Upper North Fork Clearwater River Subbasin Assessment and Total Maximum Daily Load

2017 Lake Creek Temperature TMDL

Hydrologic Unit Code 17060307

Final

State of Idaho
Department of Environmental Quality

June 2018

Printed on recycled paper, DEQ June 2018, PID 9003, CA code 2206. Costs associated with this publication are available from the State of Idaho Department of Environmental Quality in accordance with Section 60-202, Idaho Code.

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Acknowledgments

Cover photo DEQ BURP site #2013SLEWA083.

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Abbreviations, Acronyms, and Symbols

§303(d)	refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
Ag plan	*Idaho Agricultural Pollution Abatement Plan*
AU	assessment unit
BMP	best management practice
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations
CGP	Construction General Permit
CNF	Clearwater National Forest
COLD	cold water aquatic life
CWA	Clean Water Act
DEQ	Idaho Department of Environmental Quality
EPA	United States Environmental Protection Agency
GIS	geographic information systems
IDAPA	refers to citations of Idaho administrative rules
kWh	kilowatt-hour
LA	load allocation
LC	load capacity
m	meter
Mkcal	million kilocalories
MOS	margin of safety
NB	natural background
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
PNV	potential natural vegetation
SCR	secondary contact recreation
SS	salmon spawning
SWPPP	stormwater pollution prevention plan
TMDL	total maximum daily load
UNFCR	Upper North Fork Clearwater River
USFS	United States Forest Service
USC	United States Code
WAG	watershed advisory group
WLA	wasteload allocation

Executive Summary

The federal Clean Water Act requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the Clean Water Act, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the Clean Water Act 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 (a "§303(d) list") of impaired waters. Currently, this list is published every 2 years as the list of Category 5 water bodies in Idaho's Integrated Report. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants causing impairment, set at a level to achieve water quality standards. This document addresses one assessment unit in the Upper North Fork Clearwater River (UNFCR) subbasin (hydrologic unit code 17060307) that is in Category 5 of Idaho's most recent federally approved Integrated Report (DEQ 2017).

This TMDL describes the key physical and biological characteristics of the subbasin; water quality concerns and status; pollutant sources; and recent pollution control actions in the UNFCR subbasin, located in northern Idaho. For more detailed information about the subbasin and previous TMDLs, see the *Upper North Fork Clearwater River Subbasin Assessment and Total Maximum Daily Loads* (DEQ 2003).

The TMDL analysis establishes water quality targets and load capacities, estimates existing pollutant loads, and allocates responsibility for load reductions needed to return listed waters to a condition meeting water quality standards. It also identifies implementation strategies—including reasonable time frames, approach, responsible parties, and monitoring strategies—necessary to achieve load reductions and meet water quality standards.

Subbasin at a Glance

The UNFCR subbasin is located in north-central Idaho, running 130 miles from the divide on the Idaho/Montana border westward towards Orofino, Idaho (Figure A). The UNFCR is a 75-mile-long, 8th-order water body (based on 1:24,000-scale hydrography), draining 1,294 square miles (828,000 acres). The vast majority of the UNFCR subbasin is managed by the Clearwater National Forest, with much smaller areas managed by Idaho Department of Lands, Potlatch Corporation, and other private ownership. Figure B shows the UNFCR subbasin, its ownership, the major tributary streams, and the location of Lake Creek.

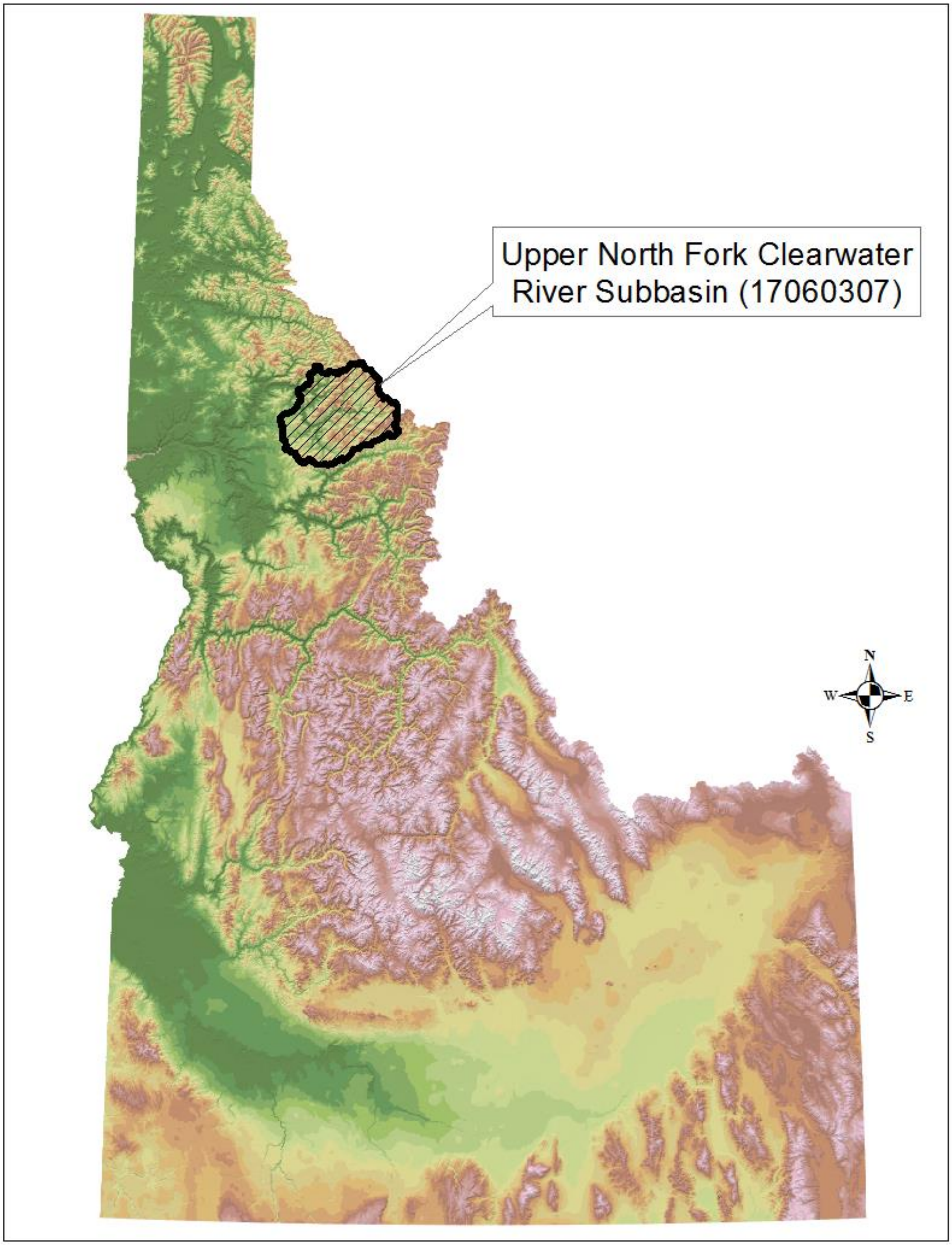

Figure A. Upper North Fork Clearwater River subbasin.

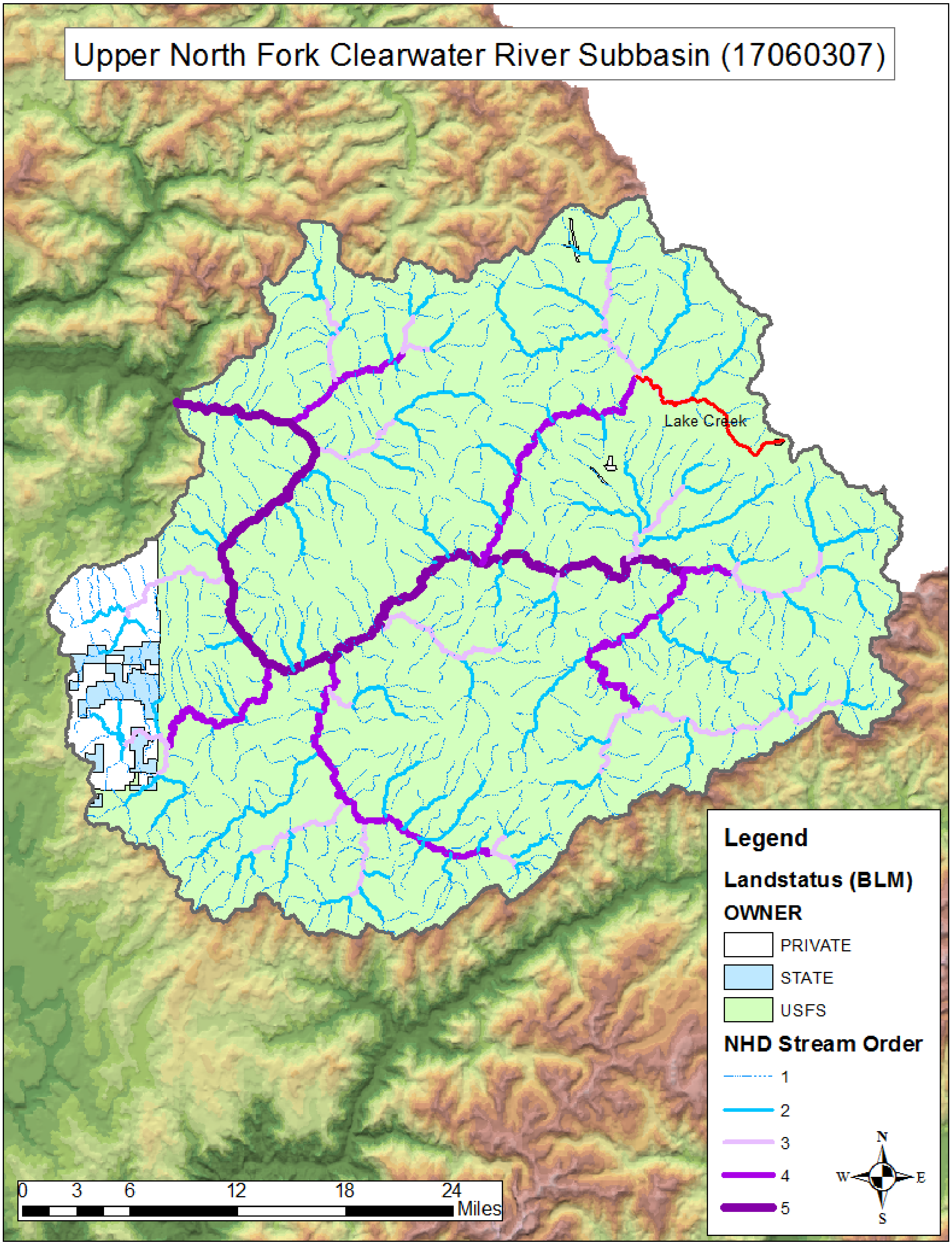

Figure B. Landownership and Lake Creek location in the UNFCR subbasin.

Key Findings

One water body (Lake Creek) was placed on the 2010 §303(d) list of impaired waters for temperature criteria violations, and the Idaho Department of Environmental Quality (DEQ) has developed a temperature TMDL for this water (Table A).

Effective target shade levels were established for one assessment unit based on the concept of shading under potential natural vegetation resulting in natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation that was partially field verified with Solar Pathfinder data. Target and existing shade levels were compared to determine the amount of shade needed to bring the water body into compliance with temperature criteria in Idaho's water quality standards (IDAPA 58.01.02). A summary of assessment outcomes, including recommended changes to listing status in the next Integrated Report, is presented in Table B.

Lower Lake Creek lacks a minor amount of shade most likely as a result of minor channel widening. The stream on average lacks about 4% shade when compared to target shade values for Clearwater National Forest breaklands forest and alder-forest mix landtypes; however, portions of the stream have abundant shade that exceeds targets.

Table A. Water bodies and pollutants for which TMDLs were developed.

Water Body	Assessment Unit Number	Pollutant(s)
Lake Creek	ID17060307CL033_03	Temperature

Table B. Summary of assessment outcomes for §303(d)-listed assessment units.

Assessment Unit Name	Assessment Unit Number	Pollutant	TMDL(s) Completed	Recommended Changes to Next Integrated Report	Justification
Lake Creek–3rd-Order Segment	ID17060307CL033_03	Temperature	Yes	Move to Category 4a	Insufficient existing shade

Public Participation

The Clearwater Basin Advisory Group was requested to act on behalf of a local watershed advisory group because of the remote nature of the UNFCR subbasin and Lake Creek watershed.

The general public was able to comment on the draft document during the public comment period. This document was on public comment from March 15, 2018 through April 16, 2018.

Introduction

This document addresses one assessment unit (AU) in the Upper North Fork Clearwater River (UNFCR) subbasin (hydrologic unit code 17060307) that is in Category 5 of Idaho's most recent federally approved Integrated Report (DEQ 2017) for temperature. The purpose of this total maximum daily load (TMDL) is to characterize and document pollutant loads within the UNFCR subbasin. The first portion of this document presents key characteristics or updated information for the subbasin assessment, which is divided into four major sections: subbasin characterization (section 1), water quality concerns and status (section 2), pollutant source inventory (section 3), and a summary of past and present pollution control efforts (section 4). While the subbasin assessment is not a requirement of the TMDL, the Idaho Department of Environmental Quality (DEQ) performs the assessment to ensure impairment listings are up-to-date and accurate.

The subbasin assessment is used to develop a TMDL for each pollutant of concern for the UNFCR subbasin. The TMDL (section 5) is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (40 CFR 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable loads of individual pollutants among the various sources contributing the pollutant. Effective shade targets were established for one AU based on the concept of shading under potential natural vegetation (PNV) resulting in natural background temperatures.

Regulatory Requirements

This document was prepared in compliance with both federal and state regulatory requirements. The federal government, through the United States Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. DEQ implements the Clean Water Act (CWA) in Idaho, while EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Congress passed the Federal Water Pollution Control Act, more commonly called the CWA, in 1972. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 USC §1251). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to ensure "swimmable and fishable" conditions. These goals relate water quality to more than just chemistry.

The CWA requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to §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 nation's waters whenever possible. DEQ must review those standards every 3 years, and EPA must approve Idaho's water quality standards. Idaho adopts water quality standards to protect public health and welfare, enhance water quality, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

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 (a "§303(d) list") of impaired waters. Currently, this list is published every 2 years as the list of Category 5 waters in Idaho's Integrated Report. For waters identified on this list, states and tribes must develop a TMDL for the pollutants, set at a level to achieve water quality standards.

DEQ monitors waters, and for those not meeting water quality standards, DEQ must establish a TMDL for each pollutant impairing the waters. However, some conditions that impair water quality do not require TMDLs. EPA considers certain unnatural conditions—such as flow alteration, human-caused lack of flow, or habitat alteration—that are not the result of discharging a specific pollutant as "pollution", unsuitable for TMDL calculation. TMDLs are not required for water bodies impaired by pollution, rather than a specific pollutant. A TMDL is only required when a pollutant can be identified and in some way quantified.

1 Subbasin Assessment—Subbasin Characterization

The UNFCR subbasin (hydrologic unit code 17060307) was previously assessed and received TMDLs (DEQ 2003). The starting point for that assessment was Idaho's 1998 §303(d) list of water quality limited water bodies. Nineteen segments of the UNFCR subbasin were on this list. All the water bodies were §303(d) listed for sediment (only Osier Creek was listed for temperature). However, analysis of the data indicated that only one of the listed water bodies, Deception Gulch, was water quality limited as the result of sediment. Except for Deception Gulch, DEQ recommended that all the water bodies be removed from the §303(d) list for sediment. A sediment TMDL was written for Deception Gulch (DEQ 2003).

Temperature TMDLs were developed for 18 water bodies using percent stream canopy closure increase by stream segment as the target, based on the appropriate water temperature standard as the load capacity. The 2003 TMDL discussed how the percent canopy closure target relates to heat as a pollutant. To meet the stream temperature targets in the various water bodies, 75%–100% of the stream miles required increased stream canopy closure.

A sediment TMDL was developed for Deception Gulch based on sediment mass balance. Most of the excess sediment was coming from roads on high hazard landtypes and mass failures associated with these roads—the total required load reduction was assigned to these nonpoint sources. A sediment target was set at 390 tons/year, while total load to the stream was 770 tons/year. The load reduction target was 380 tons/year, or about a 50% sediment load reduction. To achieve this target, we recommended that the Clearwater National Forest (CNF) improve management activities on approximately 50% of the roads in the watershed, especially those on high hazard landtypes.

In 2010, an additional water body was added to the §303(d) list of water quality limited water bodies ((DEQ 2011]). The 3rd-order segment of Lake Creek was determined to be impaired for temperature criteria violations. Lake Creek is located in the upper northeast corner of the subbasin near the Idaho/Montana border (Figure 1).

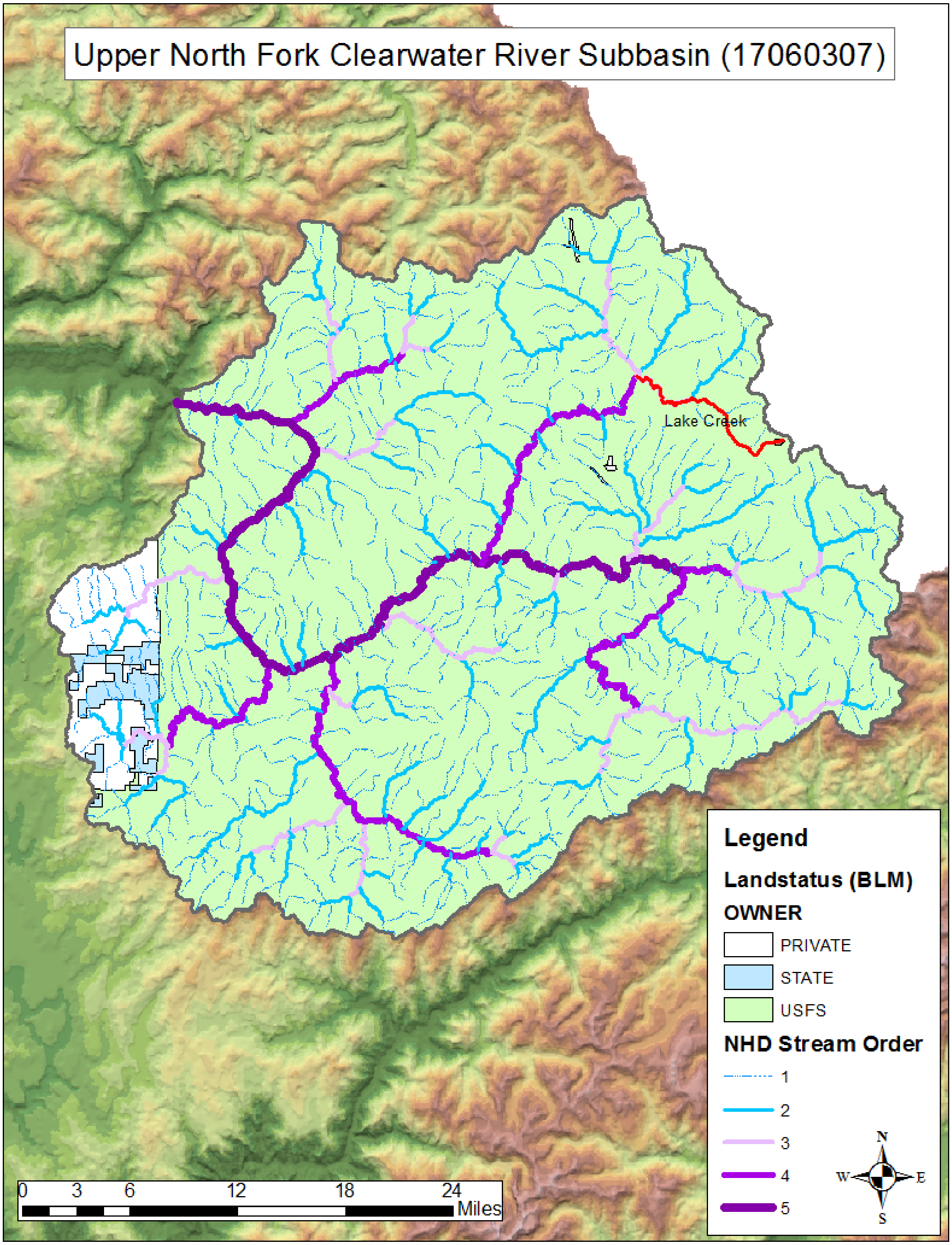

Figure 1. Landownership and Lake Creek location in the UNFCR subbasin.

2 Subbasin Assessment—Water Quality Concerns and Status

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

CWA §303(d) states that waters that are unable to support their beneficial uses and do not meet water quality standards must be listed as water quality limited. Subsequently, these waters are required to have TMDLs developed to bring them into compliance with water quality standards.

2.1.1 Assessment Units

AUs are a subdivision of water body units, which allows them to relate directly to the water quality standards. An AU is a group of similar streams that have similar land use practices, ownership, or land management. However, stream order is the main basis for determining AUs—even if ownership and land use change significantly, the AU usually remains the same for the same stream order.

Using AUs as a basis for assessments and TMDLs offers the benefit of being more precise, such that all waters of the state are defined consistently.

2.1.2 Listed Waters

Table 1 shows the pollutants and basis for listing for each §303(d)-listed AU in the subbasin (i.e., AUs in Category 5 of the Integrated Report).

Table 1. UNFCR subbasin §303(d)-listed assessment units in the subbasin.

Assessment Unit Name	Assessment Unit Number	Listed Pollutants	Listing Basis
Lake Creek–3rd-Order Segment	ID17060307CL033_03	Temperature	2010 §303(d) list

2.2 Applicable Water Quality Standards and Beneficial Uses

Idaho water quality standards (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. Idaho water quality standards require that surface waters of the state be protected for beneficial uses, including recreational use and the preservation and propagation of aquatic life wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are also classified as existing, designated, and presumed (see Appendix A). The *Water Body Assessment Guidance* (DEQ 2016a) provides a more detailed description of beneficial use identification for use assessment purposes.

Beneficial uses in Idaho's Water Quality Standards include the following:

- Aquatic life support—cold water, seasonal cold water, warm water, salmonid spawning, and modified
- Contact recreation—primary (e.g., swimming) or secondary (e.g., boating)

- Water supply—domestic, agricultural, and industrial
- Wildlife habitats
- Aesthetics

2.2.1 Beneficial Uses in the Subbasin

Lake Creek (AU ID17060307CL033_03) is identified in Idaho's water quality standards as having designated uses (Table 2). This AU is in DEQ's 2014 Integrated Report as fully supporting its secondary contact recreation use but not supporting the cold water aquatic life or salmonid spawning uses due to temperature criteria violations. Biological and habitat scores from Beneficial Use Reconnaissance Program (BURP) sites rated conditions as good to excellent in Lake Creek.

Table 2. UNFCR subbasin beneficial uses of §303(d)-listed streams.

Assessment Unit Name	Assessment Unit Number	Beneficial Uses[a]	Type of Use
Lake Creek–3rd-Order Segment	ID17060307CL033_03	COLD, SS, SCR	Designated

[a] Cold water aquatic life (COLD), salmonid spawning (SS), secondary contact recreation (SCR)

2.2.2 Water Quality Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of water quality criteria, which include *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity, and *narrative* criteria for pollutants such as sediment and nutrients (IDAPA 58.01.02.250–251) (Table 3). For more about temperature criteria and natural background provisions relevant to the PNV approach, see Appendix B.

Table 3. Numeric temperature criteria supportive of beneficial uses in Idaho water quality standards.

Parameter	Cold Water Aquatic Life	Salmonid Spawning[a]
Water Quality Standards: IDAPA 58.01.02.250		
Temperature[b]	22 °C or less daily maximum; 19 °C or less daily average **Seasonal Cold Water**: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average **Bull Trout**: Not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June–August; not to exceed 9 °C daily average in September and October
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho 40 CFR Part 131		
Temperature	—	7-day moving average of 10 °C or less maximum daily temperature for June–September

[a] During spawning and incubation periods for inhabiting species
[b] Temperature exemption: Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the 7-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.050.02. The procedure relies heavily upon biological parameters and is presented in detail in the *Water Body Assessment Guidance*

(DEQ 2016a). This guidance requires DEQ to use the most complete data available to make beneficial use support status determinations.

2.3 Summary and Analysis of Existing Water Quality Data

Periodic United States Forest Service (USFS) temperature data collected at the mouth of Lake Creek since 1995 suggest that Lake Creek may have slightly elevated temperatures during salmonid spawning periods (Appendix C). The mouth of Lake Creek had exceedances of salmonid spawning criteria, probably consistent with the North Fork Clearwater River itself. Lake Creek daily average stream temperatures were slightly greater than daily average criteria (9 °C) resulting in days, sometimes weeks, exceeding salmonid spawning criteria. Because fish spawning criteria were applied to a default time period for spring and fall spawning species, individual streams may have had warmer temperatures near the end of the spring spawning period (mid-July) or at the beginning of the fall spawning period (September 1) without seriously harming the actual spawning in the stream (i.e., fish spawn when the temperature is right and there is sufficient time to do so). Additionally, because we often consider average condition, there will be hot years when criteria are exceeded more often, and there will be cold years when criteria may not be exceeded. The goal of this TMDL is to achieve the natural temperature regime in the stream by returning the effective shade to its natural condition. We anticipated the natural temperature regime would be cooler than the present condition; however, the natural temperature regime may not necessarily exclude all temperature criteria exceedances.

2.3.1 Status of Beneficial Uses

The 1999, 2006, and 2013 BURP data for Lake Creek are listed below (Table 4). USFS stream temperature data violated temperature criteria to warrant a temperature TMDL.

Table 4. Resulting assessment scores for BURP sites on Lake Creek.

Assessment Unit Name and BURP ID	Assessment Unit Number	SMI	SFI	SHI	Average	Current Integrated Report Category
Lake Creek[a] 2013SLEWA083	ID17060307CL033_03	3	2	2	2.00	5
Lake Creek[b] 2006SLEWA020	ID17060307CL033_03	2	—	3.00	2.50	5
Lake Creek[b] 2006SLEWA049	ID17060307CL033_03	3	—	3.00	3.00	5
Lake Creek[b] 1999SLEWB025	ID17060307CL033_03	3	3	3.00	3.00	5

Notes: SFI = stream fish index, SHI = stream habitat index, SMI = stream macroinvertebrate index
[a] Calculated to be consistent with the *Water Body Assessment Guidance* (DEQ 2016a)
[b] Calculated to be consistent with *Water Body Assessment Guidance* (Grafe et al. 2002) and the 2002 small stream assessment framework

Data collected between 1999 and 2006 were calculated consistent with the *Water Body Assessment Guidance* (Grafe et al. 2002) and the 2002 small stream assessment framework. Data collected in 2013 were calculated consistent with the *Water Body Assessment Guidance* (DEQ 2016a).

2.3.2 Assessment Unit Summary

A summary of the data analysis, literature review, and field investigations and a list of conclusions for the AU included in Category 5 of the 2014 Integrated Report follows. This section includes changes that will be documented in the next Integrated Report once the TMDL in this document has been approved by EPA.

ID17060307CL033_03, Lake Creek–3rd-Order Segment

- Listed for temperature by EPA (non-DEQ USFS temperature logger data used)
- Lower Lake Creek on average lacks about 4% shade when compared to target shade values for CNF breaklands forest and alder-forest mix landtypes; however, portions of the stream have abundant shade that exceeds targets.

3 Subbasin Assessment—Pollutant Source Inventory

Pollution within the Lake Creek watershed is primarily from temperature.

3.1 Point Sources

There are no permitted point sources with the Lake Creek watershed. The watershed has had a history of mining for gold and other precious metals.

3.2 Nonpoint Sources

Because this TMDL is based on PNV-style riparian shade calculations, which are equivalent to natural background loading, the load allocation is essentially the desire to achieve natural background conditions. However, in order to reach that objective, load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade as a whole. Therefore, load allocations are stream segment specific and dependent on the target load for a given segment. This target load (i.e., load capacity) is necessary to achieve natural background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL is dependent on natural background conditions for achieving water quality standards, all tributaries to the waters examined here need to reflect natural conditions to prevent excess heat loads to the system.

3.3 Pollutant Transport

Pollutant transport refers to the pathway by which pollutants move from the pollutant source to cause a problem or water quality violation in the receiving water body. In the case of temperature, most pollutant transport is in the form of solar radiation directly to the stream as a result of exposure. In the Lake Creek watershed, stream exposure has resulted from past mining activities within and adjacent to the channel, timber harvesting, site development removal of vegetation, roads, and livestock grazing activities.

4 Subbasin Assessment—Summary of Past and Present Pollution Control Efforts

The USFS actively manages Forest Service lands using federal land management protocols developed to sustain environmental conditions and support natural, recreational, and specific land uses permitted. These land uses are vetted through programs and procedures established by the CNF specifically to meet state and federal regulations for the use of such lands. The USFS should continue to protect the UNFCR subbasin and Lake Creek watershed area of the riparian corridor.

We have examined the original existing shade conditions on Lake Creek. The results of which will be presented below in section 5. Existing shade was evaluated through aerial photo interpretation of 2011 National Agricultural Imagery Program imagery. Solar Pathfinder monitoring of existing shade has taken place at four sites in the watershed for the purpose of calibrating and enhancing the aerial interpretation.

5 Total Maximum Daily Loads

A TMDL prescribes an upper limit (i.e., load capacity) on discharge of a pollutant from all sources to ensure water quality standards are met. It further allocates this load capacity among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation, and nonpoint sources, each of which receives a load allocation. Natural background contributions, when present, are considered part of the load allocation but are often treated separately because they represent a part of the load not subject to control. Because of uncertainties about quantifying loads and the relation of specific loads to attaining water quality standards, the rules regarding TMDLs (40 CFR 130) require a margin of safety be included in the TMDL. Practically, the margin of safety and natural background are both reductions in the load capacity available for allocation to pollutant sources.

Load capacity can be summarized by the following equation:

$$LC = MOS + NB + LA + WLA = TMDL$$

Where:

LC = load capacity
MOS = margin of safety
NB = natural background
LA = load allocation
WLA = wasteload allocation

The equation is written in this order because it represents the logical order in which a load analysis is conducted. First, the load capacity is determined. Then the load capacity is broken down into its components. After the necessary margin of safety and natural background, if relevant, are quantified, the remainder is allocated among pollutant sources (i.e., the load allocation and wasteload allocation). When the breakdown and allocation are complete, the result is a TMDL, which must equal the load capacity.

The load capacity must 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 load capacity and pollutant source loads vary, and not necessarily in concert, determining critical conditions can be more complicated than it may initially appear.

Another step in a load analysis is quantifying current pollutant loads by source. This step allows for the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary for pollutant trading to occur. A load is fundamentally a quantity of 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 (40 CFR 130.2). 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 temperature, EPA allows for seasonal or annual loads.

5.1 Instream Water Quality Targets

For the Lake Creek temperature TMDL, we utilized a PNV approach. The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09) that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and for temperature TMDLS, the natural level of shade and channel width become the TMDL target. The instream temperature that results from attaining these conditions is consistent with the water quality standards, even if it exceeds numeric temperature criteria. See Appendix B for further discussion of water quality standards and natural background provisions.

The PNV approach is described briefly below. The procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in detail in *The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual* (Shumar and De Varona 2009). The manual also provides a more complete discussion of shade and its effects on stream water temperature.

5.1.1 Factors Controlling Water Temperature in Streams

There are several important contributors of heat to a stream, including ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most controllable. The parameters that affect the amount of solar radiation hitting a stream throughout its length are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Stream morphology (i.e., structure) affects riparian vegetation density and water storage in the alluvial aquifer. Riparian vegetation and channel morphology are the factors influencing shade that are most likely to have been influenced by anthropogenic activities and can be most readily corrected and addressed by a TMDL.

Riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. However, depending on how much vertical elevation surrounds the stream, vegetation further away from the riparian corridor can also provide shade. We can measure the amount of shade that a stream receives in a number of ways. Effective shade (i.e., that shade provided by all objects that intercept the sun as it makes its way across the sky) can be measured in a given location with a Solar Pathfinder or with other optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and stream aspect.

In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream and can be measured using a densiometer or estimated visually either on-site or using aerial photography. All of these methods provide information about how much of the stream is covered and how much is exposed to direct solar radiation.

5.1.2 Potential Natural Vegetation for Temperature TMDLs

PNV along a stream is that riparian plant community that could grow to an overall mature state, although some level of natural disturbance is usually included in the development and use of shade targets. Vegetation can be removed by disturbance either naturally (e.g., wildfire, disease/old age, wind damage, wildlife grazing) or anthropogenically (e.g., domestic livestock grazing, vegetation removal, erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural level of solar load to the stream without any anthropogenic removal of shade-producing vegetation. Vegetation levels less than PNV (with the exception of natural levels of disturbance and age distribution) result in the stream heating up from anthropogenically created additional solar inputs.

We can estimate PNV (and therefore target shade) from models of plant community structure (shade curves for specific riparian plant communities), and we can measure or estimate existing canopy cover or shade. Comparing the two (target and existing shade) tells us how much excess solar load the stream is receiving and what potential exists to decrease solar gain. Streams disturbed by wildfire, flood, or some other natural disturbance will be at less than PNV and require time to recover. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery.

Existing and PNV shade levels were converted to solar loads from data collected on flat-plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations collecting these data. In this case, we used the Missoula, MT station. The difference between existing and target solar loads, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (see Appendix B).

PNV shade and the associated solar loads are assumed to be the natural condition; thus, stream temperatures under PNV conditions are assumed to be natural (so long as no point sources or other anthropogenic sources of heat exist in the watershed) and are considered to meet the requirements of the Idaho water quality standards, even if they exceed numeric criteria by more than 0.3 °C.

5.1.2.1 Existing Shade Estimates

Existing shade was estimated for one AU of Lake Creek from visual interpretation of aerial photos. Estimates of existing shade based on plant type and density were marked out as stream segments on a 1:100,000- or 1:250,000-scale hydrography taking into account natural breaks in vegetation density. Stream segment length for each estimate of existing shade varies depending on the land use or landscape that has affected that shade level. Each segment was assigned a single value representing the bottom of a 10% shade class (adapted from the cumulative watershed effects process, IDL 2000). For example, if shade for a particular stream segment was estimated somewhere between 50% and 59%, we assigned a 50% shade class to that segment. Doing so provides an inherent margin of safety to the resulting TMDL.

The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and stream width. Streams where the banks and water are clearly visible are usually in low shade classes (10%, 20%, or 30%). Streams with dense forest or heavy brush where no portion of the stream is visible are usually in high shade classes (70%, 80%, or 90%). More open canopies where portions of the stream may be visible usually fall into moderate shade classes (40%, 50%, or 60%).

Visual estimates made from aerial photos are strongly influenced by canopy cover and do not always take into account topography or any shading that may occur from physical features other than vegetation. It is not always possible to visualize or anticipate shade characteristics resulting from topography and landform. However, research has shown that shade and canopy cover measurements are remarkably similar (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade. The visual estimates of shade in this TMDL were partially field verified with a Solar Pathfinder, which measures effective shade and takes into consideration other physical features that block the sun from hitting the stream surface (e.g., hillsides, canyon walls, terraces, and human-made structures).

Solar Pathfinder Field Verification

The accuracy of the aerial photo interpretations was field verified with a Solar Pathfinder at four sites (Table 5). The Solar Pathfinder is a device that allows one to trace the outline of shade-producing objects on monthly solar path charts. The percentage of the sun’s path covered by these objects is the effective shade on the stream at the location where the tracing is made. To adequately characterize the effective shade on a stream segment, ten traces are taken at systematic or random intervals along the length of the stream in question.

At each sampling location, the Solar Pathfinder was placed in the middle of the stream at about the bankfull water level. Ten traces were taken following the manufacturer’s instructions (i.e., orient to south and level). Systematic sampling was used because it is easiest to accomplish without biasing the sampling location. For each sampled segment, the sampler started at a unique location, such as 50 to 100 meters (m) from a bridge or fence line, and proceeded upstream or downstream taking additional traces at fixed intervals (e.g., every 50 m, 50 paces, etc.).

Alternatively, one can randomly locate points of measurement by generating random numbers to be used as interval distances.

When possible, the sampler also measured bankfull widths, took notes, and photographed the landscape of the stream at several unique locations while taking traces. Special attention was given to changes in riparian plant communities and what kinds of plant species (the large, dominant, shade-producing ones) were present. One can also take densiometer readings at the same location as Solar Pathfinder traces. These readings provide the potential to develop relationships between canopy cover and effective shade for a given stream.

The four Solar Pathfinder sites on Lake Creek showed a general tendency of the original aerial interpretation to underestimate shade (Table 5). The average difference between that interpretation and Solar Pathfinder data was an underestimate of 2 classes ± 1.60 (mean ± 95% confidence interval). One site showed an accurate interpretation, whereas the other three sites were underestimated by 20%–40%. These data were used to correct the original interpretation. Existing shade data presented in this document reflect those changes.

Table 5. Solar Pathfinder field verification results at four sites on Lake Creek.

Pathfinder Site	Aerial Classification	Pathfinder Measurement	Pathfinder Classification	Classification Difference[a]
Site #1	40	60.4	60	-2
Site #2	40	68.2	60	-2
Site #3	20	63.6	60	-4
Site #4	10	15.7	10	0

[a] Mean = -2, Standard Deviation = 1.63, Confidence Level (95%) = 1.60

5.1.2.2 Target Shade Determination

PNV targets were determined from an analysis of probable vegetation at the streams and comparing that to shade curves developed for similar vegetation communities in Idaho (Shumar and De Varona 2009). A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, shade decreases as vegetation has less ability to shade the center of wide streams. As the vegetation gets taller, the more shade the plant community is able to provide at any given channel width.

Natural Bankfull Widths

Stream width must be known to calculate target shade since the width of a stream affects the amount of shade the stream receives. Bankfull width is used because it best approximates the width between the points on either side of the stream where riparian vegetation starts. Measures of current bankfull width may not reflect widths present under PNV (i.e., natural widths). As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase such that streams become wider and shallower. Shade produced by vegetation covers a lower percentage of the water surface in wider streams, and widened streams can also have less vegetative cover if shoreline vegetation has eroded away.

Since existing bankfull width may not be discernible and/or may not reflect natural bankfull widths, this parameter must be estimated from available information. We use regional curves for the major basins in Idaho—developed from data compiled by Diane Hopster of the Idaho Department of Lands—to estimate natural bankfull width (Figure 2).

For each stream evaluated in the load analysis, natural bankfull width was estimated based on the drainage area of the Clearwater curve from Figure 2. Although estimates from other curves were examined (i.e., Spokane, Kootenai, Pend Oreille), the Clearwater curve was ultimately chosen because of its proximity to the Lake Creek watershed and similar climate and geology. According to the Clearwater curve, the Lake Creek width varies from 10 m at the top of the AU (below Goose Creek) to 11 m at the mouth (Table 6).

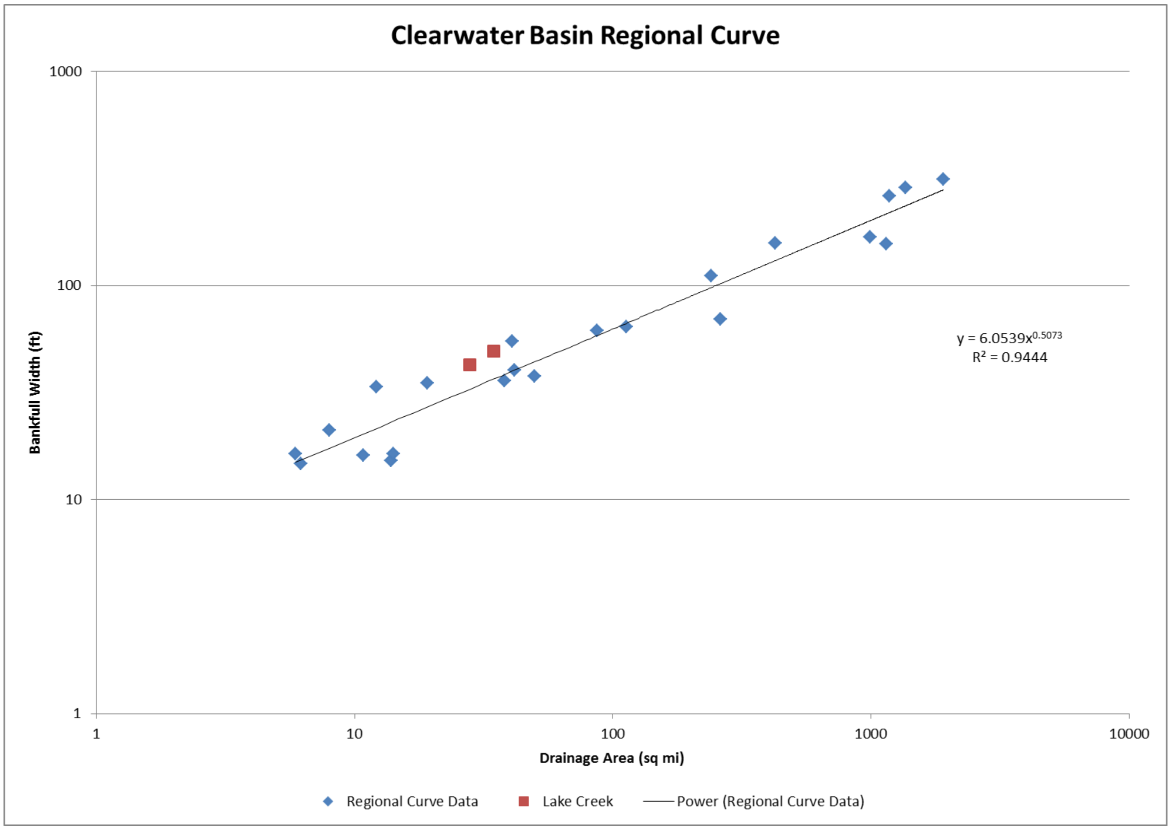

Figure 2. Bankfull width as a function of drainage area.

Table 6. Channel widths for Lake Creek as estimated by regional curves and field measurements.

Location	Area (square miles)	Spokane	Kootenai	Pend Oreille	Clearwater
		(meters)			
Lake Creek a Mouth	34.5	14	12	11	11
Lake Creek below Goose Creek	27.9	12	11	10	10
Lake Creek above Goose Creek	13.6	9	7	7	7
Goose Creek at Mouth	14.3	9	8	7	7

Existing width data should also be evaluated and compared to these curve estimates if such data are available. For the Lake Creek AU, existing width was examined on 2015 aerial photos

(Figure 3). Thirty points located systematically from the top of the AU to the bottom reveal variable channel widths. A four-point moving average was computed in order to smooth out the variation. The Lake Creek AU appears to transition from an average of 13 m wide to about 15 m wide through the length of the AU (Figure 3).

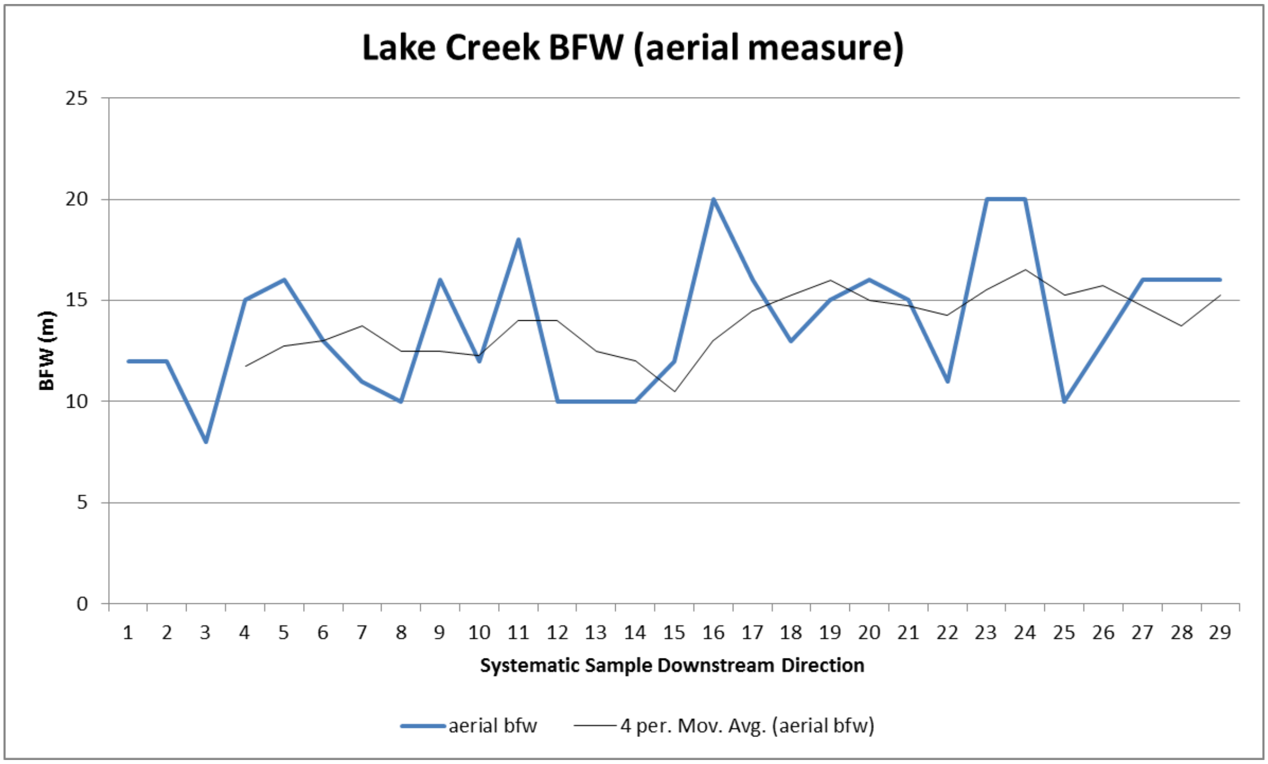

Figure 3. Bankfull width estimates from aerial photos for Lake Creek.

In general, we found existing bankfull width data to be slightly larger than predicted natural bankfull width estimates from the Clearwater curve. However, Lake Creek widths (13 to 15 m) are still within the normal variability of data used to generate the Clearwater curve (Figure 2). Therefore, we have chosen to make natural widths larger than these Clearwater curve estimates to match existing estimates. Existing widths and natural widths are the same in load tables when no data support making them differ. In this case, natural widths are set to match existing widths that are generally wider than curve-estimated widths.

Design Conditions

Lake Creek is a headwaters tributary to the UNFCR near the boundary between two Northern Rockies sub-ecoregions, St Joe Shist-Gneiss Level 4 ecoregion to the north and Clearwater Mountains and Breaks Level 4 ecoregion to the south (McGrath et al. 2001).

The St Joe Shist-Gneiss ecoregion is a mountainous area mantled in volcanic ash and prone to landslides. High-gradient stream systems receive episodic sedimentation from slides. Historic logging and log transport through streams has left altered aquatic systems and stream morphologies. Strong Pacific influence results in cedar-hemlock-pine forests, although hemlock is likely absent from the ecoregion’s southern border.

The Clearwater Mountains and Breaks ecoregion is also mantled with thick volcanic ash but over granitics, unlike the shist-gneiss to the north. Here, substantial Pacific maritime influence results in moist coniferous forests that lack hemlock and are transitional between Idaho Panhandle forests and the drier forests of the southern Idaho Batholith.

Shade Curve Selection

To determine PNV shade targets for Lake Creek, effective shade curves from the CNF group were examined (Shumar and De Varona 2009). These curves were produced using vegetation community modeling of Idaho plant communities. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis.

For Lake Creek, curves for the most similar vegetation type were selected for shade target determinations (Table 7). In general, the shade curve for the breaklands landtype was used on lower Lake Creek with the exception of one 1,300-m-long section of low-gradient meadow where an alder-forest mix plant community was found. A special shade curve was developed for this meadow and other shrub meadows and frost pockets found in the upper Clearwater basin. The alder-forest mix shade curve results from setting the first 22 m adjacent to the stream as an alder community (55% canopy density, 5.1-m weighted average height, 2.4-m overhang), and the remaining background as CNF breaklands forest (59% canopy density, 21-m weighted average height, 2.1-m overhang). Table 7 shows that, at the 13-m channel width, the alder-forest mix target is 16% less than the corresponding CNF breaklands target. This difference results from the shorter statured shrub vegetation of the alder-forest mix adjacent to the stream as opposed to taller trees.

Table 7. Shade targets for the Lake Creek vegetation type at two stream widths.

Shade Curve	13 m	15 m
CNF Breaklands	40%	36%
Alder-Forest Mix	24%	0%

5.2 Load Capacity

The load capacity for a stream under PNV is essentially the solar load allowed under the shade targets specified for the segments within that stream. These loads are determined by multiplying the solar load measured by a flat-plate collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e., the percent open or 100% minus percent shade). In other words, if a shade target is 60% (or 0.6), the solar load hitting the stream under that target is 40% of the load hitting the flat-plate collector under full sun.

We obtained solar load data from flat-plate collectors at the NREL weather station in Missoula, MT. The solar load data used in this TMDL analysis are spring/summer averages (i.e., an average load for the 6-month period from April through September). As such, load capacity calculations are also based on this 6-month period, which coincides with the time of year when stream temperatures are increasing, deciduous vegetation is in leaf, and spawning is occurring. During this period, temperatures may affect beneficial uses such as spring and fall salmonid spawning and cold water aquatic life criteria may be exceeded during summer months. Late July and early August typically represent the period of highest stream temperatures. However, solar gains can begin early in the spring and affect not only the highest temperatures reached later in the summer but also salmonid spawning temperatures in spring and fall.

Table 8 and Figure 4 show the PNV shade targets. The table also shows corresponding target summer loads (in kilowatt-hours per square meter per day [kWh/m^2/day] and kWh/day) that serve as the load capacities for the streams. Existing and target loads in kWh/day can be summed for the entire stream or portion of stream examined in a single load analysis table. These total loads are shown at the bottom of their respective columns in the table. Because load calculations involve stream segment area calculations, the segment's channel width, which typically only has one or two significant figures, dictates the level of significance of the corresponding loads. One significant figure in the resulting load can create rounding errors when existing and target loads are subtracted. The totals row of the load table represents total loads with two significant figures in an attempt to reduce apparent rounding errors.

The target load (i.e., load capacity) for the 3rd-order segment of Lake Creek (AU ID17060307CL033_03) was 400,000 kWh/day (Table 8) or 344 million kilocalories per (Mkcal)/day.

5.3 Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (Water Quality Planning and Management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed) but may be aggregated by type of source or area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

Existing loads in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations. There are currently no known permitted point sources in the affected AU. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat-plate collector at the NREL weather station in Missoula. Existing shade data are presented in Table 8 and Figure 5. Like load capacities (target loads), existing loads in Table 8 are presented on an area basis (kWh/m^2/day) and as a total load (kWh/day). Existing loads in kWh/day are also summed for the entire stream or portion of stream examined in a single load analysis table. The difference between target and existing load is also summed for the entire table. Should existing load exceed target load, this difference becomes the excess load (i.e., shade deficit) to be discussed next in the load allocation section and as depicted in the shade deficit figure (Figure 6).

The existing load for the 3rd-order segment of Lake Creek (AU ID17060307CL033_03) was 390,000 kWh/day (Table 8) or 335 Mkcal/day. This existing load is 12,000 kWh/day less than the expected target load.

Table 8. Existing and target solar loads for the 3rd-order segment of Lake Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
033_03	Lake Creek	1	1080	CNF breakland	40%	3.30	13	14,000	46,000	50%	2.75	13	14,000	39,000	(7,000)	0%
033_03	Lake Creek	2	80	CNF breakland	40%	3.30	13	1,000	3,300	40%	3.30	13	1,000	3,300	0	0%
033_03	Lake Creek	3	160	CNF breakland	40%	3.30	13	2,100	6,900	50%	2.75	13	2,100	5,800	(1,100)	0%
033_03	Lake Creek	4	270	CNF breakland	40%	3.30	13	3,500	12,000	30%	3.85	13	3,500	13,000	1,000	-10%
033_03	Lake Creek	5	510	CNF breakland	40%	3.30	13	6,600	22,000	40%	3.30	13	6,600	22,000	0	0%
033_03	Lake Creek	6	1300	alder-forest mix	24%	4.18	13	17,000	71,000	10%	4.95	13	17,000	84,000	13,000	-14%
033_03	Lake Creek	7	230	CNF breakland	36%	3.52	15	3,500	12,000	40%	3.30	15	3,500	12,000	0	0%
033_03	Lake Creek	8	160	CNF breakland	36%	3.52	15	2,400	8,400	30%	3.85	15	2,400	9,200	800	-6%
033_03	Lake Creek	9	220	CNF breakland	36%	3.52	15	3,300	12,000	20%	4.40	15	3,300	15,000	3,000	-16%
033_03	Lake Creek	10	210	CNF breakland	36%	3.52	15	3,200	11,000	40%	3.30	15	3,200	11,000	0	0%
033_03	Lake Creek	11	220	CNF breakland	36%	3.52	15	3,300	12,000	50%	2.75	15	3,300	9,100	(2,900)	0%
033_03	Lake Creek	12	590	CNF breakland	36%	3.52	15	8,900	31,000	60%	2.20	15	8,900	20,000	(11,000)	0%
033_03	Lake Creek	13	220	CNF breakland	36%	3.52	15	3,300	12,000	50%	2.75	15	3,300	9,100	(2,900)	0%
033_03	Lake Creek	14	330	CNF breakland	36%	3.52	15	5,000	18,000	10%	4.95	15	5,000	25,000	7,000	-26%
033_03	Lake Creek	15	660	CNF breakland	36%	3.52	15	9,900	35,000	40%	3.30	15	9,900	33,000	(2,000)	0%
033_03	Lake Creek	16	320	CNF breakland	36%	3.52	15	4,800	17,000	30%	3.85	15	4,800	18,000	1,000	-6%
033_03	Lake Creek	17	340	CNF breakland	36%	3.52	15	5,100	18,000	40%	3.30	15	5,100	17,000	(1,000)	0%
033_03	Lake Creek	18	500	CNF breakland	36%	3.52	15	7,500	26,000	60%	2.20	15	7,500	17,000	(9,000)	0%
033_03	Lake Creek	19	310	CNF breakland	36%	3.52	15	4,700	17,000	30%	3.85	15	4,700	18,000	1,000	-6%
033_03	Lake Creek	20	150	CNF breakland	36%	3.52	15	2,300	8,100	50%	2.75	15	2,300	6,300	(1,800)	0%
							Totals		400,000					390,000	-12,000	

Note: All assessment unit (AU) numbers start with ID17060307CL in all load tables (Table 8). Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

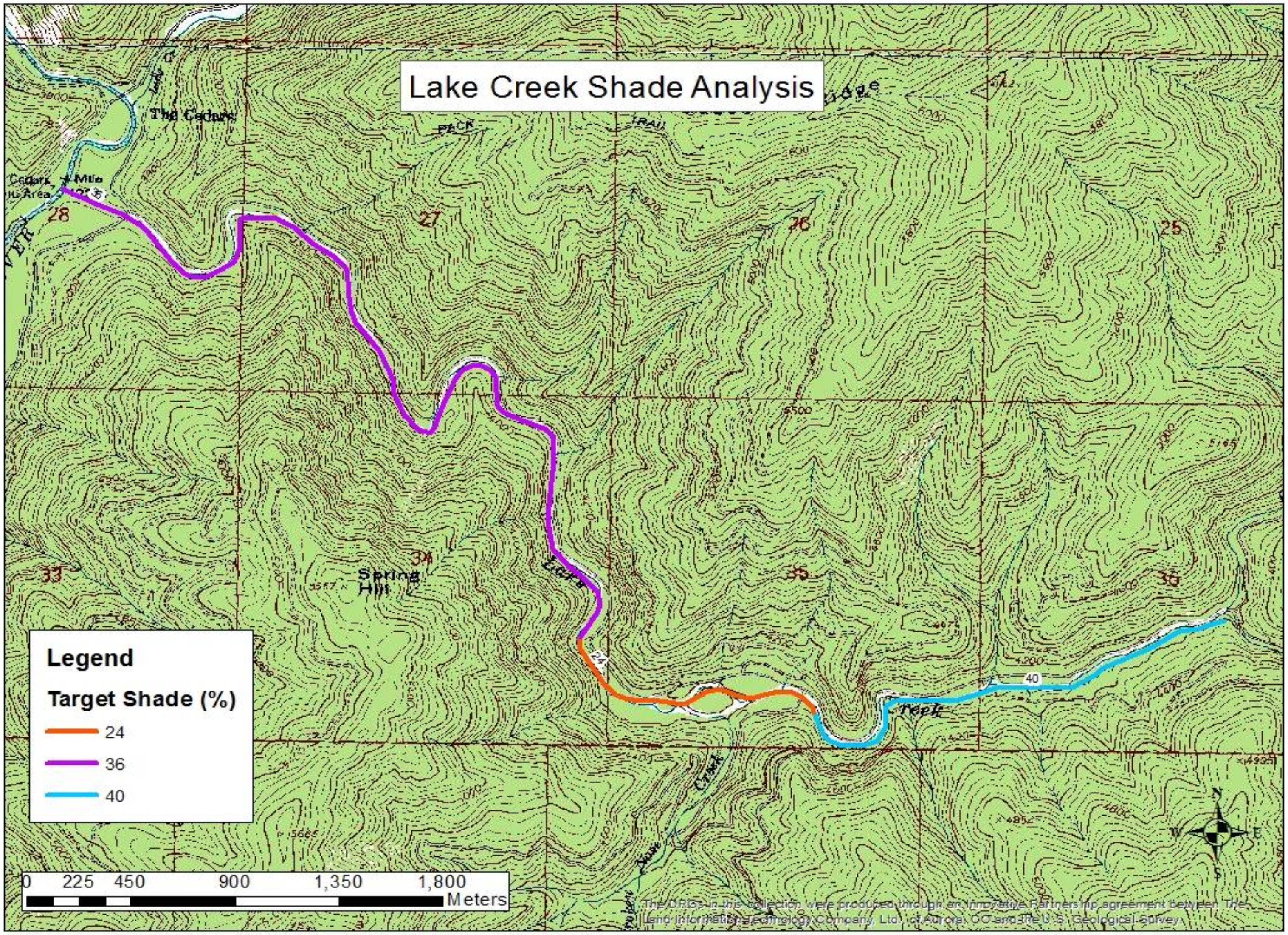

Figure 4. Target shade for Lake Creek.

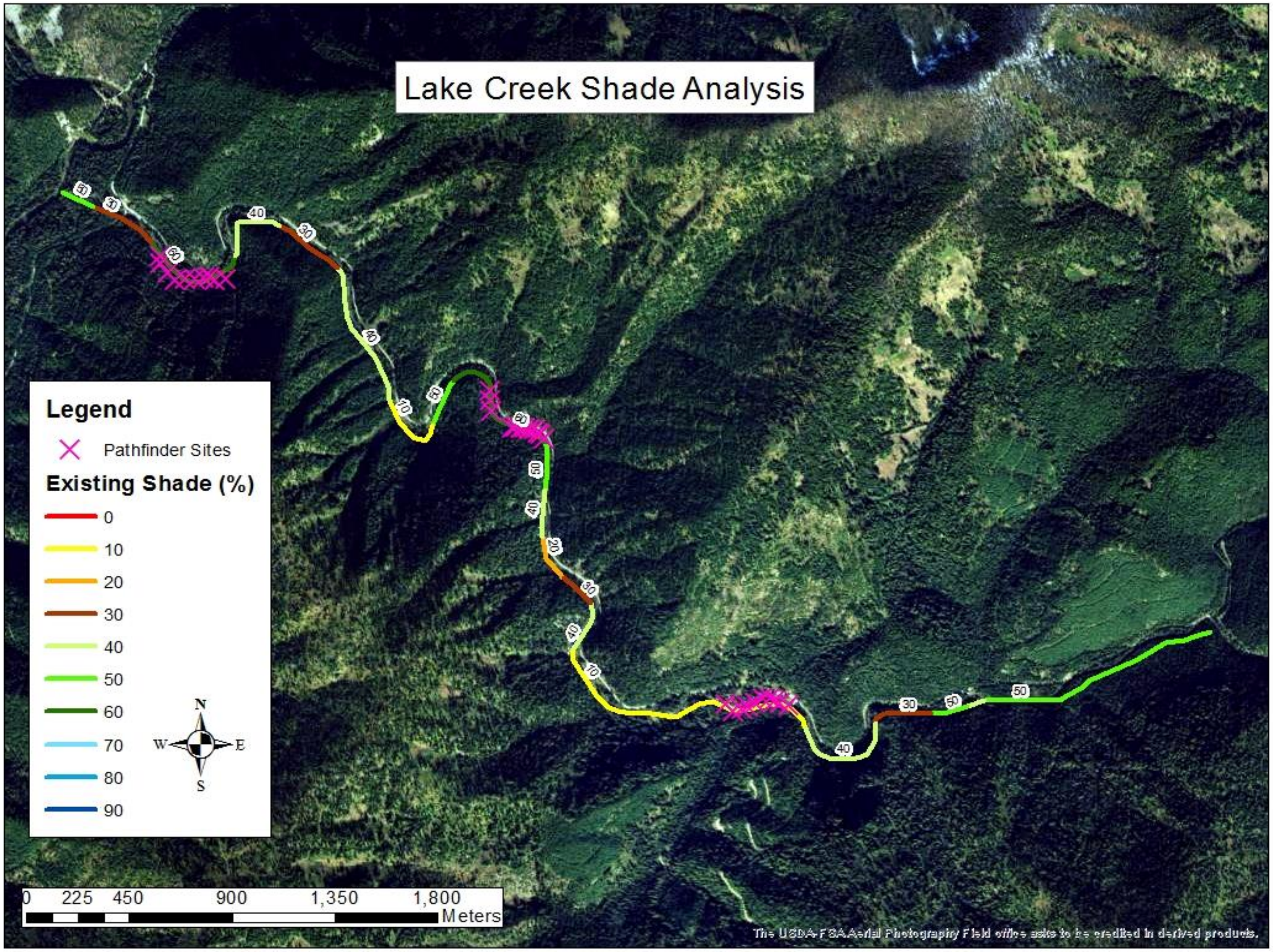

Figure 5. Existing shade estimated for Lake Creek by aerial photo interpretation.

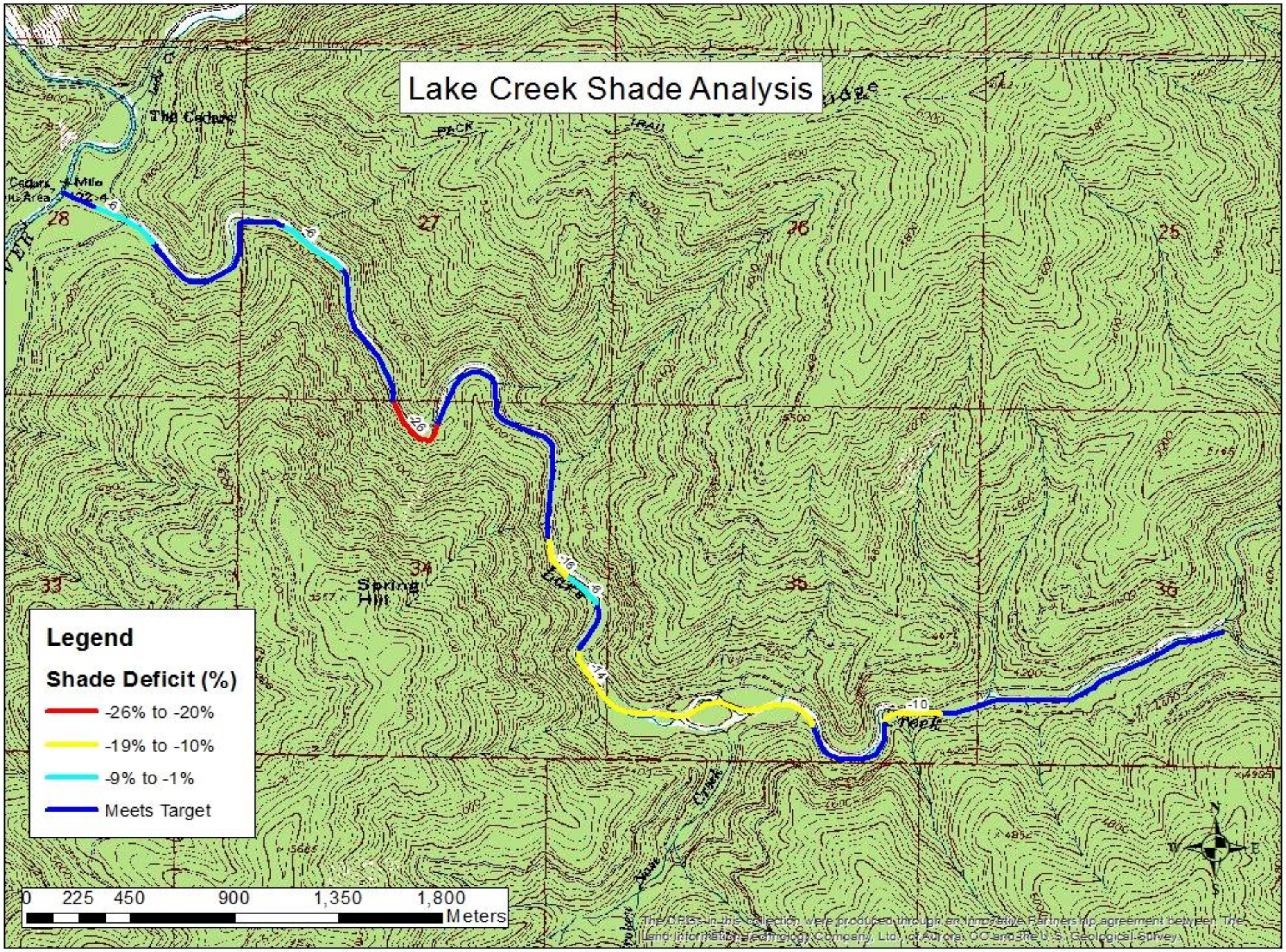

Figure 6. Shade deficit (difference between existing and target) for Lake Creek.

5.4 Load and Wasteload Allocation

Because this TMDL is based on PNV, which is equivalent to natural background loading, the load allocation is essentially the desire to achieve natural background conditions. However, in order to reach that objective, load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade as a whole. Therefore, load allocations are stream segment specific and dependent upon the target load for a given segment. Table 8 shows the target shade and corresponding target summer load. This target load (i.e., load capacity) is necessary to achieve background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL is dependent upon natural background conditions for achieving water quality standards, all tributaries to the waters examined here need to be in natural conditions to prevent excess heat loads to the system.

Table 9 shows the total existing, target, and excess loads and the average lack of shade for each water body examined. The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths.

Although this TMDL analysis focuses on total solar loads, it is important to note that differences between existing and target shade, as depicted in the shade deficit figure (Figure 6), are the key to successfully restoring these waters to achieving water quality standards. Managers should strive to meet target shade levels for individual stream segments with future implementation plans and should prioritize implementation efforts in segments with the largest deficit between existing and target shade. The load analysis table (Table 9) contains a column that lists the lack of shade on the stream segment. This value is derived from subtracting target shade from existing shade for each segment. Thus, stream segments with the largest lack of shade are in the worst shape. The average lack of shade derived from the last column in the load analysis table is listed in Table 9 and provides a general level of comparison among streams.

Table 9. Total solar loads and average lack of shade for all waters.

Water Body/ Assessment Unit Number	Total Existing Load	Total Target Load	Excess Load (% Reduction)	Average Shade Deficit (%)
		(kWh/day)		
Lake Creek (ID17060307CL033_03)	390,000	400,000	0 (0)	-4

Note: Load data are rounded to two significant figures, which may present rounding errors.

Lake Creek lacks some shade in relation to its target PNV shade requirements. Shade deficits vary from -6% to -26%; however, portions of the stream have abundant shade that exceeds targets. This results in an average shade deficit of -4%, however overall the existing load is less than target load; hence, there is no excess solar load to this AU.

A certain amount of excess load is potentially created by the existing shade/target shade difference inherent in the load analysis. Because existing shade is reported as a 10% shade class and target shade is reported as a unique integer between 0 and 100%, there is usually a difference between the two. For example, say a particular stream segment has a target shade of 86% based on its vegetation type and natural bankfull width. If existing shade on that segment were at target level, it would be recorded as 80% in the load analysis because it falls into the 80% existing shade class. There is an automatic difference of 6%, which could be attributed to the margin of safety.

5.4.1 Water Diversion

Stream temperature may be affected by diversions of water for water rights purposes. Diversion of flow reduces the amount of water exposed to a given level of solar radiation in the stream channel, which can result in increased water temperature in that channel. Loss of flow in the channel also affects the ability of the near-stream environment to support shade-producing vegetation, resulting in an increase in solar load to the channel.

Although these water temperature effects may occur, nothing in this TMDL supersedes any water appropriation in the affected watershed. Section 101(g), the Wallop Amendment, was added to the CWA as part of the 1977 amendments to address water rights. It reads as follows:

> It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this chapter. It is the further policy of Congress that nothing in this chapter shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.

Additionally, Idaho water quality standards indicate the following:

> The adoption of water quality standards and the enforcement of such standards is not intended to…interfere with the rights of Idaho appropriators, either now or in the future, in the utilization of the water appropriations which have been granted to them under the statutory procedure… (IDAPA 58.01.02.050.01)

There are no known diversions in this assessment unit therefore, we have not quantified what impact, if any, diversions are having on stream temperature. Water diversions are allowed for in state statute, and it is possible for a water body to be 100% allocated. Diversions notwithstanding, reaching shade targets as discussed in the TMDL will protect what water remains in the channel and allow the stream to meet water quality standards for temperature. This TMDL will lead to cooler water by achieving shade that would be expected under natural conditions and water temperatures resulting from that shade. DEQ encourages local landowners and holders of water rights to voluntarily do whatever they can to help instream flow for the purpose of keeping channel water cooler for aquatic life.

5.4.2 Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially natural background conditions, loads (shade levels) are allocated to lands adjacent to these streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, or more conservative, levels. Additionally, existing shade levels are reduced to the next lower 10% shade class, which on average underestimates actual shade in the load analysis. Although the load analysis used in this TMDL involves gross estimations that are likely to have large variances, load allocations are applied to the stream and its riparian vegetation rather than specific nonpoint source activities and can be adjusted as more information is gathered from the stream environment.

5.4.3 Seasonal Variation

This TMDL is based on average spring-summer loads. All loads have been calculated to be inclusive of the 6-month period from April through September. This time period is when the combination of increasing air and water temperatures coincide with increasing solar inputs and vegetative shade. The critical time periods are April through June when spring salmonid spawning occurs, July and August when maximum temperatures may exceed cold water aquatic life criteria, and September when fall salmonid spawning is most likely to be affected by higher temperatures. Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

5.4.4 Reasonable Assurance

CWA §319 requires each state to develop and submit a nonpoint source management plan. The *Idaho Nonpoint Source Management Plan* was approved by EPA in March 2015 (DEQ 2015). The plan identifies programs to achieve implementation of nonpoint source best management practices (BMPs), includes a schedule for program milestones, outlines key agencies and agency roles, is certified by the state attorney general to ensure that adequate authorities exist to implement the plan, and identifies available funding sources.

Idaho’s nonpoint source management program describes many of the voluntary and regulatory approaches the state will take to abate nonpoint pollution sources. One of the prominent programs described in the plan is the provision for public involvement, including basin advisory groups and watershed advisory groups (WAGs). The Clearwater Basin Advisory Group is the designated WAG for the Lake Creek watershed of the UNFCR subbasin.

The Idaho water quality standards refer to existing authorities to control nonpoint pollution sources in Idaho. Some of these authorities and responsible agencies are listed in Table 10.

Table 10. State of Idaho's regulatory authority for nonpoint pollution sources.

Authority	Water Quality Standard	Responsible Agency
Rules Pertaining to the Idaho Forest Practices Act (IDAPA 20.02.01)	58.01.02.350.03(a)	Idaho Department of Lands
Solid Waste Management Rules and Standards (IDAPA 58.01.06)	58.01.02.350.03(b)	Idaho Department of Environmental Quality
Individual/Subsurface Sewage Disposal Rules (IDAPA 58.01.03)	58.01.02.350.03(c)	Idaho Department of Environmental Quality
Stream Channel Alteration Rules (IDAPA 37.03.07)	58.01.02.350.03(d)	Idaho Department of Water Resources
Rules Governing Exploration, Surface Mining and Closure of Cyanidation Facilities (IDAPA 20.03.02)	58.01.02.350.03(f)	Idaho Department of Lands
Dredge and Placer Mining Operations in Idaho (IDAPA 20.03.01)	58.01.02.350.03(g)	Idaho Department of Lands

Idaho uses a voluntary approach to address agricultural nonpoint sources; however, regulatory authority is found in the water quality standards (IDAPA 58.01.02.350.01–03). IDAPA 58.01.02.055.07 refers to the *Idaho Agricultural Pollution Abatement Plan* (Ag Plan) (ISWCC 2015), which provides direction to the agricultural community regarding approved BMPs. A portion of the Ag Plan outlines responsible agencies or elected groups (soil conservation districts) that will take the lead if nonpoint source pollution problems need to be addressed. For agricultural activity, the Ag Plan assigns the local soil conservation districts to assist the landowner/operator with developing and implementing BMPs to abate nonpoint source pollution associated with the land use. If a voluntary approach does not succeed in abating the pollutant problem, the state may seek injunctive relief for those situations determined to be an imminent and substantial danger to public health or the environment (IDAPA 58.01.02.350.02(a)).

The Idaho water quality standards specify that if water quality monitoring indicates that water quality standards are not being met, even with the use of BMPs or knowledgeable and reasonable practices, the state may request that the designated agency evaluate and/or modify the BMPs to protect beneficial uses. If necessary, the state may seek injunctive or other judicial relief against the operator of a nonpoint source activity in accordance with the DEQ director's authority provided in Idaho Code §39-108 (IDAPA 58.01.02.350). The water quality standards list designated agencies responsible for reviewing and revising nonpoint source BMPs: the Idaho Department of Lands for timber harvest activities, oil and gas exploration and development, and mining activities; Idaho Soil and Water Conservation Commission for grazing and agricultural activities; Idaho Transportation Department for public road construction; Idaho State Department of Agriculture for aquaculture; and DEQ for all other activities (IDAPA 58.01.02.010.24).

5.4.5 Construction Stormwater and TMDL Wasteload Allocation

There are no known National Pollutant Discharge Elimination System (NPDES) permitted point sources in the affected watershed and thus no wasteload allocations. Should a point source be proposed that would have thermal consequences on the water, background provisions in Idaho water quality standards addressing such discharges (IDAPA 58.01.02.200.09; IDAPA 58.01.02.401.01) should be applied (Appendix B).

Stormwater runoff is water from rain or snowmelt that does not immediately infiltrate into the ground and flows over or through natural or human-made storage or conveyance systems. When undeveloped areas are converted to land uses with impervious surfaces—such as buildings, parking lots, and roads—the natural hydrology of the land is altered and can result in increased surface runoff rates, volumes, and pollutant loads. Certain types of stormwater runoff are considered point source discharges for CWA purposes, including stormwater that is associated with municipal separate storm sewer systems, industrial stormwater covered under the Multi-Sector General Permit, and construction stormwater covered under the Construction General Permit. For more information about these permits and managing stormwater, see Appendix D.

5.4.6 Reserve for Growth

A growth reserve has not been included in this TMDL. The load capacity has been allocated to the existing sources in the watershed. Any new sources must obtain an allocation from the existing load allocation.

5.5 Implementation Strategies

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the load analysis table presented in this TMDL (Table 9). This table needs to be updated, first to field verify the remaining existing shade levels and second to monitor progress toward achieving reductions and TMDL goals. Using the Solar Pathfinder to measure existing shade levels in the field is important for achieving both objectives. It is likely that further field verification will find discrepancies with reported existing shade levels in the load analysis table. Due to the inexact nature of the aerial photo interpretation technique, this table should not be viewed as complete until verified. Implementation strategies should include Solar Pathfinder monitoring to simultaneously field verify the TMDL and mark progress toward achieving desired load reductions.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or significant progress is not being made toward achieving the goals. Reasonable assurance (addressed in section 5.4.4) for the TMDL to meet water quality standards is based on the implementation strategy. There may be a variety of reasons that individual stream segments do not meet shade targets, including natural phenomena (e.g., beaver ponds, springs, wet meadows, and past natural disturbances) and/or historic land-use activities (e.g., logging, grazing, and mining). It is important that existing shade for the stream segment be field verified to determine if shade differences are real and result from activities that are controllable. Information within this TMDL (maps and load analysis tables) should be used to guide and prioritize implementation investigations. The information in this TMDL may need further adjustment to reflect new information and conditions in the future.

5.5.1 Time Frame

Implementation of this TMDL relies on riparian area management practices that will provide a mature canopy cover to shade the stream and prevent excess solar loading. Because implementation is dependent on mature riparian communities to substantially improve stream temperatures, DEQ believes 10–20 years may be a reasonable amount of time for achieving water quality standards. Shade targets will not be achieved all at once. Given their smaller bankfull widths, targets for smaller streams may be reached sooner than those for larger streams.

DEQ and the designated advisory group will continue to re-evaluate TMDLs on a 5-year cycle. During the 5-year review, implementation actions completed, in progress, and planned will be reviewed, and pollutant load allocations will be reassessed accordingly.

5.5.2 Approach

Development of the implementation plan for this TMDL will proceed under the existing practice established for the state of Idaho. DEQ, the Clearwater BAG, federal land management agencies, and other watershed stakeholders with input through the established public process will cooperatively develop and implement the plan. Other individuals may be identified to assist in the development of site-specific implementation plans if their areas of expertise are identified as beneficial to the process.

In addition to the designated agencies, the public (through the BAG’s process and other equivalent processes) will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical. Public participation significantly affects public acceptance of the document and the proposed control actions. Stakeholders (landowners, local governing authorities, taxpayers, industries, and land managers) are the most educated regarding the pollutant sources and will be called upon to help identify the most appropriate control actions for each area. Experience has shown that the best and most effective implementation plans are those that are developed with substantial public cooperation and involvement.

5.5.3 Responsible Parties

The USFS actively manages Forest Service lands using federal land management protocols developed to sustain environmental conditions and support natural, recreational, and specific land uses permitted. These land uses are vetted through programs and procedures established by the USFS specifically to meet state and federal regulations for the use of such lands. The USFS should continue to protect the UNFCR subbasin and Lake Creek watershed area of the riparian corridor.

5.5.4 Implementation Monitoring Strategy

Effective shade monitoring can take place on any section of the 3rd-order segment of Lake Creek and be compared to existing shade estimates seen in Figure 5 and described in Table 8. Those areas with the largest disparity between existing and target shade should be periodically monitored with Solar Pathfinders to verify existing shade levels and determine progress toward meeting shade targets. Since many existing shade estimates have not been field verified, they may require adjustment during the implementation process. Stream section length for each estimate of existing shade varies depending on the land use or landscape that has affected that shade level. It is appropriate to monitor within a given existing shade section to see if that section has increased its existing shade toward target levels. Ten equally spaced Solar Pathfinder measurements averaged together within that section should suffice to determine new shade levels in the future.

5.5.5 Pollutant Trading

Pollutant trading (also known as water quality trading) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost-effective, local solutions to problems caused by pollutant discharges to surface waters. Pollutant trading is one of the tools available to meet reductions called for in a TMDL where point and nonpoint sources both exist in a watershed. For additional information, see Appendix E.

6 Conclusions

Effective shade targets were established for lower (3rd-order segment) Lake Creek based on the concept of natural shading under PNV resulting in natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation and partially field verified with Solar Pathfinder data. Target and existing shade levels were compared to determine the amount of shade needed to bring water bodies into compliance with temperature criteria in Idaho's water quality standards (IDAPA 58.01.02). A summary of assessment outcomes, including recommended changes to listing status in the next Integrated Report, is presented in Table 11.

Lower Lake Creek exhibits a minor lack of shade most likely as a result of minor channel widening. The stream on average lacks about 4% shade when compared to target shade values for CNF breaklands forest and alder-forest mix landtypes; however, portions of the stream have abundant shade that exceeds targets. The 3rd-order segment of Lake Creek does not need to reduce solar loads to achieve target solar loading.

Managers should strive to meet target shade levels for individual stream segments with future implementation plans and should prioritize implementation efforts regarding the largest differences between existing and target shade.

Table 11. Summary of assessment outcomes.

Assessment Unit Name	Assessment Unit Number	Pollutant	TMDL(s) Completed	Recommended Changes to Next Integrated Report	Justification
Lake Creek–3rd-Order Segment	ID17060307CL033_03	Temperature	Yes	Move to Category 4a	Lack of existing shade

This document was prepared with input from the public, as described in Appendix F. Following the public comment period, comments and DEQ responses will also be included in this appendix, and a distribution list will be included in Appendix G.

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GIS Coverages

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Glossary

§303(d)
Refers to section 303 subsection "d" of the Clean Water Act. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to US Environmental Protection Agency approval.

Ambient
General conditions in the environment (Armantrout 1998). In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations or specific disturbances such as a wastewater outfall (EPA 1996).

Anthropogenic
Relating to, or resulting from, the influence of human beings on nature.

Assessment Unit (AU)
A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses, and any associated causes and sources must be applied to the entirety of the unit.

Beneficial Use
Any of the various uses of water, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics, that are recognized in water quality standards.

Beneficial Use Reconnaissance Program (BURP)
A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, wadeable streams, and rivers.

Exceedance
A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

Fully Supporting
In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (DEQ 2016a).

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

Load(ing)

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

Load Capacity (LC)

How much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, a margin of safety, and natural background contributions, it becomes a total maximum daily load.

Margin of Safety (MOS)

An implicit or explicit portion of a water body's loading capacity set aside to allow for uncertainty about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.

Natural Condition

The condition that exists with little or no anthropogenic influence.

Nonpoint Source

A dispersed source of pollutants generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point of origin. They include, but are not limited to, irrigated and nonirrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Not Assessed (NA)

A concept and an assessment category describing water bodies that have been studied but are missing critical information needed to complete a use support assessment.

Not Fully Supporting

Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (DEQ 2016a).

Point Source

A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant

Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Pollution

A very broad concept that encompasses human-caused changes in the environment that alter the functioning of natural processes and produce undesirable environmental and health effects. These changes include human-induced alterations of the physical, biological, chemical, and radiological integrity of water and other media.

Potential Natural Vegetation (PNV)

A.U. Küchler (1964) defined potential natural vegetation as vegetation that would exist without human interference and if the resulting plant succession were projected to its climax condition while allowing for natural disturbance processes such as fire. Our use of the term reflects Küchler's definition in that riparian vegetation at PNV would produce a system potential level of shade on streams and includes recognition of some level of natural disturbance.

Riparian

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

Stream Order

Hierarchical ordering of streams based on the degree of branching. A 1st-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher-order streams result from the joining of two streams of the same order.

Total Maximum Daily Load (TMDL)

A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual basis. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Wasteload Allocation (WLA)

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

Water Body

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

Water Quality Criteria

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

Water Quality Standards

State-adopted and US Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Appendix A. Beneficial Uses

Idaho water quality standards (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses.

Existing Uses

Existing uses under the Clean Water Act are “those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards” (40 CFR 131.3). The existing instream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.051.01). Existing uses need to be protected, whether or not the level of water quality to fully support the uses currently exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that supported salmonid spawning since November 28, 1975, but does not now due to other factors, such as blockage of migration, channelization, sedimentation, or excess heat.

Designated Uses

Designated uses under the Clean Water Act are “those uses specified in water quality standards for each water body or segment, whether or not they are being attained” (40 CFR 131.3). Designated uses are simply uses officially recognized by the state. In Idaho, these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Multiple uses often apply to the same water; in this case, water quality must be sufficiently maintained to meet the most sensitive use (designated or existing). Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are described in the Idaho water quality standards (IDAPA 58.01.02.100) and specifically listed by water body in sections 110–160.

Undesignated Surface Waters and Presumed Use Protection

In Idaho, due to a change in scale of cataloging waters in 2000, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated waters ultimately need to be designated for appropriate uses. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called *presumed uses*, DEQ applies the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use (e.g., salmonid spawning) exists, then the additional numeric criteria for salmonid spawning would also apply (e.g., intergravel dissolved oxygen, temperature) because of the requirement to protect water quality for existing uses. However, if for example, cold water aquatic life is not found to be an existing use, a use designation (rulemaking) to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Appendix B. State and Site-Specific Water Quality Standards and Criteria

Water Quality Standards Applicable to Salmonid Spawning Temperature

Water quality standards for temperature are specific numeric values not to be exceeded during the salmonid spawning and egg incubation period, which varies by species. For spring-spawning salmonids, the default spawning and incubation period recognized by the Idaho Department of Environmental Quality (DEQ) is generally March 15 to July 15 (DEQ 2016a). Fall spawning can occur as early as September 1 and continue with incubation into the following spring up to June 1. Per IDAPA 58.01.02.250.02.f.ii., the following water quality criteria need to be met during spawning and incubation periods:

- 13 °C as a daily maximum water temperature
- 9 °C as a daily average maximum water temperature

For the purposes of a temperature TMDL, the highest recorded water temperature in a recorded data set (excluding any high water temperatures that may occur on days when air temperatures exceed the 90th percentile of the highest annual maximum weekly maximum air temperatures) is compared to the daily maximum criterion of 13 °C. The difference between the two water temperatures represents the temperature reduction necessary to achieve compliance with temperature standards.

Natural Background Provisions

For potential natural vegetation temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during certain time periods. If potential natural vegetation targets are achieved yet stream temperatures are warmer than these criteria, it is assumed that the stream's temperature is natural (provided there are no point sources or human-induced ground water sources of heat) and natural background provisions of Idaho water quality standards apply:

> When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, there shall be no lowering of water quality from natural background conditions. Provided, however, that temperature may be increased above natural background conditions when allowed under Section 401. (IDAPA 58.01.02.200.09)

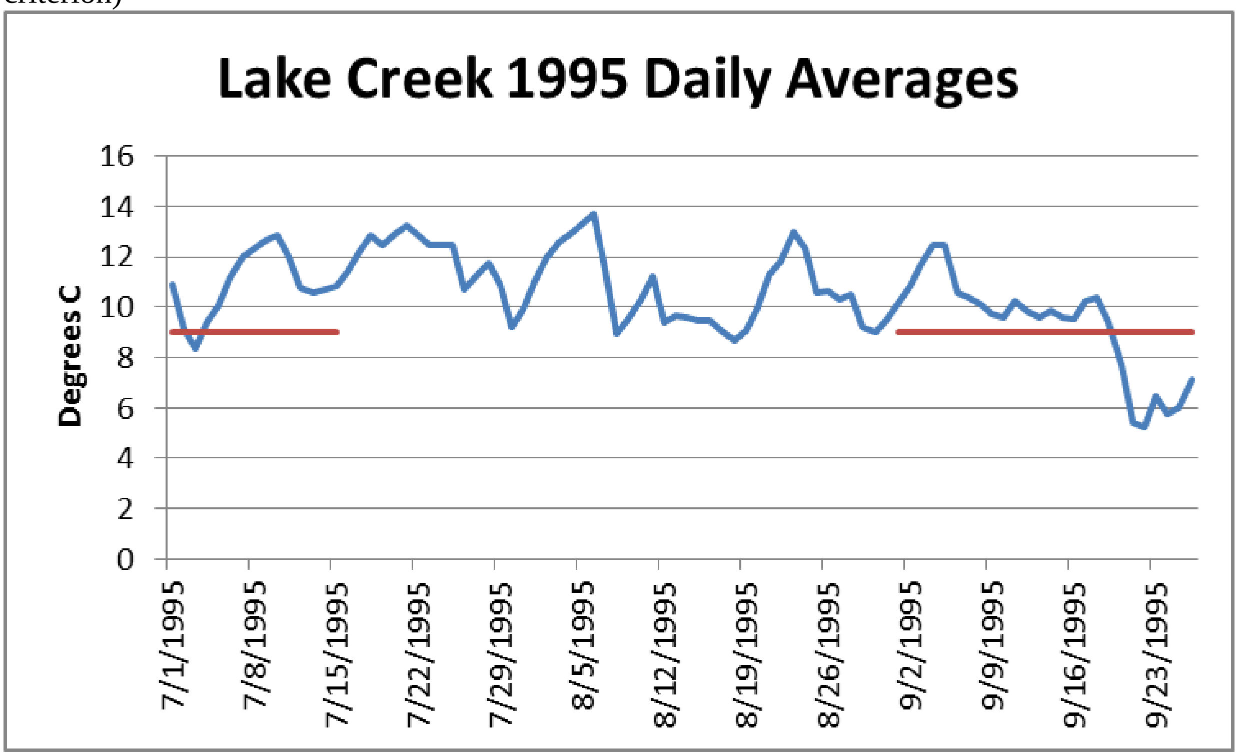
Section 401 relates to point source wastewater treatment requirements. In this case, if temperature criteria for any aquatic life use are exceeded due to natural conditions, then a point source discharge cannot raise the water temperature by more than 0.3 °C (IDAPA 58.01.02.401.01.c).

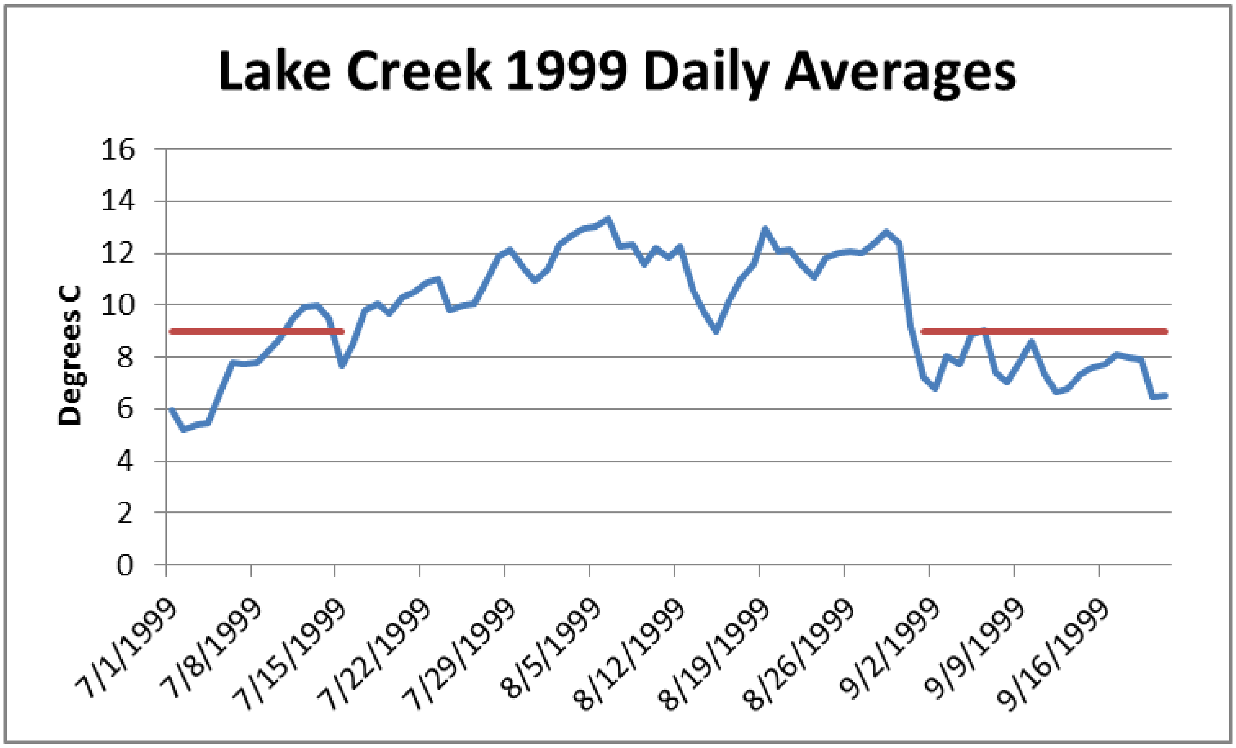
Appendix C. Data Sources and USFS Temperature Data

Table C1. Data sources for Upper NF Clearwater subbasin assessment.

Water Body	Data Source	Type of Data	Collection Date
Lake Creek	DEQ Lewiston Regional Office	Solar Pathfinder effective shade and stream width	August 2013
Lake Creek	DEQ State Technical Services Office	Aerial photo interpretation of existing shade and stream width estimation	August 2013
Lake Creek	DEQ IDASA Database	Temperature	--

Lake Creek Temperature Data from USFS (Red line = 9 °C daily average salmonid spawning criterion)




Lake Creek 1999 Daily Averages
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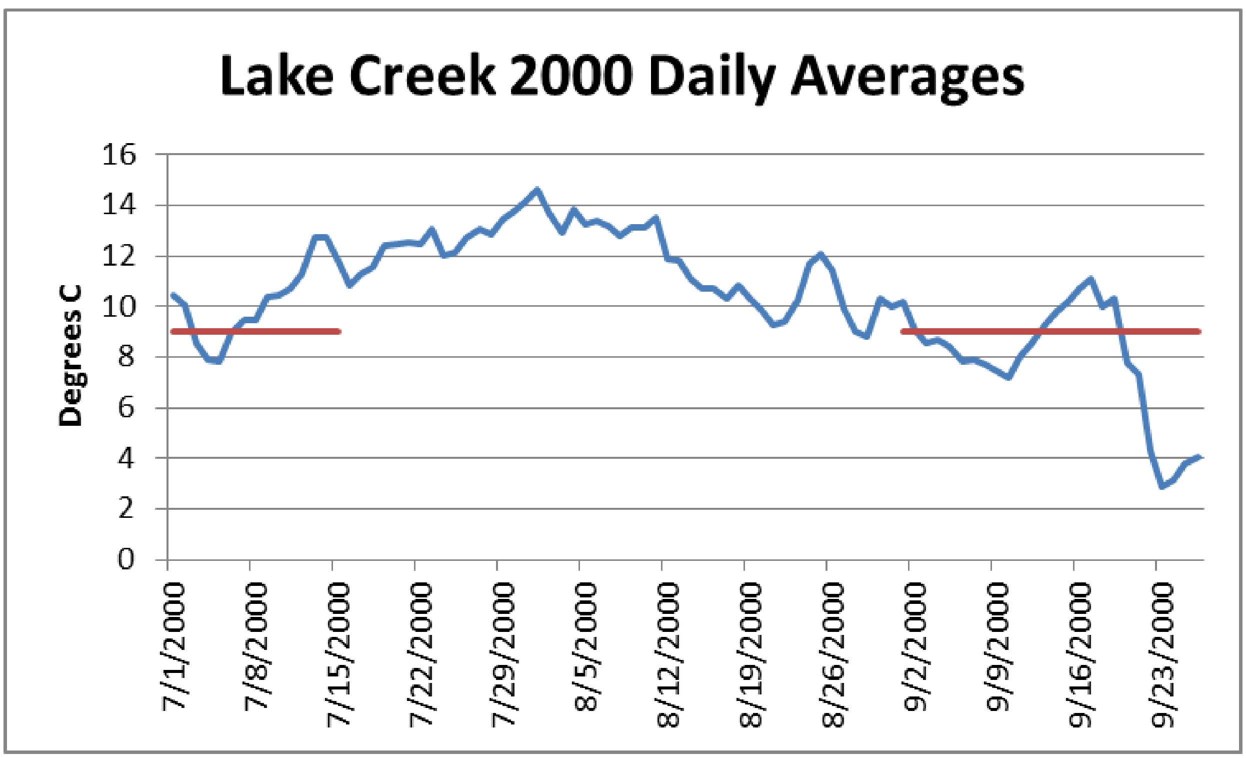
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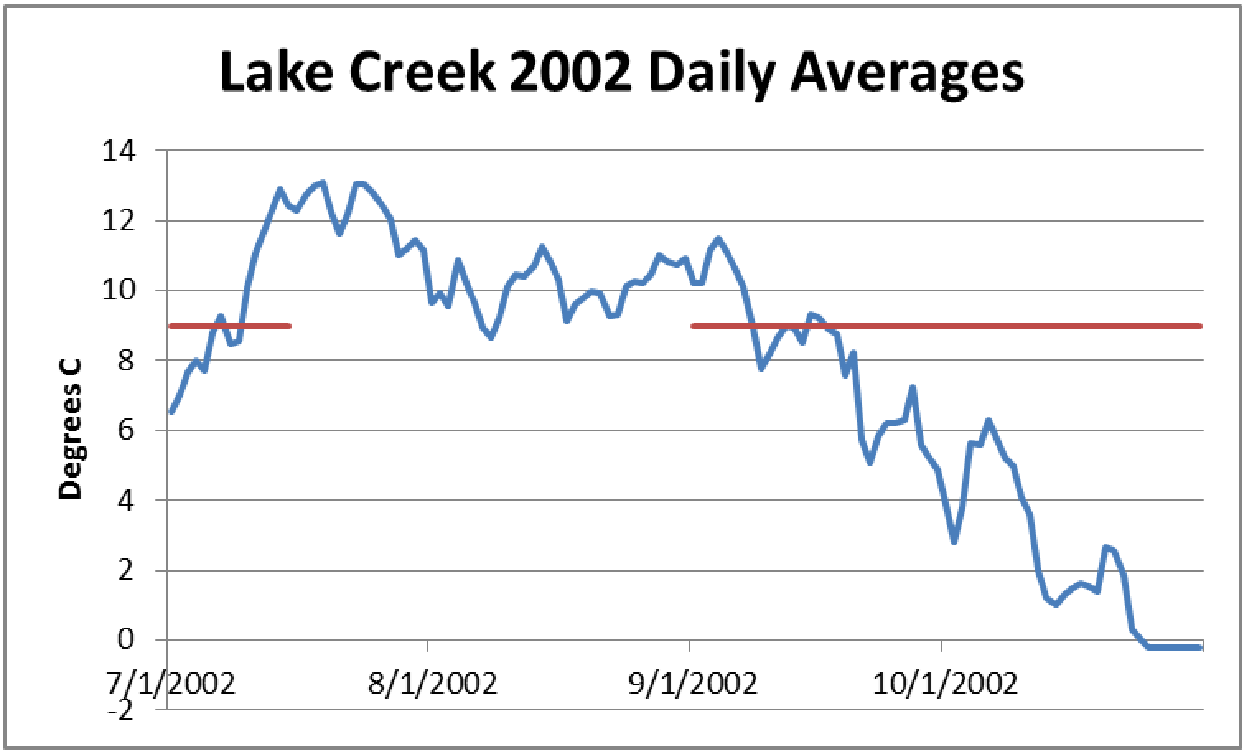
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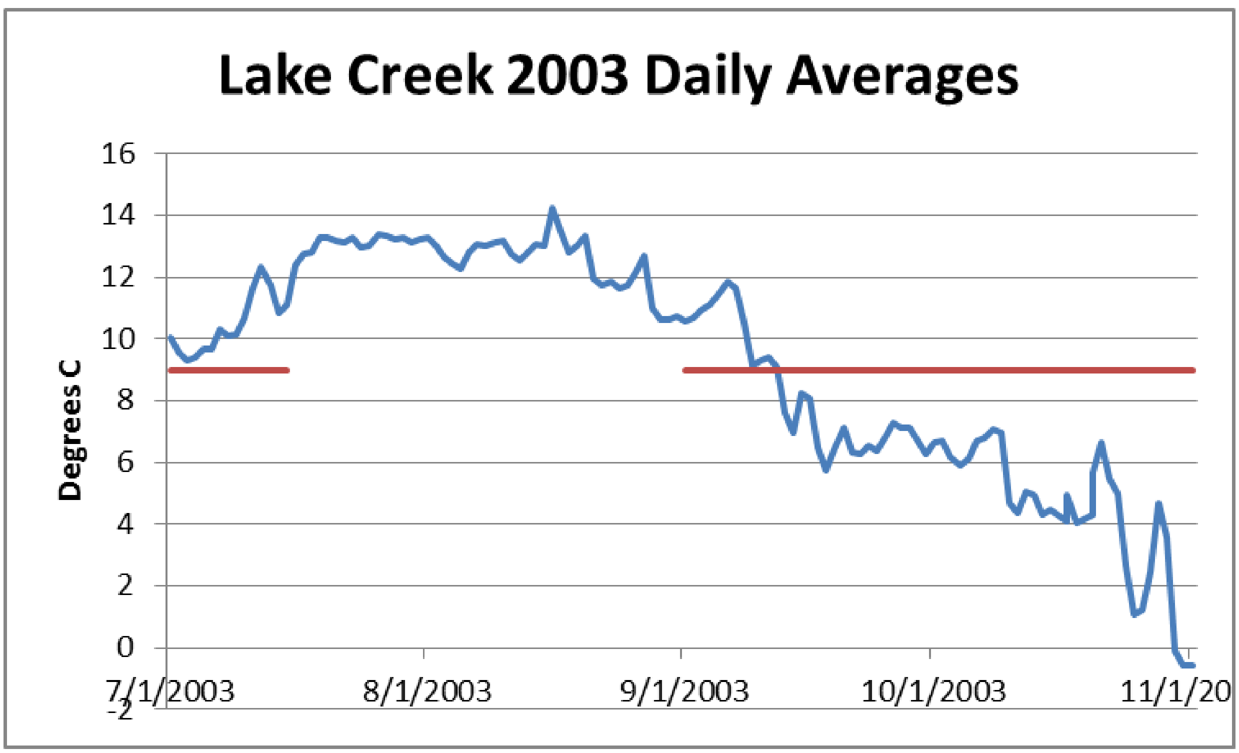
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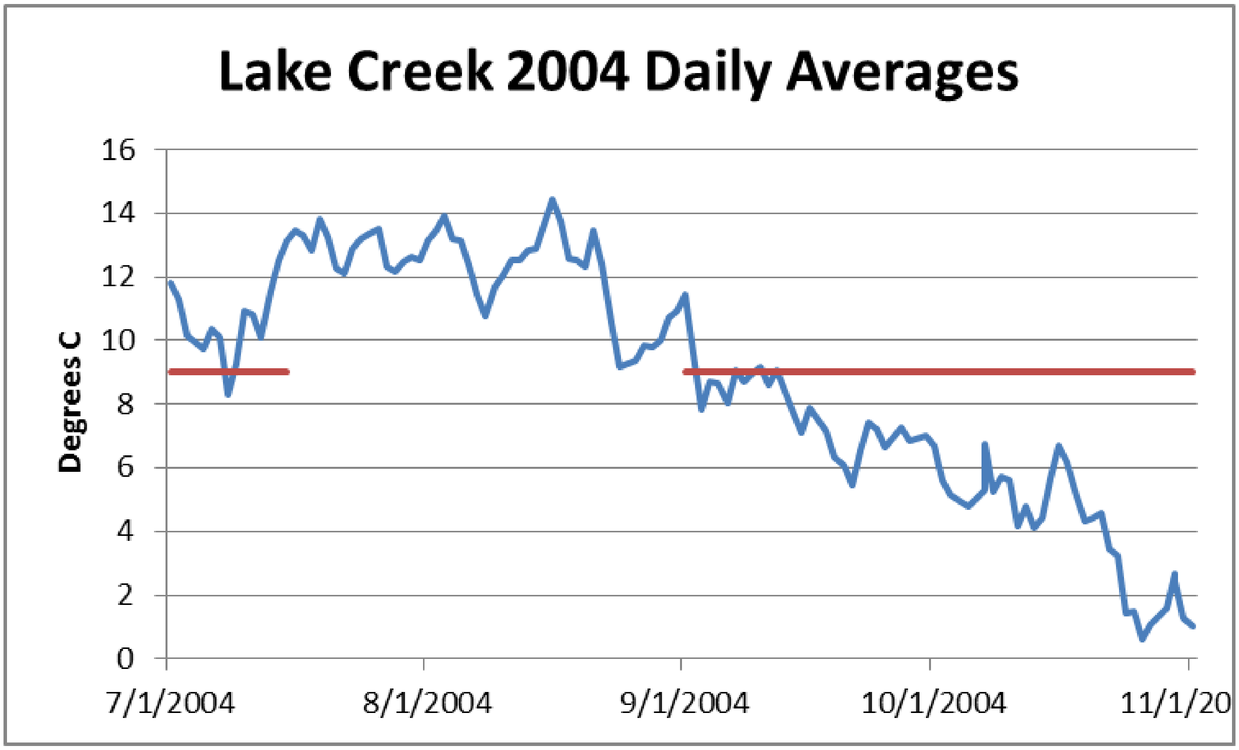
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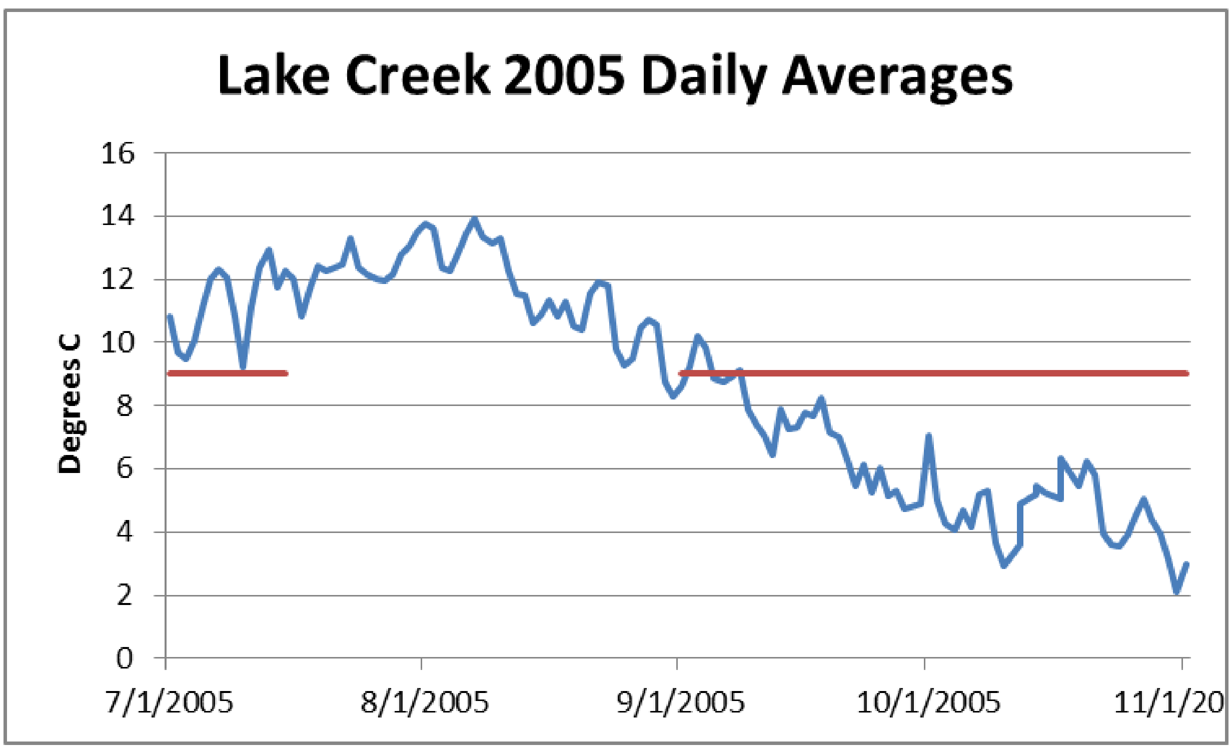
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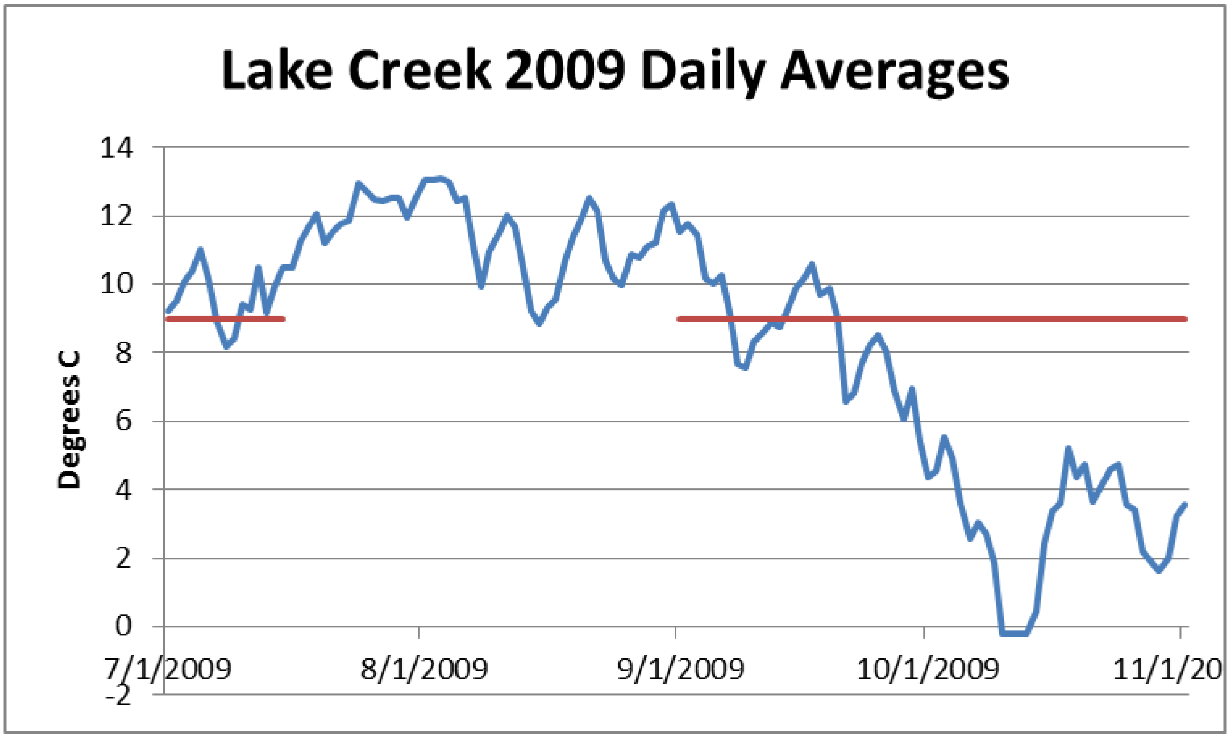
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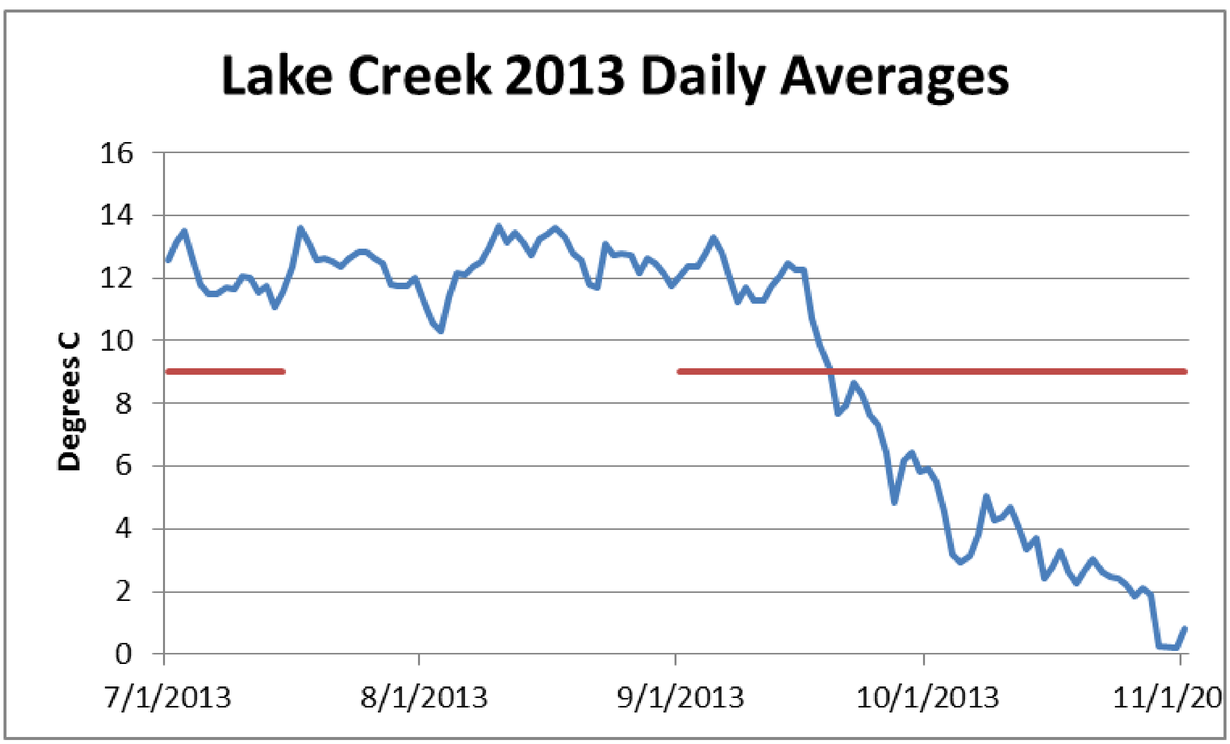
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Appendix D. Managing Stormwater

Construction Stormwater

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge stormwater to a water body or municipal storm sewer. In Idaho, EPA has issued a general permit for stormwater discharges from construction sites.

Construction General Permit (CGP) and Stormwater Pollution Prevention Plans

If a construction project disturbs more than 1 acre of land (or is part of a larger common development that will disturb more than 1 acre), the operator is required to apply for a CGP from EPA after developing a site-specific SWPPP. The SWPPP must provide for the erosion, sediment, and pollution controls they intend to use; inspection of the controls periodically; and maintenance of BMPs throughout the life of the project. Operators are required to keep a current copy of their SWPPP on site or at an easily accessible location.

TMDL Construction Stormwater Requirements

When a stream is on Idaho’s §303(d) list and has a TMDL developed, DEQ may incorporate a gross wasteload allocation for anticipated construction stormwater activities. Most loads developed in the past did not have a numeric wasteload allocation for construction stormwater activities. Construction stormwater activities are considered in compliance with provisions of the TMDL if operators obtain a CGP under the NPDES program and implement the appropriate BMPs. Typically, operators must also follow specific requirements to be consistent with any local pollutant allocations. The CGP has monitoring requirements that must be followed.

Postconstruction Stormwater Management

Many communities throughout Idaho are currently developing rules for postconstruction stormwater management. Sediment is usually the main pollutant of concern in construction site stormwater. DEQ’s *Catalog of Stormwater Best Management Practices for Idaho Cities and Counties* (DEQ 2005) should be used to select the proper suite of BMPs for the specific site, soils, climate, and project phasing in order to sufficiently meet the standards and requirements of the CGP to protect water quality. Where local ordinances have more stringent and site-specific standards, those are applicable.

Appendix E. Pollutant Trading

Pollutant trading (also known as water quality trading) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost-effective, local solutions to problems caused by pollutant discharges to surface waters. Pollutant trading is one of the tools available to meet reductions called for in a TMDL where point and nonpoint sources both exist in a watershed.

The appeal of trading emerges when pollutant sources face substantially different pollutant reduction costs. Typically, a party facing relatively high pollutant reduction costs compensates another party to achieve an equivalent, though less costly, pollutant reduction.

Pollutant trading is voluntary. Parties trade only if both are better off because of the trade, and trading allows parties to decide how to best reduce pollutant loads within the limits of certain requirements.

Pollutant trading is recognized in Idaho's water quality standards at IDAPA 58.01.02.055.06. DEQ allows for pollutant trading as a means to meet TMDLs, thus restoring water quality limited water bodies to compliance with water quality standards. DEQ's *Water Quality Trading Guidance* sets forth the procedures to be followed for pollutant trading (DEQ 2016b).

Trading Components

The major components of pollutant trading are trading parties (buyers and sellers) and credits (the commodity being bought and sold). Ratios are used to ensure environmental equivalency of trades on water bodies covered by a TMDL. All trading activity must be recorded in the trading database by DEQ or its designated party.

Both point and nonpoint sources may create marketable credits, which are a reduction of a pollutant beyond a level set by a TMDL:

- Point sources create credits by reducing pollutant discharges below NPDES effluent limits set initially by the wasteload allocation.
- Nonpoint sources create credits by implementing approved BMPs that reduce the amount of pollutant runoff. Nonpoint sources must follow specific design, maintenance, and monitoring requirements for that BMP; apply discounts to credits generated, if required; and provide a water quality contribution to ensure a net environmental benefit. The water quality contribution also ensures the reduction (the marketable credit) is surplus to the reductions the TMDL assumes the nonpoint source is achieving to meet the water quality goals of the TMDL.

Watershed-Specific Environmental Protection

Trades must be implemented so that the overall water quality of the water bodies covered by the TMDL is protected. To do this, hydrologically based ratios are developed to ensure trades between sources distributed throughout TMDL water bodies result in environmentally equivalent or better outcomes at the point of environmental concern. Moreover, localized adverse impacts to water quality are not allowed.

Trading Framework

For pollutant trading to be authorized, it must be specifically mentioned within a TMDL document. After adoption of an EPA-approved TMDL, DEQ, in concert with the WAG, must develop a pollutant trading framework document. The framework would mesh with the implementation plan for the watershed that is the subject of the TMDL. The elements of a trading document are described in DEQ’s pollutant trading guidance (DEQ 2016b).

Appendix F. Public Participation and Public Comments

This TMDL was developed with participation from the United States Forest Service (USFS)and the Clearwater Basin Advisory Group (BAG). The USFS is the primary land manager for the watershed and actively manages land use within the watershed. The Clearwater BAG was requested to act on behalf of a local watershed advisory group because of the remote nature of the watershed.

The Clearwater BAG concurred to provide a 30-day public comment period for the draft Lake Creek Temperature TMDL during the March 2017 Clearwater BAG meeting. Notice was provided to the general public through the *Clearwater Tribune* and the DEQ website of the opportunity to comment from March 15, 2018 through April 16, 2018. Copies of the document were made available through the DEQ Lewiston Regional Office and were available for download on the website.

No comments were received during the public comment period.

Appendix G. Distribution List

Clearwater Basin Advisory Group

Department of Environmental Quality – State Office

Department of Environmental Quality – Lewiston Regional Office

US Environmental Protection Agency – Idaho Operations Office