road on land holdings is provided in Table 26. Graphic representation of Bear/Little Bear and Mica Creeks road mileage is available in Appendix D, and in Figures D-2 and D-4, respectively.

Table 26. Sediment loading proportion based on ownership.

a) Bear/Little Bear Creeks

Owner/ Manager	Bear and Little Bear Creeks	
	Acreage	% of Sediment Load
Bureau of Land Management	307	15
U.S. Forest Service	1,395	67
Private	372	18
Total	2,074	100

b) Mica Creek

Owner/ Manager	Mica Creek	
	Acreage	% of Sediment Load
Bureau of Land Management	740	3
U.S. Forest Service	911	3
Idaho Department of Lands	5,210	20
Private	19,309	74
Total	26,170	100

5.2.4 Pollutant Load Allocation

The pollutant allocation is comprised of the load capacity minus the margin of safety and the background. A pollutant allocation would be comprised of the waste load allocation of point sources and the load allocation of nonpoint sources, but since there are no point sources, the sediment TMDL has a load allocation only.

Margin of Safety

The margins of safety is implicit in the model used. The model is estimated to be 231% conservative when applied on the Belt terrain (Appendix C). This level of conservative assumptions provides an over-estimation of sediment yield. The over-estimation is the implicit margin of safety. Given the conservatively high estimations developed by the model, no additional explicit margin of safety is deemed necessary.

Background

The background sediment loads for the watersheds are shown in Table 25. These loads are treated as part of the load capacity and are allocated as part of the load capacity below. Any unknown unallocated point sources would be included in the background portion of the allocation.

Reserve

No part of the load allocation is held for additional load. All new infrastructures should be constructed or mitigated to allow no net increase in sediment yield to the watersheds.

Remaining Available Load

The remaining available load is allocated between the nonpoint sources (load allocation), since no point sources of sediment exist in the watersheds or are expected to exist.

Load Allocation

The load allocations and reductions are shown in Table 27. The allocations are based on a reduction to 50% above background and on the modeled estimate of nonpoint source sediment contribution of Bear/Little Bear and Mica Creeks (93 and 1,221 tons per year, respectively). The allocation includes the background sediment yield of 48 and 602 tons per year, respectively, and the margin of safety is applied at the points of compliance. The load reduction required for each land owner is based on the difference between the existing sediment contribution and the load capacity at 50% above background. After implementation, 30 years have been allotted for meeting load allocations. This time frame will permit two to three large channel forming events to occur in the streams.

Table 27. Sediment load allocation and load reduction required for land owners along Bear/Little Bear and Mica Creeks.

a) Bear/Little Bear Creeks

Owner/Manager	Percent of load source (%)	Load allocation (tons/year)	Load reduction required (tons/year)	Time frame for meeting allocations
Bureau of Land Management	15	11	3	30 years
U.S. Forest Service	67	48	14	30 years
Private	18	13	4	30 years
Total	100	72	21	-

b) Mica Creek

Owner/Manager	Percent of load source (%)	Load allocation (tons/year)	Load reduction required (tons/year)	Time frame for meeting allocations
Bureau of Land Management	3	27	10	30 years
U.S. Forest Service	3	27	10	30 years
Idaho Department of Lands	20	181	63	30 years
Private	74	668	235	30 years
Total	100	903	318	-

Reasonable Assurance

The model identifies forest roads as the primary source of sediment. The federal government manages 82% of the roads in the Bear/Little Bear watersheds and 6% of the roads in the Mica Creek watershed, while the state of Idaho manages 20% of the roads in the Mica Creek watershed. The Idaho Department of Lands has been directed by a gubernatorial executive order to implement state developed TMDLs on lands that they manage directly or oversee implementation of the Forest Practices Act. The plan will be implemented based primarily on the budgetary constraints of the federal and state agencies.

Monitoring Provisions

In-stream monitoring of the beneficial uses (cold water and salmonid spawning) support status during and after implementation of sediment abatement projects will establish the final sediment load reduction required by the TMDL. In-stream monitoring, which will determine if threshold values have been met, will be completed every year on a randomly selected 1% of the watershed's Rosgen B channel types. These are the channel types, when in good condition, most likely to house cold water aquatic life and salmonid populations. Monitoring will assess stream reaches of at least 30 times bank full width in length. These reaches will be randomly selected from the total stream channel in B types until at least 5% of these channels have been assessed after five years. Identical measurements will be made in appropriate reference streams where beneficial uses are supported. Data will be compiled after five years. The yearly increments of random testing that sum to 5% of the stream after five years should provide a database not biased by transit fish and macroinvertebrate population shifts. Based on this database the beneficial use support status will be determined.

Feedback Provisions

When beneficial use (cold water) support meets the full attainment level, further sediment load reducing activities will not be required in the watershed. The interim sediment load capacity will be replaced in a revised TMDL with the ambient sediment load. Best management practices for forest and mining will be prescribed by the revised TMDL with provisions to maintain erosion abatement structures. Regular monitoring of the beneficial use will be continued for an appropriate period to document maintenance of the full support of the beneficial use (cold water aquatic life).

5.2.5 Conclusions

Sediment modeling conducted as part of the assessment of the St. Joe River subbasin shows that Bear and Little Bear Creeks have sediment impairment of the cold water use. Mica Creek has a modeled sediment yield in excess of 100% above background.

A sediment TMDL was prepared for the Bear/Little Bear and Mica watersheds. The TMDL sets a goal of 50% above natural background sediment yield based on sediment yield from watersheds of the subbasin fully supporting the cold water beneficial use. A load capacity was set based on this goal. An implicit margin of safety of 231% was applied in the sediment model. No point sources of sediment exist or are expected. The load capacity was allocated to land owners based on the percent of land owned.

5.3 Lower St. Joe River Segments Temperature TMDL

This TMDL addresses tributaries to the lower St. Joe River that have been listed as water quality limited by temperature, including Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creeks.

5.3.1 In-Stream Water Quality Targets

Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creeks are in the St. Joe River bull trout recovery area (headwaters to Mica Creek) (Panhandle Bull Trout Technical Advisory Team 1998). The governing temperature standards for these water bodies and their tributaries are the federal 10 ^{o}C seven-day running average from May 1 to September 1, and the state 9 ^{o}C daily maximum spawning standard from September 1 through October 31. After October 31, water temperatures are expected to be well below 9 ^{o}C in the St. Joe River subbasin. In practice, these two standards are essentially the same standard (Dupont 2002): a 10 ^{o}C seven-day running average from May 1 through October 31 will meet both federal and state requirements.

Monitoring temperatures in St. Joe River subbasin streams with little or no human development and at relatively high elevations indicates that this standard is not attainable throughout the entire stream course (see Table 10). Temperature assessments of Bear, Little Bear, Blackjack, Fishhook, and Harvey Creeks indicate significant exceedences of both the federal and state bull trout standards (Table 10, Appendix B). Similar exceedences are expected for Tank Creek, a neighbor to Harvey Creek. It is currently beyond DEQ's technical capability to assess the sufficiency of cold water habitat during the summer and early fall months.

Design Conditions

Point sources of thermal input are not a consideration for Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creeks. Stream temperature is affected by natural weather conditions and the adjacent plant community potential, including disturbance and recovery. Vegetation manipulation to create access or to forest harvest is the major anthropogenic cause of stream temperature changes.

The environmental factors affecting stream temperature are local air temperature, stream depth, ground water inflow, and stream shading by riparian cover and/or topography (Sullivan and Adams 1990, Theurer et al. 1984, Beschta and Weatherred 1984). Topographic elevation affects ambient air temperature; higher elevations have lower ambient air temperature. In forest streams, ambient temperature and shading are believed to account for up to 90% of the stream temperature variability (Brown 1971, IDL 2000). Riparian shade can be modified by management; ambient temperature cannot.

Several models can be used to assess the impact of riparian shade on stream temperature. Heat Source (Boyd 1996) and SSTEMP (Bartholow 1997) quantify the energy transfer mechanisms in streams. These models require extensive data inputs, many of which are not available for mountain streams. Use of process-based models was found a workable approach for the North Fork Clearwater temperature TMDL (Dechert et al. 2001). This TMDL follows this approach and uses the IDL CWE canopy closure-stream temperature protocol (IDL 2000). Energy loading values are developed using SSTEMP as comparative data to the primary TMDL target measurement of percent canopy cover.

The CWE empirical model is based on continuous stream temperature measurements, topographic elevation, and percent of vegetative canopy cover data collected throughout northern Idaho. The model calculation is as follows:

Equation (1) $$MWMT = 29.1 - 0.00262E - 0.0849C$$

where MWMT = maximum weekly maximum temperature (^{o}C)
E = stream reach elevation (feet)
C = riparian canopy cover (%)

The equation can be solved for canopy cover to predict the required canopy at a given elevation.

Equation (2) $$C = (29.1/0.085) - (E * 0.0026/0.085) - (MWMT/0.085)$$

To calculate required canopy cover for the water bodies, MWMT would be set at 10°C.

Equation (3) $C = 224.7 - 0.031 * E$

To satisfy the requirement for an analysis of heat loading (energy per unit area per unit time) to a stream due to insolation, the method of Dechert et al. (2001) was used. The approach uses SSTEMP (Bartholow 1997) to derive insolation rate data for August 1, 2000 (median hottest day) and calculates heat loading for different levels of percent shade. The amount of solar radiation incident on a stream and its immediate surroundings at different shade levels for three non-redundant stream orientations are presented in Table 28. The fixed conditions used in SSTEMP to develop the solar radiation numbers for (in the case of Dechert *et al*.), the North Fork Clearwater River were 47 degrees north latitude, 5,000 feet elevation, 10-foot stream width, 60-foot buffer height, 30-foot buffer width, and 30? topographic shade (Dechert et al. 2001). Under these conditions incident solar radiation decreases regularly by 21 watts per square meter for every 10% increase in canopy density for north-south oriented streams and 26 watts per square meter for east-west oriented streams. The St. Joe River subbasin borders the North Fork Clearwater Subbasin where the model calculations were made. The Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creek watersheds are at lower elevation, ranging from 2,200 to 4,800 feet. Since solar radiation is stronger at higher elevation, the modeled energy inputs are conservative for these water bodies.

The heat fluctuation amounts in Table 28 do not represent the entire heat budget of the streams, but only that from direct sunlight (insolation). This is the portion of the heat fluctuation that the TMDL, and ultimately, vegetation management, can address. Land management cannot significantly affect other environmental factors affecting temperature.

Target Selection

The TMDL selects canopy cover by stream reach elevation as the target for load capacity goals or a defined target for reducing heat load. Canopy cover can be allocated as a surrogate for heat load reduction that is easily understood by the general public and can be affected in part by vegetation management. Canopy cover can be related to thermal load reduction by the SSTEMP estimates provided in Table 28. Canopy cover can be mapped on a stream reach basis to facilitate management prescriptions in a TMDL implementation plan.

Table 28. Average daily solar radiation incident related to canopy closure on a stream, as developed for the Upper North Fork Clearwater River.[1]

Canopy Density (percent)	Average Daily Solar Radiation in Relation to Stream Orientation		
	North-South (watts/m^2)	East-West (watts/m^2)	SE-NW or SW-NE (watts/m^2)
0	226	274	250
10	205	248	227
20	185	223	204
30	164	197	181
40	143	172	197
50	122	146	134
60	101	120	111
70	80	95	87
80	59	69	64
90	38	43	41
100	17	18	17.5

[1]SSTEMP model output (Dechert 2001) based on the following calculations:
North-South = (100-target canopy %)*2.1+1.7
East-West = (100-target canopy %)*2.56+18
SE-NW or SW-NE = (100-target canopy %)*2.33+17.5

Canopy cover can be easily assessed using aerial photography techniques. Milestones can be set on a 10-year basis in the implementation plan to coincide with the normal frequency of aerial photographic surveys.

Applicable reference streams are available in the St. Joe River subbasin above the Mosquito Creek confluence. This area was burned during the 1910 fires and has recovered seral timber stands, but timber harvest has been less intensive than in other watersheds of the subbasin. Bacon, Bean, and Yankee Bar Creeks are streams that could be used as reference streams. The streams of the upper subbasin currently support bull trout populations and most approach the 10 ^{o}C standard during August, when stream temperatures peak.

Monitoring Points

Although there are no specific regulations requiring monitoring, points of compliance have been selected to assess the success of the TMDL. These points are listed in Table 29. The sites would be used to assess both rearing and spawning temperatures.

Table 29. Points of compliance for the Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creeks temperature TMDL.

Water Body	Location	Beneficial Use Reconnaissance Site Number
Bear Creek	Near mouth	1995 SCDAA063
Little Bear Creek	Near mouth	1995 SCDAA009
Blackjack Creek	Near mouth	1996 SCDAA057
Fishhook Creek	Near mouth	1995 SCDAA025
Fishhook Creek	At Lick Creek confluence	1995 SCDAA024
Harvey Creek	Near mouth	1996 SCDAB012
Tank Creek	Near mouth	1996 SCAAB017

Primary TMDL monitoring will be with aerial photograph interpretation of canopy recovery over the streams. Aerial photography is repeated by the USFS on a 10-year time frame. This time frame will allow a sufficient period to assess canopy recovery. In addition, a set number of representative sites should be assessed on a periodic basis using canopy densiometer methodology to ground truth and calibrate the aerial photograph interpretation. These monitoring issues should be addressed and specified in a monitoring section of the implementation plan.

5.3.2 Load Capacity

The load capacity is stated in terms of canopy cover and the insolation rate required to maintain a 10 ^{o}C Maximum Weekly Maximum Temperature (MWMT). The load capacity is developed for each stream reach covering 200 feet of elevation. Equation 2 is used to calculate the percent cover required for each stream reach. Under elevations of 4,000 feet, the CWE model predicts greater than 100% canopy closure is necessary to maintain the 10 ^{o}C MWMT goal. Since this is not possible, canopy closure is defaulted to 100%. The Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creek watersheds have an elevation range of 2,200 to 4,800 feet. As a consequence, 100% canopy cover is required on all streams between 2,200 and 4,000 feet to achieve the 10 ^{o}C MWMT goal. Even this goal may not be achievable on some stream reaches due to natural plant community types or habitat type restrictions. The canopy cover goals are currently met on only a few of the 200 feet elevation increment reaches of the Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creek watersheds.

The CWE model and corroboration of its accuracy for predicting relationships between canopy cover, thermal input, and stream temperature have been documented in the *North Fork Clearwater Temperature TMDL* (Dechert et al. 2001).

Critical Conditions

Critical conditions are a part of the load capacity analysis. The critical conditions are low discharge conditions in August and early September (mid to late summer). The goal is set to meet the 10 ^{o}C MWMT during this time period, and the manageable thermal input is modeled to achieve this goal (Table 30). Acute and chronic violations of the 10 ^{o}C MWMT goal may contribute to the lack of bull trout in the Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creeks (Table 10, Appendix B).

Table 30. Cumulative Watershed Effects (CWE) calculated canopy cover required at stated elevations to maintain the 10^{o}C Maximum Weekly Maximum Temperature (MWMT) and corresponding heat load capacity.[1]

Elevation Range	CWE Target Canopy Cover (%)	Heat Load Capacity North-South Oriented Stream (watts/m^2)	Heat Load Capacity East-West Oriented Stream (watts/m^2)	Heat Load Capacity SW-NE or SE-NW Oriented Stream (watts/m^2)
4,800 – 4,999	71	79	93	86
4,600 – 4,799	77	66	77	71
4,400 –4,599	83	53	62	57
4,200 – 4,399	89	40	46	43
4,000 – 4,199	95	27	30	28
3,800 – 3,999	101	17	18	17.5
3,600 – 3,799	108	17	18	17.5
3,400 – 3,599	114[2]	17	18	17.5
3,200 – 3,399	120[2]	17	18	17.5
3,000 – 3,199	126[2]	17	18	17.5
2,800 – 2,999	132[2]	17	18	17.5
2,600 – 2,799	139[2]	17	18	17.5
2,400 – 2,599	145[2]	17	18	17.5
2,200 – 2,399	152[2]	17	18	17.5

[1] SSTEMP predicts insolation rates of 17-18 watts/m^2 for 100% canopy closure.

[2] Below 4,000 feet elevation the Cumulative Watershed Effects (CWE) model predicts a need for greater than 100% canopy closure to protect a maximum stream temperature of 10^{o}C Maximum Weekly Maximum Temperature (MWMT). Since this is not possible, 100% canopy closure is set as the surrogate. In some cases, 100% canopy closure may not be achievable because of plant community type or habitat type restrictions.

5.3.3 Estimates of Existing Pollutant Loads

There are no point sources of thermal input to Bear, Little Bear, Blackjack, Fishhook, Harvey, or Tank Creeks. Natural inputs include ambient air temperature, inflow ground water temperature, direct insolation, and several other minor natural inputs. Of these factors only direct insolation can be estimated and managed through the management of stream canopy cover.

Canopy cover was surveyed using aerial photographs and was assessed using the guidelines listed in Table 31. The canopy cover was ground verified by CWE crews. Insufficient canopy cover is the primary manageable temperature input. Current canopy coverage of reaches of Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creeks is provided in Tables 32a-e.

Table 31. General canopy cover estimate guide for aerial photo interpretation.[1]

Visibility on Aerial Photographs	Percent Canopy
Stream surface not visible	>90%
Stream surface slightly visible	76-90%
Stream surface visible in patches	61-75%
Stream surface visible, but banks are mostly not visible	46-60%
Stream surface visible and banks visible in places	31-45%
Stream surface and banks visible in most places	16-30%
Stream surface and banks visible	0-15%

[1] From Table C-4, IDL 2000.

5.3.4 Pollutant Load Allocation

There are no point sources of thermal input to Bear, Little Bear, Blackjack, Fishhook, Harvey, or Tank Creeks. For this reason, the temperature TMDL contains no waste load allocation or reserve of the waste load allocation. The load capacity is distributed between the margin of safety and the load allocation to the 200 feet elevation segments of the stream system.

Margin of Safety

Since the canopy cover required between 2,200 and 4,000 feet elevation is 100%, and the Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank watersheds exceed 4,000 feet elevation only in a few stream reaches, only a slight amount of further margin of safety above the built-in calculations is available. Canopy cover of 100% is both the requirement and the limit of management for temperature below 4,000 feet. The federal standard of 10 ^{o}C MWMT is used. Use of this standard incorporates some margin of safety, as it is more conservative than the state of Idaho's 12 ^{o}C bull trout standard.

Seasonal Variation

Heat loading capacity applicable to the St. Joe River watershed in relation to the EPA bull trout temperature standard is primarily a consideration during August and early September. Because of the seasonal progression in stream temperature, if a stream's annual temperature peak is targeted, and this peak is brought down to within criteria limits, then it can safely be assumed that the criteria will also be met at cooler times of the year. This is the basis of using the MWMT metric for criteria. The 10 °C MWMT criteria calculations for bull trout translates closely to the 9 °C daily average criteria for cutthroat.

Reasonable Assurance

Reasonable assurance is provided by nonpoint source implementation of BMPs based on land management agencies' assurance that reductions will occur. Additionally, trend monitoring will be used to document relative changes in various aquatic organism populations and in physical and chemical water quality parameters. This data in conjunction with data from various agencies, organizations, and water user industries will be used to assess overall progress towards attainment of water quality standards and related beneficial uses.

Background

The background temperatures and thermal inputs to Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creeks are not known. Neither pre-canopy removal stream temperature nor level of stream canopy cover was measured. Significant reaches of lower Bear Creek traverse a meadow, while the main stem and lower tributaries of Fishhook Creek flow through a deeply incised rocky canyon that certainly existed prior to development. These topographic features would not, and will not, support vegetation communities capable of providing 100% canopy cover to the stream. Any TMDL implementation plan should note and account for these areas of natural thermal loading.

Reserve

Reserve is typically removed from a waste load allocation for installations that might be made in the future. No waste load allocation or reserve is developed for this TMDL. The thermal capacity of the watershed has been exceeded by canopy removal. Canopy restoration to the degree possible is required to address the thermal loading. Point sources of thermal input cannot be permitted for the foreseeable future.

Remaining Available Load

The remaining load is allocated to the segments of the watershed based on the canopy requirements. The elevation range of the stream segments is used to develop the target canopy cover using the CWE temperature relationship (Tables 32a-e). These targets are, in most cases, greater than 100% because the Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creek watersheds exceed 4,000 feet elevation only in their upper stream reaches. These target values are revised to 100% canopy cover. Those segments over 4,000 feet require less than 100% canopy cover. The existing canopy cover is subtracted from the required cover to calculate the amount of canopy cover restoration required. Using the SSTEMP model outputs for canopy cover and the stream orientation, the target heat load capacity is calculated for each segment. Based on current canopy cover and the SSTEMP model outputs for percentage canopy cover, the current heat loading is estimated. Simple subtraction and division provide the target heat loading reduction required for each segment.

The current level of canopy cover is provided in Figures 9a-c. The target canopy cover for all segments is provided in Figures 10a-c.

Canopy Habitat Type Limitations

Some habitat types arrayed along streams are not capable of sustaining sufficient stream canopy coverage. These habitat types either have physical limitations that preclude sufficient tree density to develop complete canopy coverage or are habitat types that do not support tree establishment to any significant degree.

Two such habitat types are present on two different streams in this temperature TMDL. Bear and Little Bear Creeks have wet meadow communities along substantial portions of their lower courses. Trees and shrubs are excluded by physical factors from much of this community type. Soils are too saturated for tree establishment. The lower reach of Fishhook Creek is in a steep canyon and is bordered by a forest scree community. This community can develop limited tree density due to the limited sites available for tree establishment. As a consequence, limited canopy cover will develop. The extent of these limiting communities is mapped in Figures 9a-c and stream segments with canopy habitat type limitations are identified with a footnote in Table 32. These segments were assigned interim target canopy cover levels. The actual maximum potential canopy for these streams will be determined by a committee of forest and riparian professionals during the implementation phase of TMDL development. After a determination is made, thisTMDL will be amended to reflect the new values.

Table 32. Watershed temperature TMDLs – Cumulative Watershed Effects (CWE) calculated percent canopy cover and heat loading.

a) Bear and Little Bear Creeks

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Loading (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Bear Creek	3,200-3,400	644	35.0	120	100	65	EW	18.0	184.4	90.2
Bear Creek	3,200-3,400	1,362	80.0	120	100	20	EW	18.0	69.2	74.0
Bear Creek	3,400-3,600	6,890	20.0	114	100	80	NS	17.0	185.0	90.8
Little Bear Creek	3,200-3,400	1,584	35.0	120	100	65	NS	17.0	153.5	88.9
Little Bear Creek	3,400-3,600	2,883	20.0	114	100	80	NS	17.0	185.0	90.8

b) Blackjack Creek

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Blackjack Creek	2,200-2,400	338	65.0	150.9	100	35	NS	17.0	90.5	81.2
Blackjack Creek	2,400-2,600	2,128	50.0	144.7	100	50	NS	17.0	122.0	86.1
Blackjack Creek	2,600-2,800	1,769	80.0	138.5	100	20	NS	17.0	59.0	71.2
Blackjack Creek	2,800-3,000	1,869	65.0	132.3	100	35	NS	17.0	90.5	81.2
Blackjack Creek	3,000-3,200	3,173	20.0	126.2	100	80	NS	17.0	185.0	90.8
Blackjack Creek	3,200-3,400	855	20.0	120.0	100	80	NS	17.0	185.0	90.8

c) Fishhook Creek

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Fishhook Creek	2,400-2,600	5,935	15.0	144.7	100[1]	85.0	NS	17.0	195.5	91.3
Fishhook Creek	2,600-2,800	3,120	15.0	138.5	100[1]	85.0	NS	17.0	195.5	91.3
Fishhook Creek	2,600-2,800	4,567	15.0	138.5	100[1]	85.0	NS	17.0	195.5	91.3
Fishhook Creek	2,800-3,000	4,831	15.0	132.3	100[1]	85.0	NS	17.0	195.5	91.3
Fishhook Creek	2,800-3,000	7,207	15.0	132.3	100[1]	85.0	NS	17.0	195.5	91.3
Fishhook Creek	3,000-3,200	2,867	15.0	126.2	100[1]	85.0	NS	17.0	195.5	91.3
Fishhook Creek	3,000-3,200	8,242	15.0	126.2	100[1]	85.0	NS	17.0	195.5	91.3
Fishhook Creek	3,200-3,400	3,384	40.0	120.0	100	60.0	NS	17.0	143.0	88.1
Fishhook Creek	3,400-3,600	2,307	40.0	113.8	100	60.0	NS	17.0	143.0	88.1
Fishhook Creek	3,600-3,800	855	40.0	107.7	100	60.0	NS	17.0	143.0	88.1
West Fork Fishhook Creek	3,600-3,800	2,767	20.0	107.7	100	80.0	NESW	17.5	203.9	91.4
Outlaw Creek	3,600-3,800	4,847	70.0	107.7	100.0	30.0	NS	17.0	80.0	78.8
Unnamed Tributary 1	2,800-3,000	296	95.0	132.3	100	5.00	EW	18.0	30.8	41.6
Unnamed Tributary 1	3,000-3,200	259	95.0	126.2	100	5.00	EW	18.0	30.8	41.6
Unnamed Tributary 1	3,000-3,200	454	95.0	126.2	100	5.00	EW	18.0	30.8	41.6

[1]Interim target canopy cover; physical habitat limitations in these segments make it unlikely that current target levels will be reached. Final target canopy cover to be determined during implementation phase.

Table 32-c, Fishhook Creek, continued.

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Unnamed Tributary 1	3,200-3,400	972	50.0	120.0	100	50.0	EW	18.0	146.0	87.7
Unnamed Tributary 1	3,400-3,600	829	50.0	113.8	100	50.0	EW	18.0	146.0	87.7
Unnamed Tributary 1	3,400-3,600	1,014	15.0	113.8	100	85.0	EW	18.0	235.6	92.4
Unnamed Tributary 2	2,800-3,000	422	95.0	132.3	100	5.00	EW	18.0	30.8	41.6
Unnamed Tributary 2	3,000-3,200	391	95.0	126.2	100	5.00	EW	18.0	30.8	41.6
Unnamed Tributary 2	3,200-3,400	982	95.0	120.0	100	5.00	EW	18.0	30.8	41.6
Unnamed Tributary 2	3,400-3,600	1,415	95.0	113.8	100	5.00	EW	18.0	30.8	41.6
Unnamed Tributary 2	3,600-3,800	771	80.0	107.7	100	20.0	EW	18.0	69.2	74.0
Unnamed Tributary 3	2,800-3,000	190	95.0	132.3	100	5.00	EW	18.0	30.8	41.6
Unnamed Tributary 3	3,000-3,200	322	95.0	126.2	100	5.00	EW	18.0	30.8	41.6
Unnamed Tributary 3	3,200-3,400	338	95.0	120.0	100	5.00	EW	18.0	30.8	41.6
Unnamed Tributary 3	3,200-3,400	840	70.0	120.0	100	30.0	EW	18.0	94.8	81.0
Unnamed Tributary 3	3,400-3,600	1,690	95.0	113.8	100	5.00	EW	18.0	30.8	41.6

Table 32-c, Fishhook Creek, continued.

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Unnamed Tributary 3	3,600-3,800	1,341	40.0	107.7	100	60.0	EW	18.0	171.6	89.5
Unnamed Tributary 4	2,800-3,000	486	15.0	132.3	100	85.0	EW	18.0	235.6	92.4
Unnamed Tributary 4	3,000-3,200	610	80.0	126.2	100	20.0	EW	18.0	69.2	74.0
Unnamed Tributary 4	3,200-3,400	375	80.0	120.0	100	20.0	EW	18.0	69.2	74.0
Unnamed Tributary 4	3,200-3,400	507	80.0	120.0	100	20.0	EW	18.0	69.2	74.0
Unnamed Tributary 4	3,400-3,600	480	80.0	113.8	100	20.0	EW	18.0	69.2	74.0
Unnamed Tributary 4	3,400-3,600	576	40.0	113.8	100	60.0	EW	18.0	171.6	89.5
Unnamed Tributary 4	3,600-3,800	845	70.0	107.7	100	30.0	EW	18.0	94.8	81.0
Unnamed Tributary 4	3,800-4,000	977	70.0	101.5	100	30.0	EW	18.0	94.8	81.0
Unnamed Tributary 4	4,000-4,200	480	70.0	95.3	95.3	25.3	EW	30.0	94.8	68.4
Horsecamp Creek	2,800-3,000	148	80.0	132.3	100	20.0	EW	18.0	69.2	74.0
Horsecamp Creek	3,000-3,200	919	80.0	126.2	100	20.0	EW	18.0	69.2	74.0
Horsecamp Creek	3,200-3,400	708	95.0	120.0	100	5.00	EW	18.0	30.8	41.6
Horsecamp Creek	3,200-3,400	470	70.0	120.0	100	30.0	EW	18.0	94.8	81.0

Table 32-c, Fishhook Creek, continued.

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m²)	Current Heat Load (watts/m²)	Target Heat Load Reduction (%)
Horsecamp Creek	3,400-3,600	459	70.0	113.8	100	30.0	EW	18.0	94.8	81.0
Horsecamp Creek	3,400-3,600	354	50.0	113.8	100	50.0	EW	18.0	146.0	87.7
Horsecamp Creek	3,600-3,800	808	50.0	107.7	100	50.0	EW	18.0	146.0	87.7
Horsecamp Creek	3,800-4,000	549	80.0	101.5	100	20.0	EW	18.0	69.2	74.0
Horsecamp Creek	3,800-4,000	1,357	95.0	101.5	100	5.00	EW	18.0	30.8	41.6
Cougar Creek	3,000-3,200	406	20.0	126.2	100	80.0	EW	18.0	222.8	91.9
Cougar Creek	3,200-3,400	359	20.0	120.0	100	80.0	EW	18.0	222.8	91.9
Cougar Creek	3,400-3,600	533	20.0	113.8	100	80.0	EW	18.0	222.8	91.9
Cougar Creek	3,600-3,800	602	20.0	107.7	100	80.0	EW	18.0	222.8	91.9
Cougar Creek	3,800-4,000	1,236	40.0	101.5	100	60.0	EW	18.0	171.6	89.5
East Fork Fishhook Creek	3,600-3,800	861	80.0	107.7	100	20.0	NWSE	17.5	64.1	72.7
East Fork Fishhook Creek	3,600-3,800	850	80.0	107.7	100	20.0	NWSE	17.5	64.1	72.7
East Fork Fishhook Creek	3,800-4,000	676	80.0	101.5	100	20.0	NS	17.0	59.0	71.2
East Fork Fishhook Creek	3,800-4,000	686	70.0	101.5	100	30.0	NS	17.0	80.0	78.8

Table 32-c, Fishhook Creek, continued.

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
East Fork Fishhook Creek	4,000-4,200	422	70.0	95.3	95.3	25.3	NS	26.8	80.0	66.5
East Fork Fishhook Creek	4,000-4,200	3,205	50.0	95.3	95.3	45.3	NS	26.8	122.0	78.0
Red Raven Creek	3,800-4,000	4,731	40.0	101.5	100	60.0	NESW	17.5	157.3	88.9
Red Raven Creek	4,000-4,200	2,899	20.0	95.3	95.3	75.3	NS	26.8	185.0	85.5
Red Raven Creek	4,200-4,200	924	40.0	89.1	89.1	49.1	NS	39.8	143.0	72.2
Outlaw Creek	3,800-4,000	3,480	70.0	101.5	100	30.0	EW	18.0	94.8	81.0
Outlaw Creek	4,000-4,200	1,705	70.0	95.3	95.3	25.3	EW	30.0	94.8	68.4
Outlaw Creek	4,000-4,200	1,278	50.0	95.3	95.3	45.3	EW	30.0	146.0	79.5
Outlaw Creek	4,200-4,400	723	50.0	89.1	89.1	39.1	EW	45.8	146.0	68.6
Outlaw Creek	4,200-4,400	1,975	40.0	89.1	89.1	49.1	EW	45.8	171.6	73.3
Outlaw Creek	4,400-4,600	1,457	70.0	83.0	83.0	13.0	EW	61.6	94.8	35.0
Lick Creek	3,000-3,200	574	20.0	126.2	100	80.0	NESW	17.5	203.9	91.4
Lick Creek	3,200-3,400	192	20.0	120.0	100	80.0	NESW	17.5	203.9	91.4
Lick Creek	3,200-3,400	1,306	50.0	120.0	100	50.0	NESW	17.5	134.0	86.9

Table 32-c, Fishhook Creek, continued.

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Lick Creek	3,200-3,400	277	40.0	120.0	100	60.0	NESW	17.5	157.3	88.9
Lick Creek	3,400-3,600	512	40.0	113.8	100	60.0	NESW	17.5	157.3	88.9
Lick Creek	3,400-3,600	997	20.0	113.8	100	80.0	EW	18.0	222.8	91.9
Lick Creek	3,600-3,800	515	20.0	107.7	100	80.0	NWSE	17.5	203.9	91.4
Lick Creek	3,600-3,800	876	50.0	107.7	100	50.0	NESW	17.5	134.0	86.9
Lick Creek	3,800-4,000	406	50.0	101.5	100	50.0	NESW	17.5	134.0	86.9
Lick Creek	3,800-4,000	392	10.0	101.5	100	90.0	NESW	17.5	227.2	92.3
Lick Creek	3,000-3,200	122	50.0	126.2	100	50.0	EW	18.0	146.0	87.7
Lick Creek	3,200-3,400	478	50.0	120.0	100	50.0	EW	18.0	146.0	87.7
Lick Creek	3,200-3,400	1,445	20.0	120.0	100	80.0	NESW	17.5	203.9	91.4

d) Harvey Creek

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Harvey Creek	2,200-2,400	285	20.0	150.9	100	80.0	NS	17.0	185.0	90.8
Harvey Creek	2,400-2,600	3,590	80.0	144.7	100	20.0	NS	17.0	59.0	71.2
Harvey Creek	2,600-2,800	1,911	20.0	138.5	100	80.0	NS	17.0	185.0	90.8
Harvey Creek	2,800-3,000	4,277	50.0	132.3	100	50.0	NS	17.0	122.0	86.1
Harvey Creek	3,000-3,200	2,328	40.0	126.2	100	60.0	NS	17.0	143.0	88.1
Harvey Creek	3,200-3,400	2,772	50.0	120.0	100	50.0	NS	17.0	122.0	86.1
Harvey Creek	3,400-3,600	2,672	65.0	113.8	100	35.0	NS	17.0	90.5	81.2

e) Tank Creek

Stream Segment	Elevation Range (ft)	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Tank Creek	2,200-2,400	602	15.0	150.9	100	85.0	NS	17.0	195.5	91.3
Tank Creek	2,400-2,600	3,696	80.0	144.7	100	20.0	NS	17.0	59.0	71.2
Tank Creek	2,600-2,800	1,183	40.0	138.5	100	60.0	NS	17.0	143.0	88.1
Tank Creek	2,800-3,000	2,387	50.0	132.3	100	50.0	NS	17.0	122.0	86.1
Tank Creek	3,000-3,200	1,267	70.0	126.2	100	30.0	NS	17.0	80.0	78.8
Tank Creek	3,000-3,200	1,156	20.0	126.2	100	80.0	NS	17.0	185.0	90.8
Tank Creek	3,200-3,400	549	20.0	120.0	100	80.0	NS	17.0	185.0	90.8

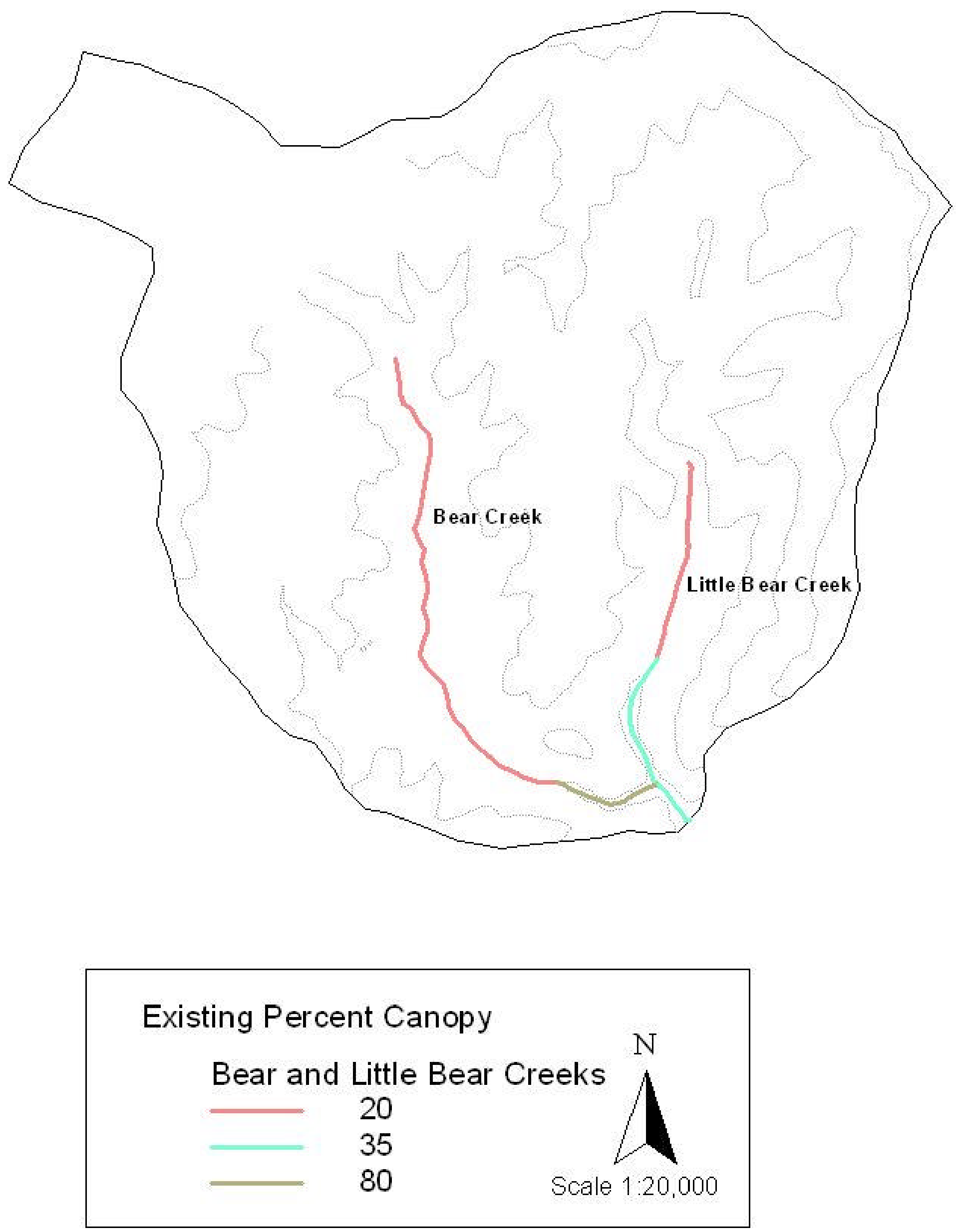

Figure 9a. Existing Shading Canopy: Bear and Little Bear Creeks

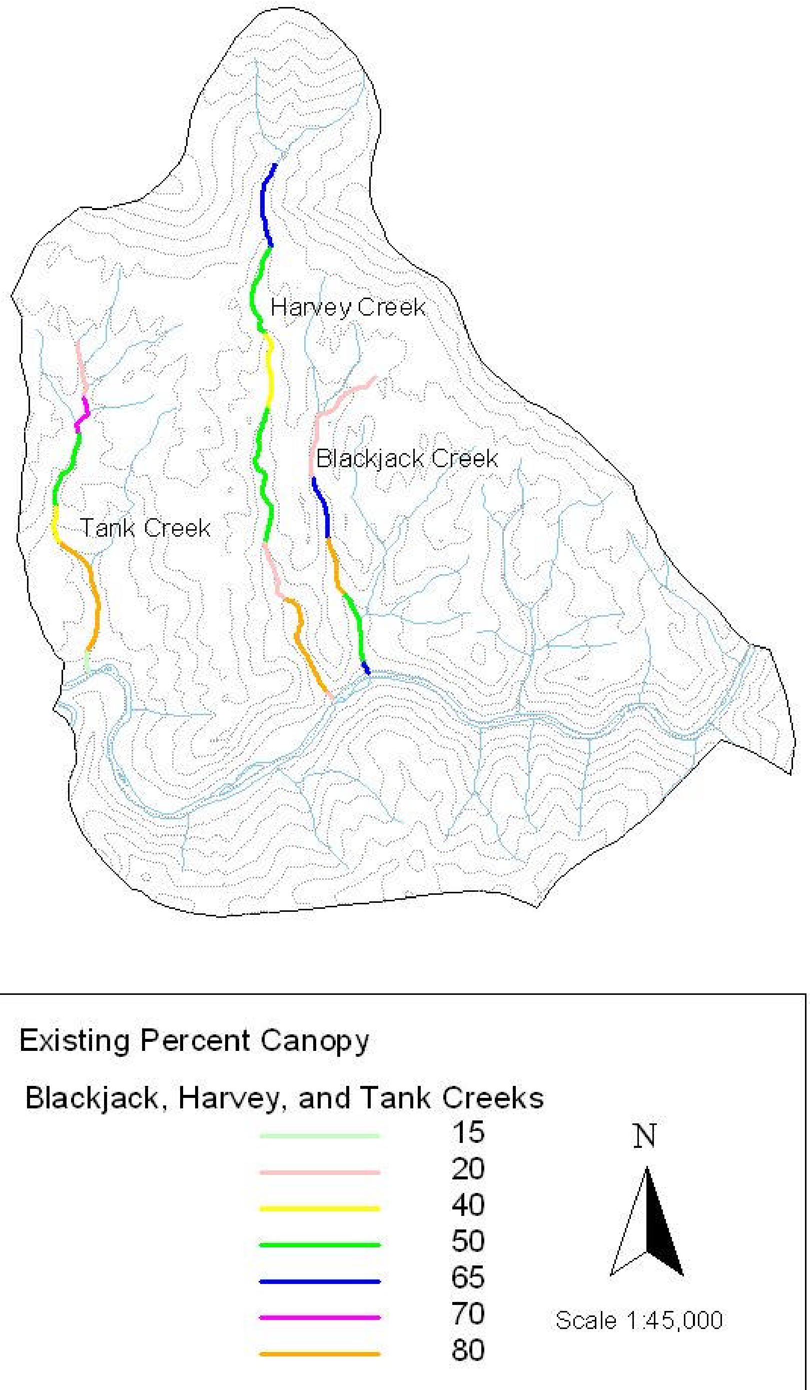

Figure 9b. Existing Shading Canopy: Blackjack, Harvey, and Tank Creeks

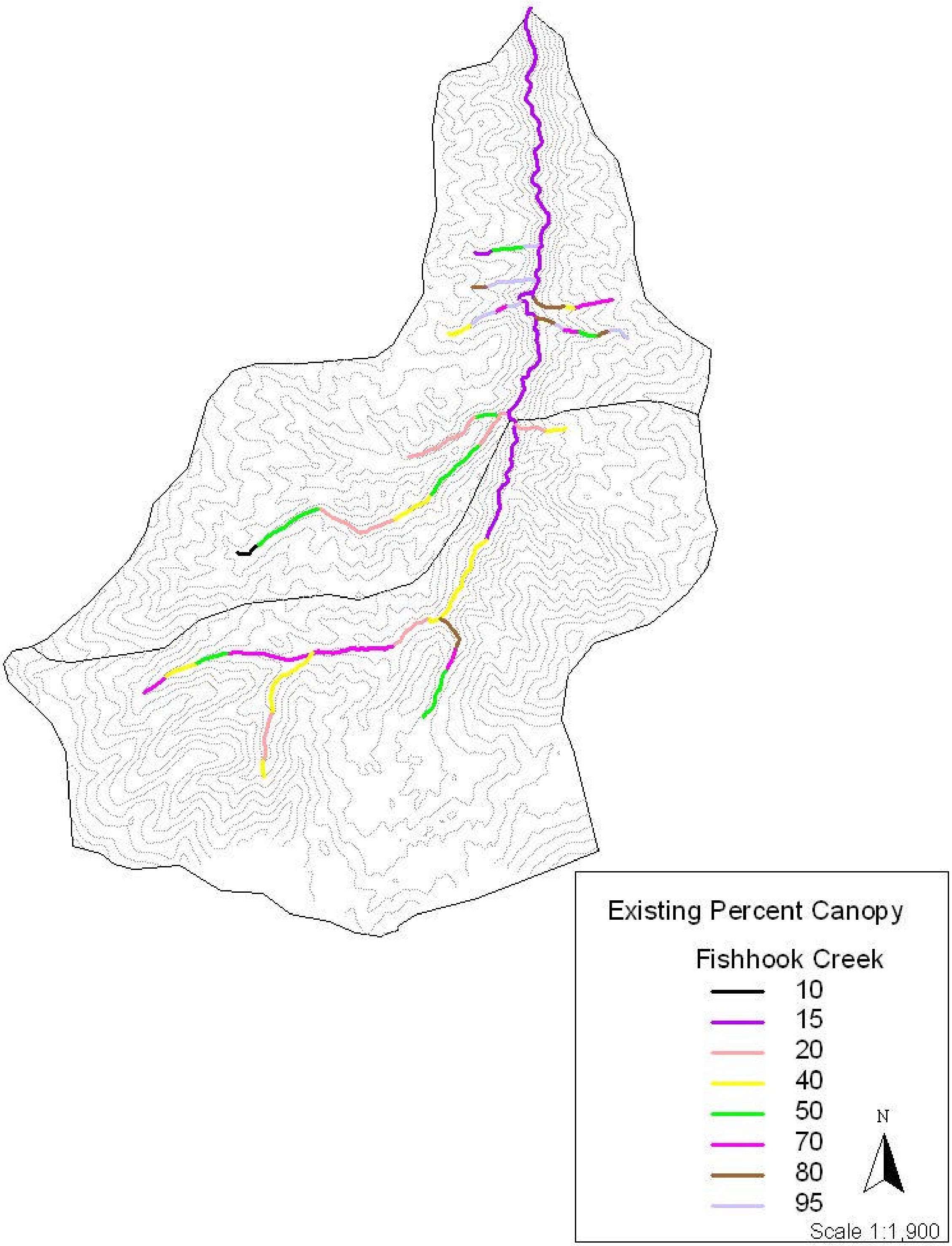

Figure 9c. Existing Shading Canopy: Fishhook Creek

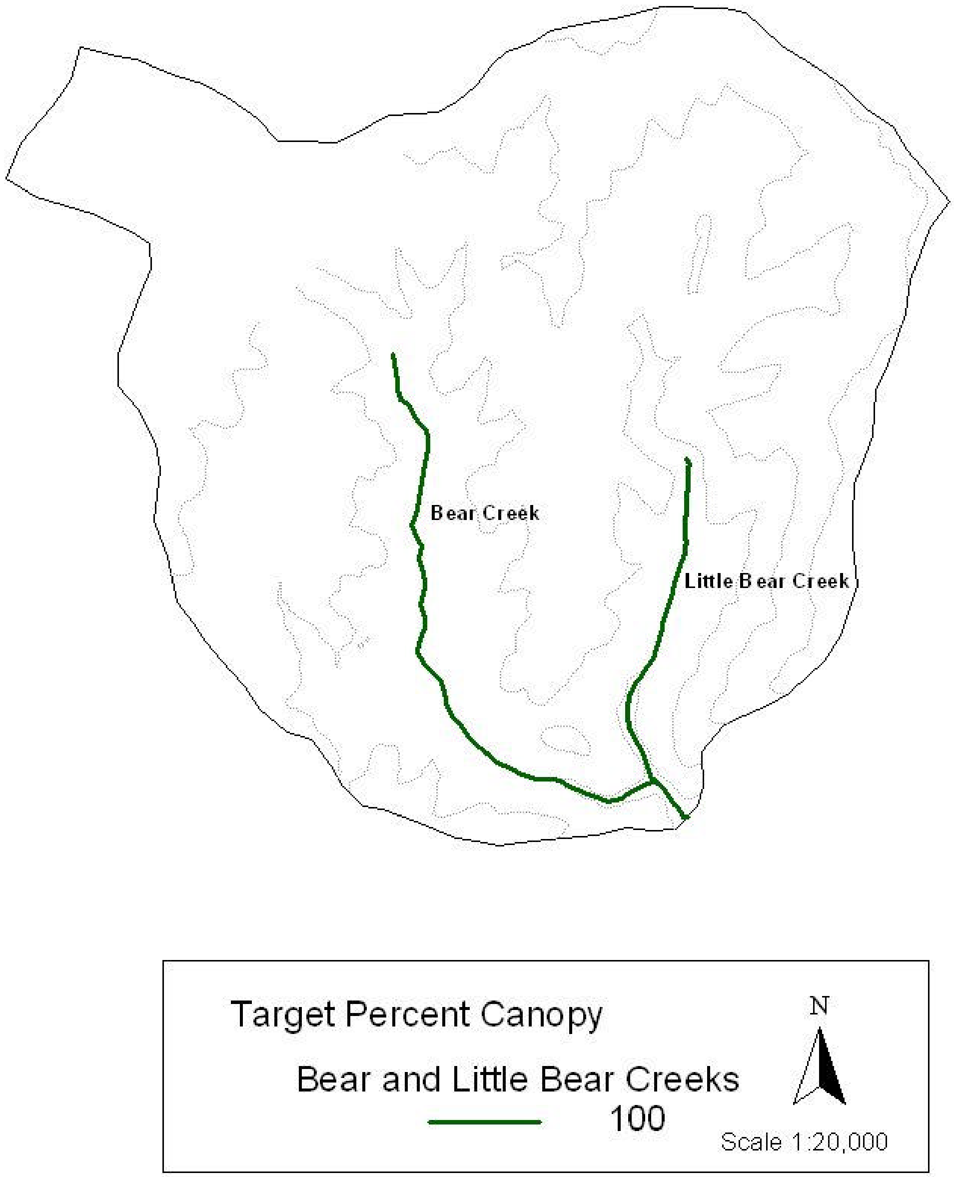

Figure 10a. Target Shade Canopy: Bear and Little Bear Creeks

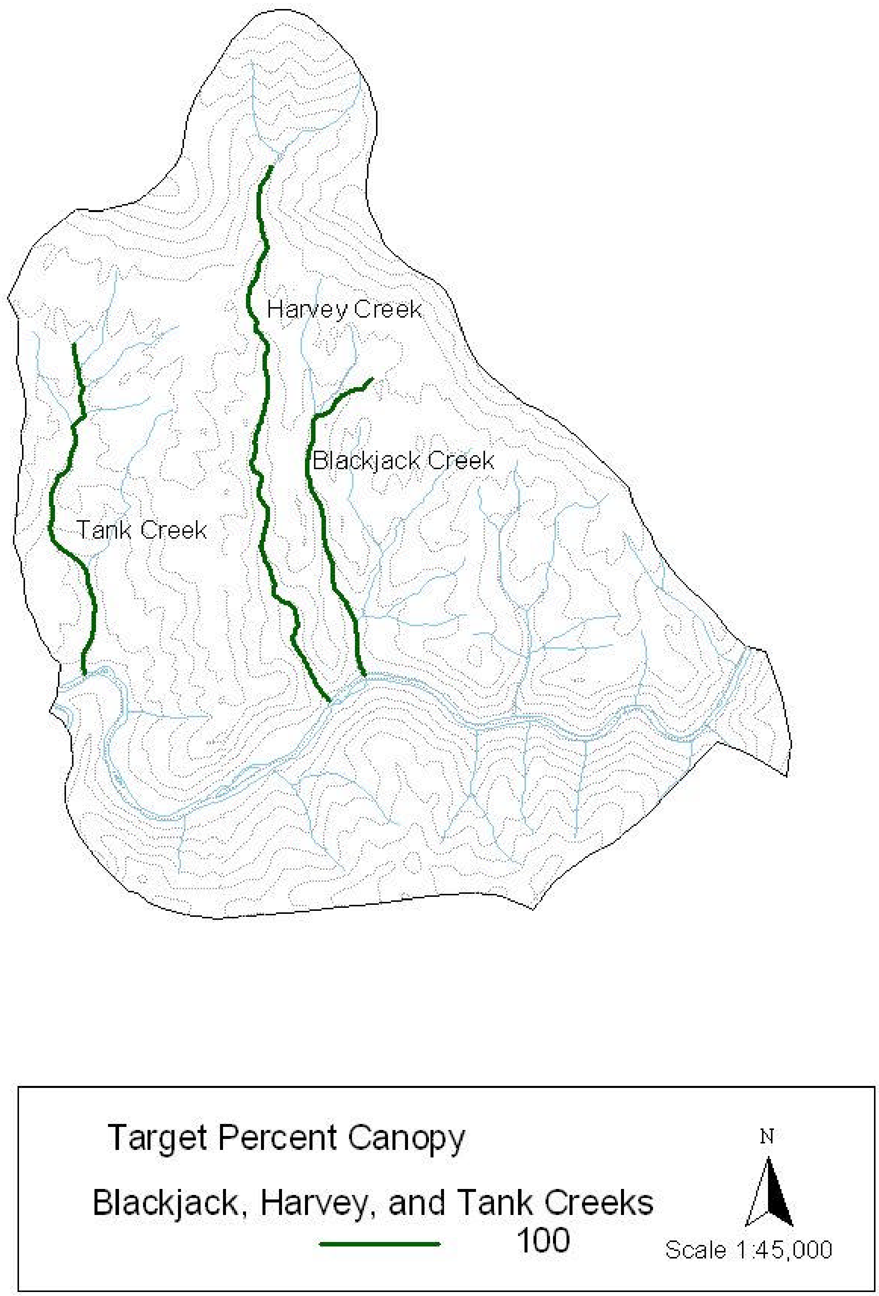

Figure 10b. Target Shade Canopy: Blackjack, Harvey, and Tank Creeks

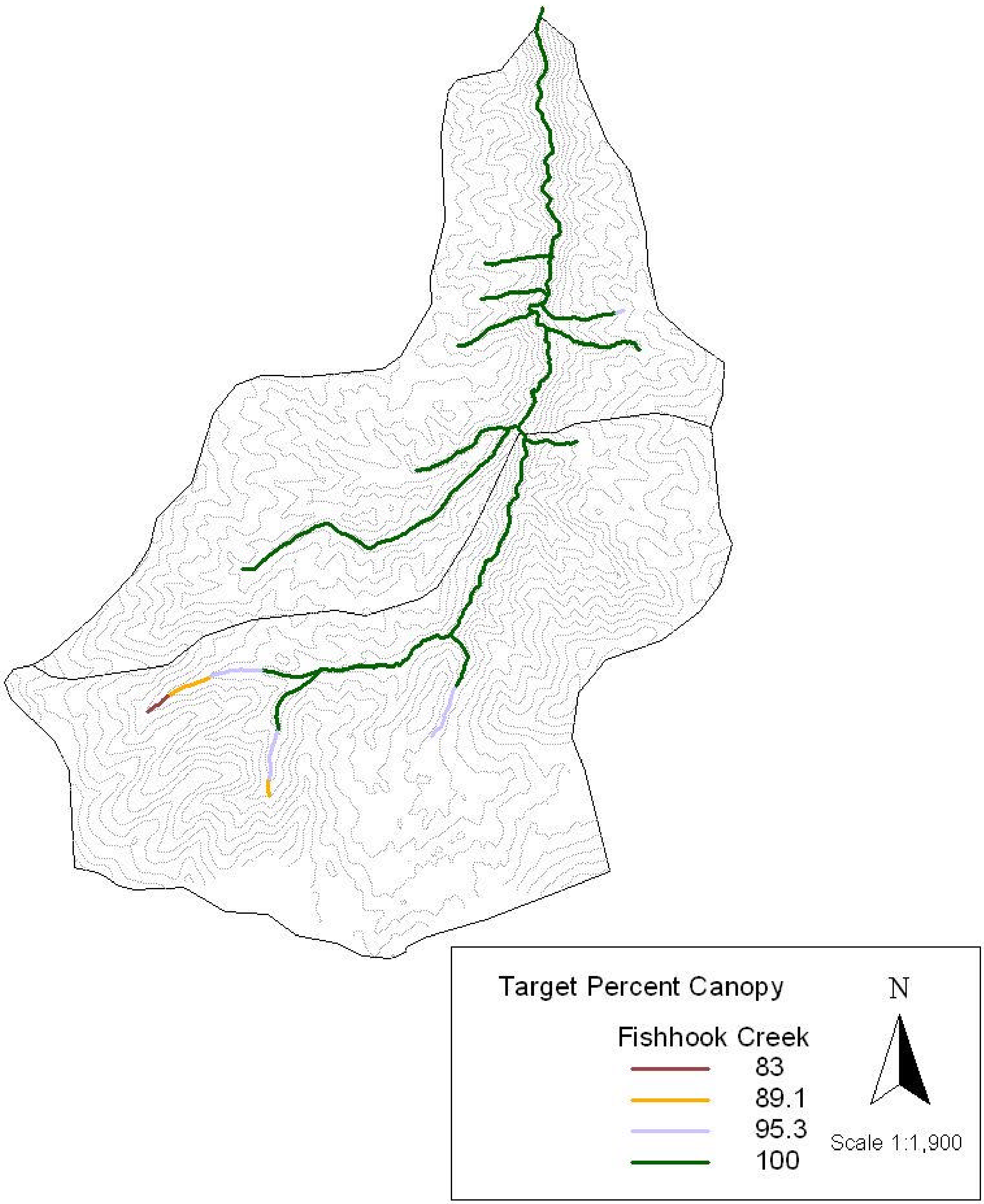

Figure 10c. Target Shade Canopy: Fishhook Creek

Monitoring Provisions

Temperature will be monitored on the streams with continuous recorders after the canopy has reached 70% of its potential. Temperature recorders will be placed in representative locations on second and third order reaches of the streams as near as feasible to the points of compliance. Temperature data developed will be compared with the current temperature standards to assess temperature standard exceedences. Biomonitoring of macroinvertebrates and fish will be completed to assess the status of the cold water use.

Feedback Provisions

When temperatures meet the standard or natural background levels, further canopy increasing activities will not be required in the watershed. Best management practices will be prescribed by the revised TMDL with provisions to maintain and protect canopy cover of the streams. Regular monitoring of the beneficial use will be continued for an appropriate period to document maintenance of the full support of the beneficial use (cold water aquatic life).

5.3.5 Conclusions

Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creeks are in the St. Joe bull trout recovery area where the federal temperature standard of 10 ^{o}C MWMT applies. Continuous temperature monitoring in Bear, Little Bear, Blackjack, Fishhook, Harvey, and Tank Creeks has demonstrated that this standard is violated for significant periods of the critical season (May 1 - October 31) and the state bull trout spawning standard is also violated for significant periods of the critical season (September 1 - October 31). A temperature TMDL based on the CWE relationship between canopy cover, elevation, and direct insolation input to the streams was developed. The watershed topography is between 2,200 and 4,800 feet elevation. The shade requirement between 2,400 and 4,000 feet is 100% or full potential shade. Lesser amounts of shade are progressively necessary above 4,000 feet. Figures 9a-c provide the current level of canopy cover of the streams, while Figures 10a-c depict the canopy cover required.

5.4 Upper St. Joe River Segments Temperature TMDL

This TMDL addresses tributaries to the upper St. Joe River that have been listed as water quality limited by temperature; including Beaver, Bluff, Fly, Gold, Heller, Loop, Mosquito, and Simmons Creeks.

5.4.1 In-Stream Water Quality Targets

Beaver, Bluff, Fly, Gold, Heller, Loop, Mosquito, and Simmons Creeks are in the St. Joe bull trout recovery area (headwaters to Mica Creek) (Panhandle Bull Trout Technical Advisory Team 1998). The governing temperature standards for these creeks and their tributaries are the federal 10 ^{o}C seven-day running average from May 1 to September 1 and the state 9 ^{o}C daily maximum spawning standard from September 1 through October 31. After October 31, water temperature is expected to be well below 9 ^{o}C in the St. Joe River subbasin. In practice, the two standards are essentially the same (Dupont 2002): a standard 10 ^{o}C seven-day running average from May 1 through October 31 will meet both federal and state requirements.

Monitoring temperatures in St. Joe River subbasin streams with little or no human development and at relatively high elevations indicates that the 10 ^{o}C standard is not attainable throughout the entire stream course (see Table 10). Temperature assessments of Beaver, Bluff, Fly, Gold, Heller, Loop, and Simmons Creeks demonstrate substantial exceedences of both the federal and state bull trout standards (Table 10, Appendix B). It is currently beyond DEQ's technical capability to assess the sufficiency of cold water habitat during the summer and early fall months.

<u>Design Conditions</u>

Point sources of thermal input do not exist for the St. Joe River tributaries listed for temperature. Stream temperature is affected by natural weather conditions and the adjacent plant community potential, including disturbance and recovery. Vegetation manipulation to create access or to forest harvest is the major anthropomorphic cause of stream temperature changes.

The environmental factors affecting stream temperature are local air temperature, stream depth, ground water inflow, and stream shading by riparian cover and/or topography (Sullivan and Adams 1990, Theurer et al. 1984, Beschta and Weatherred 1984). Topographic elevation affects ambient air temperature; higher elevations have lower ambient air temperature. In forest streams, ambient temperature and shading are believed to account for up to 90% of the stream temperature variability (Brown 1971, IDL 2000). Riparian shade can be modified by management; ambient temperature cannot.

Several models can be used to assess the impact of riparian shade on stream temperature. Heat Source (Boyd 1996) and SSTEMP (Bartholow 1997) quantify the energy transfer mechanisms in streams. These models require extensive data inputs, many of which are not available for mountain streams. Using process-based models was found to be a workable approach for the North Fork Clearwater temperature TMDL (Dechert et al. 2001). This TMDL follows this approach and uses the IDL CWE canopy closure-stream temperature protocol (IDL 2000). Energy loading values are developed using SSTEMP as comparative data to the primary TMDL target measurement of percent canopy cover.

The CWE empirical model is based on continuous stream temperature measurements, topographic elevation, and percent of vegetative canopy cover data collected throughout northern Idaho. The model calculation is as follows:

Equation (1) MWMT = 29.1 - 0.00262E - 0.0849C

where MWMT = maximum weekly maximum temperature (^{o}C)
E = stream reach elevation (feet)
C = riparian canopy cover (%)

The equation can be solved for canopy cover to predict the required canopy at a given elevation.

Equation (2) C = (29.1/0.085) - (E * 0.0026/0.085) - (MWMT/0.085)

To calculate required canopy cover for the water bodies, MWMT would be set at 10^{o}C.

Equation (3) C = 224.7 - 0.031 * E

To satisfy the requirement for an analysis of heat loading (energy per unit area per unit time) to a stream due to insolation, the method of Dechert et al. (2001) was used. The approach uses SSTEMP (Bartholow 1997) to derive insolation rate data for August 1, 2000 (median hottest day), and calculates heat loading for different levels of percent shade. The amount of solar radiation incident on a stream and its immediate surroundings at different shade levels for three non-redundant stream orientations are presented in Table 30. The fixed conditions used in SSTEMP to develop the solar radiation numbers for (in the case of *Dechert et al.*), the North Fork Clearwater River were 47 degrees north latitude, 5,000 feet elevation, 10-foot stream width, 60-foot buffer height, 30-foot buffer width, and 30? topographic shade (Dechert et al. 2001). Under these conditions incident solar radiation decreases regularly by 21 watts per square meter for every 10% increase in canopy density for north-south oriented streams and 26 watts per square meter for east-west oriented streams. The upper St. Joe River subbasin is near the North Fork Clearwater Subbasin where the model calculations were made. The upper St. Joe watersheds are of similar elevation, ranging from 3,000 to 6,800 feet.

The heat fluctuation amounts in Table 33 do not represent the entire heat budget of the streams, but only that from direct sunlight (insolation). This is the portion of the heat fluctuation the TMDL and ultimately vegetation management can address. Land management cannot significantly affect other environmental factors affecting temperature.

Target Selection

The TMDL selects canopy cover by stream reach elevation as the target for load capacity goals or a defined target for reducing heat load. Canopy cover can be allocated as a surrogate for heat load reduction that is easily understood by the general public and can be affected in part by vegetation management. Canopy cover can be related to thermal load reduction by the SSTEMP estimates provided in Table 33. Canopy cover can be mapped on a stream reach basis to facilitate management prescriptions in a TMDL implementation plan.

Table 33. Average daily solar radiation incident related to canopy closure on a stream, as developed for the Upper North Fork Clearwater River.[1]

Canopy Density (Percent)	Average Daily Solar Radiation in Relation to Stream Orientation		
	North-South (watts/m^2)	East-West (watts/m^2)	SE-NW or SW-NE (watts/m^2)
0	226	274	250
10	205	248	227
20	185	223	204
30	164	197	181
40	143	172	197
50	122	146	134
60	101	120	111
70	80	95	87
80	59	69	64
90	38	43	41
100	17	18	17.5

[1]SSTEMP model output (Dechert 2001) based on the following calculations:
North-South = (100-target canopy %)*2.1+1.7
East-West = (100-target canopy %)*2.56+18
SE-NW or SW-NE = (100-target canopy %)*2.33+17.5

Canopy cover can be easily assessed using aerial photography techniques. Milestones can be set on a ten-year basis in the implementation plan to coincide with the normal frequency of aerial photographic survey.

Applicable reference streams are available in the upper St. Joe River subbasin above the Mosquito Creek confluence. This area was burned during the 1910 fires and has recovered seral timber stands, but timber harvest has been less intensive as compared to adjacent watersheds of the upper St. Joe River subbasin. Bacon, Bean and Yankee Bar Creeks are streams that could be used as reference. The streams of the upper subbasin currently support bull trout populations and most approach the 10 ^oC standard during August, when stream temperatures peak.

Monitoring Points

Points of compliance have been selected for temperature monitoring. These are provided in Table 34. These sites could be used to assess both rearing and spawning temperatures.

Table 34. Points of compliance for the upper St. Joe River tributaries temperature TMDL.

Water Body	Location	Beneficial Use Reconnaissance Site
Beaver Creek	Near mouth	1995 SCDAB029
Bluff Creek	Near mouth	Site to be developed
Fly Creek	Near mouth	1994 SCDAA044
Gold Creek	Near mouth	1994 SCDAA048
Heller Creek	Near mouth	Site to be developed
Loop Creek	Near mouth	1997 SCDAA028
Mosquito Creek	Near mouth	1994 SCAAA046
Simmons Creek	Near mouth	Site to be developed

The primary TMDL monitoring will be with aerial photography interpretation of canopy recovery over the streams. Aerial photography is repeated on a ten-year time frame. This time frame will allow a sufficient period to assess canopy recovery. In addition, a set number of representative sites should be assessed on a periodic basis using canopy densiometer methodology to ground truth and calibrate the aerial photograph interpretation. Although not required by regulation, these monitoring issues should be addressed and specified in a monitoring section of the implementation plan to ensure the success of the measures outlined in the TMDL.

5.4.2 Load Capacity

The load capacity is stated in terms of canopy cover and the insolation rate required to maintain 10 ^{o}C MWMT (Table 35). The load capacity is developed for each stream reach covering 200 feet of elevation. Equation 2 is used to calculate the percent cover required for each stream reach. Under elevations of 4,000 feet the CWE model predicts greater than 100% canopy closure to maintain the 10 ^{o}C MWMT goal. Since this is not possible, canopy closure is defaulted to 100%. The upper St. Joe River watershed has an elevation range of 3,000 to 6,800 feet. A 100% canopy cover is required on all streams between 3,000 and 4,000 feet to achieve the 10 ^{o}C MWMT goal. Even this goal may not be achievable on some stream reaches due to natural plant community types, stream width, or habitat type restrictions.

Use of the CWE model and corroboration of its accuracy for predicting relationships between canopy cover, thermal input, and stream temperature has been developed in the North Fork Clearwater Temperature TMDL (Dechert et al. 2001). The application of the thermal model to the upper St. Joe River is appropriate.

Critical Conditions

Critical conditions are a part of the load capacity analysis. The critical conditions are low discharge conditions in August and early September (mid to late summer). The goal is set to meet the 10 ^{o}C MWMT goal during this time period, and the manageable thermal input modeled to achieve the goal. The acute and chronic violations of the 10 ^{o}C MWMT goal occur during the critical low discharge period.

Table 35. Cumulative Watershed Effects (CWE) calculated canopy cover required at stated elevations to maintain the 10°C MWMT and corresponding heat load capacity[1] from insolation.

Elevation Range	CWE Target Canopy Cover (%)	Heat LoadCapacity North-South Oriented Stream (watts/m^2)	Heat LoadCapacity East-West Oriented Stream (watts/m^2)	Heat LoadCapacity SWNE or SENW Oriented Stream (watts/m^2)
6,400 – 6,599	23	182	220	201
6,200 – 6,399	29	169	204	187
6,000 – 6,199	35	156	188	172
5,800 – 5,999	41	143	172	158
5,600 – 5,799	47	131	156	143
5,400 – 5,599	53	118	141	129
5,200 – 5,399	59	105	125	115
5,000 – 5,199	65	92	109	100
4,800 – 4,999	71	79	93	86
4,600 – 4,799	77	66	77	71
4,400 – 4,599	83	53	62	57
4,200 – 4,399	89	40	46	43
4,000 – 4,199	95	27	30	28
3,800 – 3,999	101	17	18	17.5
3,600 – 3,799	108	17	18	17.5
3,400 – 3,599	114[2]	17	18	17.5
3,200 – 3,399	120[2]	17	18	17.5
3,000 – 3,199	126[2]	17	18	17.5

[1] SSTEMP predicts insolation rates of 17-18 watts/m^2 for 100% canopy closure.

[2] Below 4,000 feet elevation the Cumulative Watershed Effects (CWE) model predicts a need for greater than 100% canopy closure to protect a maximum stream temperature of 10°C Maximum Weekly Maximum Temperature (MWMT). Since this is not possible, 100% canopy closure is set as the surrogate. In some cases, 100% canopy closure may not be achievable because of plant community type or habitat type restrictions.

5.4.3 Estimates of Existing Pollutant Loads

There are no point sources of thermal input to the upper St. Joe River tributaries. Natural inputs include ambient air temperature, inflow groundwater temperature, direct insolation and several minor natural inputs. Of these factors only direct insolation can be estimated and managed through the vegetation management of stream canopy cover.

Canopy cover was surveyed using aerial photometry methods and was assessed using the guidelines of Table 36. Canopy cover was ground verified by CWE crews. Insufficient canopy cover is the primary manageable temperature input. Current canopy coverage of the reaches of the upper St. Joe River tributaries is provided in Tables 37a-e.

5.4.4 Pollutant Load Allocation

There are no point sources of thermal input to the temperature-listed streams of the upper St. Joe River subbasin. For this reason, the temperature TMDL contains no waste load allocation or reserve of the waste load allocation. The load capacity is distributed between the margin of safety and the load allocation to the 200 feet elevation segments of the stream system.

Table 36. General canopy cover estimate guide for aerial photo interpretation.[1]

Visibility on Aerial Photographs	Percent Canopy
Stream surface not visible	>90%
Stream surface slightly visible	76-90%
Stream surface visible in patches	61-75%
Stream surface visible, but banks are mostly not visible	46-60%
Stream surface visible and banks visible in places	31-45%
Stream surface and banks visible in most places	16-30%
Stream surface and banks visible	0-15%

[1] From Table C-4, IDL 2000

Margin of Safety

The canopy cover that is required between 3,000 - 4,000 feet elevation is 100%. Only the lower reaches of the St. Joe River tributaries are below 4,000 feet elevation. For stream reaches above 4,000 feet, a margin of safety above that built into the calculations is available. Canopy cover of 100% is both the requirement and the limit of management for temperature below 4,000 feet. The margin of safety above 4,000 feet is the existing shade above that required to satisfy the thermal equations.

Seasonal Variation

Heat loading capacity applicable to the St. Joe River watershed in relation to the EPA bull trout temperature standard is primarily a consideration during August and early September. Because of the seasonal progression in stream temperature, if a stream’s annual temperature peak is targeted, and this peak is brought down to within criteria limits, then it can safely be assumed that the criteria will also be met at cooler times of the year. This is the basis of using the MWMT metric for criteria. The 10 °C MWMT criteria calculations for bull trout translates closely to the 9 °C daily average criteria for cutthroat.

Reasonable Assurance

Reasonable assurance is provided by nonpoint source implementation of BMPs based on land management agencies' assurance that reductions will occur. Additionally, trend monitoring will be used to document relative changes in various aquatic organism populations and in physical and chemical water quality parameters. This data in conjunction with data from various agencies, organizations, and water user industries will be used to assess overall progress towards attainment of water quality standards and related beneficial uses.

Background

The background temperatures and thermal inputs to the temperature-listed waters of the upper St. Joe River subbasin are known. Pre-canopy removal stream temperatures can be inferred from measurements made on Yankee Bar, Heller, and Sherlock Creeks (Appendix B). Natural canopy cover is intact on these streams for the most part. Significant reaches of some tributaries have shrub wash plant communities of willow that will not effectively shade these reaches of the streams. These vegetation communities existed prior to development. These sites have not, and will not, support vegetation communities capable of providing 100% canopy cover to the stream. Any TMDL implementation plan should note and account for these areas of natural thermal loading.

Reserve

Reserve is typically removed from a waste load allocation for installations that might be made in the future. No waste load allocation or reserve is developed for the TMDL. Thermal capacity of the watershed has been exceeded by canopy removal. Canopy restoration to the degree possible is required to address the thermal loading. Point sources of thermal input cannot be permitted for the foreseeable future.

Remaining Available Load

The remaining load is allocated to the segments of the watershed based on the canopy requirements. The elevation range of the stream segments is used to develop the target canopy cover using the CWE temperature relationship (Tables 37a-h). These targets are, in cases, greater than 100% in the lower reaches of the tributaries, where elevation does not exceed 4,000 feet. These target values are revised to 100% canopy cover. Those segments over 4,000 feet require less than 100% canopy cover. The required canopy is subtracted and the existing amount of canopy cover restoration required is calculated. Using the SSTEMP model outputs for canopy cover and the stream orientation, the target heat load capacity is calculated for each segment. Based on current canopy cover and the SSTEMP model outputs for percentage canopy cover the current heat loading is estimated. Simple subtraction and division provides the target heat loading reduction required for each segment.

The level of canopy cover currently present is provided in Figures 11a-g. The target canopy cover for all segments is provided in Figures 12a-g.

Canopy Habitat Type Limitations

Some habitat types arrayed along streams are not capable of sustaining sufficient stream canopy coverage. These habitat types either have physical limitations that preclude sufficient tree density to develop complete canopy coverage or are habitat types that do not support tree establishment to any significant degree. Stream segments with canopy habitat type limitations are identified with a footnote in Table 37.

Significant reaches of Beaver, Heller-Sherlock, Loop, Mosquito, and Simmons Creeks have shrub wash communities of willow that preclude effective shading during the midday hours. While these sites are not expected to ever support dense conifer growth, a certain degree of stream shading may be expected.

These segments were assigned interim target canopy cover levels. The actual maximum potential canopy for these streams will be determined by a committee of forest and riparian professionals during the implementation phase of TMDL development. After a determination is made, the temperature TMDL will be amended to reflect the new values.

Monitoring Provisions

Temperature will be monitored on the streams with continuous recorders after the canopy has reached 70% of its potential. Temperature recorders will be placed in representative locations on third order reaches of the streams as near as feasible to the points of compliance. Temperature data developed will be compared with the current temperature standards to assess temperature standard exceedences. Biomonitoring of macroinvertebrates and fish will be completed to assess the status of the cold water use.

Table 37. Upper St. Joe River watershed temperature TMDLs – Cumulative Watershed Effects (CWE) calculated percent canopy cover and heat loading.

a) Beaver Creek

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Beaver Creek	3,600-3,800	5,713	60.0	107.7	100	40.0	NESW	17.5	110.7	84.2
Beaver Creek	3,600-3,800	7,355	40.0	107.7	100[1]	60.00	EW	18.0	171.6	89.5
Beaver Creek	3,800-4,000	5,206	60.0	101.5	100	40.0	EW	18.0	120.4	85.0
Beaver Creek	3,800-4,000	2,878	50.0	101.5	100	50.0	EW	18.0	146.0	87.7
Bad Bear Creek	3,800-4,000	3,749	60.0	101.5	100	40.0	NESW	17.5	110.7	84.2
Bad Bear Creek	4,000-4,200	5,634	50.0	95.3	95.3	45.3	NESW	28.4	134.0	78.8
Bad Bear Creek	4,000-4,200	1,283	60.0	95.3	95.3	35.3	NESW	28.4	110.7	74.3
Unnamed Trib 1	4,200-4,400	2,540	60.0	89.1	89.1	29.1	EW	45.8	120.4	62.0
Unnamed Trib 1	4,400-4,600	1,468	60.0	83.0	83.0	23.0	EW	61.6	120.4	48.9
Unnamed Trib 1	4,600-4,800	956	50.0	76.8	76.8	26.8	EW	77.4	146.0	47.0
Unnamed Trib 1	4,800-5,000	644	50.0	70.6	70.6	20.6	NWSE	85.9	134.0	35.9
Unnamed Trib 1	5,000-5,200	560	50.0	64.5	64.5	14.5	NWSE	100.3	134.0	25.1
Unnamed Trib 1	5,200-5,400	454	50.0	58.3	58.3	8.3	NWSE	114.7	134.0	14.4
Bad Bear Creek	4,200-4,400	2,107	80.0	89.1	89.1	9.1	NS	39.8	59.0	32.6
Bad Bear Creek	4,400-4,600	1,447	80.0	83.0	83.0	3.0	NWSE	57.2	64.1	10.8
Bad Bear Creek	4,600-4,800	803	70.0	76.8	76.8	6.8	NS	65.7	80.0	17.9
Bad Bear Creek	4,800-5,000	623	70.0	70.6	70.6	0.6	NS	78.7	80.0	1.6
Bad Bear Creek	5,000-5,200	639	70.0	64.5	70.0	0.0	NS	80.0	80.0	0.0
Bad Bear Creek	5,200-5,400	655	80.0	58.3	80.0	0.0	NS	59.0	59.0	0.0
Bad Bear Creek	5,400-5,600	739	80.0	52.1	80.0	0.0	NWSE	64.1	64.1	0.0
Beaver Creek	3,800-4,000	591	60.0	101.5	100	40.0	NESW	17.5	110.7	84.2
Beaver Creek	4,000-4,200	623	60.0	95.3	95.3	35.3	NWSE	28.4	110.7	74.3
Beaver Creek	4,000-4,200	5,391	50.0	95.3	95.3	45.3	EW	30.0	146.0	79.5
Beaver Creek	4,200-4,400	2,387	60.0	89.1	89.1	29.1	EW	45.8	120.4	62.0

Table 37-a, Beaver Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Beaver Creek	4,400-4,600	1,188	50.0	83.0	83.0	33.0	NWSE	57.2	134.0	57.3
Beaver Creek	4,600-4,800	591	50.0	76.8	76.8	26.8	NWSE	71.5	134.0	46.6
Beaver Creek	4,800-5,000	517	50.0	70.6	70.6	20.6	NWSE	85.9	134.0	35.9

b) Bluff Creek

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Bluff Creek	3,000-3,200	5,095	60.0	126.2	100	40.0	NESW	17.5	110.7	84.2
Bluff Creek	3,200-3,400	7,086	60.0	120.0	100	40.0	NS	17.0	101.0	83.2
Bluff Creek	3,400-3,600	4,984	60.0	113.8	100	40.0	NS	17.0	101.0	83.2
EF Bluff Creek	3,600-3,800	8,781	70.0	107.7	100	30.0	NESW	17.5	87.4	80.0
EF Bluff Creek	3,800-4,000	6,273	70.0	101.5	100	30.0	NESW	17.5	87.4	80.0
EF Bluff Creek	4,000-4,200	6,310	70.0	95.3	95.3	25.3	NESW	28.4	87.4	67.5
EF Bluff Creek	4,200-4,400	4,557	80.0	89.1	89.1	9.1	NESW	42.8	64.1	33.2
EF Bluff Creek	4,400-4,600	2,793	80.0	83.0	83.0	3.0	EW	61.6	69.2	11.0
EF Bluff Creek	4,600-4,800	1,695	70.0	76.8	76.8	6.8	EW	77.4	94.8	18.4
EF Bluff Creek	4,800-5,000	1,230	70.0	70.6	70.6	0.6	NESW	85.9	87.4	1.7
EF Bluff Creek	5,000-5,200	1,030	70.0	64.5	70.0	0.0	EW	94.8	94.8	0.0
EF Bluff Creek	5,200-5,400	919	70.0	58.3	70.0	0.0	NESW	87.4	87.4	0.0
EF Bluff Creek	4,200-4,400	1,056	80.0	89.1	89.1	9.1	NS	39.8	59.0	32.5
EF Bluff Creek	4,400-4,600	1,489	80.0	83.0	83.0	3.0	NESW	57.2	64.1	10.8
EF Bluff Creek	4,600-4,800	1,119	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
EF Bluff Creek	4,800-5,000	935	70.0	70.6	70.6	0.6	NESW	85.9	87.4	1.7
EF Bluff Creek	5,000-5,200	908	70.0	64.5	70.0	0.0	NS	80.0	80.0	0.0
EF Bluff Creek	5,200-5,400	1,109	70.0	58.3	70.0	0.0	NS	80.0	80.0	0.0

Table 37-b, Bluff Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
EF Bluff Creek	5,400-5,600	776	70.0	52.1	70.0	0.0	NS	80.0	80.0	0.0
EF Bluff Creek	5,600-5,800	840	70.0	46.0	70.0	0.0	NESW	87.4	87.4	0.0
EF Bluff Creek	5,800-6,000	354	70.0	39.8	70.0	0.0	NESW	87.4	87.4	0.0
WF Bluff Creek	3,400-3,600	6,938	60.0	113.8	100	40.0	NESW	17.5	110.7	84.2
WF Bluff Creek	3,600-3,800	5,359	60.0	107.7	100	40.0	NESW	17.5	110.7	84.2
WF Bluff Creek	3,800-4,000	8,311	60.0	101.5	100	40.0	NESW	17.5	110.7	84.2
WF Bluff Creek	4,000-4,200	5,871	70.0	95.3	95.3	25.3	NESW	28.4	87.4	67.5
WF Bluff Creek	4,200-4,400	3,627	70.0	89.1	89.1	19.1	NS	39.8	80.0	50.3
WF Bluff Creek	4,400-4,600	2,123	70.0	83.0	83.0	13.0	NESW	57.2	87.4	34.6
Unnamed Trib 8	4,600-4,800	1,225	50.0	76.8	76.8	26.8	NS	65.7	122.0	46.1
Unnamed Trib 8	4,800-5,000	887	50.0	70.6	70.6	20.6	NS	78.7	122.0	35.5
Unnamed Trib 1	3,400-3,600	444	70.0	113.8	100	30.0	EW	18.0	94.8	81.0
Unnamed Trib 1	3,600-3,800	840	70.0	107.7	100	30.0	EW	18.0	94.8	81.0
Unnamed Trib 1	3,800-4,000	1,568	70.0	101.5	100	30.0	NWSE	17.5	87.4	80.0
Unnamed Trib 1	4,000-4,200	465	70.0	95.3	95.3	25.3	EW	30.0	94.8	68.4
Unnamed Trib 1	4,200-4,400	565	80.0	89.1	89.1	9.1	NESW	42.8	64.1	33.2
Unnamed Trib 1	4,400-4,600	612	80.0	83.0	83.0	3.0	NESW	57.2	64.1	10.8
Unnamed Trib 1	4,600-4,800	760	80.0	76.8	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 1	4,800-5,000	776	80.0	70.6	80.0	0.0	EW	69.2	69.2	0.0
Unnamed Trib 1	5,000-5,200	586	80.0	64.5	80.0	0.0	NWSE	64.1	64.1	0.0
Unnamed Trib 2	3,600-3,800	744	70.0	107.7	100	30.0	NWSE	17.5	87.4	80.0
Unnamed Trib 2	3,800-4,000	1,056	60.0	101.5	100	40.0	NWSE	17.5	110.7	84.2
Unnamed Trib 2	4,000-4,200	496	60.0	95.3	95.3	35.3	NWSE	28.4	110.7	74.3
Unnamed Trib 2	4,200-4,400	597	70.0	89.1	89.1	19.1	NWSE	42.8	87.4	51.0
Unnamed Trib 2	4,400-4,600	570	80.0	83.0	83.0	3.0	NWSE	57.2	64.1	10.8
Unnamed Trib 2	4,600-4,800	496	80.0	76.8	80.0	0.0	NWSE	64.1	64.1	0.0
Unnamed Trib 2	4,800-5,000	554	80.0	70.6	80.0	0.0	NWSE	64.1	64.1	0.0
Unnamed Trib 2	5,000-5,200	407	80.0	64.5	80.0	0.0	NWSE	64.1	64.1	0.0
Unnamed Trib 2	5,200-5,400	628	80.0	58.3	80.0	0.0	NWSE	64.1	64.1	0.0
Unnamed Trib 2	5,400-5,600	338	80.0	52.1	80.0	0.0	NWSE	64.1	64.1	0.0

Table 37-b, Bluff Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Unnamed Trib 2	5,600-5,800	586	80.0	46.0	80.0	0.0	NWSE	64.1	64.1	0.0
Bad Luck Creek	3,600-3,800	734	60.0	107.7	100	40.0	NS	17.0	101.0	83.2
Bad Luck Creek	3,800-4,000	1,526	60.0	101.5	100	40.0	NWSE	17.5	110.7	84.2
Bad Luck Creek	4,000-4,200	1,774	70.0	95.3	95.3	25.3	NWSE	28.4	87.4	67.5
Bad Luck Creek	4,200-4,400	1,637	70.0	89.1	89.1	19.1	NWSE	42.8	87.4	51.0
Bad Luck Creek	4,400-4,600	1,082	70.0	83.0	83.0	13.0	NWSE	57.2	87.4	34.6
Bad Luck Creek	4,600-4,800	824	80.0	76.8	80.0	0.0	NWSE	64.1	64.1	0.0
Bad Luck Creek	4,800-5,000	729	80.0	70.6	80.0	0.0	EW	69.2	69.2	0.0
Bad Luck Creek	5,000-5,200	502	80.0	64.5	80.0	0.0	EW	69.2	69.2	0.0
Bad Luck Creek	5,200-5,400	459	80.0	58.3	80.0	0.0	EW	69.2	69.2	0.0
Bad Luck Creek	5,400-5,600	407	80.0	52.1	80.0	0.0	EW	69.2	69.2	0.0
Unnamed Trib 3	4,000-4,200	1,267	80.0	95.3	95.3	15.3	EW	30.0	69.2	56.6
Unnamed Trib 3	4,200-4,400	1,896	80.0	89.1	89.1	9.1	EW	45.8	69.2	33.8
Unnamed Trib 3	4,400-4,600	1,790	80.0	83.0	83.0	3.0	NESW	57.2	64.1	10.8
Unnamed Trib 3	4,600-4,800	1,114	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Unnamed Trib 3	4,800-5,000	665	30.0	70.6	70.6	40.6	NESW	85.9	180.6	52.4
Unnamed Trib 3	5,000-5,200	512	30.0	64.5	64.5	34.5	NESW	100.3	180.6	44.5
Unnamed Trib 4	3,600-3,800	565	70.0	107.7	100	30.0	EW	18.0	94.8	81.0
Unnamed Trib 4	3,800-4,000	1,542	70.0	101.5	100	30.0	NWSE	17.5	87.4	80.0
Unnamed Trib 4	4,000-4,200	1,162	80.0	95.3	95.3	15.3	NWSE	28.4	64.1	55.7
Unnamed Trib 4	4,200-4,400	781	80.0	89.1	89.1	9.1	NWSE	42.8	64.1	33.2
Unnamed Trib 4	4,400-4,600	1,320	70.0	83.0	83.0	13.0	NWSE	57.2	87.4	34.6
Unnamed Trib 4	4,600-4,800	554	70.0	76.8	76.8	6.8	NWSE	71.5	87.4	18.2
Unnamed Trib 4	4,800-5,000	723	60.0	70.6	70.6	10.6	NWSE	85.9	110.7	22.4
Unnamed Trib 4	5,000-5,200	417	60.0	64.5	64.5	4.5	NWSE	100.3	110.7	9.4
Unnamed Trib 5	3,800-4,000	1,573	70.0	101.5	100	30.0	NWSE	17.5	87.4	80.0
Unnamed Trib 5	4,000-4,200	1,135	70.0	95.3	95.3	25.3	NWSE	28.4	87.4	67.5
Unnamed Trib 5	4,200-4,400	560	30.0	89.1	89.1	59.1	NWSE	42.8	180.6	76.3
Unnamed Trib 5	4,400-4,600	887	30.0	83.0	83.0	53.0	NWSE	57.2	180.6	68.3
Unnamed Trib 5	4,600-4,800	739	50.0	76.8	76.8	26.8	NWSE	71.5	134.0	46.6
Unnamed Trib 5	4,800-5,000	554	50.0	70.6	70.6	20.6	NWSE	85.9	134.0	35.9

Table 37-b, Bluff Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Unnamed Trib 5	5,000-5,200	496	50.0	64.5	64.5	14.5	NWSE	100.3	134.0	25.1
Unnamed Trib 6	3,800-4,000	576	50.0	101.5	100	50.0	NWSE	17.5	134.0	86.9
Unnamed Trib 6	4,000-4,200	1,463	50.0	95.3	95.3	45.3	NWSE	28.4	134.0	78.8
Unnamed Trib 6	4,200-4,400	1,230	50.0	89.1	89.1	39.1	NS	39.8	122.0	67.4
Unnamed Trib 6	4,400-4,600	935	70.0	83.0	83.0	13.0	NWSE	57.2	87.4	34.6
Unnamed Trib 6	4,600-4,800	649	70.0	76.8	76.8	6.8	NWSE	71.5	87.4	18.2
Unnamed Trib 6	4,800-5,000	602	50.0	70.6	70.6	20.6	NS	78.7	122.0	35.5
Unnamed Trib 6	5,000-5,200	422	50.0	64.5	64.5	14.5	SN	100.3	134.0	25.1
Unnamed Trib 6	5,200-5,400	417	50.0	58.3	58.3	8.3	NS	104.6	122.0	14.3
Unnamed Trib 6	5,400-5,600	312	50.0	52.1	52.1	2.1	NS	117.5	122.0	3.7
Unnamed Trib 7	3,800-4,000	2,297	70.0	101.5	100	30.0	NWSE	17.5	87.4	80.0
Unnamed Trib 7	4,000-4,200	1,468	70.0	95.3	95.3	25.3	NWSE	28.4	87.4	67.5
Unnamed Trib 7	4,200-4,400	2,133	70.0	89.1	89.1	19.1	NWSE	42.8	87.4	51.0
Unnamed Trib 7	4,400-4,600	1,257	60.0	83.0	83.0	23.0	NWSE	57.2	110.7	48.3
Unnamed Trib 7	4,600-4,800	676	40.0	76.8	76.8	36.8	EW	77.4	171.6	54.9
Unnamed Trib 7	4,800-5,000	396	40.0	70.6	70.6	30.6	EW	93.2	171.6	45.7
Whistling Creek	4,000-4,200	465	60.0	95.3	95.3	35.3	EW	30.0	120.4	75.1
Whistling Creek	4,200-4,400	2,746	60.0	89.1	89.1	29.1	EW	45.8	120.4	62.0
Whistling Creek	4,400-4,600	3,606	60.0	83.0	83.0	23.0	EW	61.6	120.4	48.9
WF Bluff Creek	4,200-4,400	2,651	60.0	89.1	89.1	29.1	EW	45.8	120.4	62.0
WF Bluff Creek	4,200-4,400	3,860	70.0	89.1	89.1	19.1	NESW	42.8	87.4	51.1
Unnamed Trib 9	4,400-4,600	2,603	80.0	83.0	83.0	3.0	NS	52.7	59.0	10.7
Unnamed Trib 9	4,600-4,800	1,790	70.0	76.8	76.8	6.8	NS	65.7	80.0	17.9
Unnamed Trib 9	4,800-5,000	972	80.0	70.6	80.0	0.0	NS	59.0	59.0	0.0
Unnamed Trib 9	5,000-5,200	1,093	80.0	64.5	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 9	5,200-5,400	750	80.0	58.3	80.0	0.0	NESW	64.1	64.1	0.0
WF Bluff Creek	4,200-4,400	1,130	80.0	89.1	89.1	9.1	EW	45.8	69.2	33.8
WF Bluff Creek	4,400-4,600	3,210	80.0	83.0	83.0	3.0	EW	61.6	69.2	11.0
WF Bluff Creek	4,600-4,800	1,368	60.0	76.8	76.8	16.8	EW	77.4	120.4	35.7
WF Bluff Creek	4,800-5,000	903	60.0	70.6	70.6	10.6	NESW	85.9	110.7	22.4
WF Bluff Creek	5,000-5,200	787	60.0	64.5	64.5	4.5	NESW	100.3	110.7	9.4

Table 37-b, Bluff Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
WF Bluff Creek	5,200-5,400	855	60.0	58.3	60.0	0.0	NESW	110.7	110.7	0.0
Unnamed Trib 10	4,400-4,600	2,154	70.0	83.0	83.0	13.0	NESW	57.2	87.4	34.6
Unnamed Trib 10	4,600-4,800	1,927	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Unnamed Trib 10	4,800-5,000	834	80.0	70.6	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 10	5,000-5,200	1,341	80.0	64.5	80.0	0.0	NESW	64.1	64.1	0.0
Junction Creek	3,800-4,000	264	70.0	101.5	100	30.0	NWSE	17.5	87.4	80.0
Junction Creek	4,000-4,200	2,677	70.0	95.3	95.3	25.3	NWSE	28.4	87.4	67.5
Junction Creek	4,200-4,400	2,006	80.0	89.1	89.1	9.1	NWSE	42.8	64.1	33.2
Junction Creek	4,400-4,600	2,033	80.0	83.0	83.0	3.0	NWSE	57.2	64.1	10.8
Junction Creek	4,600-4,800	1,436	80.0	76.8	80.0	0.0	NS	59.0	59.0	0.0
Junction Creek	4,800-5,000	665	80.0	70.6	80.0	0.0	NESW	64.1	64.1	0.0
Junction Creek	5,000-5,200	655	70.0	64.5	70.0	0.0	NESW	87.4	87.4	0.0
Junction Creek	5,200-5,400	855	70.0	58.3	70.0	0.0	NESW	87.4	87.4	0.0
Junction Creek	5,400-5,600	480	70.0	52.1	70.0	0.0	NESW	87.4	87.4	0.0

c) Fly Creek

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Fly Creek	3,400-3,600	3,284	60.0	113.8	100	40.0	NESW	17.5	110.7	84.2
Fly Creek	3,600-3,800	4,678	50.0	107.7	100	50.0	NESW	17.5	134.0	86.9
Fly Creek	3,800-4,000	5,634	50.0	101.5	100	50.0	EW	18.0	146.0	87.7
Fly Creek	4,000-4,200	5,676	70.0	95.3	95.3	25.3	NESW	28.4	87.4	67.5
Fly Creek	4,200-4,400	4,757	70.0	89.1	89.1	19.1	NESW	42.8	87.4	51.0
Fly Creek	4,400-4,600	2,091	70.0	83.0	83.0	13.0	NESW	57.2	87.4	34.6
Fly Creek	4,600-4,800	1,515	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Fly Creek	4,800-5,000	1,225	60.0	70.6	70.6	10.6	NESW	85.9	110.7	22.4

Table 37-c, Fly Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Fly Creek	5,000-5,200	913	60.0	64.5	64.5	4.5	EW	109.0	120.4	9.5
Fly Creek	5,200-5,400	766	60.0	58.3	60.0	0.0	NWSE	110.7	110.7	0.0
Fly Creek	5,400-5,600	607	70.0	52.1	70.0	0.0	NWSE	87.4	87.4	0.0
Fly Creek	5,600-5,800	803	70.0	46.0	70.0	0.0	NWSE	87.4	87.4	0.0
Fly Creek	5,800-6,000	370	70.0	52.1	70.0	0.0	EW	94.8	94.8	0.0
Unnamed Trib 1	3,600-3,800	169	70.0	107.7	100	30.0	NS	17.0	80.0	78.8
Unnamed Trib 1	3,800-4,000	935	70.0	101.5	100	30.0	NS	17.0	80.0	78.8
Unnamed Trib 1	4,000-4,200	1,864	70.0	95.3	95.3	25.3	NWSE	28.4	87.4	67.5
Unnamed Trib 1	4,200-4,400	2,144	70.0	89.1	89.1	19.1	NESW	42.8	87.4	51.0
Unnamed Trib 1	4,400-4,600	1,077	70.0	83.0	83.0	13.0	NESW	57.2	87.4	34.6
Unnamed Trib 1	4,600-4,800	549	60.0	76.8	76.8	16.8	NESW	71.5	110.7	35.4

d) Gold Creek

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Gold Creek	3,200-3,400	2,930	80.0	120.0	100	20.0	NESW	17.5	64.1	72.7
Gold Creek	3,400-3,600	248	80.0	113.8	100	20.0	NESW	17.5	64.1	72.7
Gold Creek	3,400-3,600	8,907	60.0	113.8	100	40.0	NESW	17.5	110.7	84.2
Gold Creek	3,600-3,800	3,770	60.0	107.7	100	40.0	NESW	17.5	110.7	84.2
Gold Creek	3,600-3,800	6,880	50.0	107.7	100	50.0	NS	17.0	122.0	86.1
Gold Creek	3,800-4,000	8,279	50.0	101.5	100	50.0	NS	17.0	122.0	86.1
Gold Creek	4,000-4,200	6,447	60.0	95.3	95.3	35.3	NESW	28.4	110.7	74.3
Gold Creek	4,200-4,400	2,170	70.0	89.1	89.1	19.1	NS	39.8	80.0	50.3
Gold Creek	4,400-4,600	2,592	70.0	83.0	83.0	13.0	NS	52.7	80.0	34.1
Gold Creek	4,600-4,800	1,552	70.0	76.8	76.8	6.8	NWSE	71.5	87.4	18.2

Table 37-d, Gold Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Gold Creek	4,800-5,000	2,170	60.0	70.6	70.6	10.6	NWSE	85.9	110.7	22.4
Gold Creek	5,000-5,200	1,668	60.0	64.5	64.5	4.5	NWSE	100.3	110.7	9.4
Gold Creek	5,200-5,400	834	60.0	58.3	60.0	0.0	NWSE	110.7	110.7	0.0
Gold Creek	5,400-5,600	644	60.0	52.1	60.0	0.0	NWSE	110.7	110.7	0.0
Gold Creek	5,600-5,800	581	60.0	46.0	60.0	0.0	NWSE	110.7	110.7	0.0
Gold Creek	5,800-6,000	665	60.0	39.8	60.0	0.0	NWSE	110.7	110.7	0.0
EF Gold Creek	3,400-3,600	1,262	50.0	113.8	100	50.0	NWSE	17.5	134.0	86.9
EF Gold Creek	3,600-3,800	1,368	50.0	107.7	100	50.0	EW	18.0	146.0	87.7
EF Gold Creek	3,800-4,000	3,738	80.0	101.5	100	20.0	EW	18.0	69.2	74.0
EF Gold Creek	4,000-4,200	3,754	80.0	95.3	95.3	15.3	NESW	28.4	64.1	55.7
EF Gold Creek	4,200-4,400	3,432	80.0	89.1	89.1	9.1	NESW	42.8	64.1	33.2
EF Gold Creek	4,400-4,600	2,814	80.0	83.0	83.0	3.0	EW	61.6	69.2	11.0
EF Gold Creek	4,600-4,800	1,764	80.0	76.8	80.0	0.0	NWSE	64.1	64.1	0.0
EF Gold Creek	4,800-5,000	1,445	80.0	70.6	80.0	0.0	NWSE	64.1	64.1	0.0
EF Gold Creek	5,000-5,200	1,394	90.0	64.5	90.0	0.0	NWSE	40.8	40.8	0.0
EF Gold Creek	5,200-5,400	1,214	90.0	58.3	90.0	0.0	NWSE	40.8	40.8	0.0
EF Gold Creek	5,400-5,600	813	80.0	52.1	80.0	0.0	NWSE	64.1	64.1	0.0
EF Gold Creek	5,600-5,800	628	70.0	46.0	70.0	0.0	NWSE	87.4	87.4	0.0
Berge Creek	3,600-3,800	623	60.0	107.7	100	40.0	EW	18.0	120.4	85.0
Berge Creek	3,800-4,000	2,614	60.0	101.5	100	40.0	NESW	17.5	110.7	84.2
Berge Creek	4,000-4,200	2,608	70.0	95.3	95.3	25.3	NESW	28.4	87.4	67.5
Berge Creek	4,200-4,400	1,705	70.0	89.1	89.1	19.1	EW	45.8	94.8	51.7
Berge Creek	4,400-4,600	1,748	70.0	83.0	83.0	13.0	NESW	57.2	87.4	34.6
Berge Creek	4,600-4,800	866	60.0	76.8	76.8	16.8	NESW	71.5	110.7	35.4
Berge Creek	4,800-5,000	1,378	60.0	70.6	70.6	10.6	NESW	85.9	110.7	22.4
Berge Creek	5,000-5,200	676	60.0	64.5	64.5	4.5	EW	109.0	120.4	9.5
Unnamed Trib 1	3,800-4,000	602	60.0	101.5	100	40.0	EW	18.0	120.4	85.0
Unnamed Trib 1	4,000-4,200	1,579	60.0	95.3	95.3	35.3	EW	30.0	120.4	75.1
Unnamed Trib 1	4,200-4,400	459	60.0	89.1	89.1	29.1	EW	45.8	120.4	62.0
Unnamed Trib 1	4,200-4,400	919	70.0	89.1	89.1	19.1	EW	45.8	94.8	51.7

Table 37-d, Gold Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Unnamed Trib 1	4,400-4,600	824	70.0	83.0	83.0	13.0	EW	61.6	94.8	35.0
Unnamed Trib 1	4,600-4,800	776	70.0	76.8	76.8	6.8	NWSE	71.5	87.4	18.2
Broadaxe Creek	3,800-4,000	491	60.0	101.5	100	40.0	EW	18.0	120.4	85.0
Broadaxe Creek	4,000-4,200	1,019	60.0	95.3	95.3	35.3	NESW	28.4	110.7	74.3
Broadaxe Creek	4,000-4,200	5,032	70.0	95.3	95.3	25.3	EW	30.0	94.8	68.4
Broadaxe Creek	4,200-4,400	3,596	70.0	89.1	89.1	19.1	EW	45.8	94.8	51.7
Broadaxe Creek	4,400-4,600	2,540	70.0	83.0	83.0	13.0	NWSE	57.2	87.4	34.6
Broadaxe Creek	4,600-4,800	1,526	70.0	76.8	76.8	6.8	NS	65.7	80.0	17.9
Broadaxe Creek	4,800-5,000	1,114	70.0	70.6	70.6	0.6	NS	78.7	80.0	1.6
Broadaxe Creek	5,000-5,200	2,001	60.0	64.5	64.5	4.5	NWSE	100.3	110.7	9.4
Broadaxe Creek	5,200-5,400	1,536	60.0	58.3	60.0	0.0	NWSE	110.7	110.7	0.0
Broadaxe Creek	5,400-5,600	1,357	70.0	52.1	70.0	0.0	NS	80.0	80.0	0.0
Broadaxe Creek	5,600-5,800	781	70.0	46.0	70.0	0.0	NS	80.0	80.0	0.0
Unnamed Trib 2	4,000-4,200	892	60.0	95.3	95.3	35.3	NWSE	28.4	110.7	74.3
Unnamed Trib 2	4,200-4,400	2,571	60.0	89.1	89.1	29.1	EW	45.8	120.4	62.0
Unnamed Trib 2	4,400-4,600	2,181	70.0	83.0	83.0	13.0	EW	61.6	94.8	35.0
Unnamed Trib 2	4,600-4,800	2,534	70.0	76.8	76.8	6.8	NWSE	71.5	87.4	18.2
Unnamed Trib 2	4,800-5,000	1,727	70.0	70.6	70.6	0.6	NWSE	85.9	87.4	1.7
Unnamed Trib 2	5,000-5,200	1,130	70.0	64.5	70.0	0.0	NWSE	87.4	87.4	0.0
Unnamed Trib 2	5,200-5,400	1,109	80.0	58.3	80.0	0.0	EW	69.2	69.2	0.0
Float Creek	4,000-4,200	1,795	70.0	95.3	95.3	25.3	NWSE	28.4	87.4	67.5
Float Creek	4,200-4,400	3,337	70.0	89.1	89.1	19.1	NWSE	42.8	87.4	51.0
Float Creek	4,400-4,600	1,653	70.0	83.0	83.0	13.0	NWSE	57.2	87.4	34.6
Float Creek	4,600-4,800	2,930	70.0	76.8	76.8	6.8	NWSE	71.5	87.4	18.2
Float Creek	4,800-5,000	1,447	70.0	70.6	70.6	0.6	NWSE	85.9	87.4	1.7

e) Heller-Sherlock Creeks

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Heller Creek	4,600-4,800	6,510	30.0	76.8	76.8[1]	46.8	NS	65.7	164.0	59.9
Heller Creek	4,800-5,000	4,308	30.0	70.6	70.6[1]	40.6	NESW	85.9	180.6	52.4
Heller Creek	4,800-5,000	2,936	50.0	70.6	70.6	20.6	NESW	85.9	134.0	35.9
Heller Creek	5,000-5,200	3,527	60.0	64.5	64.5	4.5	EW	109.0	120.4	9.5
Heller Creek	5,200-5,400	2,186	70.0	58.3	70.0	0.0	NWSE	87.4	87.4	0.0
Sherlock Creek	4,600-4,800	5,882	30.0	76.8	76.8[1]	46.8	EW	77.4	197.2	60.8
Sherlock Creek	4,800-5,000	5,106	20.0	70.6	70.6	50.6	NWSE	85.9	203.9	57.9
Sherlock Creek	4,800-5,000	1,975	50.0	70.6	70.6	20.6	NESW	85.9	134.0	35.9
Sherlock Creek	5,000-5,200	2,334	60.0	64.5	64.5	4.5	EW	109.0	120.4	9.5
Sherlock Creek	5,000-5,200	1,267	10.0	64.5	64.5	54.5	NESW	100.3	227.2	55.9
Unnamed Trib 2	5,000-5,200	1,230	60.0	64.5	64.5	4.5	EW	109.0	120.4	9.5
Unnamed Trib 2	5,200-5,400	2,450	60.0	58.3	60.0	0.0	NESW	110.7	110.7	0.0
Unnamed Trib 2	5,400-5,600	1,980	70.0	52.1	70.0	0.0	NWSE	87.4	87.4	0.0
Unnamed Trib 2	5,600-5,800	1,605	70.0	46.0	70.0	0.0	NS	80.0	80.0	0.0
Unnamed Trib 2	5,800-6,000	639	60.0	39.8	60.0	0.0	NWSE	110.7	110.7	0.0
Unnamed Trib 2	6,000-6,200	744	40.0	33.6	40.0	0.0	NWSE	157.3	157.3	0.0
Unnamed Trib 2	6,200-6,400	797	40.0	27.4	40.0	0.0	NWSE	157.3	157.3	0.0
Sherlock Creek	5,200-5,400	2,751	60.0	58.3	60.0	0.0	NWSE	110.7	110.7	0.0
Sherlock Creek	5,400-5,600	1,679	70.0	52.1	70.0	0.0	NWSE	87.4	87.4	0.0
Sherlock Creek	5,600-5,800	1,389	70.0	46.0	70.0	0.0	NWSE	87.4	87.4	0.0
Sherlock Creek	5,800-6,000	554	80.0	39.8	80.0	0.0	NWSE	64.1	64.1	0.0
Unnamed Trib 1	4,600-4,800	480	50.0	76.8	76.8	26.8	NWSE	71.5	134.0	46.6
Unnamed Trib 1	4,800-5,000	3,474	60.0	70.6	70.6	10.6	EW	93.2	120.4	22.6
Unnamed Trib 1	5,000-5,200	2,181	70.0.	64.5	70.0	0.0	EW	94.8	94.8	0.0
Unnamed Trib 1	5,200-5,400	1,114	70.0	58.3	70.0	0.0	EW	94.8	94.8	0.0
Unnamed Trib 1	5,400-5,600	1,436	80.0	52.1	80.0	0.0	EW	69.2	69.2	0.0
Unnamed Trib 1	5,600-5,800	639	80.0	46.0	80.0	0.0	NESW	64.1	64.1	0.0

f) Loop Creek

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Loop Creek	3,000-3,200	15,096	10.0	126.2	100	90.0	EW	18.0	248.4	92.8
Loop Creek	3,000-3,200	2,640	10.0	126.2	100[1]	90.0	EW	18.0	248.4	92.8
Loop Creek	3,200-3,400	6,447	20.0	120.0	100	80.0	EW	18.0	222.8	91.9
Loop Creek	3,200-3,400	3,722	50.0	120.0	100	50.0	NWSE	17.5	134.0	86.9
Loop Creek	3,200-3,400	2,466	30.0	120.0	100	70.0	EW	18.0	197.2	90.9
Loop Creek	3,400-3,600	1,985	50.0	113.8	100	50.0	NWSE	17.5	134.0	86.9
Loop Creek	3,400-3,600	3,252	20.0	113.8	100[1]	80.0	NWSE	17.5	203.9	91.4
Loop Creek	3,600-3,800	4,683	20.0	107.7	100[1]	80.0	NWSE	17.5	203.9	91.4
Loop Creek	3,800-4,000	6,378	50.0	101.5	100	50.0	NESW	17.5	134.0	86.9
Loop Creek	4,000-4,200	5,581	40.0	95.3	95.3[1]	55.3	NESW	28.4	157.3	81.9
Loop Creek	4,200-4,400	4,398	50.0	89.1	89.1	39.1	EW	45.8	146.0	68.6
Loop Creek	4,400-4,600	1,774	70.0	83.0	83.0	13.0	EW	61.6	94.8	35.0
Loop Creek	4,600-4,800	1,969	60.0	76.8	76.8	16.8	EW	77.4	120.4	35.7
Loop Creek	4,800-5,000	1,869	50.0	70.6	70.6	20.6	EW	93.2	146.0	36.2
Loop Creek	5,000-5,200	1,162	50.0	64.5	64.5	14.5	EW	109.0	146.0	25.3
Frazier Creek	3,000-3,200	1,067	60.0	126.2	100	40.0	NS	17.0	101.0	83.2
Frazier Creek	3,200-3,400	1,531	70.0	120.0	100	30.0	NS	17.0	80.0	78.8
Frazier Creek	3,400-3,600	1,853	70.0	113.8	100	30.0	NS	17.0	80.0	78.8
Frazier Creek	3,600-3,800	1,769	70.0	107.7	100	30.0	NS	17.0	80.0	78.8
Frazier Creek	3,800-4,000	1,932	70.0	101.5	100	30.0	NS	17.0	80.0	78.8
Frazier Creek	4,000-4,200	1,837	60.0	95.3	95.3	35.3	NS	26.8	101.0	73.5
Frazier Creek	4,200-4,400	1,003	60.0	89.1	89.1	29.1	NESW	42.8	110.7	61.3
Frazier Creek	4,400-4,600	729	60.0	83.0	83.0	23.0	NS	52.7	101.0	47.8
Cliff Creek	3,200-3,400	2,841	50.0	120.0	100	50.0	NESW	17.5	134.0	86.9
Cliff Creek	3,400-3,600	1,441	60.0	113.8	100	40.0	NS	17.0	101.0	83.2
Cliff Creek	3,600-3,800	2,355	50.0	107.7	100	50.0	NS	17.0	122.0	86.1
Cliff Creek	3,800-4,000	2,181	60.0	101.5	100	40.0	NS	17.0	101.0	83.2
Cliff Creek	4,000-4,200	2,513	50.0.	95.3	95.3	45.3	NS	26.8	122.0	78.0
Cliff Creek	4,200-4,400	2,434	80.0	89.1	89.1	9.1	NESW	42.8	64.1	33.2
Cliff Creek	4,400-4,600	1,679	80.0	83.0	83.0	3.0	NS	52.7	59.0	10.7

Table 37-f, Loop Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Cliff Creek	4,600-4,800	1,167	80.0	76.8	80.0	0.0	NS	59.0	59.0	0.0
Cliff Creek	4,800-5,000	977	70.0	70.6	70.6	0.6	NS	78.7	80.0	1.6
Unnamed Trib 1	3,800-4,000	913	70.0	101.5	100	30.0	NESW	17.5	87.4	80.0
Unnamed Trib 1	4,000-4,200	1,283	60.0	95.3	95.3	35.3	EW	30.0	120.4	75.1
Unnamed Trib 1	4,200-4,400	1,399	60.0	89.1	89.1	29.1	NESW	42.8	110.7	61.3
Unnamed Trib 1	4,400-4,600	922	70.0	83.0	83.0	13.0	NESW	57.2	87.4	34.6
Unnamed Trib 1	4,600-4,800	705	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Unnamed Trib 1	4,800-5,000	790	70.0	70.6	70.6	0.6	NESW	85.9	87.4	1.7
Unnamed Trib 2	3,200-3,400	549	50.0	120.0	100	50.0	NS	17.0	122.0	86.1
Unnamed Trib 2	3,400-3,600	876	50.0	113.8	100	50.0	NS	17.0	122.0	86.1
Unnamed Trib 2	3,600-3,800	1,019	50.0	107.7	100	50.0	NS	17.0	122.0	86.1
Unnamed Trib 2	3,800-4,000	333	50.0	101.5	100	50.0	NS	17.0	122.0	86.1
Unnamed Trib 2	3,800-4,000	628	70.0	101.5	100	30.0	NS	17.0	80.0	78.8
Unnamed Trib 2	4,000-4,200	940	70.0	95.3	95.3	25.3	NS	26.8	80.0	66.5
Unnamed Trib 2	4,200-4,400	496	80.0	89.1	89.1	9.1	NS	39.8	59.0	32.5
Unnamed Trib 2	4,400-4,600	734	80.0	83.0	83.0	3.0	NS	52.7	59.0	10.7
Unnamed Trib 3	3,200-3,400	296	70.0	120.0	100	30.0	NS	17.0	80.0	78.8
Unnamed Trib 3	3,400-3,600	1,542	70.0	113.8	100	30.0	NESW	17.5	87.4	80.0
Unnamed Trib 3	3,600-3,800	1,616	70.0	107.7	100	30.0	NS	17.0	80.0	78.8
Unnamed Trib 3	3,800-4,000	1,309	60.0	101.5	100	40.0	NS	17.0	101.0	83.2
Unnamed Trib 3	4,000-4,200	1,447	70.0	95.3	95.3	25.3	NS	26.8	80.0	66.5
Unnamed Trib 3	4,200-4,400	1,621	70.0	89.1	89.1	19.1	NESW	42.8	87.4	51.0
Unnamed Trib 3	4,400-4,600	1,473	60.0	83.0	83.0	23.0	NESW	57.2	110.7	48.3
Unnamed Trib 3	4,600-4,800	549	60.0	76.8	76.8	16.8	NESW	71.5	110.7	35.4
Kelly Creek	3,400-3,600	475	60.0	113.8	100	40.0	NS	17.0	101.0	83.2
Kelly Creek	3,600-3,800	1,996	60.0	107.7	100	40.0	NS	17.0	101.0	83.2
Kelly Creek	3,800-4,000	1,394	60.0	101.5	100	40.0	NS	17.0	101.0	83.2
Kelly Creek	4,000-4,200	2,080	60.0	95.3	95.3	35.3	NS	26.8	101.0	73.5
Kelly Creek	4,200-4,400	1,357	60.0	89.1	89.1	29.1	NESW	42.8	110.7	61.3
Kelly Creek	4,400-4,600	2,297	60.0	83.0	83.0	23.0	NESW	57.2	110.7	48.3

Table 37-f, Loop Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Kelly Creek	4,600-4,800	1,911	60.0	76.8	76.8	16.8	NESW	71.5	110.7	35.4
Kelly Creek	4,800-5,000	1,410	50.0	70.6	70.6	20.6	NS	78.7	122.0	35.5
Kelly Creek	5,000-5,200	1,230	50.0	64.5	64.5	14.5	NWSE	100.3	134.0	25.2
Manhattan Creek	3,600-3,800	570	60.0	107.7	100	40.0	NESW	17.5	110.7	84.2
Manhattan Creek	3,800-4,000	1,568	60.0	101.5	100	40.0	NESW	17.5	110.7	84.2
Manhattan Creek	4,000-4,200	982	60.0	95.3	95.3	35.3	NESW	28.4	110.7	74.3
Manhattan Creek	4,200-4,400	1,119	70.0	89.1	89.1	19.1	NESW	42.8	87.4	51.0
Manhattan Creek	4,400-4,600	1,853	60.0	83.0	83.0	23.0	NESW	57.2	110.7	48.3
Manhattan Creek	4,600-4,800	1,684	60.0	76.8	76.8	16.8	NS	65.7	101.0	34.9
Manhattan Creek	4,800-5,000	945	60.0	70.6	70.6	10.6	NESW	85.9	110.7	22.4
Manhattan Creek	5,000-5,200	1,991	70.0	64.5	70.0	0.0	NESW	87.4	87.4	0.0
Manhattan Creek	5,200-5,400	523	70.0	58.3	70.0	0.0	EW	94.8	94.8	0.0
Manhattan Creek	5,200-5,400	407	60.0	58.3	60.0	0.0	EW	120.4	120.4	0.0
Manhattan Creek	5,400-5,600	686	60.0	52.1	60.0	0.0	NESW	110.7	110.7	0.0
Mineral Creek	3,800-4,000	385	70.0	101.5	100	30.0	EW	18.0	94.8	81.0
Mineral Creek	4,000-4,200	781	70.0	95.3	95.3	25.3	EW	30.0	94.8	68.4
Mineral Creek	4,200-4,400	1,389	80.0	89.1	89.1	9.1	NESW	42.8	64.1	33.2
Mineral Creek	4,400-4,600	1,236	80.0	83.0	83.0	3.0	NESW	57.2	64.1	10.8
Mineral Creek	4,600-4,800	1,542	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Mineral Creek	4,800-5,000	1,420	60.0	70.6	70.6	10.6	NESW	85.9	110.7	22.4
Mineral Creek	5,000-5,200	1,468	60.0	64.5	64.5	4.5	NESW	100.3	110.7	9.4
Mineral Creek	5,200-5,400	1,177	70.0	58.3	70.0	0.0	NESW	87.4	87.4	0.0
Mineral Creek	5,400-5,600	998	70.0	52.1	70.0	0.0	NESW	87.4	87.4	0.0
Mineral Creek	5,600-5,800	502	70.0	46.0	70.0	0.0	NESW	87.4	87.4	0.0
Olentange Creek	4,000-4,200	1,288	40.0	95.3	95.3[1]	55.3	NESW	28.4	110.7	74.3
Olentange Creek	4,200-4,400	2,529	60.0	89.1	89.1	29.1	NESW	42.8	110.7	61.3
Olentange Creek	4,400-4,600	2,144	60.0	83.0	83.0	23.0	NESW	57.2	110.7	48.3
Olentange Creek	4,600-4,800	1,642	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Olentange Creek	4,800-5,000	2,519	70.0	70.6	70.6	0.6	NESW	85.9	87.4	1.7

Table 37-f, Loop Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Olentange Creek	5,000-5,200	2,054	70.0	64.5	70.0	0.0	NESW	87.4	87.4	0.0
Olentange Creek	5,000-5,200	940	80.0	64.5	80.0	0.0	EW	69.2	69.2	0.0
Olentange Creek	5,200-5,400	1,742	80.0	58.3	80.0	0.0	EW	69.2	69.2	0.0
Olentange Creek	5,400-5,600	882	80.0	52.1	80.0	0.0	EW	69.2	69.2	0.0
Unnamed Trib 6	4,200-4,400	1,288	70.0	89.1	89.1	19.1	NS	39.8	80.0	50.3
Unnamed Trib 6	4,400-4,600	1,526	70.0	83.0	83.0	13.0	NS	52.7	80.0	34.1
Unnamed Trib 6	4,600-4,800	1,336	70.0	76.8	76.8	6.8	NWSE	71.5	87.4	18.2
Unnamed Trib 6	4,800-5,000	1,098	80.0	70.6	80.0	0.0	NS	59.0	59.0	0.0
Unnamed Trib 6	5,000-5,200	1,077	80.0	64.5	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 6	5,200-5,400	607	80.0	58.3	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 7	4,400-4,600	840	70.0	83.0	83.0	13.0	NS	52.7	80.0	34.1
Unnamed Trib 7	4,600-4,800	2,049	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Unnamed Trib 7	4,800-5,000	1,193	70.0	70.6	70.6	0.6	NESW	85.9	87.4	1.7
Unnamed Trib 7	5,000-5,200	1,679	80.0	64.5	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 7	5,200-5,400	1,500	80.0	58.3	80.0	0.0	NS	59.0	59.0	0.0
Ward Creek	4,000-4,200	4,500	50.0	95.3	95.3	45.3	NESW	28.4	134.0	78.8
Ward Creek	4,200-4,400	1,711	50.0	89.1	89.1	39.1	EW	45.8	146.0	68.6
Ward Creek	4,200-4,400	3,390	60.0	89.1	89.1	29.1	EW	45.8	120.4	62.0
Ward Creek	4,400-4,600	2,170	60.0	83.0	83.0	23.0	EW	61.6	120.4	48.8
Ward Creek	4,600-4,800	1,272	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Ward Creek	4,800-5,000	803	50.0	70.6	70.6	20.6	EW	93.2	146.0	36.2
Turkey Creek	3,400-3,600	1,125	60.0	113.8	100	40.0	NS	17.0	101.0	83.2
Turkey Creek	3,600-3,800	4,636	60.0	107.7	100	40.0	NS	17.0	101.0	83.2
Turkey Creek	3,800-4,000	2,598	50.0	101.5	100	50.0	NS	17.0	122.0	86.1
Turkey Creek	3,800-4,000	1,114	60.0	101.5	100	40.0	NESW	17.5	110.7	84.2
Turkey Creek	4,000-4,200	2,307	70.0	95.3	95.3	25.3	NESW	28.4	87.4	67.5
Turkey Creek	4,200-4,400	1,468	60.0	89.1	89.1	29.1	EW	45.8	120.4	62.0
Turkey Creek	4,400-4,600	708	60.0	83.0	83.0	23.0	EW	61.6	120.4	48.8
Turkey Creek	4,600-4,800	644	60.0	76.8	76.8	16.8	EW	77.4	120.4	35.7
Unnamed Trib 5	3,800-4,000	2,223	50.0	101.5	100	50.0	NS	17.0	122.0	86.1

Table 37-f, Loop Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Unnamed Trib 5	3,800-4,000	2,640	40.0	101.5	100[1]	60.0	NS	17.0	143.0	88.1
Unnamed Trib 5	4,000-4,200	781	40.0	95.3	95.3[1]	55.3	NWSE	28.4	157.3	81.9
Unnamed Trib 5	4,000-4,200	803	80.0	95.3	95.3	15.3	NWSE	28.4	64.1	55.7
Unnamed Trib 5	4,200-4,400	924	80.0	89.1	89.1	9.1	NESW	42.8	64.1	33.2
Unnamed Trib 4	3,400-3,600	1,378	70.0	113.8	100	30.0	NS	17.0	80.0	78.8
Unnamed Trib 4	3,600-3,800	3,443	50.0	107.7	100	50.0	NS	17.0	122.0	86.1
Unnamed Trib 4	3,800-4,000	1,536	60.0	101.5	100	40.0	NWSE	17.5	110.7	84.2
Unnamed Trib 4	3,800-4,000	850	70.0	101.5	100	30.0	NS	17.0	80.0	78.8
Unnamed Trib 4	4,000-4,200	982	70.0	95.3	95.3	25.3	NESW	28.4	87.4	67.5
Clear Creek	3,200-3,400	1,774	50.0	120.0	100	50.0	NESW	17.5	134.0	86.9
Clear Creek	3,400-3,600	4,483	50.0	113.8	100[1]	50.0	NESW	17.5	134.0	86.9
Clear Creek	3,600-3,800	2,957	50.0	107.7	100[1]	50.0	NESW	17.5	134.0	86.9
Clear Creek	3,800-4,000	1,595	60.0	101.5	100[1]	40.0	NS	17.0	101.0	83.2
Clear Creek	4,000-4,200	1,573	60.0	95.3	95.3[1]	35.3	NWSE	28.4	110.7	74.3
Clear Creek	4,200-4,400	639	70.0	89.1	89.1[1]	19.1	NESW	42.8	87.4	51.0
Clear Creek	4,400-4,600	813	70.0	83.0	83.0[1]	13.0	NESW	57.2	87.4	34.6
Clear Creek	4,600-4,800	1,199	70.0	76.8	76.8[1]	6.8	NESW	71.5	87.4	18.2
Clear Creek	4,800-5,000	1,853	50.0	70.6	70.6[1]	20.6	NESW	85.9	134.0	35.9
Clear Creek	5,000-5,200	771	50.0	64.5	64.5	14.5	NS	91.6	122.0	24.9

g) Mosquito Creek

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Mosquito Creek	3,200-3,400	2,233	70.0	120.0	100	30.0	NESW	17.5	87.4	80.0
Mosquito Creek	3,400-3,600	3,047	60.0	113.8	100	40.0	NESW	17.5	110.7	84.2
Mosquito Creek	3,600-3,800	1,800	70.0	107.7	100	30.0	NESW	17.5	87.4	80.0

Table 37-g, Mosquito Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Mosquito Creek	3,600-3,800	6,236	40.0	107.7	100[1]	60.0	NESW	17.5	157.3	88.9
Mosquito Creek	3,800-4,000	7,186	50.0	101.5	100	50.0	NESW	17.5	134.0	86.9
Mosquito Creek	4,000-4,200	5,840	50.0	95.3	95.3	45.3	NESW	28.4	134.0	78.8
Mosquito Creek	4,200-4,400	3,200	70.0	89.1	89.1	19.1	NESW	42.8	87.4	51.0
Mosquito Creek	4,400-4,600	1,283	80.0	83.0	83.0	3.0	NS	52.7	59.0	10.7
Mosquito Creek	4,600-4,800	961	80.0	76.8	80.0	0.0	NS	59.0	59.0	0.0
Mosquito Creek	4,800-5,000	1,547	80.0	70.6	80.0	0.0	NESW	64.1	64.1	0.0
Mosquito Creek	5,000-5,200	644	80.0	64.5	80.0	0.0	NS	59.0	59.0	0.0
Mosquito Creek	5,200-5,400	591	80.0	58.3	80.0	0.0	NESW	64.1	64.1	0.0
Mosquito Creek	5,400-5,600	412	80.0	52.1	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 1	3,600-3,800	539	70.0	107.7	100	30.0	NWSE	17.5	87.4	80.0
Unnamed Trib 1	3,800-4,000	1,859	70.0	101.5	100	30.0	NWSE	17.5	87.4	80.0
Unnamed Trib 1	4,000-4,200	1,383	70.0	95.3	95.3	25.3	EW	30.0	94.8	68.4
Unnamed Trib 1	4,200-4,400	671	80.0	89.1	89.1	9.1	EW	45.8	69.2	33.8
Unnamed Trib 1	4,400-4,600	644	80.0	83.0	83.0	3.0	EW	61.6	69.2	11.0
Unnamed Trib 1	4,600-4,800	517	80.0	76.8	80.0	0.0	EW	69.2	69.2	0.0
Unnamed Trib 2	3,800-4,000	259	70.0	101.5	100	30.0	NWSE	17.5	87.4	80.0
Unnamed Trib 2	4,000-4,200	1,632	70.0	95.3	95.3	25.3	NWSE	28.4	87.4	67.5
Unnamed Trib 2	4,200-4,400	1,183	70.0	89.1	89.1	19.1	EW	45.8	94.8	51.7
Unnamed Trib 2	4,400-4,600	1,162	70.0	83.0	83.0	13.0	EW	61.6	94.8	35.0
Unnamed Trib 2	4,600-4,800	935	70.0	76.8	76.8	6.8	NWSE	71.5	87.4	18.2
Unnamed Trib 2	4,800-5,000	697	70.0	70.6	70.6	0.6	EW	93.2	94.8	1.7
Unnamed Trib 2	5,000-5,200	708	60.0	64.5	64.5	4.5	EW	109.0	120.4	9.5
Unnamed Trib 3	4,000-4,200	2,233	60.0	95.3	95.3	35.3	NWSE	28.4	110.7	74.3
Unnamed Trib 3	4,200-4,400	1,785	70.0	89.1	89.1	19.1	NWSE	42.8	87.4	51.0
Unnamed Trib 3	4,400-4,600	1,061	70.0	83.0	83.0	13.0	NWSE	57.2	87.4	34.6
Unnamed Trib 3	4,600-4,800	781	80.0	76.8	80.0	0.0	NS	59.0	59.0	0.0
Unnamed Trib 3	4,800-5,000	623	80.0	70.6	80.0	0.0	NS	59.0	59.0	0.0
Unnamed Trib 3	5,000-5,200	602	80.0	64.5	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 3	5,200-5,400	544	80.0	58.3	80.0	0.0	NESW	64.1	64.1	0.0

h) Simmons Creek

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m²)	Current Heat Load (watts/m²)	Target Heat Load Reduction (%)
Simmons Creek	3,200-3,400	232	50.0	120.0	100	50.0	EW	18.0	146.0	87.7
Simmons Creek	3,400-3,600	7,212	50.0	113.8	100	50.0	NESW	17.5	134.0	86.9
Simmons Creek	3,600-3,800	6,088	50.0	107.7	100	50.0	EW	18.0	146.0	87.7
Simmons Creek	3,800-4,000	882	50.0	101.5	100	50.0	NWSE	17.5	134.0	86.9
Simmons Creek	3,800-4,000	6,331	60.0	101.5	100	40.0	NWSE	17.5	110.7	84.2
Simmons Creek	4,000-4,200	5,945	60.0	95.3	95.3	35.3	NWSE	28.4	110.7	74.3
Simmons Creek	4,000-4,200	3,949	50.0	95.3	95.3	45.3	EW	30.0	146.0	79.5
Simmons Creek	4,200-4,400	3,617	40.0	89.1	89.1[1]	49.1	EW	45.8	171.6	73.3
Simmons Creek	4,200-4,400	5,407	50.0	89.1	89.1	39.1	EW	45.8	146.0	68.6
Simmons Creek	4,200-4,400	4,984	60.0	89.1	89.1	29.1	NWSE	42.8	110.7	61.3
Simmons Creek	4,400-4,600	8,194	20.0	83.0	83.0[1]	63.0	NWSE	57.2	203.9	72.0
Simmons Creek	4,400-4,600	1,974	40.0	83.0	83.0	43.0	NWSE	57.2	157.3	63.6
Simmons Creek	4,600-4,800	1,969	50.0	76.8	76.8	26.8	NS	65.7	122.0	46.1
Unnamed Trib 10	4,600-4,800	1,093	60.0	76.8	76.8	16.8	NESW	71.5	110.7	35.4
Unnamed Trib 10	4,800-5,000	2,313	60.0	70.6	70.6	10.6	NESW	85.9	110.7	22.4
Unnamed Trib 10	5,000-5,200	2,175	60.0	64.5	64.5	4.5	NESW	100.3	110.7	9.4
Unnamed Trib 10	5,200-5,400	1,362	50.0	58.3	58.3	8.3	NESW	114.7	134.0	14.4
Unnamed Trib 10	5,400-5,600	1,510	60.0	52.1	60.0	0.0	NS	101.0	101.0	0.0
Unnamed Trib 10	5,600-5,800	1,272	50.0	46.0	50.0	0.0	NESW	134.0	134.0	0.0
Unnamed Trib 10	5,800-6,000	956	50.0	39.8	50.0	0.0	EW	146.0	146.0	0.0
Simmons Creek	4,600-4,800	1,193	60.0	76.8	76.8	16.8	NWSE	71.5	110.7	35.4
Simmons Creek	4,800-5,000	2,033	60.0	70.6	70.6	10.6	NS	78.7	101.0	22.1
Simmons Creek	5,000-5,200	993	70.0	64.5	70.0	0.0	NESW	87.4	87.4	0.0
Unnamed Trib 1	3,600-3,800	708	70.0	107.7	100	30.0	NS	17.0	80.0	78.8
Unnamed Trib 1	3,800-4,000	660	70.0	101.5	100	30.0	NWSE	17.5	87.4	80.0
Unnamed Trib 1	4,000-4,200	475	70.0	95.3	95.3	25.3	NWSE	28.4	87.4	67.5
Unnamed Trib 1	4,200-4,400	655	70.0	89.1	89.1	19.1	NWSE	42.8	87.4	51.0
Unnamed Trib 1	4,400-4,600	1,563	60.0	83.0	83.0	23.0	NWSE	57.2	110.7	48.3

Table 37-h, Simmons Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Unnamed Trib 1	4,600-4,800	766	60.0	76.8	76.8	16.8	NWSE	71.5	110.7	35.4
Unnamed Trib 1	4,800-5,000	1,067	60.0	70.6	70.6	10.6	NWSE	85.9	110.7	22.4
NF Simmons Ck.	3,800-4,000	2,582	60.0	101.5	100	40.0	NS	17.0	101.0	83.2
NF Simmons Ck.	4,000-4,200	5,011	60.0	95.3	95.3	35.3	NESW	28.4	110.7	74.3
Unnamed Trib 2	4,200-4,400	5,919	70.0	89.1	89.1	19.1	EW	45.8	94.8	51.7
Unnamed Trib 2	4,400-4,600	3,084	70.0	83.0	83.0	13.0	NESW	57.2	87.4	34.6
Unnamed Trib 2	4,600-4,800	1,959	70.0	76.8	76.8	6.8	NS	65.7	80.0	17.9
Unnamed Trib 2	4,800-5,000	1,262	70.0	70.6	70.6	0.6	NS	78.7	80.0	1.6
Unnamed Trib 2	5,000-5,200	744	70.0	64.5	70.0	0.0	NESW	87.4	87.4	0.0
Unnamed Trib 2	5,200-5,400	649	70.0	58.3	70.0	0.0	NESW	87.4	87.4	0.0
NF Simmons Ck.	4,400-4,600	3,643	70.0	83.0	83.0	13.0	EW	61.6	94.8	35.0
NF Simmons Ck.	4,600-4,800	2,022	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
NF Simmons Ck.	4,800-5,000	1,257	70.0	70.6	70.6	0.6	EW	93.2	94.8	1.7
NF Simmons Ck.	5,000-5,200	1,764	70.0	64.5	70.0	0.0	NESW	87.4	87.4	0.0
NF Simmons Ck.	5,200-5,400	1,061	70.0	58.3	70.0	0.0	NESW	87.4	87.4	0.0
NF Simmons Ck.	5,400-5,600	618	80.0	52.1	80.0	0.0	EW	69.2	69.2	0.0
NF Simmons Ck.	5,600-5,800	1,288	80.0	46.0	80.0	0.0	NESW	64.1	64.1	0.0
NF Simmons Ck.	5,800-6,000	354	80.0	39.8	80.0	0.0	NESW	64.1	64.1	0.0
NF Simmons Ck.	6,000-6,200	766	80.0	33.6	80.0	0.0	NESW	64.1	64.1	0.0
Three Lakes Creek	4,000-4,200	760	70.0	95.3	95.3	25.3	NWSE	28.4	87.4	67.5
Three Lakes Creek	4,200-4,400	2,307	80.0	89.1	89.1	9.1	NWSE	42.8	64.1	33.2
Three Lakes Creek	4,400-4,600	3,928	70.0	83.0	83.0	13.0	NWSE	57.2	87.4	34.6
Three Lakes Creek	4,600-4,800	2,064	80.0	76.8	80.0	0.0	NWSE	64.1	64.1	0.0
Three Lakes Creek	4,800-5,000	2,144	80.0	70.6	80.0	0.0	NWSE	64.1	64.1	0.0
Three Lakes Creek	5,000-5,200	1,885	80.0	64.5	80.0	0.0	NWSE	64.1	64.1	0.0
Three Lakes Creek	5,200-5,400	1,241	80.0	58.3	80.0	0.0	NWSE	64.1	64.1	0.0

Table 37-h, Simmons Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Loading (watts/m^2)	Current Heat Loading (watts/m^2)	Target Heat Load Reduction (%)
Three Lakes Creek	5,400-5,600	882	80.0	52.1	80.0	0.0	NS	59.0	59.0	0.0
Unnamed Trib 4	4,600-4,800	1,257	80.0	76.8	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 4	4,800-5,000	1,067	80.0	70.6	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 4	5,000-5,200	781	80.0	64.5	80.0	0.0	NS	59.0	59.0	0.0
Unnamed Trib 4	5,200-5,400	671	80.0	58.3	80.0	0.0	NS	59.0	59.0	0.0
Unnamed Trib 4	5,400-5,600	708	80.0	52.1	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 4	5,600-5,800	428	80.0	46.0	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 3	4,200-4,400	396	70.0	89.1	89.1	19.1	NESW	42.8	87.4	51.0
Unnamed Trib 3	4,400-4,600	987	70.0	83.0	83.0	13.0	NESW	57.2	87.4	34.6
Unnamed Trib 3	4,600-4,800	1,019	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Unnamed Trib 3	4,800-5,000	887	70.0	70.6	70.6	0.6	NESW	85.9	87.4	1.7
Unnamed Trib 3	5,000-5,200	866	70.0	64.5	70.0	0.0	NESW	87.4	87.4	0.0
Unnamed Trib 3	5,200-5,400	840	70.0	58.3	70.0	0.0	NESW	87.4	87.4	0.0
Unnamed Trib 3	5,400-5,600	533	70.0	52.1	70.0	0.0	NESW	87.4	87.4	0.0
Unnamed Trib 5	4,200-4,400	2,297	60.0	89.1	89.1	29.1	NS	39.8	101.0	60.6
Unnamed Trib 5	4,400-4,600	1,668	60.0	83.0	83.0	23.0	NS	52.7	101.0	47.8
Unnamed Trib 5	4,600-4,800	1,199	40.0	76.8	76.8	36.8	NS	65.7	143.0	54.1
Unnamed Trib 5	4,800-5,000	470	40.0	70.6	70.6	30.6	EW	93.2	171.6	45.7
Unnamed Trib 5	5,000-5,200	665	70.0	64.5	70.0	0.0	NWSE	87.4	87.4	0.0
Unnamed Trib 6	4,200-4,400	2,830	70.0	89.1	89.1	19.1	NESW	42.8	87.4	51.0
Unnamed Trib 6	4,400-4,600	2,402	60.0	83.0	83.0	23.0	NWSE	57.2	110.7	48.3
Unnamed Trib 6	4,600-4,800	1,473	60.0	76.8	76.8	16.8	NESW	71.5	110.7	35.4
Unnamed Trib 6	4,800-5,000	998	70.0	70.6	70.6	0.6	NESW	85.9	87.4	1.7
Unnamed Trib 7	4,200-4,400	919	70.0	89.1	89.1	19.1	NESW	42.8	87.4	51.0
Unnamed Trib 7	4,400-4,600	1,911	70.0	83.0	83.0	13.0	NS	52.7	80.0	34.1
Unnamed Trib 7	4,600-4,800	1,368	70.0	76.8	76.8	6.8	NS	65.7	80.0	17.9
Unnamed Trib 7	4,800-5,000	1,135	70.0	70.6	70.6	0.6	NS	78.7	80.0	1.6
Unnamed Trib 7	5,000-5,200	1,045	70.0	64.5	70.0	0.0	NS	80.0	80.0	0.0
Unnamed Trib 7	5,200-5,400	602	70.0	58.3	70.0	0.0	NESW	87.4	87.4	0.0
Dolly Creek	4,400-4,600	2,603	80.0	83.0	83.0	3.0	NESW	57.2	64.1	10.8

Table 37-h, Simmons Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m^2)	Current Heat Load (watts/m^2)	Target Heat Load Reduction (%)
Dolly Creek	4,600-4,800	1,494	80.0	76.8	80.0	0.0	NESW	64.1	64.1	0.0
Dolly Creek	4,800-5,000	982	80.0	70.6	80.0	0.0	NESW	64.1	64.1	0.0
Dolly Creek	5,000-5,200	945	80.0	64.5	80.0	0.0	NESW	64.1	64.1	0.0
Dolly Creek	5,200-5,400	945	80.0	58.3	80.0	0.0	NESW	64.1	64.1	0.0
Dolly Creek	5,400-5,600	1,500	80.0	52.1	80.0	0.0	NESW	64.1	64.1	0.0
Dolly Creek	5,600-5,800	1,969	70.0	46.0	70.0	0.0	EW	94.8	94.8	0.0
Dolly Creek	5,800-6,000	1,130	60.0	39.8	60.0	0.0	NWSE	110.7	110.7	0.0
Washout Creek	4,400-4,600	866	60.0	83.0	83.0	23.0	NESW	57.2	110.7	48.3
Washout Creek	4,600-4,800	2,846	60.0	76.8	76.8	16.8	NESW	71.5	110.7	35.4
Washout Creek	4,800-5,000	2,492	70.0	70.6	70.6	0.6	NESW	85.9	87.4	1.7
Washout Creek	5,000-5,200	1,758	70.0	64.5	70.0	0.0	NESW	87.4	87.4	0.0
Washout Creek	5,200-5,400	1,193	70.0	58.3	70.0	0.0	NESW	87.4	87.4	0.0
Washout Creek	5,400-5,600	1,267	70.0	52.1	70.0	0.0	NESW	87.4	87.4	0.0
Washout Creek	5,600-5,800	1,104	70.0	46.0	70.0	0.0	NESW	87.4	87.4	0.0
Washout Creek	5,800-6,000	866	70.0	39.8	70.0	0.0	NESW	87.4	87.4	0.0
Washout Creek	6,000-6,200	517	70.0	33.6	70.0	0.0	NWSE	87.4	87.4	0.0
Unnamed Trib 8	4,400-4,600	2,270	30.0	83.0	83.0	53.0	EW	61.6	197.2	68.8
Unnamed Trib 8	4,600-4,800	3,601	50.0	76.8	76.8	26.8	EW	77.4	146.0	47.0
Unnamed Trib 8	4,800-5,000	2,529	50.0	70.6	70.6	20.6	NESW	85.9	134.0	35.9
Unnamed Trib 8	5,000-5,200	1,494	60.0	64.5	64.5	4.5	NESW	100.3	110.7	9.4
Unnamed Trib 8	5,200-5,400	1,119	70.0	58.3	70.0	0.0	NESW	87.4	87.4	0.0
Unnamed Trib 8	5,400-5,600	940	80.0	52.1	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 8	5,600-5,800	760	80.0	46.0	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 8	5,800-6,000	623	80.0	39.8	80.0	0.0	EW	69.2	69.2	0.0
Unnamed Trib 8	6,000-6,200	607	80.0	33.6	80.0	0.0	EW	69.2	69.2	0.0
Unnamed Trib 9	4,600-4,800	792	70.0	76.8	76.8	6.8	NESW	71.5	87.4	18.2
Unnamed Trib 9	4,800-5,000	2,017	70.0	70.6	70.6	0.6	NESW	85.9	87.4	1.7
Unnamed Trib 9	5,000-5,200	1,299	80.0	64.5	80.0	0.0	EW	69.2	69.2	0.0
Unnamed Trib 9	5,200-5,400	1,246	80.0	58.3	80.0	0.0	NESW	64.1	64.1	0.0

Table 37-h, Simmons Creek, continued.

Stream Segment	Elevation Range	Stream Segment Length (ft)	Existing Canopy Cover (%)	CWE Target Canopy Cover (%)	Adjusted Target Canopy Cover (%)	Canopy Increase to Meet Target (%)	Stream Orien-tation	Target Heat Load (watts/m²)	Current Heat Load (watts/m²)	Target Heat Load Reduction (%)
Unnamed Trib 9	5,400-5,600	845	80.0	52.1	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 9	5,600-5,800	972	80.0	46.0	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 9	5,800-6,000	840	80.0	39.8	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 9	6,000-6,200	945	80.0	33.6	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 9	6,200-6,400	1,109	80.0	27.4	80.0	0.0	NESW	64.1	64.1	0.0
Unnamed Trib 11	4,400-4,600	1,948	50.0	83.0	83.0	33.0	NESW	57.2	134.0	57.3
Unnamed Trib 11	4,600-4,800	2,281	60.0	76.8	76.8	16.8	NESW	71.5	110.7	35.4
Unnamed Trib 11	4,800-5,000	1,690	60.0	70.6	70.6	10.6	NESW	85.9	110.7	22.4
Unnamed Trib 11	5,000-5,200	1,621	60.0	64.5	64.5	4.5	NESW	100.3	110.7	9.4
Unnamed Trib 11	5,200-5,400	1,478	50.0	58.3	58.3	8.3	NESW	114.7	134.0	14.4
Unnamed Trib 11	5,400-5,600	1,605	40.0	52.1	52.1[1]	12.1	NESW	129.0	157.3	18.0

[1]Interim target canopy cover; physical habitat limitations in these segments make it unlikely that current target levels will be reached. Final target canopy cover to be determined during the implementation phase.

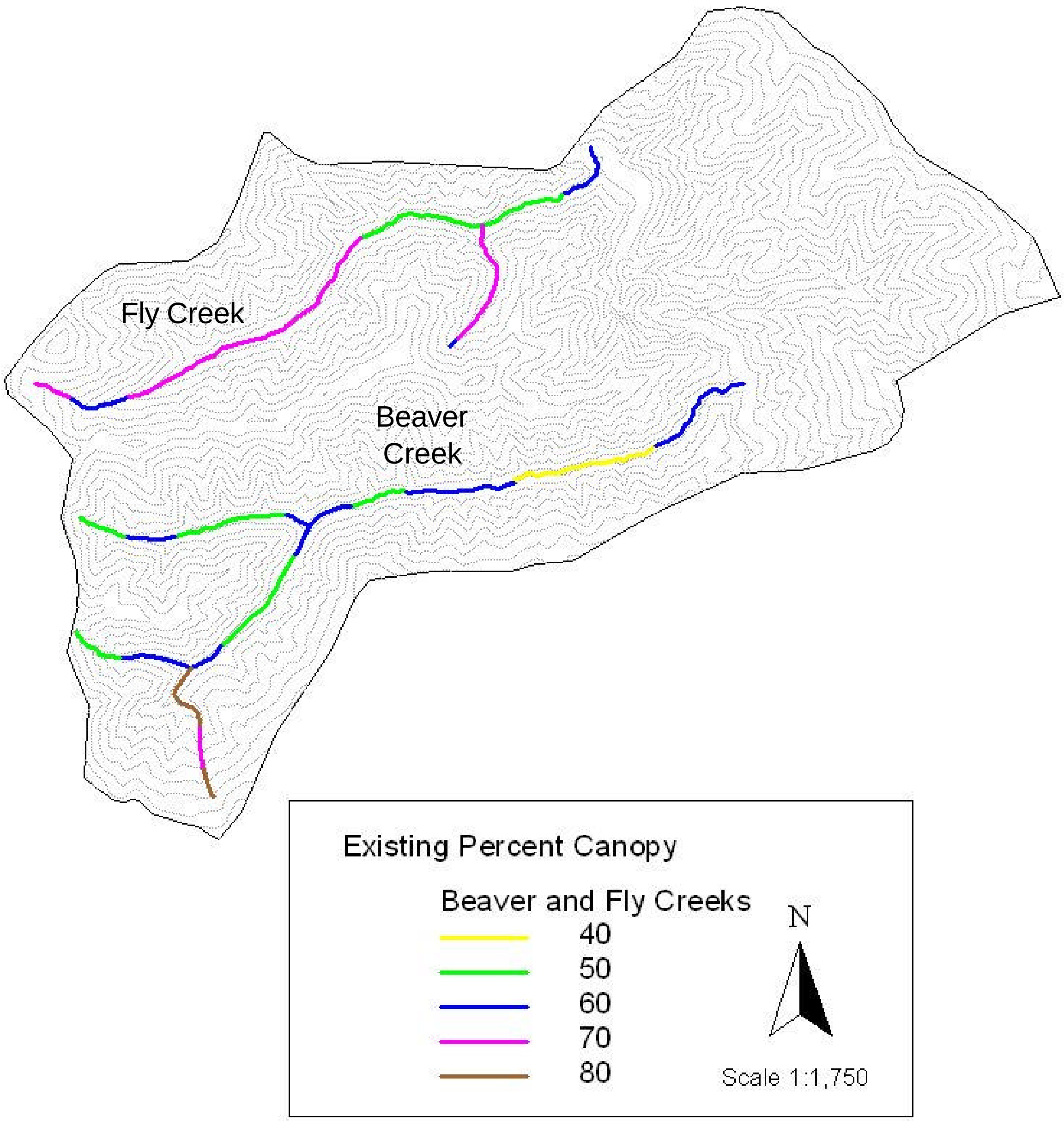

Figure 11a. Existing Shading Canopy: Beaver and Fly Creeks

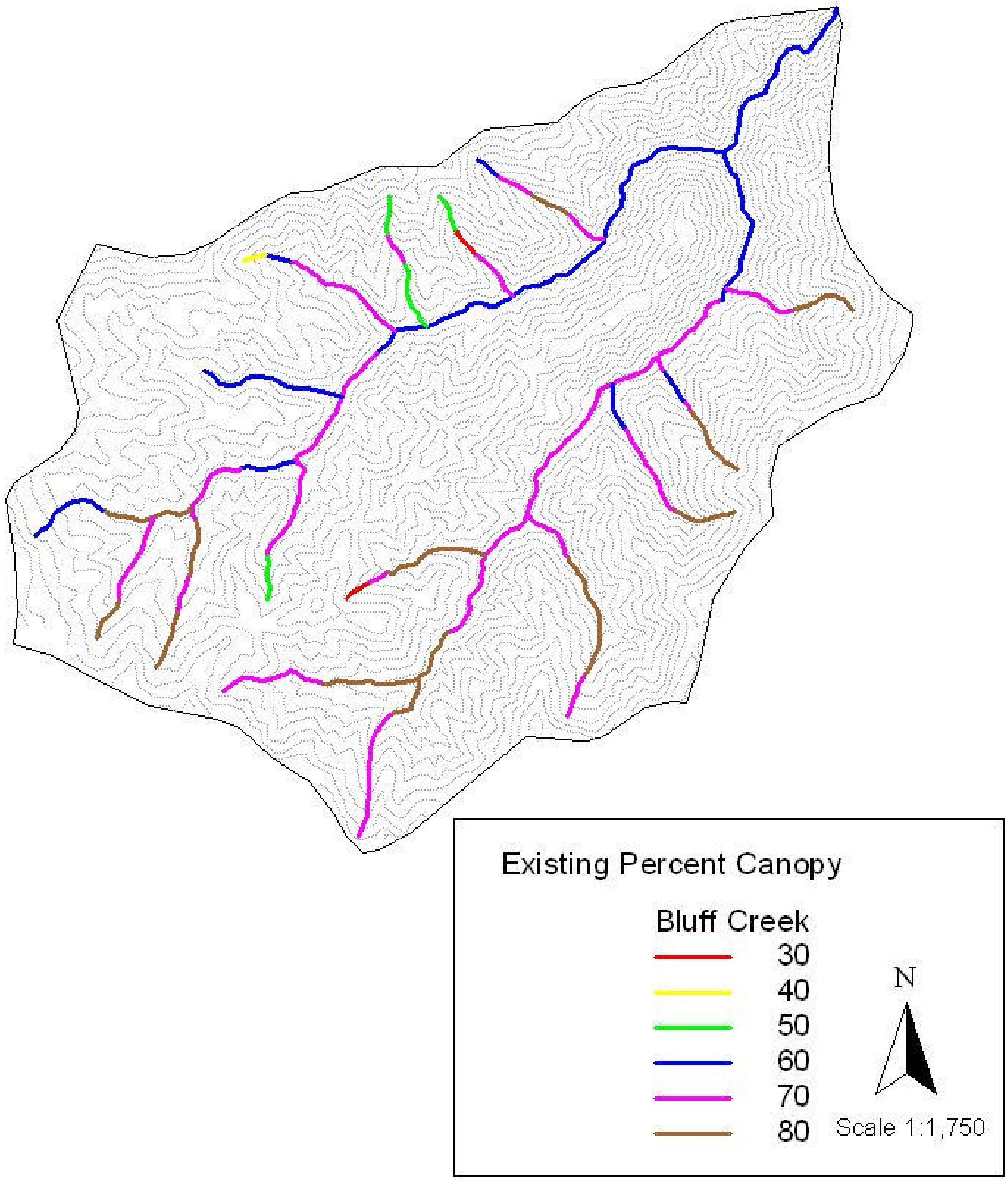

Figure 11b. Existing Shading Canopy: Bluff Creek

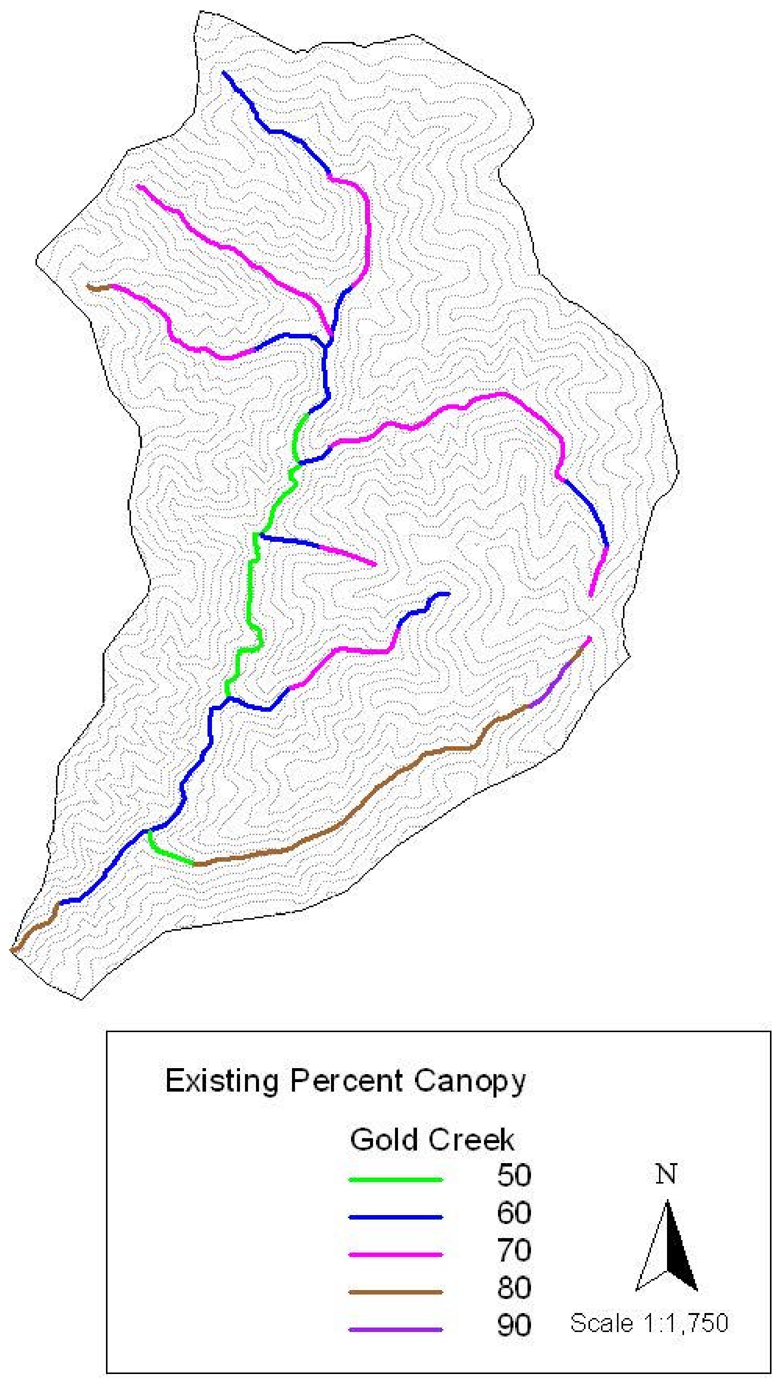

Figure 11c. Existing Shading Canopy: Gold Creek

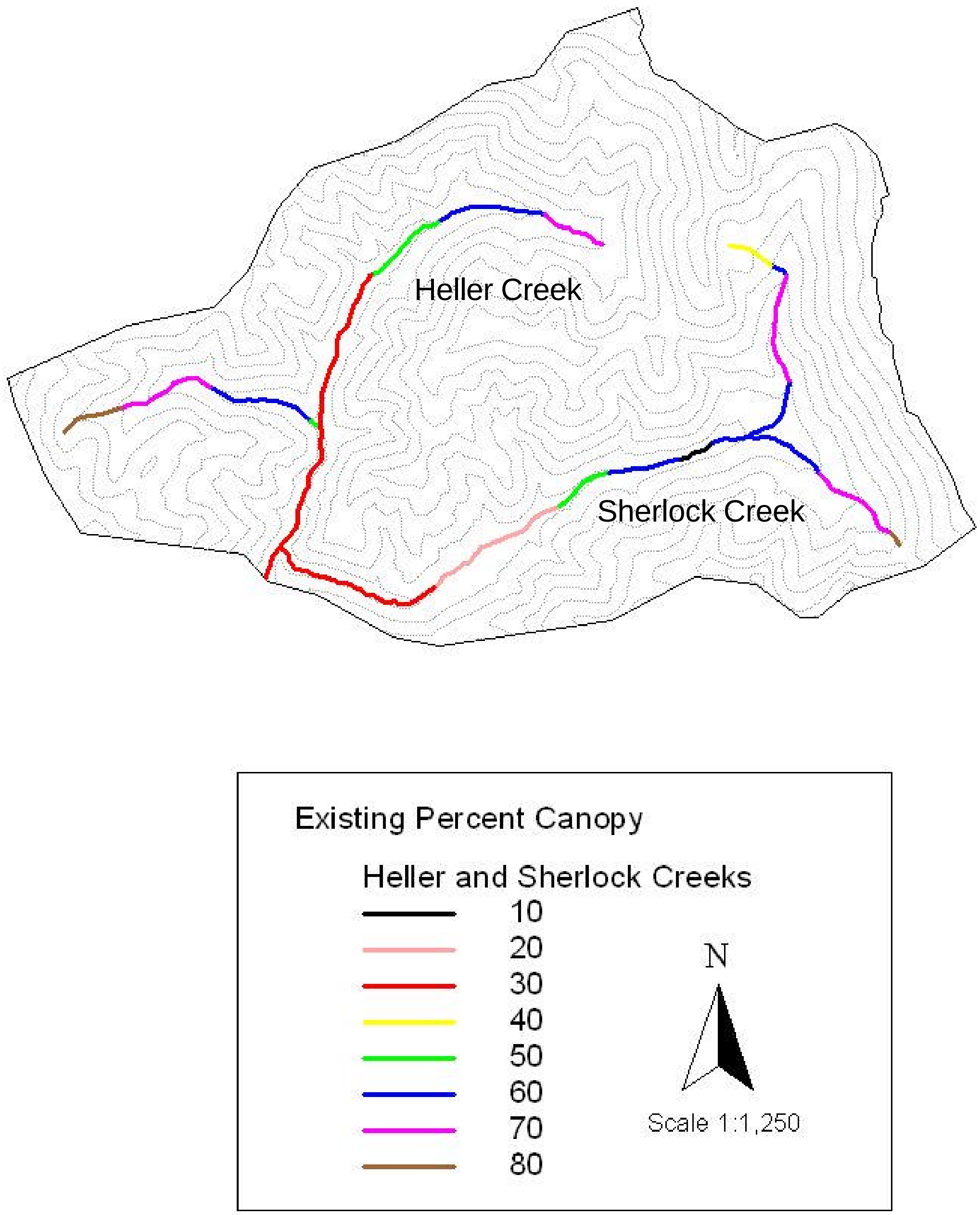

Figure 11d. Existing Shading Canopy: Heller and Sherlock Creeks

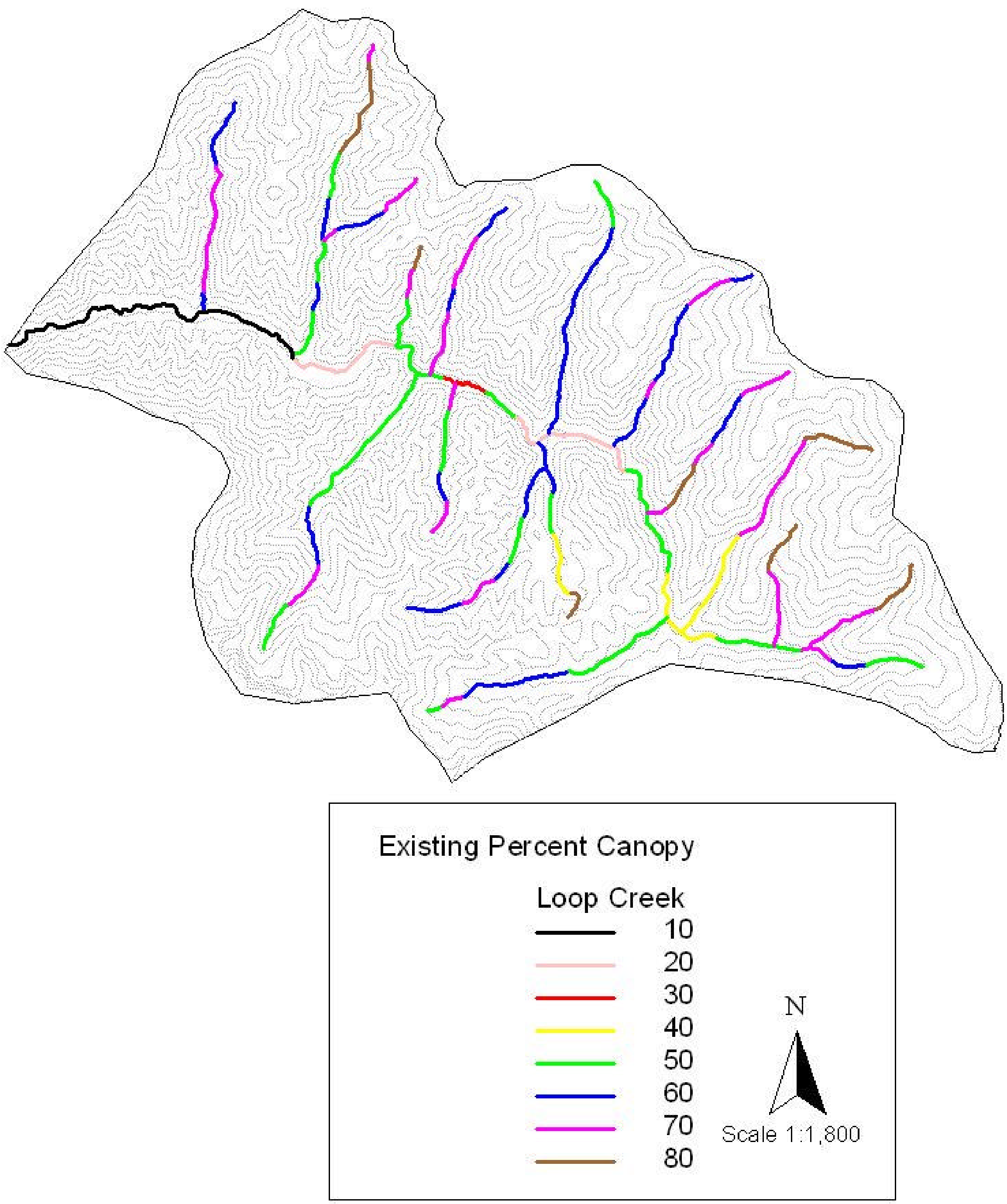

Figure 11e. Existing Shading Canopy: Loop Creek

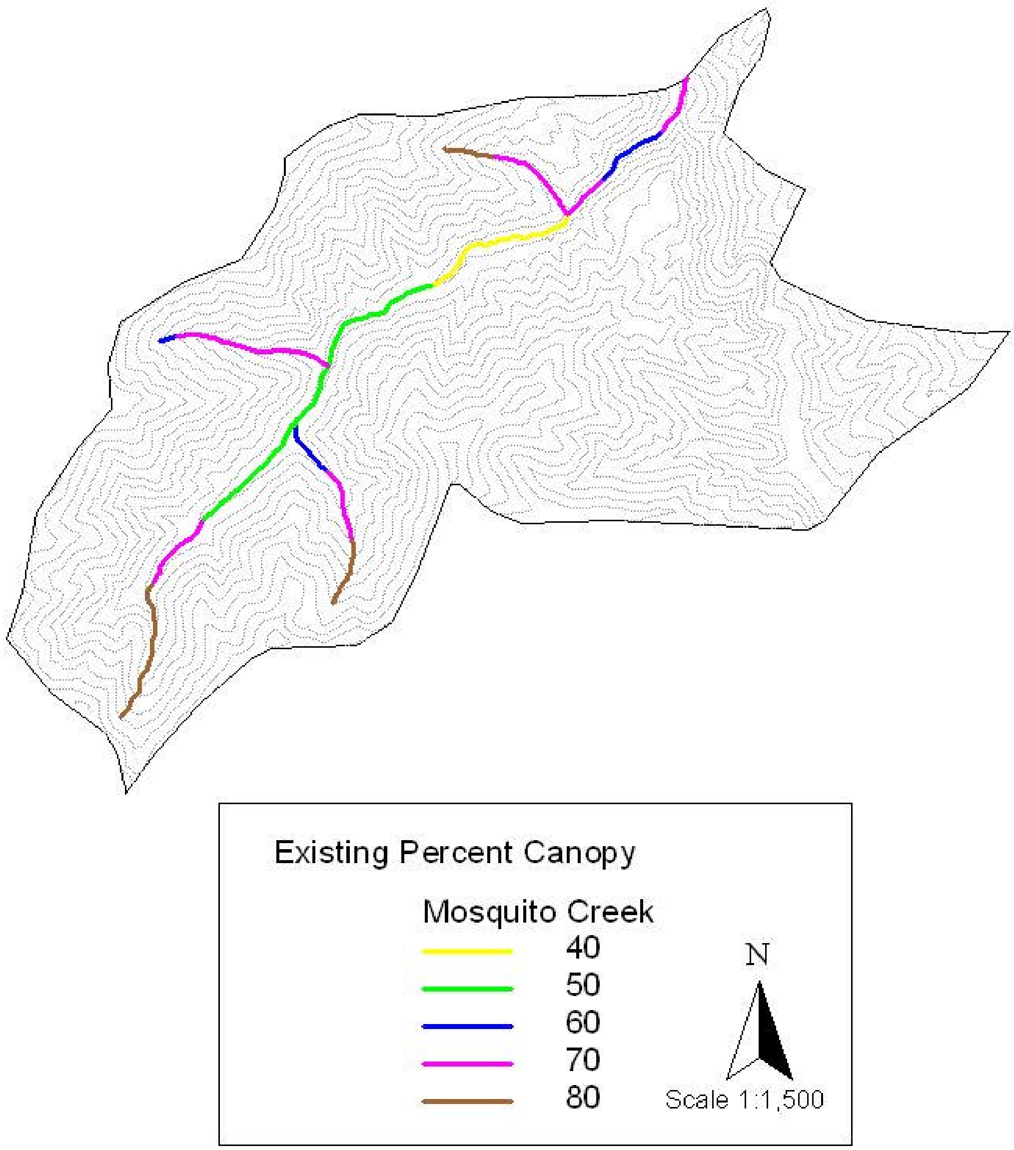

Figure 11f. Existing Shading Canopy: Mosquito Creek

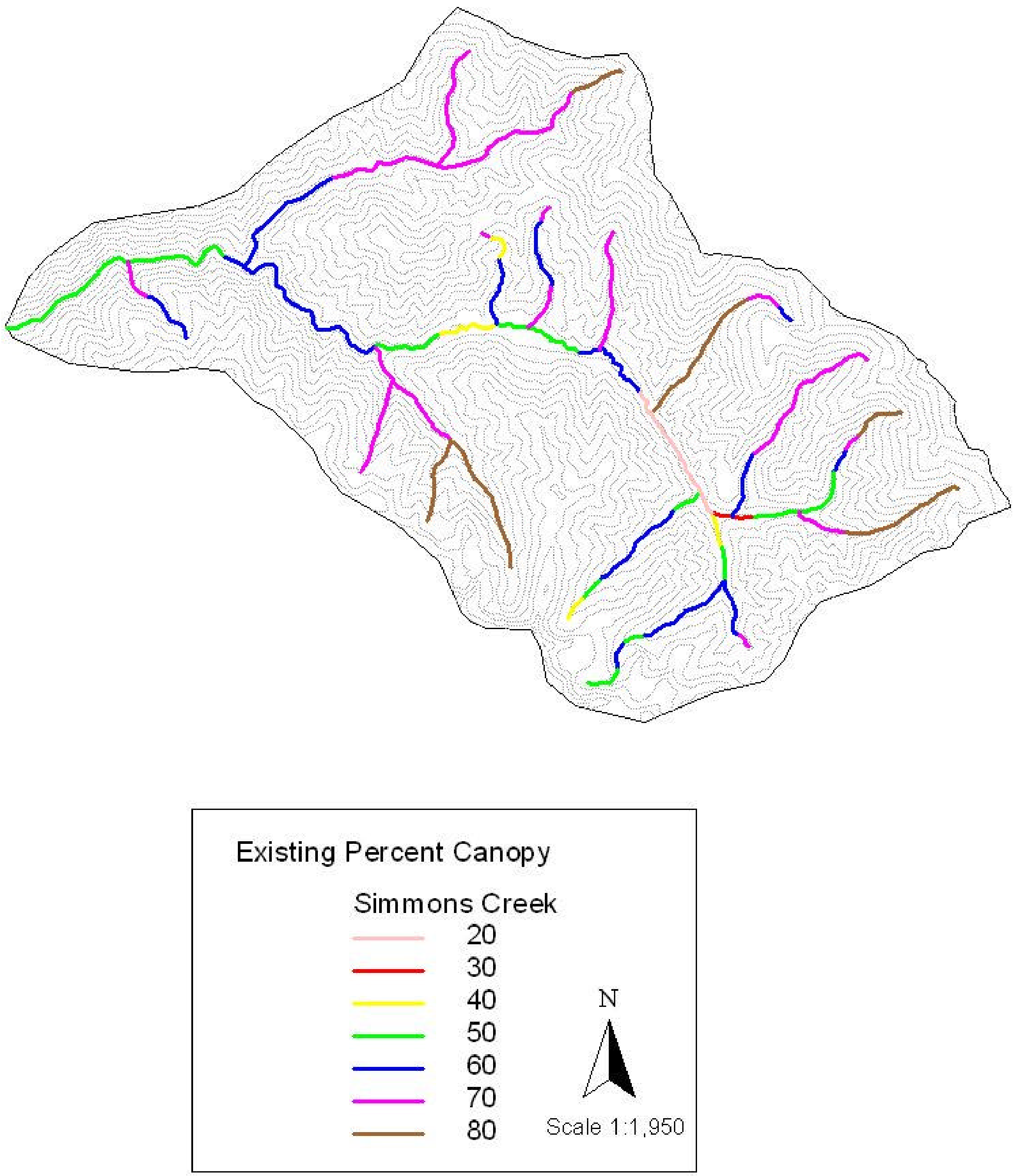

Figure 11g. Existing Shading Canopy: Simmons Creek

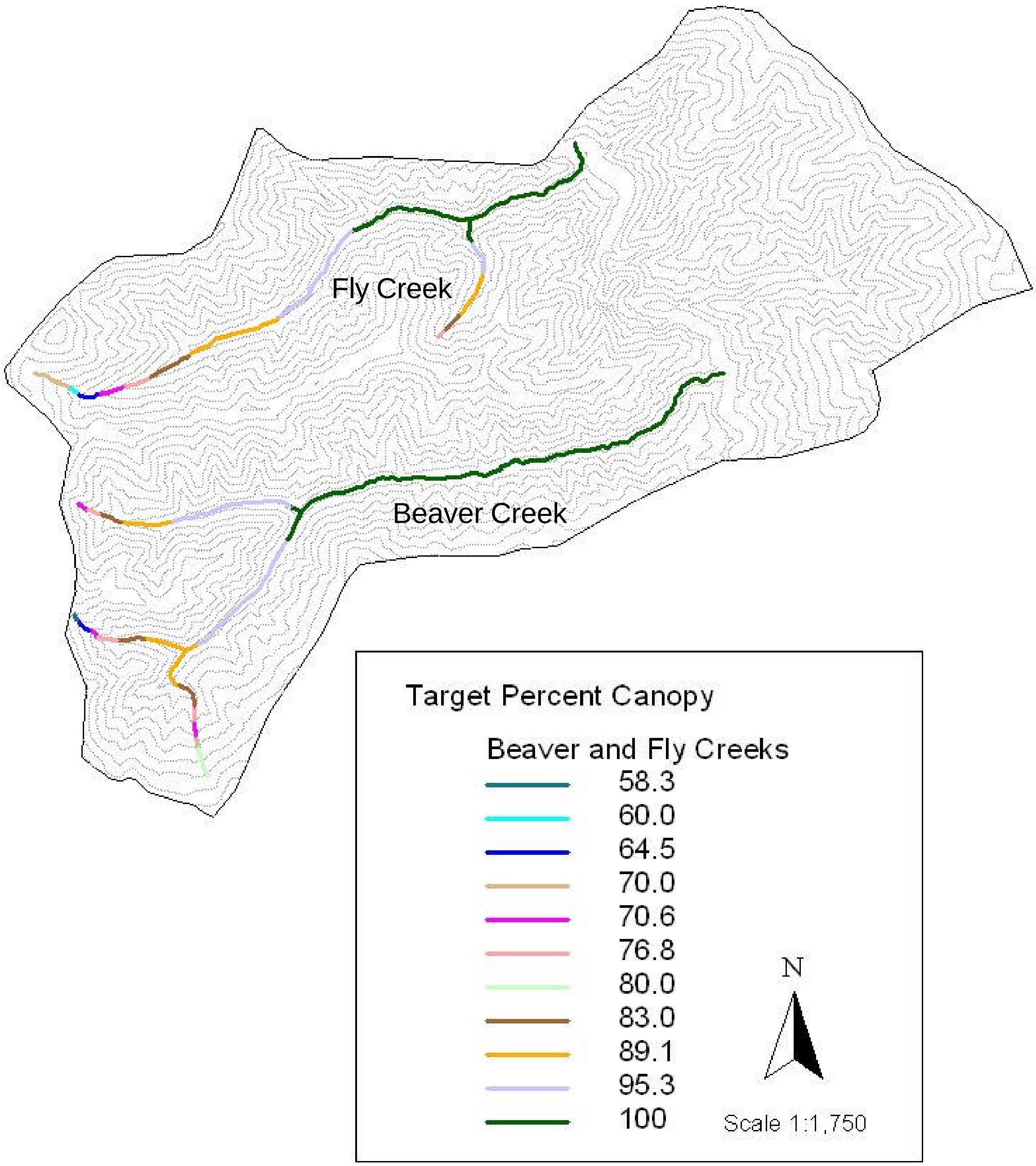

Figure 12a. Target Shade Canopy: Beaver and Fly Creeks

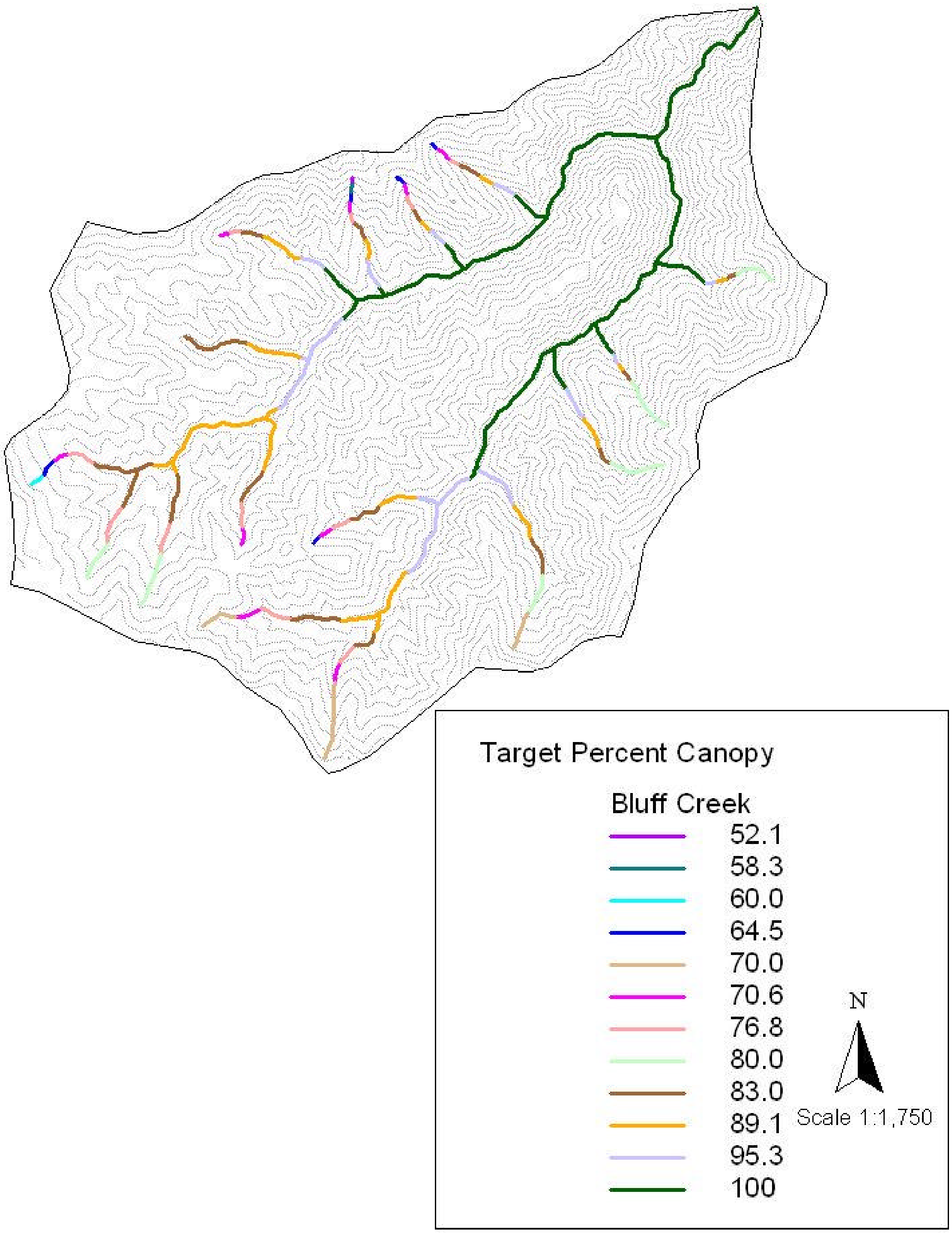

Figure 12b. Target Shade Canopy: Bluff Creek

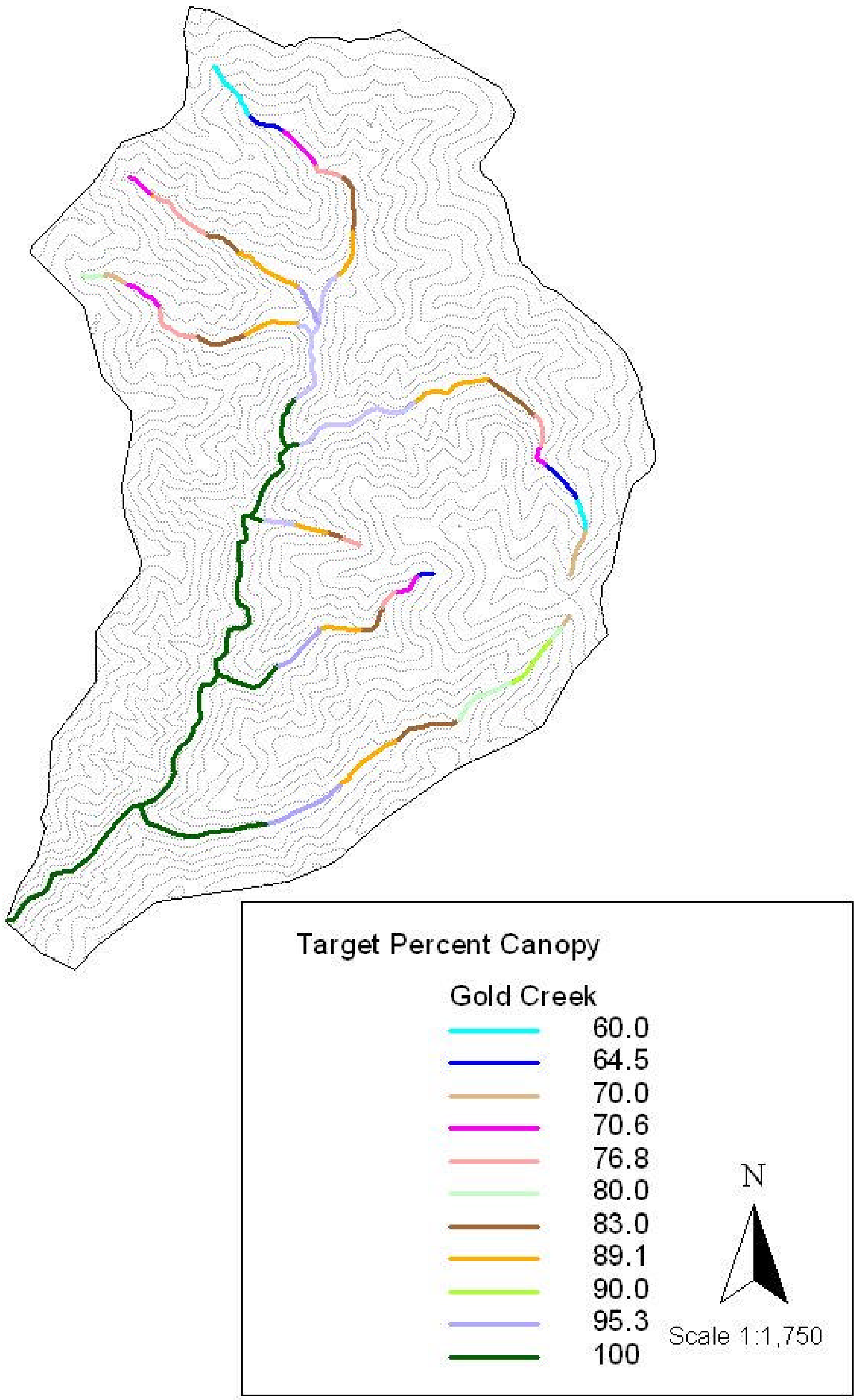

Figure 12c. Target Shade Canopy: Gold Creek

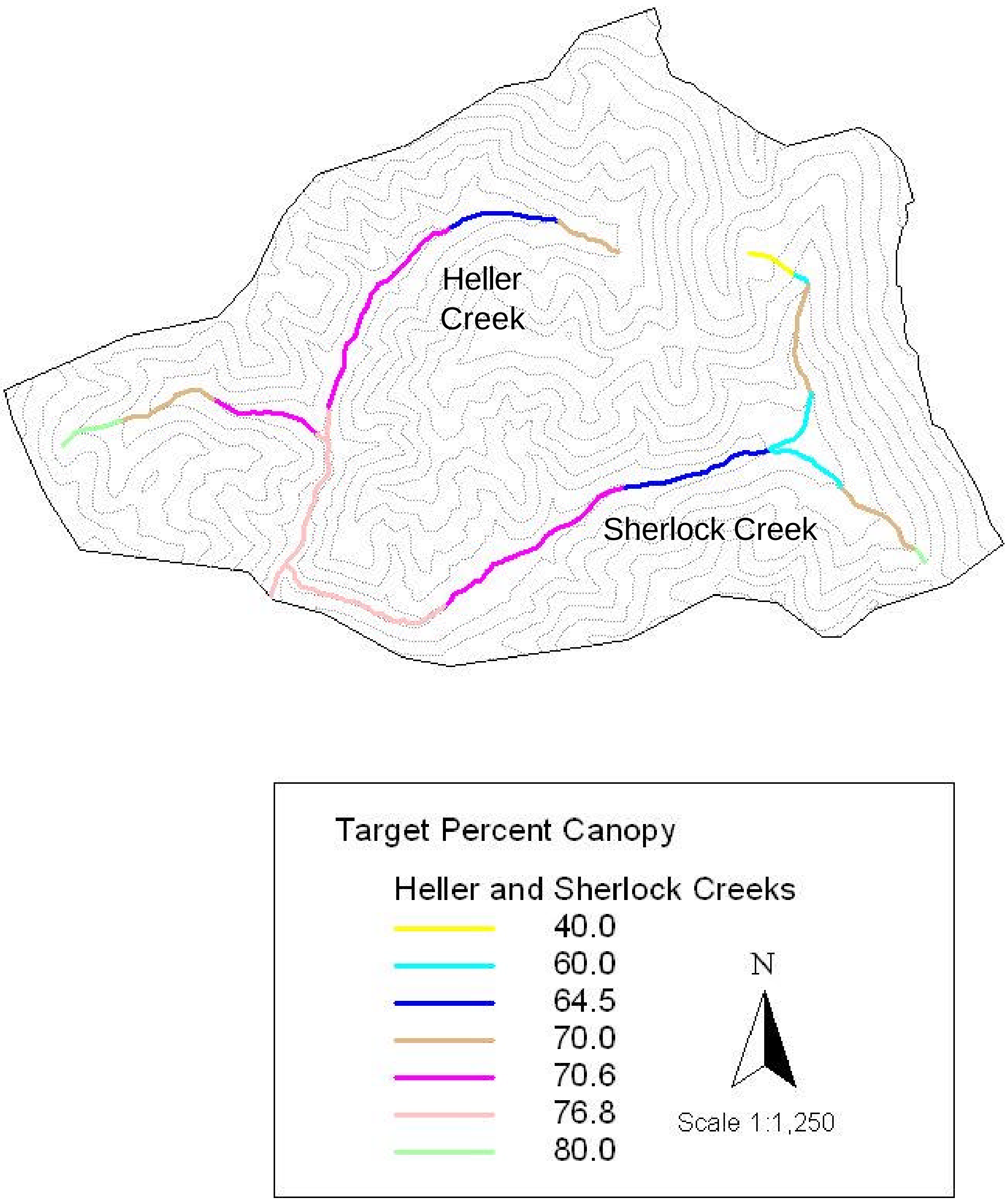

Figure 12d. Target Shade Canopy: Heller and Sherlock Creeks

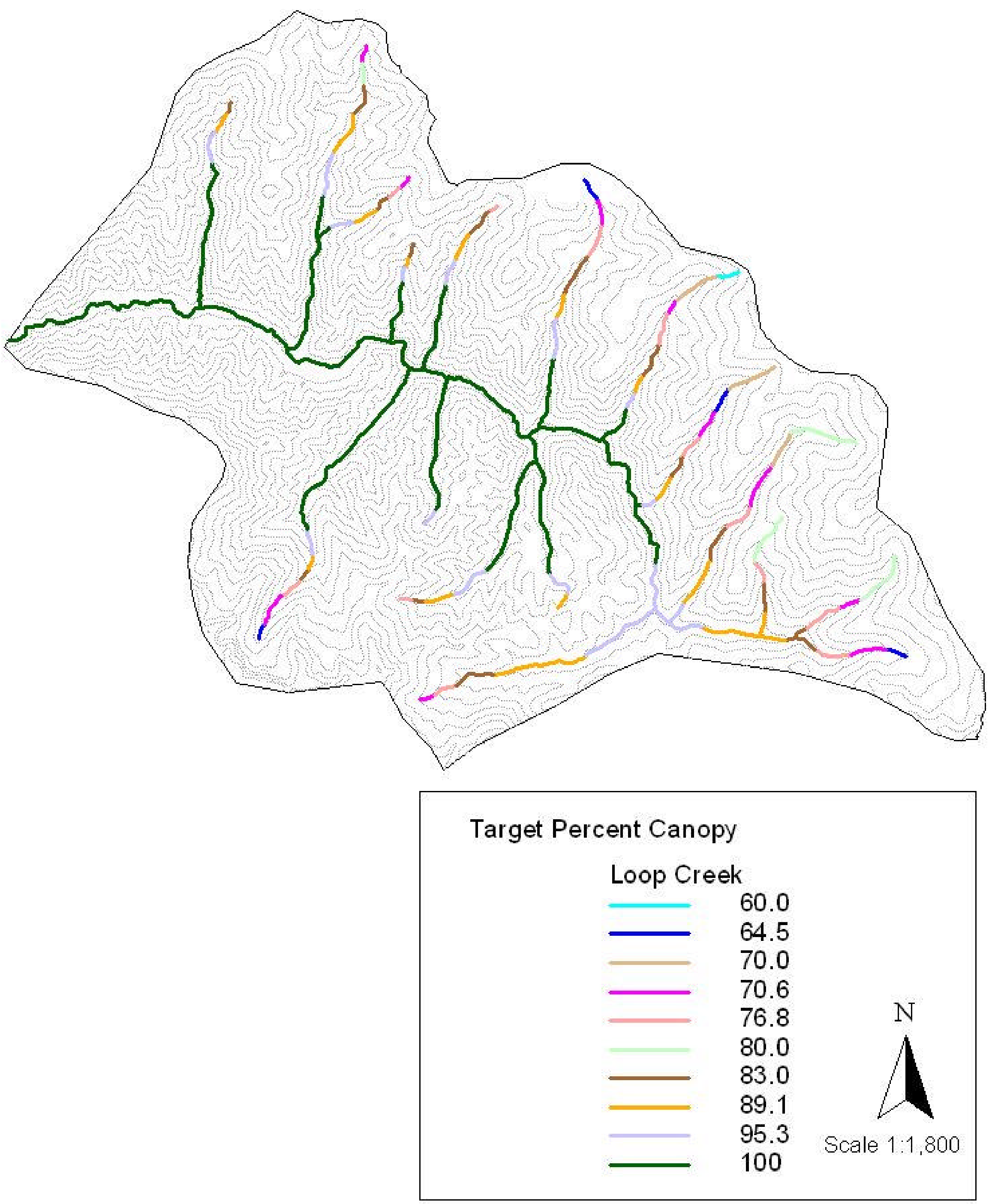

Figure 12e. Target Shade Canopy: Loop Creek

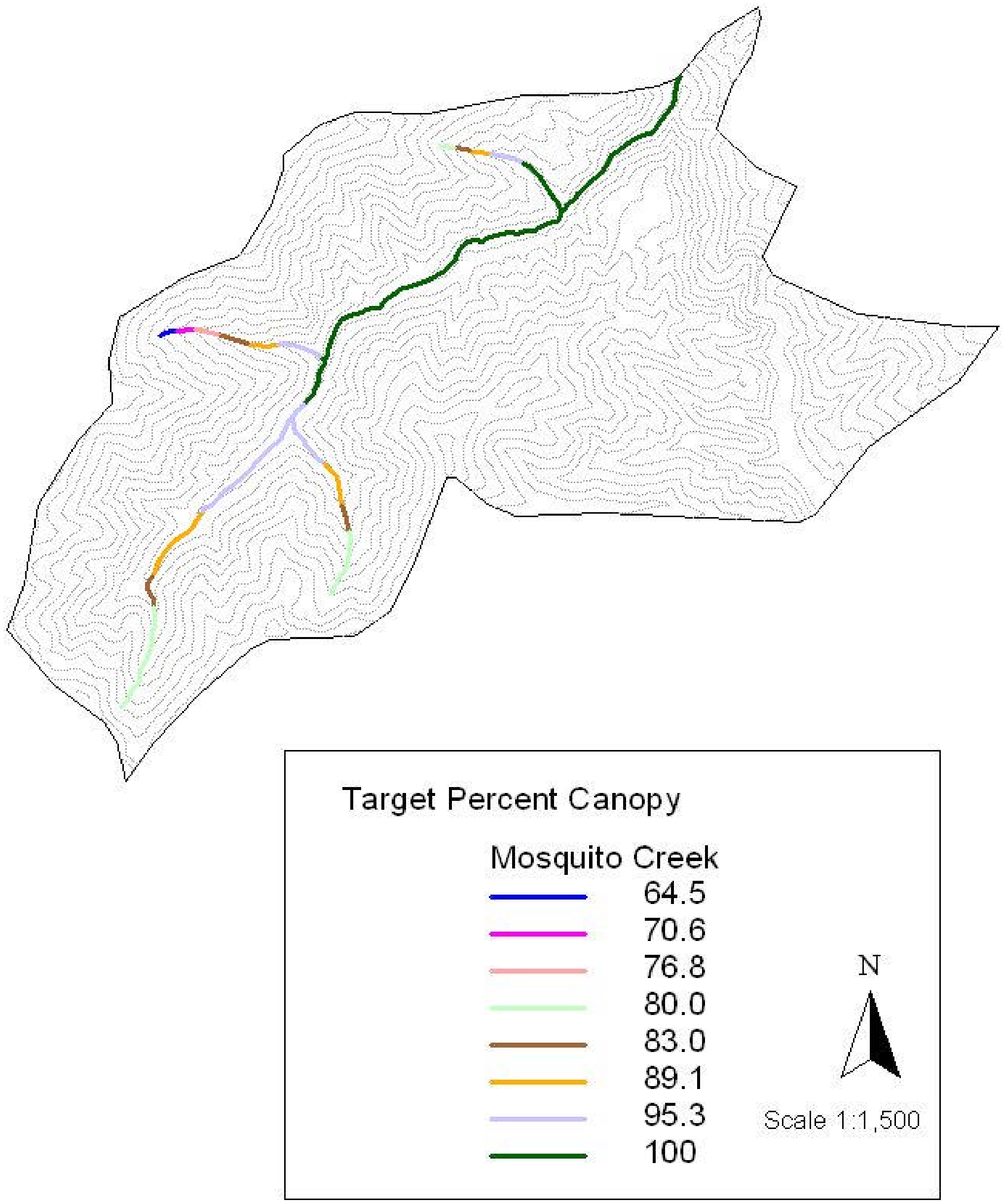

Figure 12f. Target Shade Canopy: Mosquito Creek

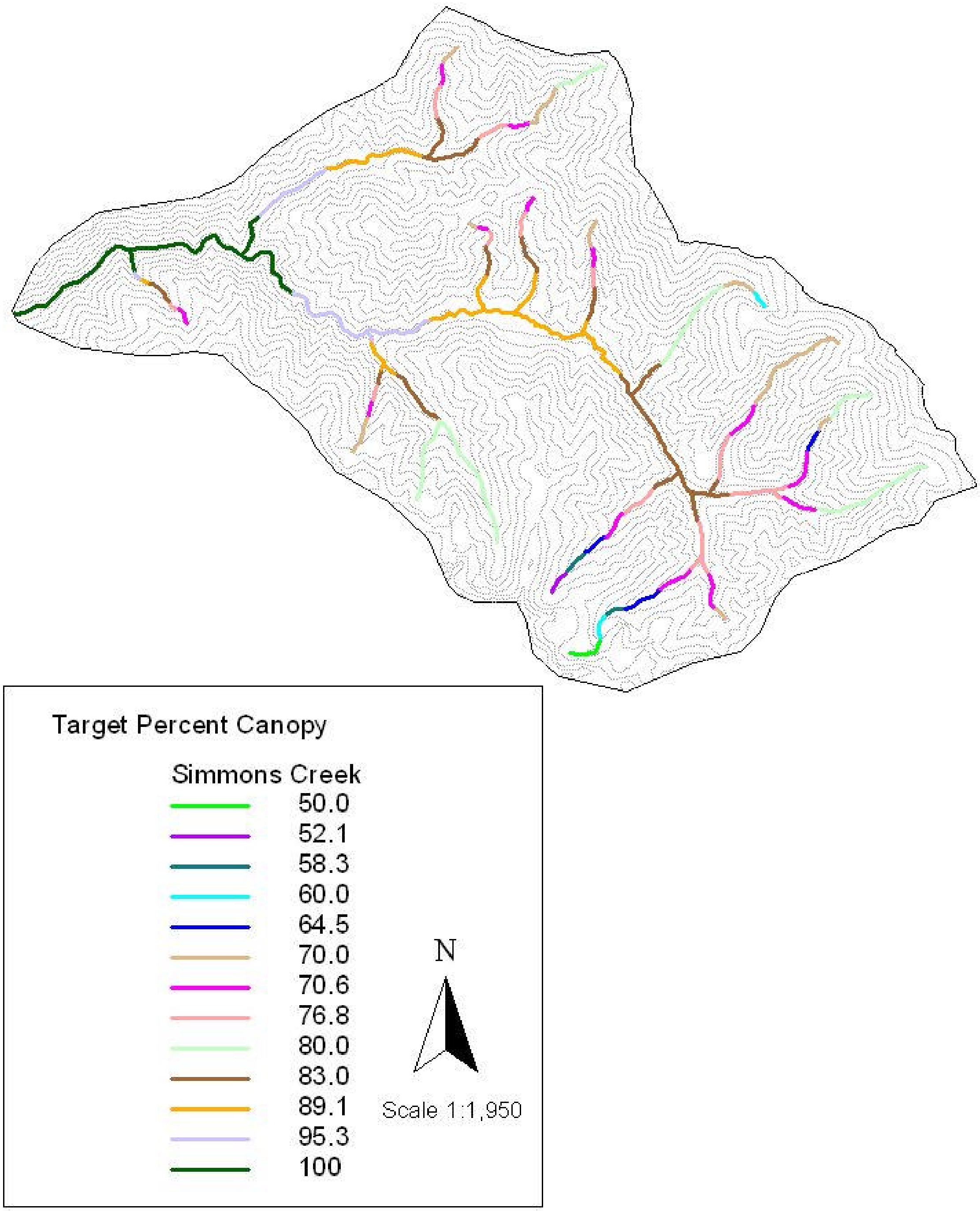

Figure 12g. Target Shade Canopy: Simmons Creek

Table 38. Canopy habitat limited reaches of tributaries to the upper St. Joe River.

Stream	Canopy Habitat Limited Reach	Boundaries	Maximum Shade (%)	Length (miles)
Beaver Creek	1	1.9 miles below Bad Bear confluence to 1.1 miles above mouth	40%	1.4
Heller Creek	1	1.6 miles from Heller Creek source to mouth	30%	2.0
	2	1.3 miles below unnamed tributary 2 of Sherlock Creek to mouth	30%	1.1
Loop Creek	1	Frazier Creek 0.5 miles upstream toward Cliff Creek	10%	0.5
	2	Loop Tunnels to 1.5 miles downstream of tunnels	20%	1.5
	3	0.6 miles above unnamed tributary 6 to 1.3 miles downstream; toward Mineral Creek	40%	1.3
	4	0.3 miles from source of unnamed tributary of Turkey Creek to 0.6 miles downstream; toward confluence	40%	0.6
	5	Source of Clear Creek to 0.3 miles above mouth	50-70%	3.0
Mosquito Creek	1	Confluence of main stem of unnamed tributary 1 upstream toward confluence of main stem and unnamed tributary 2	40%	1.2
Simmons Creek	1	Unnamed tributary 5 to Three Lakes Creek confluence	40%	0.7
	2	Source of unnamed tributary 11 to 0.3 miles downstream of source	40%	0.3
	3	Confluence of unnamed tributary 10 and Simmons Creek to Forest Service Road 1278	20%	1.5

Feedback Provisions

When temperature meets the standard or natural background levels, further canopy increase activities will not be required in the watershed. Best management practices will be prescribed by the revised TMDL with provisions to maintain and protect canopy cover of the streams. Regular monitoring of the beneficial use will be continued for an appropriate period to document maintenance of the full support of the beneficial use (cold water aquatic life).

5.4.5 Conclusions

The upper St. Joe River tributaries (Beaver, Bluff, Fly, Gold, Heller, Sherlock, Loop, Mosquito, and Simmons Creeks) are in the St. Joe River bull trout recovery area where the federal temperature standard of 10°C MWMT applies. Continuous temperature monitoring of these tributaries demonstrates this standard is violated for significant periods of the critical season (May 1- October 31) and the state bull trout spawning standard is violated for significant periods of the critical season (September 1 - October 31). A temperature TMDL based on the CWE relationship between canopy cover, elevation and direct insolation input to the streams was developed. The watershed topography is between 3,000 and 6,800 feet elevation. The shade requirement between 3,000 and 4,000 feet is 100% or full potential shade. Lesser amounts of shade are progressively necessary above 4,000 feet. Figures 11a-g provide the current level of canopy cover of the streams, while Figures 12a-g depict the canopy cover required. Substantial reaches of the tributaries have natural shrub wash plant communities of willow. This community is not capable of fully shading these reaches. A canopy cover of 40% is the upper limit of shade expected on these reaches.

5.5 Implementation Strategies

DEQ and designated lead agencies responsible for TMDL implementation will make every effort to address past, present, and future pollution problems in an attempt to link them to watershed characteristics and management practices designed to improve water quality and restore the beneficial uses of the water body. Any and all solutions to help restore beneficial uses of a stream will be considered as part of a TMDL implementation plan in an effort to make the process as effective and cost efficient as possible. Using additional information collected during the implementation phase of the TMDL, DEQ and the designated agencies will continue to evaluate suspect sources of impairment and develop management actions appropriate to deal with these issues.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

Time Frame

For sediment TMDLs, 30 years have been allotted for meeting load allocations. This time frame will permit two or three large channel forming events to occur in the stream.

Primary TMDL monitoring of temperature TMDLs will be with aerial photograph interpretation of canopy recovery over the streams. Aerial photography is repeated by the USFS on a 10-year time frame. This time frame will allow a sufficient period to assess canopy recovery. In addition, a set number of representative sites should be assessed on a periodic basis using canopy densiometer methodology to ground truth and calibrate the aerial photograph interpretation.

Approach

TMDLs will be implemented through continuation of ongoing pollution control activities in the subbasin. The designated agencies, WAG, and other appropriate public process participants are expected to:

-- Develop best management practices (BMPs) to achieve load allocations
-- Give reasonable assurance that management measures will meet load allocations through both quantitative and qualitative analysis of management measures
-- Adhere to measurable milestones for progress
-- Develop a timeline for implementation, with reference to costs and funding
-- Develop a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, if load allocations and waste load allocations are being met, and whether or not water quality standards are being met

The designated agencies will recommend specific control actions and will then submit the implementation plan to DEQ. DEQ will act as a repository for approved implementation plans.

Responsible Parties

Development of the final implementation plan for the St. Joe River TMDL will proceed under the existing practice established for the state of Idaho. The plan will be cooperatively developed by DEQ, the St. Joe WAG, the affected private landowners, and other “designated agencies” with input from the established public process. Of the three entities, the WAG will act as the integral part of the implementation planning process to identify appropriate implementation measures. In addition to the designated agencies, the public, through the WAG and other equivalent processes, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical.

Monitoring Strategy

In-stream monitoring of the beneficial uses (cold water and salmonid spawning) support status during and after implementation of sediment abatement projects will establish the final sediment load reduction required by the TMDL. In-stream monitoring, which will determine if the threshold values have been met, will be completed every year on randomly selected sites on each stream order in the subbasin after 70% of the plan has been implemented. Monitoring will be conducted using the DEQ-approved monitoring procedure at the time of sampling. Identical measurements will be made in appropriate reference streams where beneficial uses are supported.

Temperature will be monitored on the streams with continuous recorders after the canopy has reached 70% of its potential. Temperature recorders will be placed in representative locations on third order reaches of the streams as near as feasible to the points of compliance. Temperature data developed will be compared with the current temperature standards to assess temperature standard exceedences. Biomonitoring of macroinvertebrates and fish will be completed to assess the status of the cold water use.

5.6 Conclusion

Nine TMDLs were developed for streams in the St. Joe River subbasin. The TMDLs addressed sediment and temperature only, as no other pollutants were found to be inhibiting beneficial uses in the subbasin’s streams.

Specifically, it is recommended that Bear/Little Bear, Blackjack, Harvey, and Tank Creeks be delisted for bacteria. It is also recommended that Blackjack, Harvey, and Tank Creeks be delisted for dissolved oxygen limitation.

No streams were found to be impacted by excess nutrients, therefore it is recommended that Gold Creek be delisted for this pollutant.

Sediment modeling and analysis of WBAGII scores revealed that Bird, Blackjack, East Fork Bluff, Gold, Harvey, Loop, and Tank Creeks are not impaired by sediment. Conversely, Bear/Little Bear, Fishook, and Mica Creeks were found to be impaired by sediment and had TMDLs developed.

Temperature TMDLs were developed for Bear/Little Bear, Blackjack, Fishhook, Gold, Harvey, and Tank Creeks.

Lastly, Gold Creek will remain listed for habitat alteration, but no TMDL will be developed, as the EPA considers habitat alteration as "pollution." A TMDL is not required for a water body impaired by pollution, but not specific pollutants.

Conditions in all of the streams listed above will be monitored on an ongoing basis. This will ensure that beneficial uses currently supported remain that way and that streams not in full support of their beneficial uses are making progress, through implementation, towards that goal.

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Glossary

303(d)	Refers to section 303 subsection "d" of the Clean Water Act. 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to U.S. Environmental Protection Agency approval.
Ambient	General conditions in the environment. In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations, or specific disturbances such as a wastewater outfall (Armantrout 1998, EPA 1996).
Bedload	Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.
Beneficial Use	Any of the various uses of water, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics, which are recognized in water quality standards.
Beneficial Use Reconnaissance Program (BURP)	A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. Beneficial Use Reconnaissance Program protocols address lakes, reservoirs, and wadeable streams and rivers.
Best Management Practices (BMPs)	Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.
Biota	The animal and plant life of a given region.
Clean Water Act (CWA)	The Federal Water Pollution Control Act (Public Law 92-500, commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987 (Public Law 100-4), establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.
Coliform Bacteria	A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria).

Community A group of interacting organisms living together in a given place.

Conductivity The ability of an aqueous solution to carry electric current, expressed in micro (µ) mhos/cm at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.

Criteria In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. EPA develops criteria guidance; states establish criteria.

Cubic Feet per Second A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Designated Uses Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.

Discharge The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).

Dissolved Oxygen (DO) The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

Disturbance Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.

E. coli Short for *Escherichia Coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans. Their presence is often indicative of fecal contamination.

Endangered Species Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.

Environment	The complete range of external conditions, physical and biological, that affect a particular organism or community.
Erosion	The wearing away of areas of the earth's surface by water, wind, ice, and other forces.
Exceedence	A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.
Existing Beneficial Use	A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).
Fauna	Animal life, especially the animals characteristic of a region, period, or special environment.
Fecal Coliform Bacteria	Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by bacteria (also see Coliform Bacteria).
Fecal Streptococci	A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.
Flow	See Discharge.
Fully Supporting	In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).
Fully Supporting Cold Water	Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions (EPA 1997).
Geographical Information Systems (GIS)	A georeferenced database.
Geometric Mean	A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.
Gradient	The slope of the land, water, or streambed surface.

Habitat The living place of an organism or community.

Headwater The origin or beginning of a stream.

Hydrologic Unit One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.

Hydrologic Unit Code (HUC) The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.

Inorganic Materials not derived from biological sources.

Instantaneous A condition or measurement at a moment (instant) in time.

Load Allocation (LA) A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).

Load(ing) The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.

Load capacity (LC) A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.

Macroinvertebrate An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500 µm mesh (U.S. #30) screen.

Margin of Safety (MOS)	An implicit or explicit portion of a water body's load capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.
Mass Wasting	A general term for the down slope movement of soil and rock material under the direct influence of gravity.
Mean	Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.
Metric	1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.
Milligrams per Liter (mg/L)	A unit of measure for concentration in water, essentially equivalent to parts per million (ppm).
Miocene	Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks.
Monitoring	A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a water body.
Mouth	The location where flowing water enters into a larger water body.
Nitrogen	An element essential to plant growth, and thus is considered a nutrient.
Nonpoint Source	A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Nutrient	Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.
Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.
Bacteria	Disease-producing organisms (e.g., bacteria, viruses, parasites).
pH	The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.
Phosphorus	An element essential to plant growth, often in limited supply, and thus considered a nutrient.
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Quality Assurance (QA)	A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality control; and personnel qualifications and training. The goal of QA is to assure the data provided are of the quality needed and claimed (Rand 1995, EPA 1996).

Quality Control (QC) Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples. QC is implemented at the field or bench level (Rand 1995 EPA 1996).

Quantitative Descriptive of size, magnitude, or degree.

Reach A stream section with fairly homogenous physical characteristics.

Reconnaissance An exploratory or preliminary survey of an area.

Reference A physical or chemical quantity whose value is known, and thus is used to calibrate or standardize instruments.

Reference Condition 1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).

Reference Site A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies.

Resident A term that describes fish that do not migrate.

Riffle A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.

Riparian Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.

River A large, natural, or human-modified stream that flows in a defined course or channel, or a series of diverging and converging channels.

Runoff The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.

Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.
Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Stream	A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched adverse effects on ecosystems or human health.
Subbasin	A large watershed of several hundred thousand acres. This is the name commonly given to 4^{th} field hydrologic units (also see Hydrologic Unit).
Subbasin Assessment (SBA)	A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.
Subwatershed	A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6^{th} field hydrologic units.
Surface Fines	Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 mm depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.
Surface Water	All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.
Threatened Species	Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Total Maximum Daily Load (TMDL) A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. TMDL = Load capacity = Load Allocation + Waste Load Allocation + Margin of Safety. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Tributary A stream feeding into a larger stream or lake.

Turbidity A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

Waste Load Allocation (WLA) The portion of receiving water's load capacity that is allocated to one of its existing or future point sources of pollution. Waste load allocations specify how much pollutant each point source may release to a water body.

Water Body A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.

Water Column Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.

Water Pollution Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.

Water Quality A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.

Water Quality Criteria Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.

Water Quality Limited A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a 303(d) list.

Water Quality Limited Segment (WQLS) Any segment placed on a state's 303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "303(d) listed."

Water Quality Standards State-adopted and EPA-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Watershed 1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a water body.

Wetland An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

Young of the Year Young fish born the year captured; evidence of spawning activity.

Appendix A

Unit Conversions Chart

Appendix A. Unit Conversions Chart

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft^2) Square Miles (mi^2)	Hectares (ha) Square Meters (m^2) Square Kilometers (km^2)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft^2 = 0.09 m^2 1 m^2 = 10.76 ft^2 1 mi^2 = 2.59 km^2 1 km^2 = 0.39 mi^2	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft^2 = 0.28 m^2 3 m^2 = 32.29 ft^2 3 mi^2 = 7.77 km^2 3 km^2 = 1.16 mi^2
Volume	Gallons (g) Cubic Feet (ft^3)	Liters (L) Cubic Meters (m^3)	1 g = 3.78 l 1 l = 0.26 g 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 g = 11.35 l 3 l = 0.79 g 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic Feet per Second (ft^3/sec)[1]	Cubic Meters per Second (m^3/sec)	1 ft^3/sec = 0.03 m^3/sec 1 m^3/sec = ft^3/sec	3 ft^3/sec = 0.09 m^3/sec 3 m^3/sec = 105.94 ft^3/sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L[2]	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 kg
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 ° C = 37.4 °F

Appendix B

Data and Data Sources

Appendix B. Data and Data Sources

Continuous temperature data collected at several stream locations in the St. Joe River subbasin (17010304).

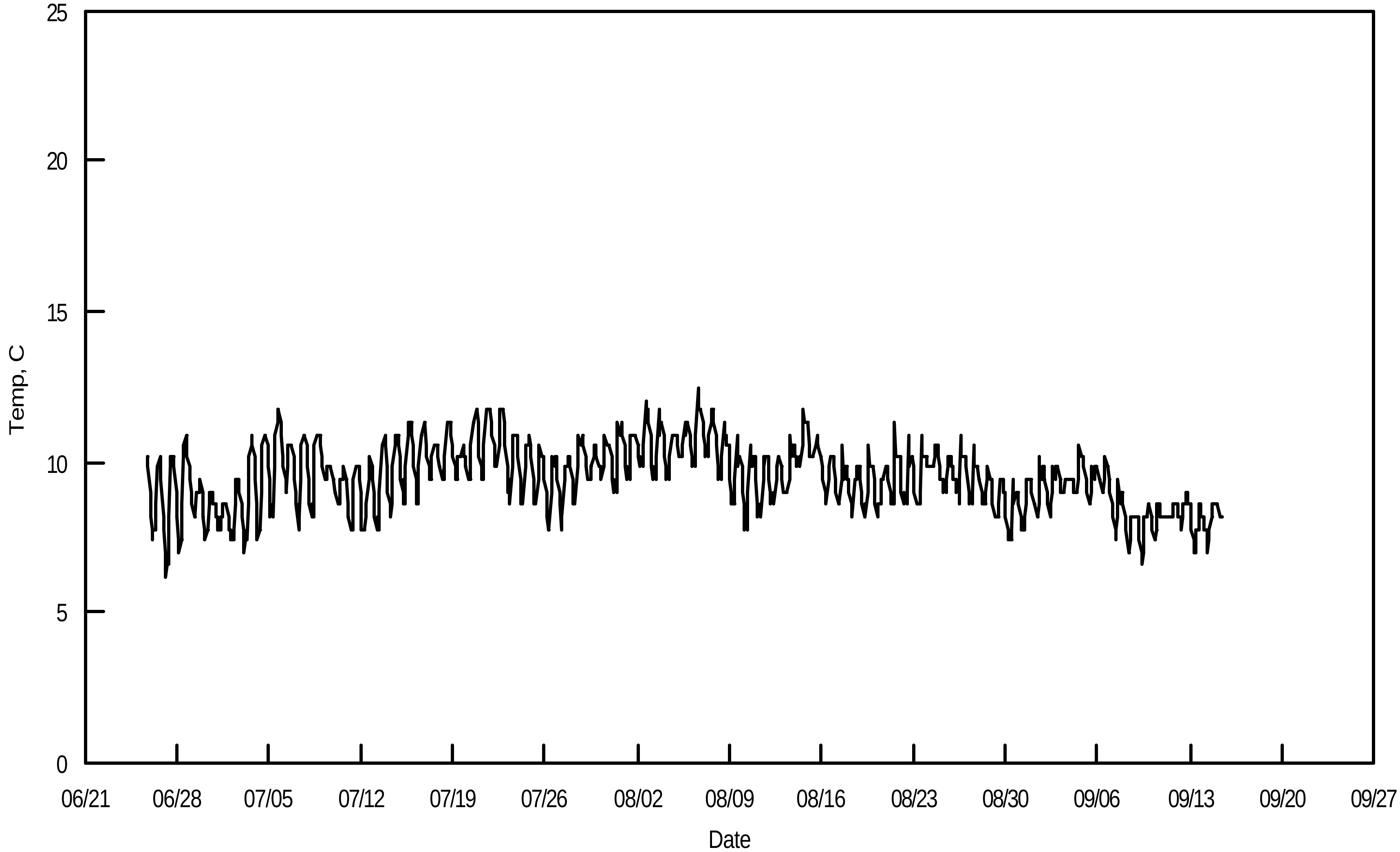

Figure B-1. Bear Creek Temperature Profile, Summer 1997

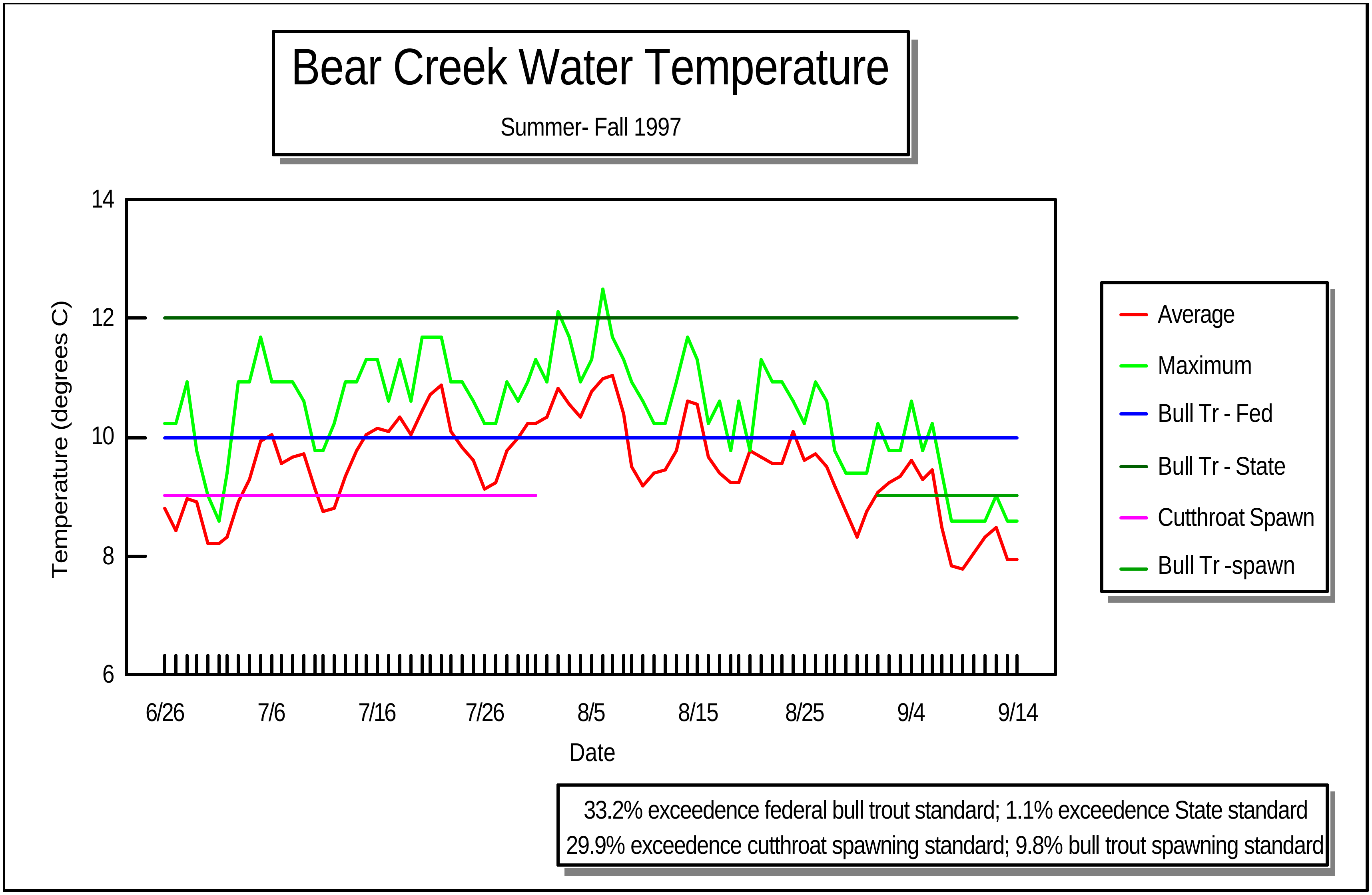

Figure B-2. Bear Creek Water Temperature Analysis

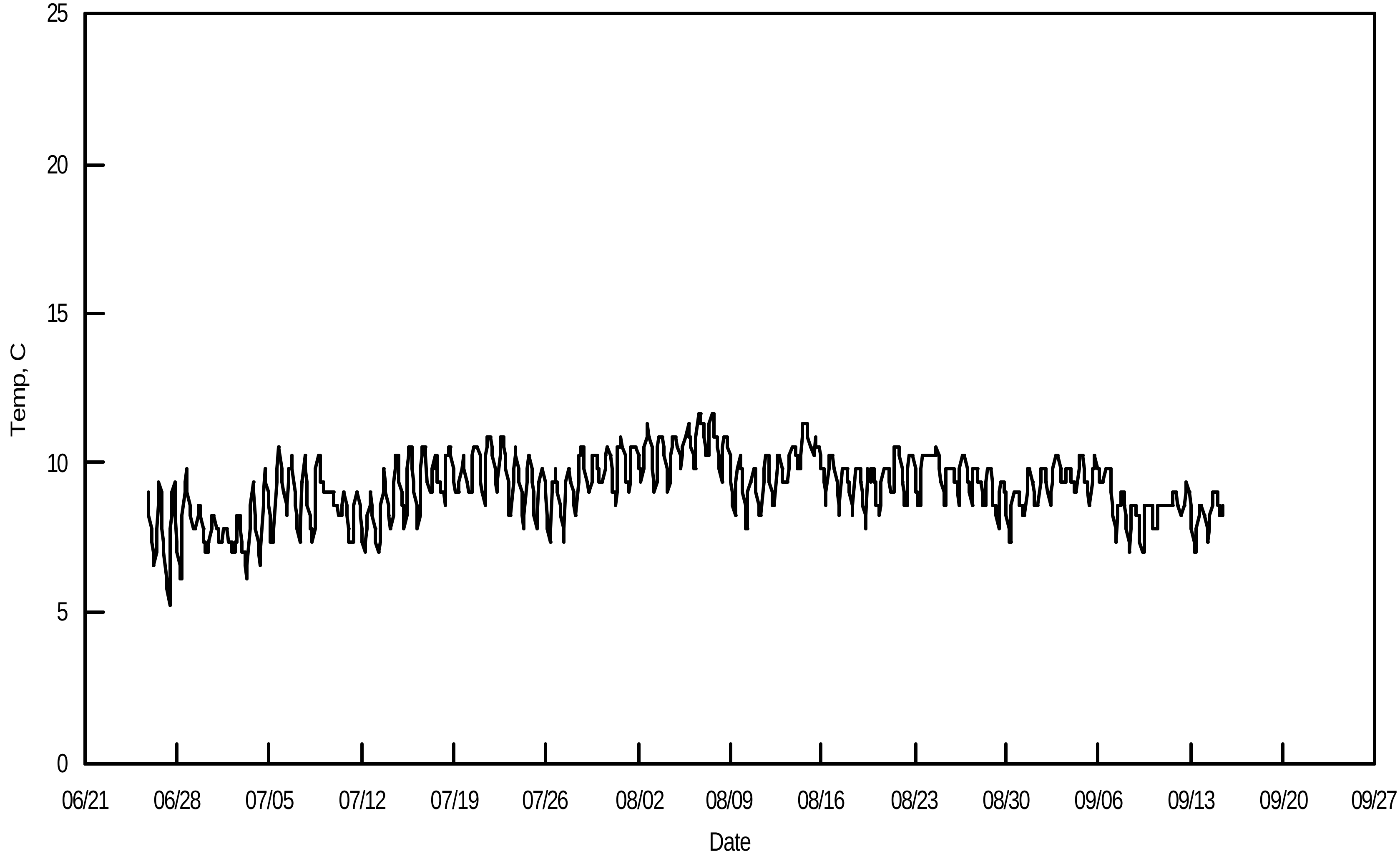

Figure B-3. Little Bear Creek Temperature Profile, Summer 1997

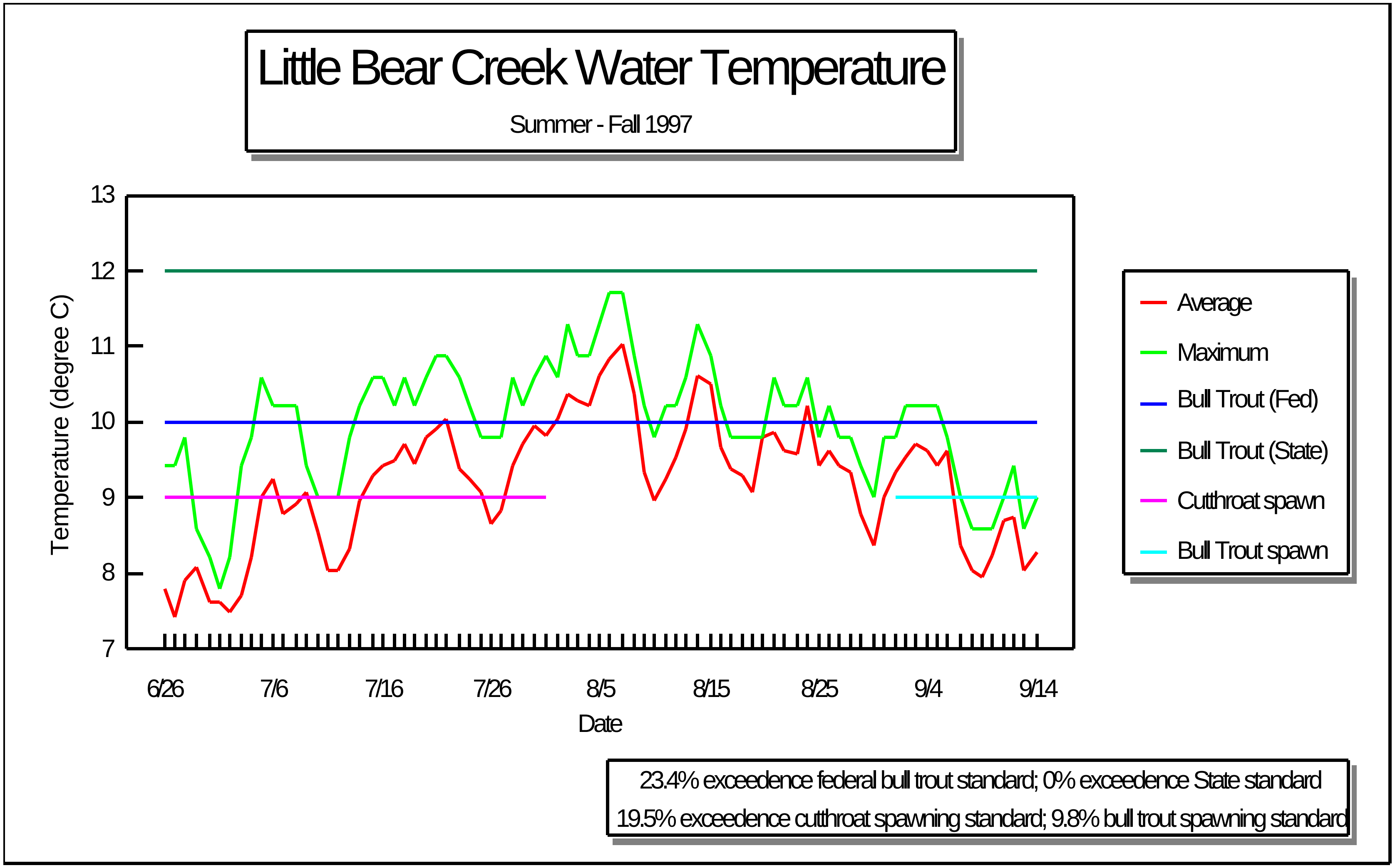

Figure B-4. Little Bear Creek Water Temperature Analysis

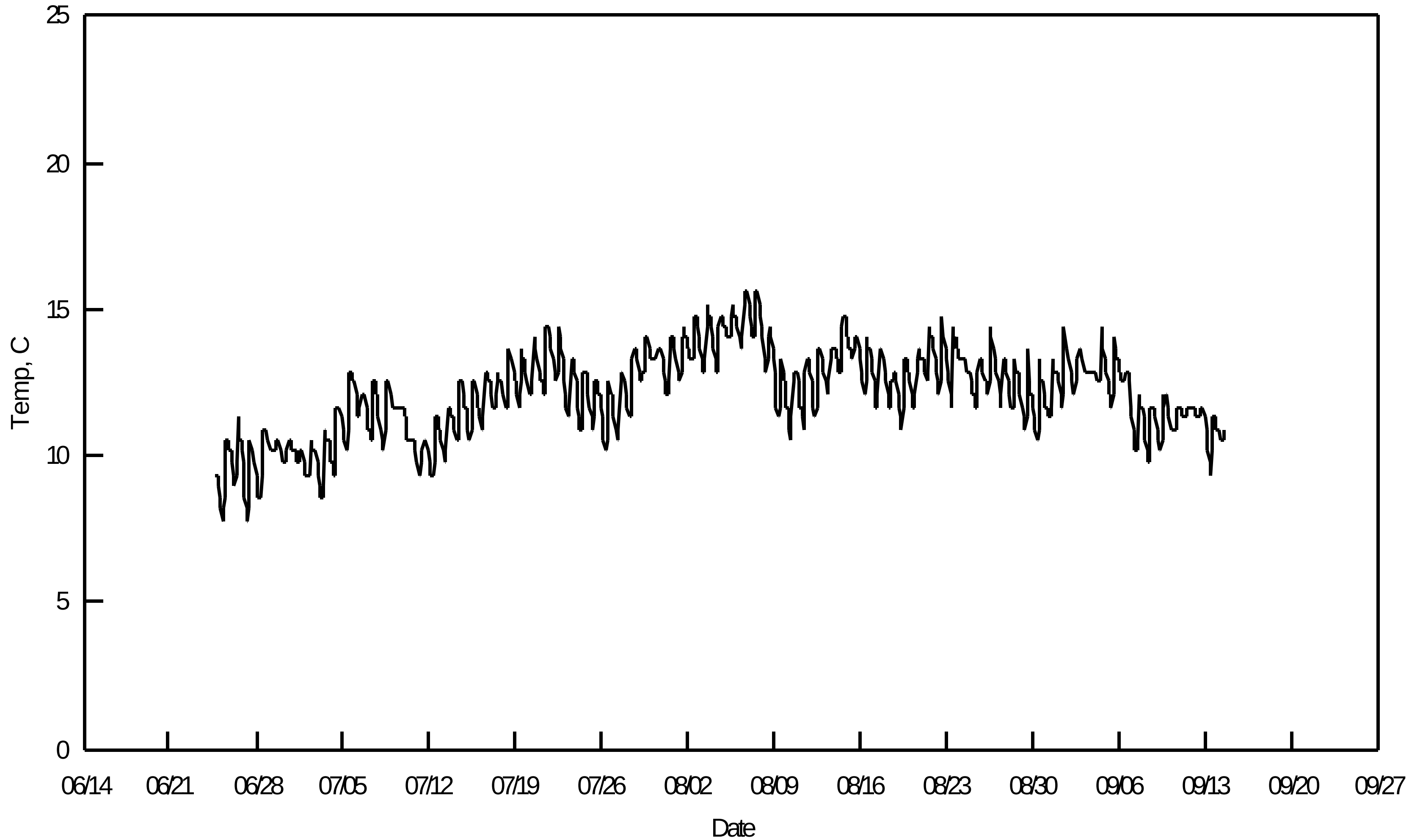

Figure B-5. Blackjack Creek Temperature Profile, Summer 1997

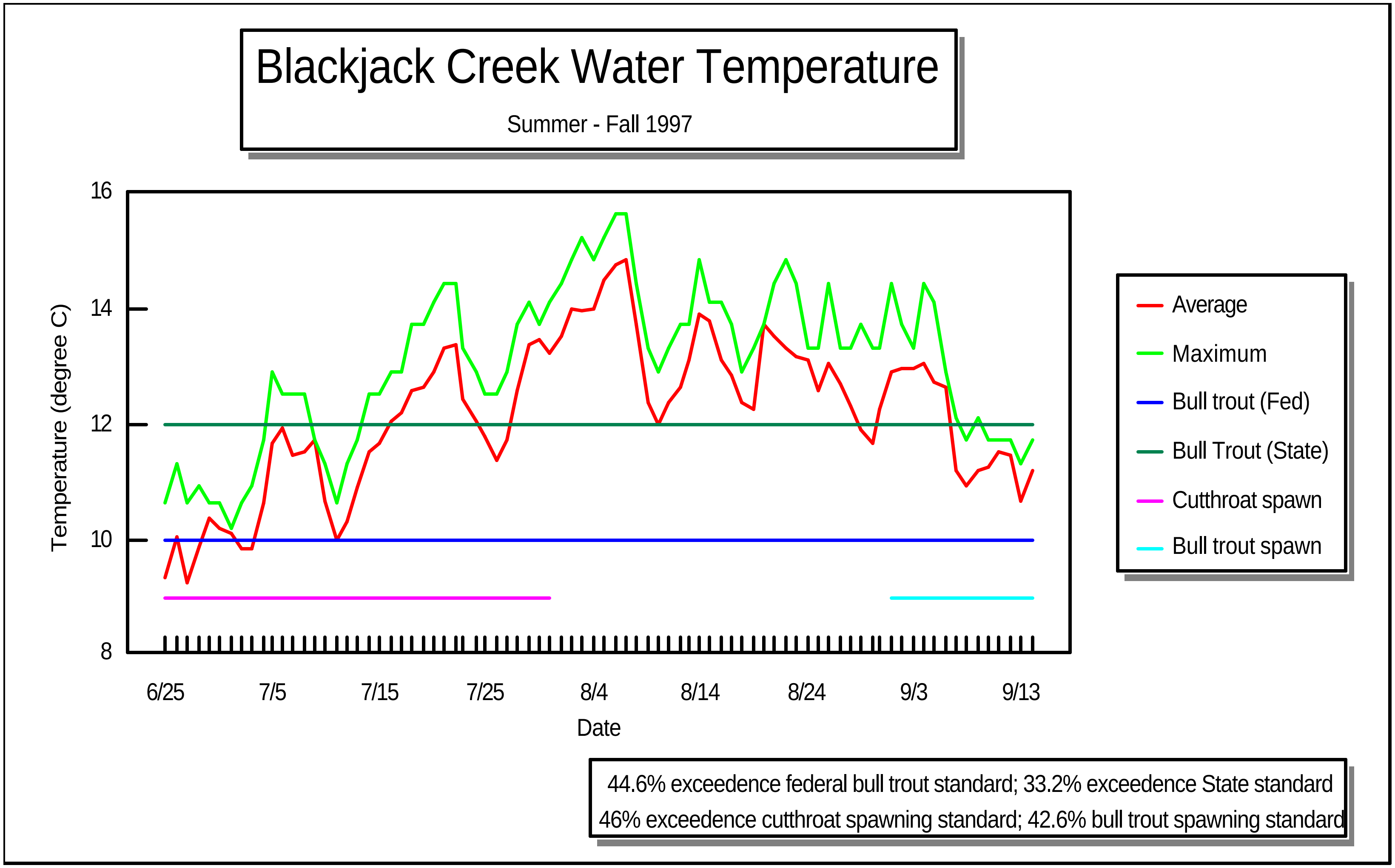

Figure B-6. Blackjack Creek Water Temperature Analysis

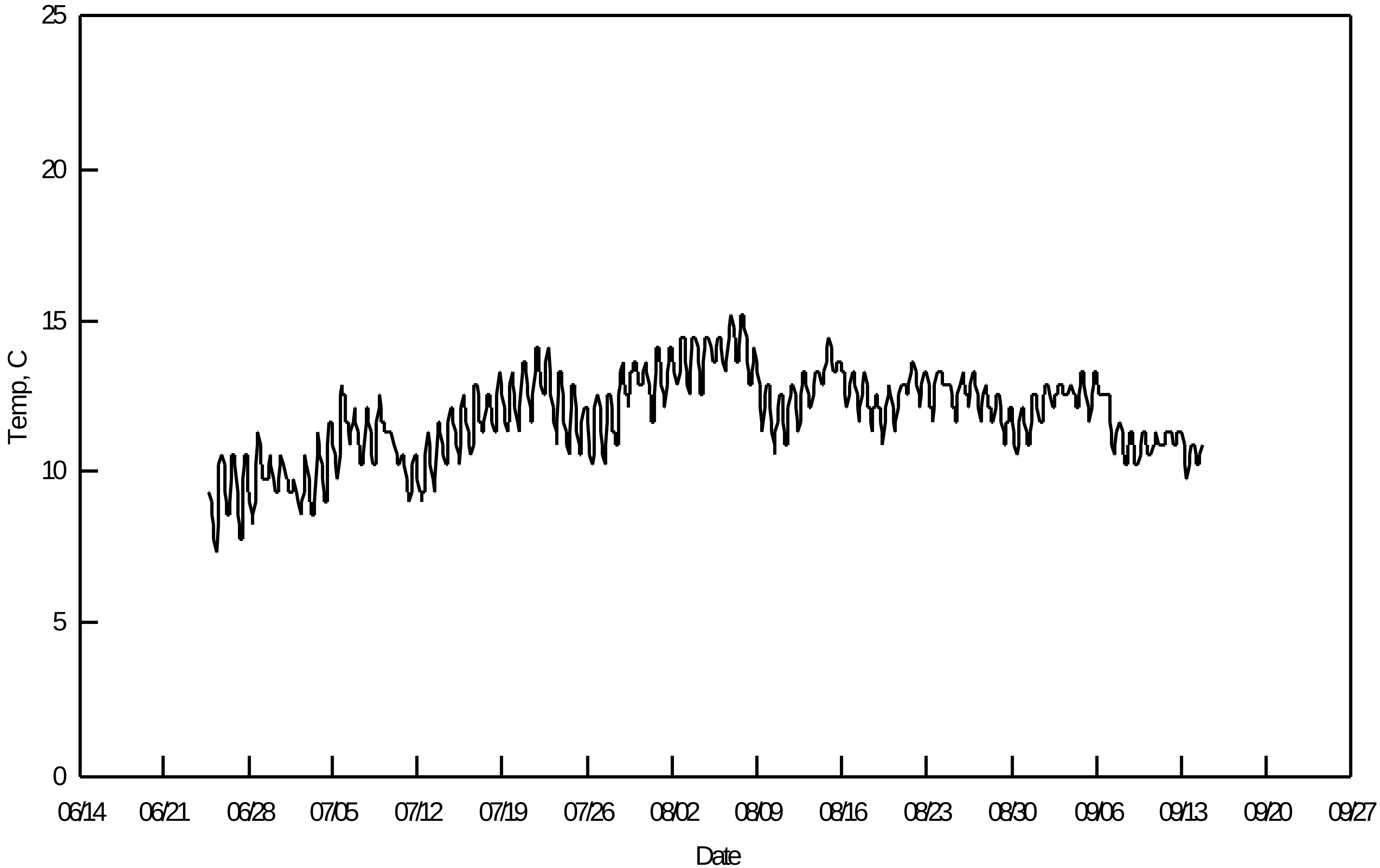

Figure B-7. Harvey Creek Temperature Profile, Summer 1997

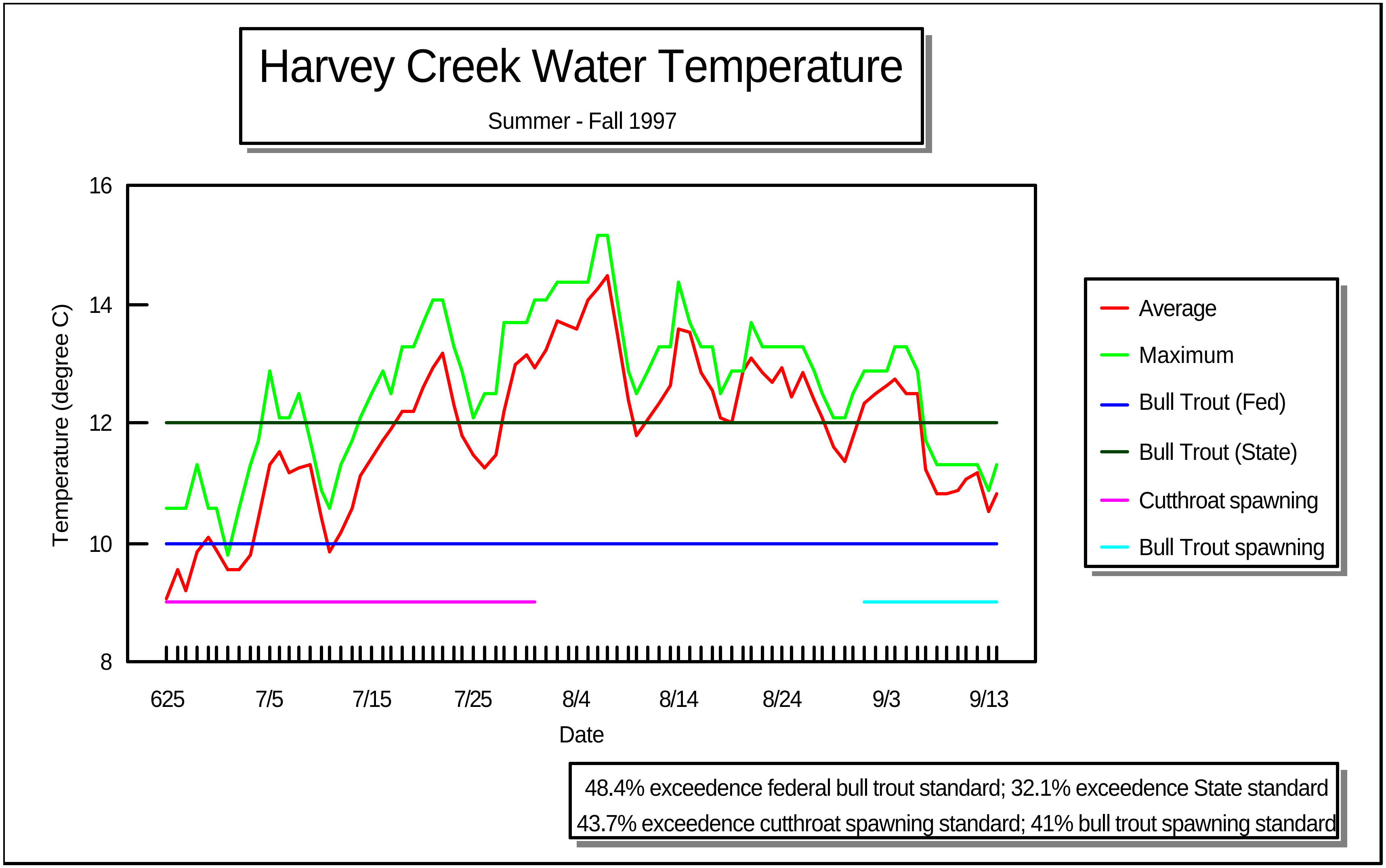

Figure B-8. Harvey Creek Water Temperature Analysis

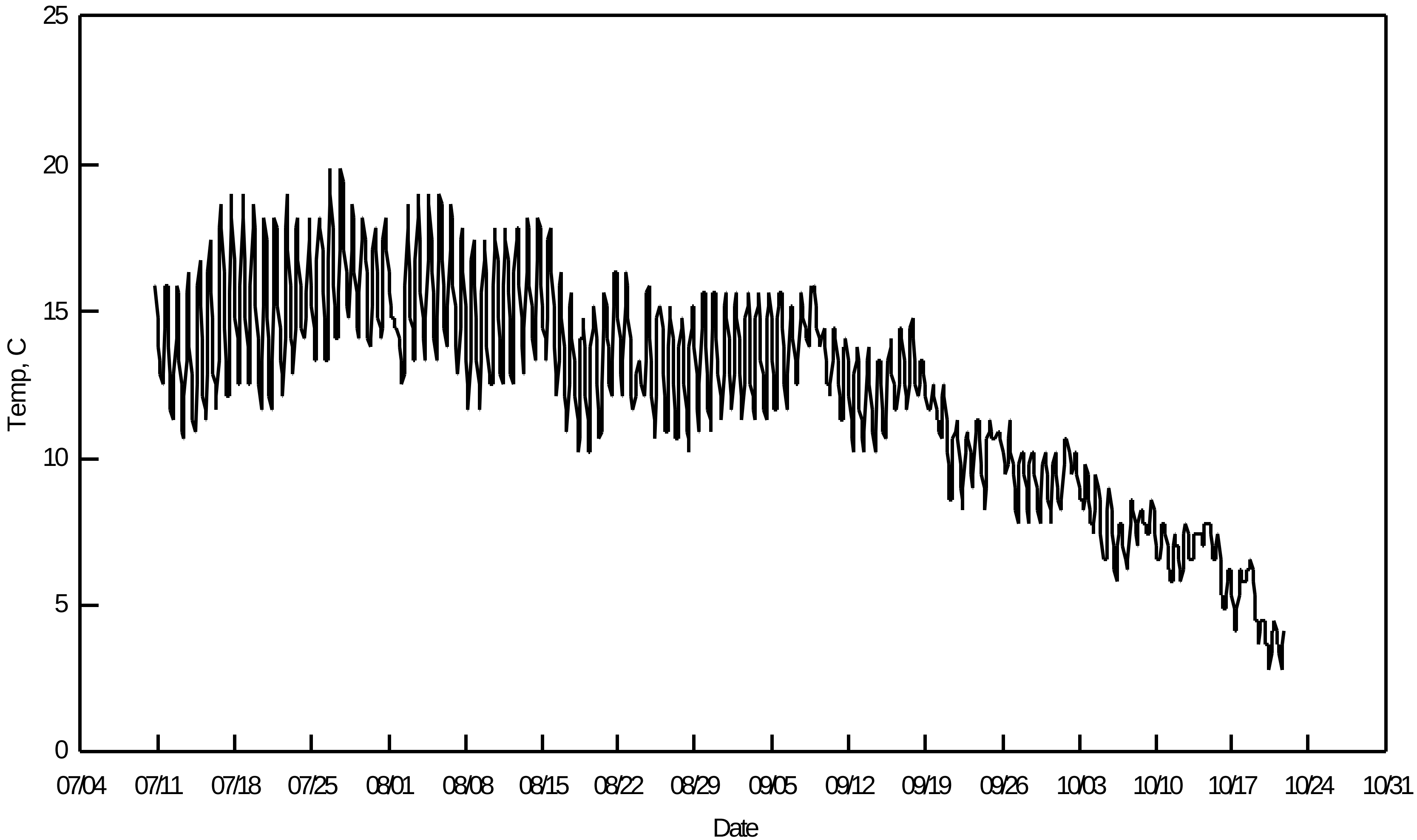

Figure B-9. Big Creek Temperature Profile, Summer 1998

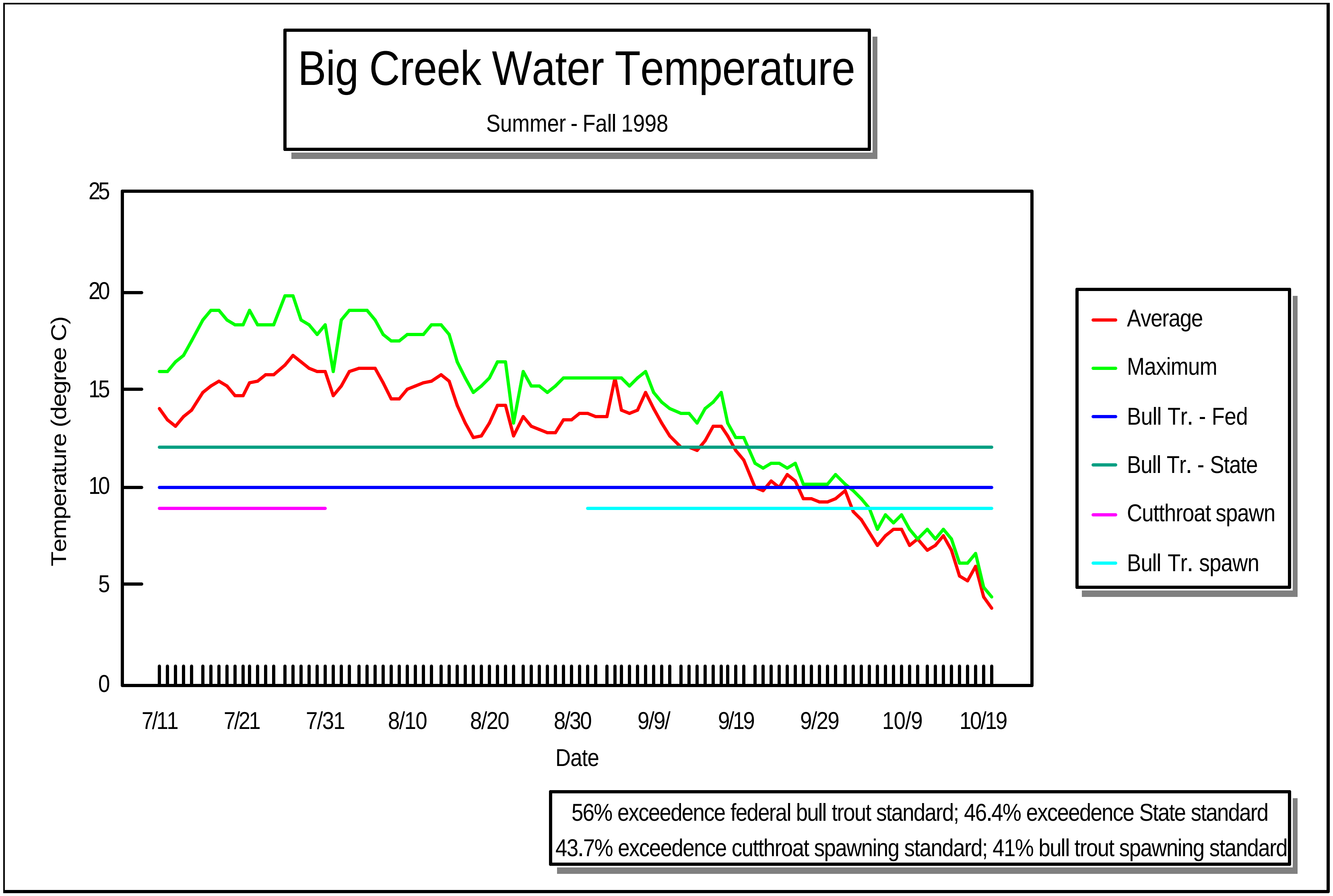

Figure B-10. Big Creek Water Temperature Analysis

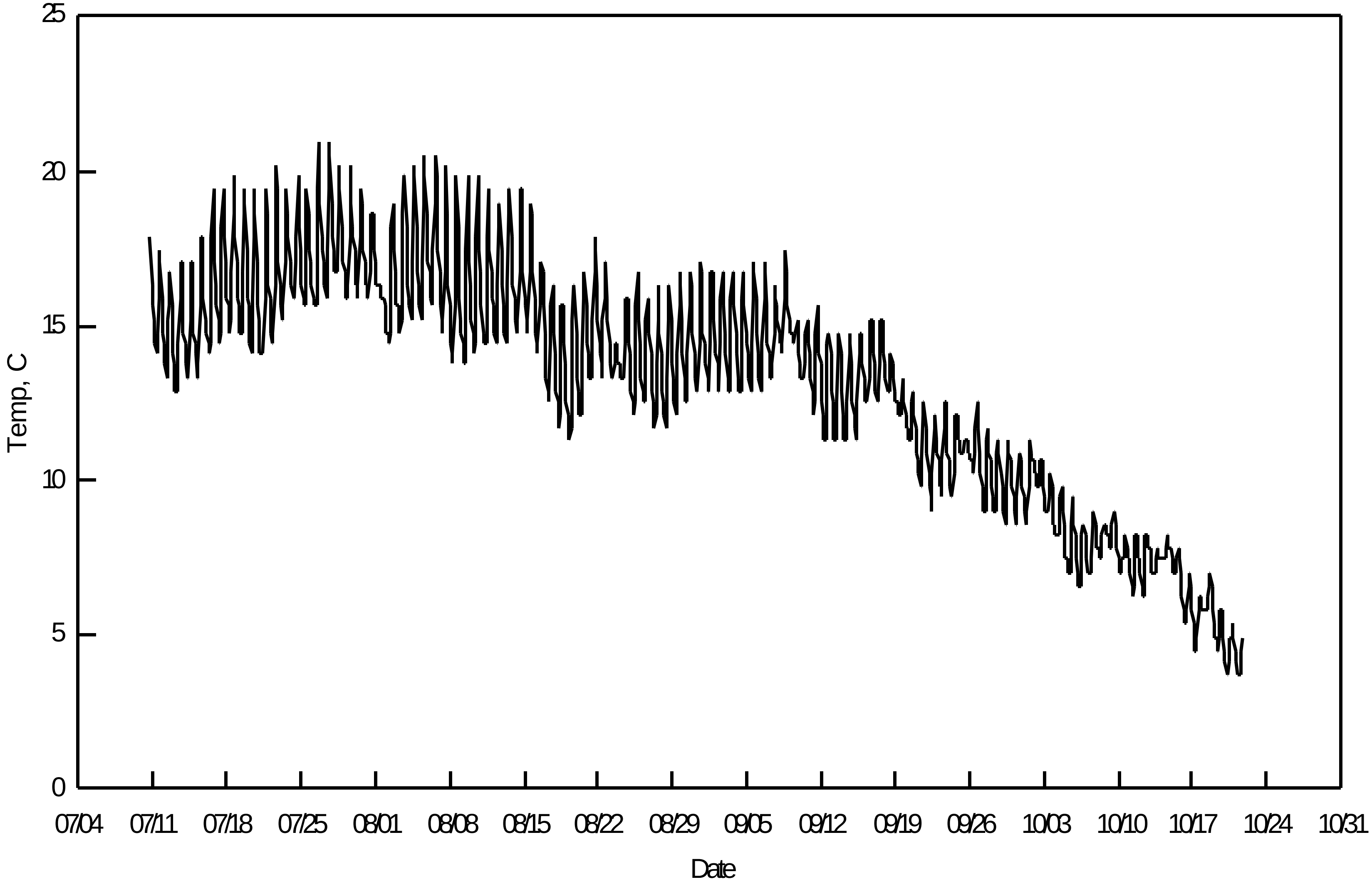

Figure B-11. East Fork Big Creek Temperature Profile, Summer 1998

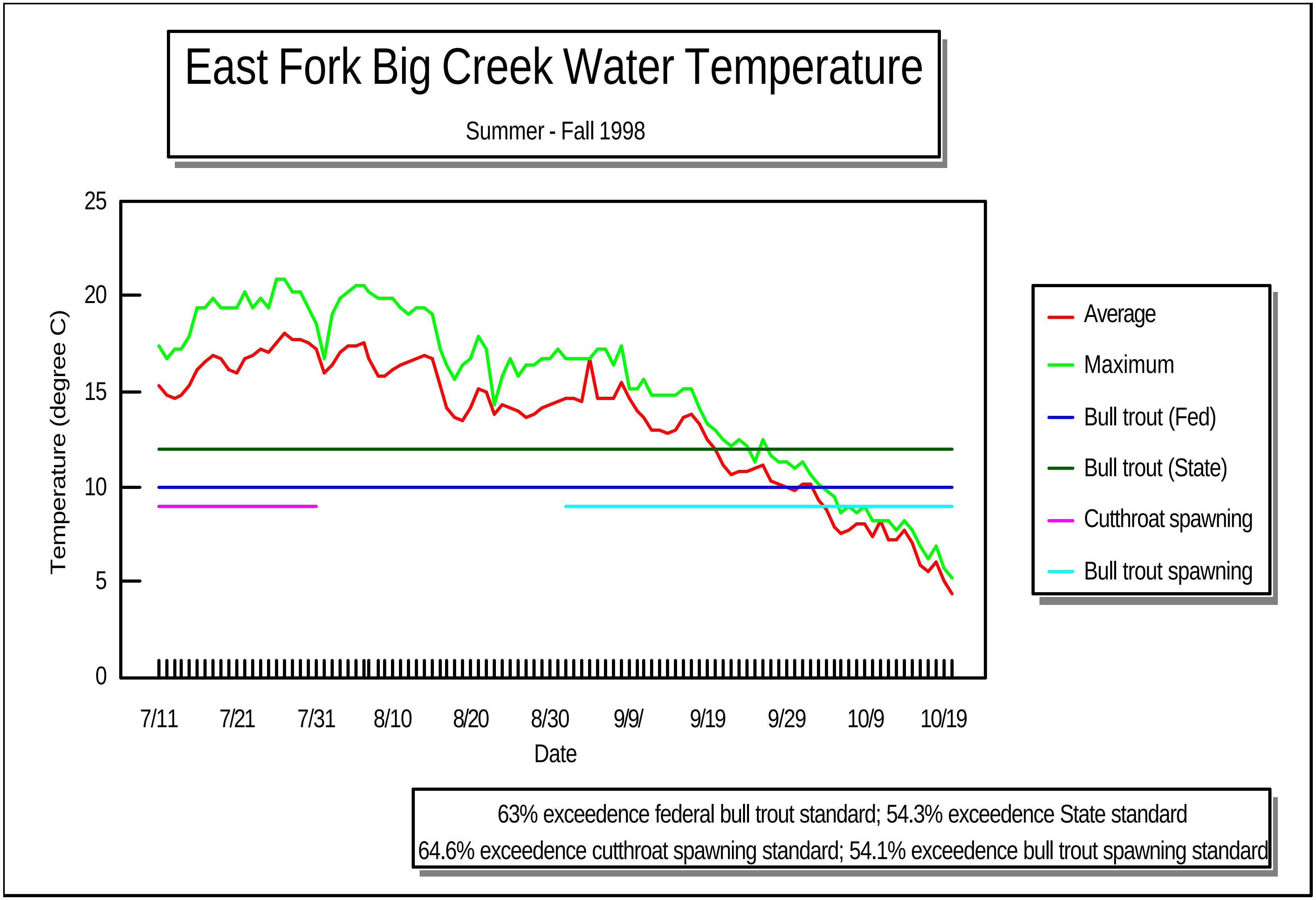

Figure B-12. East Fork Big Creek Water Temperature Analysis

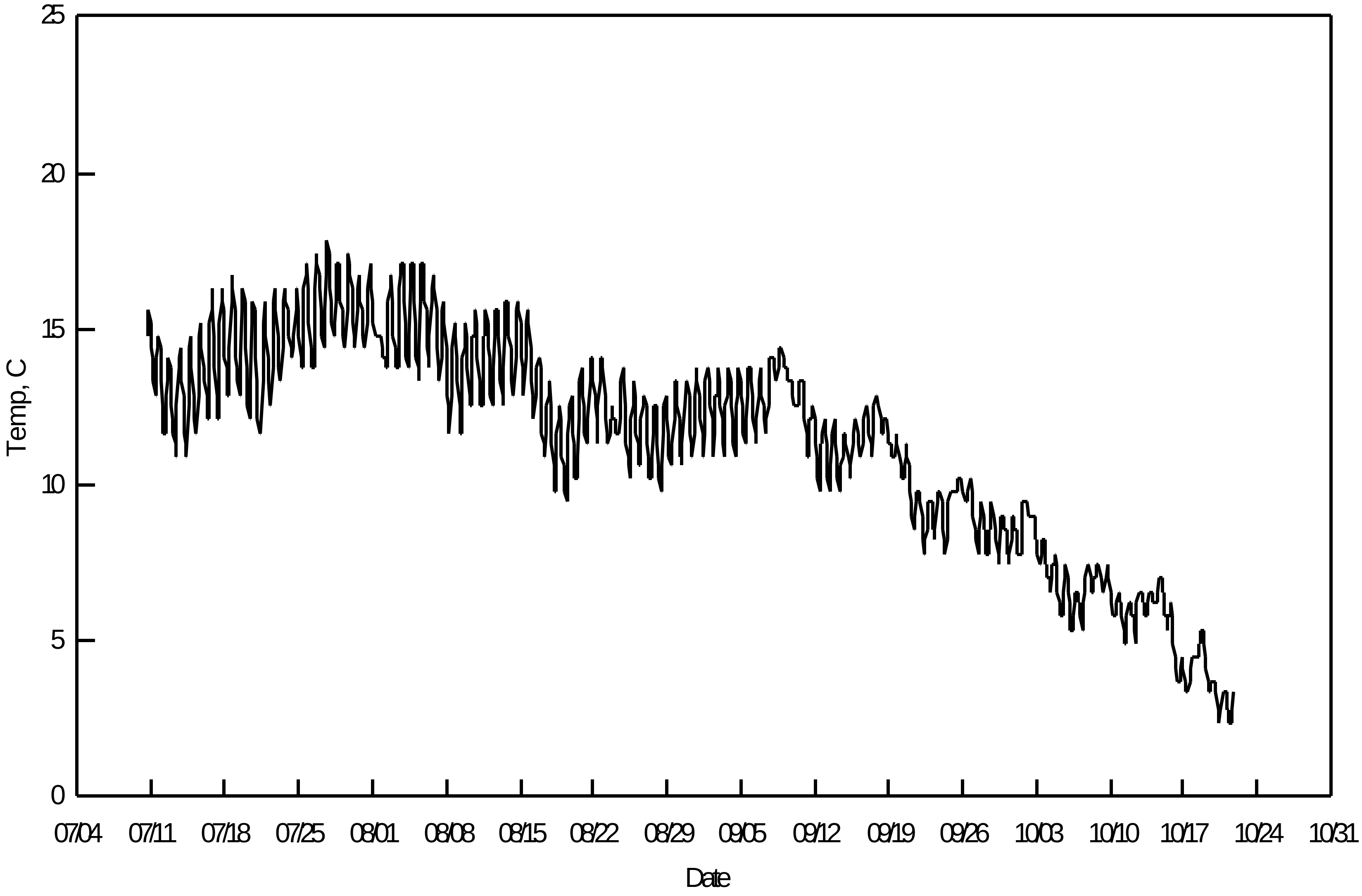

Figure B-13. Boulder Creek Temperature Profile, Summer 1998

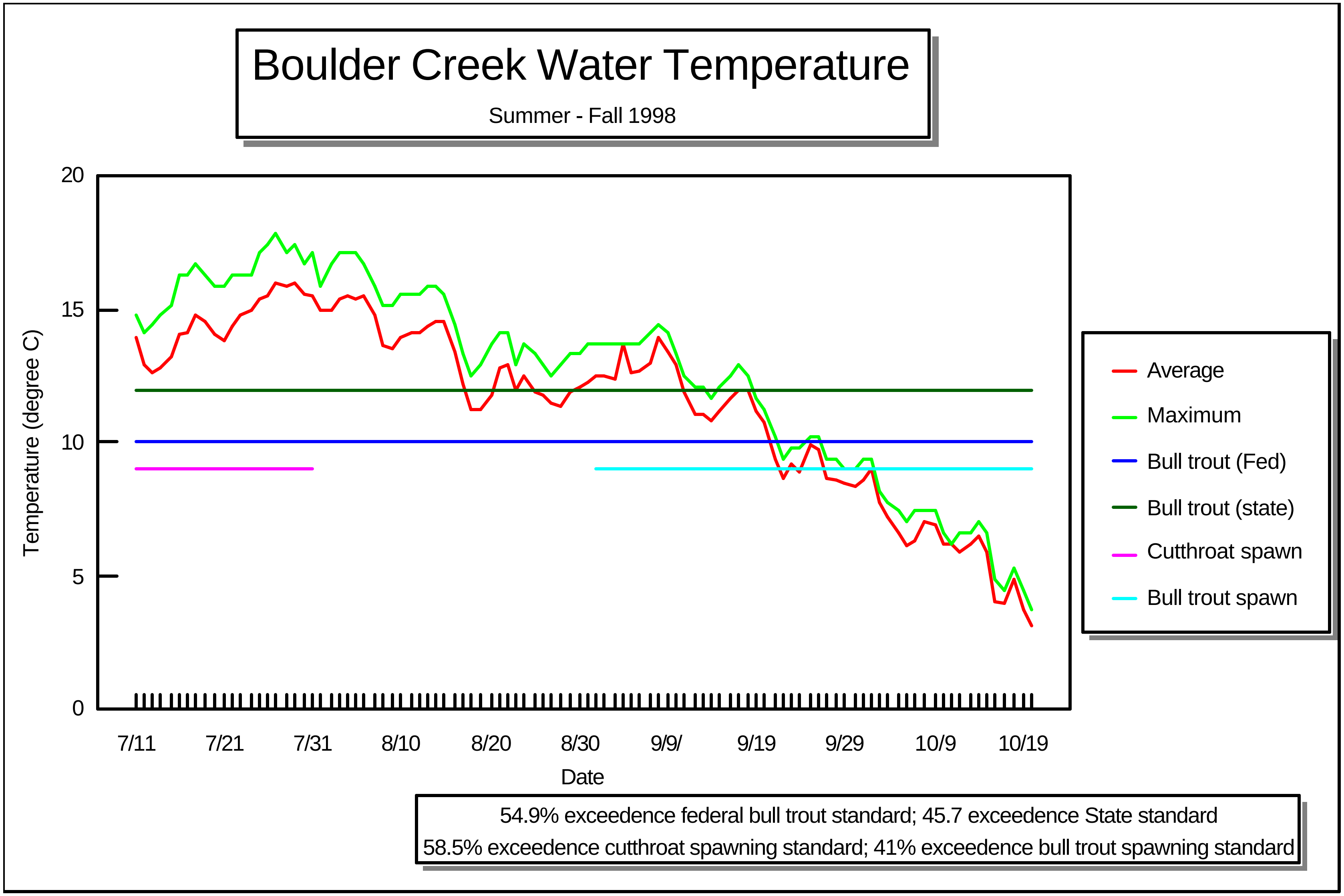

Figure B-14. Boulder Creek Water Temperature Analysis

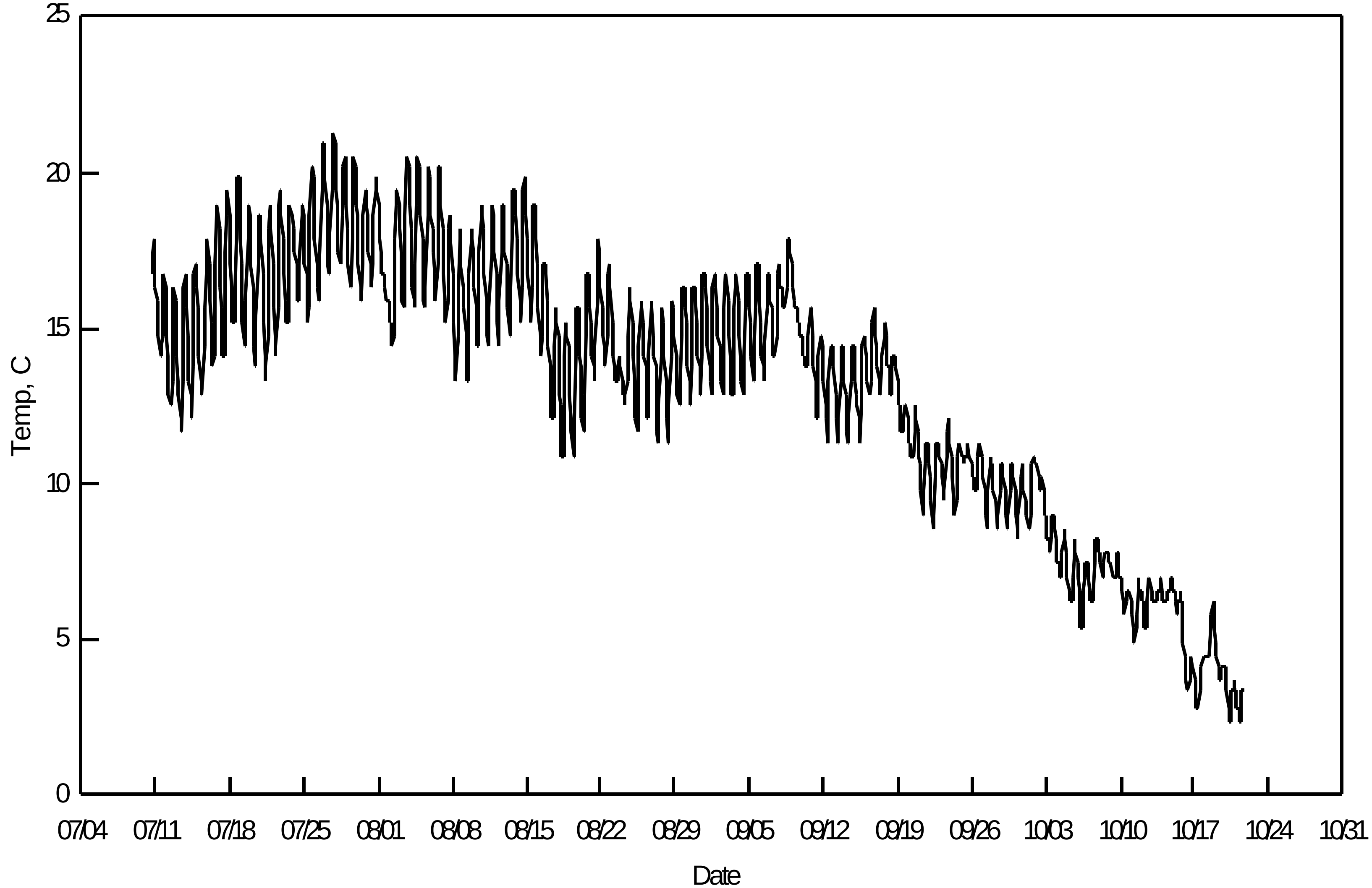

Figure B-15. Marble Creek Temperature Profile, Summer 1998

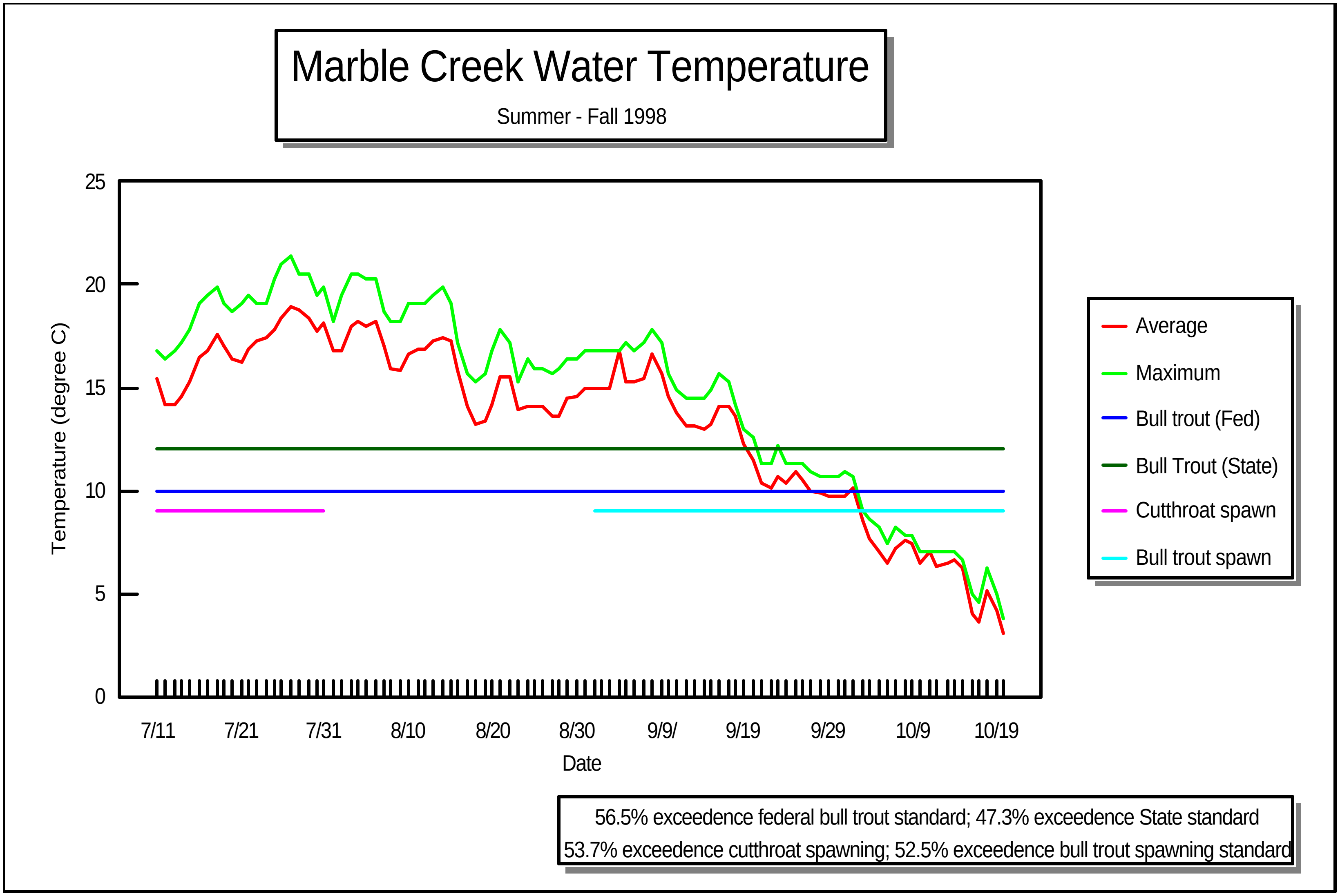

Figure B-16. Marble Creek Water Temperature Analysis

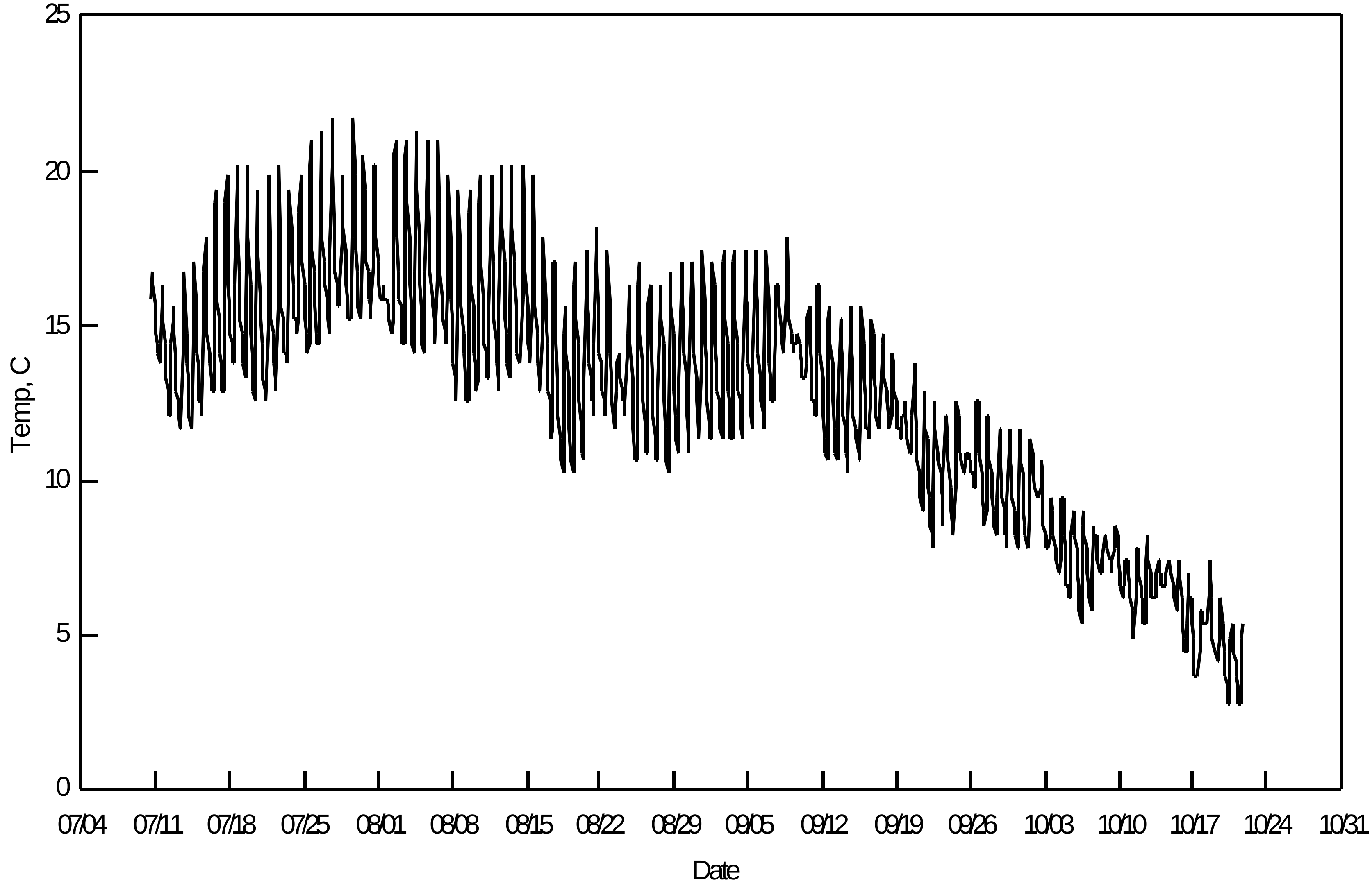

Figure B-17. Fishhook Creek Temperature Profile, Summer 1998

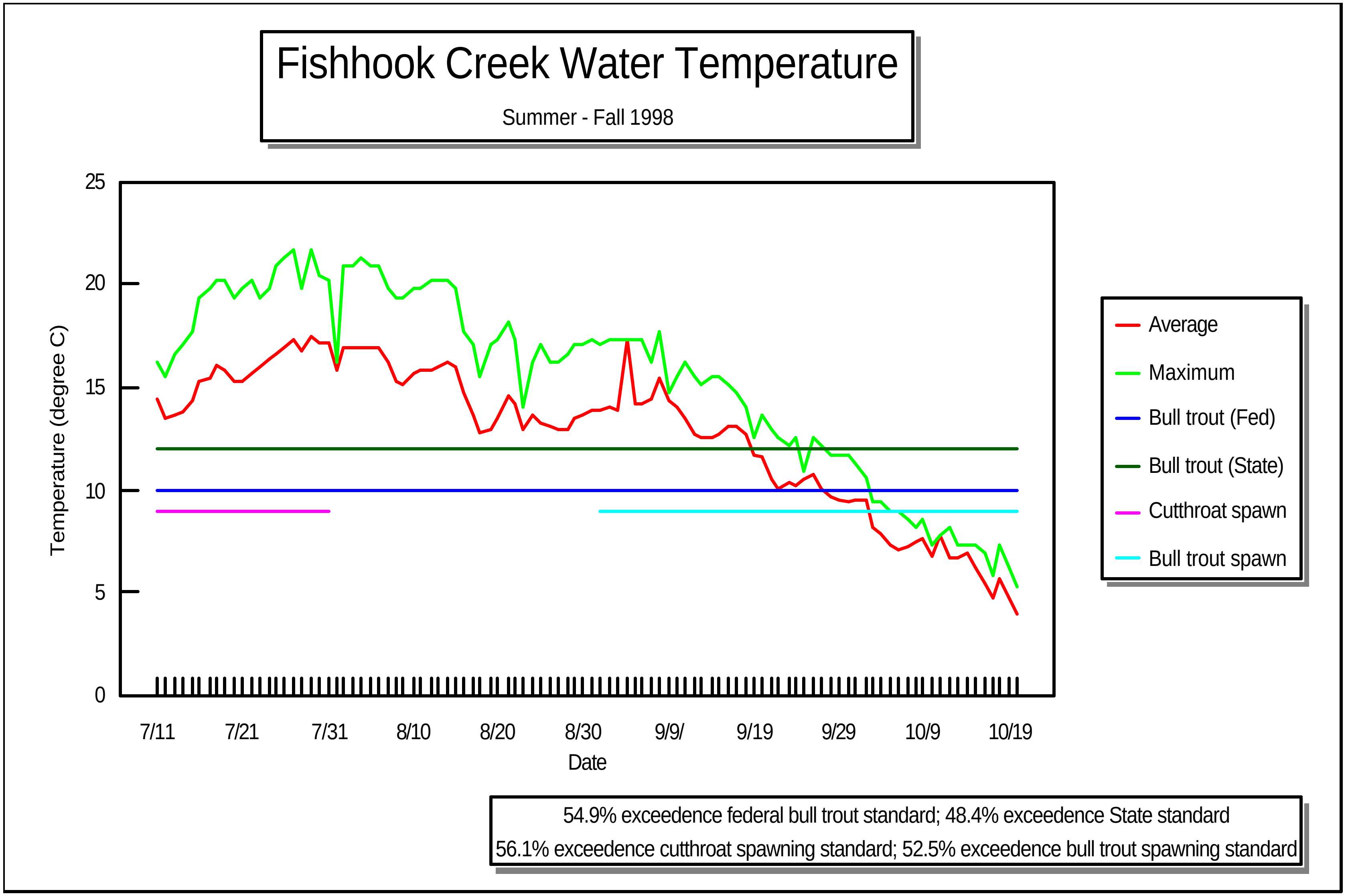

Figure B-18. Fishhook Creek Water Temperature Analysis

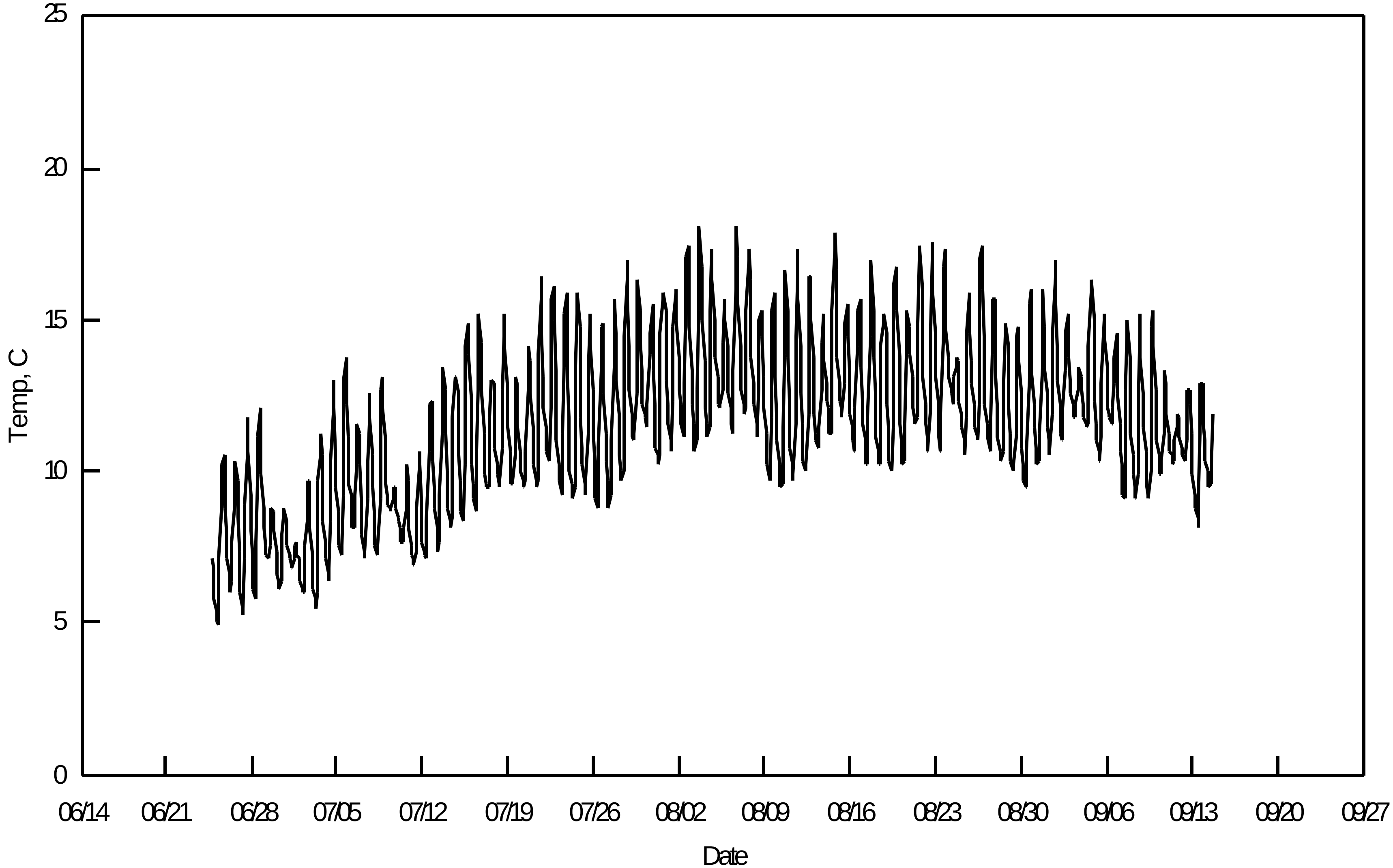

Figure B-19. Loop Creek Temperature Profile, Summer 1997

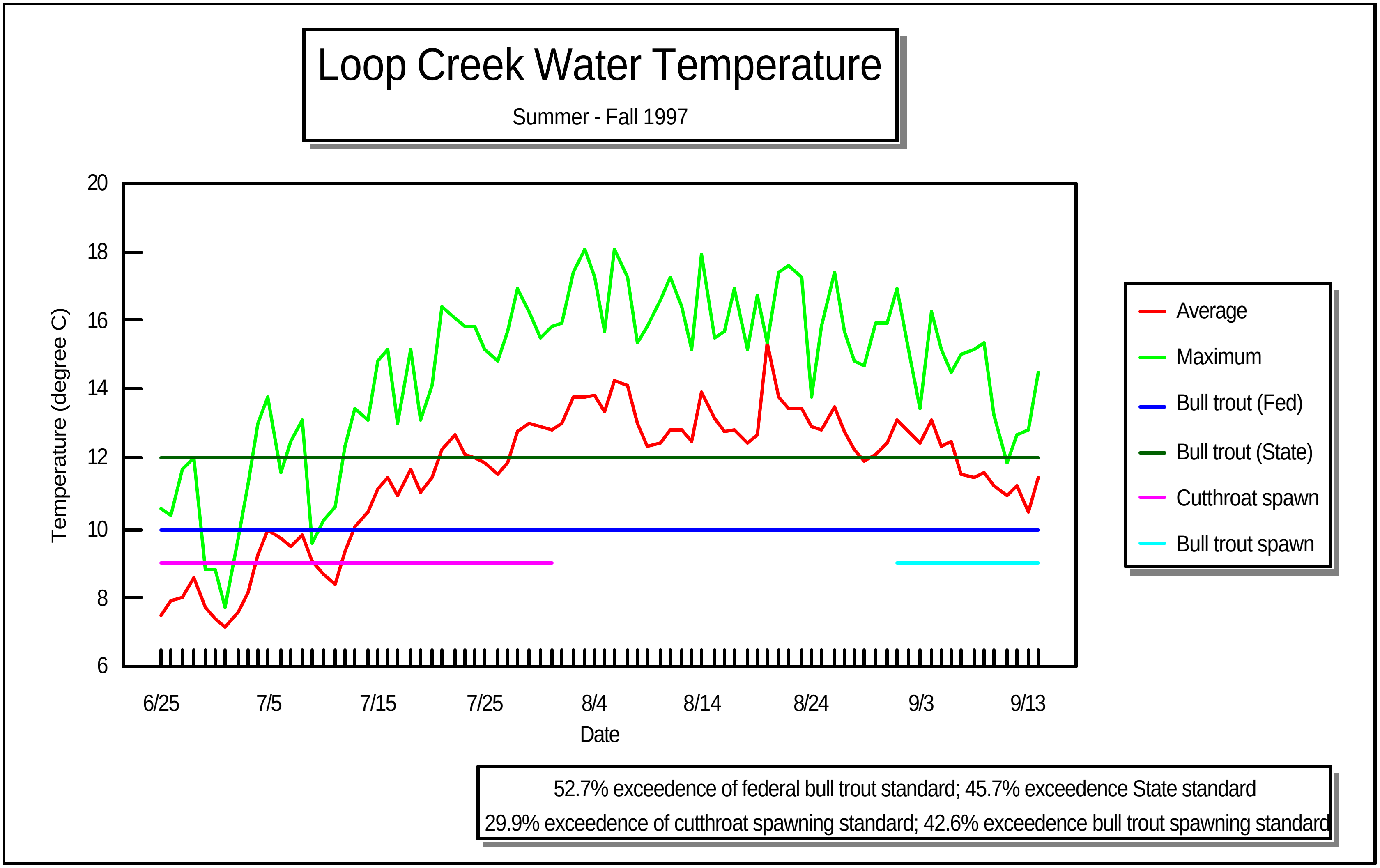

Figure B-20. Loop Creek Water Temperature Analysis

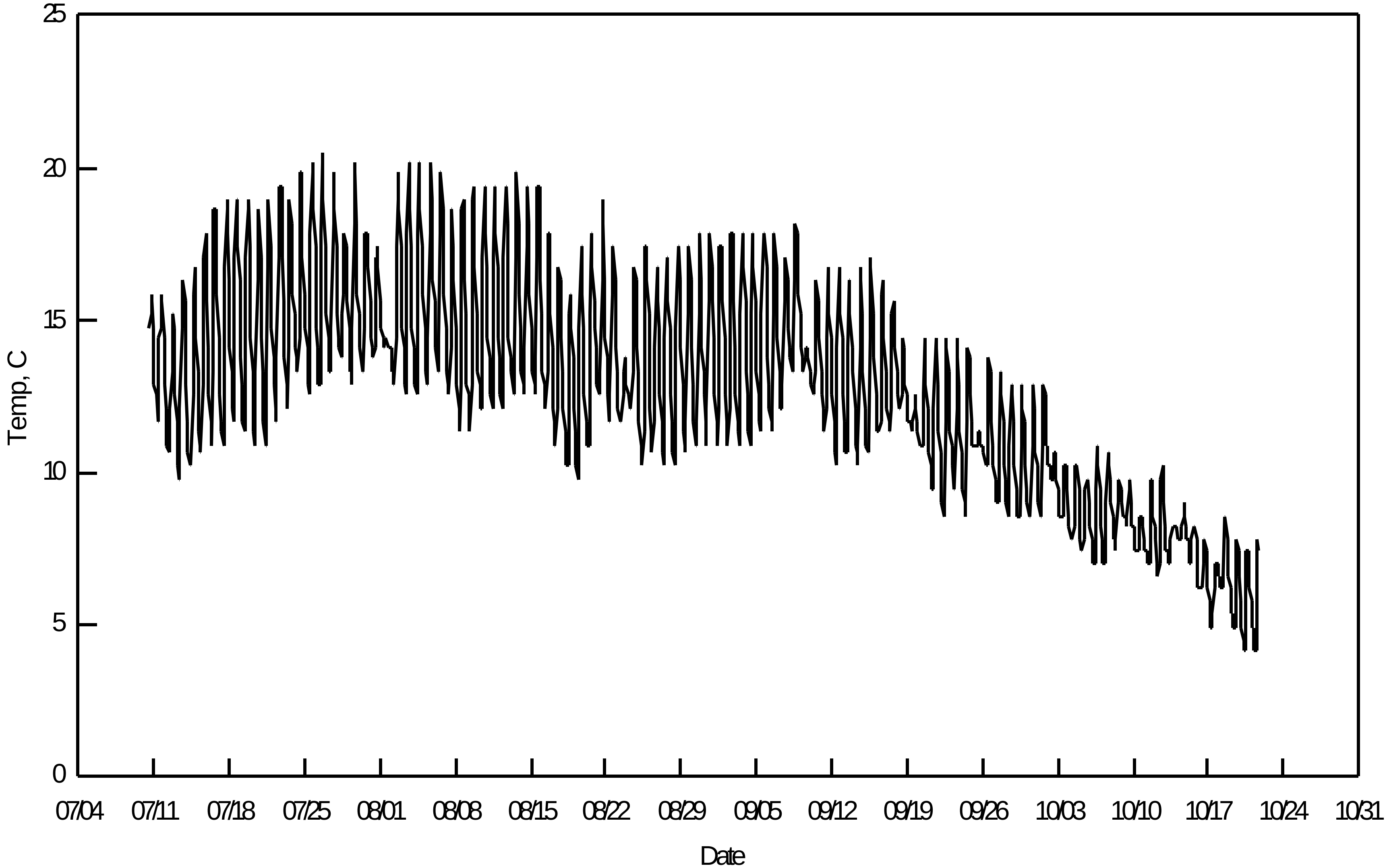

Figure B-21. North Fork St. Joe River Temperature Profile, Summer 1997

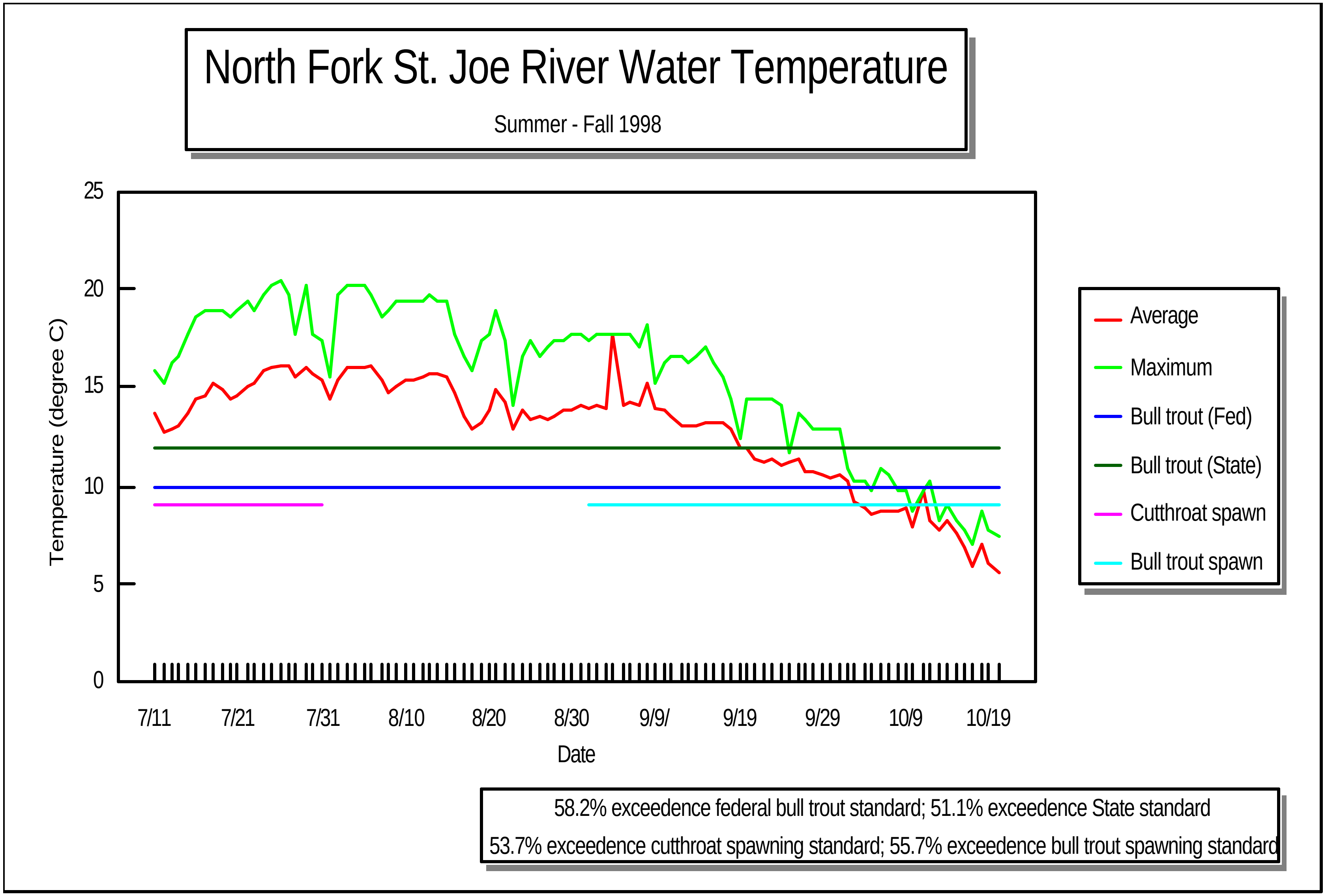

Figure B-22. North Fork St. Joe River Water Temperature Analysis

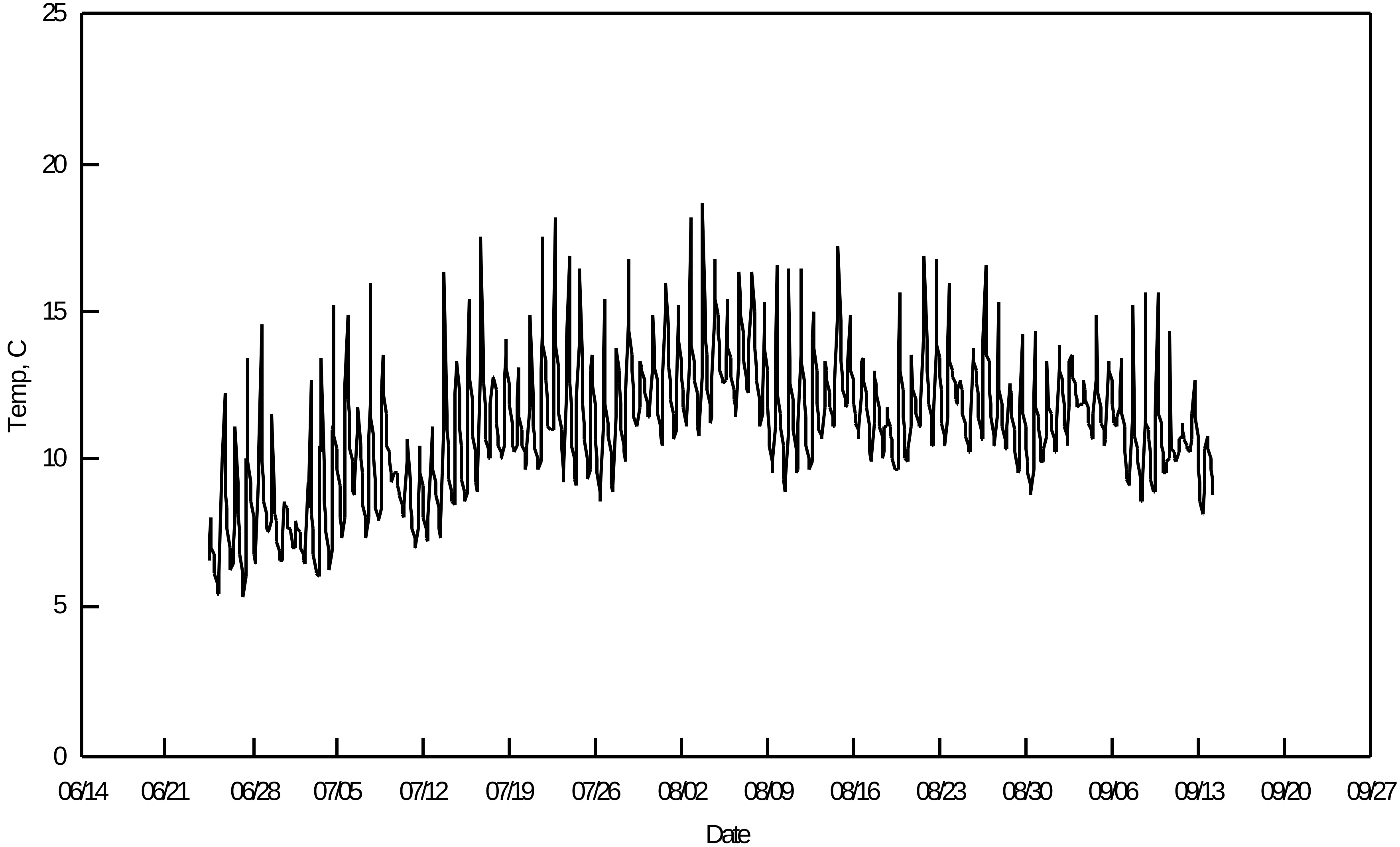

Figure B-23. Bluff Creek Water Temperature Profile, Summer 1997

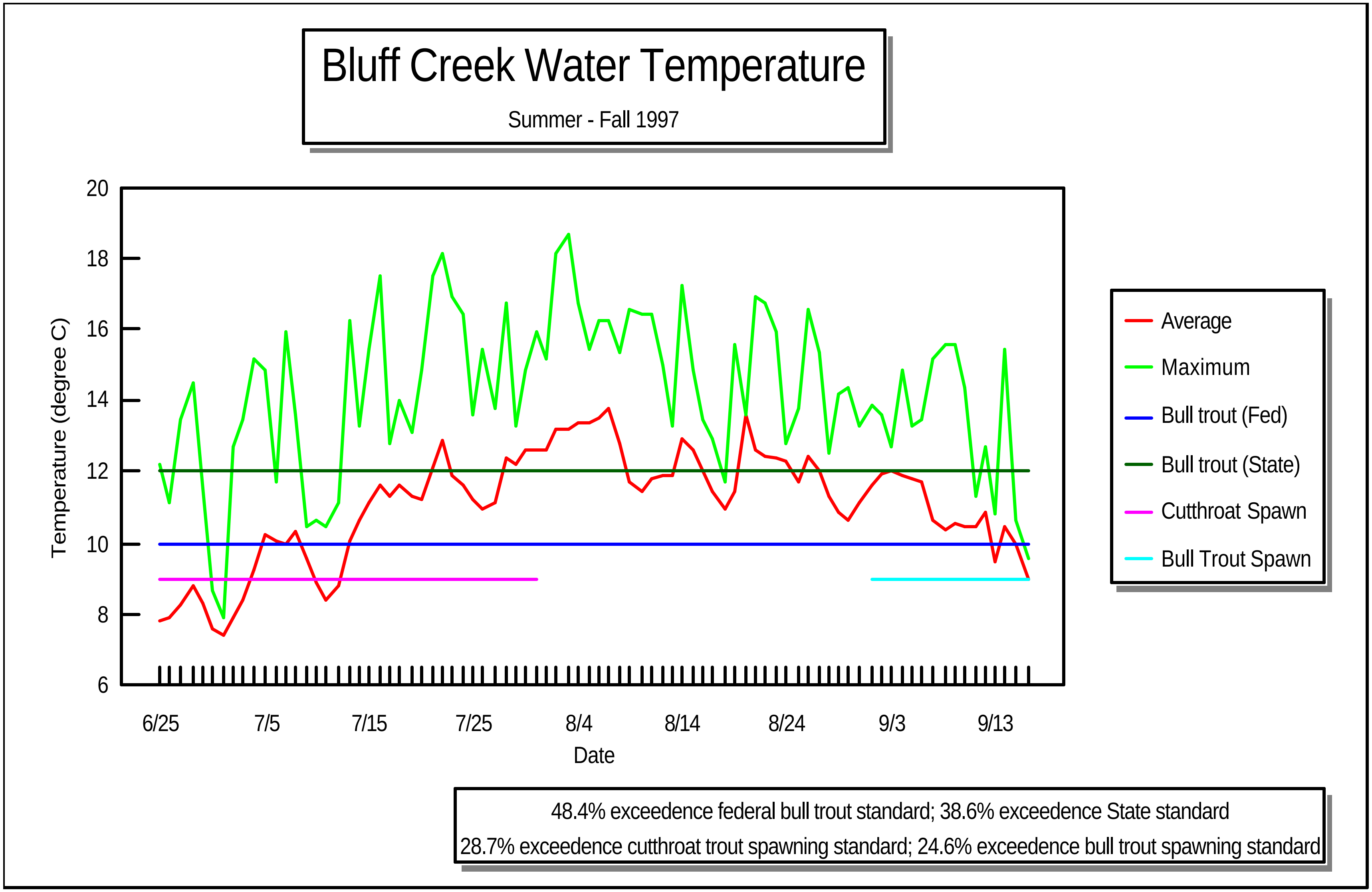

Figure B-24. Bluff Creek Water Temperature Analysis

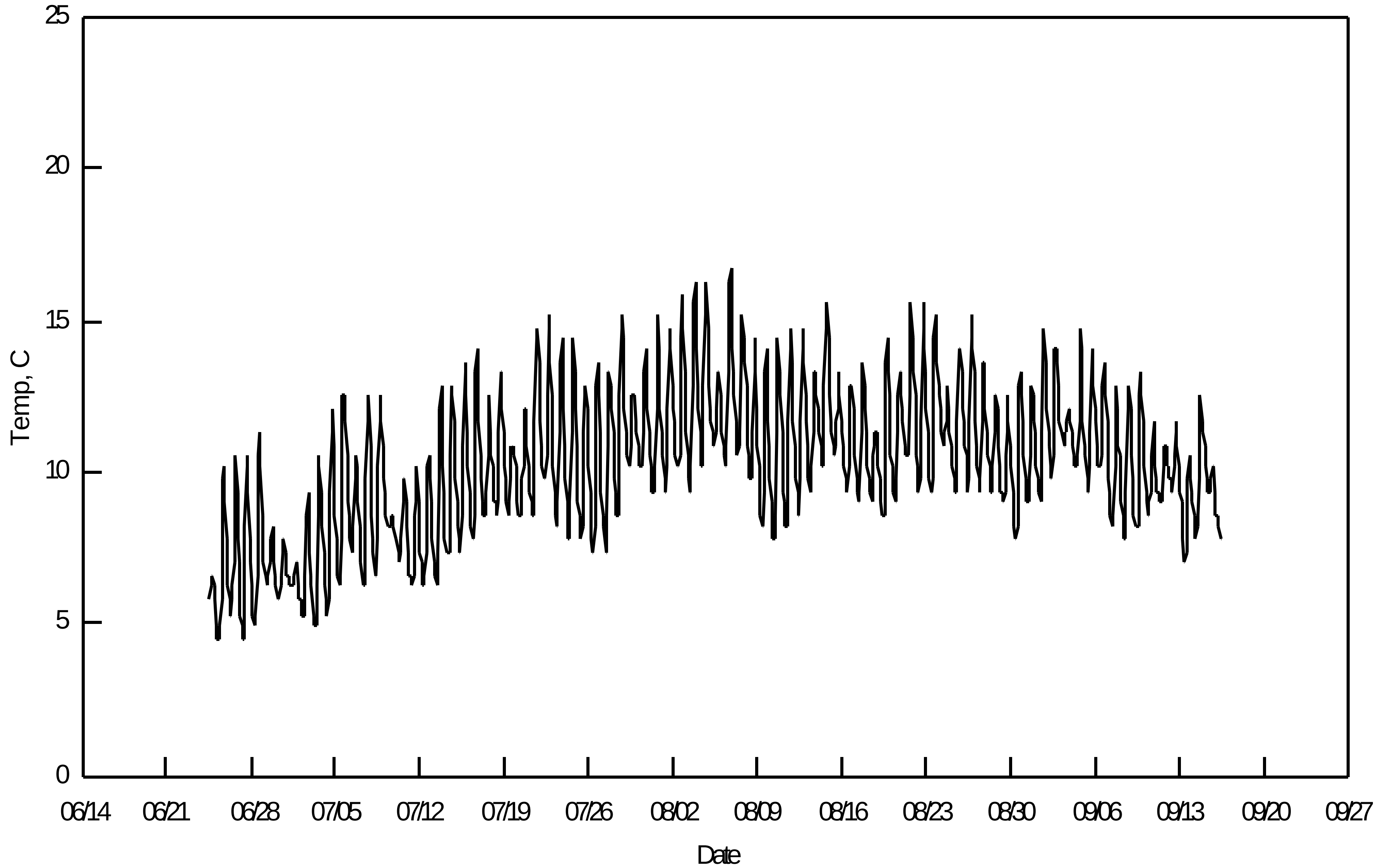

Figure B-25. Gold Creek Temperature Profile, Summer 1997

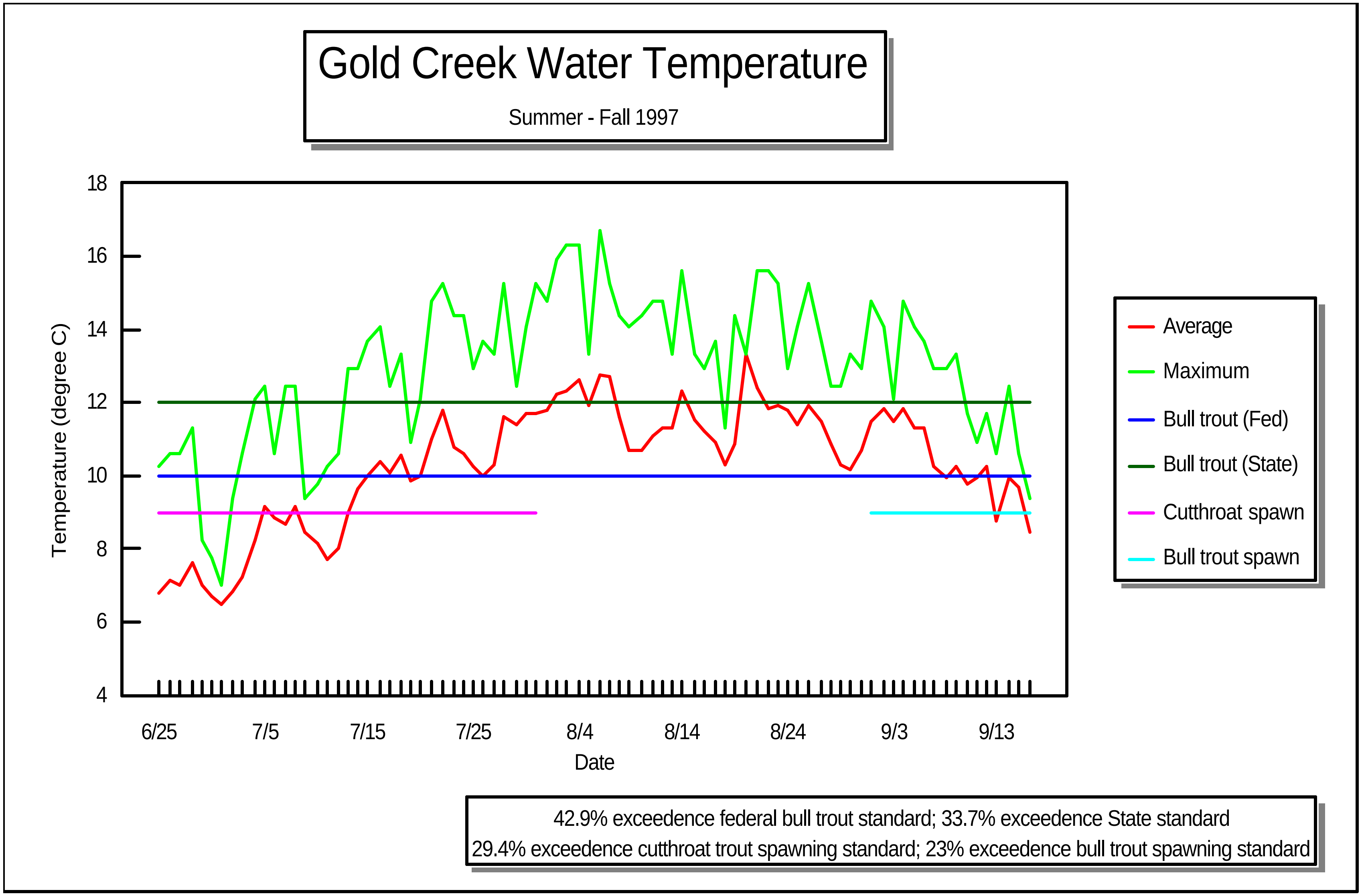

Figure B-26. Gold Creek Water Temperature Analysis

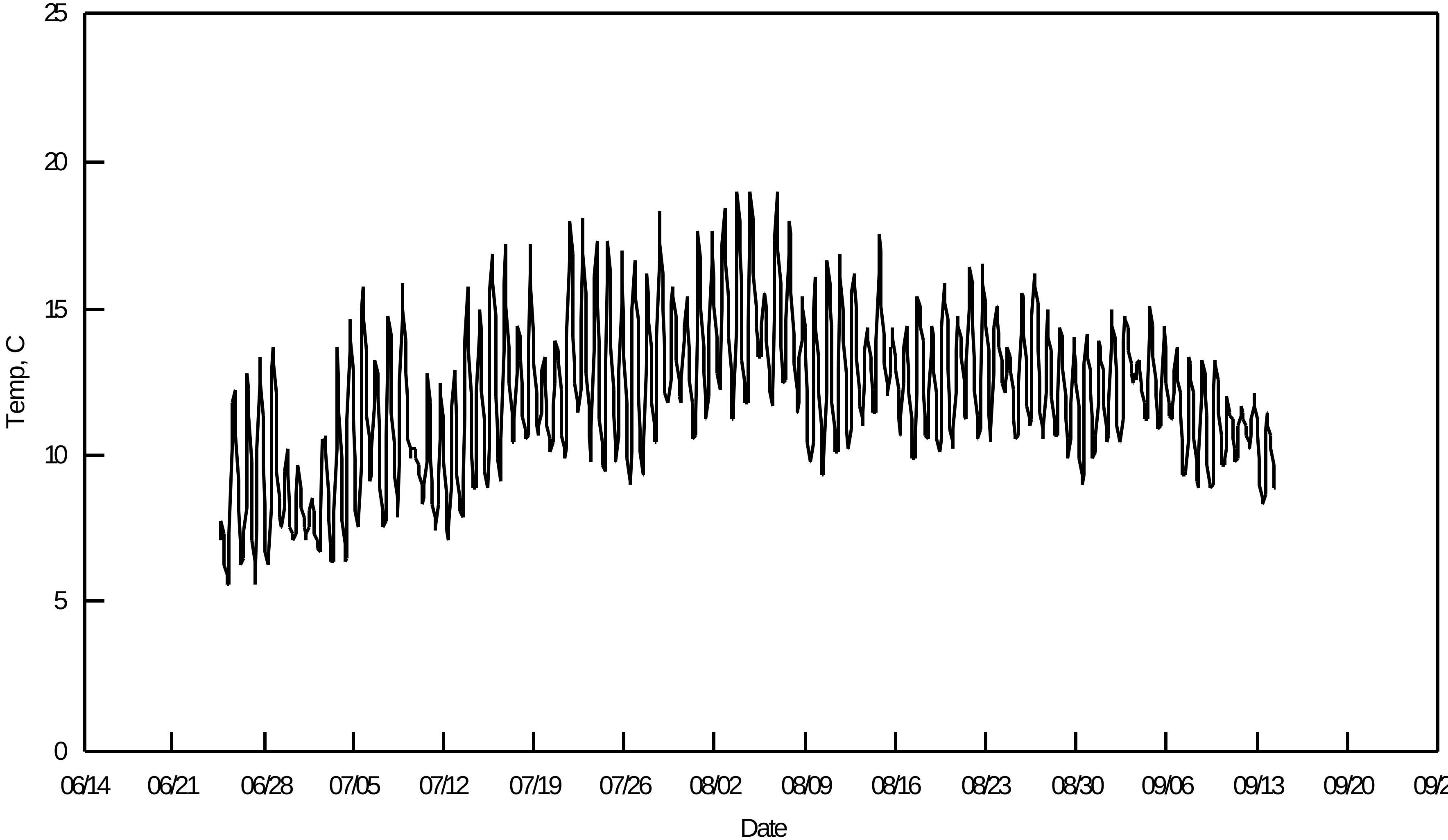

Figure B-27. Beaver Creek Temperature Profile, Summer 1997

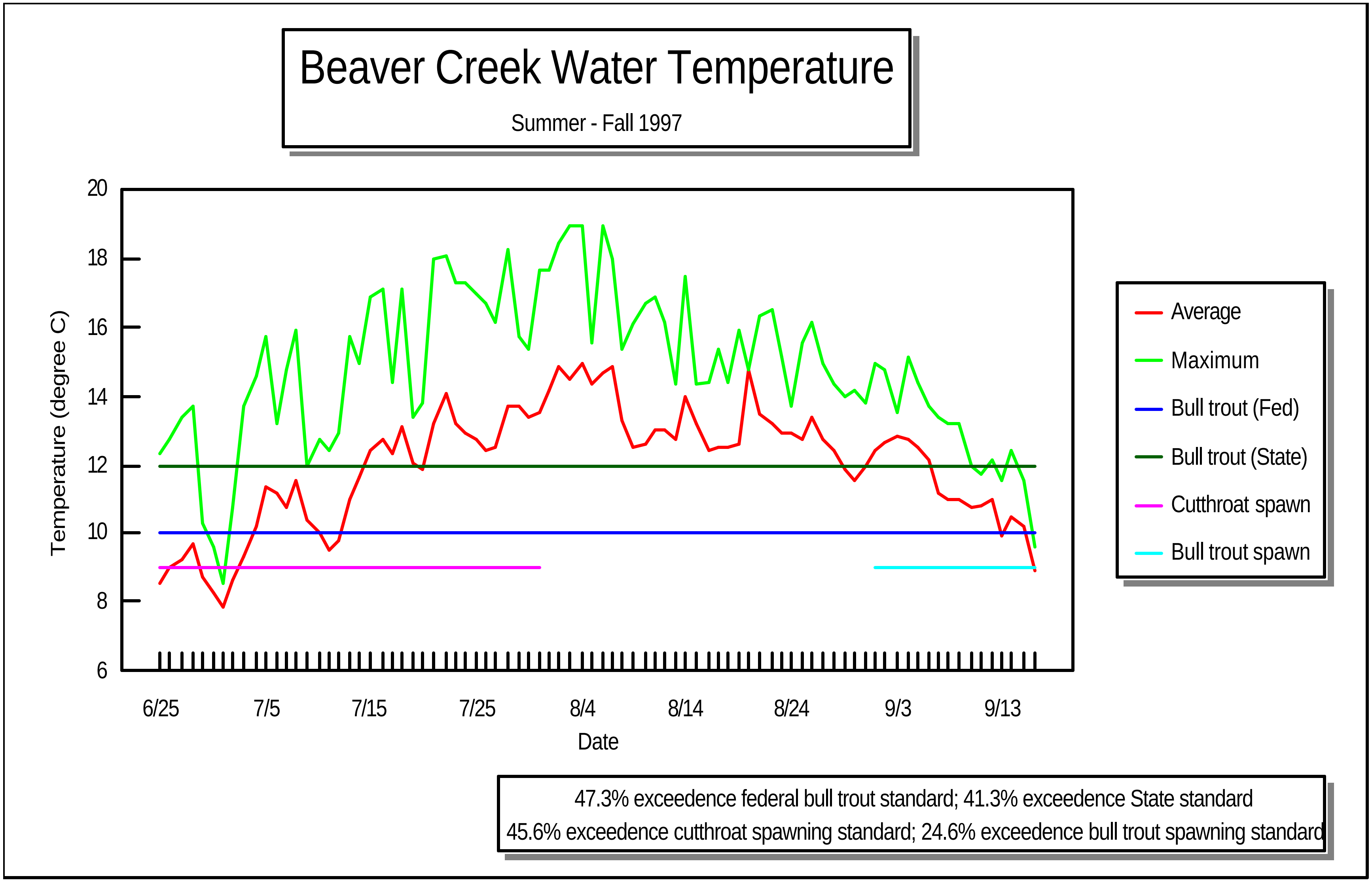

Figure B-28. Beaver Creek Water Temperature Analysis

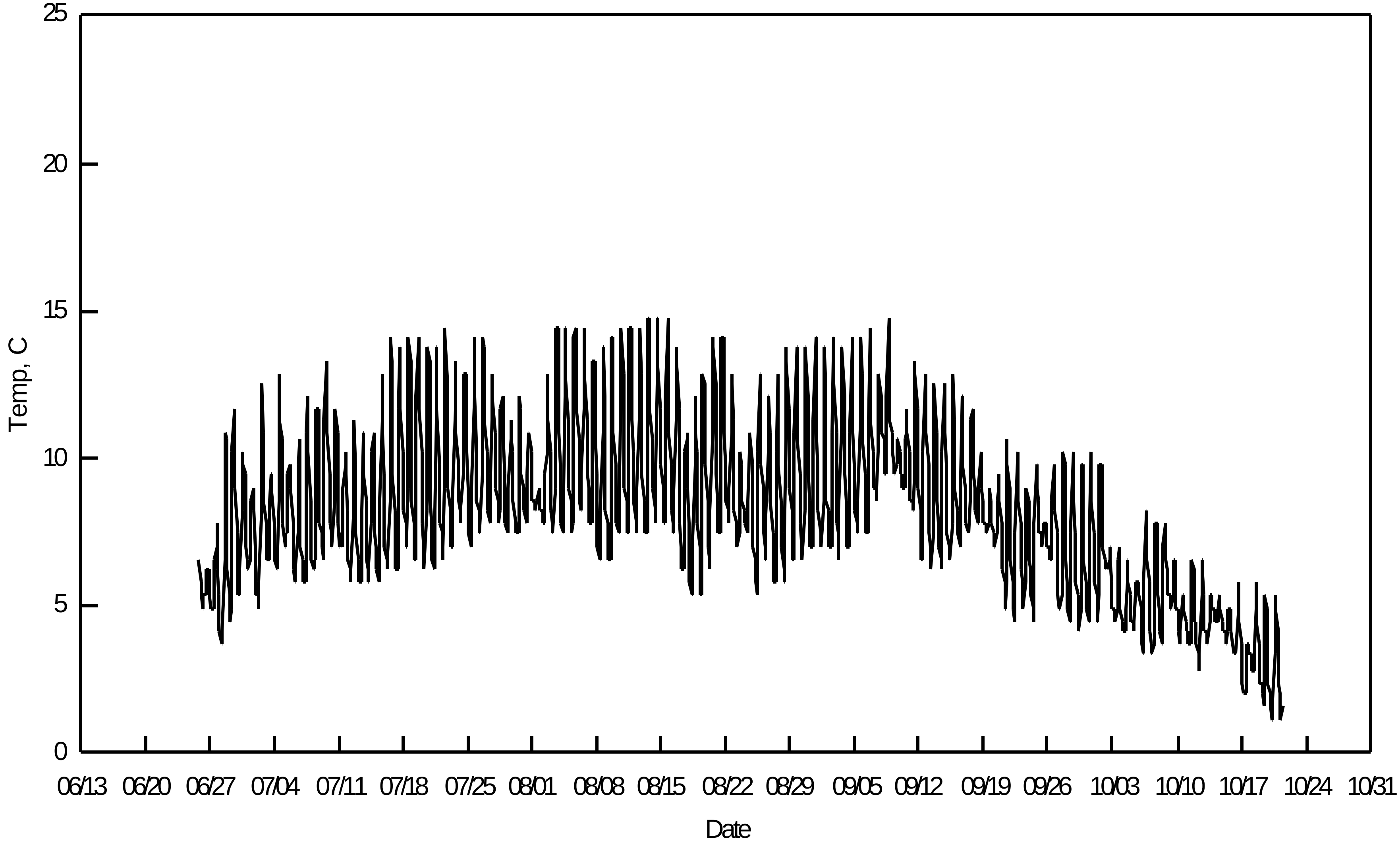

Figure B-29. Heller Creek Temperature Profile, Summer 1998

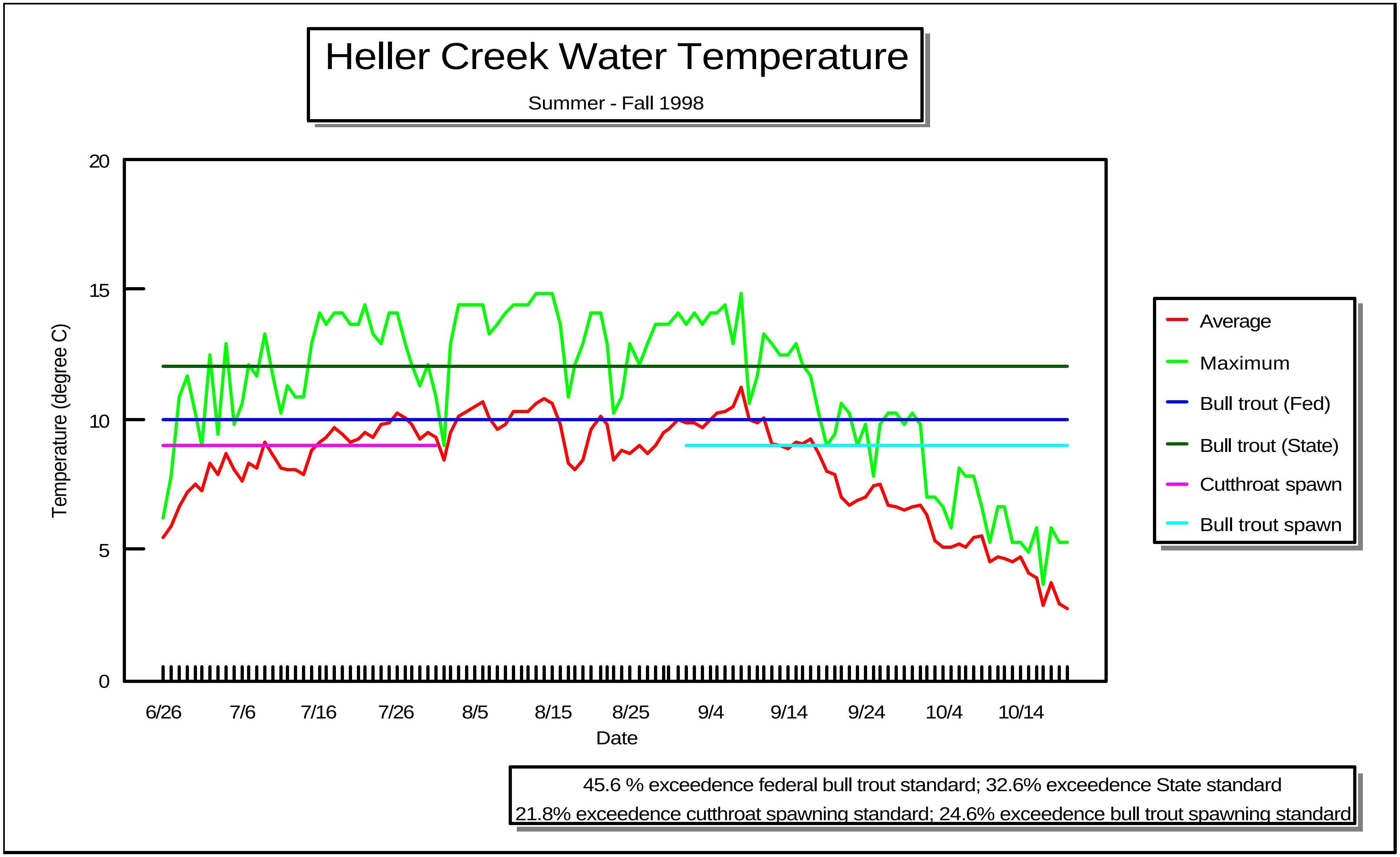

Figure B-30. Heller Creek Water Temperature Analysis

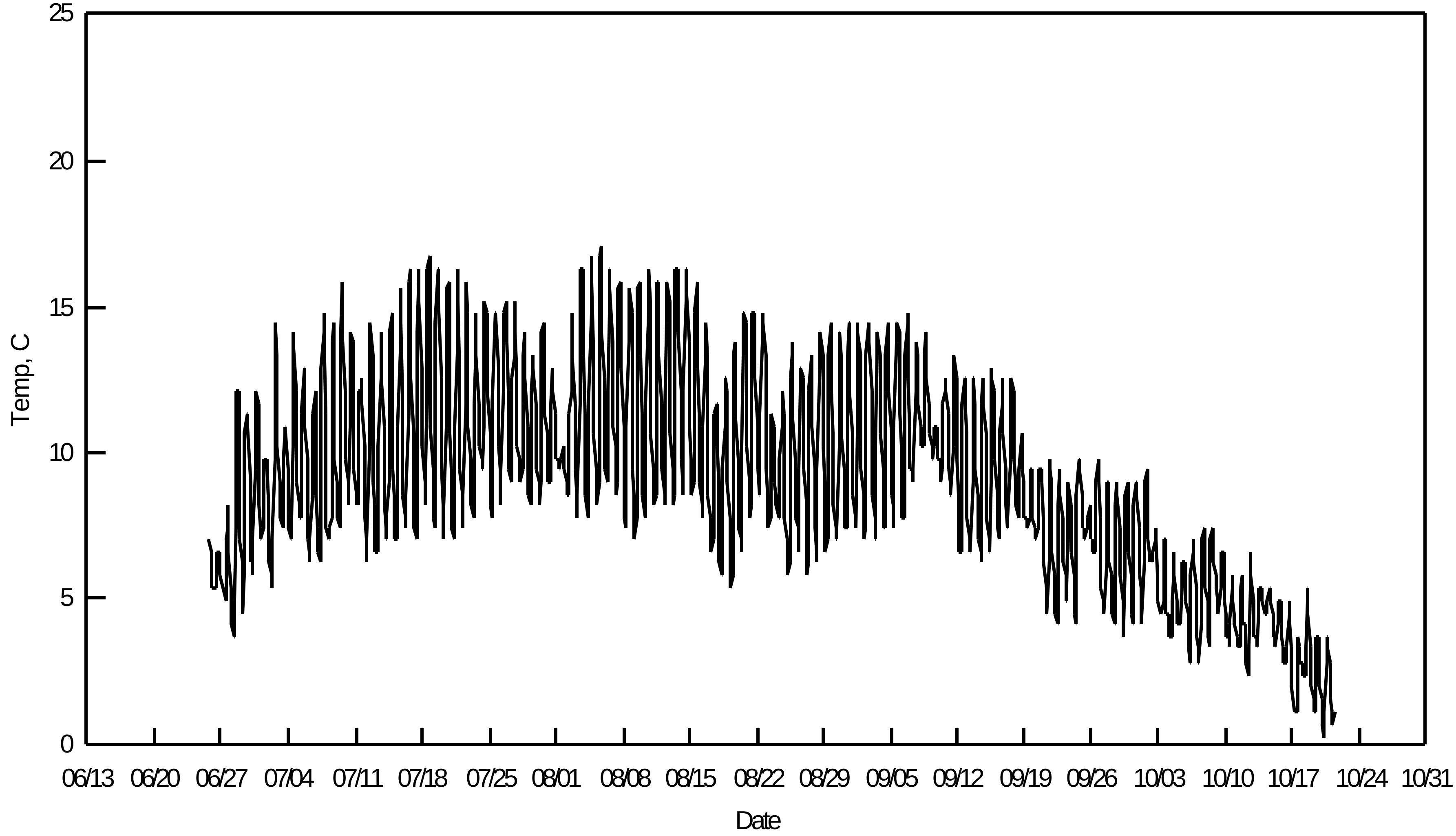

Figure B-31. Sherlock Creek Temperature Profile, Summer 1998

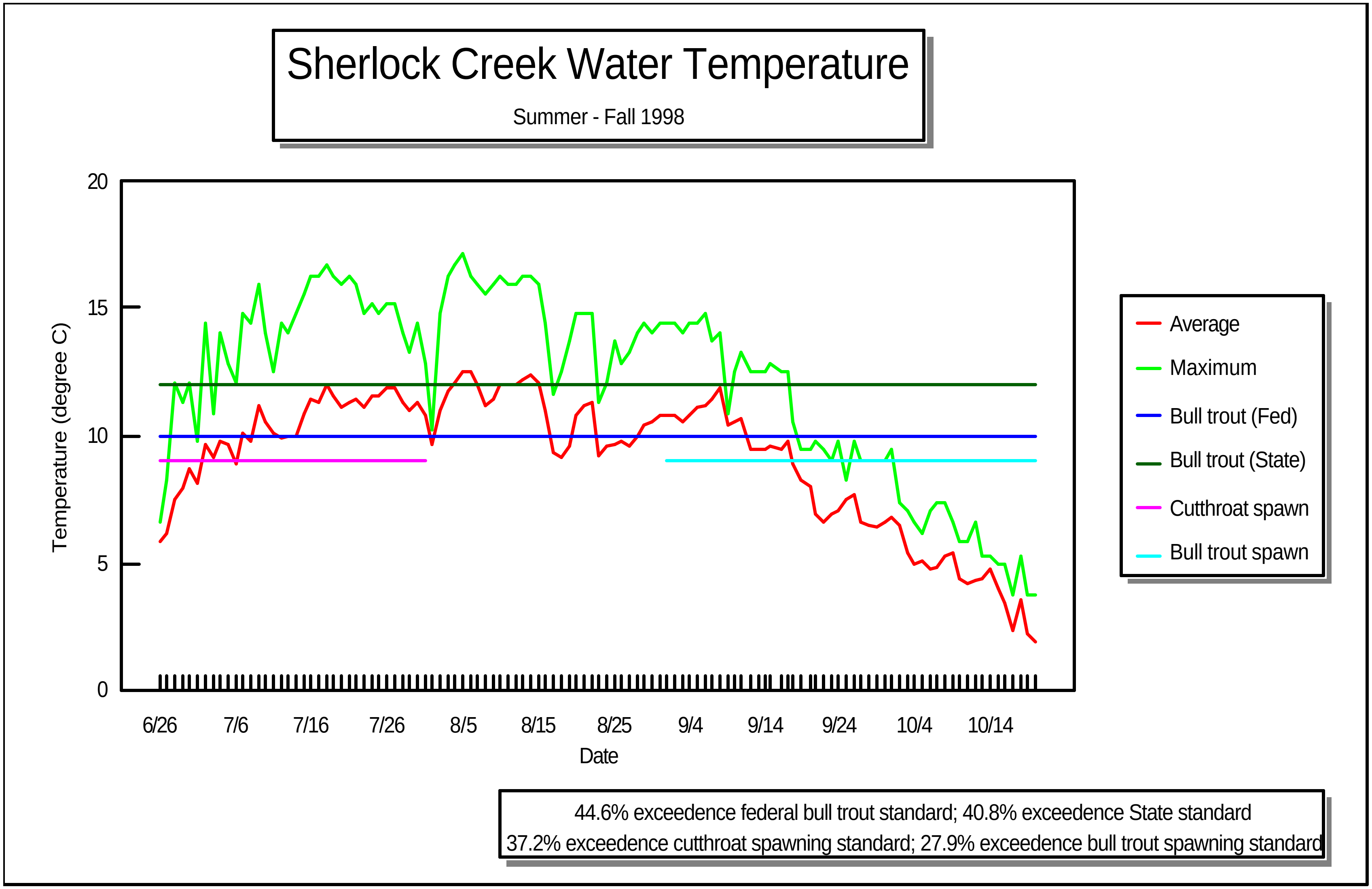

Figure B-32. Sherlock Creek Water Temperature Analysis

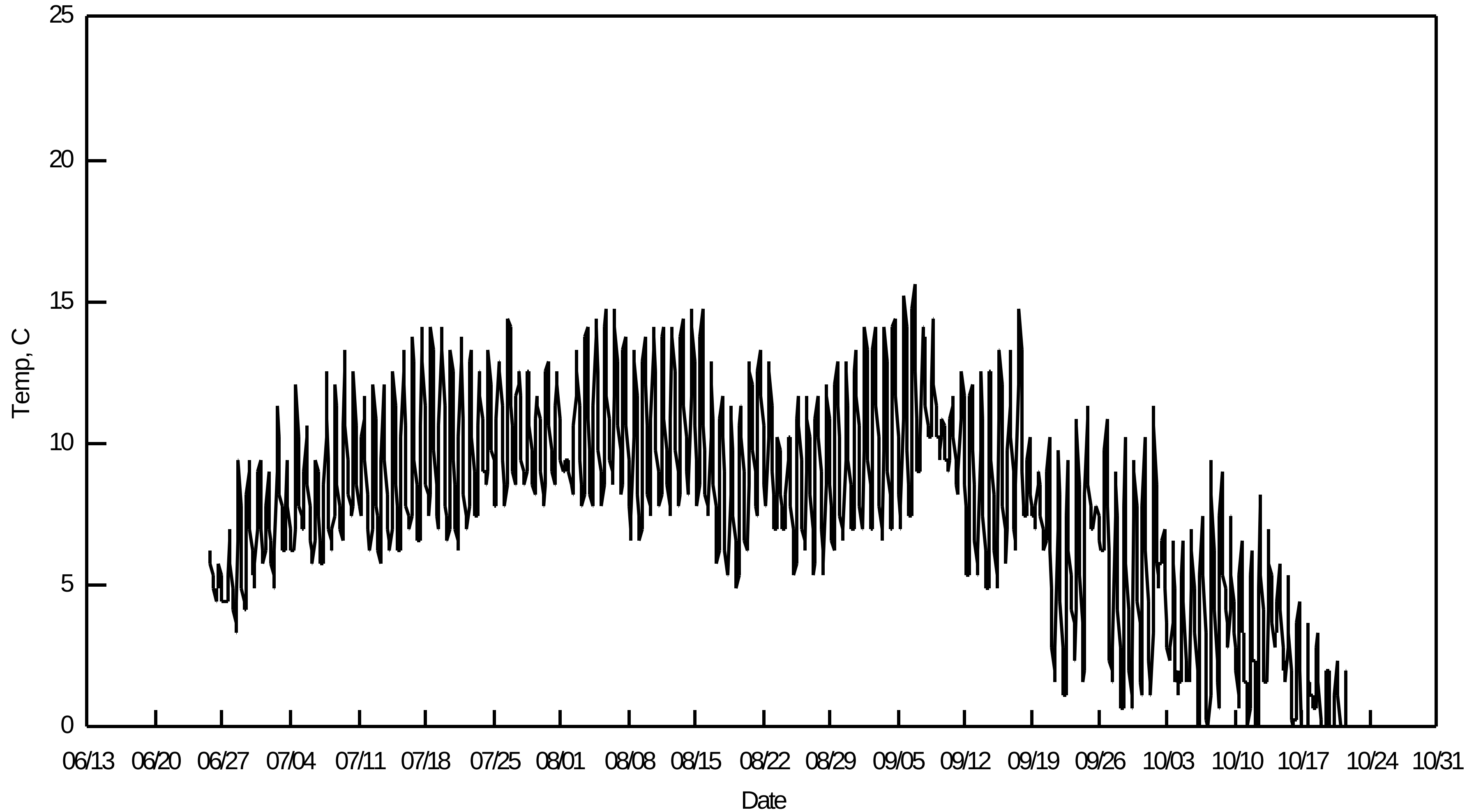

Figure B-33. Yankee Bar Creek Temperature Profile, Summer 1998

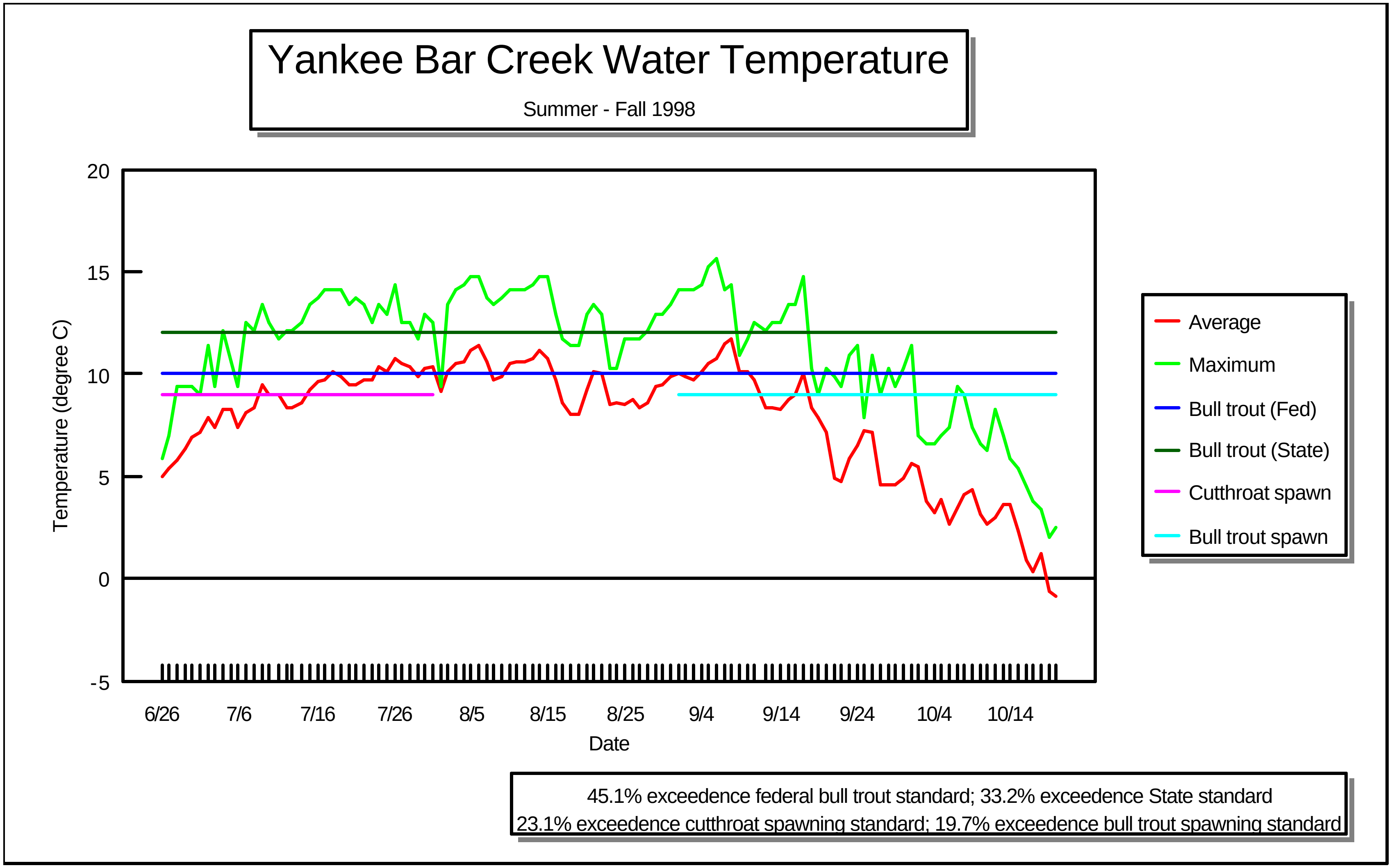

Figure B-34. Yankee Bar Creek Water Temperature Analysis

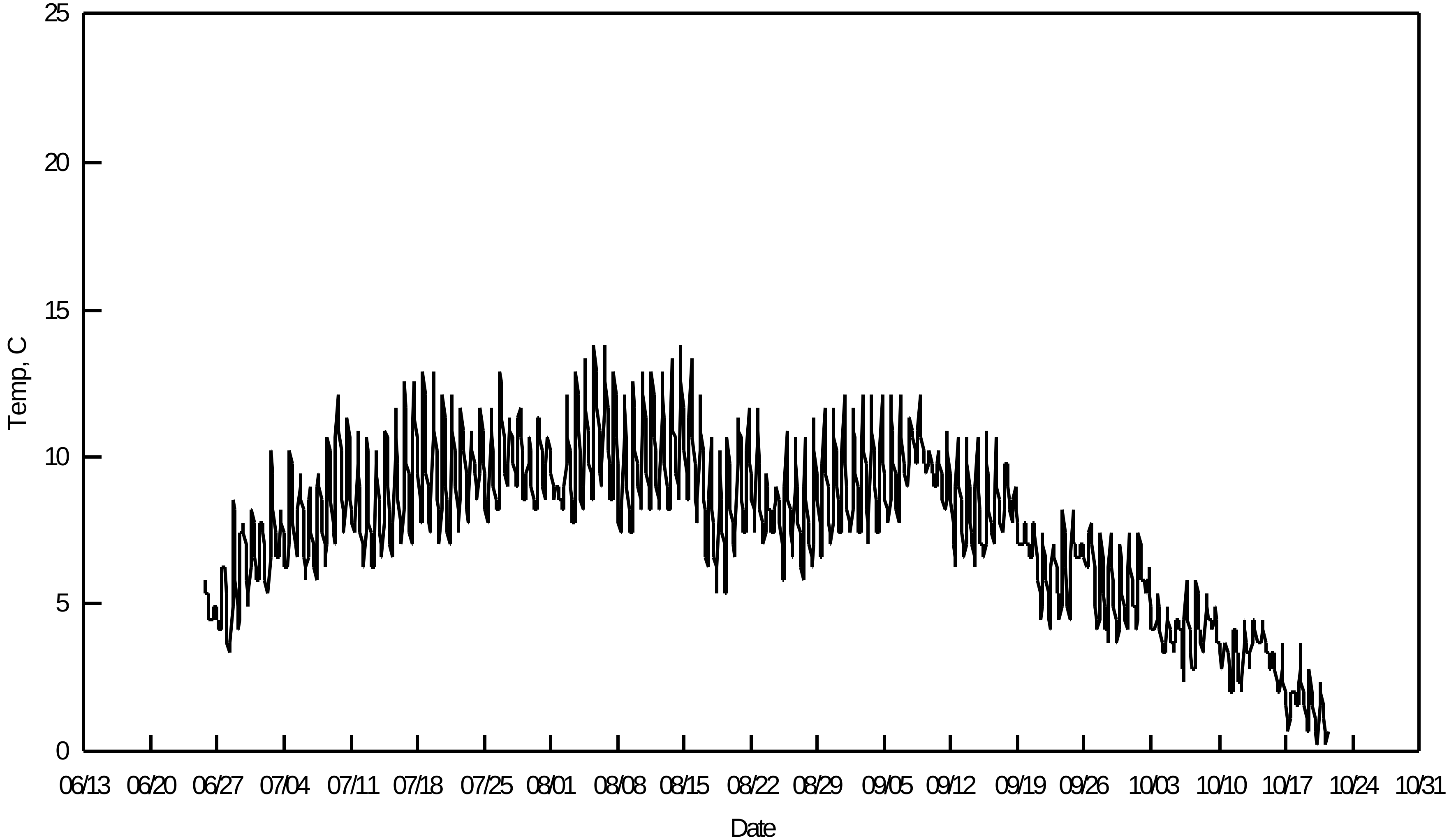

Figure B-35. California Creek Temperature Profile, Summer 1998

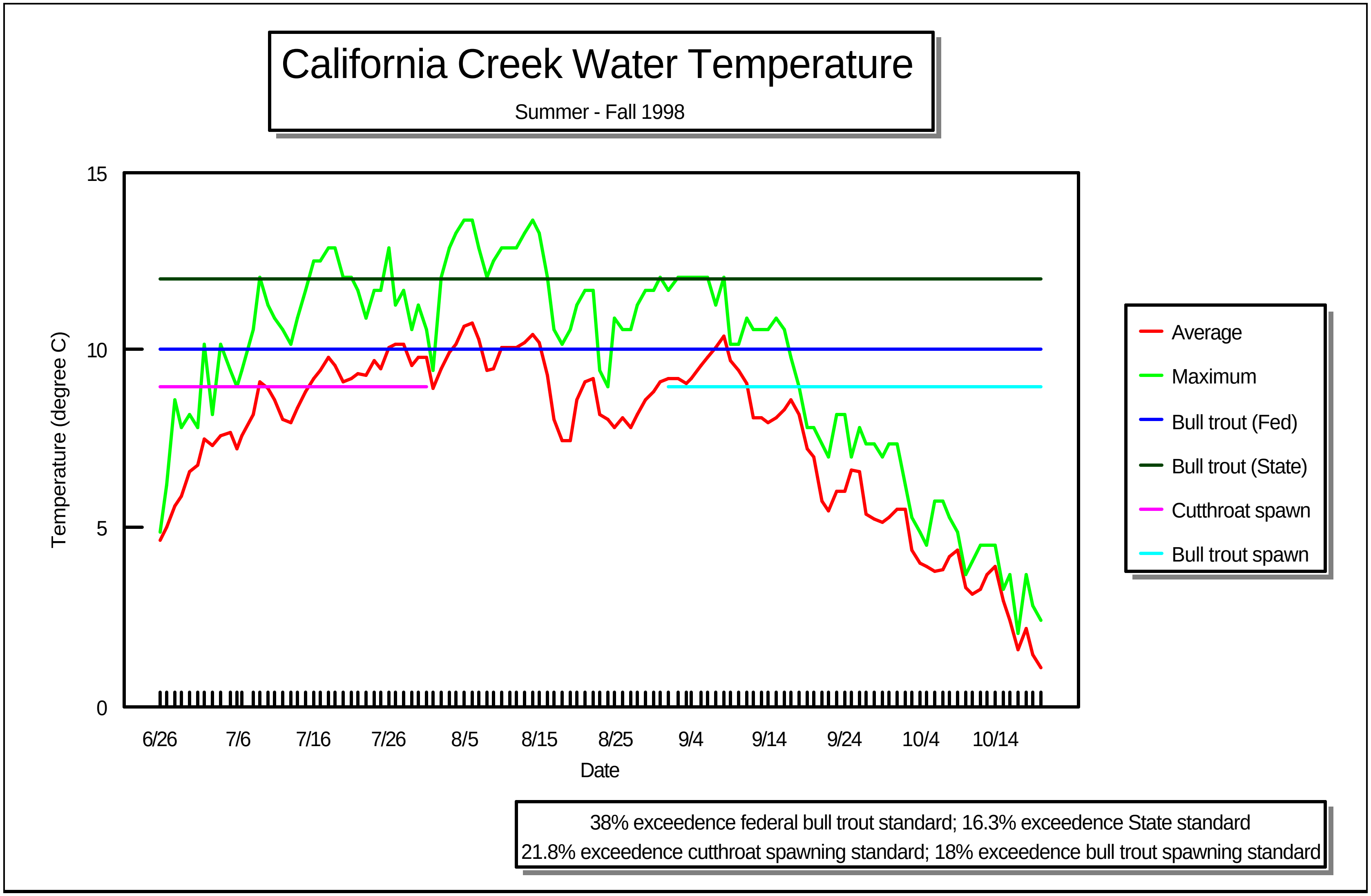

Figure B-36. California Creek Water Temperature Analysis

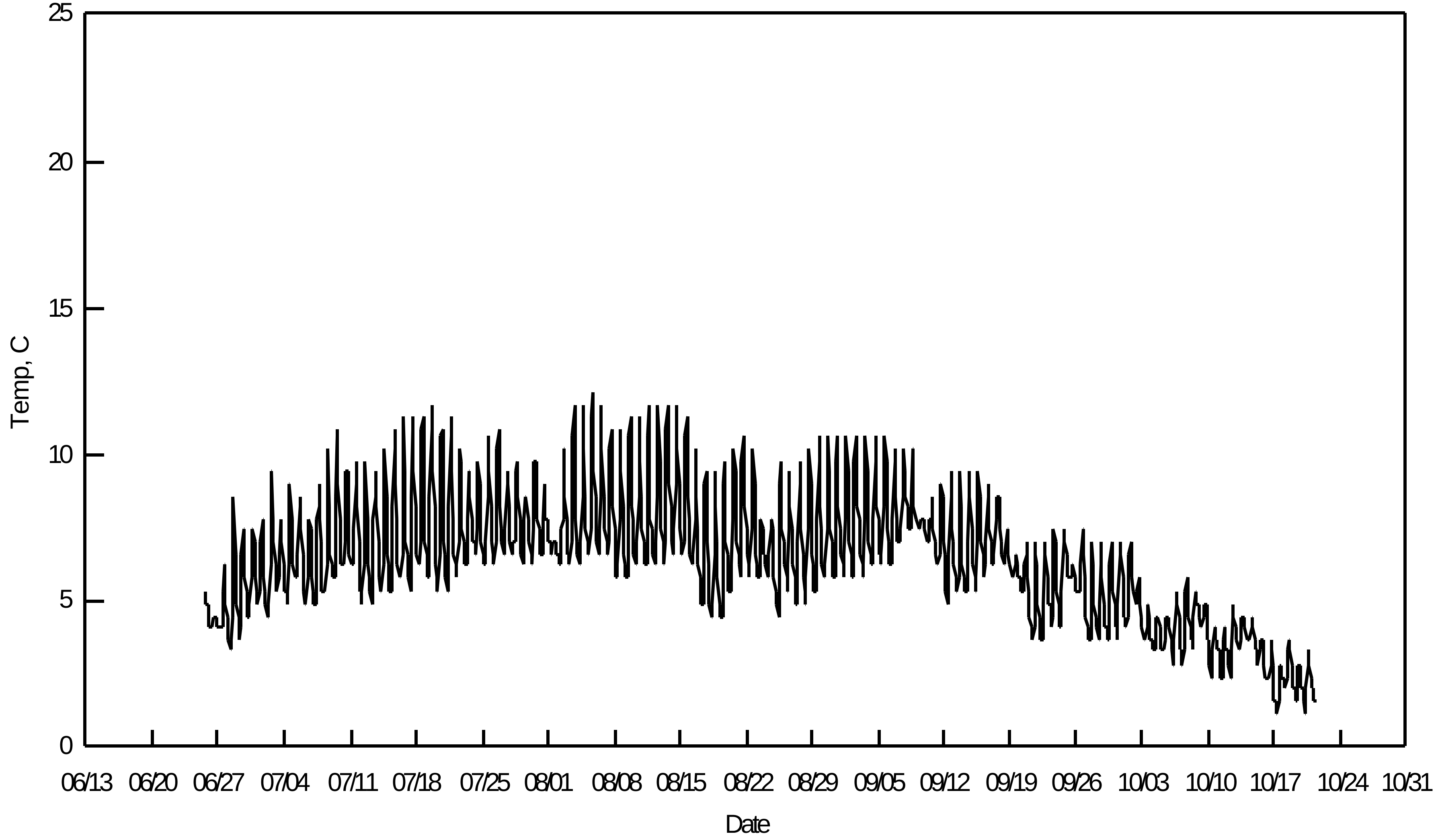

Figure B-37. Medicine Creek Temperature Profile, Summer 1998

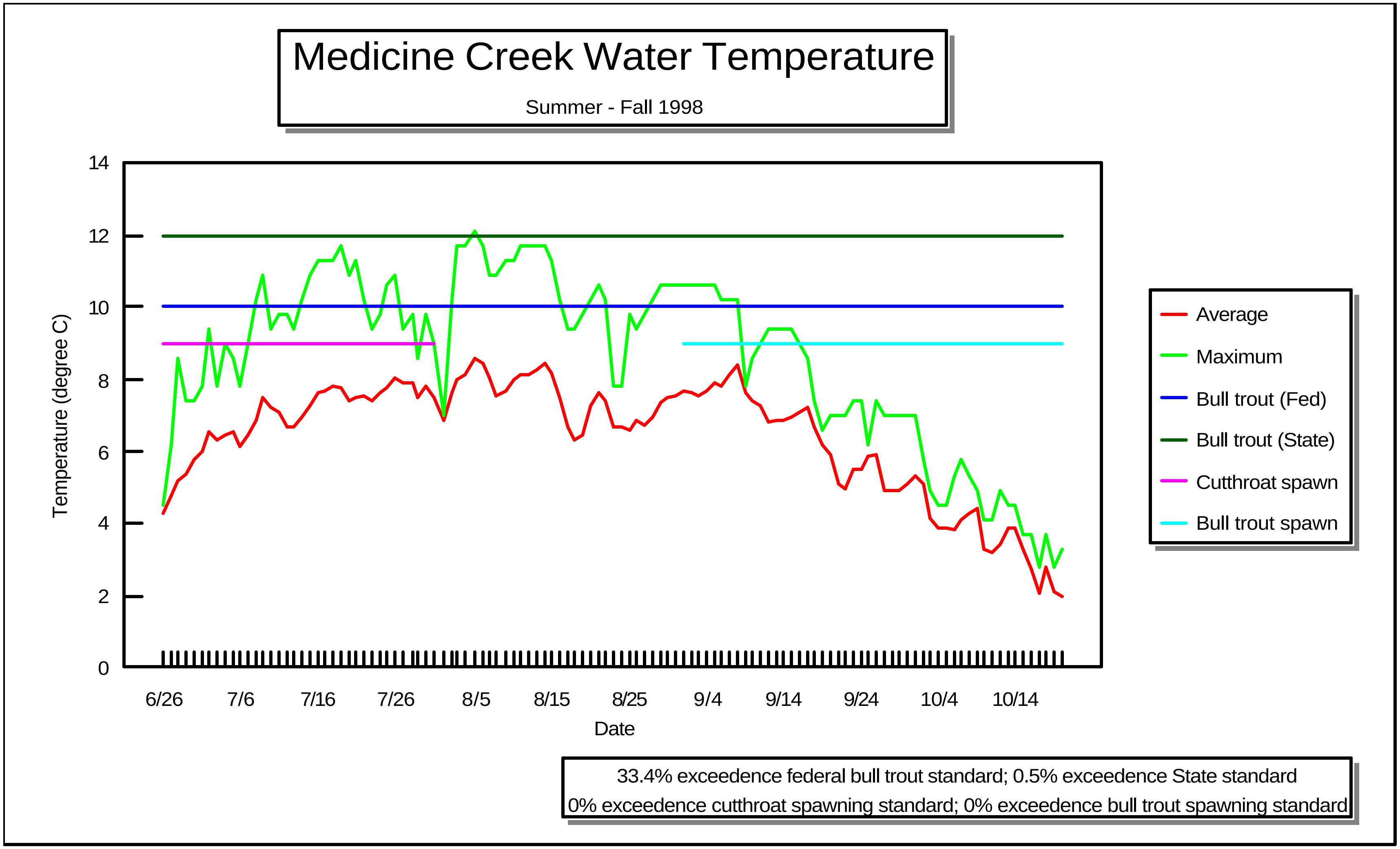

Figure B-38. Medicine Creek Water Temperature Analysis

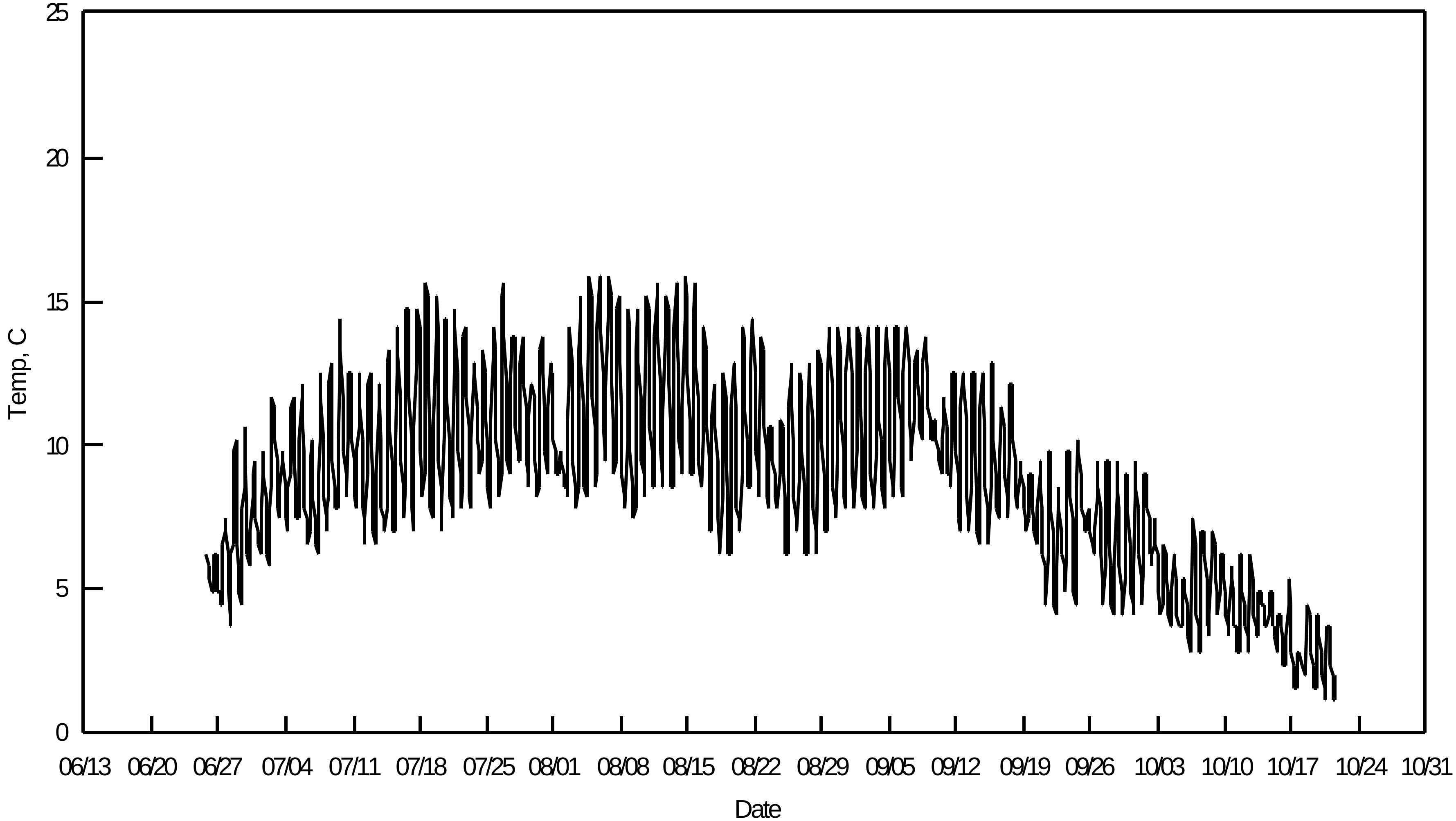

Figure B-39. Upper St. Joe River Temperature Profile, Summer 1998

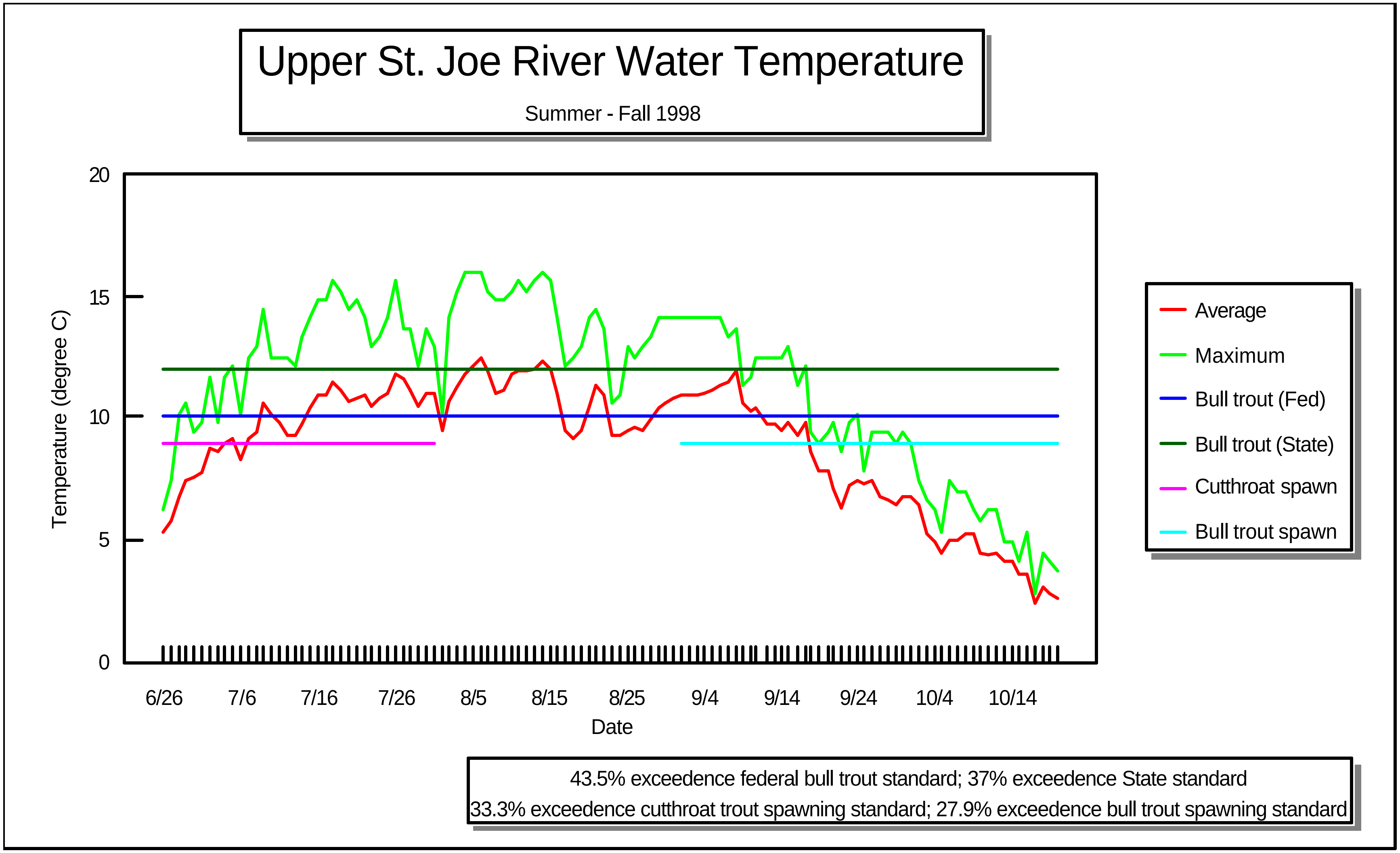

Figure B-40. Upper St. Joe River Water Temperature Analysis

Table B-1. Water quality of the St. Joe River at the Calder Gaging Station.

Sample Date	Temperature, Water (degrees Celsius)	Temperature, Air (degrees Celsius)	Barometric Pressure (millimeters of mercury)	Discharge, Instantaneous (cubic feet per second)	Turbidity (nephelometric turbidity units)	Specific Conductance (microsiemens/ cm at 25^0 C)
09/04/96	14.7	17.0	706	436	0.30	65
04/27/98	6.2	21.0	717	5,010	0.82	42
05/11/98	7.3	19.5	705	6,360	0.51	34
06/15/98	10.4	16.5	705	2,980	0.42	46
07/08/98						
07/08/98						
07/08/98						
07/08/98						
07/08/98	17.9	30.0	711	1,380	0.22	57
08/10/98	19.7	30.5	714	607	0.22	66
09/14/98	16.0	27.5	710	413		69
10/21/98	7.0	9.00		357		61
11/19/98	5.0	7.50		531		53
12/09/98	2.0	2.50		688		56
01/26/99	0.0	-2.00		1,100		51
02/09/99	1.0	0.00		952		52
03/10/99	2.0	5.00		1,140		54
04/14/99	3.1	5.50	725	2,470	1.10	53
05/10/99	3.9	6.50	709	4,320	1.50	45
06/08/99	6.0	7.50	710	6,990	1.50	34
07/14/99	11.6	17.5	706	2,790	1.60	38
08/10/99	18.7	33.0	705	929	0.32	54
09/09/99	11.1	14.5	708	546	0.42	61

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Oxygen, Dissolved (milligrams per liter)	Oxygen Dissolved (percent saturation)	pH, Water, Whole, Field (standard units)	pH, Water, Whole, Laboratory (standard units)
09/04/96	9.4	10	7.72	7.700
04/27/98	12.4	108	7.05	
05/11/98	12.1	110	7.25	
06/15/98	10.4	103	7.37	
07/08/98				
07/08/98				
07/08/98				
07/08/98				
07/08/98	9.7	111	6.72	
08/10/98	9.6	114	8.02	
09/14/98	14.6	157	7.76	7.680
10/21/98			7.51	
11/19/98			7.90	
12/09/98			7.35	
01/26/99			7.65	
02/09/99			7.36	
03/10/99			6.86	
04/14/99	12.5	100	7.06	
05/10/99	12.3	102	7.57	7.614
06/08/99	11.7		7.44	7.267
07/14/99	10.1	102	7.28	7.348
08/10/99	11.9	139	7.68	7.667
09/09/99	9.4	93	7.45	7.915

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Nitrogen, Nitrite, Dissolved (milligrams per liter as nitrogen)	Nitrogen, Ammonia Plus Organic, Total (milligrams per liter as nitrogen)	Nitrogen, Nitrate Plus Nitrite, Dissolved (milligrams per liter as nitrogen)	Phosphorus, Total (milligrams per liter as phosphorus)	Phosphorus Ortho-Phosphate, Dissolved (milligrams per liter as phosphorus)	Calcium, Dissolved (milligrams per liter as calcium)	Magnesium, Dissolved (milligrams per liter as magnesium)	Potassium, Dissolved (milligrams per liter as potassium)
09/04/96	0.010	0.200	0.050	0.010	0.010	8.200	1.800	0.80
04/27/98	0.010	0.100	0.050	0.010	0.010			
05/11/98	0.010	0.100	0.050	0.010	0.010			
06/15/98	0.010	0.100	0.057	0.019	0.014			
07/08/98								
07/08/98								
07/08/98								
07/08/98								
07/08/98	0.010	0.100	0.050	0.010	0.020			
08/10/98	0.010	0.100	0.050	0.010	0.010			
09/14/98	0.012	0.100	0.050	0.010	0.010	9.185	1.879	0.84
10/21/98		0.100	0.005	0.002	0.001	8.069	1.781	
11/19/98		0.100	0.018	0.004	0.001	6.265	1.428	
12/09/98		0.100	0.005	0.003	0.002	6.526	1.490	
01/26/99			0.010	0.0048	0.003	6.718	1.585	
02/09/99		0.100	0.007	0.0054	0.003	7.197	1.618	
03/10/99		0.100	0.005	0.004	0.002	7.207	1.615	
04/14/99		0.100	0.005	0.007	0.003	6.516	1.468	
05/10/99		0.100	0.005	0.004	0.002	5.441	1.214	
06/08/99		0.109	0.018	0.009	0.004	4.144	0.898	
07/14/99			0.005	0.005	0.002	4.525	0.960	
08/10/99			0.005	0.004	0.002	6.942	1.437	
09/09/99			0.005	0.004	0.002	7.581	1.648	0.72

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Chloride, Dissolved (milligrams per liter as chloride)	Sulfate, Dissolved (milligrams per liter as sulfate)	Fluoride, Dissolved (milligrams per liter as fluoride)	Silica, Dissolved (milligrams per liter as silica)	Cadmium, Dissolved (micrograms per liter as cadmium)	Cadmium, Total (micrograms per liter as cadmium)	Iron, Total (micrograms per liter as iron)	Iron, Dissolved (micrograms per liter as iron)
09/04/96	0.200	1.100	0.1	9.500				
04/27/98								
05/11/98								
06/15/98								
07/08/98								
07/08/98								
07/08/98								
07/08/98								
07/08/98								
08/10/98								
09/14/98	0.346	1.015	0.1	8.774				
10/21/98					1	1.0		
11/19/98					1	1.0		
12/09/98					1	1.0		
01/26/99					1	1.0		
02/09/99					1	1.0		
03/10/99					1	1.0		
04/14/99					1	1.0		
05/10/99	0.199	0.793	0.1	9.310	1	0.1	21.019	10
06/08/99	0.147	0.778	0.1	8.026	1	0.1	145.93	
07/14/99	0.110	0.370	0.1	7.853	1	0.1	47.003	
08/10/99	0.190	0.490	0.1	9.768	1	0.1	25.191	
09/09/99		0.910	0.1	9.569	1	0.1	21.891	

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Lead, Total (micro-grams per liter as lead)	Manganese, Total (micro-grams per liter as manganese)	Manganese, Dissolved (micro-Grams per liter as manganese)	Zinc, Dissolved (micro-grams per liter as zinc)	Zinc, Total (micro-grams per liter as zinc)	Alkalinity, Water, Dissolved, Fixed Endpoint Titration, Lab (milligrams per liter as calcium carbonate)	Fecal Coliform, 0.7 UM-MF (colonies/ 100 milliliters)	Fecal Streptococci, KF Streptococcus MF Method, Water, (colonies/100 milliliters)
09/04/96								
04/27/98								
05/11/98								
06/15/98								35
07/08/98								
07/08/98								
07/08/98								
07/08/98								
07/08/98								
08/10/98								
09/14/98								123
10/21/98	1.0			20.00	10			
11/19/98	1.0			20.00	10			
12/09/98	1.0			20.00	10			
01/26/99	1.0			20.00	10			
02/09/99	1.0			20.00	10			
03/10/99	1.0			20.00	40			
04/14/99	1.0			20.00	40		1	240
05/10/99	0.1	1.872	1.000	1.000	1	23.074	1	
06/08/99	0.1	5.067	1.266	1.168	1	17.824		
07/14/99	0.1	2.318	1.000	2.051	1	18.674		
08/10/99	0.1	2.472	1.485	1.000	1	26.832		
09/09/99	0.1	2.260	1.585	1.000	1	30.868		41

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Mercury, Sediment, Bottom Material < 63U, Wet Sieve, Field, Total (micrograms per gram)	Selenium, Sediment, Bottom Material < 63U, Wet Sieve, Field, Total (micrograms per gram)	Sulfur, Sediment, Bottom Material < 63U, Wet Sieve, Field, Total (percent)	Alkalinity, Water, Dissolved, Total Incremental Titration, Field (milligrams per liter as calcium carbonate)	Aluminum, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Barium, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)
09/04/96						
04/27/98						
05/11/98						
06/15/98						
07/08/98	0.04	0.24	0.05			
07/08/98						
07/08/98					20.107	0.143
07/08/98					1.486	0.260
07/08/98						
08/10/98						
09/14/98						
10/21/98						
11/19/98						
12/09/98						
01/26/99						
02/09/99						
03/10/99						
04/14/99						
05/10/99				22		
06/08/99						
07/14/99						
08/10/99						
09/09/99						

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Boron, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Chromium, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Copper, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Iron, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Manganese, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Strontium, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Zinc, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)
09/04/96							
04/27/98							
05/11/98							
06/15/98							
07/08/98							
07/08/98							
07/08/98	0.356	0.557	84.684	1845.6	7.649	0.164	157.45
07/08/98	0.390	0.500	1.510	21.2	1.380	1.210	16.38
07/08/98							
08/10/98							
09/14/98							
10/21/98							
11/19/98							
12/09/98							
01/26/99							
02/09/99							
03/10/99							
04/14/99							
05/10/99							
06/08/99							
07/14/99							
08/10/99							
09/09/99							

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Antimony, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Arsenic, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Beryllium, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Cadmium, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Cobalt, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Lead, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)
09/04/96						
04/27/98						
05/11/98						
06/15/98						
07/08/98						
07/08/98						
07/08/98	0.22	0.65	0.22	3.79	0.52	3.37
07/08/98	0.18	0.18	0.18	0.18	0.18	0.18
07/08/98						
08/10/98						
09/14/98						
10/21/98						
11/19/98						
12/09/98						
01/26/99						
02/09/99						
03/10/99						
04/14/99						
05/10/99						
06/08/99						
07/14/99						
08/10/99						
09/09/99						

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Molybdenum, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Nickel, Biota, Tissue, Dry Weight Recoverable (micrograms per gram)	Selenium, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Silver, Biota Tissue, Dry Weight, Recoverable (micrograms per gram)	Uranium, Biota, Tissue, Dry Weight, Recoverable (micrograms per gram)	Mercury, Biota Tissue, Dry Weight, Recoverable (micrograms per gram)	Alpha-BHC, D6-, Surrogate, Biota, Whole Organism, Wet Weight, Recoverable (percent)
09/04/96							
04/27/98							
05/11/98							
06/15/98							
07/08/98							
07/08/98							82
07/08/98	1.28	0.22	3.89	0.31	0.22	0.380	
07/08/98	0.18	0.18	0.98	0.18	0.18	0.164	
07/08/98							
08/10/98							
09/14/98							
10/21/98							
11/19/98							
12/09/98							
01/26/99							
02/09/99							
03/10/99							
04/14/99							
05/10/99							
06/08/99							
07/14/99							
08/10/99							
09/09/99							

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Biphenyl, 3,5-Dichloro-Surrogate, Biota, Whole Organism, Wet Weight, Recoverable (percent)	Carbon, Organic + Inorganic, Sediment, Bed Material, Wet Sieved (Nat Wat), Field <63U, Dry Weight, Recoverable (percent)	Carbon, Inorganic, Sediment, Bed Material, Wet Sieved (Nat Wat), Field <63U, Dry Weight, Recoverable (percent)	Water, Present, Biota, Tissue, Dry Weight, Recoverable (percent)	Lipids, Biota, Whole Organism, Wet Weight, Recoverable (percent)	Aldrin, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per kilogram)	PCB, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per kilogram)
09/04/96							
04/27//98							
05/11/98							
06/15/98							
07/08/98		2.37	0.02				
07/08/98	87				3.9	5	50
07/08/98				78.03			
07/08/98				71.23			
07/08/98							
08/10/98							
09/14/98							
10/21/98							
11/19/98							
12/09/98							
01/26/99							
02/09/99							
03/10/99							
04/14/99							
05/10/99							
06/08/99							
07/14/99							
08/10/99							
09/09/99							

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Toxaphene, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Pentachloroanisole, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Oxychlordane, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Trans-Nonachlor, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Cis-Nonachlor, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Mirex, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)
09/04/96						
04/27//98						
05/11/98						
06/15/98						
07/08/98						
07/08/98	200	5	5	5	5	5
07/08/98						
07/08/98						
07/08/98						
08/10/98						
09/14/98						
10/21/98						
11/19/98						
12/09/98						
01/26/99						
02/09/99						
03/10/99						
04/14/99						
05/10/99						
06/08/99						
07/14/99						
08/10/99						
09/09/99						

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Methoxychlor, P, P'-, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Methoxychlor, O, P'-, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Lindane, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Delta-BHC, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Beta-BHC, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Alpha-BHC, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Benzene, Hexachloro-, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)
09/04/96							
04/27//98							
05/11/98							
06/15/98							
07/08/98							
07/08/98	5	5	5	5	5	5	5
07/08/98							
07/08/98							
07/08/98							
08/10/98							
09/14/98							
10/21/98							
11/19/98							
12/09/98							
01/26/99							
02/09/99							
03/10/99							
04/14/99							
05/10/99							
06/08/99							
07/14/99							
08/10/99							
09/09/99							

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Heptachlor Epoxide, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Heptachlor, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Endrin, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Dieldrin, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	P,P'-DDE, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	O,P'-DDE, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)
09/04/96						
04/27//98						
05/11/98						
06/15/98						
07/08/98						
07/08/98	5	5	5	5	10	5
07/08/98						
07/08/98						
07/08/98						
08/10/98						
09/14/98						
10/21/98						
11/19/98						
12/09/98						
01/26/99						
02/09/99						
03/10/99						
04/14/99						
05/10/99						
06/08/99						
07/14/99						
08/10/99						
09/09/99						

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	O,P'-DDD, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	P,P'-DDD, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	P,P'-DDT, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	O,P'-DDT, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	DCPA, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)	Trans-Chlordane, Biota, Whole Organism, Wet Weight, Recoverable (micrograms per gram)
09/04/96						
04/27//98						
05/11/98						
06/15/98						
07/08/98						
07/08/98	5	5	5	5	5	5
07/08/98						
07/08/98						
07/08/98						
08/10/98						
09/14/98						
10/21/98						
11/19/98						
12/09/98						
01/26/99						
02/09/99						
03/10/99						
04/04/99						
05/10/99						
06/08/99						
07/14/99						
08/10/99						
09/09/99						

Table B-1, Water quality of the St. Joe River at the Calder Gaging Station, continued.

Sample Date	Cis-Chlordane Biota, Whole Organism, Wet (micrograms per gram)	Vanadium, Biota, Tissue, Dry (micrograms per gram)	Solids, Residue on Evaporation at 180?C, Dissolved (milligrams per liter)	Sediment, Suspended Sieve, Diameter, (percent finer than 0.062 millimeters)	Sediment, Suspended Concentration (milligrams per liter)	Specific Conductance (microsiemens per centimeter at 25?C)
09/04/96			58		2	67.0
04/27//98				100	3	42.2
05/11/98				100	5	34.9
06/15/98				100	2	46.8
07/08/98						
07/08/98	5					
07/08/98		0.41				
07/08/98		0.18				
07/08/98					2	57.4
08/10/98					1	67.6
09/14/98					1	70.1
10/21/98						
11/19/98						
12/09/98						
01/26/99						
02/09/99						
03/10/99						
04/04/99					1	54.2
05/10/99				100	1	46.4
06/08/99					8	35.1
07/14/99				100	2	38.3
08/10/99				100	1	53.7
09/09/99					1	61.6

Table B-2. United States Geological Survey water column data for the St. Joe River at the city of St. Maries.

Sample Date	Temperature, Water (degrees Celsius)	Temperature, Air (degrees Celsius)	Discharge, Instantaneous (cubic feet per second)
03/12/90			
01/04/91	0.0	-2.5	1,310
01/23/91	0.0	3.0	2,410
02/11/91	1.0	3.0	3,900
02/25/91	5.0	12.0	6,870
03/19/91	8.0	18.0	2,970
03/26/91	4.0	4.0	3,000
04/02/91	7.5	10.0	3,280
04/03/91			
04/09/91	5.0	9.0	8,080
04/16/91	7.0	10.0	5,480
04/23/91	7.0	9.0	9,360
04/23/91			
04/29/91			
04/29/91	6.5	12.5	6,370
05/07/91	9.0	16.0	6,770
05/14/91	7.0	11.0	11,800
05/21/91	9.0	12.0	17,200
05/29/91	9.0	16.0	8,880
06/03/91	10.5	10.0	9,340
06/19/91	10.0	16.0	5,250
07/11/91	18.0	17.0	2,910
07/30/91	26.0	26.0	1,270
08/19/91	25.5	25.5	1,030
09/10/91	18.0	19.0	703
10/01/91	16.0	20.0	472
10/18/91	14.0	2.0	663
10/30/91	5.5	-0.5	322
11/14/91	6.0	9.0	861
11/26/91	4.0	4.0	1,540
12/12/91	3.5	6.0	975
01/07/92	1.0	2.0	690
02/04/92	4.5	6.5	2,870
02/20/92	4.5	7.5	5,480
03/06/92	8.0	17.0	4,620

Table B-2, United States Geological Survey water column data for the St. Joe River at the city of St. Maries, continued.

Sample Date	Temperature, Water (degrees Celsius)	Temperature, Air (degrees Celsius)	Discharge, Instantaneous (cubic feet per second)
03/12/92	6.0	17.0	3,280
03/19/92	7.0	12.5	4,250
03/26/92	7.5	8.0	3,080
04/10/92	5.5	11.0	3,230
04/17/92	9.0	9.5	4,690
04/23/92	6.5	7.5	4,970
04/30/92	8.0	9.5	5,990
05/05/92	11.0	23.5	5,650
05/12/92	9.5	11.5	4,190
05/27/92	14.5	11.5	3,390
06/09/92	19.5	23.5	1,320
06/23/92	22.0	26.0	1,090
07/07/92	19.0	15.0	561
07/21/92	24.5	17.0	695
08/04/92	24.0	28.5	548
08/18/92	25.0	34.0	350
09/09/92	16.5	9.0	673
10/06/92			
10/21/92	8.5	11.0	567
11/18/92	4.5	6.0	1,000
12/10/92	1.0	2.0	769

Table B-2, United States Geological Survey water column data for the St. Joe River at the City of St. Maries, continued.

Sample Date	Specific Conductance (microsiemens per centimeter at 25?C)	Nitrogen, Ammonia, Total (milligrams per liter as nitrogen)	Nitrogen, Nitrite Total (milligrams per liter as nitrogen)	Nitrogen, Ammonia Plus Organic, Total (milligrams per liter as nitrogen)	Nitrogen, Nitrite Plus Nitrate, Total (milligrams per liter as nitrogen)	Phosphorus, Total (milligrams per liter as phosphorus)
03/12/90		0.015	0.006	0.2	0.008	0.007
01/04/91	61	0.014	0.002	0.2	0.078	0.004
01/23/91	52	0.015	0.005	0.2	0.037	0.040
02/11/91	57	0.015	0.009	0.2	0.025	0.007
02/25/91	46	0.029	0.006	0.2	0.029	0.001
03/19/91	49	0.030	0.003	0.3	0.101	0.010
03/26/91	49	0.013	0.001	0.2	0.038	0.001
04/02/91	51	0.016	0.011	0.2	0.016	0.005
04/03/91		0.025	0.014	0.2	0.079	0.005
04/09/91	42	0.017	0.005	0.2	0.030	0.007
04/16/91	46	0.019	0.014	0.2	0.021	0.006
04/23/91	40	0.019	0.011	0.2	0.036	0.007
04/23/91		0.019	0.007	0.2	0.060	0.004
04/29/91		0.028	0.006	0.4	0.035	0.006
04/29/91	43	0.017	0.004	0.2	0.008	0.002
05/07/91	46	0.032	0.001	0.2	0.601	0.001
05/14/91	34	0.022	0.003	0.5	0.022	0.011
05/21/91	34	0.014	0.001	2.5	0.026	0.077
05/29/91	31	0.057	0.001	0.4	0.103	0.016
06/03/91	36	0.015	0.002	0.2	0.014	0.019
06/19/91	39	0.009	0.002	0.3	0.005	0.017
07/11/91	40	0.030	0.002	0.2	0.078	0.011
07/30/91	48	0.008	0.004		0.005	0.008
08/19/91	52	0.039	0.003	0.2	0.011	0.009
09/10/91	67	0.010	0.002	0.2	0.005	0.013
10/01/91	52	0.013	0.003	0.2	0.005	0.009
10/18/91	52	0.031	0.008	0.2	0.010	0.013
10/30/91	65	0.027	0.009	0.2	0.013	0.010
11/14/91		0.026	0.004	0.2	0.009	0.01
11/26/91	51	0.019	0.011	0.2	0.018	0.025
12/12/91	51			0.2		
01/07/92	57	0.019		0.2	0.013	0.010
02/04/92	41	0.017	0.008	0.2	0.017	0.016
02/20/92	42	0.042	0.027	0.3	0.031	0.101

Table B-2, United States Geological Survey water column data for the St. Joe River at the city of St. Maries, continued.

Sample Date	Specific Conductance (microsiemens per centimeter at 25?C)	Nitrogen, Ammonia, Total (milligrams per liter as nitrogen)	Nitrogen, Nitrite, Total (milligrams per liter as nitrogen)	Nitrogen, Ammonia Plus Organic, Total (milligrams per liter as nitrogen)	Nitrogen, Nitrite Plus Nitrate, Total (milligrams per liter as nitrogen)	Phosphorus, Total (milligrams per liter as phosphorus)
03/03/92	43	0.014	0.007	0.2	0.010	0.002
03/12/92	35					
03/19/92	42	0.015	0.008	0.2	0.032	0.009
03/26/92	53	0.014	0.022	0.2	0.027	0.011
04/10/92	31	0.024	0.007	0.2	0.009	0.007
04/17/92	65	0.018	0.004	0.2	0.006	0.009
04/23/92	40	0.002	0.003	0.2	0.013	0.005
04/30/92	39	0.007	0.001	0.2	0.013	0.008
05/05/92	37	0.006	0.001	0.2	0.009	0.009
05/12/92	35	0.002	0.002	0.2	0.009	0.004
05/27/92	48	0.013	0.006	0.2	0.047	0.015
06/09/92	47	0.033	0.003	0.2	0.005	0.003
06/23/92	55	0.006	0.001	0.2	0.005	0.007
07/07/92	58	0.004	0.003	0.2	0.005	0.006
07/21/92	63	0.011	0.001	0.2	0.005	0.010
08/04/92	75	0.006	0.001	0.2	0.019	0.012
08/18/92	71	0.018	0.001	0.2	0.015	0.003
09/09/92	68	0.017	0.002	0.2	0.005	0.006
10/06/92		0.028	0.013	0.2	0.082	0.007
10/21/92	70	0.025	0.008	0.2	0.010	0.009
11/18/92	62	0.021	0.010	0.2	0.014	0.007
12/10/92	67	0.011	0.001	0.2	0.032	0.008

Table B-2, United States Geological Survey water column data for the St. Joe River at the city of St. Maries, continued.

Sample Date	Arsenic, Total (micrograms per liter as arsenic)	Cadmium, Total (micrograms per liter as cadmium)	Copper, Total (micrograms per liter as copper)	Lead, Total (micrograms per liter as lead)	Zinc, Total (micro-grams per liter as zinc)	Phosphorus, Ortho-phosphate, Total (milligrams per liter as phosphorus)
03/12/90						0.003
01/04/91	1	1	7	6	10	0.002
01/23/91	1	1	5	3	10	0.008
02/11/91	1	1	14	8	10	0.002
02/25/91	1	1	13	5	10	0.001
03/19/91	1	1	4	5	20	0.004
03/26/91	1	1	2	5	20	0.001
04/02/91	1	1	4	3	10	
04/03/91	1	1	9	9	110	
04/09/91	1	1	6	47	10	0.003
04/16/91	1	1	8	8	20	
04/23/91	1	1	4	7	10	0.007
04/23/91	1	1	3	9	90	
04/29/91	1	1	6	13		0.005
04/29/91	1	1	12	4		
05/07/91	1	1	9	9	90	
05/14/91	1	1	9	15	20	0.007
05/21/91	1	1	2	76	10	0.002
05/29/91	1	1	6	4	40	0.001
06/03/91	1	1	8	5	10	0.004
06/19/91	1	1	6	6	10	0.001
07/11/91	1	1	4	15	10	0.001
07/30/91	1	1			10	0.003
08/19/91	1	2		10	20	0.001
09/10/91	1	1	8	5	20	0.005
10/01/91	1	4	6	8	10	0.001
10/18/91	1			17		0.004
10/30/91	1	1	4	8	30	0.004
11/14/91	2					0.004
11/26/91	1	10		3	100	0.009
12/12/91	1	10		8	180	
01/07/92	1	6	5	1	50	0.013
02/04/92	1	1	12	9	10	0.008
02/20/92	1	1	11	6	20	0.039
03/03/92	1	1	5	1	10	0.005

Table B-2, United States Geological Survey water column data for the St. Joe River at the city of St. Maries, continued.

Sample Date	Arsenic, Total (micrograms per liter as arsenic)	Cadmium, Total (micrograms per liter as cadmium)	Copper, Total (micrograms per liter as copper)	Lead, Total (micrograms per liter as zinc)	Zinc, Total (micro-grams per liter as zinc)	Phosphorus, Ortho-phosphate, Total (milligrams per liter as phosphorus)
03/12/92	1	1	6	2	10	
03/19/92	1	1	3	2	10	0.009
03/26/92	1	1	8	2	10	0.006
04/10/92	1	1	4	2	20	0.005
04/17/92	1	2	13	45	340	0.004
04/23/92	1	1	2	2	10	0.004
04/30/92	1	1	2	6	80	0.002
05/05/92	1	1	3	3	10	0.004
05/12/92	1	1	2	2	10	0.002
05/27/92	1	1	2	1	10	0.002
06/09/92	1	1	4	1	10	0.001
06/23/92	1	1	6	2	10	0.001
07/07/92	1	1	2	5	60	0.001
07/21/92	1	1	4	3	10	0.003
08/04/92	1	1	6	5	30	0.005
08/18/92	2	1	6	16	30	0.001
09/09/92	1	1	4	4	30	0.001
10/06/92	1	1	4	2	30	0.001
10/21/92	1	1	7	3	20	0.001
11/18/92	1	1	2	1	10	0.006
12/10/92	1	1	5	3	20	0.007

Appendix C

Sediment Model Assumptions and Documentation

Appendix C. Sediment Model Assumptions and Documentation

Background:

In the Panhandle Region, sediment is the pollutant of concern in the majority of water quality limited streams. The lithology or terrain of the region most often governs the form the sediment takes. Two major types of terrain dominate in northern Idaho. These are the meta-sedimentary Belt Supergroup and granitics present either in the Kaniksu batholith or in smaller intrusions such as the Round Top Pluton and the Gem Stocks. In some locations Columbia River Basalt formations are important, but these tend to be to the south and west; primarily on the Coeur d'Alene Reservation. Granitics mainly weather to sandy materials, but also weather to pebbles or larger-sized particles. Pebbles and larger particles with significant amounts of sand remain in the higher gradient stream bedload. The Belt terrain produces silt size particles, pebbles, and larger particles. Silt particles are transported to low gradient reaches, while the larger particles comprise the majority of the higher gradient stream bedload. Basalts erode to silt and particles similar in size to the Belt terrain. Large basalt particles are less resistant and weather to smaller particles.

Any attempt to model the sediment output of watersheds will provide relative, rather than exact, sediment yields. The model documented here attempts to account for all significant sources of sediment separately. This approach is used to identify the primary sources of sediment in a watershed. Identification will be useful as implementation plans designed to remedy these sources are developed. If additional investigation indicates that sources quantified as minor are not, the model input can be altered to incorporate this new information.

Model Assumptions:

Land use and sediment delivery:

Revised Universal Soil Loss Equation (RUSLE) is the correct model for pasture land as it accounts for production and delivery of fine-grained sediment.

Sediment yield coefficients measured in-stream on geologies of northern and north central Idaho cover production and delivery of sediment from forested areas. These sediment yield coefficients reflect both fine and coarse sediment.

Sparse and heavy forests of all age classes, including the seedling-sapling age class, should be given mid range of the sediment yield coefficient for the geologies. Areas not fully stocked by Forest Practices Act standards should be given the upper end of the range.

Sediment yield coefficients can be modified within the range observed to estimate highway corridor land use and the effects of repeated wild fires.

Double burned areas have eroded significantly to the stream channel but are not now eroding; a residual sediment load in the channels is possible from previous catastrophic burns.

Erosion from stream bank lateral recession can be estimated with the direct volume method (Erosion and Sediment Yield in Channels Workshop 1983).

Road sediment production and delivery:

Road erosion using the Cumulative Watershed Effects (CWE) approach should be limited to 200 feet of road on either side of road crossings, not tied to total road mileage.

The use of the McGreer relationship between the CWE score and road surface erosion is a valid estimate of road surface fines production and yield. In the case of Belt terrain, it is a conservative estimate (overestimate).

The CWE data collected for actual road fill failures and sediment delivery reflect the situation throughout the watershed. Since the great majority of road failures occur during episodic high discharge events with a 10- to 15- year return period, road failures reflect the actions of the last large event and must be divided by ten for an annualized estimate.

Fines and coarse loading can be estimated for stream reaches where roads encroach on the stream using estimated erosion rates on defined model cross-sections. Erosion resulting from encroachment occurs primarily during episodic high discharge events with a 10- to15- year return period, therefore, road encroachment erosion must be divided by ten for an annualized estimate.

Failing road fill and eroding bank material are composed of fines and coarse material. The proportions of fines and coarse material can be estimated from the soil series descriptions of the watershed.

Sediment Delivery:

100% delivery from forestlands with sediment yield coefficients measured in-stream on geologies of northern and north central Idaho.

100% delivery from agricultural lands estimated with RUSLE

100% delivery from all road miles up to 200 feet from a stream crossing as estimated by the McGreer relationship

Fines and coarse materials are delivered at the same rate from fill failures and from erosion resulting from road encroachment and bank erosion.

Model Approach:

The sediment model attempts to account for all sources of sediment by partitioning these sources into broad categories.

Land use is the primary broad category. It is treated separate from other characteristics such as stream bank erosion and roads. Land use types are divided into agriculture, forest, urban, and highways.

Agriculture may be subdivided into working farms or ranches and small ranchettes, which currently exist on subdivided agriculture land. Sediment yields from agricultural lands that receive any tillage, even on an infrequent basis, are modeled with RUSLE. Sediment yields were estimated from agricultural lands (rangeland, pasture and dry agriculture) using RUSLE (equation 1)(Hogan 1998).

Equation 1: A = (R)(K)(LS)(C)(D) tons per acre per year where:

: A is the average annual soil loss from sheet and till erosion
: R is climate erosivity
: K is the soil erodibility
: LS is the slope length and steepness
: C is the cover management
: D is the support practices

The RUSLE does not take into account stream bank erosion, gully erosion, or scour erosion. The RUSLE applies to cropland, pasture, hayland, or other land that has some vegetation improvement by tilling or seeding. Based on the soils, the characteristics of the agriculture, and the slope, sediment yields were developed for the agricultural lands of each watershed. The RUSLE develops values that reflect the amount of sediment eroded and delivered to the active channel of the stream system annually.

Forestlands and some land in highway rights of way are modeled using the mean sediment export coefficients measured in-stream on geologies of northern and north central Idaho (USFS 1994). The values developed by these sediment yield coefficients are equal to the amount of sediment eroded and the amount of sediment delivered to the stream courses annually. Forestlands that are fully stocked with trees are treated with the median coefficient for sediment yields ascribed to that terrain. Lands not fully stocked by Idaho Forest Practices Act standards are assigned the highest coefficient of the range. Paved road rights of way are assigned the lowest coefficient of the range. Areas that were burned by two large wild fires, as delineated in the IPFIRES model, are adjusted by a coefficient that is the difference between the highest value of the coefficient for the geologic type and the median.

All coefficients are expressed as tons per acre per year and are applied to the acreage of each land type developed from Geographical Information System (GIS) coverages. All land uses are displayed with estimated sediment delivery. Land use sediment delivery is totaled.

Roads are treated separately by the model. Forest haul roads are differentiated from county and private residential roads. County roads often have larger stream passage structures and are normally much wider and have gravel or pavement surfacing. Private residential roads are often limited in length, but can have poor stream crossing structures. Sediment yields from county and private roads are modeled using a newer RUSLE model (Sandlund 1999). Road relief, slope length, surfacing, soil material, and width are the most critical factors. The sediment yield was applied only to 200 feet on either side of stream crossings. Failure of county and private road fills was assumed nonexistent because such roads are often on gentle terrain. Consequently, road fill failures are rare.

Forest roads were modeled using data developed with the cumulative watershed effects (CWE) protocol. A watershed CWE score was used to estimate surface erosion from the road surface. Forest road sediment yield was estimated using the relationship between the CWE score and the sediment yield per mile of road (Figure 1). The relationship was developed for roads on a Kaniksu granitic terrain in the LaClerc Creek watershed (McGreer 1998). Its application to roads on Belt terrain conservatively estimate sediment yields from these systems. The watershed CWE score was used to develop sediment tons per mile, which was multiplied by the estimated road mileage affecting the streams. It was assumed that all sediment was delivered to the stream system. This is a conservative estimate of actual delivery.

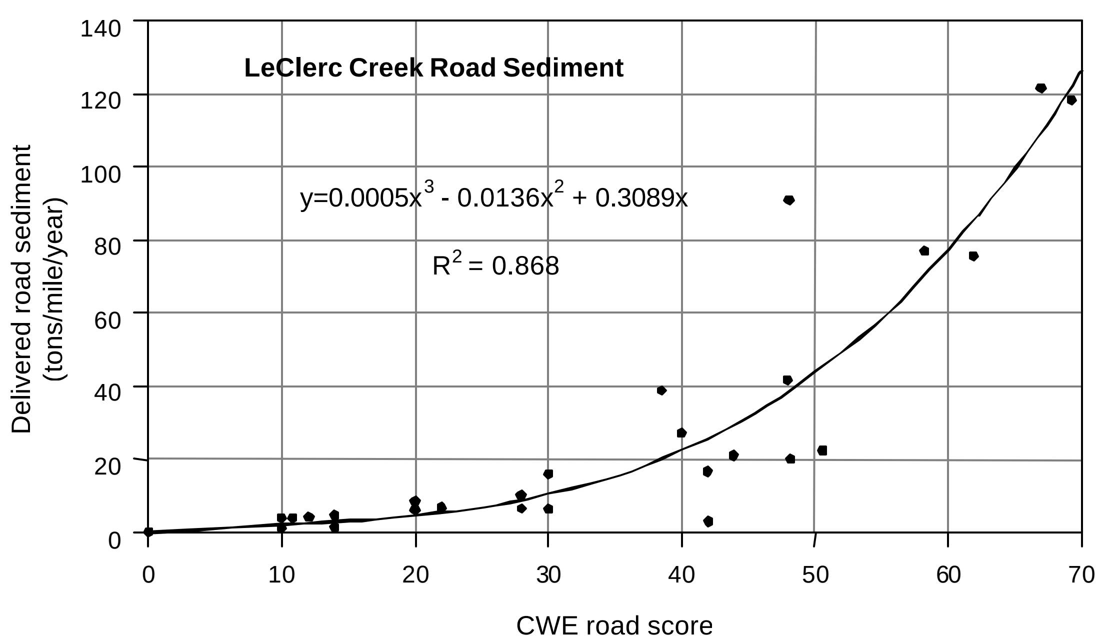

Figure C-1. Sediment Export of Roads Based on Cumulative Watershed Effects Scores

Forest road failure was estimated from actual CWE road fill failure and delivery data. These failures were interpreted as the primary result of large discharge events, which occur on a 10 – 15 year return period (McClelland *et al.* 1997). The estimates were annualized, by dividing the measured values by 10. Data are typically from a subset of the roads in a watershed. The sediment delivery value was scaled using a factor reflecting the watershed road mileage divided by the road mileage assessed. The sediments delivered through this mechanism contained both fine material (including, and smaller than, pebbles) and coarse material (pebbles and larger sizes). The percentages of fine and coarse particles were estimated using the described characteristics of the soil series found in the watershed. The weighted average of the fines and coarse composition of the B and C soil horizons to a depth of 36 inches were developed using the soils GIS coverage STATSGO, which contains the soils composition data provided by soils survey documents. The B and C horizons' composition was used because these are the strata from which forest roads are normally constructed. Based on the developed soil composition percentage and the estimated probable yield, the tons of fine and coarse material delivered to the streams by fill failure was calculated. This approach assumes equal delivery of fine and coarse materials.

Roads cause stream sedimentation by an additional mechanism. The presence of roads in the floodplain of a stream most often interferes with the stream's natural tendency to seek a steady state gradient. During high discharge periods, the constrained stream often erodes at the roadbed, or, if the bed is armored, erodes at the opposite bank or its bed. The erosion resulting from a road- imposed gradient change results in stream sedimentation. The model assumes the roads causing gradient effects to be those within 50 feet of the stream. The model then assumes 0.25-inch erosion per lineal foot of bed and bank up to three feet in height. The 0.25- inch cross-section erosion is assumed to be uniform over the bed and banks. The erosion rate was selected from a model curve of erosion in inches compared to modeled sediment yields from a channel 10 feet in width. The stream cross-section used was based on the weighted bank full width for all measurements made of streams in the Beneficial Use Reconnaissance and Use Attainability programs. The erosion is determined from the soil types in the basin with the weighted percentages of fine and coarse material. A bulk soil density of 2.6 grams per cubic centimeter is used to convert soil volume into weight in tons. The tons of fine and coarse material are totaled for all road segments within 50 lineal feet of the stream. The bulk of this erosion is assumed to occur during large discharge events which occur on a 10 - 15-year return period (McClelland *et. al* 1997). The estimates, therefore, are annualized by dividing the measured values by 10.

Estimates of bank recession are appropriate primarily along low gradient Rosgen B and C channels Rosgen 1985). The direct volume method, as discussed in the Erosion and Sediment Yield Channel Evaluation Workshop (1983), was employed to make the estimates. The method relies on measurements of eroding bank length, lateral recession rate, soil type, and particle size to make these estimates. A field crew collected these data. The fine and coarse material fractions of the bank material based on STATSGO GIS coverage are used to estimate fine and coarse material delivery to the stream. These values are added into the watershed sediment load.

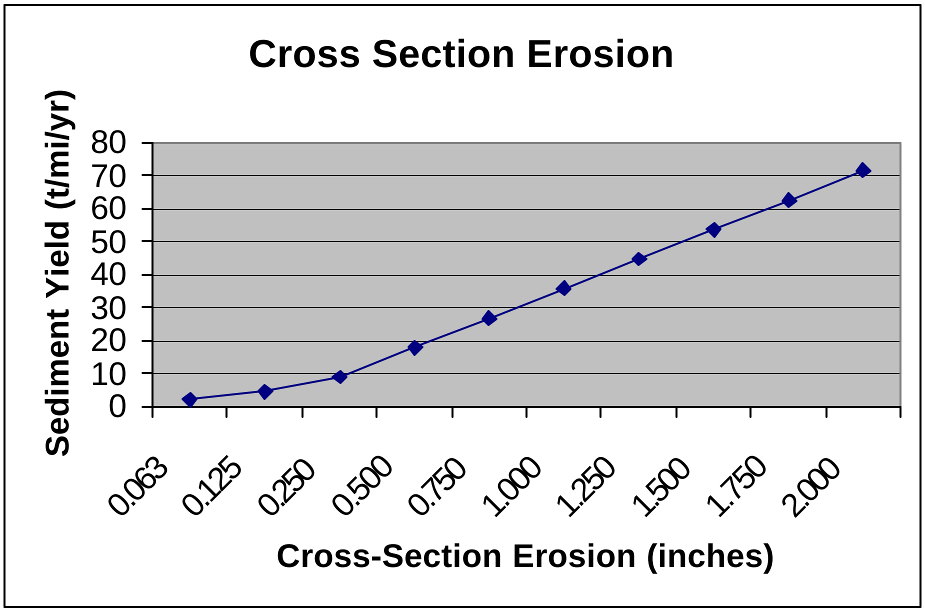

Figure C-2. Modeled Sediment Yield From Thickness of Cross-Section Erosion

The model does not consider sediment routing, nor does it attempt to estimate the erosion to streambeds and banks resulting from localized sediment deposition in the streambed. The model does not attempt to measure the effects of additional water capture at road crossings. It is assumed, that on the balance, the additional stream power created by additional water capture over a shorter period would increase net export of sediment, even though some erosion would be caused by this watershed effect.

Model Operation:

The model is an Excel workbook composed of four spreadsheets. Key data, such as acreages and percentages, are entered into sheets one and two of the model. The total estimated sediment from the varied sources is calculated in spreadsheet three. County and private road data are supplied in sheet four.

Assessment of Model's Conservative Estimate:

Several conservative assumptions were made in the model construction, which cause it to develop conservatively high estimations of sedimentation in the streams modeled. These assumptions are listed in the following paragraphs and a numerical assessment of the magnitude of the conservatism is assigned.

The model uses RUSLE and forest sediment yield coefficients to develop land use sediment delivery estimates. The output values are treated as delivery to the stream. The RUSLE assumes delivery if the slope assessed is immediately up gradient from the stream system. This is not the case on the majority of the agricultural land assessed. Estimates made in the Lake Creek Sediment Study indicate that, at most, 25% of the erosion modeled was delivered as sediment to the stream (Bauer, Golden, and Pettit 1998). A similar local estimate has not been made with sediment yield coefficients, but it is likely that this estimate would be 25% as well. The land use model component is 75% conservative.

The roads crossing component of the model assumes 100% delivery of fine sediment from the 200 feet on either side of a stream crossing. It is more likely that some fine sediment remains in ditches. A reasonable level of delivery is 80%. The model is likely 20% conservative in this component. On Belt terrain, use of the McGreer model is conservative. Since the sediment yield coefficients measured in-stream for Kaniksu granites are 167% of the coefficient for Belt terrain, this factor is estimated to be 67% conservative.

Road encroachment is defined as the existence of a road within 50 feet from the stream, primarily because this is near the resolution of commonly used GIS mapping techniques. A road 50 feet from a stream, but on a side hill, would not affect the stream gradient. The model is likely incorrect on encroachment 20% of the time and is conservative by this factor.

Fill failure data is developed from actual CWE field assessments. The CWE assessment does not assess all the roads in the watershed. The failure rate data is scaled up by the factor of the roads assessed divided into the actual watershed road mileage. The roads assessed are typically those remote from the stream system, which are very unlikely to deliver sediment to the stream. The percentage of watershed roads assessed varies, but it is commonly 60% or less of the watershed roads. The model is 40% conservative in this component. Table C-1 summarizes the conservative assumptions and assesses its numerical level of overestimation.

Table C-1. Conservative estimate of stream sedimentation provided by the sediment model.

Model Factor	Kaniksu Granites (% conservative)	Belt Supergroup (% conservative)
100% RUSLE and forest land sediment yield delivery	75%	75%
Crossing delivery	29%	20%
McGreer model	0%	67%
Road encroachment at 50 feet	20%	20%
Road failure	40%	40%
Total assessment of overestimate	164%	231%

The model provides an overestimate by factors of 1.6 and 2.3 for the Kaniksu and Belt terrain, respectively. This overestimation is a built-in margin of safety of 231% for the South Fork Coeur d'Alene River.

Model Verification:

Some verification of the model can be developed by comparing measured sediment loads with those predicted by the model. For example, the United States Geological Survey measured sediment load at the Enaville Station on the Coeur d'Alene River during water year 1999. Based on these measured estimates, the sediment load per square mile of the basin above this point was calculated to be 28 tons (URS Greiner 2001). The middle value of the Belt geology sediment yield coefficient range is 14.7 tons per square mile. The model outputs for several watersheds of the North Fork Coeur d'Alene River are provided in Table C-2. The model predicted a sediment yield of 33.6 tons/year for the entire subbasin. The agreement between the measured estimates and the modeled estimates is good.

Table C-2. Modeled sediment output from selected North Fork Coeur d'Alene River watersheds.

Watershed	Square miles	Modeled sediment	Tons/square mile
Deer	10.0	153.1	15.3
Alden	7.9	158.5	20.1
Independence	59.5	1,156.1	19.4
Trail	25.2	976.1	38.7
Flat	17.6	711.9	40.5
Prichard	53.6	1,636.5	30.6
Burnt Cabin	28.8	1,325.7	46.0
Skookum	7.1	191.2	26.9
Bumblebee	24.9	901.2	36.2
Streamboat	41.4	1,955.3	47.2
Graham	9.3	138.4	14.9
Little North Fork	169.0	6,769.2	40.1
North Fork Total[1]	903.2	30.369.7	33.6

[1]Total includes watersheds not listed above.

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Appendix D

Graphic Representation of Road Mileage

Appendix D. Graphic Representation of Road Mileage

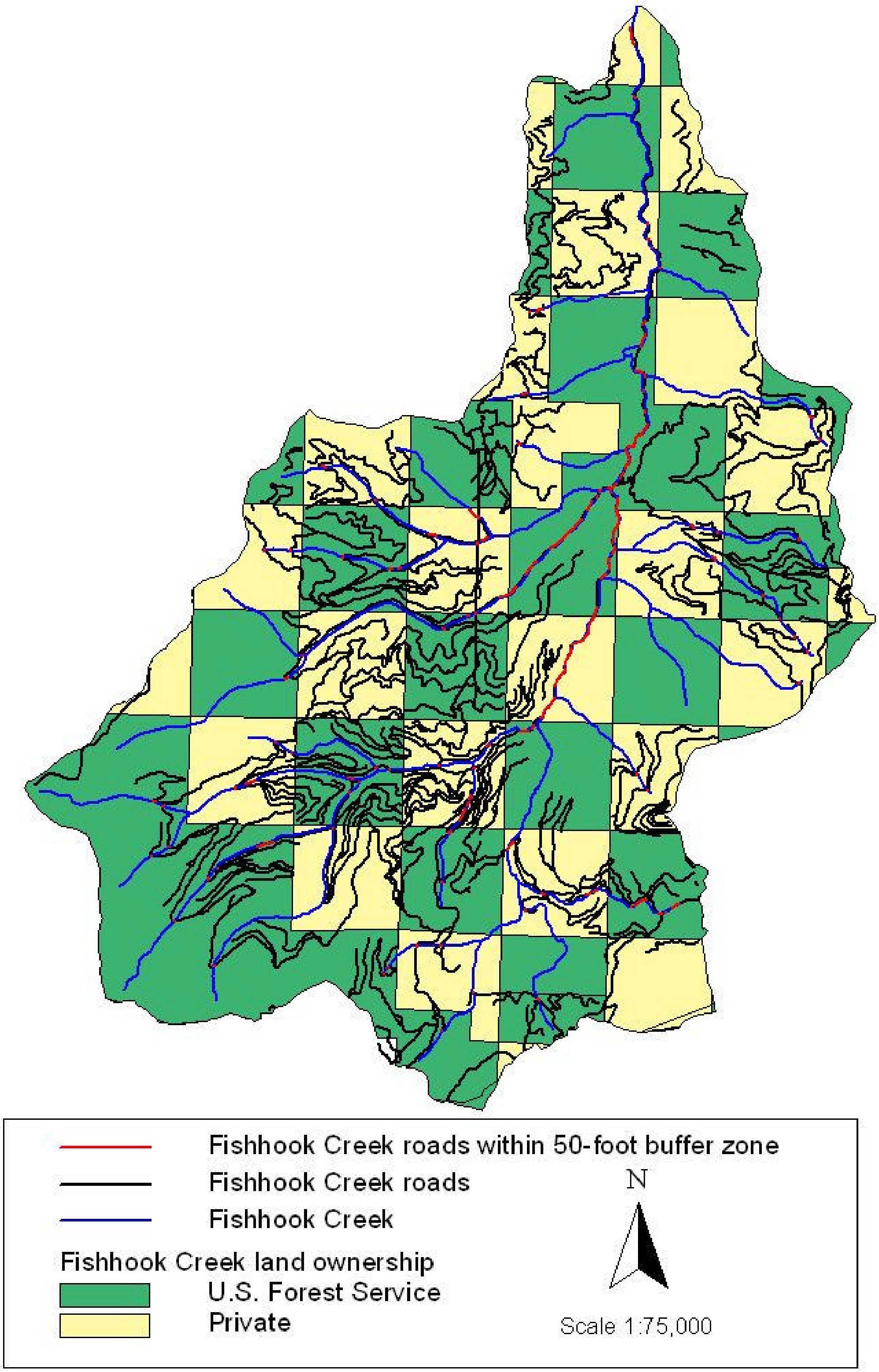

Figure D-1. Fishhook Creek Road Mileage

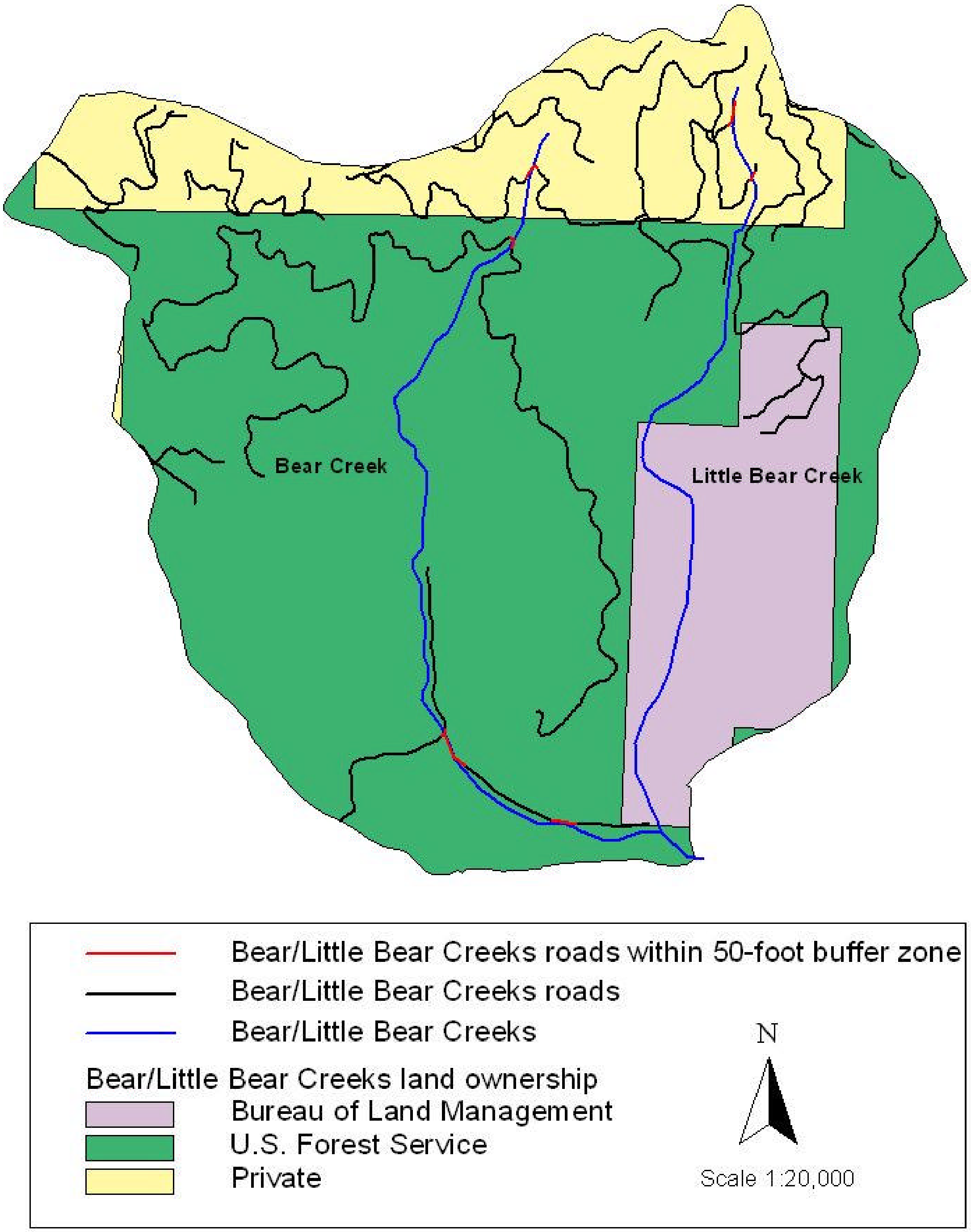

Figure D-2. Bear/Little Bear Creeks Road Mileage

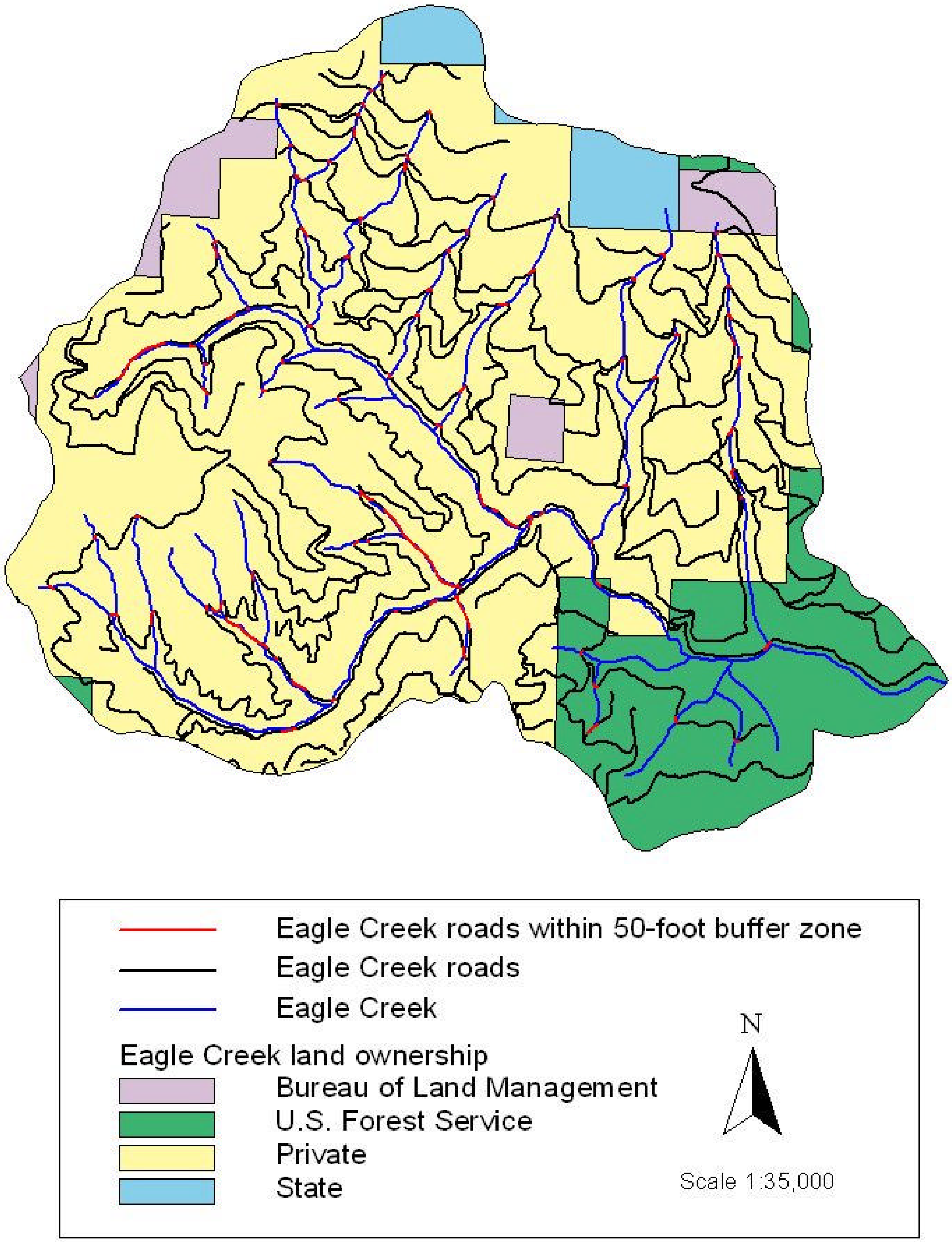

Figure D-3. Eagle Creek Road Mileage

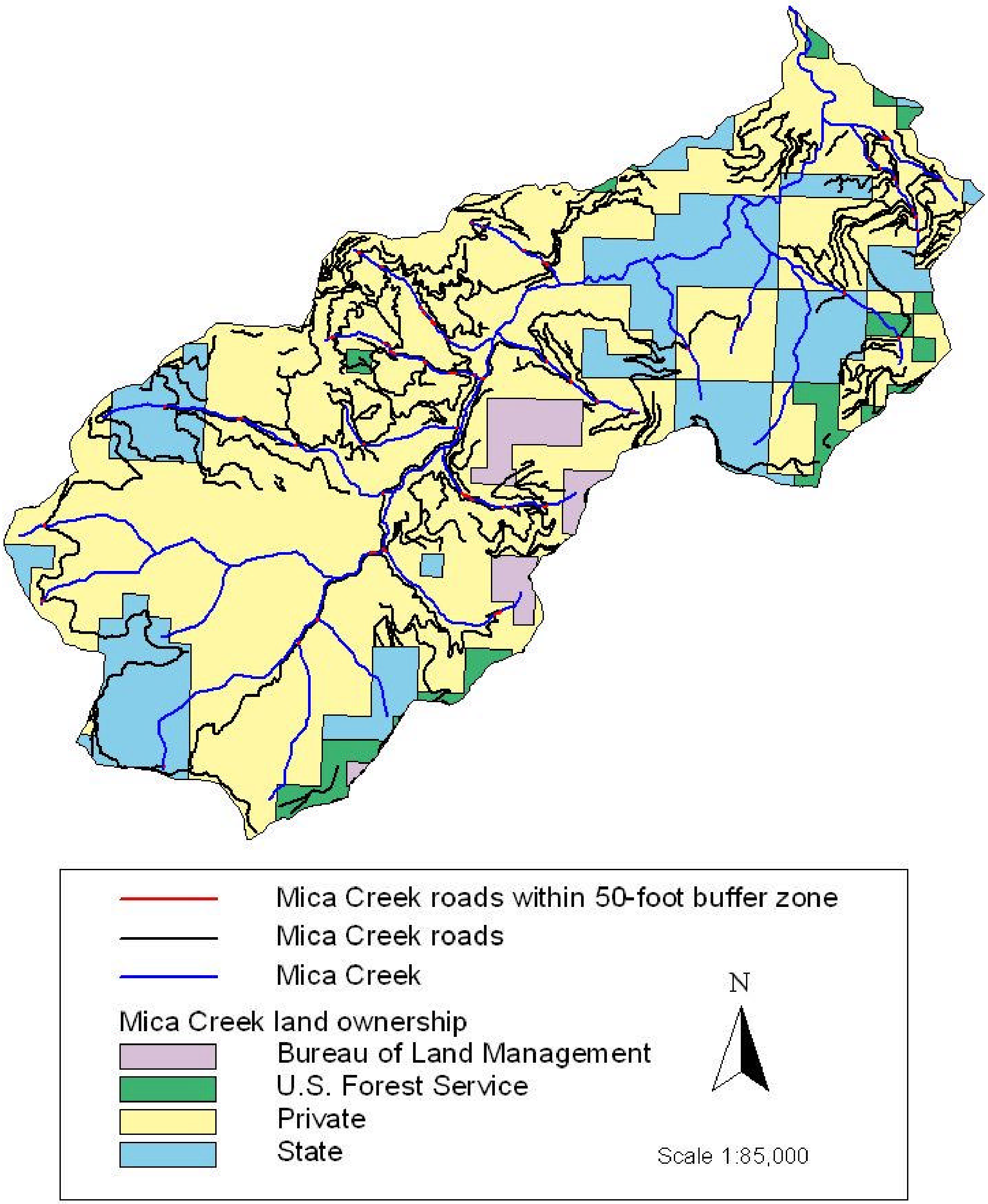

Figure D-4. Mica Creek Road Mileage

Appendix E

Distribution List

Appendix E. Distribution List

Department of Environmental Quality, State Office

Environmental Protection Agency

St. Joe Watershed Advisory Group (WAG) Participants, including:

Name	Affiliation
Mark Addy	Natural Resources Conservation Service
Bob Anderson	Avista Corporation
George Bain	United States Forest Service
Dee Bailey	Coeur d'Alene Tribe
Fred Bear	Idaho Department of Parks and Recreation
Tony Bennett	Idaho Soils Conservation Commission
Lew Brown	Bureau of Land Management
Jack Buell	Benewah County Commissioner
Marti Calabretta	Idaho State Senator
Jon Cantamessa	Shoshone County Commissioner
Jerry Collins	Idaho Conservatoin League
John Ferris	Small Timber Grower
Scott Fields	Coeur d'Alene Tribe
Bob Flagor	Benewah Soil and Water Conservation District/Shoshone Soil and Water Conservation District
Bart Gingerich	Klaveano Ranch
Dolly Hartman	St. Joe Valley Association
Ray Hennekey	Idaho Department of Fish and Game
Dave Johnson	Benewah County Commissioner
Dean Johnson	Idaho Department of Lands
Jim Kingery	University of Idaho
Norm Linton	Potlatch Corporation
Mark Liter	Idaho Department of Fish and Game
Russell Lowry	Citizen
John Macy	United States Forest Service
Bud McCall	Benewah County Commissioner
Jeff McCreary	Ducks Unlimited
Mike Mihelich	Kootenai Environmental Alliance
Alfred Nomee	Coeur d'Alene Tribe
Steve Osburn	Emerald Creek Garnet
Tasha Ozark	Benewah Soil and Water Conservation District
Dell Rust	Idaho Farm Bureau
Fred Schoenick	Benewah Cattlemen's Association
Kelly Scott	Benewah Soil and Water Conservation District
Phoebe Shelden	Benewah Soil and Water Conservation District
Neil Smith	Potlatch Corporation
John Straw	Crown Pacific Inland
Greg Tourtlotte	Idaho Department of Fish and Game
Larry Wright	Potlatch Corporation

Appendix F

Public Comments

Appendix F. Public Comments

Table F-1 summarizes the public comments received regarding the *St. Joe River Subbasin Assessment and TMDLs*, and DEQ's response to these comments.

Table F-1. Public comments and responses to the St. Joe River subbasin assessment.

Source and Comments	DEQ's Response to Comments
United States Forest Service (USFS)	
USFS 1: Roads coverage used are not up to date.	DEQ and IDL update the roads coverage before start of the Subbasin Assessment. However, in the time frame of the Subbasin Assessment, development of roads coverage may change. In order to accurately calculate load reductions, the same road coverage that was used at the start of the Subbasin Assessment will be used during the implementation phase.
USFS 2: Background stream bank erosion measurements have not been made.	Background stream bank erosion has not been accounted for to date. The Natural Resource Conservation Service is exploring methods for doing this, but to date has found them unsatisfactory. Such background erosion is considered in the basin wide export coefficients.
USFS 3: Temperature standards require revision before 303(d) listings and TMDL development.	The data available in this and other subbasin assessments call the temperature standards into question. This matter was taken up by three states in Region 10 (Idaho, Oregon, and Washington), and EPA. The states and EPA did not alter the standard except to add a natural background consideration to it. Thus the standard remains in place and must be addressed by both 303(d) listing and TMDL preparation. The states, including Idaho, are working with the USFS to identify water quality protection Best Management Practices (BMPs) that include thermal protection. If actions such as INFISH management of a stream are implemented, and the forest plan specifically states that BMPs are in place to meet state water quality standards, and the stream fully meets existing and designated beneficial uses, listing may not be required.
Kootenai Environmental Alliance (KEA)	
KEA 1: The lack of listing of lower Marble Creek as water quality limited and development of sediment TMDL.	Marble Creek and many of its tributaries were deleted in the 1998 303(d) process. However, the 2002 303(d) process identified it as water quality limited. Many stream features described qualitatively in the assessments have been quantified in the BURP database and used in the Subbasin Assessment. Unfortunately, the modeling completed in Marble Creek was not completed with actual CWE values, but with

	CWE values of adjacent watersheds. The Subbasin Assessment recommends that a CWE assessment be completed in Marble Creek and the modeling be repeated with the more relevant data. Development of a TMDL is premature because CWE values will be required. The modeling is a key indicator in this case. The stream condition may owe its origins to the history of "splash dam" log transport. If this is the case a TMDL addressing roads and other practices that are not the problem will be ineffective.
KEA 2: The relationship between CWE analysis of roads and roads in rain-on-snow prone topography is not made in the SBA [subbasin assessment] and specifically in the land use tables.	The CWE analysis analyzes the watershed for several factors, among these the location and condition of roads to include sediment yield from those roads or failures to the stream. The CWE analysis examines the conditions as they exist when the survey is completed. Rain-on-snow events are transient phenomena that have their genesis most often in the elevation range of 3,300 to 4,500 feet. We know of no direct relationship between CWE and rain-on-snow events. Specifically CWE does not identify roads or other features in this guideline elevation range. Although rain-on-snow events may be a trigger for erosion related to roads, the location and condition of the roads and road features as measured by CWE are the primary factors. The watersheds developed under periodic rain-on-snow conditions as a stressor. This has not changed. The placement of roads on the landscape is what has changed.
KEA 3: The comment notes that the SBA (subbasin assessment) should describe the TMDL regulations that require the 30-year time frame as part of the load allocation.	The Subbasin Assessment and TMDLs cite the EPA guidance for TMDL preparation. Among that guidance is the requirement that the estimated time frame for watershed recovery be stated and justified. That time frame is stated in the TMDLs and justified. In this case, two large discharge events with a return time of 10 to 15 years are deemed necessary after sediment reduction actions are implemented to remove the deposited sediment from the system. Two events should require roughly 30 years to occur.
KEA 4: The final assessment should supply data on how much land of the largest three owners/managers is in the rain-on-snow zone.	For the reasons stated above (i.e., rain-on-snow is a trigger not a cause) such information does not appear relevant.
KEA 5: Specific regulations for TMDL monitoring should be stated. The regulations under which SBA and TMDLs are developed and implemented are cited in the SBA and TMDLs. If monitoring is not required by these cited regulations it is so stated by inference.	There are no specific regulations for TMDL monitoring; the inference has been removed.

Idaho Department of Lands (IDL)	
IDL 1: The agencies are set up by the temperature standards to fail. The TMDLs will not be achievable or will not achieve the standard.	The temperature standard now has natural background conditions language as a default if the absolute standard cannot be met. Given this language, the temperature TMDLs very quickly point out that stream canopy coverage is the only factor that can reasonably be managed on the landscape and that on some landscape site or vegetation conditions preclude or restrict shading. Thus the TMDLs are designed to provide full shading over time as the management direction where this is possible and to identify those areas, and the shading possible in those areas, where less than 100% shading is possible. The state believes these TMDLs will provide thermal protection to the level of natural background. It is possible to manage stream canopy for the goals placed in the temperature TMDLs. Even natural loss of canopy shade can be included as natural background. The state believes these TMDLs are practical and achievable over time.
Coeur d'Alene Tribe (Tribe)	
Tribe 1: Multiple editorial comments.	All editorial comments were noted and corrected as necessary.
Tribe 2: This subbasin assessment does not address how it, with the proposed TMDLs, will benefit or affect the proposed revision of the Coeur d'Alene Lake Management Plan.	Any nutrient sediment reduction done in this watershed will have a net positive affect on sediment reduction in Coeur d'Alene Lake.
Tribe 3: Was Fishhook Creek listed for temperature?	Yes, Fishhook Creek was listed for temperature in the EPA's additions to the 1998 Idaho 303(d) list.
Tribe 4: Is it possible to have a warm and heavy snow pack?	This term was irrelevant and deleted.
Tribe 5: May want to explain A and B horizons.	See page 6.
Tribe 6: Why are there no scientific names?	Scientific names have been added to the document.
Tribe 7: Why isn't the main stem of the St. Joe listed for temperature?	The river has not been monitored for temperature to date. Once a monitoring program has been established and completed, a determination regarding the need to list the river will be made.
Tribe 8: How long will it take for the seedlings and saplings to get established before they are effective at holding back sediment? How fast does a forest regenerate in terms of years?	See modified text on pages 47-48.
Tribe 9: In the section entitled *Discharge Characteristics*, define the five year period.	The five year period spans 1996-2000.
Tribe 10: Explain the zero values given in Table 15.	The zeroes indicate a stream with no pools.
Tribe 11: Provide a detailed breakdown of the sediment monitoring cost estimate.	Due to the source of the information, a detailed breakdown is not possible.
Tribe 12: What is the scientific basis for the sediment goal?	See explanation starting on page 52.
Tribe 13a: You state that every year "1% of the	a) Streams that are not monitored will be

Rosgen B channels will be monitored until at least 5% of these channels have been assessed after five years." What will happen if after five years a stream has not been selected to be monitored? Are you going to base your results on the outcomes of the other steams near it or go and sample it? Tribe13b: Why were Rosgen B channel types selected and are these the channel types most conducive with fisheries and macroinvertebrate habitat? Tribe 13c: What are the statistical methods used to choose the 5% target?	assessed using data from nearby streams that have been monitored. b) Rosgen B channels were selected as monitoring sites because they are the channel types most likely to house cold water aquatic life and salmonid populations when the stream is in good condition. c) Statistical methods were not used to choose the 5% target. Target selection was based on the what DEQ expects the reasonable resource availability to be at that time.
Tribe 14: Is Fishhook going to have a separate TMDL?	Yes. See page 52.
Tribe 15: Several table modifications are recommended.	These changes have been made where practical.