St. Joe River Subbasin Assessment and Total Maximum Daily Loads

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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

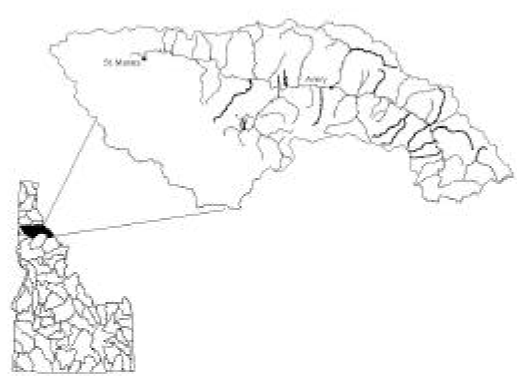

Figure A. St. Joe River Subbasin Location and Listed Segments

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

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%.

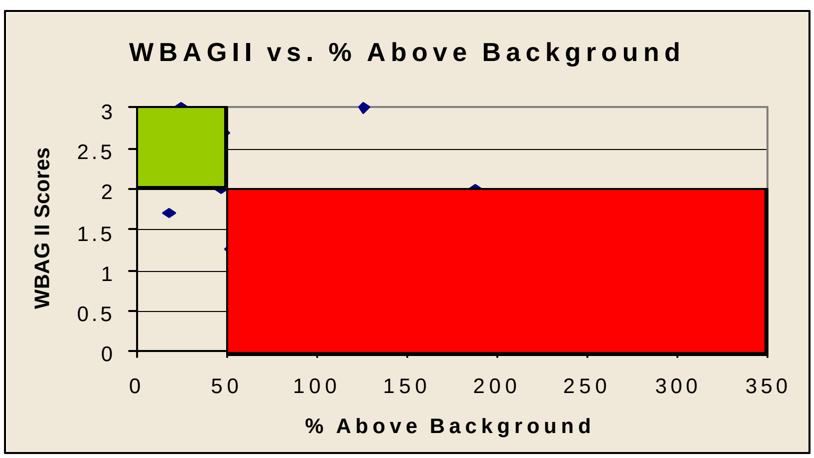

Figure 8. WBAGII Scores Versus Modeled Percent Sediment Above Background

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 ^oC seven-day running average from May 1 to September 1, and the state 9 ^oC daily maximum spawning standard from September 1 through October 31. After October 31, water temperatures are expected to be well below 9 ^oC in the St. Joe River subbasin. In practice, these two standards are essentially the same standard (Dupont 2002): a 10 ^oC 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 $10^{o}C$.

$$\text{Equation (3)} \quad C = 224.7 - 0.031 * E$$

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/m²)	East-West (watts/m²)	SE-NW or SW-NE (watts/m²)
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°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°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/m²)	Current Heat Load (watts/m²)	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/m²)	Current Heat Load (watts/m²)	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/m^2)	Current Heat Load (watts/m^2)	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

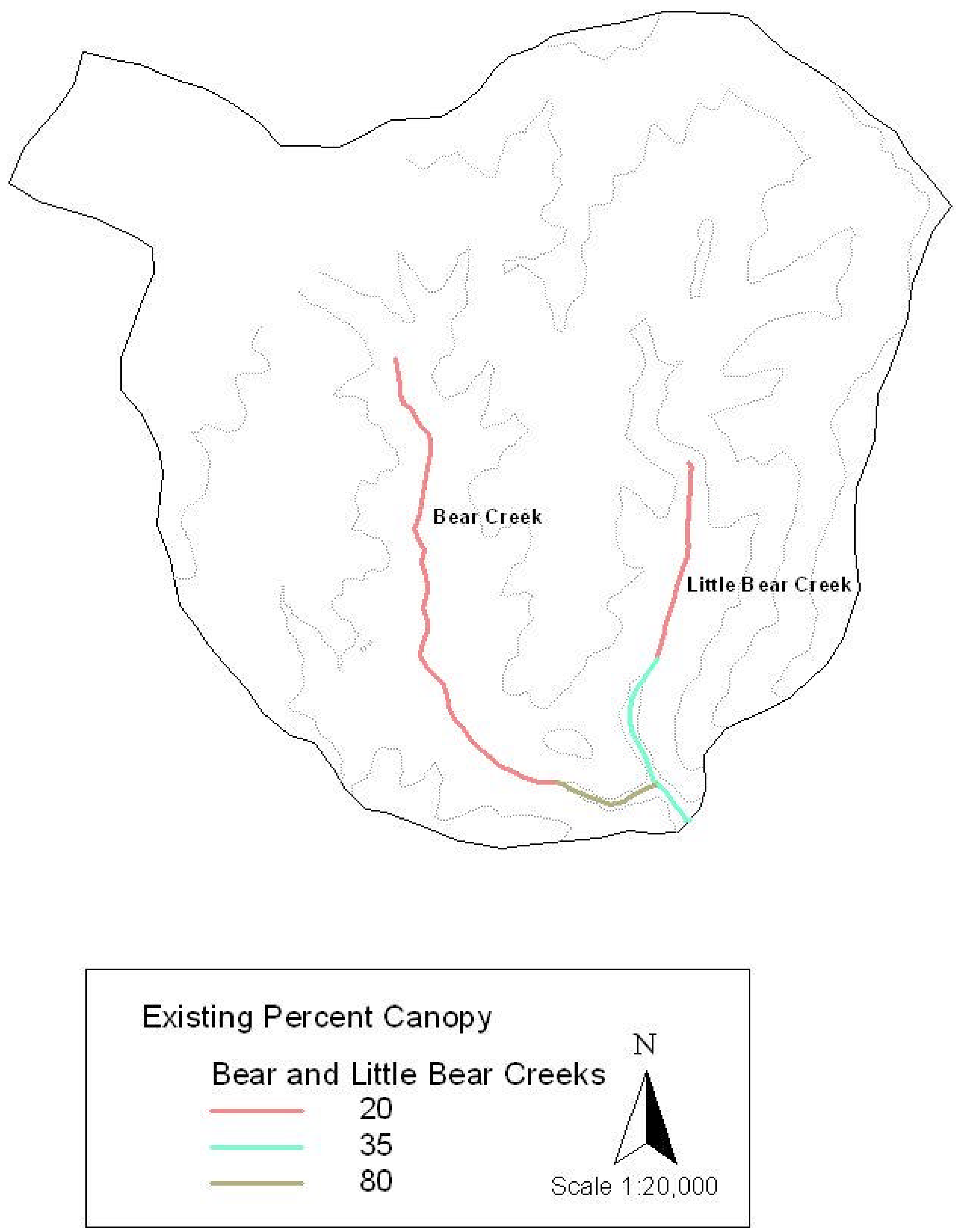

Figure 9a. Existing Shading Canopy: Bear and Little Bear Creeks

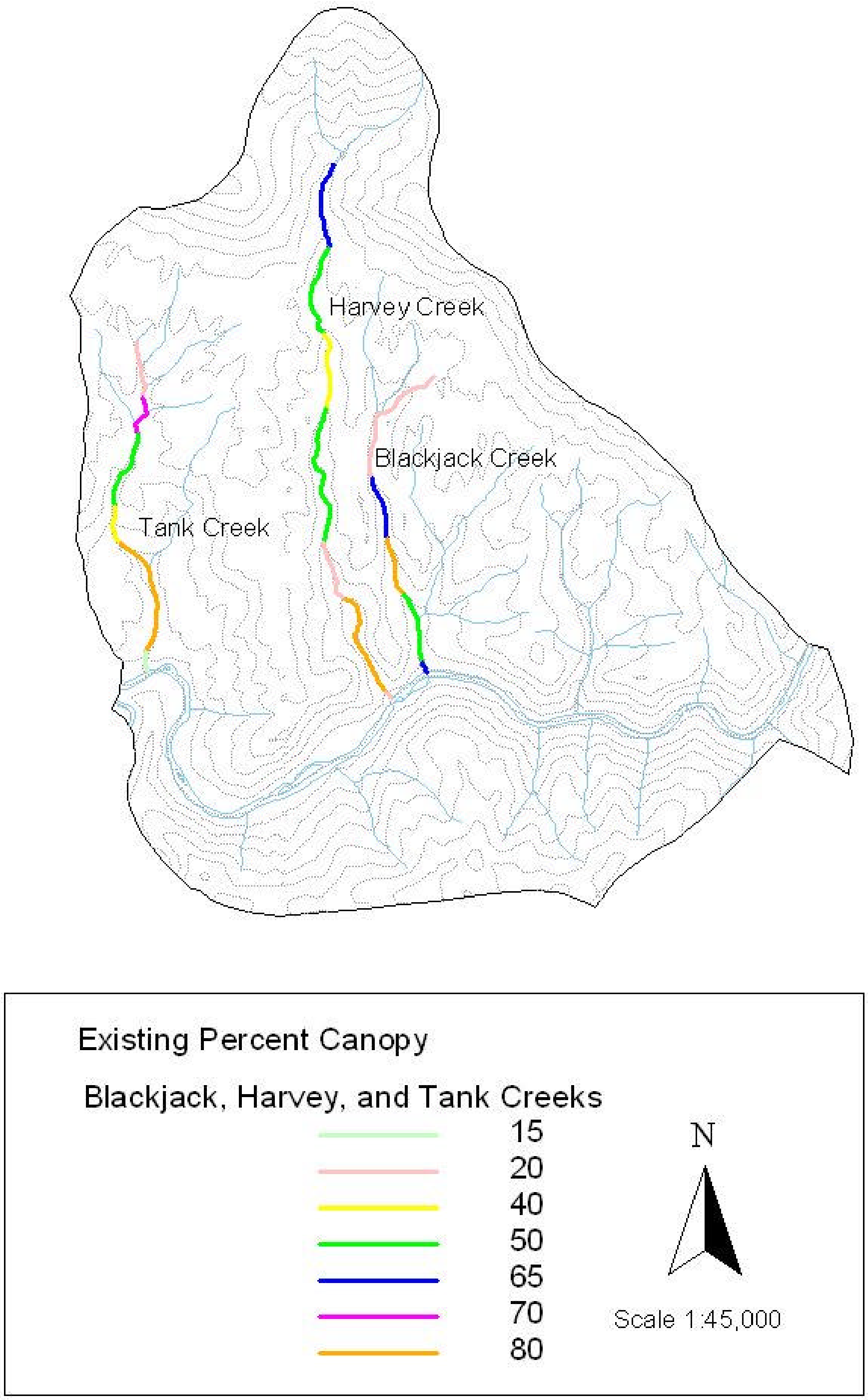

Figure 9b. Existing Shading Canopy: Blackjack, Harvey, and Tank Creeks

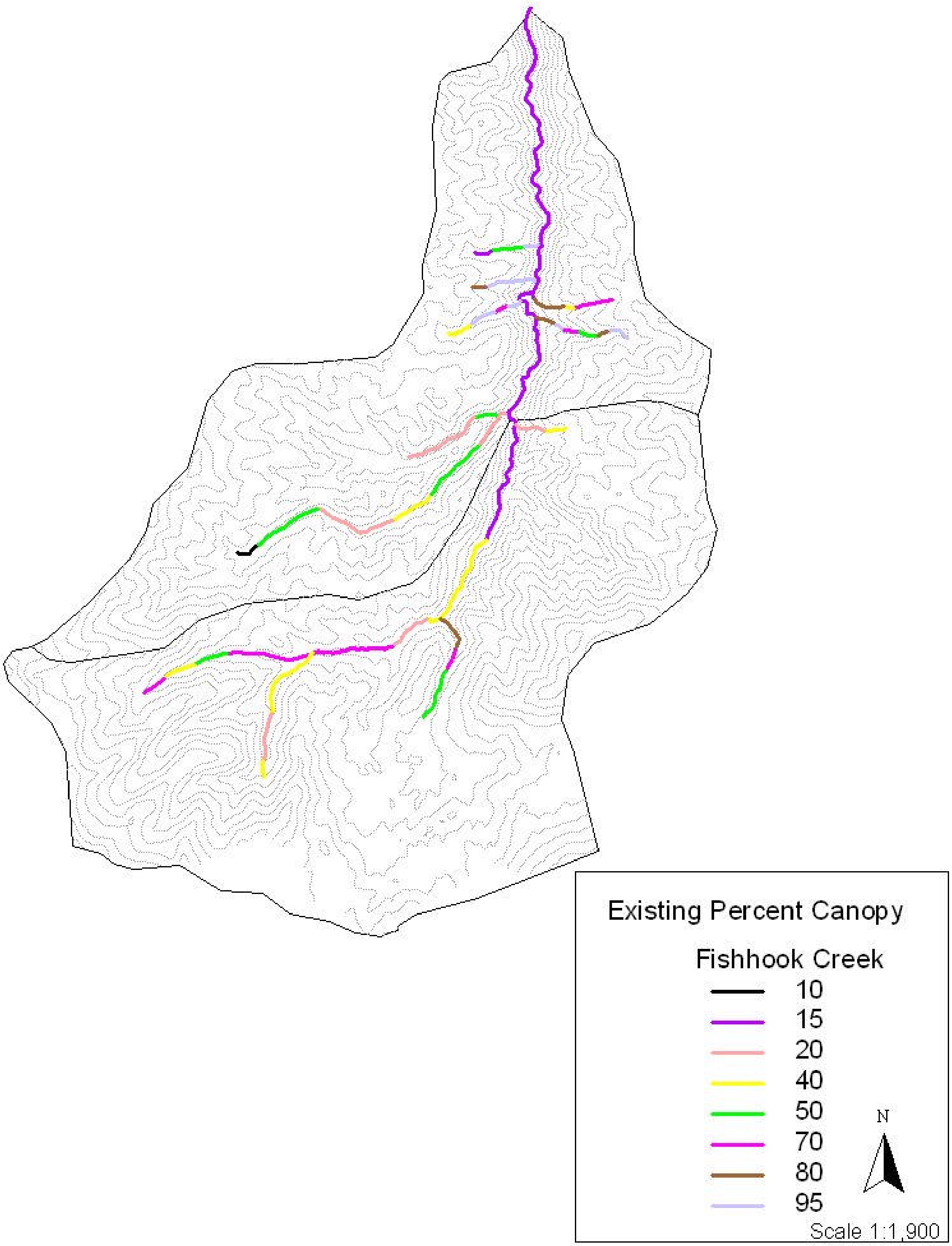

Figure 9c. Existing Shading Canopy: Fishhook Creek

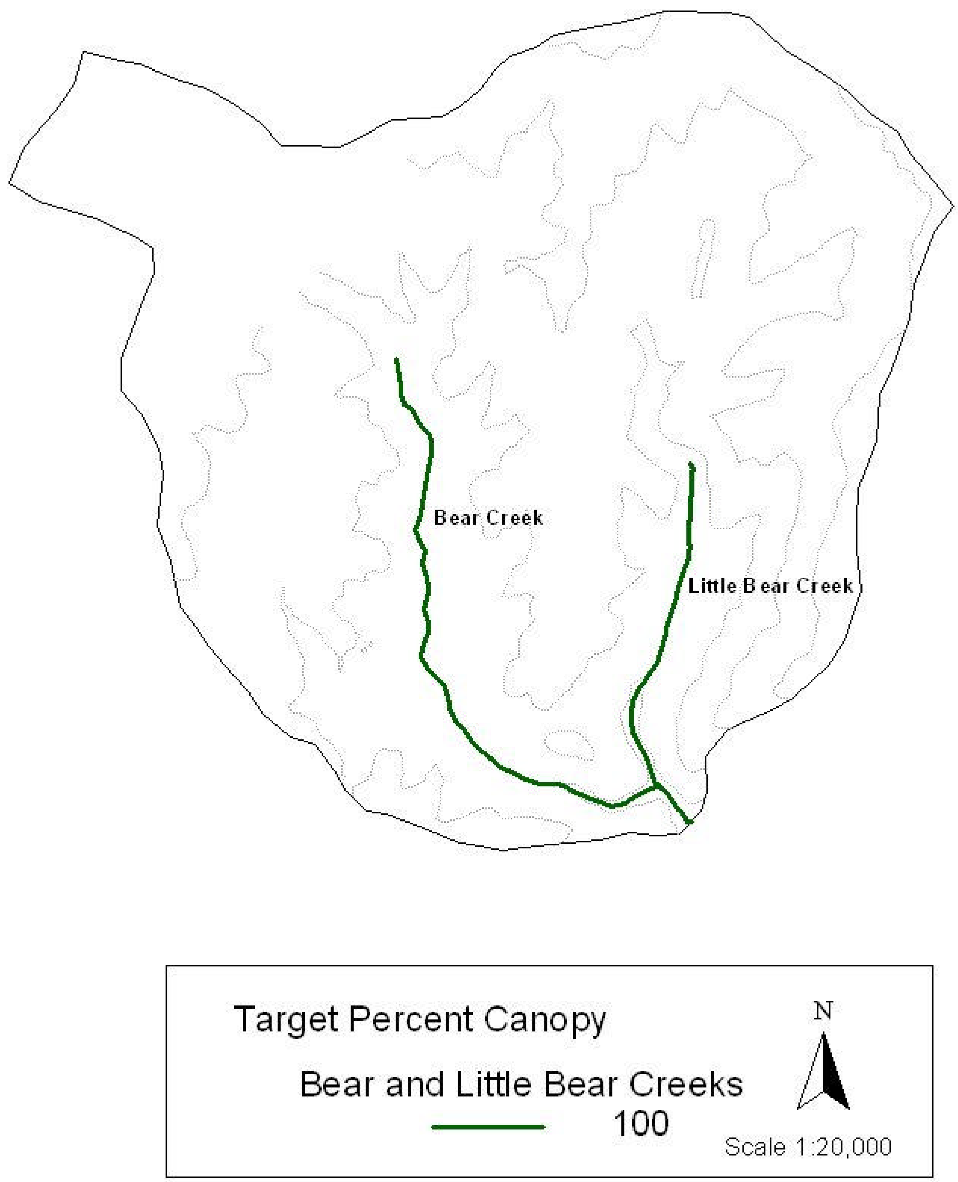

Figure 10a. Target Shade Canopy: Bear and Little Bear Creeks

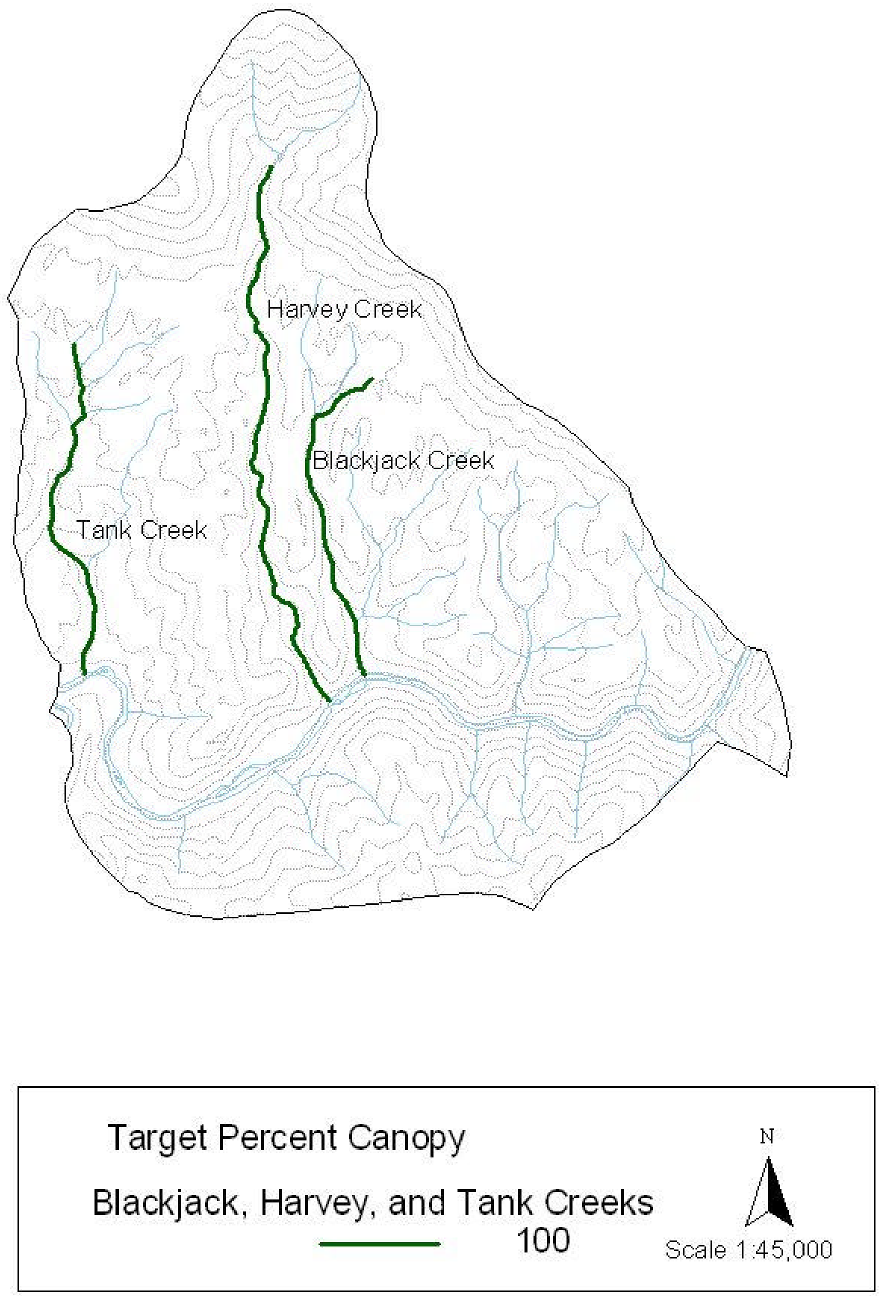

Figure 10b. Target Shade Canopy: Blackjack, Harvey, and Tank Creeks

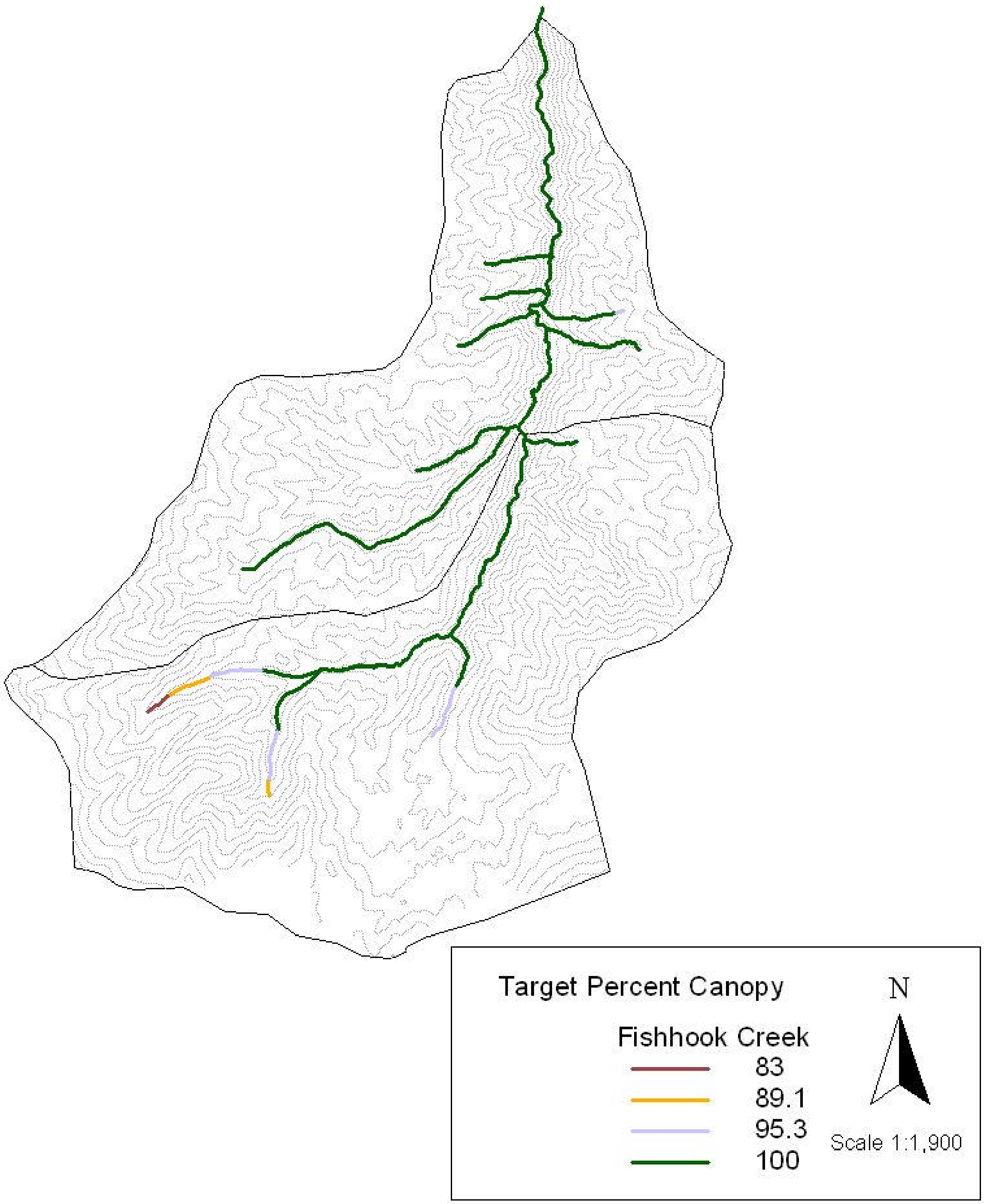

Figure 10c. Target Shade Canopy: Fishhook Creek

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 (^oC)
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^oC.

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 ^{o}C 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/m^2)	Current Heat Load (watts/m^2)	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/m^2)	Current Heat Load (watts/m^2)	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.

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^{o}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.

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.