Palouse River Subbasin

2017 Temperature TMDL

Hydrologic Unit Code 17060108

Final

State of Idaho
Department of Environmental Quality

June 2017

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Prepared by
Idaho Department of Environmental Quality
Lewiston Regional Office
1118 F Street
Lewiston, ID 83501

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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

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

Ag Plan Idaho Agricultural Pollution Abatement Plan

AU assessment unit

BMP best management practice

BOD biochemical oxygen demand

BURP Beneficial Use Reconnaissance Program

C Celsius

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

CGP Construction General Permit

CW cold water aquatic life

CWA Clean Water Act

DEQ Idaho Department of Environmental Quality

E. coli *Escherichia coli*

EPA United States Environmental Protection Agency

FS fully supporting

ft feet

GIS geographic information system

IDAPA Refers to citations of Idaho administrative rules

KWh kilowatt-hour

LA load allocation

LC load capacity

m meter

mi mile

MOS margin of safety

MS4 Municipal Separate Storm Sewer System

MSGP Multi-Sector General Permit

NA not assessed

NAIP National Agriculture Imagery Program

NB natural background

NFS not fully supporting

NPDES National Pollutant Discharge Elimination System

NREL National Renewable Energy Laboratory

PCEI Palouse-Clearwater Environmental Institute

PNV potential natural vegetation

SCR secondary contact recreation

SFI Stream Fish Index

SHI	Stream Habitat Index
SMI	Stream Macroinvertebrate Index
SS	salmonid spawning
SWPP	stormwater pollution prevention plan
TMDL	total maximum daily load
TP	total phosphorus
TSS	total suspended solids
US	United States
USC	United States Code
USDA	United States Department of Agriculture
WAG	watershed advisory group
WLA	wasteload allocation

Executive Summary

This document addresses the water bodies in the Palouse River subbasin that are in Category 4(a) of Idaho's most recent Integrated Report for temperature impairment. All temperature total maximum daily loads (TMDLs) are being revised to the potential natural vegetation (PNV) style where riparian shade is the dominant influence on heat load to the stream. The TMDL analysis establishes water quality targets and load capacities, estimates existing pollutant loads, and allocates load reductions needed to return listed waters to a condition meeting water quality standards. In compliance with Idaho Code §39-3611(7), the review describes current water quality status, pollutant sources addressed by established TMDLs, and recent pollution control efforts in the Palouse River subbasin to address the TMDLs. Temperature is the only pollutant addressed.

Subbasin at a Glance

The Palouse River subbasin (hydrologic unit code 17060108) covers 407 square miles in northwestern Idaho and borders the state of Washington. The subbasin is sparsely populated with one major town, Moscow, and several other small towns and communities, including Potlatch, Princeton, and Harvard.

The economy of the Palouse is dominated by agriculture and two universities: the University of Idaho and Washington State University. Forestry, livestock grazing, construction, and recreation are other economic factors. All of these factors affect water quality to some degree. The Palouse Prairie is one of the most productive agricultural areas in the world, and agriculture will continue to be the dominant economic force in the subbasin.

Two TMDL documents are addressed that were written for watersheds within the subbasin where temperature was included as the pollutant.

- *Palouse River Tributaries Subbasin Assessment and TMDL* (DEQ 2005a)
- *South Fork Palouse River Watershed Assessment and TMDLs* (DEQ 2007)

These temperature TMDLs were produced using an older method of determining needed percent reductions without estimating daily load. In this document, these temperature TMDLs are being updated to reflect the latest PNV-style temperature method.

Key Findings

The Palouse River watersheds were placed on a §303(d) list of impaired waters, or subsequent lists, for reasons associated with temperature criteria violations, and the Idaho Department of Environmental Quality has developed and revised temperature TMDLs for these waters (Table A).

New effective target shade levels were established for the Palouse River tributaries, and South Fork Palouse River assessment units (AUs) based on the concept of maximum 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 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 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 B.

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

Water Body	Assessment Unit Number	Pollutant
Palouse River tributaries		
Flannigan Creek watershed	ID17060108CL011a_02 ID17060108CL011a_03 ID17060108CL011b_02 ID17060108CL011b_03	Temperature
Hatter Creek watershed	ID17060108CL015a_02 ID17060108CL015b_02 ID17060108CL015b_03	Temperature
Big Creek watershed	ID17060108CL027a_02 ID17060108CL027b_02	Temperature
Gold Creek watershed	ID17060108CL029_02 ID17060108CL029_03 ID17060108CL030_02 ID17060108CL031a_02 ID17060108CL031b_02	Temperature
Deep Creek watershed	ID17060108CL032a_02 ID17060108CL032a_03 ID17060108CL032b_02 ID17060108CL032b_03	Temperature
South Fork Palouse River	ID17060108CL002_03 ID17060108CL003_02 ID17060108CL003_03	Temperature

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

Water Body	Assessment Unit Number	Pollutant	Revised TMDL Completed	Recommended Changes to the Next Integrated Report	Justification
Palouse River tributaries					
Flannigan Creek	ID17060108CL011a_02 ID17060108CL011a_03 ID17060108CL011b_02 ID17060108CL011b_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Hatter Creek	ID17060108CL015a_02 ID17060108CL015b_02 ID17060108CL015b_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Big Creek	ID17060108CL027a_02 ID17060108CL027b_02	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Gold Creek	ID17060108CL029_02 ID17060108CL029_03 ID17060108CL030_02 ID17060108CL031a_02 ID17060108CL031b_02	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Deep Creek	ID17060108CL032a_02 ID17060108CL032a_03 ID17060108CL032b_02 ID17060108CL032b_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
South Fork Palouse River	ID17060108CL002_03 ID17060108CL003_02 ID17060108CL003_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade

Palouse River Tributaries

In the Palouse River tributaries, 17 AUs were placed on the 1998 §303(d) list of impaired waters, or subsequent lists, for temperature criteria violations. Temperature TMDLs were developed and are now being revised for these waters (Table A).

This review of the 2005 approved temperature TMDL reexamined new aerial imagery and assigned new shade targets based on Idaho plant community data. New loads developed in this review should replace 2005 loads. All streams lack shade in the new analysis. Most AUs are at similar levels with respect to shade loss when compared to lack of cover in 2005. A few exceptions exist where conditions are better or worse than previously determined.

South Fork Palouse River

The South Fork Palouse River watershed was placed on the 1998 §303(d) list of impaired waters, or subsequent lists, for temperature criteria violations, and the temperature TMDLs developed for these waters are now being revised (Table A).

This review of the 2007 approved temperature TMDL reexamined new aerial imagery and assigned new shade targets based on Idaho plant community data. New loads developed in this TMDL should replace 2007 loads. In general, most stream conditions changed only slightly as a result of the new analysis. Crumarine Creek is in worse condition, and the South Fork Palouse

River is in better condition when compared to the original TMDL. All streams examined lack shade to some degree.

For the watersheds discussed, target shade levels for individual stream segments should be the goal managers strive for with future implementation plans. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts.

Public Participation

The general public had the opportunity to comment on this draft document during the public comment period.

Introduction

This document addresses two water bodies (Palouse River tributaries and South Fork Palouse River) in the Palouse River subbasin that have been placed in Category 4a of Idaho's most recent federally approved Integrated Report (DEQ 2014). This total maximum daily load (TMDL) documents pollutant loads within the Palouse River subbasin and presents key characteristics and updated information for the subbasin assessment, including subbasin characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts. While the subbasin assessment is not a requirement of the TMDL, the Idaho Department of Environmental Quality (DEQ) performs the assessment to ensure the impairment listings are up-to-date and accurate.

The subbasin assessment develops TMDLs for the pollutant of concern in the subbasin to improve water quality by limiting pollutant loads (section 5). 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). A TMDL is water body- and pollutant-specific and allocates allowable discharges among the various sources discharging the pollutant.

Regulatory Requirements

This document was prepared in compliance with both federal and state regulatory requirements. The federal government, through the US 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, or 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 U.S.C. §1251). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. The act 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.

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 CWA §303, 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.

CWA §303(d) 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." 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 Characteristics

The Palouse River subbasin (hydrologic unit code 17060108) covers 407 square miles in northwestern Idaho and borders the state of Washington. The subbasin is a sparsely populated area with one major town, Moscow, and several other small towns and communities, including Potlatch, Princeton, and Harvard. Ranching/grazing, farming, logging, and mining were the main economic resources in the area. Mining, logging, farming, grazing, and urbanization have had the greatest influence on the landscape in the Palouse in past 150 years. The establishment of the University of Idaho and Washington State University in the late 1880s as land grant colleges increased the population in the Palouse.

Most of the wetlands and floodplains in the Palouse Prairie have been eliminated by modern land use, urbanization, and transportation infrastructure. These activities have affected instream flows, channel sinuosity, and habitat diversity. In addition, the topography, soils, and climate make the Palouse River subbasin very susceptible to erosion. Land uses that contribute excess sediment, nutrients, and bacteria to the river, as well as altering shade that blocks solar loads, can degrade water quality.

The economy of the Palouse is dominated by agriculture and the two universities. Forestry, livestock, grazing, construction, and recreation are other economic factors. All of these factors affect water quality to some degree. The Palouse Prairie is one of the most productive agricultural areas in the world and agriculture will continue to be the dominant economic force in the subbasin.

1.1 Interstate Waters

The South Fork Palouse River flows from Idaho into Washington. CWA requires interstate waters meet downstream receiving water state standards when the water body crosses state lines. Idaho designated the South Fork Palouse River for cold water aquatic life and contact recreation beneficial uses. These designated beneficial uses are considered to be comparable to the aquatic life and recreational beneficial uses designated by Washington for those streams. Both Idaho and Washington water quality standards are approved by EPA for adequacy in protection of aquatic life and recreational beneficial uses.

1.2 2005 Palouse River Tributaries Subbasin Assessment and TMDL

The *Palouse River Tributaries Subbasin Assessment and TMDL* addressed six water bodies in the Palouse River subbasin: Big, Deep, Flannigan, Hatter, Gold, and Rock Creeks (Figure 1) (DEQ 2005a). The pollutants in the Palouse River subbasin are from nonpoint sources, including erosion, solar radiation, livestock, fertilizers, and septic systems.

The headwaters of the Palouse River originate in the Hoodoo Mountains of the St. Joe National Forest. The Palouse River and most of its tributaries originate in forested, mountainous terrain and flow downstream into the lower gradient rolling hill terrain of the Palouse River subbasin, which is dominated by agricultural uses. The *Palouse River Tributaries Subbasin Assessment and TMDL* written for sediment (total suspended solids [TSS]), temperature, bacteria (*Escherichia coli [E. coli]*), and nutrients (total phosphorus [TP]) was approved by EPA in 2005: *www.deq.idaho.gov/media/463321-_water_data_reports_surface_water_tmdls_palouse_river_tribs_palouse_river_tribs_entire.pdf*.

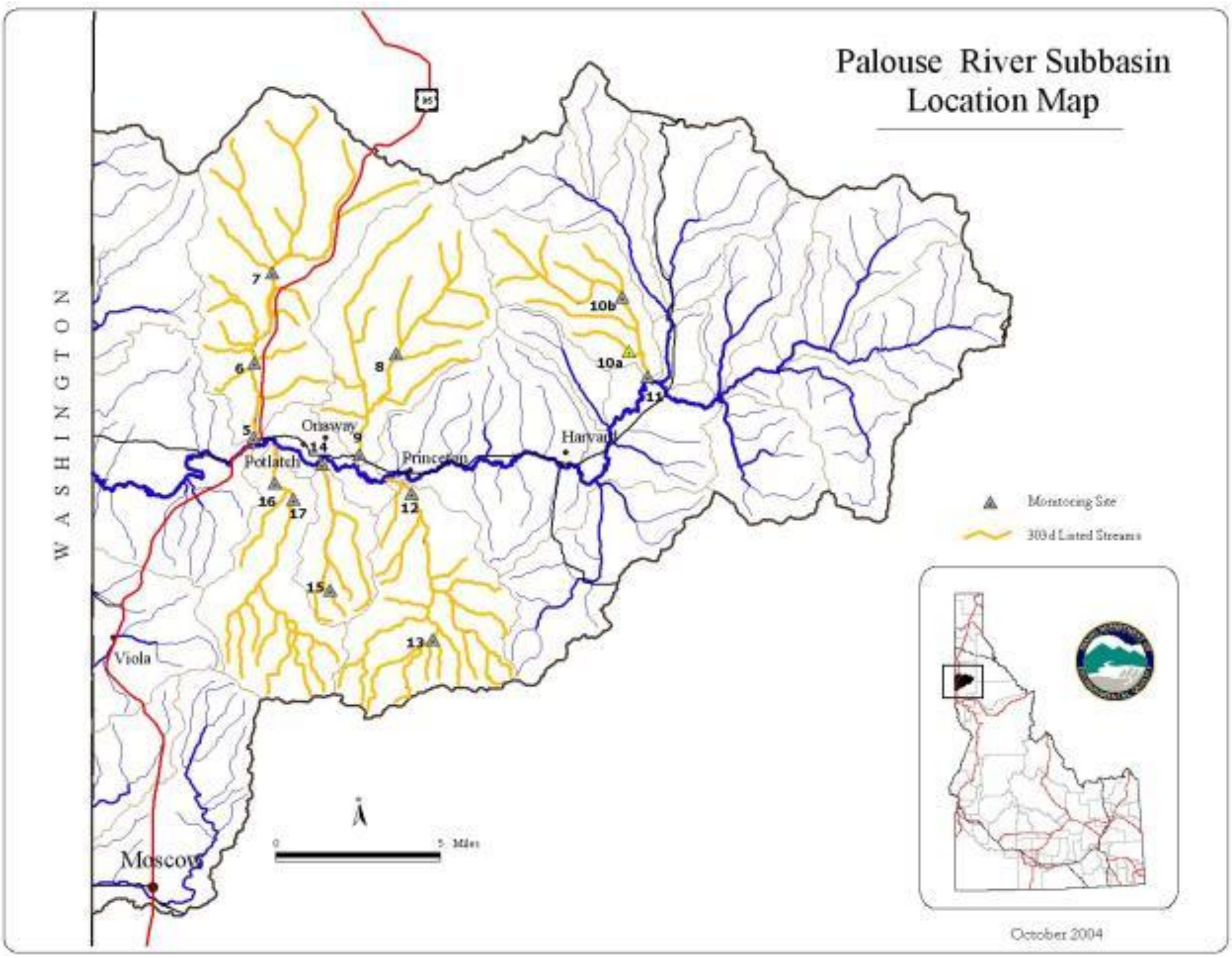


Figure 1. Location of Palouse River subbasin with Palouse River tributary TMDL §303(d) water bodies.

1.3 2007 South Fork Palouse River Watershed Assessment and TMDLs

The South Fork Palouse River drains from the southern slope of Moscow Mountain, skirts the south side of Moscow, and enters Washington upstream of Pullman (Figure 2). The watershed is approximately 30 square miles (19,200 acres).

TMDLs were established for *E. coli* bacteria and temperature throughout the watershed, and for sediment and nutrients in specific portions of the watershed. In addition to nonpoint source load allocations, February and March wasteload allocations were developed for the Syringa Mobile Home Park and Country Homes Mobile Park, both of which discharged small amounts of wastewater to the river from wastewater lagoons. These wasteload allocations are included with the load allocation in the existing load. The *South Fork Palouse River Watershed Assessment and TMDLs* written for sediment (TSS), temperature, bacteria (*E. coli*), and nutrients (TP) was approved by EPA in 2007: *www.deq.idaho.gov/media/463293-_water_data_reports_surface_water_tmdls_palouse_river_sf_palouse_river_sf_entire.pdf*.

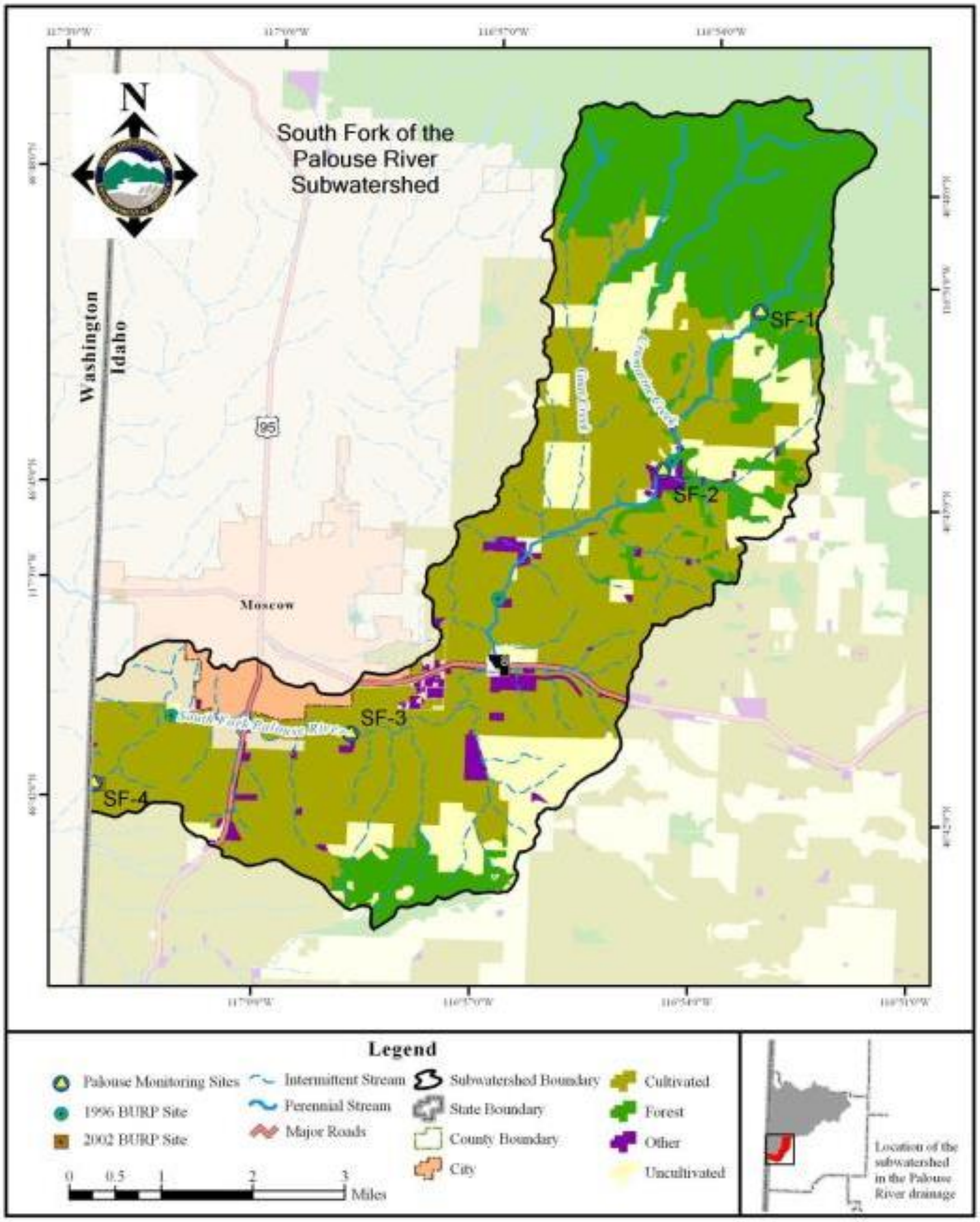


Figure 2. South Fork Palouse River watershed.

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

Assessment units (AUs) are groups of similar streams that have similar land use practices, ownership, or land management. 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 to describe water bodies offers many benefits primarily that all waters of the state are defined consistently. AUs are a subset of water body identification numbers, which allows them to relate directly to the water quality standards.

2.1.2 Listed Waters

Table 1 shows the pollutants listed and the basis for listing for each §303(d)-listed AU in the subbasin.

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

Assessment Unit Name	Assessment Unit Number	Listed Pollutants	Listing Basis
Palouse River tributaries			
Flannigan Creek watershed	ID17060108CL011a_02 ID17060108CL011a_03 ID17060108CL011b_02 ID17060108CL011b_03	Temperature	1998 §303(d) list
Hatter Creek watershed	ID17060108CL015a_02 ID17060108CL015b_02 ID17060108CL015b_03	Temperature	1998 §303(d) list
Big Creek watershed	ID17060108CL027a_02 ID17060108CL027b_02	Temperature	1998 §303(d) list
Gold Creek watershed	ID17060108CL029_02 ID17060108CL029_03 ID17060108CL030_02 ID17060108CL031a_02 ID17060108CL031b_02	Temperature	1998 §303(d) list
Deep Creek watershed	ID17060108CL032a_02 ID17060108CL032a_03 ID17060108CL032b_02 ID17060108CL032b_03	Temperature	1998 §303(d) list

Assessment Unit Name	Assessment Unit Number	Listed Pollutants	Listing Basis
South Fork Palouse River	ID17060108CL002_03 ID17060108CL003_02 ID17060108CL003_03	Temperature	2002 §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, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing, designated, and presumed uses as described briefly in the following paragraphs. The *Water Body Assessment Guidance* (Grafe et al. 2002) provides a more detailed description of beneficial use identification for use assessment purposes.

Beneficial uses include the following:

- Aquatic life support—cold water, seasonal cold water, warm water, salmonid spawning, and modified
- Contact recreation—primary (swimming) or secondary (boating)
- Water supply—domestic, agricultural, and industrial
- Wildlife habitats
- Aesthetics

2.2.1 Existing Uses

Existing uses under the CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards" (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.

2.2.2 Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained" (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.

2.2.3 Undesignated Surface Waters

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).

2.2.4 Beneficial Uses in the Subbasin

All AUs in the TMDLs included in this review are designated for cold water aquatic life and secondary contact recreation beneficial uses. Five AUs are also designated for salmonid spawning beneficial uses (Table 2).

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

Assessment Unit Name	Assessment Unit Number	Beneficial Uses	Type of Use	Use Support
South Fork Palouse River[a]				
South Fork Palouse River—Gnat Creek to Idaho/Washington border	ID17060108CL002_03	CW, SS, SCR	Designated	NFS
South Fork Palouse River—source to Gnat Creek; tributaries	ID17060108CL003_02	CW, SS, SCR	Designated	NFS
South Fork Palouse River—source to Gnat Creek	ID17060108CL003_03	CW, SS, SCR	Designated	NFS
Palouse River Tributaries[b]				
Flannigan Creek—source to T41N, R05W, Sec. 23	ID17060108CL011a_02	CW, SCR	Designated	NFS
Flannigan Creek—source to T41N, R05W, Sec. 23	ID17060108CL011a_03	CW, SCR	Designated	NFS
Flannigan Creek—T41N, R05W, Sec. 23 to mouth	ID17060108CL011b_02	CW, SCR	Designated	NFS
Flannigan Creek—T41N, R05W, Sec. 23 to mouth	ID17060108CL011b_03	CW, SCR	Designated	NFS
Hatter Creek—source to T40N, R04W, Sec. 3	ID17060108CL015a_02	CW, SCR	Designated	NFS
Hatter Creek—T40N, R04W, Sec. 3 to mouth	ID17060108CL015b_02	CW, SCR	Designated	NFS
Hatter Creek—T40N, R04W, Sec. 3 to mouth	ID17060108CL015b_03	CW, SCR	Designated	NFS

Assessment Unit Name	Assessment Unit Number	Beneficial Uses	Type of Use	Use Support
South Fork Palouse River[a]				
Big Creek—source to T42N, R03W, Sec. 08	ID17060108CL027a_02	CW, SS, SCR	Designated	NFS (CW, SS) FS (SCR)
Big Creek—T42N, R03W, Sec. 08 to mouth	ID17060108CL027b_02	CW, SCR	Designated	NFS (CW) FS (SCR)
Gold Creek—T42N, R04W, Sec. 28 to mouth	ID17060108CL029_02	CW, SCR	Designated	NFS
Gold Creek—T42N, R04W, Sec. 28 to mouth	ID17060108CL029_03	CW, SCR	Designated	NFS
Gold Creek—source to T42N, R04W, Sec. 28	ID17060108CL030_02	CW, SS, SCR	Designated	NFS
Crane Creek—source to T42N, R04W, Sec. 28	ID17060108CL031a_02	CW, SCR	Designated	NFS
Crane Creek—T42N, R04W, Sec. 28 to mouth	ID17060108CL031b_02	CW, SCR	Designated	NFS
Deep Creek—source to T42, R05, Sec. 02	ID17060108CL032a_02	CW, SCR	Designated	NFS
Deep Creek—source to T42, R05, Sec. 02	ID17060108CL032a_03	CW, SCR	Designated	NFS
Deep Creek—T42, R05, Sec. 02 to mouth	ID17060108CL032b_02	CW, SCR	Designated	NFS
Deep Creek—T42, R05, Sec. 02 to mouth	ID17060108CL032b_03	CW, SCR	Designated	NFS

[a] South Fork Palouse River Watershed Assessment and TMDLs (DEQ 2007)
[b] Palouse River Tributaries Subbasin Assessment and TMDL (DEQ 2005a)
Notes: fully supporting (FS); not fully supporting (NFS); cold water aquatic life (CW); secondary contact recreation (SCR); salmonid spawning (SS)

2.2.5 Water Quality Criteria to Support Beneficial Uses

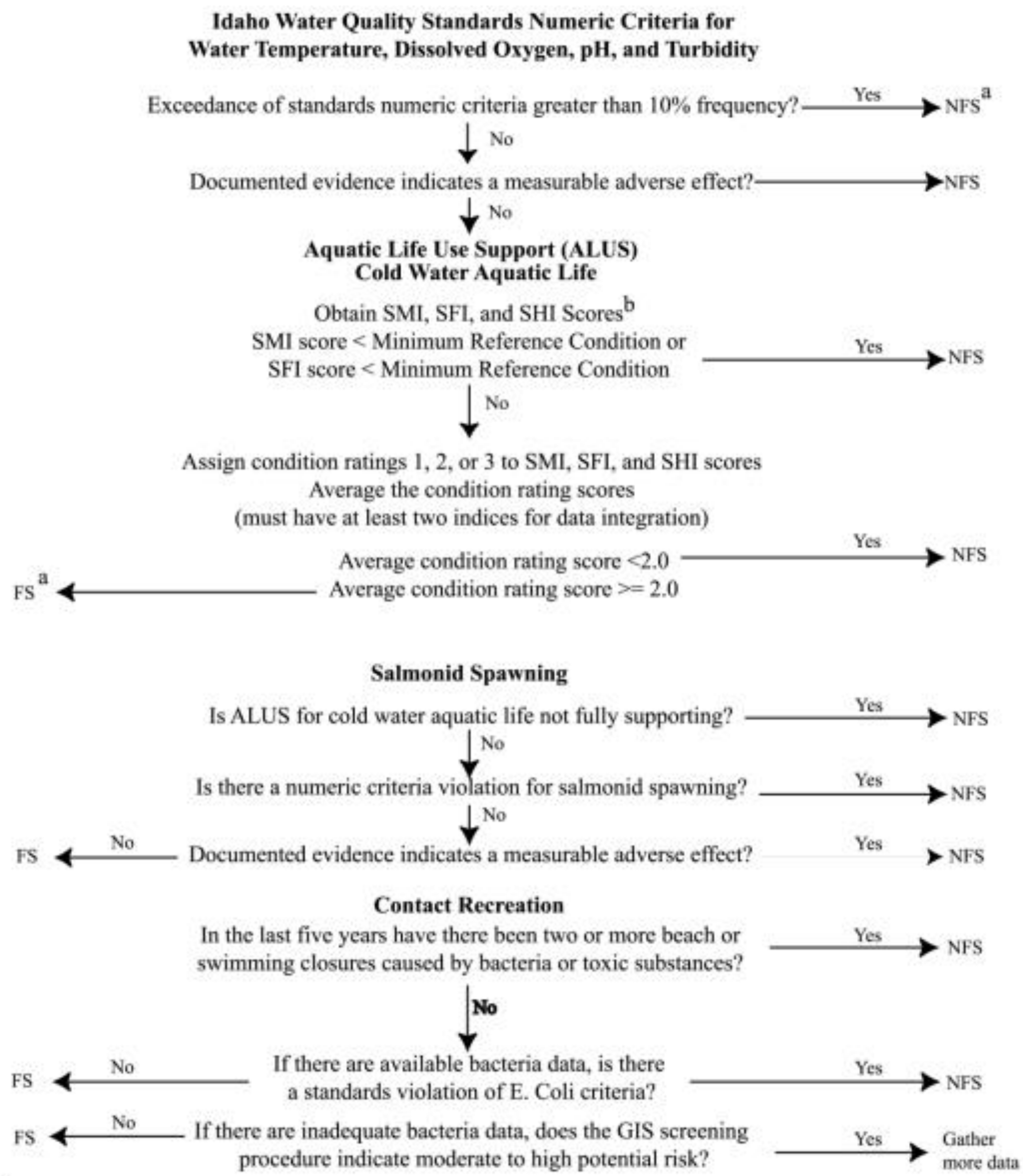
Beneficial uses are protected by a set of water quality criteria, which include numeric criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity, and narrative criteria for pollutants such as sediment and nutrients (IDAPA 58.01.02.250–251) (Table 3). Appendix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

Table 3. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards

Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning[a]
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 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* (Grafe et al. 2002). This guidance requires DEQ to use the most complete data available to make beneficial use support status determinations (Figure 3).



[a] FS = fully supporting, NFS = not fully supporting
[b] SMI = Stream Macroinvertebrate Index, SFI = Stream Fish Index, SHI = Stream Habitat Index

Figure 3. Determination steps and criteria for determining support status of beneficial uses in wadeable streams (Grafe et al. 2002).

2.3 Summary and Analysis of Existing Water Quality Data

For the Palouse River subbasin temperature TMDLs, we used a PNV approach (section 5). Temperature criteria for protection of cold water aquatic life and salmonid spawning beneficial uses were applied throughout the subbasin. The data listed in section 5 were collected for this TMDL. In addition, Beneficial Use Reconnaissance Program (BURP) data, which relate to the cold water aquatic beneficial use support, were collected and compiled into Table 4. Data sources for this section are provided in Appendix B.

2.3.1 Status of Beneficial Uses

Data were evaluated against cold water aquatic life and salmonid spawning criteria. Assessments found that all 21 AUs listed for temperature were lacking shade, and we recommend that all AUs remain in Category 4a.

Table 4. Beneficial Use Reconnaissance Program data for the Palouse River subbasin.

Assessment Unit Name	Assessment Unit Number	SMI	SFI	SHI	Average	Current Integrated Report Category
South Fork Palouse River—Gnat Creek to Idaho/Washington border	ID17060108CL002_03	0	0	1	0	4a, 4c
South Fork Palouse River—source to Gnat Creek; tributaries	ID17060108CL003_02	Dry/Denied	Dry/Denied	Dry/Denied	Dry/Denied	4a, 4c
South Fork Palouse River—source to Gnat Creek	ID17060108CL003_03	1	0	1	0	4a, 4c
Flannigan Creek—source to T41N, R05W, Sec. 23	ID17060108CL011a_02	Dry	Dry	Dry	Dry	4a, 4c
Flannigan Creek— source to T41N, R05W, Sec. 23	ID17060108CL011a_03	1	0	2	0	4a, 4c
Flannigan Creek—T41N, R05W, Sec. 23 to mouth	ID17060108CL011b_02	Dry	Dry	Dry	Dry	4a, 4c
Flannigan Creek—T41N, R05W, Sec. 23 to mouth	ID17060108CL011b_03	0	0	1	0	4a, 4c
Hatter Creek—source to T40N, R04W, Sec. 3	ID17060108CL015a_02	1	3	1	1.67	4a, 4c
Hatter Creek—T40N, R04W, Sec. 3 to mouth	ID17060108CL015b_02	No flow	No flow	No flow	No flow	4a, 4c
Hatter Creek—T40N, R04W, Sec. 3 to mouth	ID17060108CL015b_03	NA	NA	NA	NA	4a, 4c
Big Creek—source to T42N, R03W, Sec. 08	ID17060108CL027a_02	NA	NA	NA	NA	4a, 4c
Big Creek—T42N, R03W, Sec. 08 to mouth	ID17060108CL027b_02	2	1	1	1.33	4a, 4c
Gold Creek—T42N, R04W, Sec. 28 to mouth	ID17060108CL029_02	Dry	Dry	Dry	Dry	4a, 4c
Gold Creek—T42N, R04W, Sec. 28 to mouth	ID17060108CL029_03	Denied	Denied	Denied	Denied	4a, 4c
Gold Creek—source to T42N, R04W, Sec. 28	ID17060108CL030_02	3	3	3	3	4a, 4c
Crane Creek—source to T42N, R04W, Sec. 28	ID17060108CL031a_02	Beaver	Beaver	Beaver	Beaver	4a
Crane Creek—T42N, R04W, Sec. 28 to mouth	ID17060108CL031b_02	Dry	Dry	Dry	Dry	4a
Deep Creek—source to T42, R05, Sec. 02	ID17060108CL032a_02	Dry	Dry	Dry	Dry	4a, 4c
Deep Creek—source to T42, R05, Sec. 02	ID17060108CL032a_03	Denied	Denied	Denied	Denied	4a, 4c
Deep Creek—T42, R05, Sec. 02 to mouth	ID17060108CL032b_02	Dry	Dry	Dry	Dry	4a, 4c
Deep Creek—T42, R05, Sec. 02 to mouth	ID17060108CL032b_03	0	1	1	0	4a, 4c

Notes: Stream macroinvertebrate index (SMI); stream fish index (SFI); stream habitat index (SHI); not assessed (NA)

3 Subbasin Assessment—Pollutant Source Inventory

Pollutants of concern for this TMDL are limited to temperature, for which the methodology and natural background provision established in Idaho water quality standards have changed. Most of the pollutants that impair beneficial uses in streams are naturally occurring stream characteristics that have been altered by humans and when these sources reach unnatural levels, they are considered *pollutants* and can impair the beneficial uses in the stream.

3.1 Point Sources

EPA published a new Multi-Sector General Permit (MSGP) on September 29, 2008, to replace the 2000 MSGP. This permit covers industrial facility stormwater management in areas where EPA has National Pollutant Discharge Elimination System (NPDES) authority. The 2008 MSGP applies to all new and existing facilities and requires that stormwater be controlled in accordance with terms and conditions of the permit. A permit search can be performed and information about the MSGP entities under EPA's authority and can be accessed at *https://www.epa.gov/npdes*. No facilities were identified in the Palouse River subbasin. Section 5.4.6 provides more information about MSGP and stormwater.

3.2 Nonpoint Sources

The primary nonpoint sources for temperature in the Palouse River subbasin listed in the TMDLs were solar radiation, erosion, grazing lands, land development, and stormwater systems. A detailed discussion of nonpoint sources in the subbasin are provided in the *Palouse River Tributaries Subbasin Assessment and TMDL* (DEQ 2005a) and the *South Fork Palouse River Watershed Assessment and TMDLs* (DEQ 2007).

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

The *Palouse River Tributaries Total Maximum Daily Load Implementation Plan for Agriculture* (Palouse River Tributaries WAG 2009) and *South Fork of the Palouse River Total Maximum Daily Load Implementation Plan for Agriculture* (South Fork Palouse River WAG 2009) outlined critical areas for project activities with input from watershed stakeholders and the watershed advisory group (WAG). Many watershed improvement projects with diverse funding sources have been completed or are ongoing in the Palouse River subbasin. Local watershed management agencies have worked together and with private landowners to implement best management practices (BMPs) to help restore the subbasin and prevent degradation. A summary of several of the restoration and improvement activities, provided by the Palouse-Clearwater Environmental Institute (PCEI) are included in the following sections.

4.1 Palouse River Tributaries—Palouse-Clearwater Environmental Institute

4.1.1 Deep Creek Stabilization Project

For the Deep Creek Stabilization Project, PCEI stabilized 2,782 linear feet of streambank to decrease nonpoint source pollutant loads in Deep Creek. This project was cooperative and involved private landowners, Natural Resources Conservation Service, university professors and students, local students, community organizations, and volunteers. PCEI focused restoration activities along the segment of Deep Creek that bisects the property of Buck Espy, a long-time resident of Potlatch, Idaho. The goal of the project was to provide direct water quality improvements. Due to the intensive impacts from agriculture, ranching, and residential development in the watershed, sediment and temperature reduction were the primary targeted pollutants for the project based on the Deep Creek watershed priorities. The stabilization and revegetation of 2,782 feet of streambank will reduce instream erosion. Bank stabilization techniques included excavating and resloping the streambank and installing coir log and erosion control fabric. The 43,789 square feet (ft^2) of variable riparian buffer was planted with over 1,400 native woody species. The riparian buffer will act as a filter reducing overland sediment flows, while filtering nutrients and bacteria generated from upland land use practices. Restoration also included constructing a riparian fence and hardened rock crossing to allow livestock and tractor access to both sides of the creek. Off-stream watering was also installed to reduce the impacts of livestock on Deep Creek.

4.1.2 Deep Creek Riparian Restoration Project

In cooperation with the Latah Soil and Water Conservation District, PCEI completed the Deep Creek Riparian Restoration Project. PCEI's restoration project was one part of a larger, inclusive watershed-wide project aimed at addressing watershed priorities and goals. Potlatch Corporation, Idaho Department of Lands, University of Idaho, and North Latah County Highway District were also partners on the Palouse River Water Quality Improvement Project funded by a §319 nonpoint source management grant. Each organization focused on different BMPs. PCEI's focus was on riparian restoration. Restoration work took place on private property in the lower Deep Creek watershed. Restoration work was designed to reduce sediment, bacteria, nutrients, and temperature. In addition, this project improved riparian habitat. Stabilizing and revegetating 1,070 feet of creek will reduce instream erosion. Bank stabilization techniques included resloping and installing erosion control fabric. An estimated 22,500 ft^2 of variable riparian buffer was planted with native woody, herbaceous, and grass species. The riparian buffer acts as a filter reducing overland sediment flows, while filtering nutrients and bacteria generated from upland land use practices. In addition to acting as a filter for pollutants, the established riparian buffer will also provide shade, reducing extreme summer temperatures. Two wetlands were also created to filter overland flows that flow through the landowner's horse pasture. These wetlands will reduce nutrient and bacteria from entering Deep Creek.

4.1.3 Flannigan Creek Riparian Restoration Project

PCEI completed restoration work on Flannigan Creek, which took place on private properties in the upper Flannigan Creek watershed. Restoration on Flannigan Creek targeted reductions in sediment, bacteria, nutrients, and temperature. In addition, this project improved riparian habitat through native plantings. Six adjacent landowners participated in riparian restoration work on their property. Water quality improvement projects focused on stabilizing streambanks where active erosion was visible and increasing wetland area in priority locations to collect and filter runoff. Riparian plantings focused on bare areas and current construction areas. The stabilization and revegetation of 1,336 feet of streambank involved resloping the streambank and installing erosion control fabric to reduce instream erosion. The 330,280 ft^2 of variable riparian buffer was planted with native species to filter and reduce overland sediment flows, while also filtering nutrients and bacteria generated from upland land use. Wetland swales were enhanced and created in areas suitable for runoff filtration to expand the stormwater-holding capacity in the watershed.

4.2 South Fork Palouse River—Palouse-Clearwater Environmental Institute

4.2.1 Fountain Project

The riparian restoration at the Fountain Property project included resloping, stabilizing, and revegetating 1,670 feet of unstable creek bank and berm removal. An estimated 68,572 ft^2 of variable riparian buffer was planted with native plants. The site restoration goal was to reconnect the stream with the floodplain, reslope and stabilize eroding streambanks, and plant native shrubs and trees to create a variable-width riparian buffer. Restoring the streambank and implementing a riparian buffer will reduce the sediment load and contribute to load reductions for phosphorous and nitrogen transported in sediment to the South Fork Palouse River.

4.2.2 Clyde Park Site

The riparian restoration at the Arboretum site on the South Fork Palouse River focused on decreasing nonpoint source pollution and restoring riparian and floodplain areas along the riverbank. BMPs included developing a functional floodplain, resloping and stabilizing eroding streambanks with various bioengineering techniques, constructing five riparian wetlands to treat surface runoff waters before it enters the South Fork Palouse River, and planting native woody and herbaceous vegetation to create a variable-width riparian forest buffer.

4.2.3 Robinson Park Project

Restoration at the South Fork Palouse River Robinson Park site focused on reducing sediment and nutrient loads, stabilizing temperature, improving habitat for wildlife and cold water biota, and mitigating local flood damage. To decrease nonpoint source pollutant loads, the PCEI restored 3,000 linear feet of streambank. This was a cooperative restoration project involving Latah County Parks and Recreation Department, private landowners, local students, community organizations, and volunteers. PCEI focused restoration efforts in the upper South Fork Palouse River watershed on two stream segments within Robinson County Park. This reach is characterized by stream downcutting and extensive areas of active erosion. Reach restoration will have a significant impact on water quality.

These projects restored 517,957 ft^2 of streambank and riparian area, created nine wetlands, and installed livestock fencing and hardened crossings at one site.

4.3 Future Strategy

Continued monitoring will determine the effectiveness of current and future BMP implementation. Continuing to reduce nonpoint pollutant sources will be a priority in the Palouse River subbasin with continued monitoring to assess beneficial use support in the subbasin. The implementation plan for the Palouse River subbasin will be updated with input from the Palouse River subbasin WAG to prioritize restoration work that needs to be completed or augmented within the subbasin.

DEQ will assess water quality status during development of the biennial Integrated Report and 5-year TMDL review processes. DEQ will continue to collect water quality data to determine beneficial use support.

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 regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water Quality Planning and Management, 40 CFR 130) require a margin of safety be a part of 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 appear on the surface.

Another step in a load analysis is quantifying current pollutant loads by source. This step allows 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. These “other measures” must still be quantifiable and relate to water quality standards, but they allow flexibility to deal with pollutant load 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, as is the case in this temperature TMDL. 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 Palouse River subbasin temperature TMDLs, a PNV approach for nonpoint source thermal pollution was used. 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, for temperature TMDLs, the system potential shade becomes 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.

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

Outside of human influence, 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 was converted to solar loads from data collected on flat-plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations collecting these data (Pendleton, Oregon, and Missoula, Montana, stations). 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 (Appendix A).

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 (as long as no point sources or other anthropogenic sources of heat exist in the watershed) and are considered to be consistent with 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 21 AUs 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 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. 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 man-made structures).

Solar Pathfinder Field Verification

The accuracy of the aerial photo interpretations was field verified with a Solar Pathfinder. The Solar Pathfinder is a device that allows tracing 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, recorded 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 the kinds of plant species (the large, dominant, shade-producing ones) were present. Densiometer readings can also be taken 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.

Palouse River Tributaries

Solar Pathfinder data taken at six sites showed that, in general, the original aerial interpretation underestimated existing shade by one shade class (Table 5). The average difference between the original aerial class and the Solar Pathfinder class was -7% ± 5.2 (average ± 95% C.I.). Three of the six sites were underestimated by one 10% class and one site was underestimated by two 10% classes. One site showed overestimated shade but only by one percentage point, and one site's original class estimate was accurate. These data were used to correct the shade values for the site areas and to "calibrate the eye" for a second reinterpretation of existing shade on all portions of streams in the analysis.

Table 5. Solar Pathfinder field verification results for Palouse River tributaries sites.

aerial class	pathfinder actual	pathfinder class	delta		site name
20	33.033	30	-10		Deep
20	42.326	40	-20		Flannigan
70	84.241	80	-10		Gold 1
90	89.013	80	10		Gold 2
50	62.216	60	-10		Hatter
60	69.67	60	0		Big
			-7	average	
			10.33	std dev	
			5.23	95%CI	

South Fork Palouse River

Four sites along the South Fork Palouse River were measured for shade (Table 6). In general, the aerial interpretation overestimated shade by 8% ± 9.4 (mean ± 95% C.I.) or about one shade class. Specifically, two sites showed accurate estimates and two sites were overestimated by one or two classes. As a result, the original aerial interpretation was revisited and the specific Solar Pathfinder locations were corrected if necessary, and the overestimated sites were reevaluated to "calibrate the eye."

Table 6. Solar Pathfinder results for the South Fork Palouse River sites.

aerial class	pathfinder actual	pathfinder class	delta		Site Name
50	52.7	50	0		SF @ Hwy95
50	35.4	30	20		SF @ Fountain
80	77.9	70	10		SF @ Robinson
80	88.7	80	0		SF @ Crumarine
			8	average	
			9.57	std dev	
			9.38	95%CI	

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. Sometimes water withdrawals and diversions can reduce the size of the stream making channels narrower than they were historically.

Since, existing bankfull width may not be discernible from aerial photo interpretation and may not reflect natural bankfull widths, this parameter must be estimated from available information. We used 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 4).

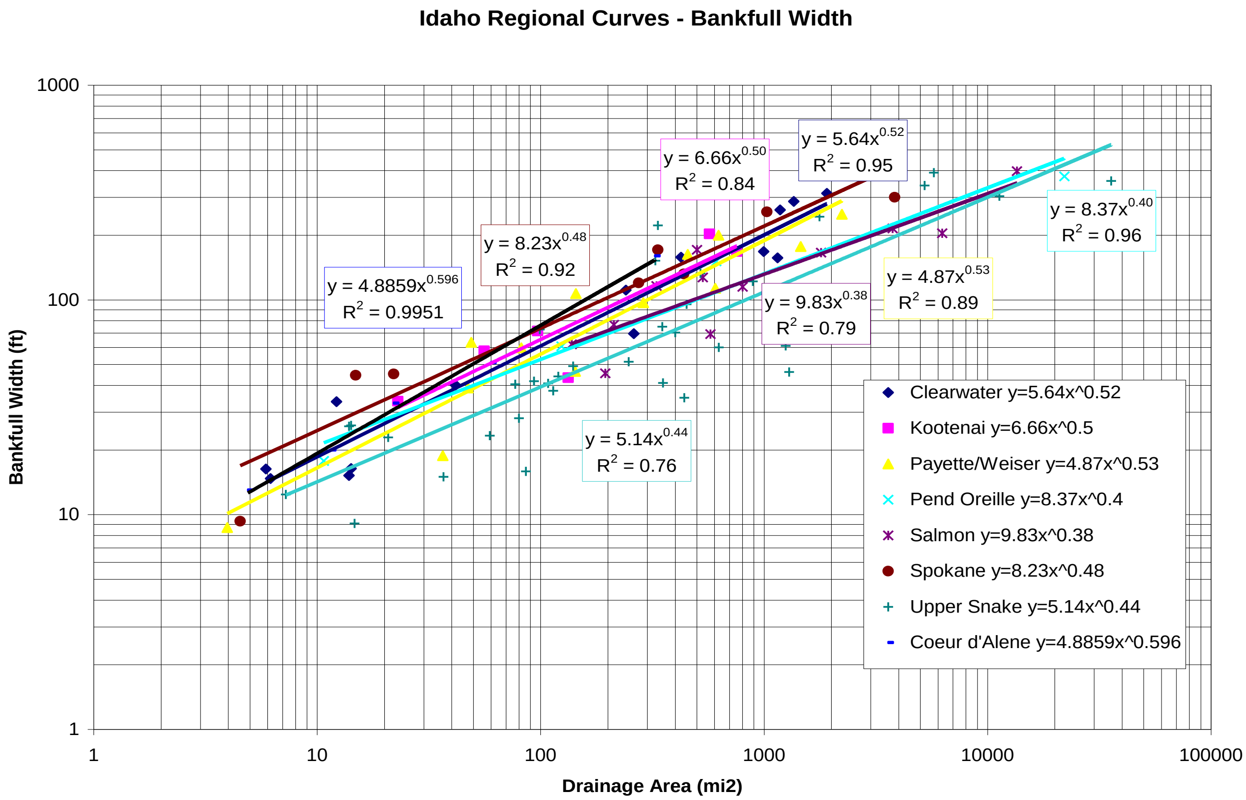


Figure 4. Bankfull width as a function of drainage area.

For each stream evaluated in the load analysis, natural bankfull width was estimated based on the drainage area of the Clearwater Basin curve from Figure 4. Although estimates from other curves were examined (i.e., Spokane, Kootenai, and Pend Oreille), the Clearwater curve was ultimately chosen because of its proximity to the Palouse River tributaries, and South Fork Palouse River watersheds and similarity of climate. Existing width data should also be evaluated and compared to these curve estimates if the data are available. However, for the Palouse River tributaries and South Fork Palouse River watersheds, only a few BURP sites exist, and bankfull width data from those sites represent only spot data (e.g., only three measured widths in a reach just several hundred meters long) that do not always represent the stream as a whole. We also evaluated channel width at various locations where Solar Pathfinder shade was measured.

5.1.2.3 Palouse River Tributaries

In general, we found BURP bankfull width data to agree with natural bankfull width estimates from the Clearwater basin curve and chose not to make natural widths any smaller than these Clearwater basin estimates for most streams in the analysis. However, we did find that lower portions of Gold Creek and Deep Creek did not conform to Clearwater basin estimates and were narrower than predicted. In these cases we used existing measurement data to guide our selection of channel widths for lower Gold Creek and lower Deep Creek. In general, channel widths were 2–4 meters smaller than predicted. The information containing natural bankfull width estimates for each stream in this analysis is presented in Table 7analysis tables in Appendix C contain natural bankfull width and existing bankfull width for every stream segment in the analysis based on the bankfull width results presented in Table 7. Existing widths and natural widths are the same in the load tables when data do not support making them differ.

Table 7. Channel width estimates for streams in the Palouse River tributaries analysis.

Location	area (sq mi)	Spokane (m)	Kootenai (m)	PendOreille (m)	Clearwater (m)	Measurement (yr)
Big Creek below Olevan Creek	5.16	6	5	5	4	3.7(96)
Confluance of Chelsey and Big Creek	7.71	7	6	6	5	2.9(02), 3(14) [ab Chelsey]
EF Big Creek @ mouth	1.8	3	3	3	2	
Confluance of East Fork and Big Creek	10.04	8	6	6	6	
Last Chance Creek @ mouth	2.07	4	3	3	3	
Lost Creek @ mouth	2.22	4	3	4	3	
Big Creek @ mouth	16.07	10	8	8	7	5(02)
Flannigan Creek @ 2760 ft.	6.84	6	5	6	5	
2nd tributary to Flannigan Cr	2.86	4	3	4	3	
WF Flannigan Creek @ mouth	4.68	5	4	5	4	
1st tributary to WF Flannigan Creek	0.64	2	2	2	1	
Confluance of WF and Flannigan Creek	12.49	8	7	7	6	4(14)
Flannigan Creek @ 2656	14.1	9	8	7	7	7(96)
4th tributary to Flannigan Creek	1.79	3	3	3	2	
Flannigan Creek @ mouth	19.14	10	9	8	8	2.4(02), 6.7(96)
1st tributary to Hatter Cr	1.04	3	2	3	2	
2nd 015b_02 tributary	6.45	6	5	5	5	
4th 015b_02 tributary	1.74	3	3	3	2	
Hatter Creek ab Long Creek	5.2	6	5	5	4	3(13) [ab Long Cr]
Long Cr @ tributary	1.37	3	2	3	2	
Long Creek @ mouth	4.41	5	4	5	4	
Confluance of Hatter and Long Creek	9.62	7	6	6	6	
Hatter Creek at mouth	25.31	12	10	9	9	5(96), 9(13)
EF Gold Creek @ mouth	1.1	3	2	3	2	
Waterhole creek @ mouth	1.36	3	2	3	2	
Arson Creek @ mouth	1.21	3	2	3	2	
Confluance of Arson Cr and Gold Cr	10.83	8	7	7	6	6.5(14), 4.3(96) [ab Waterhole]
Nelson Creek @ mouth	1.5	3	2	3	2	
Gold Creek above Crane Cr	13.78	9	8	7	7	4(96) [ab Nelson]
Crane Creek @ 2740ft	6.63	6	5	5	5	2.7(96) [@ 2800ft]
Crane Creek @ mouth	12.02	8	7	7	6	
Confluance of Crane and Gold Creek	25.78	12	10	9	9	
Gold Creek at mouth	28.32	12	11	10	10	3.1(02), 6(11)
WF Deep Cr @ mouth	5.53	6	5	5	4	
MF Deep Cr @ mouth	8.99	7	6	6	5	10.7(96)
EF Deep Cr @ mouth	8.98	7	6	6	5	
tributary to EF	2.95	4	3	4	3	
MF/EF confluence (top of 32a_03)	17.97	10	9	8	8	
Deep Cr @ bottom of 32a_03	26.24	12	10	9	9	7(11)
Deep Cr above 32b_02 tribs	28.59	13	11	10	10	
Deep Cr below 32b_02 tribs	37.3	14	12	11	11	4.3(96), 1.9(02)
Deep Cr @ Palouse R	42.7	15	13	11	12	8(11)

Notes: square mile (sq mi); meter (m); year (yr)

Design Conditions

Tributary streams of the Palouse River arise within the Northern Idaho Hills and Low Relief Mountains level 4 subecoregion of the Northern Rockies ecoregion (McGrath et al. 2001). Volcanic ash and loess provide rich forest soils. Grand fir, western red cedar, Douglas fir, and ponderosa pine are common. Forest harvest activities are relatively easy on lower gradient hills. Streams pass quickly into the Columbia Plateau, and the Palouse Hills level 4 subecoregion dominates the landscape with loess covered, unforested grasslands. Nearby mountain streams are fed perennially, giving rise to loess-bottomed intermittent waters. Dry channels tend to be tilled and indistinguishable from surrounding farmland.

Shade Curve Selection

To determine PNV shade targets for the Palouse River tributaries, effective shade curves from the St Joe National Forest and nonforest types were examined (Table 8). These curves were produced using vegetation community modeling of Idaho plant communities (Shumar and de Varona 2009). Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. For the Palouse River tributaries, curves for the most similar vegetation type were selected for shade target determinations. Forested headwaters were represented by either the St Joe National Forest Group B (moist) or a combination of this forest group and hardwood meadows vegetation. The St Joe hardwood vegetation type is a lower gradient stream riparian area that tends to be dominated by a mixture of coniferous trees and hardwood species (alders and hawthorns). Once streams emerge from higher gradient hills and emerge onto prairie regions, riparian areas become dominated by hawthorns with an absence of trees. The Palouse hawthorn vegetation type shade curve was developed specifically for these hawthorn-dominated riparian regions. These curves are presented in Appendix C (Figures C-19 to C-21).

Table 8. Shade target vegetation types for the Palouse River tributaries.

Forest Types	Nonforest Types
St Joe National Forest Group B (moist) Forests	Palouse hawthorn
St Joe Group B/hardwoods Mix	—

5.1.2.4 South Fork Palouse River

In general, we found BURP bankfull width data to disagree with natural bankfull width estimates from the Clearwater basin curve and chose to make natural widths smaller than the Clearwater basin estimates. Natural bankfull width estimates for each stream in this analysis are presented in Table 9. The load analysis tables in Appendix C contain a natural bankfull width and an existing bankfull width for every stream segment in the analysis based on the bankfull width results presented in Table 9. Existing widths and natural widths are the same in the load tables when data do not support making them differ.

Table 9. Bankfull width estimates for the South Fork Palouse River watershed.

Location	area (sq mi)	Clearwater (m)	BURP measures (m)
SF Palouse R @ state line	30.8	10	2.4 (2002), 5.3 (1996), 3.8 (2013)
SF Palouse R @ Lenville Rd	22.1	9	
SF Palouse R bl Gnat Creek	14.6	7	3.5 (1996)
SF Palouse R ab Gnat Creek	9.9	6	
SF Palouse R bl Crumarine Creek	6.2	4	5.7 (1996), 1.6 (2013)
SF Palouse R ab Crumarine Creek	3	3	
SF Palouse R ab 1st tributary	2.14	3	
1st tributary @ mouth	0.65	1	
Crumarine Creek @ mouth	3.23	3	2.0 (2005)
3rd tributary @ Robinson Lake	1.63	2	
4th tributary @ mouth	1.18	2	

Notes: square miles (sq mi); meter (m)

Design Conditions

Headwater streams of the South Fork Palouse River arise within the Northern Idaho Hills and Low Relief Mountains level 4 subecoregion of the Northern Rockies ecoregion (McGrath et al. 2001). Volcanic ash and loess provide rich forest soils. Grand fir, western red cedar, Douglas fir, and ponderosa pine are common. Forest harvest activities are relatively easy on lower gradient hills. Streams pass quickly into the Grassy Potlatch Ridges level 4 subecoregion of the Northern Rockies where volcanic and loess soils were once dominated by Idaho fescue/bluebunch wheatgrass/snowberry and occasional ponderosa pine parks. Small grain farming, hay pastures and livestock grazing are common. At the lowest levels of the South Fork Palouse River near Moscow, the ecoregion changes to the Columbia Plateau and the Palouse Hills level 4 subecoregion dominates the landscape with loess covered, unforested grasslands. Nearby mountain streams are perennially fed, giving rise to loess-bottomed intermittent waters. Dry channels tend to be tilled and indistinguishable from surrounding farmland.

Shade Curve Selection

To determine PNV shade targets for the South Fork Palouse River watershed, effective shade curves from Panhandle National Forest and nonforest types were examined (Table 10) (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 the South Fork Palouse River, curves for the most similar vegetation type were selected for shade target determinations. Forested headwaters were represented by either the St Joe National Forest Group B (moist) or a combination of this forest group and hardwood meadows vegetation. The St Joe hardwood vegetation type is a lower gradient stream riparian area that tends to be dominated by a mixture of coniferous trees and hardwood species (alders and hawthorns). Once streams emerge from higher gradient hills and emerge onto prairie regions, riparian areas become dominated by hawthorns with an absence of trees. The Palouse hawthorn vegetation type shade curve was developed specifically for these hawthorn-dominated riparian regions.

Table 10. Shade target vegetation types for the South Fork Palouse River watershed.

Forest Types	Nonforest Types
St Joe National Forest Group B (moist) Forests	Palouse hawthorn
St Joe Group B/hardwoods Mix	—

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 NREL weather stations for the Palouse River tributaries and South Fork Palouse River from Pendleton, Oregon, and Missoula, Montanan. 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 fall 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.

For each watershed, PNV shade targets are provided in Appendix C. The tables in Appendix C show 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 each table. Because load calculations involve stream segment area calculations, the segments 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 each load table represents total loads with two significant figures in an attempt to reduce apparent rounding errors.

5.3 Estimates of Existing Pollutant Loads

Regulations allow that loads "...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 permitted point sources in the Palouse River tributaries; and no permitted point sources in the South Fork Palouse River. 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. Existing shade data are presented in Appendix C. Like load capacities (target loads), existing loads provided in Appendix C 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. If the existing load exceeds target load, the difference becomes the excess load (i.e., lack of shade) (discussed in section 5.4 and depicted in the lack-of-shade figures in Appendix C).

Palouse River Tributaries

The AU with the largest target load (i.e., load capacity) was Deep Creek (ID17060108CL032b_03) with 300,000 kWh/day (Table C-17). The smallest target load was in the Flannigan Creek AU (ID17060108CL011b_02) with 4,100 kWh/day (Table C-3).

The AU with the largest existing load was Deep Creek (ID17060108CL032b_03) with 380,000 kWh/day (Table C-17). The smallest existing load was in the Big Creek AU (ID17060108CL027a_02) with 14,000 kWh/day (Table C-8).

South Fork Palouse River

The AU with the largest target load (i.e., load capacity) was the lower South Fork Palouse River (ID17060108CL002_03) with 140,000 kWh/day (Table C-20). The smallest target load was in the middle South Fork Palouse River AU (ID17060108CL003_03) with 10,000 kWh/day (Table C-19).

The AU with the largest existing load was lower South Fork Palouse River (ID17060108CL002_03) with 180,000 kWh/day (Table C-20). The smallest existing load was in the middle South Fork Palouse River AU (ID17060108CL003_03) with 15,000 kWh/day (Table C-19).

5.4 Load and Wasteload Allocation

Because this TMDL is based on PNV, which is equivalent to background load, the load allocation is essentially the desire to achieve background conditions. However, 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 depend upon the target load for a given segment. Table 11 shows the target shade and corresponding target summer load. This target load (i.e., load capacity) is necessary to achieve background conditions. No opportunity exists to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL depends upon background conditions for achieving water quality standards, all tributaries to the waters examined here must be in natural conditions to prevent excess heat loads to the system.

Table 11 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. Table 11 lists the tributaries in order of their excess loads, from highest to lowest. Therefore, large tributaries tend to be listed first and small tributaries last.

Although this TMDL analysis focuses on total solar loads, it is important to note that the differences between existing and target shade, as depicted in the lack-of-shade figures in Appendix C, are the key to successfully restoring these waters to achieving water quality standards. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts. Each load analysis table 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 each load analysis table (Appendix C) is also listed in Table 11 and provides a general level of comparison among streams.

Table 11. Total solar loads and average lack of shade for all waters in the Palouse River tributaries and South Fork Palouse River.

Water Body/ Assessment Unit	Total Existing Load	Total Target Load	Excess Load (Reduction)	Average Lack of Shade (%)
	(kWh/day)			
Palouse River tributaries				
Deep Creek tributaries ID17060108CL032a_02	190,000	100,000	92,000 (48%)	-29
Deep Creek ID17060108CL032b_03	380,000	300,000	83,000 (22%)	-16
Gold Creek ID17060108CL030_02	120,000	36,000	80,000 (67%)	-21
Deep Creek tributaries ID17060108CL032b_02	68,000	13,000	56,000 (82%)	-61
Flannigan Creek ID17060108CL011a_02	61,000	15,000	49,000 (80%)	-23
Big Creek ID17060108CL027b_02	200,000	150,000	44,000 (22%)	-16
Hatter Creek ID17060108CL015b_02	83,000	40,000	43,000 (52%)	-22
Hatter Creek ID17060108CL015a_02	48,000	14,000	34,000 (71%)	-24
Flannigan Creek ID17060108CL011b_03	190,000	160,000	33,000 (17%)	-23
Flannigan Creek tributaries ID17060108CL011b_02	33,000	4,100	32,000 (97%)	-69
Crane Creek ID17060108CL031b_02	91,000	62,000	29,000 (32%)	-28
Flannigan Creek ID17060108CL011a_03	71,000	46,000	25,000 (35%)	-22
Gold Creek ID17060108CL029_03	79,000	56,000	23,000 (29%)	-21

Water Body/ Assessment Unit	Total Existing Load	Total Target Load	Excess Load (Reduction)	Average Lack of Shade (%)
	(kWh/day)			
Crane Creek ID17060108CL031a_02	18,000	6,300	13,000 (72%)	-31
Deep Creek ID17060108CL032a_03	30,000	20,000	10,000 (33%)	-32
Big Creek ID17060108CL027a_02	14,000	7,000	6,700 (48%)	-15
Hatter Creek ID17060108CL015b_03	220,000	260,000	0 (0%)	-8
South Fork Palouse River ID17060108CL002_03	180,000	140,000	39,000 (22%)	-11
South Fork Palouse River ID17060108CL003_02	38,000	18,000	20,000 (53%)	-14
South Fork Palouse River ID17060108CL003_03	15,000	10,000	4,700 (31%)	-12

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

Palouse River Tributaries

For the Palouse River tributaries, all streams in the analysis lack shade; although a 3rd-order reach of Hatter Creek (ID17060108CL015b_03) is the only AU that does not have excess solar load. Deep Creek (ID17060108CL032b_03) and its tributaries (ID17060108CL032a_02 and ID17060108CL032b_02) have some of the largest excess loads. Percent reductions necessary to achieve target levels of solar load vary from 17% (Flannigan Creek—ID17060108CL011b_03) to 97% (Flannigan Creek tributaries—ID17060108CL011b_02).

A certain amount of excess load is potentially created by the existing shade/target shade difference inherent in the load analysis (Table 12). Because existing shade is reported as a 10% shade class and target shade a unique integer between 0% and 100%, a difference usually exists between the two. For example, 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. An automatic difference of 6% could be attributed to the margin of safety.

Table 12. Comparison of average load allocations (2005) to average lack of shade (2015) in Palouse River tributaries.

Stream Name/	Assessment Unit Number	2005 Average Load Allocation[a] (%)	2015 Average Shade Deficit (%)	Trend
Deep Creek tributaries	ID17060108CL032a_02	-12 to -37.3	-29	Similar
Deep Creek	ID17060108CL032b_03	-70.2	-16	Improve
Gold Creek	ID17060108CL030_02	0 to -16	-21	Similar
Deep Creek tributaries	ID17060108CL032b_02	-69.3	-61	Similar
Flannigan Creek	ID17060108CL011a_02	0 to -5	-23	Decline
Big Creek	ID17060108CL027b_02	0 to -19	-16	Similar
Hatter Creek tributary	ID17060108CL015b_02	-16.9 to -35.1	-22	Similar
Hatter Creek	ID17060108CL015a_02	-14 to -20	-24	Similar
Flannigan Creek	ID17060108CL011b_03	-36.3	-23	Improve
Flannigan Creek tributaries	ID17060108CL011b_02	-49	-69	Decline
Crane Creek	ID17060108CL011b_02	-21.5 to -53.2	-28	Similar
Flannigan Creek	ID17060108CL011a_03	0	-22	Decline
Gold Creek	ID17060108CL029_03	-60.8	-21	Improve
Crane Creek	ID17060108CL031a_02	-5	-31	Decline
Deep Creek	ID17060108CL032a_03	-50	-32	Improve
Big Creek	ID17060108CL027a_02	0 to -11	-15	Similar
Hatter Creek	ID17060108CL015b_03	-37.6	-8	Improve

[a] Load allocation = ((Existing cover – Potential cover)/Potential cover) x 100.

The 2005 approved temperature TMDL showed load allocations for individual AUs as ratios of existing cover to potential cover over the streams (LA = {{existing cover – potential cover}/potential cover} x 100) (DEQ 2005a). Measures of riparian cover are similar to shade estimates; however, the previous TMDL did not present load allocations in terms of a daily load. The present analysis converts estimates of shade on the stream to daily solar loads in kWh/day. To compare the results of the previously approved temperature TMDL to the current analysis, we have chosen to compare average lack of shade values for each AU as shown in Table 12 to the average cover ratios for each AU presented as load allocations in the previous TMDL (DEQ 2005a).

Table 12 presents the average cover difference from 2005 to the average lack of shade from the present analysis. In general, similarities exist between the two estimates with notable exceptions. We identified these similarities in Table 12, Trend column (i.e., Similar) as well as AUs that appear to be different (i.e., Improve or Decline). In 2005, the Deep Creek AU (ID17060108CL032b_03) was identified with considerable lack of cover (-70.2%), whereas the present analysis shows the AU lacked an average of only 16% shade. Hatter Creek (ID17060108CL015b_03) and Gold Creek (ID17060108CL029_03) are similarly in better condition now than previously determined. Conversely, Flannigan Creek (ID17060108CL011a_02 and ID17060108CL011a_03) and Crane Creek (ID17060108CL031a_02) are in worse condition than previously identified.

South Fork Palouse River

For the South Fork Palouse River, analysis indicates that all AUs in the temperature TMDL continue to lack shade. As shown in Table 11, the lower 3rd-order AU (ID17060108CL002_03) had the largest excess load resulting from the shade deficit, but it was only 22% of its total existing solar load. The 2nd-order AU (ID17060108CL003_02), including the headwaters of the South Fork Palouse River and most its tributaries, had the highest excess load relative to its total load and requires a 53% reduction to meet target levels. The middle 3rd-order AU (ID17060108CL003_03) had the lowest excess load but requires a 31% reduction to meet target levels.

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 a unique integer between 0% and 100%, a difference usually exists between the two. For example, 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. An automatic difference of 6% could be attributed to the margin of safety.

The analysis of existing shade was enhanced by newer and better aerial imagery. The 2013 National Agriculture Imagery Program has a resolution of half meter and provides some of the clearest images we have seen to date. In addition to new imagery, this analysis was enhanced by using target shade curves specifically developed from Idaho plant community data (Shumar and de Varona 2009). The original PNV TMDL for the South Fork Palouse River watershed completed in 2007 borrowed target shade curves from surrounding states (Oregon, Washington, and California) or other watersheds in Idaho, which were not specific enough to accurately characterize the vegetation growing in the South Fork Palouse River watershed.

The 2007 TMDL looked at solar load characteristics for two named streams, Crumarine Creek and South Fork Palouse River but did not represent them as AUs. To compare previous loads to the present analysis (Table 13), we selected and tallied loads for these two streams from the tables in Appendix C.

Table 13. Comparison of total solar loads for selected waters in South Fork Palouse River (2007 versus 2014).

Stream Name	2007				2014			
	Existing Load	Target Load	Excess Load	Reduction	Existing Load	Target Load	Excess Load	Reduction
	(kWh/day)			(%)	(kWh/day)			(%)
Crumarine Creek	12,333	8,514	3,818	31	13,700	7,570	5,800	42
South Fork Palouse River	378,813	235,422	143,391	38	212,400	165,750	43,300	20

In the present analysis, loads for Crumarine Creek are slightly greater resulting in a higher needed reduction. Loads for the South Fork Palouse River went down considerably resulting in a lower excess load and a lower needed reduction. These results are likely due to a refinement of our shade targets and better quality imagery for determining existing shade conditions.

In the future, refer to the new load calculations for the South Fork Palouse River provided in Appendix C. Load results in the 2007 temperature TMDL should be considered inaccurate and out-of-date.

5.4.1 Water Diversion

Stream temperature may be affected by diversions of water for water rights purposes. However, there are no known diversions in the Palouse River subbasin on the AUs discussed in this document.

5.4.2 Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially 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 likely 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 summer loads. All loads have been calculated to include 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

Under CWA §319, each state is required to develop and submit a nonpoint source management plan. Idaho's most recent *Nonpoint Source Management Plan* was approved in March 2015 (DEQ 2015). The plan was submitted to and approved by EPA. The plan identifies programs to achieve implementation of nonpoint source 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, such as the formation of basin advisory groups and WAGs.

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 14.

Table 14. State of Idaho's regulatory authority for nonpoint pollution sources.

Authority	Water Quality Standard Citation	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
Rathdrum Prairie Sewage Disposal Regulations (Panhandle District Health Department)	58.01.02.350.03(e)	Idaho Department of Environmental Quality/ Panhandle District Health Department
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
Rules Governing Dairy Waste (IDAPA 02.04.14)	58.01.02.350.03(h)	Idaho State Department of Agriculture

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 and DEQ 2015), which provides direction to the agricultural community regarding approved BMPs. A portion of the Ag Plan outlines responsible agencies or elected groups (soil and water 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 and water 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 and wastewater treatment requirements 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, the Idaho Soil and Water Conservation Commission for grazing and agricultural activities, the Idaho Transportation Department for public road construction, the Idaho State Department of Agriculture for aquaculture, and DEQ for all other activities (IDAPA 58.01.02.010.24).

5.4.5 TMDL Wasteload Allocation

For the Palouse River tributaries, no known NPDES-permitted point sources exist in the affected watersheds, and no wasteload allocations are required.

For South Fork Palouse River, no known NPDES-permitted point sources exist in the affected watersheds.

If a point source is proposed that would have thermal consequences on these waters, background provisions in Idaho's water quality standards addressing such discharges (IDAPA 58.01.02.200.09; IDAPA 58.01.02.401.01) should be involved (Appendix A).

5.4.6 Stormwater

Stormwater runoff is water from rain or snowmelt that does not immediately infiltrate into the ground and flows over or through natural or man-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 (MS4s), industrial stormwater covered under the MSGP, and construction stormwater covered under the Construction General Permit (CGP).

5.4.6.1 Municipal Separate Storm Sewer Systems

Polluted stormwater runoff is commonly transported through MS4s, from which it is often discharged untreated into local water bodies. An MS4, according to (40 CFR 122.26(b)(8)), is a conveyance or system of conveyances that meets the following criteria:

- Owned by a state, city, town, village, or other public entity that discharges to waters of the United States.
- Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.)
- Not a combined sewer
- Not part of a publicly owned treatment works (sewage treatment plant)

To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain an NPDES permit from EPA, implement a comprehensive municipal stormwater management program, and use BMPs to control pollutants in stormwater discharges to the maximum extent practicable.

5.4.6.2 Industrial Stormwater Requirements

Stormwater runoff picks up industrial pollutants and typically discharges them into nearby water bodies directly or indirectly via storm sewer systems. When facility practices allow exposure of industrial materials to stormwater, runoff from industrial areas can contain toxic pollutants (e.g., heavy metals and organic chemicals) and other pollutants such as trash, debris, and oil and grease. This increased flow and pollutant load can impair water bodies, degrade biological habitats, pollute drinking water sources, and cause flooding and hydrologic changes, such as channel erosion, to the receiving water body.

Multi-Sector General Permit and Stormwater Pollution Prevention Plans

In Idaho, if an industrial facility discharges industrial stormwater into waters of the United States, the facility must be permitted under EPA's most recent MSGP. To obtain an MSGP, the facility must prepare a stormwater pollution prevention plan (SWPPP) before submitting a notice of intent for permit coverage. The SWPPP must document the site description, design, and installation of control measures; describe monitoring procedures; and summarize potential pollutant sources. A copy of the SWPPP must be kept on site in a format that is accessible to workers and inspectors and be updated to reflect changes in site conditions, personnel, and stormwater infrastructure.

Industrial Facilities Discharging to Impaired Water Bodies

Any facility that discharges to an impaired water body must monitor all pollutants for which the water body is impaired and for which a standard analytical method exists (40 CFR 136).

Also, because different industrial activities have sector-specific types of material that may be exposed to stormwater, EPA grouped the different regulated industries into 29 sectors, based on their typical activities. Part 8 of EPA's MSGP details the stormwater management practices and monitoring that are required for the different industrial sectors. EPA issued a new MSGP in June 2015. The new MSGP will detail the specific monitoring requirements.

TMDL Industrial Stormwater Requirements

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a wasteload allocation for industrial stormwater activities under the MSGP. However, most load analyses developed in the past have not identified sector-specific numeric wasteload allocations for industrial stormwater activities. Industrial stormwater activities are considered in compliance with provisions of the TMDL if operators obtain an MSGP 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 next MSGP will have specific monitoring requirements that must be followed.

5.4.6.3 Construction Stormwater

CWA 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 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 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 2005b) should be used to select the proper suite of BMPs for the specific site, soils, climate, and project phasing to sufficiently meet the standards and requirements of the CGP and protect water quality. Where local ordinances have more stringent and site-specific standards, those are applicable.

5.4.7 Reserve for Growth

An explicit growth reserve has not been included in this TMDL addendum. The load capacity has been allocated to the existing sources in the watershed. Any new sources will need to obtain an allocation from the existing load allocation. The TMDL is based on target shade and Idaho's temperature water quality standards (IDAPA 58.01.02. 250.02.b). Therefore, growth can occur provided the following are true:

- The receiving stream channel can handle the extra heat added.
- The effluent contains temperature levels equal to or less than water quality standards after mixing.

DEQ and this addendum make no statement about water rights or availability.

5.5 Implementation Strategies

The *Palouse River Tributaries Total Maximum Daily Load Implementation Plan for Agriculture* (Palouse River tributaries WAG 2009) *http://swc.idaho.gov/media/22572/PalouseTributariesAgImplementationPlan.pdf*; and *South Fork of the Palouse River Total Maximum Daily Load Implementation Plan for Agriculture* (South Fork Palouse River WAG 2009) *http://swc.idaho.gov/media/22566/PalouseSouthForkAgImplementationPlan.pdf* outlined critical areas for project activities with input from watershed stakeholders and WAG. Many watershed improvement projects with diverse funding sources have been completed or are ongoing in the Palouse River subbasin. Local watershed management agencies have worked together and with private landowners to implement BMPs to restore the subbasin and prevent degradation.

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the load analysis tables presented in this TMDL (Appendix C). These tables must 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 to achieving both objectives. It is likely that further field verification will find discrepancies with reported existing shade levels in the load analysis tables. Due to the inexact nature of the aerial photo interpretation technique, these tables 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. 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 to field verify existing shade for each stream segment 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 load. Because implementation depends on mature riparian communities to substantially improve stream temperatures, DEQ believes 10–20 years may be a reasonable amount 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 WAG will continue to reevaluate 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 Implementation Monitoring Strategy

Effective shade monitoring can take place on any segment throughout the Palouse River tributaries and South Fork Palouse River AUs and can be compared to existing shade estimates provided in Appendix C. Those areas with the largest disparity between existing and target shade should be 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 segment 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 segment to see if that segment has increased its existing shade toward target levels. Ten equally spaced Solar Pathfinder measurements averaged together within that segment should suffice to determine new shade levels in the future.

5.5.3 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 Pollutant Trading Guidance* sets forth the procedures to be followed for pollutant trading (DEQ 2010).

5.5.3.1 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.

5.5.3.2 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.

5.5.3.3 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 2010).

6 Conclusions

Effective shade targets were established for Palouse River tributaries (17 AUs), and South Fork Palouse River (3 AUs) based on the concept of maximum 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 15.

Palouse River Tributaries

For the Palouse River tributaries, this review of the 2005 approved temperature TMDL reexamined new aerial imagery and assigned new shade targets based on Idaho plant community data. New loads developed in this review should replace 2005 loads. The new analysis determined that all streams lack shade. Most AUs are at similar levels with respect to shade loss when compared to lack of cover in 2005. A few exceptions exist where conditions are better or worse than previously determined.

In the Palouse River subbasin, target shade levels for individual stream segments should be the goal managers strive for with future implementation plans. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts.

South Fork Palouse River

For the South Fork Palouse River, this review of the 2007 approved temperature TMDL reexamined new aerial imagery and assigned new shade targets based on Idaho plant community data. New loads developed in this review should replace 2007 loads. In general, most stream conditions changed only slightly as a result of the new analysis. Crumarine Creek is in worse condition, and South Fork Palouse River is in better condition when compared to the original TMDL. All streams examined lack shade to some degree.

Table 15. Summary of assessment outcomes for the Palouse River tributaries and South Fork Palouse River.

Water Body	Assessment Unit Number	Pollutant	TMDL Completed	Recommended Changes to the Next Integrated Report	Justification
Palouse River tributaries					
Flannigan Creek	ID17060108CL011a_02 ID17060108CL011a_03 ID17060108CL011b_02 ID17060108CL011b_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Hatter Creek	ID17060108CL015a_02 ID17060108CL015b_02 ID17060108CL015b_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Big Creek	ID17060108CL027a_02 ID17060108CL027b_02	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Gold Creek	ID17060108CL029_02 ID17060108CL029_03 ID17060108CL030_02 ID17060108CL031a_02 ID17060108CL031b_02	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Deep Creek	ID17060108CL032a_02 ID17060108CL032a_03 ID17060108CL032b_02 ID17060108CL032b_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
South Fork Palouse River	ID17060108CL002_03 ID17060108CL003_02 ID17060108CL003_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade

This document was prepared with input from the public, as described in Appendix D. Comments and DEQ responses are included in that appendix, and a distribution list is included in Appendix E.

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GIS Coverages

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USDA–FSA Aerial Photography Field Office—2013 National Agricultural Imagery Program 0.5m imagery

USDA–FSA Aerial Photography Field Office—2011 National Agricultural Imagery Program 1.0m imagery

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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* (Grafe et al. 2002).

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

The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Load 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 load 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* (Grafe et al. 2002).

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. 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 (Grafe et al. 2002). Fall spawning can occur as early as September 1 and continue with incubation into the following spring up to June 1. As per IDAPA 58.01.02.250.02.f.ii., the following water quality criteria need to be met during that time period:

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

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Appendix B. Data Sources and Other Data

Table B-1. Data sources for water bodies in the Palouse River subbasin.

Water Body	Data Source	Type of Data	Collection Date
Palouse River tributaries	DEQ Lewiston Regional Office	Solar Pathfinder effective shade and stream width	Summer/fall 2014
Palouse River tributaries	DEQ Lewiston Regional Office	Aerial photo interpretation of existing shade and stream width estimation	Fall/winter 2014
Palouse River tributaries	DEQ IDASA Database	Temperature	—
South Fork Palouse River watershed	DEQ Lewiston Regional Office	Solar Pathfinder effective shade and stream width	—
South Fork Palouse River watershed	DEQ State Technical Services Office	Aerial photo interpretation of existing shade and stream width estimation	November 2014
South Fork Palouse River watershed	DEQ IDASA Database	Temperature	—

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Appendix C. Existing and Potential Solar Load Tables and Target Shade Curves

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Palouse River Tributaries

Table C-1. Existing and target solar loads for Flannigan Creek (ID17060108CL011a_02).

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
011a_02	Flannigan Creek	1	2,786	St Joe Group B	98%	0.12	1	3,000	300	90%	0.58	1	3,000	2,000	2,000	-8%
011a_02	Flannigan Creek	2	1,898	St Joe Group B	98%	0.12	2	4,000	500	80%	1.16	2	4,000	5,000	5,000	-18%
011a_02	Flannigan Creek	3	221	St Joe Group B	97%	0.17	3	700	100	70%	1.74	3	700	1,000	900	-27%
011a_02	1st Trib to Flannigan Creek	1	1,828	St Joe Group B	98%	0.12	1	2,000	200	80%	1.16	1	2,000	2,000	2,000	-18%
011a_02	2nd Trib to Flannigan Creek	1	2,763	St Joe Group B	98%	0.12	1	3,000	300	90%	0.58	1	3,000	2,000	2,000	-8%
011a_02	2nd Trib to Flannigan Creek	2	342	St Joe hardwood	93%	0.41	2	700	300	80%	1.16	2	700	800	500	-13%
011a_02	2nd Trib to Flannigan Creek	3	560	St Joe hardwood	93%	0.41	2	1,000	400	70%	1.74	2	1,000	2,000	2,000	-23%
011a_02	2nd Trib to Flannigan Creek	4	281	St Joe hardwood	93%	0.41	2	600	200	60%	2.32	2	600	1,000	800	-33%
011a_02	2nd Trib to Flannigan Creek	5	464	St Joe hardwood	93%	0.41	3	1,000	400	50%	2.90	3	1,000	3,000	3,000	-43%
011a_02	Trib to 2nd Trib Flannigan Cr	1	3,622	St Joe Group B	98%	0.12	1	4,000	500	90%	0.58	1	4,000	2,000	2,000	-8%
011a_02	Trib to 2nd Trib Flannigan Cr	2	289	St Joe hardwood	93%	0.41	2	600	200	70%	1.74	2	600	1,000	800	-23%
011a_02	3rd Trib to Flannigan Creek	1	1,300	St Joe Group B	98%	0.12	1	1,000	100	80%	1.16	1	1,000	1,000	900	-18%
011a_02	3rd Trib to Flannigan Creek	2	1,215	St Joe Group B	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
011a_02	3rd Trib to Flannigan Creek	3	180	St Joe Group B	98%	0.12	2	400	50	80%	1.16	2	400	500	500	-18%
011a_02	3rd Trib to Flannigan Creek	4	372	St Joe Group B	98%	0.12	2	700	80	60%	2.32	2	700	2,000	2,000	-38%
011a_02	West Fork Flannigan Creek	1	1,250	St Joe Group B	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
011a_02	West Fork Flannigan Creek	2	499	St Joe Group B	98%	0.12	2	1,000	100	90%	0.58	2	1,000	600	500	-8%
011a_02	West Fork Flannigan Creek	3	263	St Joe Group B	98%	0.12	2	500	60	80%	1.16	2	500	600	500	-18%
011a_02	West Fork Flannigan Creek	4	302	St Joe Group B	98%	0.12	2	600	70	70%	1.74	2	600	1,000	900	-28%
011a_02	West Fork Flannigan Creek	5	840	St Joe Group B	98%	0.12	2	2,000	200	80%	1.16	2	2,000	2,000	2,000	-18%
011a_02	West Fork Flannigan Creek	6	231	St Joe Group B	98%	0.12	2	500	60	70%	1.74	2	500	900	800	-28%
011a_02	West Fork Flannigan Creek	7	113	St Joe Group B	98%	0.12	2	200	20	80%	1.16	2	200	200	200	-18%
011a_02	West Fork Flannigan Creek	8	96	St Joe Group B	98%	0.12	3	300	30	70%	1.74	3	300	500	500	-28%
011a_02	West Fork Flannigan Creek	9	310	Palouse hawthorn	71%	1.68	3	900	2,000	10%	5.21	3	900	5,000	3,000	-61%
011a_02	West Fork Flannigan Creek	10	207	Palouse hawthorn	71%	1.68	3	600	1,000	50%	2.90	3	600	2,000	1,000	-21%
011a_02	West Fork Flannigan Creek	11	231	Palouse hawthorn	71%	1.68	3	700	1,000	70%	1.74	3	700	1,000	0	-1%
011a_02	West Fork Flannigan Creek	12	76	Palouse hawthorn	71%	1.68	3	200	300	80%	1.16	3	200	200	(100)	0%
011a_02	West Fork Flannigan Creek	13	184	Palouse hawthorn	60%	2.32	4	700	2,000	10%	5.21	4	700	4,000	2,000	-50%
011a_02	West Fork Flannigan Creek	14	82	Palouse hawthorn	60%	2.32	4	300	700	0%	5.79	4	300	2,000	1,000	-60%
011a_02	West Fork Flannigan Creek	15	138	St Joe hardwood	74%	1.51	4	600	900	20%	4.63	4	600	3,000	2,000	-54%
011a_02	West Fork Flannigan Creek	16	379	St Joe Group B	96%	0.23	4	2,000	500	70%	1.74	4	2,000	3,000	3,000	-26%
011a_02	West Fork Flannigan Creek	17	150	Palouse hawthorn	60%	2.32	4	600	1,000	50%	2.90	4	600	2,000	1,000	-10%
011a_02	1st Trib to WF Flannigan Cr	1	1050	St Joe Group B	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
011a_02	1st Trib to WF Flannigan Cr	2	429	St Joe Group B	98%	0.12	1	400	50	80%	1.16	1	400	500	500	-18%
011a_02	1st Trib to WF Flannigan Cr	3	463	St Joe Group B	98%	0.12	1	500	60	90%	0.58	1	500	300	200	-8%
011a_02	1st Trib to WF Flannigan Cr	4	542	St Joe Group B	98%	0.12	1	500	60	80%	1.16	1	500	600	500	-18%
011a_02	1st Trib to WF Flannigan Cr	5	341	St Joe hardwood	94%	0.35	1	300	100	70%	1.74	1	300	500	400	-24%
011a_02	1st Trib to WF Flannigan Cr	6	181	Palouse hawthorn	97%	0.17	1	200	30	20%	4.63	1	200	900	900	-77%
011a_02	2nd Trib to WF Flannigan Cr	1	793	St Joe Group B	98%	0.12	1	800	90	90%	0.58	1	800	500	400	-8%
011a_02	2nd Trib to WF Flannigan Cr	2	1620	St Joe Group B	98%	0.12	1	2,000	200	80%	1.16	1	2,000	2,000	2,000	-18%
011a_02	2nd Trib to WF Flannigan Cr	3	316	St Joe hardwood	94%	0.35	1	300	100	80%	1.16	1	300	300	200	-14%
								Totals	15,000					61,000	49,000	

Table C-2. Existing and target solar loads for Flannigan Creek (ID17060108CL011a_03).

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
011a_03	Flannigan Creek	1	720	St Joe Group B	96%	0.23	4	3,000	700	60%	2.32	4	3,000	7,000	6,000	-36%
011a_03	Flannigan Creek	2	970	St Joe hardwood	74%	1.51	4	4,000	6,000	60%	2.32	4	4,000	9,000	3,000	-14%
011a_03	Flannigan Creek	3	600	St Joe hardwood	65%	2.03	5	3,000	6,000	70%	1.74	5	3,000	5,000	(1,000)	0%
011a_03	Flannigan Creek	4	180	St Joe hardwood	65%	2.03	5	900	2,000	60%	2.32	5	900	2,000	0	-5%
011a_03	Flannigan Creek	5	395	St Joe hardwood	65%	2.03	5	2,000	4,000	50%	2.90	5	2,000	6,000	2,000	-15%
011a_03	Flannigan Creek	6	280	St Joe hardwood	65%	2.03	5	1,000	2,000	30%	4.05	5	1,000	4,000	2,000	-35%
011a_03	Flannigan Creek	7	500	St Joe hardwood	65%	2.03	5	3,000	6,000	20%	4.63	5	3,000	10,000	4,000	-45%
011a_03	Flannigan Creek	8	490	St Joe hardwood	58%	2.43	6	3,000	7,000	40%	3.47	6	3,000	10,000	3,000	-18%
011a_03	Flannigan Creek	9	380	St Joe hardwood	58%	2.43	6	2,000	5,000	30%	4.05	6	2,000	8,000	3,000	-28%
011a_03	Flannigan Creek	10	320	St Joe hardwood	58%	2.43	6	2,000	5,000	40%	3.47	6	2,000	7,000	2,000	-18%
011a_03	Flannigan Creek	11	80	St Joe hardwood	52%	2.78	7	600	2,000	20%	4.63	7	600	3,000	1,000	-32%
							Totals		46,000					71,000	25,000	

Table C-3. Existing and target solar loads for Flannigan Creek (ID17060108CL011b_02).

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
011b_02	4th Trib to Flannigan Creek	1	230	Palouse hawthorn	97%	0.17	1	200	30	60%	2.32	1	200	500	500	-37%
011b_02	4th Trib to Flannigan Creek	2	1,325	Palouse hawthorn	97%	0.17	1	1,000	200	10%	5.21	1	1,000	5,000	5,000	-87%
011b_02	4th Trib to Flannigan Creek	3	200	Palouse hawthorn	97%	0.17	1	200	30	20%	4.63	1	200	900	900	-77%
011b_02	4th Trib to Flannigan Creek	4	460	Palouse hawthorn	97%	0.17	1	500	90	50%	2.90	1	500	1,000	900	-47%
011b_02	4th Trib to Flannigan Creek	5	2,010	Palouse hawthorn	88%	0.69	2	4,000	3,000	10%	5.21	2	4,000	20,000	20,000	-78%
011b_02	4th Trib to Flannigan Creek	6	580	Palouse hawthorn	88%	0.69	2	1,000	700	0%	5.79	2	1,000	6,000	5,000	-88%
							Totals		4,100					33,000	32,000	

Table C-4. Existing and target solar loads for Flannigan Creek (ID17060108CL011b_03).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
011b_03	Flannigan Creek	1	750	St Joe hardwood	52%	2.78	7	5,000	10,000	30%	4.05	7	5,000	20,000	10,000	-22%
011b_03	Flannigan Creek	2	110	St Joe hardwood	52%	2.78	7	800	2,000	0%	5.79	7	800	5,000	3,000	-52%
011b_03	Flannigan Creek	3	345	St Joe hardwood	52%	2.78	7	2,000	6,000	20%	4.63	7	2,000	9,000	3,000	-32%
011b_03	Flannigan Creek	4	305	St Joe hardwood	52%	2.78	7	2,000	6,000	30%	4.05	7	2,000	8,000	2,000	-22%
011b_03	Flannigan Creek	5	170	St Joe hardwood	52%	2.78	7	1,000	3,000	20%	4.63	7	1,000	5,000	2,000	-32%
011b_03	Flannigan Creek	6	175	St Joe hardwood	52%	2.78	7	1,000	3,000	60%	2.32	7	1,000	2,000	(1,000)	0%
011b_03	Flannigan Creek	7	80	St Joe hardwood	52%	2.78	7	600	2,000	20%	4.63	7	600	3,000	1,000	-32%
011b_03	Flannigan Creek	8	100	St Joe hardwood	52%	2.78	7	700	2,000	0%	5.79	7	700	4,000	2,000	-52%
011b_03	Flannigan Creek	9	155	St Joe hardwood	52%	2.78	7	1,000	3,000	60%	2.32	7	1,000	2,000	(1,000)	0%
011b_03	Flannigan Creek	10	90	St Joe hardwood	52%	2.78	7	600	2,000	0%	5.79	7	600	3,000	1,000	-52%
011b_03	Flannigan Creek	11	580	Palouse hawthorn	35%	3.76	7	4,000	20,000	10%	5.21	7	4,000	20,000	0	-25%
011b_03	Flannigan Creek	12	350	Palouse hawthorn	35%	3.76	7	2,000	8,000	20%	4.63	7	2,000	9,000	1,000	-15%
011b_03	Flannigan Creek	13	120	Palouse hawthorn	35%	3.76	8	1,000	4,000	10%	5.21	8	1,000	5,000	1,000	-25%
011b_03	Flannigan Creek	14	220	Palouse hawthorn	35%	3.76	8	2,000	8,000	0%	5.79	8	2,000	10,000	2,000	-35%
011b_03	Flannigan Creek	15	720	Palouse hawthorn	35%	3.76	8	6,000	20,000	10%	5.21	8	6,000	30,000	10,000	-25%
011b_03	Flannigan Creek	16	645	Palouse hawthorn	35%	3.76	8	5,000	20,000	30%	4.05	8	5,000	20,000	0	-5%
011b_03	Flannigan Creek	17	590	Palouse hawthorn	35%	3.76	8	5,000	20,000	40%	3.47	8	5,000	20,000	0	0%
011b_03	Flannigan Creek	18	230	Palouse hawthorn	35%	3.76	8	2,000	8,000	10%	5.21	8	2,000	10,000	2,000	-25%
011b_03	Flannigan Creek	19	200	Palouse hawthorn	35%	3.76	8	2,000	8,000	70%	1.74	8	2,000	3,000	(5,000)	0%
011b_03	Flannigan Creek	20	90	Palouse hawthorn	35%	3.76	8	700	3,000	30%	4.05	8	700	3,000	0	-5%
							Totals		160,000					190,000	33,000	

Table C-5. Existing and target solar loads for Hatter Creek (ID17060108CL015a_02).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
015a_02	Hatter Creek	1	4950	St. Joe Group B	98%	0.12	1	5,000	600	90%	0.58	1	5,000	3,000	2,000	-8%
015a_02	Hatter Creek	2	245	St. Joe Group B	98%	0.12	1	200	20	80%	1.16	2	500	600	600	-18%
015a_02	Hatter Creek	3	290	St. Joe hardwood	93%	0.41	2	600	200	70%	1.74	2	600	1,000	800	-23%
015a_02	Hatter Creek	4	1565	St. Joe hardwood	93%	0.41	2	3,000	1,000	80%	1.16	2	3,000	3,000	2,000	-13%
015a_02	Hatter Creek	5	295	St. Joe hardwood	93%	0.41	2	600	200	70%	1.74	4	1,000	2,000	2,000	-23%
015a_02	1st trib to Hatter Cr	1	1215	St. Joe Group B	98%	0.12	1	1,000	100	10%	5.21	1	1,000	5,000	5,000	-88%
015a_02	1st trib to Hatter Cr	2	2720	St. Joe Group B	98%	0.12	2	5,000	600	90%	0.58	2	5,000	3,000	2,000	-8%
015a_02	2nd trib to Hatter Cr	1	1535	St. Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
015a_02	2nd trib to Hatter Cr	2	600	St. Joe hardwood	93%	0.41	2	1,000	400	70%	1.74	2	1,000	2,000	2,000	-23%
015a_02	3rd trib to Hatter Cr	1	240	St. Joe Group B	98%	0.12	1	200	20	10%	5.21	1	200	1,000	1,000	-88%
015a_02	3rd trib to Hatter Cr	2	185	St. Joe Group B	98%	0.12	1	200	20	90%	0.58	1	200	100	80	-8%
015a_02	3rd trib to Hatter Cr	3	185	St. Joe Group B	98%	0.12	1	200	20	10%	5.21	1	200	1,000	1,000	-88%
015a_02	3rd trib to Hatter Cr	4	1300	St. Joe Group B	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
015a_02	3rd trib to Hatter Cr	5	1185	St. Joe hardwood	93%	0.41	2	2,000	800	70%	1.74	2	2,000	3,000	2,000	-23%
015a_02	Long Creek	1	2530	St. Joe Group B	98%	0.12	1	3,000	300	90%	0.58	1	3,000	2,000	2,000	-8%
015a_02	Long Creek	2	450	St. Joe Group B	98%	0.12	2	900	100	70%	1.74	2	900	2,000	2,000	-28%
015a_02	Long Creek	3	730	St. Joe Group B	98%	0.12	2	1,000	100	80%	1.16	2	1,000	1,000	900	-18%
015a_02	Long Creek	4	540	St. Joe Group B	98%	0.12	2	1,000	100	70%	1.74	2	1,000	2,000	2,000	-28%
015a_02	Long Creek	5	1670	St. Joe Group B	98%	0.12	3	5,000	600	80%	1.16	3	5,000	6,000	5,000	-18%
015a_02	Long Creek	6	345	St. Joe hardwood	85%	0.87	3	1,000	900	70%	1.74	3	1,000	2,000	1,000	-15%
015a_02	Long Creek	7	680	St. Joe hardwood	74%	1.51	4	3,000	5,000	80%	1.16	4	3,000	3,000	(2,000)	0%
015a_02	Long Creek	8	240	Palouse hawthorn	60%	2.32	4	1,000	2,000	60%	2.32	4	1,000	2,000	0	0%
015a_02	trib to Long Creek	1	610	St. Joe Group B	98%	0.12	1	600	70	90%	0.58	1	600	300	200	-8%
015a_02	trib to Long Creek	2	305	St. Joe Group B	98%	0.12	1	300	30	70%	1.74	1	300	500	500	-28%
015a_02	trib to Long Creek	3	1175	St. Joe Group B	98%	0.12	1	1,000	100	80%	1.16	1	1,000	1,000	900	-18%
							Totals		14,000					48,000	34,000	

Table C-6. Existing and target solar loads for Hatter Creek (ID17060108CL015b_02).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
015b_02	1st AU tributary	1	520	St Joe Group B	98%	0.12	1	500	60	90%	0.58	1	500	300	200	-8%
015b_02	1st AU tributary	2	290	St Joe hardwood	94%	0.35	1	300	100	70%	1.74	1	300	500	400	-24%
015b_02	1st AU tributary	3	80	St Joe hardwood	94%	0.35	1	80	30	20%	4.63	1	80	400	400	-74%
015b_02	1st AU tributary	4	770	St Joe hardwood	93%	0.41	2	2,000	800	80%	1.16	2	2,000	2,000	1,000	-13%
015b_02	1st AU tributary	5	610	Palouse hawthorn	88%	0.69	2	1,000	700	70%	1.74	2	1,000	2,000	1,000	-18%
015b_02	2nd AU tributary	1	2000	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
015b_02	2nd AU tributary	2	140	St Joe hardwood	93%	0.41	2	300	100	80%	1.16	2	300	300	200	-13%
015b_02	2nd AU tributary	3	270	St Joe hardwood	93%	0.41	2	500	200	60%	2.32	2	500	1,000	800	-33%
015b_02	2nd AU tributary	4	170	St Joe Group B	98%	0.12	2	300	30	90%	0.58	2	300	200	200	-8%
015b_02	2nd AU tributary	5	140	St Joe hardwood	93%	0.41	2	300	100	80%	1.16	2	300	300	200	-13%
015b_02	2nd AU tributary	6	820	St Joe Group B	97%	0.17	3	2,000	300	90%	0.58	3	2,000	1,000	700	-7%
015b_02	2nd AU tributary	7	90	meadow	21%	4.57	3	300	1,000	30%	4.05	3	300	1,000	0	0%
015b_02	2nd AU tributary	8	450	St Joe hardwood	85%	0.87	3	1,000	900	80%	1.16	3	1,000	1,000	100	-5%
015b_02	2nd AU tributary	9	220	St Joe Group B	97%	0.17	3	700	100	90%	0.58	3	700	400	300	-7%
015b_02	2nd AU tributary	10	240	St Joe hardwood	74%	1.51	4	1,000	2,000	80%	1.16	4	1,000	1,000	(1,000)	0%
015b_02	2nd AU tributary	11	970	St Joe hardwood	74%	1.51	4	4,000	6,000	70%	1.74	4	4,000	7,000	1,000	-4%
015b_02	2nd AU tributary	12	280	Palouse hawthorn	60%	2.32	4	1,000	2,000	60%	2.32	4	1,000	2,000	0	0%
015b_02	2nd AU tributary	13	160	Palouse hawthorn	60%	2.32	4	600	1,000	50%	2.90	4	600	2,000	1,000	-10%
015b_02	2nd AU tributary	14	160	Palouse hawthorn	51%	2.84	5	800	2,000	50%	2.90	5	800	2,000	0	-1%
015b_02	2nd AU tributary	15	230	St Joe hardwood	65%	2.03	5	1,000	2,000	70%	1.74	5	1,000	2,000	0	0%
015b_02	2nd AU tributary	16	230	Palouse hawthorn	51%	2.84	5	1,000	3,000	60%	2.32	5	1,000	2,000	(1,000)	0%
015b_02	2nd AU tributary	17	290	Palouse hawthorn	51%	2.84	5	1,000	3,000	30%	4.05	5	1,000	4,000	1,000	-21%
015b_02	2nd AU tributary	18	210	Palouse hawthorn	51%	2.84	5	1,000	3,000	60%	2.32	5	1,000	2,000	(1,000)	0%
015b_02	1st to 2nd	1	1800	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
015b_02	1st to 2nd	2	140	St Joe hardwood	94%	0.35	1	100	30	80%	1.16	1	100	100	70	-14%
015b_02	2nd to 2nd	1	730	St Joe Group B	98%	0.12	1	700	80	90%	0.58	1	700	400	300	-8%
015b_02	2nd to 2nd	2	130	St Joe hardwood	94%	0.35	1	100	30	80%	1.16	1	100	100	70	-14%
015b_02	2nd to 2nd	3	1400	St Joe Group B	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
015b_02	2nd to 2nd	4	290	St Joe hardwood	93%	0.41	2	600	200	80%	1.16	2	600	700	500	-13%
015b_02	3rd to 2nd	1	610	St Joe Group B	98%	0.12	1	600	70	90%	0.58	1	600	300	200	-8%
015b_02	3rd to 2nd	2	150	St Joe Group B	98%	0.12	1	200	20	40%	3.47	1	200	700	700	-58%
015b_02	3rd to 2nd	3	260	St Joe Group B	98%	0.12	1	300	30	80%	1.16	1	300	300	300	-18%
015b_02	3rd to 2nd	4	1400	St Joe Group B	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
015b_02	3rd to 2nd	5	230	St Joe hardwood	93%	0.41	2	500	200	60%	2.32	2	500	1,000	800	-33%
015b_02	3rd to 2nd	6	730	St Joe hardwood	93%	0.41	2	1,000	400	70%	1.74	2	1,000	2,000	2,000	-23%
015b_02	3rd to 2nd	7	70	Palouse hawthorn	88%	0.69	2	100	70	0%	5.79	2	100	600	500	-88%
015b_02	3rd to 2nd	8	300	Palouse hawthorn	88%	0.69	2	600	400	60%	2.32	2	600	1,000	600	-28%

Table C-6 (cont.). Existing and target solar loads for Hatter Creek (ID17060108CL015b_02).

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
015b_02	4th to 2nd	1	1700	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
015b_02	4th to 2nd	2	430	St Joe hardwood	93%	0.41	2	900	400	70%	1.74	2	900	2,000	2,000	-23%
015b_02	4th to 2nd	3	250	St Joe hardwood	93%	0.41	2	500	200	60%	2.32	2	500	1,000	800	-33%
015b_02	4th to 2nd	4	320	St Joe hardwood	93%	0.41	2	600	200	80%	1.16	2	600	700	500	-13%
015b_02	4th to 2nd	5	290	St Joe hardwood	93%	0.41	2	600	200	60%	2.32	2	600	1,000	800	-33%
015b_02	4th to 2nd	6	290	Palouse hawthorn	88%	0.69	2	600	400	40%	3.47	2	600	2,000	2,000	-48%
015b_02	3rd AU tributary	1	220	St Joe Group B	98%	0.12	1	200	20	90%	0.58	1	200	100	80	-8%
015b_02	3rd AU tributary	2	340	St Joe Group B	98%	0.12	1	300	30	80%	1.16	1	300	300	300	-18%
015b_02	3rd AU tributary	3	230	St Joe hardwood	94%	0.35	1	200	70	60%	2.32	1	200	500	400	-34%
015b_02	3rd AU tributary	4	200	St Joe hardwood	94%	0.35	1	200	70	40%	3.47	1	200	700	600	-54%
015b_02	3rd AU tributary	5	360	St Joe hardwood	94%	0.35	1	400	100	60%	2.32	1	400	900	800	-34%
015b_02	3rd AU tributary	6	180	St Joe hardwood	94%	0.35	1	200	70	80%	1.16	1	200	200	100	-14%
015b_02	3rd AU tributary	7	130	St Joe hardwood	93%	0.41	2	300	100	60%	2.32	2	300	700	600	-33%
015b_02	3rd AU tributary	8	360	St Joe hardwood	93%	0.41	2	700	300	80%	1.16	2	700	800	500	-13%
015b_02	3rd AU tributary	9	150	Palouse hawthorn	88%	0.69	2	300	200	60%	2.32	2	300	700	500	-28%
015b_02	4th AU tributary	1	500	St Joe hardwood	94%	0.35	1	500	200	80%	1.16	1	500	600	400	-14%
015b_02	4th AU tributary	2	340	St Joe hardwood	94%	0.35	1	300	100	60%	2.32	1	300	700	600	-34%
015b_02	4th AU tributary	3	130	St Joe hardwood	94%	0.35	1	100	30	80%	1.16	1	100	100	70	-14%
015b_02	4th AU tributary	4	330	St Joe hardwood	94%	0.35	1	300	100	50%	2.90	1	300	900	800	-44%
015b_02	4th AU tributary	5	500	St Joe hardwood	94%	0.35	1	500	200	60%	2.32	1	500	1,000	800	-34%
015b_02	4th AU tributary	6	740	St Joe hardwood	94%	0.35	1	700	200	80%	1.16	1	700	800	600	-14%
015b_02	4th AU tributary	7	790	St Joe Group B	98%	0.12	1	800	90	90%	0.58	1	800	500	400	-8%
015b_02	4th AU tributary	8	130	St Joe hardwood	94%	0.35	1	100	30	80%	1.16	1	100	100	70	-14%
015b_02	4th AU tributary	9	400	St Joe hardwood	94%	0.35	1	400	100	70%	1.74	1	400	700	600	-24%
015b_02	4th AU tributary	10	420	St Joe hardwood	93%	0.41	2	800	300	70%	1.74	2	800	1,000	700	-23%
015b_02	4th AU tributary	11	760	St Joe hardwood	93%	0.41	2	2,000	800	80%	1.16	2	2,000	2,000	1,000	-13%
015b_02	4th AU tributary	12	140	St Joe hardwood	93%	0.41	2	300	100	90%	0.58	2	300	200	100	-3%
015b_02	4th AU tributary	13	230	St Joe hardwood	93%	0.41	2	500	200	80%	1.16	2	500	600	400	-13%
015b_02	4th AU tributary	14	90	Palouse hawthorn	88%	0.69	2	200	100	40%	3.47	2	200	700	600	-48%
015b_02	4th AU tributary	15	130	Palouse hawthorn	88%	0.69	2	300	200	50%	2.90	2	300	900	700	-38%
015b_02	4th AU tributary	16	110	Palouse hawthorn	88%	0.69	2	200	100	40%	3.47	2	200	700	600	-48%
015b_02	4th AU tributary	17	320	Palouse hawthorn	88%	0.69	2	600	400	60%	2.32	2	600	1,000	600	-28%
015b_02	5th AU tributary	1	1600	St Joe hardwood	94%	0.35	1	2,000	700	80%	1.16	1	2,000	2,000	1,000	-14%
015b_02	5th AU tributary	2	90	Palouse hawthorn	88%	0.69	2	200	100	0%	5.79	2	200	1,000	900	-88%
015b_02	5th AU tributary	3	330	Palouse hawthorn	88%	0.69	2	700	500	60%	2.32	2	700	2,000	2,000	-28%
015b_02	5th AU tributary	4	330	Palouse hawthorn	88%	0.69	2	700	500	70%	1.74	2	700	1,000	500	-18%
015b_02	5th AU tributary	5	380	Palouse hawthorn	88%	0.69	2	800	600	40%	3.47	2	800	3,000	2,000	-48%
015b_02	5th AU tributary	6	250	Palouse hawthorn	88%	0.69	2	500	300	80%	1.16	2	500	600	300	-8%
015b_02	5th AU tributary	7	450	Palouse hawthorn	88%	0.69	2	900	600	50%	2.90	2	900	3,000	2,000	-38%
							Totals		40,000					83,000	43,000	

Table C-7. Existing and target solar loads for Hatter Creek (ID17060108CL015b_03).

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
015b_03	Hatter Creek	1	450	Palouse hawthorn	45%	3.18	6	3,000	10,000	60%	2.32	6	3,000	7,000	(3,000)	0%
015b_03	Hatter Creek	2	185	Palouse hawthorn	45%	3.18	6	1,000	3,000	50%	2.90	6	1,000	3,000	0	0%
015b_03	Hatter Creek	3	210	Palouse hawthorn	45%	3.18	6	1,000	3,000	10%	5.21	6	1,000	5,000	2,000	-35%
015b_03	Hatter Creek	4	905	Palouse hawthorn	45%	3.18	6	5,000	20,000	30%	4.05	6	5,000	20,000	0	-15%
015b_03	Hatter Creek	5	260	Palouse hawthorn	45%	3.18	6	2,000	6,000	40%	3.47	6	2,000	7,000	1,000	-5%
015b_03	Hatter Creek	6	580	Palouse hawthorn	39%	3.53	7	4,000	10,000	50%	2.90	7	4,000	10,000	0	0%
015b_03	Hatter Creek	7	425	Palouse hawthorn	39%	3.53	7	3,000	10,000	60%	2.32	7	3,000	7,000	(3,000)	0%
015b_03	Hatter Creek	8	220	Palouse hawthorn	39%	3.53	7	2,000	7,000	80%	1.16	7	2,000	2,000	(5,000)	0%
015b_03	Hatter Creek	9	135	Palouse hawthorn	39%	3.53	7	900	3,000	10%	5.21	7	900	5,000	2,000	-29%
015b_03	Hatter Creek	10	245	Palouse hawthorn	39%	3.53	7	2,000	7,000	70%	1.74	7	2,000	3,000	(4,000)	0%
015b_03	Hatter Creek	11	225	Palouse hawthorn	39%	3.53	7	2,000	7,000	10%	5.21	7	2,000	10,000	3,000	-29%
015b_03	Hatter Creek	12	95	Palouse hawthorn	39%	3.53	7	700	2,000	70%	1.74	7	700	1,000	(1,000)	0%
015b_03	Hatter Creek	13	825	Palouse hawthorn	35%	3.76	8	7,000	30,000	0%	5.79	8	7,000	40,000	10,000	-35%
015b_03	Hatter Creek	14	145	Palouse hawthorn	35%	3.76	8	1,000	4,000	30%	4.05	8	1,000	4,000	0	-5%
015b_03	Hatter Creek	15	420	Palouse hawthorn	35%	3.76	8	3,000	10,000	60%	2.32	8	3,000	7,000	(3,000)	0%
015b_03	Hatter Creek	16	535	Palouse hawthorn	35%	3.76	8	4,000	20,000	50%	2.90	8	4,000	10,000	(10,000)	0%
015b_03	Hatter Creek	17	1685	Palouse hawthorn	32%	3.94	9	20,000	80,000	60%	2.32	9	20,000	50,000	(30,000)	0%
015b_03	Hatter Creek	18	535	Palouse hawthorn	32%	3.94	9	5,000	20,000	40%	3.47	9	5,000	20,000	0	0%
015b_03	Hatter Creek	19	315	Palouse hawthorn	32%	3.94	9	3,000	10,000	30%	4.05	9	3,000	10,000	0	-2%
							Totals		260,000					220,000	-41,000	

Table C-8. Existing and target solar loads for Big Creek (ID17060108CL027a_02).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
027a_02	Big Creek	1	1825	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
027a_02	Big Creek	2	265	St Joe Group B	98%	0.12	2	500	60	70%	1.74	2	500	900	800	-28%
027a_02	Big Creek	3	255	St Joe Group B	98%	0.12	2	500	60	80%	1.16	2	500	600	500	-18%
027a_02	Big Creek	4	300	St Joe hardwood	93%	0.41	2	600	200	70%	1.74	2	600	1,000	800	-23%
027a_02	Big Creek	5	590	St Joe Group B	97%	0.17	3	2,000	300	80%	1.16	3	2,000	2,000	2,000	-17%
027a_02	Big Creek	6	880	St Joe hardwood	74%	1.51	4	4,000	6,000	70%	1.74	4	4,000	7,000	1,000	-4%
027a_02	Olevan Creek	1	1770	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
							Totals		7,000					14,000	6,700	

Table C-9. Existing and target solar loads for Big Creek (ID17060108CL027b_02).

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
027b_02	Big Creek	1	1300	St Joe hardwood	74%	1.51	4	5,000	8,000	70%	1.74	4	5,000	9,000	1,000	-4%
027b_02	Big Creek	2	1670	St Joe hardwood	74%	1.51	4	7,000	10,000	60%	2.32	4	7,000	20,000	10,000	-14%
027b_02	Big Creek	3	1250	St Joe hardwood	65%	2.03	5	6,000	10,000	80%	1.16	5	6,000	7,000	(3,000)	0%
027b_02	Big Creek	4	350	St Joe hardwood	65%	2.03	5	2,000	4,000	70%	1.74	5	2,000	3,000	(1,000)	0%
027b_02	Big Creek	5	935	St Joe hardwood	65%	2.03	5	5,000	10,000	60%	2.32	5	5,000	10,000	0	-5%
027b_02	Big Creek	6	1170	St Joe hardwood	58%	2.43	6	7,000	20,000	70%	1.74	6	7,000	10,000	(10,000)	0%
027b_02	Big Creek	7	205	Palouse hawthorn	45%	3.18	6	1,000	3,000	50%	2.90	6	1,000	3,000	0	0%
027b_02	Big Creek	8	95	Palouse hawthorn	45%	3.18	6	600	2,000	20%	4.63	6	600	3,000	1,000	-25%
027b_02	Big Creek	9	225	Palouse hawthorn	45%	3.18	6	1,000	3,000	40%	3.47	6	1,000	3,000	0	-5%
027b_02	Big Creek	10	285	Palouse hawthorn	45%	3.18	6	2,000	6,000	50%	2.90	6	2,000	6,000	0	0%
027b_02	Big Creek	11	45	Palouse hawthorn	45%	3.18	6	300	1,000	10%	5.21	6	300	2,000	1,000	-35%
027b_02	Big Creek	12	110	Palouse hawthorn	45%	3.18	6	700	2,000	30%	4.05	6	700	3,000	1,000	-15%
027b_02	Big Creek	13	250	Palouse hawthorn	45%	3.18	6	2,000	6,000	40%	3.47	6	2,000	7,000	1,000	-5%
027b_02	Big Creek	14	150	Palouse hawthorn	39%	3.53	7	1,000	4,000	20%	4.63	7	1,000	5,000	1,000	-19%
027b_02	Big Creek	15	41	Palouse hawthorn	39%	3.53	7	300	1,000	40%	3.47	7	300	1,000	0	0%
027b_02	Big Creek	16	230	Palouse hawthorn	39%	3.53	7	2,000	7,000	30%	4.05	7	2,000	8,000	1,000	-9%
027b_02	Big Creek	17	145	Palouse hawthorn	39%	3.53	7	1,000	4,000	20%	4.63	7	1,000	5,000	1,000	-19%
027b_02	Big Creek	18	45	Palouse hawthorn	39%	3.53	7	300	1,000	30%	4.05	7	300	1,000	0	-9%
027b_02	Big Creek	19	115	Palouse hawthorn	39%	3.53	7	800	3,000	0%	5.79	7	800	5,000	2,000	-39%
027b_02	Big Creek	20	680	Palouse hawthorn	39%	3.53	7	5,000	20,000	30%	4.05	7	5,000	20,000	0	-9%
027b_02	Big Creek	21	500	Palouse hawthorn	39%	3.53	7	4,000	10,000	20%	4.63	7	4,000	20,000	10,000	-19%
027b_02	Big Creek	22	120	Palouse hawthorn	39%	3.53	7	800	3,000	0%	5.79	7	800	5,000	2,000	-39%
027b_02	Chelsey Creek	1	415	St Joe Group B	98%	0.12	1	400	50	90%	0.58	1	400	200	200	-8%
027b_02	Chelsey Creek	2	1820	St Joe Group B	98%	0.12	2	4,000	500	80%	1.16	2	4,000	5,000	5,000	-18%
027b_02	East Fork Big Creek	1	380	St Joe Group B	98%	0.12	1	400	50	90%	0.58	1	400	200	200	-8%
027b_02	East Fork Big Creek	2	1415	St Joe Group B	98%	0.12	1	1,000	100	80%	1.16	1	1,000	1,000	900	-18%
027b_02	East Fork Big Creek	3	500	St Joe Group B	98%	0.12	2	1,000	100	80%	1.16	2	1,000	1,000	900	-18%
027b_02	East Fork Big Creek	4	1035	St Joe hardwood	93%	0.41	2	2,000	800	80%	1.16	2	2,000	2,000	1,000	-13%
027b_02	Last Chance Creek	1	110	St Joe Group B	98%	0.12	1	100	10	60%	2.32	1	100	200	200	-38%
027b_02	Last Chance Creek	2	330	St Joe Group B	98%	0.12	1	300	30	80%	1.16	1	300	300	300	-18%
027b_02	Last Chance Creek	3	810	St Joe Group B	98%	0.12	1	800	90	50%	2.90	1	800	2,000	2,000	-48%
027b_02	Last Chance Creek	4	380	St Joe Group B	98%	0.12	1	400	50	80%	1.16	1	400	500	500	-18%
027b_02	Last Chance Creek	5	625	St Joe GroupB	98%	0.12	1	600	70	70%	1.74	1	600	1,000	900	-28%
027b_02	Last Chance Creek	6	1765	St Joe hardwood	93%	0.41	2	4,000	2,000	80%	1.16	2	4,000	5,000	3,000	-13%
027b_02	Last Chance Creek	7	340	St Joe hardwood	93%	0.41	2	700	300	70%	1.74	2	700	1,000	700	-23%
027b_02	Last Chance Creek	8	220	St Joe hardwood	85%	0.87	3	700	600	80%	1.16	3	700	800	200	-5%
027b_02	Last Chance Creek	9	915	St Joe hardwood	85%	0.87	3	3,000	3,000	70%	1.74	3	3,000	5,000	2,000	-15%
027b_02	Last Chance Creek	10	440	St Joe hardwood	85%	0.87	3	1,000	900	60%	2.32	3	1,000	2,000	1,000	-25%
027b_02	Lost Creek	1	195	St Joe Group B	98%	0.12	1	200	20	60%	2.32	1	200	500	500	-38%
027b_02	Lost Creek	2	285	St Joe Group B	98%	0.12	1	300	30	40%	3.47	1	300	1,000	1,000	-58%
027b_02	Lost Creek	3	590	St Joe Group B	98%	0.12	1	600	70	80%	1.16	1	600	700	600	-18%
027b_02	Lost Creek	4	170	St Joe Group B	98%	0.12	1	200	20	90%	0.58	1	200	100	80	-8%
027b_02	Lost Creek	5	400	St Joe hardwood	93%	0.41	2	800	300	80%	1.16	2	800	900	600	-13%
027b_02	Lost Creek	6	405	St Joe hardwood	93%	0.41	2	800	300	90%	0.58	2	800	500	200	-3%
027b_02	Lost Creek	7	280	St Joe hardwood	93%	0.41	2	600	200	80%	1.16	2	600	700	500	-13%
027b_02	Lost Creek	8	100	St Joe hardwood	93%	0.41	2	200	80	90%	0.58	2	200	100	20	-3%
027b_02	Lost Creek	9	370	St Joe hardwood	93%	0.41	2	700	300	80%	1.16	2	700	800	500	-13%
027b_02	Lost Creek	10	375	St Joe hardwood	85%	0.87	3	1,000	900	90%	0.58	3	1,000	600	(300)	0%
027b_02	Lost Creek	11	245	St Joe hardwood	85%	0.87	3	700	600	60%	2.32	3	700	2,000	1,000	-25%
027b_02	Lost Creek	12	310	St Joe hardwood	85%	0.87	3	900	800	70%	1.74	3	900	2,000	1,000	-15%
027b_02	Lost Creek	13	220	St Joe hardwood	85%	0.87	3	700	600	50%	2.90	3	700	2,000	1,000	-35%
							Totals		150,000					200,000	44,000	

Table C-10. Existing and target solar loads for Gold Creek (ID17060108CL029_03).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
029_03	Gold Creek	1	130	Palouse hawthorn	51%	2.84	5	700	2,000	10%	5.21	5	700	4,000	2,000	-41%
029_03	Gold Creek	2	1140	Palouse hawthorn	51%	2.84	5	6,000	20,000	20%	4.63	5	6,000	30,000	10,000	-31%
029_03	Gold Creek	3	82	Palouse hawthorn	51%	2.84	5	400	1,000	60%	2.32	5	400	900	(100)	0%
029_03	Gold Creek	4	89	Palouse hawthorn	51%	2.84	5	400	1,000	20%	4.63	5	400	2,000	1,000	-31%
029_03	Gold Creek	5	1500	Palouse hawthorn	45%	3.18	6	9,000	30,000	30%	4.05	6	9,000	40,000	10,000	-15%
029_03	Gold Creek	6	100	Palouse hawthorn	45%	3.18	6	600	2,000	40%	3.47	6	600	2,000	0	-5%
							Totals		56,000					79,000	23,000	

Table C-11. Existing and target solar loads for Gold Creek (ID17060108CL030_02).

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
030_02	Gold Creek	1	2900	St Joe Group B	98%	0.12	1	3,000	300	90%	0.58	1	3,000	2,000	2,000	-8%
030_02	Gold Creek	2	270	St Joe Group B	98%	0.12	2	500	60	80%	1.16	2	500	600	500	-18%
030_02	Gold Creek	3	2840	St Joe Group B	98%	0.12	2	6,000	700	80%	1.16	3	9,000	10,000	9,000	-18%
030_02	Gold Creek	4	530	St Joe Group B	97%	0.17	3	2,000	300	80%	1.16	4	2,000	2,000	2,000	-17%
030_02	Gold Creek	5	35	St Joe Group B	97%	0.17	3	100	20	70%	1.74	4	100	200	200	-27%
030_02	Gold Creek	6	75	St Joe Group B	97%	0.17	3	200	30	80%	1.16	4	300	300	300	-17%
030_02	Gold Creek	7	275	St Joe hardwood	85%	0.87	3	800	700	70%	1.74	4	1,000	2,000	1,000	-15%
030_02	Gold Creek	8	590	St Joe hardwood	85%	0.87	3	2,000	2,000	60%	2.32	4	2,000	5,000	3,000	-25%
030_02	Gold Creek	9	900	St Joe hardwood	85%	0.87	3	3,000	3,000	70%	1.74	5	5,000	9,000	6,000	-15%
030_02	Gold Creek	10	180	Palouse Hawthorn	71%	1.68	3	500	800	30%	4.05	5	900	4,000	3,000	-41%
030_02	Gold Creek	11	490	Palouse Hawthorn	60%	2.32	4	2,000	5,000	80%	1.16	5	2,000	2,000	(3,000)	0%
030_02	Gold Creek	12	260	Palouse Hawthorn	60%	2.32	4	1,000	2,000	30%	4.05	6	2,000	8,000	6,000	-30%
030_02	Gold Creek	13	650	Palouse hawthorn	60%	2.32	4	3,000	7,000	50%	2.90	6	4,000	10,000	3,000	-10%
030_02	Gold Creek	14	500	Palouse hawthorn	60%	2.32	4	2,000	5,000	30%	4.05	6	3,000	10,000	5,000	-30%
030_02	Gold Creek	15	330	Palouse hawthorn	60%	2.32	4	1,000	2,000	20%	4.63	7	2,000	9,000	7,000	-40%
030_02	Gold Creek	16	370	Palouse hawthorn	60%	2.32	4	1,000	2,000	30%	4.05	7	3,000	10,000	8,000	-30%
030_02	Gold Creek	17	95	Palouse hawthorn	60%	2.32	4	400	900	20%	4.63	7	700	3,000	2,000	-40%
030_02	Treasure Gulch	1	2200	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
030_02	East Fork Gold Creek	1	1590	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
030_02	East Fork Gold Creek	2	1335	St Joe Group B	98%	0.12	2	3,000	300	90%	0.58	2	3,000	2,000	2,000	-8%
030_02	Hoteling Creek	1	1500	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
030_02	Hoteling Creek	2	1700	St Joe Group B	98%	0.12	2	3,000	300	80%	1.16	2	3,000	3,000	3,000	-18%
030_02	Waterhole Creek	1	1000	St Joe Group B	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
030_02	Waterhole Creek	2	2500	St Joe Group B	98%	0.12	2	5,000	600	80%	1.16	2	5,000	6,000	5,000	-18%
030_02	Waterhole Creek	3	71	St Joe Group B	98%	0.12	2	100	10	70%	1.74	2	100	200	200	-28%
030_02	Arson Creek	1	765	St Joe Group B	98%	0.12	1	800	90	80%	1.16	1	800	900	800	-18%
030_02	Arson Creek	2	185	St Joe Group B	98%	0.12	1	200	20	90%	0.58	1	200	100	80	-8%
030_02	Arson Creek	3	1825	St Joe Group B	98%	0.12	1	2,000	200	80%	1.16	1	2,000	2,000	2,000	-18%
030_02	Arson Creek	4	70	St Joe Group B	98%	0.12	1	70	8	50%	2.90	1	70	200	200	-48%
030_02	Nelson Creek	1	2000	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
030_02	Nelson Creek	2	1260	St Joe hardwood	94%	0.35	1	1,000	300	80%	1.16	1	1,000	1,000	700	-14%
030_02	Nelson Creek	3	860	St Joe hardwood	93%	0.41	2	2,000	800	70%	1.74	2	2,000	3,000	2,000	-23%
030_02	Nelson Creek	4	725	St Joe hardwood	93%	0.41	2	1,000	400	60%	2.32	2	1,000	2,000	2,000	-33%
030_02	Nelson Creek	5	530	Palouse hawthorn	88%	0.69	2	1,000	700	30%	4.05	2	1,000	4,000	3,000	-58%
							Totals		36,000					120,000	80,000	

Table C-12. Existing and target solar loads for Gold Creek (ID17060108CL031a_02).

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
031a_02	Crane Creek	1	2960	St Joe Group B	98%	0.12	1	3,000	300	90%	0.58	1	3,000	2,000	2,000	-8%
031a_02	Crane Creek	2	1645	St Joe Group B	98%	0.12	2	3,000	300	80%	1.16	2	3,000	3,000	3,000	-18%
031a_02	Crane Creek	3	150	St Joe hardwood	85%	0.87	3	500	400	70%	1.74	3	500	900	500	-15%
031a_02	Crane Creek	4	170	St Joe hardwood	85%	0.87	3	500	400	20%	4.63	3	500	2,000	2,000	-65%
031a_02	Crane Creek	5	465	St Joe hardwood	85%	0.87	3	1,000	900	30%	4.05	3	1,000	4,000	3,000	-55%
031a_02	Crane Creek	6	320	St Joe hardwood	74%	1.51	4	1,000	2,000	40%	3.47	4	1,000	3,000	1,000	-34%
031a_02	Crane Creek	7	260	St Joe hardwood	74%	1.51	4	1,000	2,000	50%	2.90	4	1,000	3,000	1,000	-24%
							Totals		6,300					18,000	13,000	

Table C-13. Existing and target solar loads for Gold Creek (ID17060108CL031b_02).

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
031b_02	Crane Creek	1	165	St Joe hardwood	74%	1.51	4	700	1,000	70%	1.74	4	700	1,000	0	-4%
031b_02	Crane Creek	2	305	St Joe hardwood	74%	1.51	4	1,000	2,000	60%	2.32	4	1,000	2,000	0	-14%
031b_02	Crane Creek	3	290	Palouse hawthorn	60%	2.32	4	1,000	2,000	50%	2.90	4	1,000	3,000	1,000	-10%
031b_02	Crane Creek	4	700	Palouse hawthorn	60%	2.32	4	3,000	7,000	80%	1.16	4	3,000	3,000	(4,000)	0%
031b_02	Crane Creek	5	740	Palouse hawthorn	60%	2.32	4	3,000	7,000	70%	1.74	4	3,000	5,000	(2,000)	0%
031b_02	Crane Creek	6	300	Palouse hawthorn	60%	2.32	4	1,000	2,000	40%	3.47	4	1,000	3,000	1,000	-20%
031b_02	Crane Creek	7	560	Palouse hawthorn	60%	2.32	4	2,000	5,000	50%	2.90	4	2,000	6,000	1,000	-10%
031b_02	Crane Creek	8	145	Palouse hawthorn	60%	2.32	4	600	1,000	20%	4.63	4	600	3,000	2,000	-40%
031b_02	Crane Creek	9	830	Palouse hawthorn	60%	2.32	4	3,000	7,000	30%	4.05	4	3,000	10,000	3,000	-30%
031b_02	Crane Creek	10	810	Palouse hawthorn	60%	2.32	4	3,000	7,000	20%	4.63	4	3,000	10,000	3,000	-40%
031b_02	Crane Creek	11	1780	Palouse hawthorn	60%	2.32	4	7,000	20,000	30%	4.05	4	7,000	30,000	10,000	-30%
031b_02	1st Trib Crane Creek	1	1605	Palouse hawthorn	97%	0.17	1	2,000	300	20%	4.63	1	2,000	9,000	9,000	-77%
031b_02	1st Trib Crane Creek	2	240	Palouse hawthorn	97%	0.17	1	200	30	50%	2.90	1	200	600	600	-47%
031b_02	1st Trib Crane Creek	3	530	Palouse hawthorn	88%	0.69	2	1,000	700	20%	4.63	2	1,000	5,000	4,000	-68%
							Totals		62,000					91,000	29,000	

Table C-14. Existing and target solar loads for Deep Creek (ID17060108CL032a_02).

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
032a_02	Middle Fork Deep Creek	1	230	St Joe Group B	98%	0.12	1	200	20	70%	1.74	1	200	300	300	-28%
032a_02	Middle Fork Deep Creek	2	2,560	St Joe Group B	98%	0.12	1	3,000	300	90%	0.58	1	3,000	2,000	2,000	-8%
032a_02	Middle Fork Deep Creek	3	450	St Joe Group B	98%	0.12	2	900	100	90%	0.58	2	900	500	400	-8%
032a_02	Middle Fork Deep Creek	4	300	St Joe hardwood	93%	0.41	2	600	200	10%	5.21	2	600	3,000	3,000	-83%
032a_02	Middle Fork Deep Creek	5	190	St Joe hardwood	93%	0.41	2	400	200	0%	5.79	2	400	2,000	2,000	-93%
032a_02	Middle Fork Deep Creek	6	300	St Joe hardwood	93%	0.41	2	600	200	30%	4.05	2	600	2,000	2,000	-63%
032a_02	Middle Fork Deep Creek	7	1,120	St Joe hardwood	93%	0.41	2	2,000	800	0%	5.79	2	2,000	10,000	9,000	-93%
032a_02	Middle Fork Deep Creek	8	320	St Joe hardwood	85%	0.87	3	1,000	900	60%	2.32	3	1,000	2,000	1,000	-25%
032a_02	Middle Fork Deep Creek	9	1195	St Joe hardwood	85%	0.87	3	4,000	3,000	70%	1.74	3	4,000	7,000	4,000	-15%
032a_02	Middle Fork Deep Creek	10	90	St Joe hardwood	85%	0.87	3	300	300	60%	2.32	3	300	700	400	-25%
032a_02	Middle Fork Deep Creek	11	470	St Joe hardwood	74%	1.51	4	2,000	3,000	50%	2.90	4	2,000	6,000	3,000	-24%
032a_02	Middle Fork Deep Creek	12	410	St Joe hardwood	74%	1.51	4	2,000	3,000	70%	1.74	4	2,000	3,000	0	-4%
032a_02	Middle Fork Deep Creek	13	310	St Joe hardwood	74%	1.51	4	1,000	2,000	60%	2.32	4	1,000	2,000	0	-14%
032a_02	Middle Fork Deep Creek	14	150	St Joe hardwood	65%	2.03	5	800	2,000	40%	3.47	5	800	3,000	1,000	-25%
032a_02	Middle Fork Deep Creek	15	140	Palouse hawthorn	51%	2.84	5	700	2,000	20%	4.63	5	700	3,000	1,000	-31%
032a_02	Middle Fork Deep Creek	16	510	Palouse hawthorn	51%	2.84	5	3,000	9,000	70%	1.74	5	3,000	5,000	(4,000)	0%
032a_02	1st trib to MF Deep Cr	1	1,925	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
032a_02	2nd trib to MF Deep Cr	1	623	St Joe Group B	98%	0.12	1	600	70	80%	1.16	1	600	700	600	-18%
032a_02	2nd trib to MF Deep Cr	2	240	St Joe Group B	98%	0.12	1	200	20	60%	2.32	1	200	500	500	-38%
032a_02	2nd trib to MF Deep Cr	3	110	St Joe Group B	98%	0.12	1	100	10	20%	4.63	1	100	500	500	-78%
032a_02	2nd trib to MF Deep Cr	4	210	St Joe Group B	98%	0.12	2	400	50	30%	4.05	2	400	2,000	2,000	-68%
032a_02	2nd trib to MF Deep Cr	5	260	St Joe hardwood	93%	0.41	2	500	200	0%	5.79	2	500	3,000	3,000	-93%
032a_02	2nd trib to MF Deep Cr	6	210	St Joe hardwood	93%	0.41	2	400	200	60%	2.32	2	400	900	700	-33%
032a_02	East Fork Deep Creek	1	460	St Joe Group B	98%	0.12	1	500	60	90%	0.58	1	500	300	200	-8%
032a_02	East Fork Deep Creek	2	150	St Joe Group B	98%	0.12	1	200	20	80%	1.16	1	200	200	200	-18%
032a_02	East Fork Deep Creek	3	340	St Joe Group B	98%	0.12	1	300	30	90%	0.58	1	300	200	200	-8%
032a_02	East Fork Deep Creek	4	170	St Joe Group B	98%	0.12	1	200	20	80%	1.16	1	200	200	200	-18%
032a_02	East Fork Deep Creek	5	460	St Joe Group B	98%	0.12	1	500	60	90%	0.58	1	500	300	200	-8%
032a_02	East Fork Deep Creek	6	19	St Joe Group B	98%	0.12	1	20	2	80%	1.16	1	20	20	20	-18%
032a_02	East Fork Deep Creek	7	81	St Joe hardwood	94%	0.35	1	80	30	80%	1.16	1	80	90	60	-14%
032a_02	East Fork Deep Creek	8	350	St Joe hardwood	94%	0.35	1	400	100	90%	0.58	1	400	200	100	-4%
032a_02	East Fork Deep Creek	9	140	St Joe hardwood	93%	0.41	2	300	100	70%	1.74	2	300	500	400	-23%
032a_02	East Fork Deep Creek	10	390	St Joe hardwood	93%	0.41	2	800	300	90%	0.58	2	800	500	200	-3%
032a_02	East Fork Deep Creek	11	140	St Joe hardwood	93%	0.41	2	300	100	70%	1.74	2	300	500	400	-23%
032a_02	East Fork Deep Creek	12	41	St Joe hardwood	93%	0.41	2	80	30	40%	3.47	2	80	300	300	-53%
032a_02	East Fork Deep Creek	13	180	St Joe hardwood	93%	0.41	2	400	200	80%	1.16	2	400	500	300	-13%
032a_02	East Fork Deep Creek	14	63	St Joe hardwood	93%	0.41	2	100	40	40%	3.47	2	100	300	300	-53%
032a_02	East Fork Deep Creek	15	72	St Joe hardwood	93%	0.41	2	100	40	30%	4.05	2	100	400	400	-63%
032a_02	East Fork Deep Creek	16	200	St Joe hardwood	93%	0.41	2	400	200	90%	0.58	2	400	200	0	-3%
032a_02	East Fork Deep Creek	17	210	St Joe hardwood	93%	0.41	2	400	200	70%	1.74	2	400	700	500	-23%
032a_02	East Fork Deep Creek	18	81	St Joe hardwood	93%	0.41	2	200	80	40%	3.47	2	200	700	600	-53%
032a_02	East Fork Deep Creek	19	120	Palouse hawthorn	88%	0.69	2	200	100	0%	5.79	2	200	1,000	900	-88%
032a_02	East Fork Deep Creek	20	43	Palouse hawthorn	88%	0.69	2	90	60	30%	4.05	2	90	400	300	-58%
032a_02	East Fork Deep Creek	21	93	Palouse hawthorn	88%	0.69	2	200	100	60%	2.32	2	200	500	400	-28%
032a_02	East Fork Deep Creek	22	190	Palouse hawthorn	88%	0.69	3	600	400	30%	4.05	3	600	2,000	2,000	-58%
032a_02	East Fork Deep Creek	23	440	St Joe Group B	97%	0.17	3	1,000	200	90%	0.58	3	1,000	600	400	-7%
032a_02	East Fork Deep Creek	24	240	Palouse hawthorn	71%	1.68	3	700	1,000	80%	1.16	3	700	800	(200)	0%
032a_02	East Fork Deep Creek	25	310	Palouse hawthorn	71%	1.68	3	900	2,000	10%	5.21	3	900	5,000	3,000	-61%
032a_02	East Fork Deep Creek	26	64	Palouse hawthorn	71%	1.68	3	200	300	80%	1.16	3	200	200	(100)	0%
032a_02	East Fork Deep Creek	27	170	Palouse hawthorn	71%	1.68	3	500	800	10%	5.21	3	500	3,000	2,000	-61%
032a_02	East Fork Deep Creek	28	350	Palouse hawthorn	71%	1.68	3	1,000	2,000	40%	3.47	3	1,000	3,000	1,000	-31%
032a_02	East Fork Deep Creek	29	59	Palouse hawthorn	60%	2.32	4	200	500	40%	3.47	4	200	700	200	-20%
032a_02	East Fork Deep Creek	30	150	Palouse hawthorn	60%	2.32	4	600	1,000	10%	5.21	4	600	3,000	2,000	-50%

Table C-14 (cont.). Existing and target solar loads for Deep Creek (ID17060108CL032a_02).

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
032a_02	East Fork Deep Creek	31	110	Palouse hawthorn	60%	2.32	4	400	900	80%	1.16	4	400	500	(400)	0%
032a_02	East Fork Deep Creek	32	53	Palouse hawthorn	60%	2.32	4	200	500	40%	3.47	4	200	700	200	-20%
032a_02	East Fork Deep Creek	33	400	Palouse hawthorn	60%	2.32	4	2,000	5,000	80%	1.16	4	2,000	2,000	(3,000)	0%
032a_02	East Fork Deep Creek	34	220	Palouse hawthorn	60%	2.32	4	900	2,000	60%	2.32	4	900	2,000	0	0%
032a_02	East Fork Deep Creek	35	260	Palouse hawthorn	60%	2.32	4	1,000	2,000	20%	4.63	4	1,000	5,000	3,000	-40%
032a_02	East Fork Deep Creek	36	120	Palouse hawthorn	60%	2.32	4	500	1,000	60%	2.32	4	500	1,000	0	0%
032a_02	East Fork Deep Creek	37	180	Palouse hawthorn	60%	2.32	4	700	2,000	30%	4.05	4	700	3,000	1,000	-30%
032a_02	East Fork Deep Creek	38	160	Palouse hawthorn	60%	2.32	4	600	1,000	50%	2.90	4	600	2,000	1,000	-10%
032a_02	East Fork Deep Creek	39	360	Palouse hawthorn	60%	2.32	4	1,000	2,000	60%	2.32	4	1,000	2,000	0	0%
032a_02	East Fork Deep Creek	40	370	Palouse hawthorn	51%	2.84	5	2,000	6,000	70%	1.74	5	2,000	3,000	(3,000)	0%
032a_02	East Fork Deep Creek	41	280	Palouse hawthorn	51%	2.84	5	1,000	3,000	60%	2.32	5	1,000	2,000	(1,000)	0%
032a_02	East Fork Deep Creek	42	320	Palouse hawthorn	51%	2.84	5	2,000	6,000	30%	4.05	5	2,000	8,000	2,000	-21%
032a_02	Trib to EF Deep Creek	1	440	St Joe Group B	98%	0.12	1	400	50	90%	0.58	1	400	200	200	-8%
032a_02	Trib to EF Deep Creek	2	520	St Joe Group B	98%	0.12	1	500	60	80%	1.16	1	500	600	500	-18%
032a_02	Trib to EF Deep Creek	3	380	St Joe Group B	98%	0.12	1	400	50	90%	0.58	1	400	200	200	-8%
032a_02	Trib to EF Deep Creek	4	300	St Joe Group B	98%	0.12	1	300	30	80%	1.16	1	300	300	300	-18%
032a_02	Trib to EF Deep Creek	5	78	St Joe Group B	98%	0.12	1	80	9	60%	2.32	1	80	200	200	-38%
032a_02	Trib to EF Deep Creek	6	1,090	St Joe Group B	98%	0.12	2	2,000	200	90%	0.58	2	2,000	1,000	800	-8%
032a_02	Trib to EF Deep Creek	7	160	St Joe Group B	98%	0.12	2	300	30	70%	1.74	2	300	500	500	-28%
032a_02	Trib to EF Deep Creek	8	180	St Joe hardwood	93%	0.41	2	400	200	50%	2.90	2	400	1,000	800	-43%
032a_02	Trib to EF Deep Creek	9	170	St Joe hardwood	93%	0.41	2	300	100	60%	2.32	2	300	700	600	-33%
032a_02	Trib to EF Deep Creek	10	150	St Joe hardwood	93%	0.41	2	300	100	40%	3.47	2	300	1,000	900	-53%
032a_02	Trib to EF Deep Creek	11	280	St Joe hardwood	93%	0.41	3	800	300	70%	1.74	3	800	1,000	700	-23%
032a_02	Trib to EF Deep Creek	12	90	St Joe hardwood	85%	0.87	3	300	300	60%	2.32	3	300	700	400	-25%
032a_02	Trib to EF Deep Creek	13	510	St Joe hardwood	85%	0.87	3	2,000	2,000	80%	1.16	3	2,000	2,000	0	-5%
032a_02	Trib to EF Deep Creek	14	64	St Joe hardwood	85%	0.87	3	200	200	60%	2.32	3	200	500	300	-25%
032a_02	Trib to EF Deep Creek	15	170	St Joe hardwood	85%	0.87	3	500	400	80%	1.16	3	500	600	200	-5%
032a_02	Trib to EF Deep Creek	16	88	Palouse hawthorn	71%	1.68	3	300	500	30%	4.05	3	300	1,000	500	-41%
032a_02	Trib to EF Deep Creek	17	220	Palouse hawthorn	71%	1.68	3	700	1,000	80%	1.16	3	700	800	(200)	9%
032a_02	West Fork Deep Creek	1	1650	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
032a_02	West Fork Deep Creek	2	1090	St Joe Group B	98%	0.12	2	2,000	200	90%	0.58	2	2,000	1,000	800	-8%
032a_02	West Fork Deep Creek	3	160	St Joe Group B	98%	0.12	2	300	30	10%	5.21	2	300	2,000	2,000	-88%
032a_02	West Fork Deep Creek	4	260	St Joe Group B	98%	0.12	2	500	60	90%	0.58	2	500	300	200	-8%
032a_02	West Fork Deep Creek	5	180	St Joe hardwood	85%	0.87	3	500	400	80%	1.16	3	500	600	200	-5%
032a_02	West Fork Deep Creek	6	400	St Joe hardwood	85%	0.87	3	1,000	900	70%	1.74	3	1,000	2,000	1,000	-15%
032a_02	West Fork Deep Creek	7	81	St Joe hardwood	85%	0.87	3	200	200	20%	4.63	3	200	900	700	-65%
032a_02	West Fork Deep Creek	8	240	St Joe hardwood	85%	0.87	3	700	600	80%	1.16	3	700	800	200	-5%
032a_02	West Fork Deep Creek	9	310	St Joe hardwood	85%	0.87	3	900	800	60%	2.32	3	900	2,000	1,000	-25%
032a_02	West Fork Deep Creek	10	340	Palouse hawthorn	71%	1.68	3	1,000	2,000	20%	4.63	3	1,000	5,000	3,000	-51%
032a_02	West Fork Deep Creek	11	580	Palouse hawthorn	60%	2.32	4	2,000	5,000	0%	5.79	4	2,000	10,000	5,000	-60%
032a_02	West Fork Deep Creek	12	290	St Joe hardwood	60%	2.32	4	1,000	2,000	70%	1.74	4	1,000	2,000	0	10%
032a_02	West Fork Deep Creek	13	230	St Joe hardwood	60%	2.32	4	900	2,000	50%	2.90	4	900	3,000	1,000	-10%
032a_02	West Fork Deep Creek	14	170	Palouse hawthorn	60%	2.32	4	700	2,000	40%	3.47	4	700	2,000	0	-20%
032a_02	West Fork Deep Creek	15	180	Palouse hawthorn	60%	2.32	4	700	2,000	0%	5.79	4	700	4,000	2,000	-60%
032a_02	Trib to WF Deep Creek	1	940	St Joe Group B	98%	0.12	1	900	100	90%	0.58	1	900	500	400	-8%
032a_02	Trib to WF Deep Creek	2	29	St Joe Group B	98%	0.12	2	60	7	20%	4.63	2	60	300	300	-78%
032a_02	Trib to WF Deep Creek	3	220	St Joe Group B	98%	0.12	2	400	50	80%	1.16	2	400	500	500	-18%
032a_02	Trib to WF Deep Creek	4	43	St Joe Group B	98%	0.12	2	90	10	10%	5.21	2	90	500	500	-88%
032a_02	Trib to WF Deep Creek	5	590	St Joe Group B	98%	0.12	2	1,000	100	90%	0.58	2	1,000	600	500	-8%
032a_02	Deep Creek Tributary	1	580	St Joe Group B	98%	0.12	1	600	70	90%	0.58	1	600	300	200	-8%
032a_02	Deep Creek Tributary	2	1000	St Joe hardwood	94%	0.35	1	1,000	300	70%	1.74	1	1,000	2,000	2,000	-24%
032a_02	Deep Creek Tributary	3	52	St Joe hardwood	93%	0.41	2	100	40	40%	3.47	2	100	300	300	-53%
032a_02	Deep Creek Tributary	4	380	St Joe hardwood	93%	0.41	2	800	300	50%	2.90	2	800	2,000	2,000	-43%
032a_02	Deep Creek Tributary	5	370	Palouse hawthorn	88%	0.69	2	700	500	20%	4.63	2	700	3,000	3,000	-68%
032a_02	Deep Creek Tributary	6	280	Palouse hawthorn	88%	0.69	2	600	400	60%	2.32	2	600	1,000	600	-28%
032a_02	Deep Creek Tributary	7	220	Palouse hawthorn	88%	0.69	2	400	300	30%	4.05	2	400	2,000	2,000	-58%
032a_02	Deep Creek Tributary	8	170	Palouse hawthorn	71%	1.68	3	500	800	20%	4.63	3	500	2,000	1,000	-51%
032a_02	Deep Creek Tributary	9	100	Palouse hawthorn	71%	1.68	3	300	500	10%	5.21	3	300	2,000	2,000	-61%
032a_02	Deep Creek Tributary	10	310	Palouse hawthorn	71%	1.68	3	900	2,000	60%	2.32	3	900	2,000	0	-11%
032a_02	Deep Creek Tributary	11	340	Palouse hawthorn	71%	1.68	3	1,000	2,000	30%	4.05	3	1,000	4,000	2,000	-41%
							Totals		100,000					190,000	92,000	

Table C-15. Existing and target solar loads for Deep Creek (ID17060108CL032a_03).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
032a_03	Deep Creek	1	585	Palouse hawthorn	45%	3.18	6	4,000	10,000	0%	5.79	6	4,000	20,000	10,000	-45%
032a_03	Deep Creek	2	430	Palouse hawthorn	39%	3.53	7	3,000	10,000	20%	4.63	7	3,000	10,000	0	-19%
							Totals		20,000					30,000	10,000	

Table C-16. Existing and target solar loads for Deep Creek (ID17060108CL032b_02).

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
032b_02	1st trib Deep Creek	1	725	Palouse hawthorn	97%	0.17	1	700	100	20%	4.63	1	700	3,000	3,000	-77%
032b_02	1st trib Deep Creek	2	240	Palouse hawthorn	97%	0.17	1	200	30	10%	5.21	1	200	1,000	1,000	-87%
032b_02	2nd trib Deep Creek	1	485	Palouse hawthorn	97%	0.17	1	500	90	60%	2.32	1	500	1,000	900	-37%
032b_02	2nd trib Deep Creek	2	190	Palouse hawthorn	97%	0.17	1	200	30	40%	3.47	1	200	700	700	-57%
032b_02	2nd trib Deep Creek	3	340	Palouse hawthorn	97%	0.17	1	300	50	50%	2.90	1	300	900	900	-47%
032b_02	2nd trib Deep Creek	4	340	Palouse hawthorn	97%	0.17	1	300	50	60%	2.32	1	300	700	700	-37%
032b_02	2nd trib Deep Creek	5	380	Palouse hawthorn	97%	0.17	1	400	70	40%	3.47	1	400	1,000	900	-57%
032b_02	2nd trib Deep Creek	6	1225	Palouse hawthorn	88%	0.69	2	2,000	1,000	10%	5.21	2	2,000	10,000	9,000	-78%
032b_02	2nd trib Deep Creek	7	355	Palouse hawthorn	88%	0.69	2	700	500	40%	3.47	2	700	2,000	2,000	-48%
032b_02	2nd trib Deep Creek	8	155	Palouse hawthorn	71%	1.68	3	500	800	0%	5.79	3	500	3,000	2,000	-71%
032b_02	2nd trib Deep Creek	9	400	Palouse hawthorn	71%	1.68	3	1,000	2,000	30%	4.05	3	1,000	4,000	2,000	-41%
032b_02	2nd trib Deep Creek	10	330	Palouse hawthorn	71%	1.68	3	1,000	2,000	50%	2.90	3	1,000	3,000	1,000	-21%
032b_02	2nd trib Deep Creek	11	310	Palouse hawthorn	71%	1.68	3	900	2,000	20%	4.63	3	900	4,000	2,000	-51%
032b_02	3rd trib Deep Creek	1	470	Palouse hawthorn	97%	0.17	1	500	90	70%	1.74	1	500	900	800	-27%
032b_02	3rd trib Deep Creek	2	1280	Palouse hawthorn	88%	0.69	2	3,000	2,000	20%	4.63	2	3,000	10,000	8,000	-68%
032b_02	3rd trib Deep Creek	3	125	Palouse hawthorn	71%	1.68	3	400	700	0%	5.79	3	400	2,000	1,000	-71%
032b_02	trib to 3rd trib Deep Cr	1	550	Palouse hawthorn	97%	0.17	1	600	100	30%	4.05	1	600	2,000	2,000	-67%
032b_02	trib to 3rd trib Deep Cr	2	965	Palouse hawthorn	97%	0.17	1	1,000	200	0%	5.79	1	1,000	6,000	6,000	-97%
032b_02	trib to 3rd trib Deep Cr	3	415	Palouse hawthorn	88%	0.69	2	800	600	10%	5.21	2	800	4,000	3,000	-78%
032b_02	4th trib to Deep Creek	1	455	Palouse hawthorn	97%	0.17	1	500	90	0%	5.79	1	500	3,000	3,000	-97%
032b_02	4th trib to Deep Creek	2	400	Palouse hawthorn	97%	0.17	1	400	70	60%	2.32	1	400	900	800	-37%
032b_02	4th trib to Deep Creek	3	300	Palouse hawthorn	97%	0.17	1	300	50	10%	5.21	1	300	2,000	2,000	-87%
032b_02	4th trib to Deep Creek	4	270	Palouse hawthorn	88%	0.69	2	500	300	40%	3.47	2	500	2,000	2,000	-48%
032b_02	4th trib to Deep Creek	5	170	Palouse hawthorn	88%	0.69	2	300	200	20%	4.63	2	300	1,000	800	-68%
							Totals		13,000					68,000	56,000	

Table C-17. Existing and target solar loads for Deep Creek (ID17060108CL032b_03).

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
032b_03	Deep Creek	1	80	Palouse hawthorn	39%	3.53	7	600	2,000	20%	4.63	7	600	3,000	1,000	-19%
032b_03	Deep Creek	2	110	Palouse hawthorn	39%	3.53	7	800	3,000	30%	4.05	7	800	3,000	0	-9%
032b_03	Deep Creek	3	340	Palouse hawthorn	39%	3.53	7	2,000	7,000	20%	4.63	7	2,000	9,000	2,000	-19%
032b_03	Deep Creek	4	240	Palouse hawthorn	39%	3.53	7	2,000	7,000	30%	4.05	7	2,000	8,000	1,000	-9%
032b_03	Deep Creek	5	150	Palouse hawthorn	39%	3.53	7	1,000	4,000	20%	4.63	7	1,000	5,000	1,000	-19%
032b_03	Deep Creek	6	970	Palouse hawthorn	39%	3.53	7	7,000	20,000	30%	4.05	7	7,000	30,000	10,000	-9%
032b_03	Deep Creek	7	600	Palouse hawthorn	39%	3.53	7	4,000	10,000	20%	4.63	7	4,000	20,000	10,000	-19%
032b_03	Deep Creek	8	220	Palouse hawthorn	39%	3.53	7	2,000	7,000	40%	3.47	7	2,000	7,000	0	0%
032b_03	Deep Creek	9	340	Palouse hawthorn	39%	3.53	7	2,000	7,000	20%	4.63	7	2,000	9,000	2,000	-19%
032b_03	Deep Creek	9	230	Palouse hawthorn	39%	3.53	7	2,000	7,000	30%	4.05	7	2,000	8,000	1,000	-9%
032b_03	Deep Creek	10	240	Palouse hawthorn	39%	3.53	7	2,000	7,000	10%	5.21	7	2,000	10,000	3,000	-29%
032b_03	Deep Creek	11	820	Palouse hawthorn	39%	3.53	7	6,000	20,000	20%	4.63	7	6,000	30,000	10,000	-19%
032b_03	Deep Creek	13	100	Palouse hawthorn	39%	3.53	7	700	2,000	30%	4.05	7	700	3,000	1,000	-9%
032b_03	Deep Creek	14	480	Palouse hawthorn	39%	3.53	7	3,000	10,000	10%	5.21	7	3,000	20,000	10,000	-29%
032b_03	Deep Creek	15	90	Palouse hawthorn	39%	3.53	7	600	2,000	30%	4.05	7	600	2,000	0	-9%
032b_03	Deep Creek	16	60	Palouse hawthorn	39%	3.53	7	400	1,000	20%	4.63	7	400	2,000	1,000	-19%
032b_03	Deep Creek	17	90	Palouse hawthorn	39%	3.53	7	600	2,000	10%	5.21	7	600	3,000	1,000	-29%
032b_03	Deep Creek	18	80	Palouse hawthorn	39%	3.53	7	600	2,000	20%	4.63	7	600	3,000	1,000	-19%
032b_03	Deep Creek	19	210	Palouse hawthorn	39%	3.53	7	1,000	4,000	10%	5.21	7	1,000	5,000	1,000	-29%
032b_03	Deep Creek	20	220	Palouse hawthorn	35%	3.76	8	2,000	8,000	20%	4.63	8	2,000	9,000	1,000	-15%
032b_03	Deep Creek	21	170	Palouse hawthorn	35%	3.76	8	1,000	4,000	30%	4.05	8	1,000	4,000	0	-5%
032b_03	Deep Creek	22	110	Palouse hawthorn	35%	3.76	8	900	3,000	10%	5.21	8	900	5,000	2,000	-25%
032b_03	Deep Creek	23	850	Palouse hawthorn	35%	3.76	8	7,000	30,000	30%	4.05	8	7,000	30,000	0	-5%
032b_03	Deep Creek	24	160	Palouse hawthorn	35%	3.76	8	1,000	4,000	10%	5.21	8	1,000	5,000	1,000	-25%
032b_03	Deep Creek	25	320	Palouse hawthorn	35%	3.76	8	3,000	10,000	20%	4.63	8	3,000	10,000	0	-15%
032b_03	Deep Creek	26	480	Palouse hawthorn	35%	3.76	8	4,000	20,000	10%	5.21	8	4,000	20,000	0	-25%
032b_03	Deep Creek	27	100	Palouse hawthorn	35%	3.76	8	800	3,000	40%	3.47	8	800	3,000	0	0%
032b_03	Deep Creek	28	160	Palouse hawthorn	35%	3.76	8	1,000	4,000	20%	4.63	8	1,000	5,000	1,000	-15%
032b_03	Deep Creek	29	210	Palouse hawthorn	35%	3.76	8	2,000	8,000	0%	5.79	8	2,000	10,000	2,000	-35%
032b_03	Deep Creek	30	350	Palouse hawthorn	35%	3.76	8	3,000	10,000	30%	4.05	8	3,000	10,000	0	-5%
032b_03	Deep Creek	31	380	Palouse hawthorn	35%	3.76	8	3,000	10,000	0%	5.79	8	3,000	20,000	10,000	-35%
032b_03	Deep Creek	32	100	Palouse hawthorn	35%	3.76	8	800	3,000	50%	2.90	8	800	2,000	(1,000)	0%
032b_03	Deep Creek	33	530	Palouse hawthorn	35%	3.76	8	4,000	20,000	0%	5.79	8	4,000	20,000	0	-35%
032b_03	Deep Creek	34	80	Palouse hawthorn	35%	3.76	8	600	2,000	30%	4.05	8	600	2,000	0	-5%
032b_03	Deep Creek	35	240	Palouse hawthorn	35%	3.76	8	2,000	8,000	20%	4.63	8	2,000	9,000	1,000	-15%
032b_03	Deep Creek	36	230	Palouse hawthorn	35%	3.76	8	2,000	8,000	30%	4.05	8	2,000	8,000	0	-5%
032b_03	Deep Creek	37	720	Palouse hawthorn	35%	3.76	8	6,000	20,000	20%	4.63	8	6,000	30,000	10,000	-15%
							Totals		300,000					380,000	83,000	

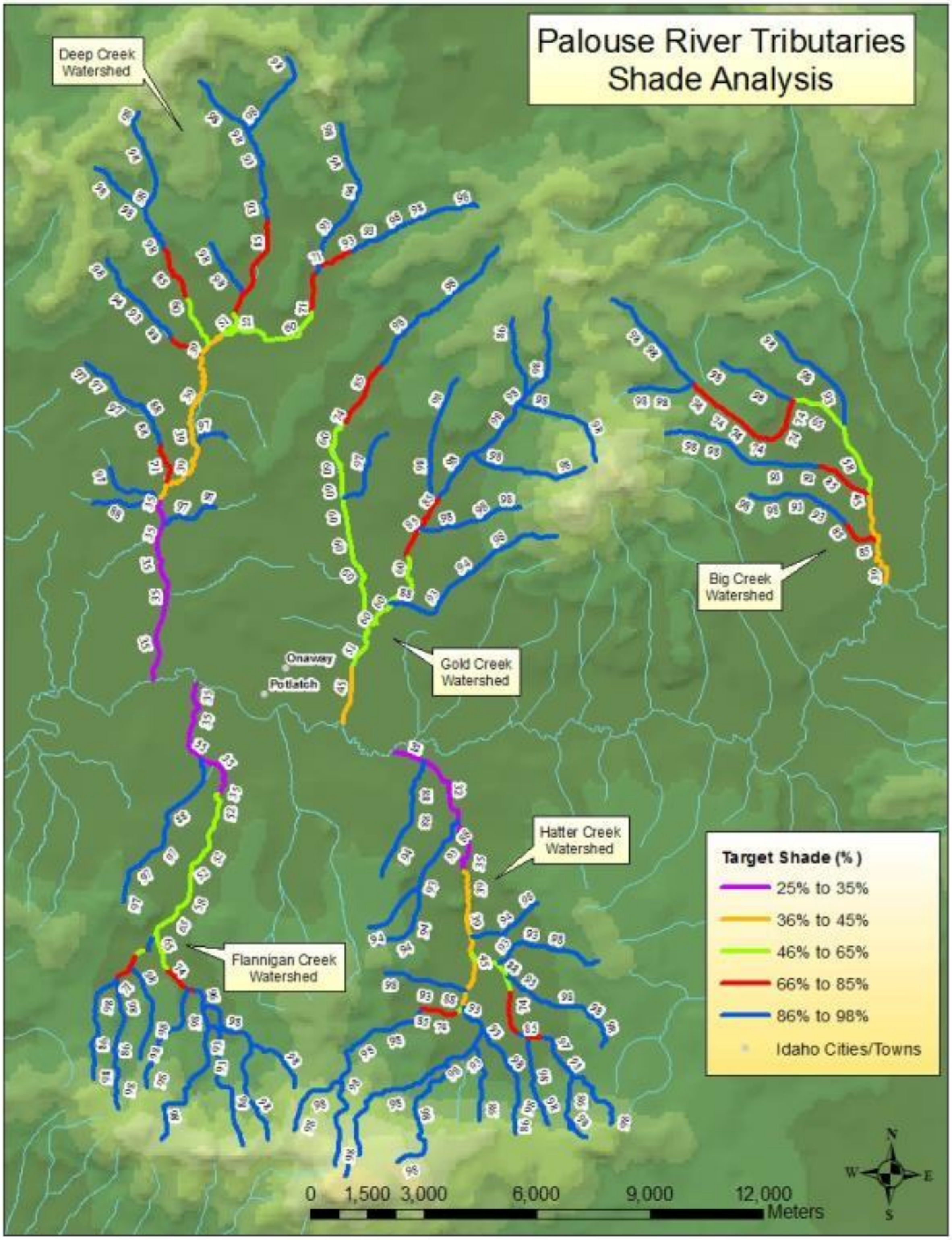


Figure C-1. Target shade for the Palouse River tributaries.

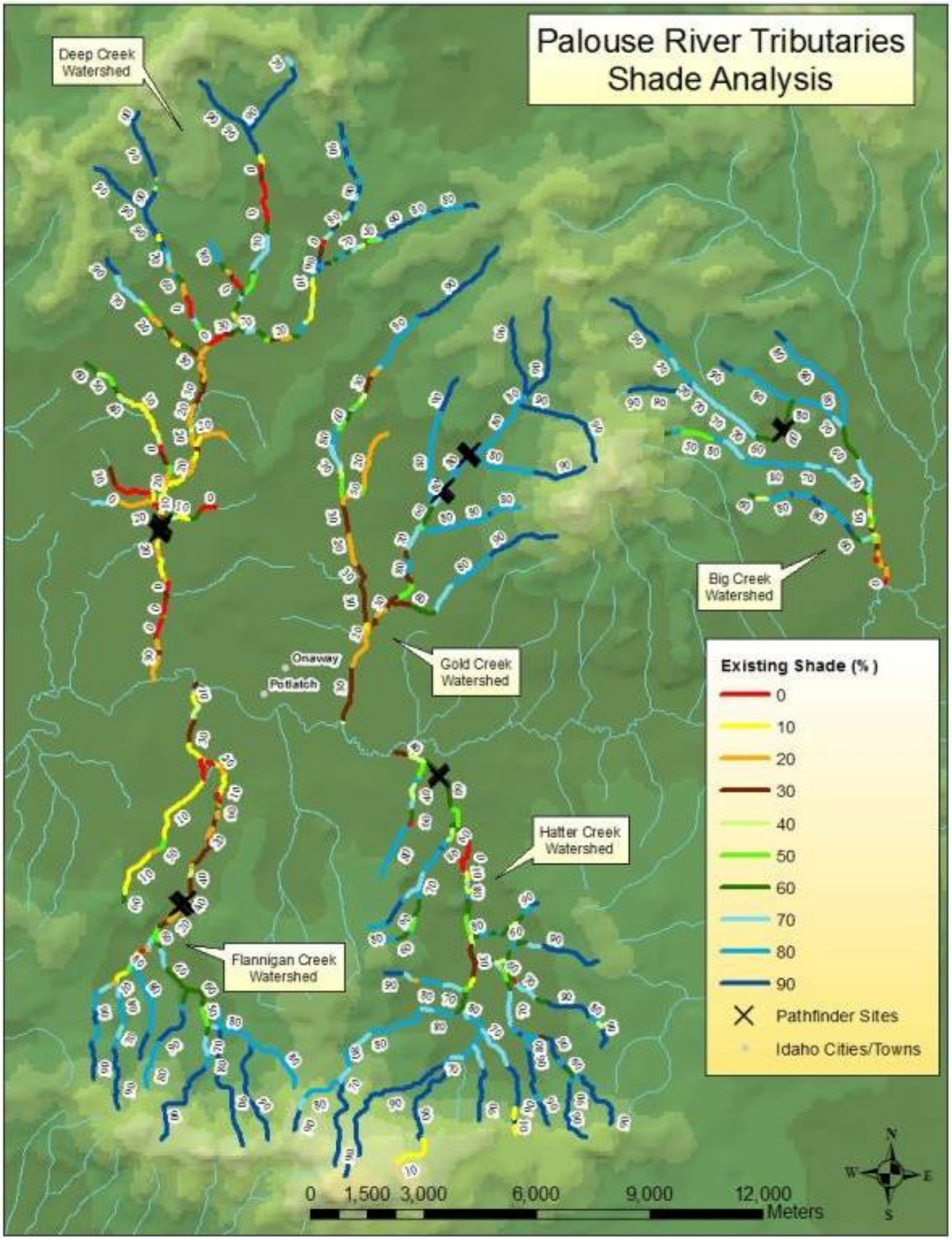


Figure C-2. Existing shade estimated for the Palouse River tributaries by aerial photo interpretation.

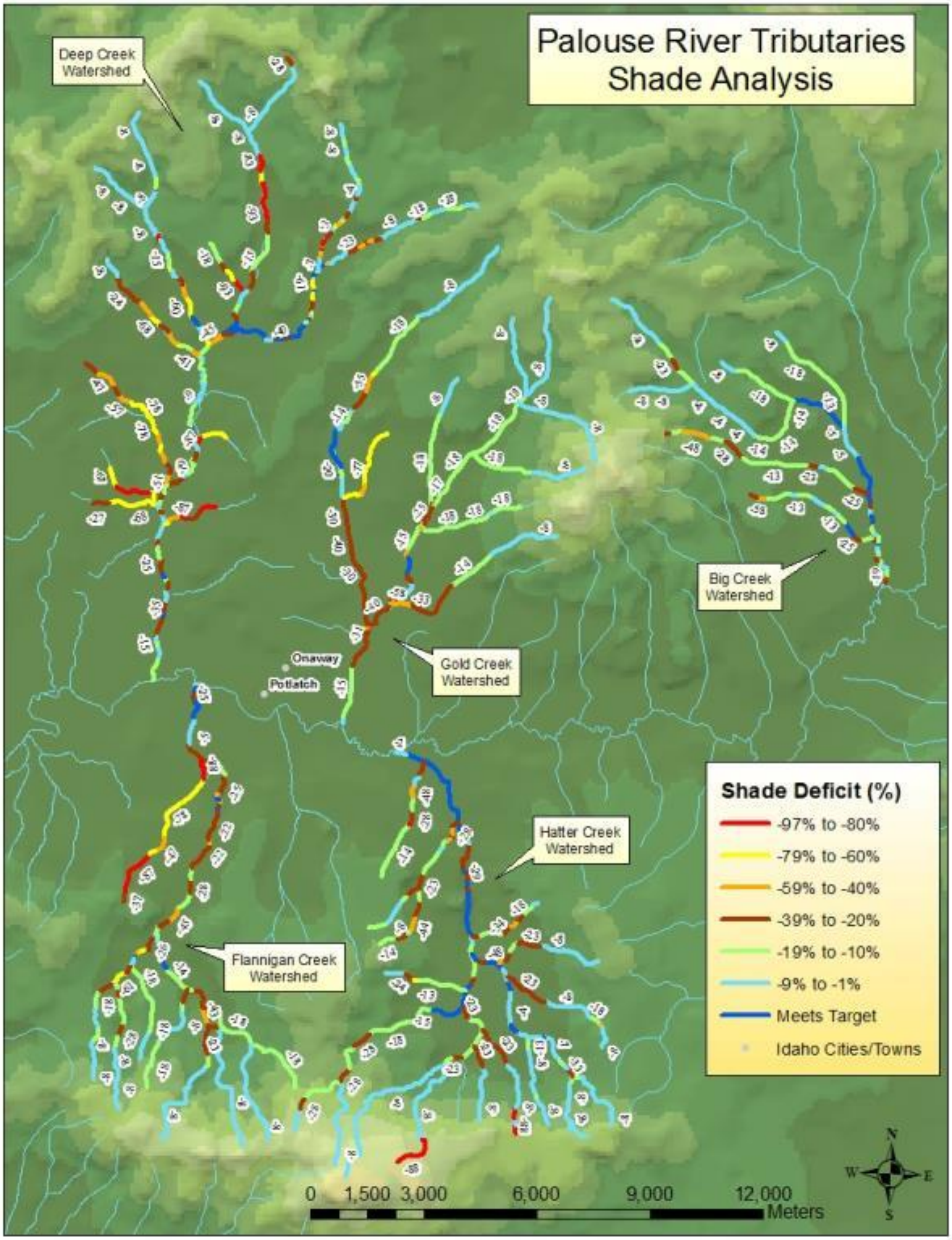


Figure C-3. Shade deficit (difference between existing and target) for the Palouse River tributaries.

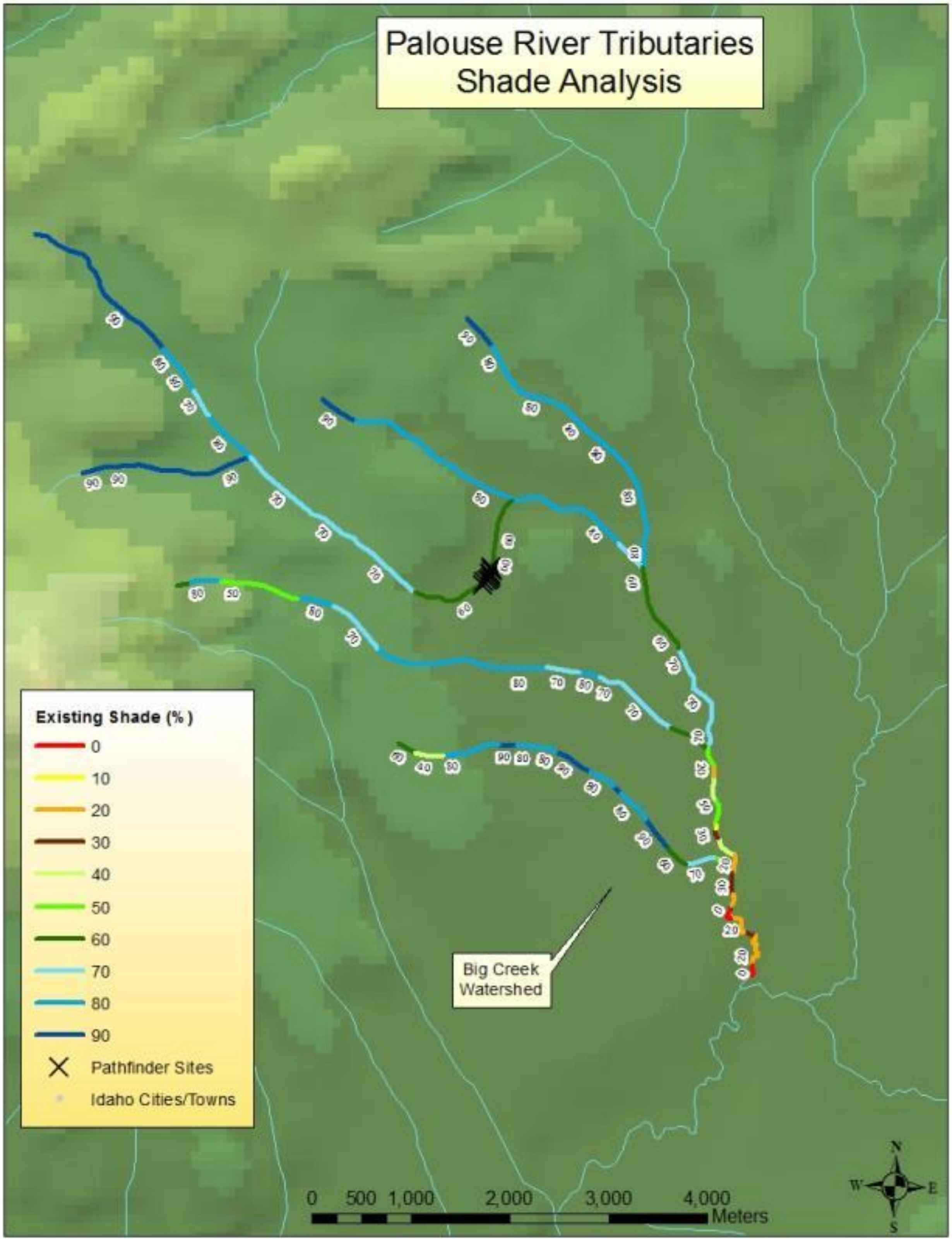


Figure C-4. Existing shade estimated for the Big Creek watershed by aerial photo interpretation.

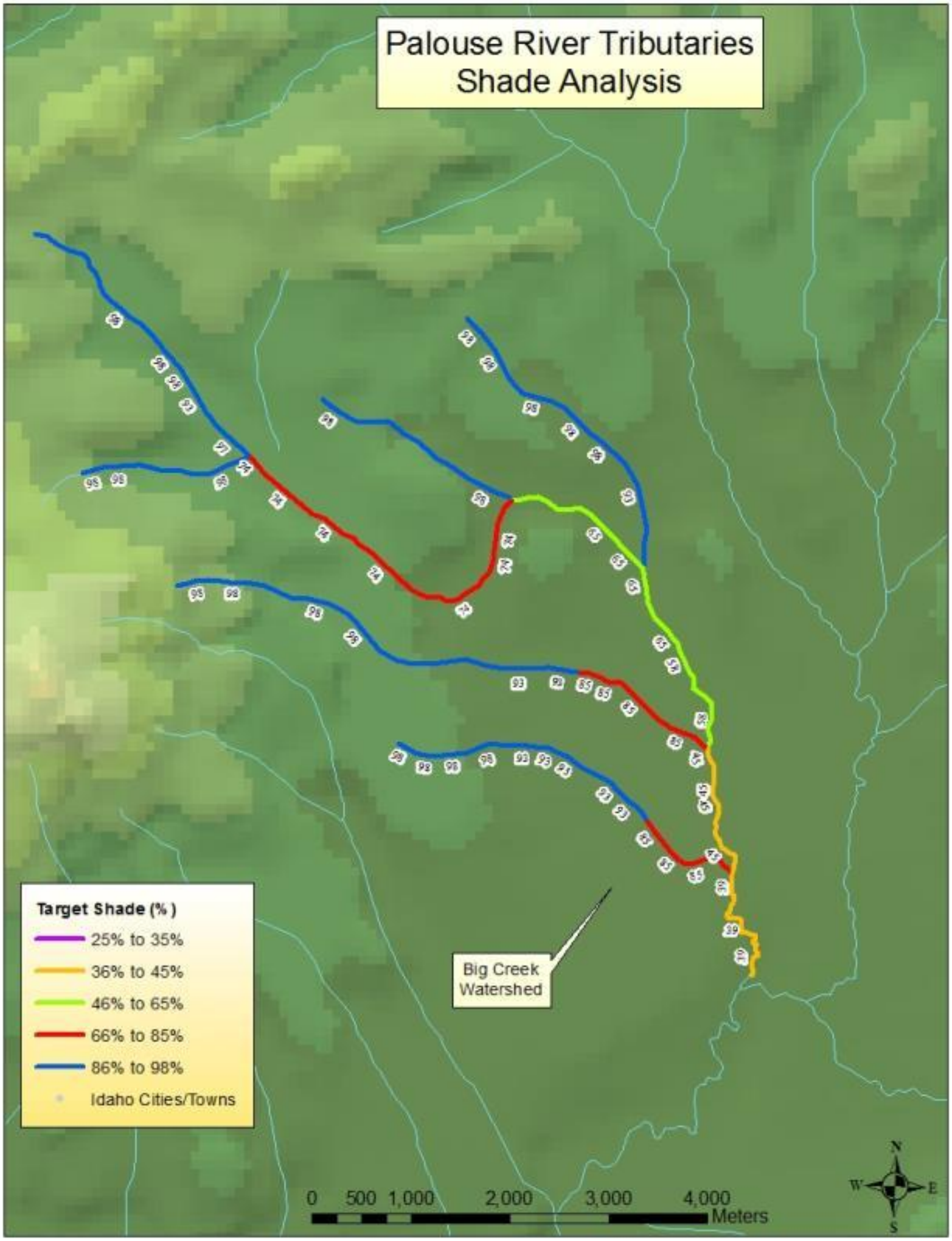


Figure C-5. Target shade for the Big Creek watershed.

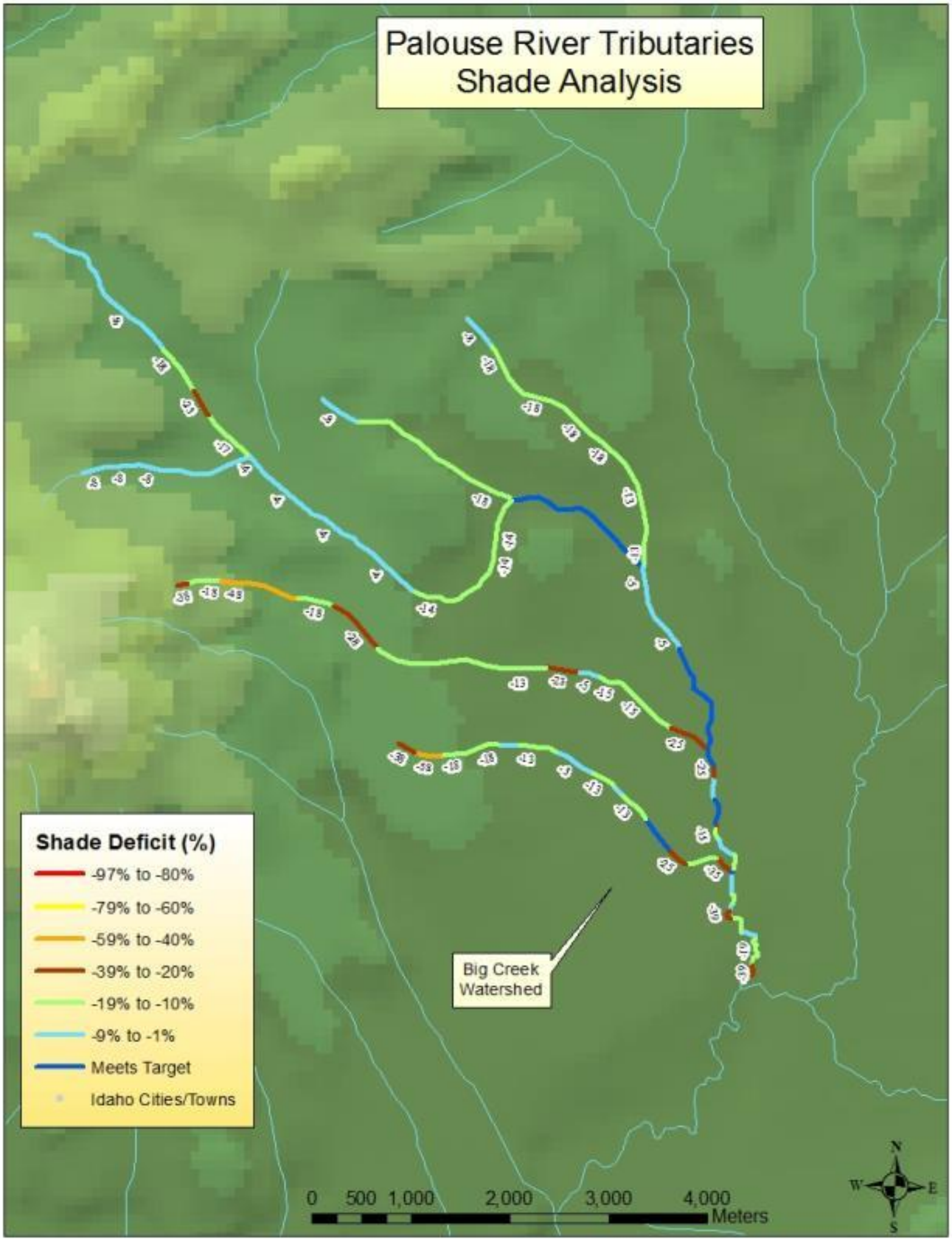


Figure C-6. Shade deficit (difference between existing and target) for the Big Creek watershed.

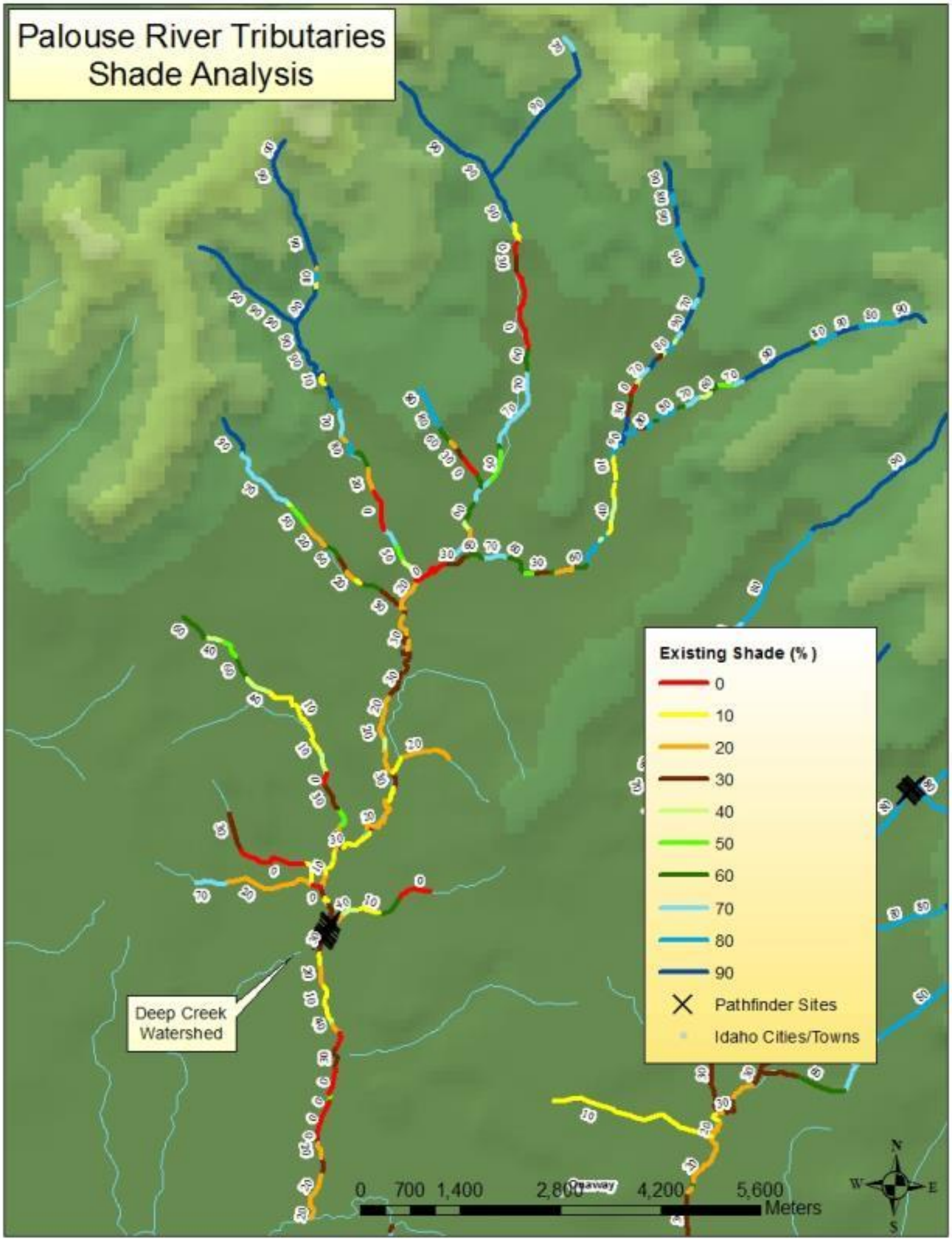


Figure C-7. Existing shade estimated for the Deep Creek watershed by aerial photo interpretation.

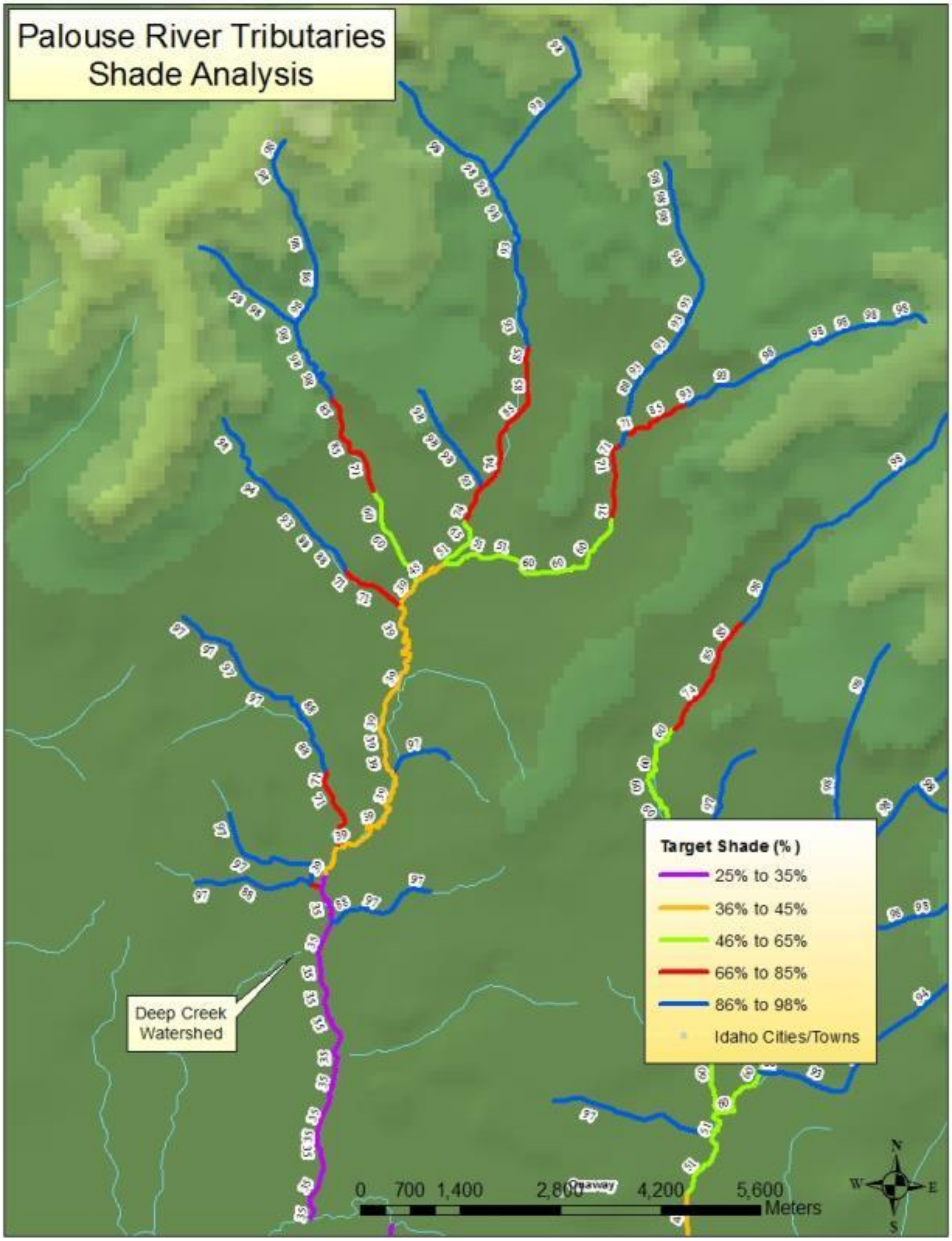


Figure C-8. Target shade for the Deep Creek watershed.

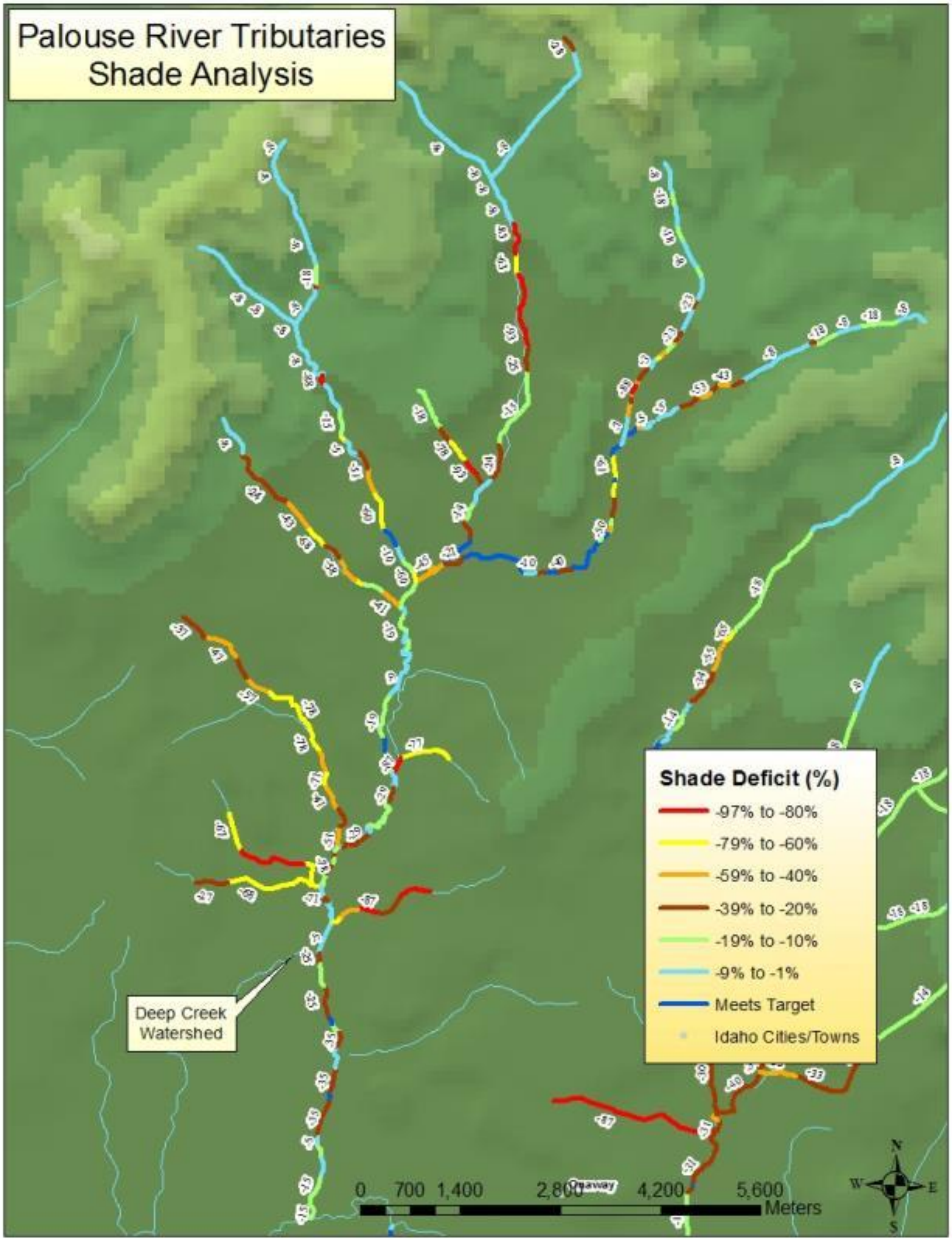


Figure C-9. Shade deficit (difference between existing and target) for the Deep Creek watershed.

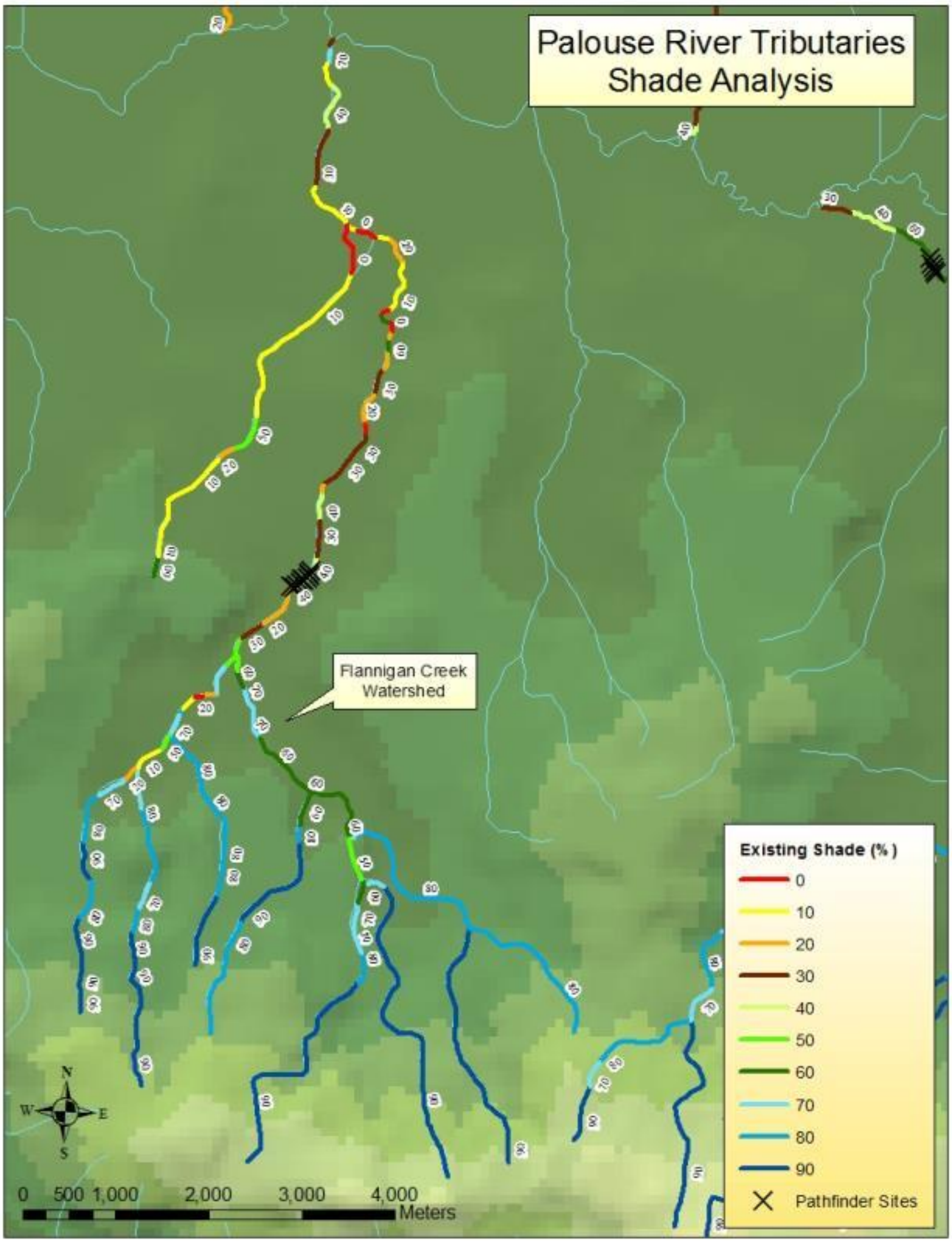


Figure C-10. Existing shade estimated for the Flannigan Creek watershed by aerial photo interpretation.

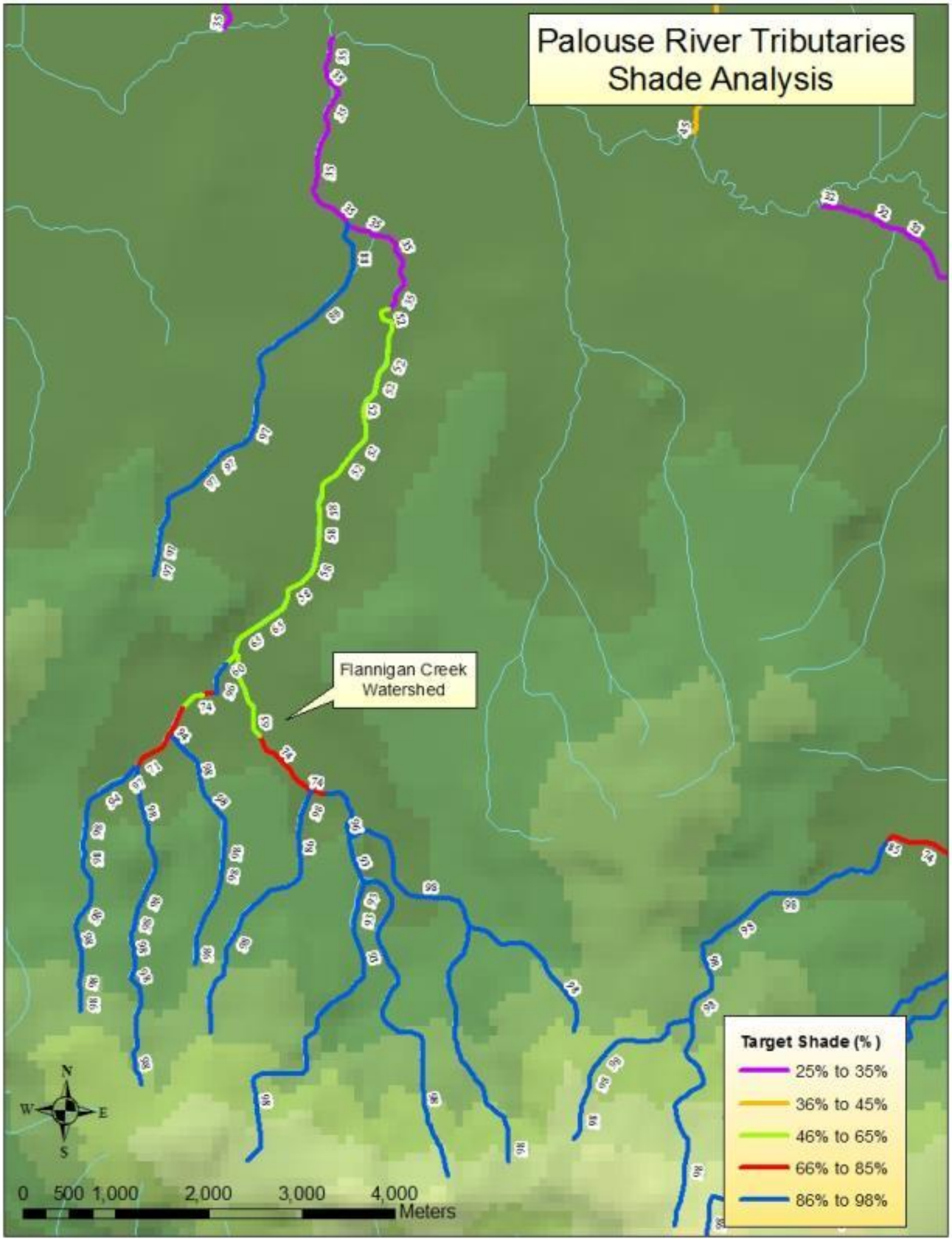


Figure C-11. Target shade for the Flannigan Creek watershed.

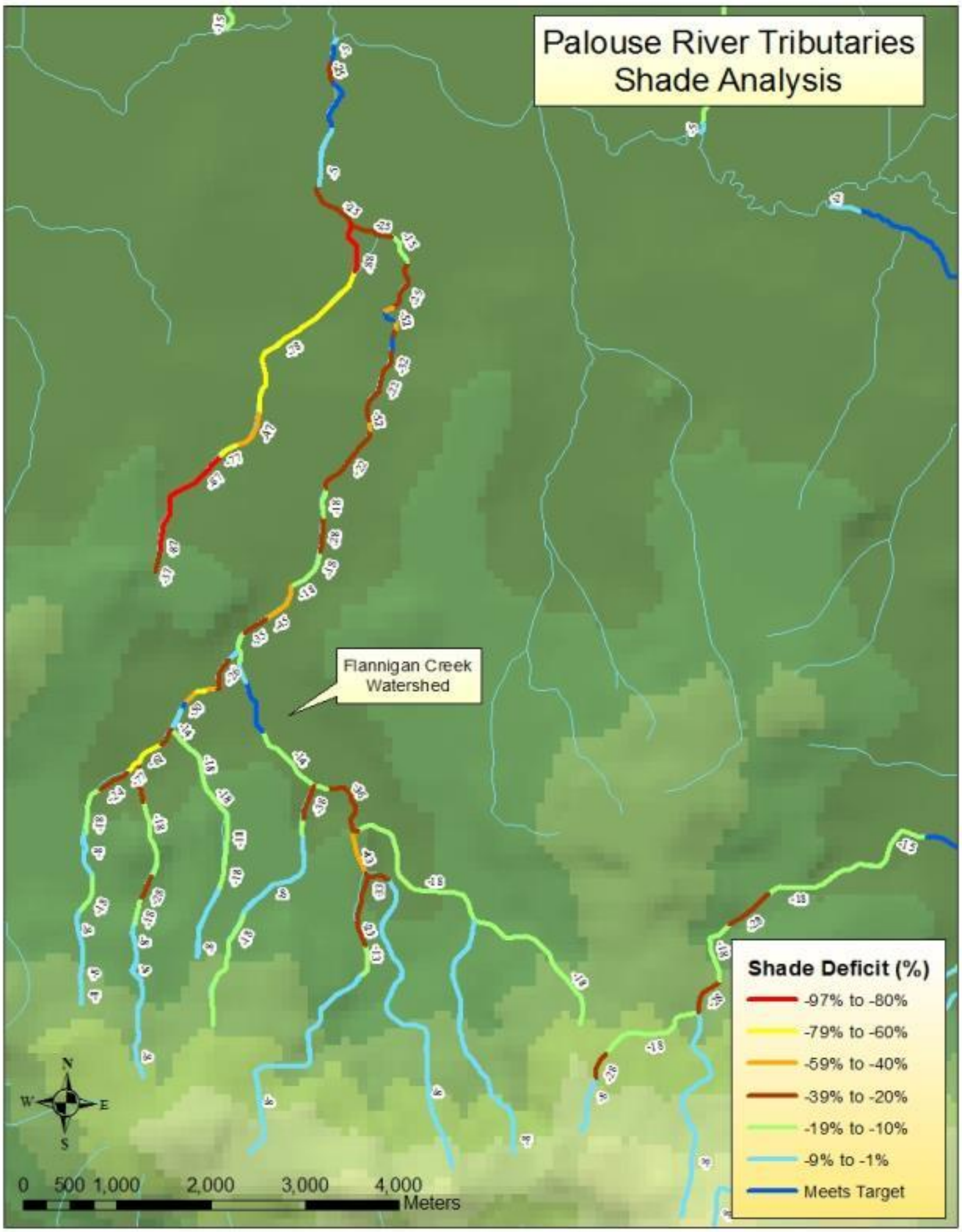


Figure C-12. Shade deficit (difference between existing and target) for the Flannigan Creek watershed.

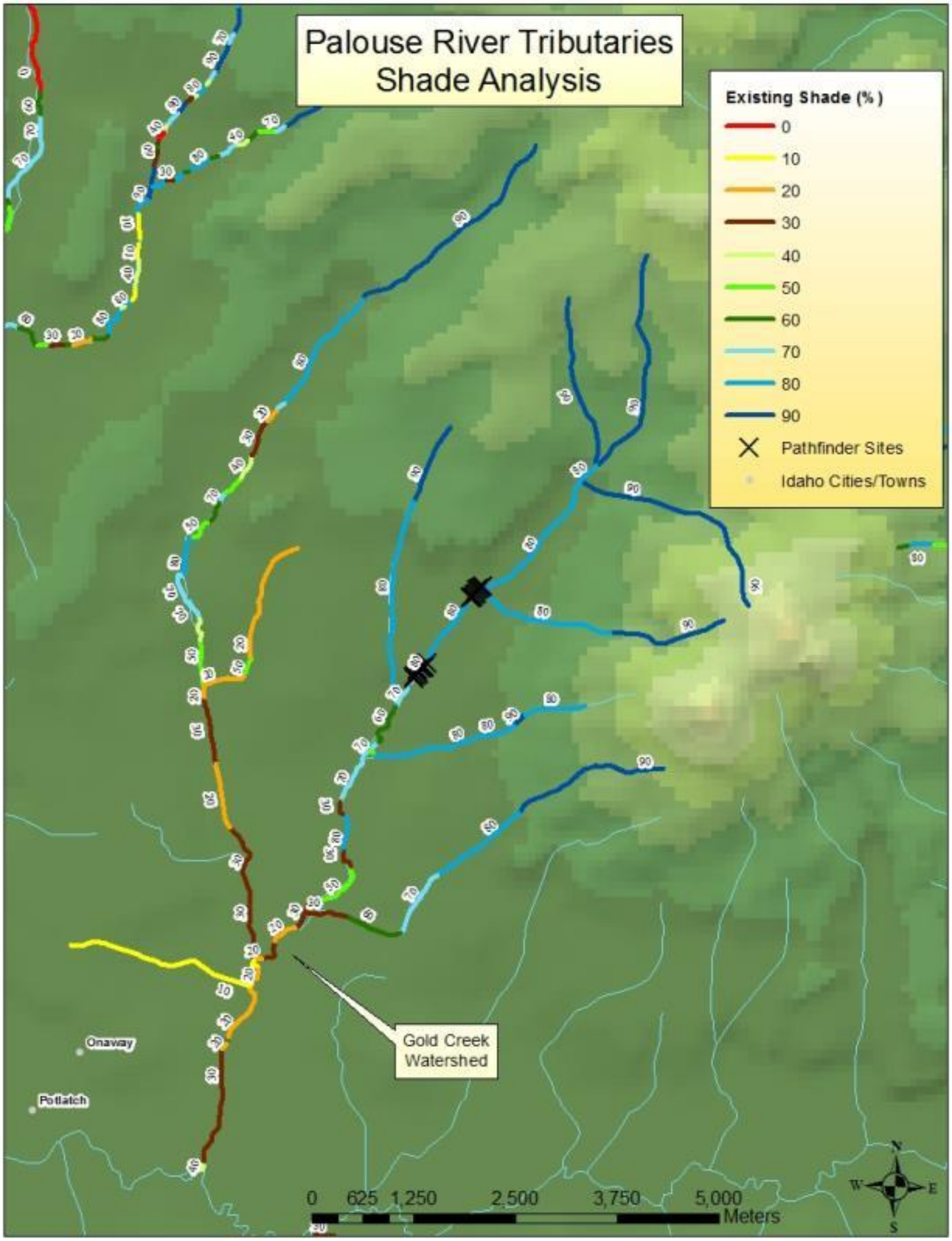


Figure C-13. Existing shade estimated for the Gold Creek watershed by aerial photo interpretation.

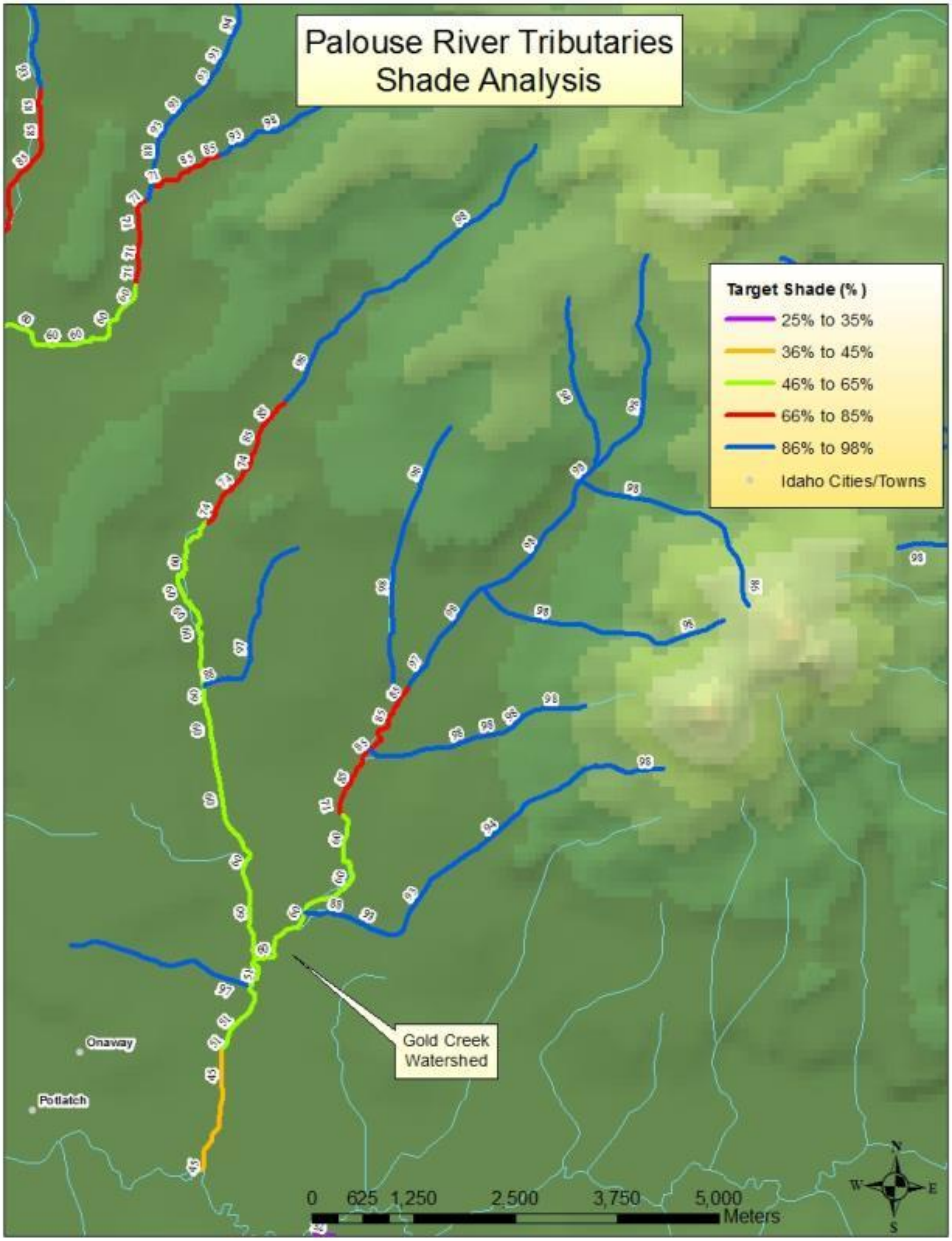


Figure C-14. Target shade for the Gold Creek watershed.

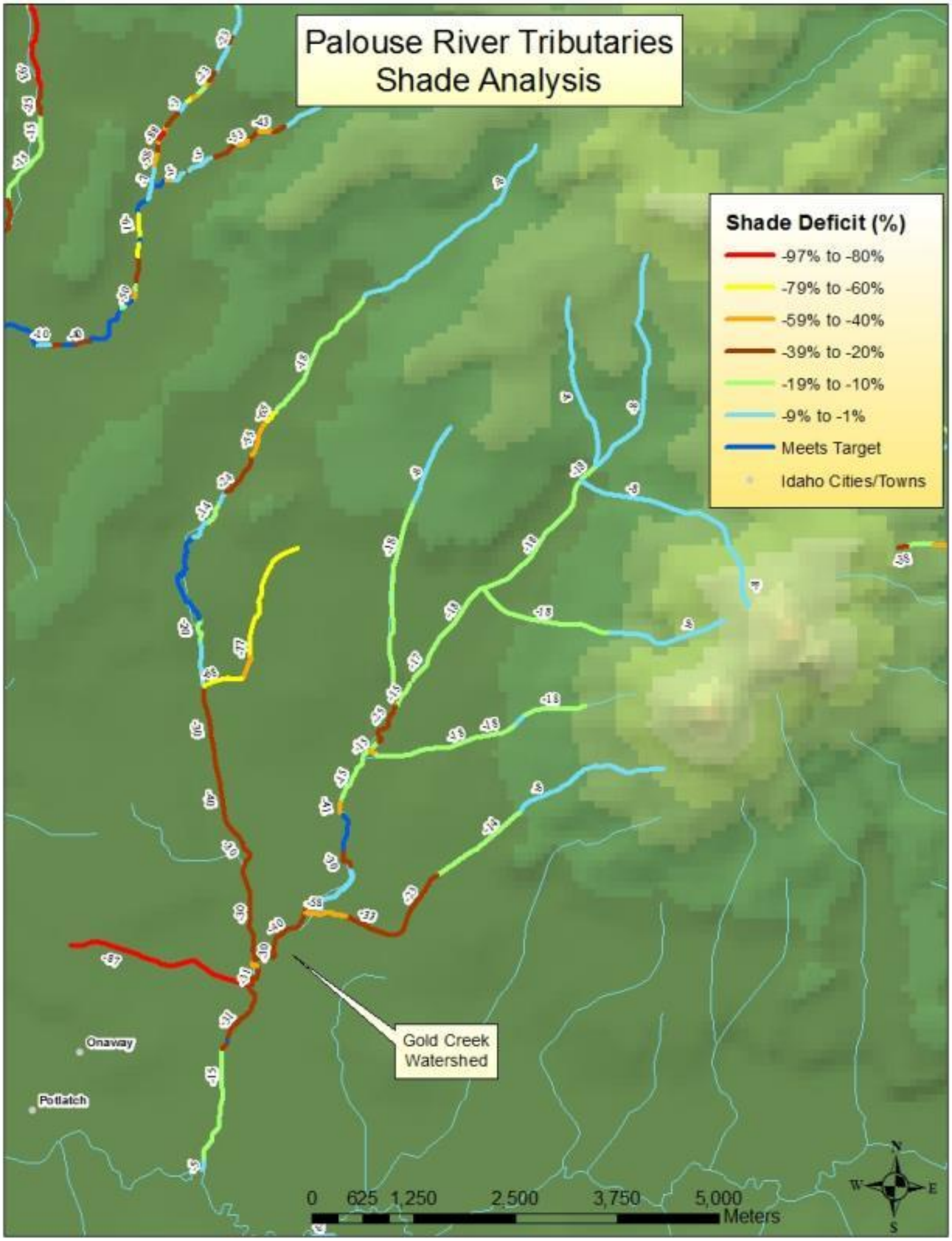


Figure C-15. Shade deficit (difference between existing and target) for the Gold Creek watershed.

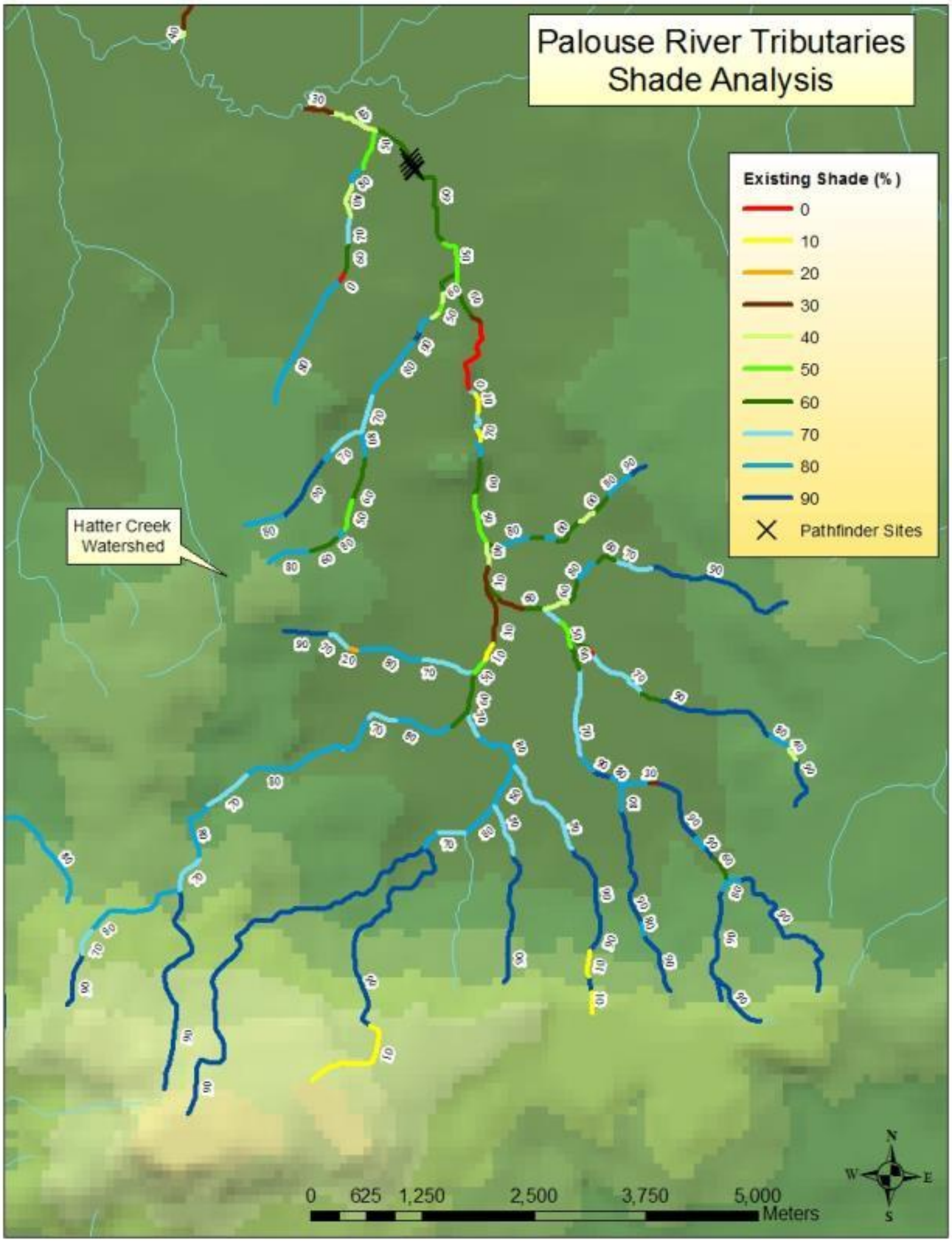


Figure C-16. Existing shade estimated for the Hatter Creek watershed by aerial photo interpretation.

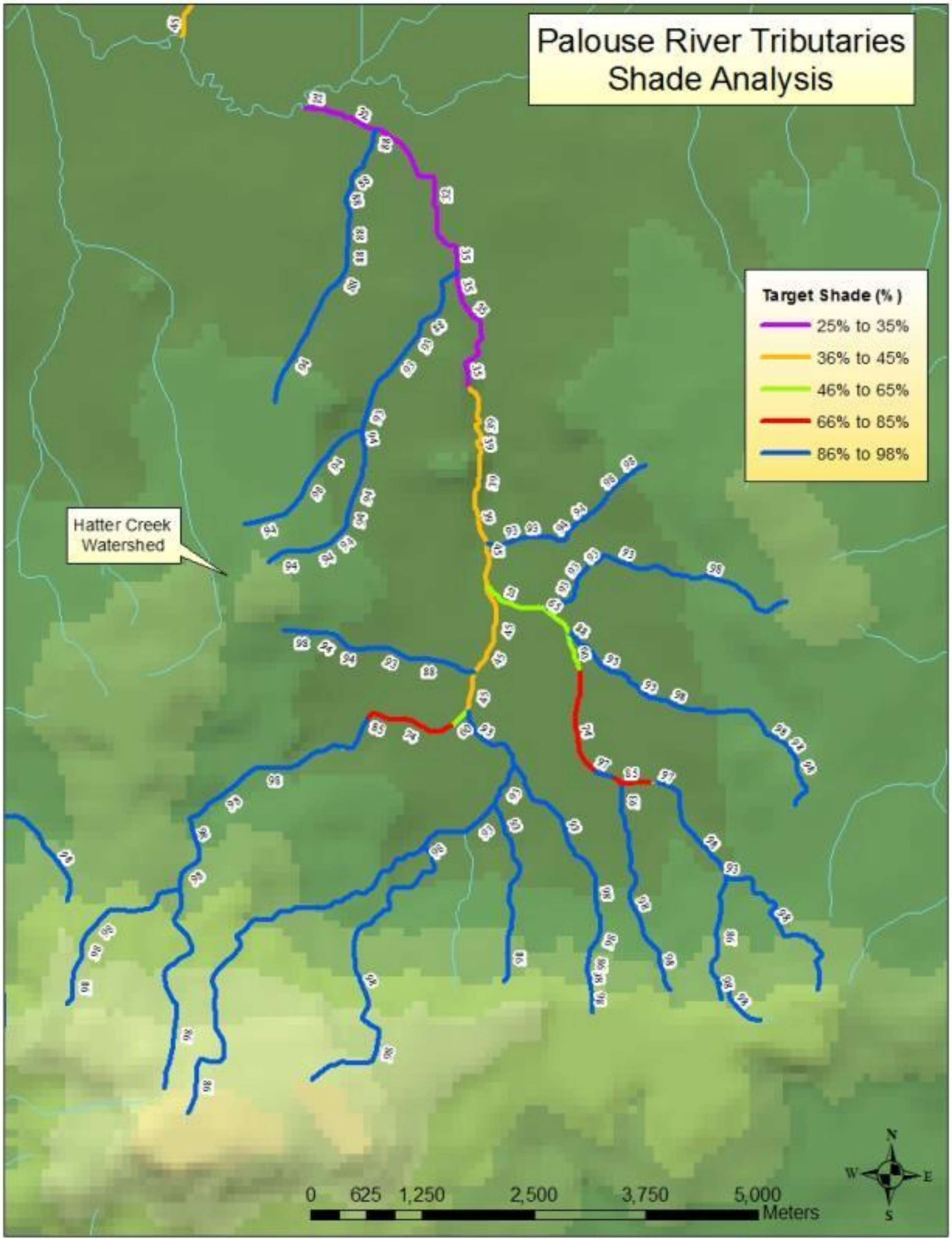


Figure C-17. Target shade for the Hatter Creek watershed.

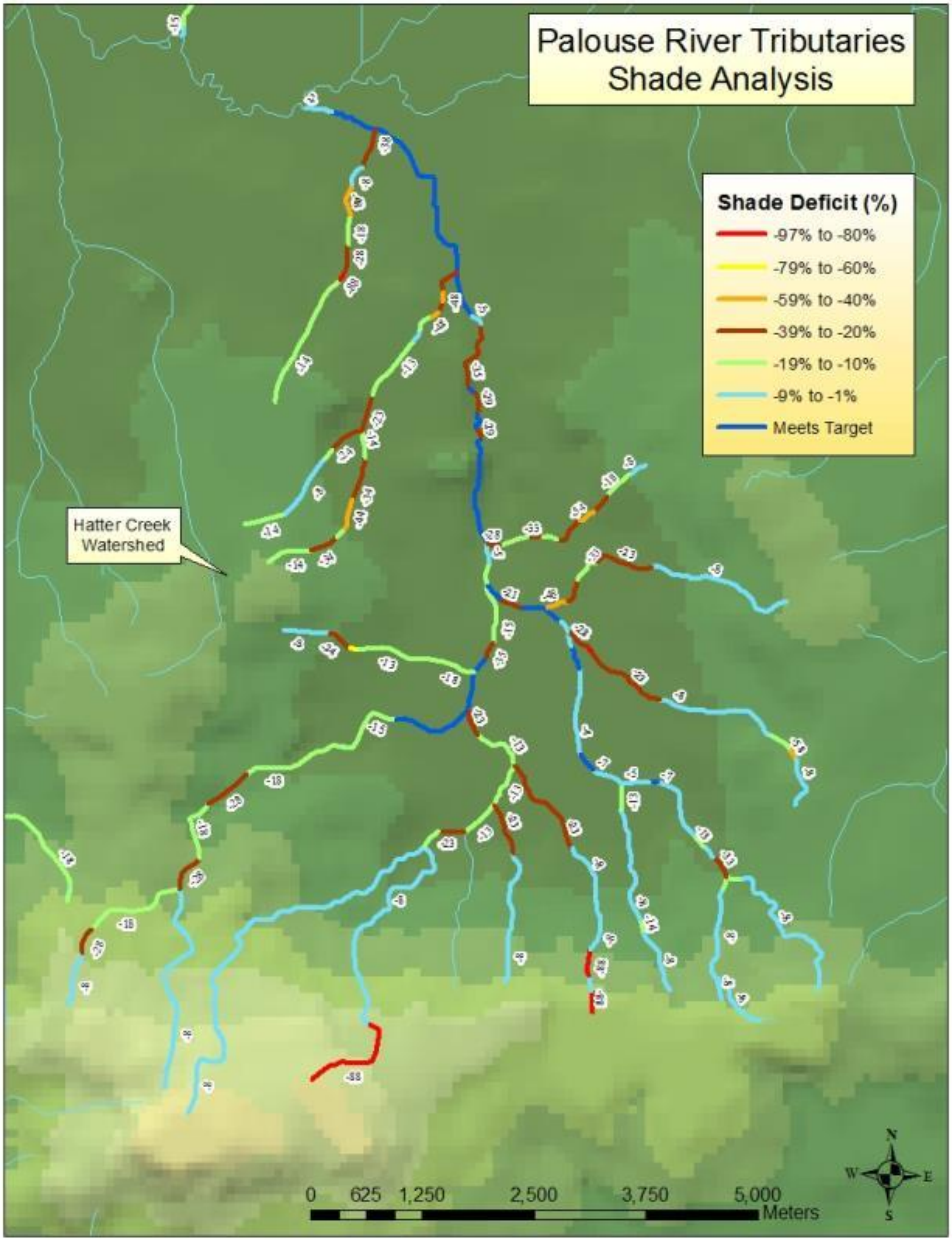
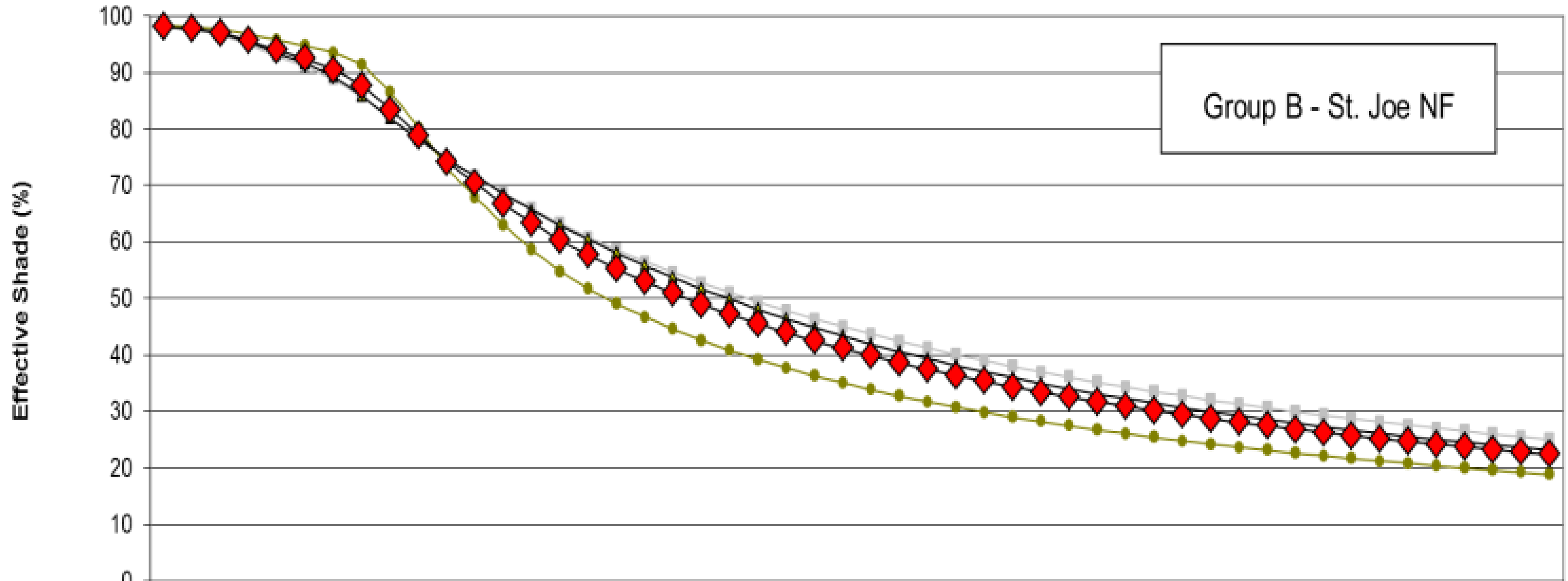


Figure C-18. Shade deficit (difference between existing and target) for the Hatter Creek watershed.

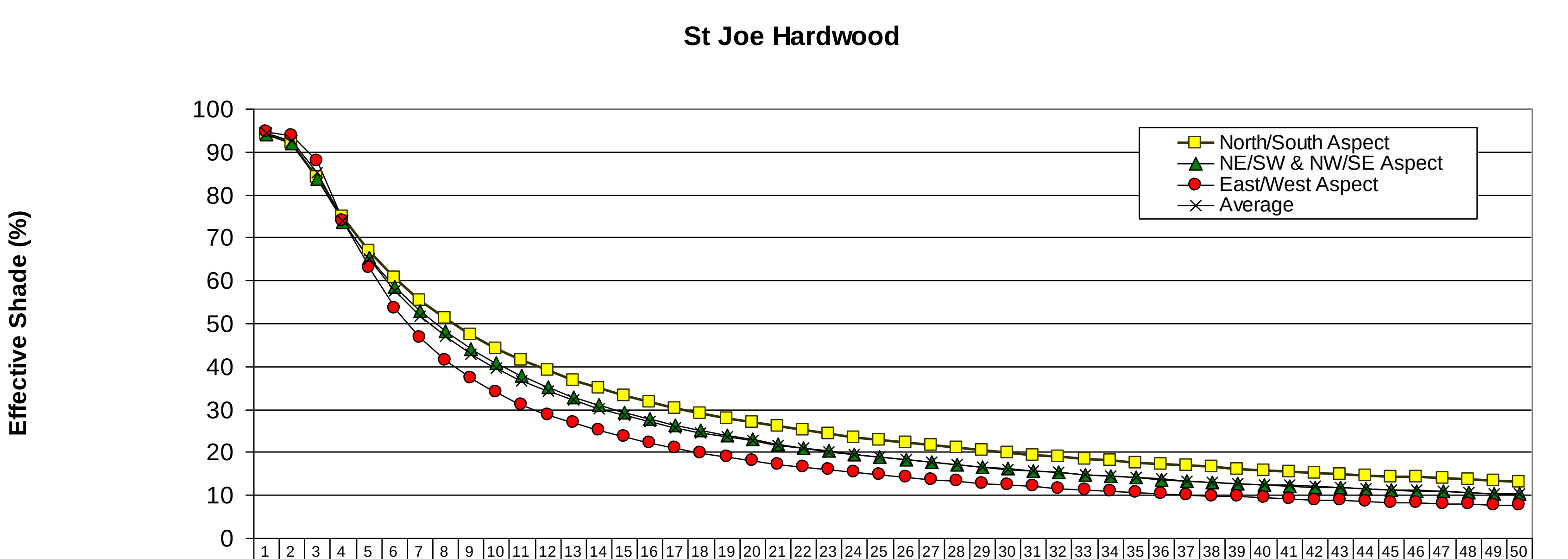


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North - South	98	98	97	95	93	91	89	86	82	78	75	72	69	66	63	61	59	56	55	53	51	49	48	46	45
Northeast/Southwest	98	98	97	95	93	92	89	86	82	78	75	72	68	66	63	60	58	56	54	52	50	48	46	45	43
East - West	98	98	98	97	96	95	94	92	87	80	73	68	63	59	55	52	49	47	45	43	41	39	38	36	35
Average	98	98	97	96	94	92	91	88	83	79	74	70	67	63	60	58	55	53	51	49	47	46	44	43	41

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North - South	44	42	41	40	39	38	37	36	35	34	34	33	32	31	31	30	29	29	28	28	27	27	26	26	25
Northeast/Southwest	42	41	39	38	37	36	35	34	33	32	31	31	30	29	29	28	27	27	26	26	25	25	24	24	23
East - West	34	33	32	31	30	29	28	27	27	26	25	25	24	24	23	23	22	22	21	21	20	20	20	19	19
Average	40	39	37	36	35	34	33	33	32	31	30	29	29	28	27	27	26	26	25	25	24	24	23	23	22

"Vegetation" Channel Width (meters) and Calculated Shade Conditions

Figure C-19. Target shade curve for the St Joe National Forest Group B forest type.

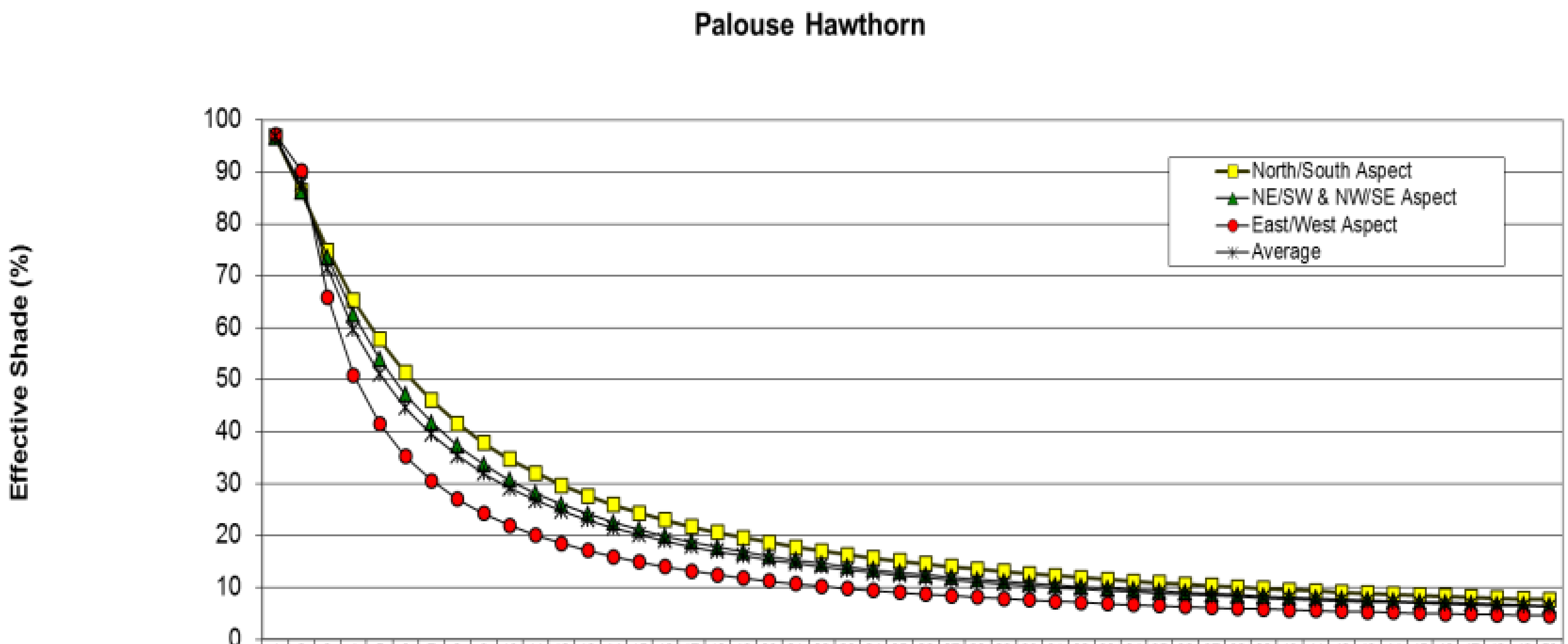


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	94	92	84	75	67	61	55	51	47	44	41	39	37	35	33	32	30	29	28	27	26	25	24	23	23
NE/SW & NW/SE Aspect	94	92	84	74	65	59	53	48	44	41	38	35	33	31	29	28	26	25	24	23	22	21	20	20	19
East/West Aspect	95	94	88	74	63	54	47	41	37	34	31	29	27	25	24	22	21	20	19	18	17	17	16	15	15
Average	94	93	85	74	65	58	52	47	43	40	37	34	32	30	29	27	26	25	24	23	22	21	20	19	19

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	22	21	21	20	20	19	19	18	18	18	17	17	16	16	16	15	15	15	15	14	14	14	14	13	13
NE/SW & NW/SE Aspect	18	18	17	17	16	16	15	15	14	14	14	13	13	13	13	12	12	12	11	11	11	11	11	10	10
East/West Aspect	14	14	13	13	12	12	12	11	11	11	10	10	10	10	9	9	9	9	9	8	8	8	8	8	8
Average	18	18	17	17	16	16	15	15	14	14	14	13	13	13	13	12	12	12	12	11	11	11	11	10	10

"Vegetation" Channel Width (meters)

Figure C-20. Target shade curve for the St Joe Group B/Hardwood mix forest type.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	97	86	75	65	58	51	46	42	38	35	32	30	28	26	24	23	22	21	20	19	18	17	16	16	15	14	14	13	13	13	12	12	11	11	11	11	10	10	10	10	9	9	9	9	8	8	8	8	8	8
NE/SW & NW/SE Aspect	97	86	73	62	54	47	42	37	34	31	28	26	24	23	21	20	19	18	17	16	15	15	14	13	13	12	12	12	11	11	10	10	10	10	9	9	9	9	8	8	8	8	8	7	7	7	7	7	7	7
East/West Aspect	97	90	66	51	42	35	31	27	24	22	20	18	17	16	15	14	13	12	12	11	11	10	10	9	9	9	8	8	8	8	7	7	7	7	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5
Average	97	88	71	60	51	45	39	35	32	29	27	25	23	21	20	19	18	17	16	15	15	14	13	13	12	12	11	11	11	10	10	10	9	9	9	9	8	8	8	8	8	7	7	7	7	7	7	6	6	6

"Vegetation" Channel Width (meters) and Calculated Shade Conditions

Figure C-21. Target shade curve for the Palouse Hawthorn nonforest type.

South Fork Palouse River

Table C-18. Existing and target solar loads for the South Fork Palouse River (ID17060108CL002_03).

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
002_03	SF Palouse River	1	400	Palouse hawthorn	60%	2.32	4	2,000	5,000	50%	2.90	4	2,000	6,000	1,000	-10%
002_03	SF Palouse River	2	120	Palouse hawthorn	60%	2.32	4	500	1,000	80%	1.16	4	500	600	(400)	0%
002_03	SF Palouse River	3	220	Palouse hawthorn	60%	2.32	4	900	2,000	50%	2.90	4	900	3,000	1,000	-10%
002_03	SF Palouse River	4	480	Palouse hawthorn	60%	2.32	4	2,000	5,000	40%	3.47	4	2,000	7,000	2,000	-20%
002_03	SF Palouse River	5	1400	Palouse hawthorn	60%	2.32	4	6,000	10,000	50%	2.90	4	6,000	20,000	10,000	-10%
002_03	SF Palouse River	6	280	Palouse hawthorn	60%	2.32	4	1,000	2,000	60%	2.32	4	1,000	2,000	0	0%
002_03	SF Palouse River	7	3280	Palouse hawthorn	60%	2.32	4	10,000	20,000	50%	2.90	4	10,000	30,000	10,000	-10%
002_03	SF Palouse River	8	59	Palouse hawthorn	60%	2.32	4	200	500	0%	5.79	4	200	1,000	500	-60%
002_03	SF Palouse River	9	840	Palouse hawthorn	51%	2.84	5	4,000	10,000	20%	4.63	5	4,000	20,000	10,000	-31%
002_03	SF Palouse River	10	2350	Palouse hawthorn	51%	2.84	5	10,000	30,000	30%	4.05	5	10,000	40,000	10,000	-21%
002_03	SF Palouse River	11	1670	Palouse hawthorn	51%	2.84	5	8,000	20,000	50%	2.90	5	8,000	20,000	0	0%
002_03	SF Palouse River	12	91	Palouse hawthorn	51%	2.84	5	500	1,000	80%	1.16	5	500	600	(400)	0%
002_03	SF Palouse River	13	550	Palouse hawthorn	51%	2.84	5	3,000	9,000	50%	2.90	5	3,000	9,000	0	-1%
002_03	SF Palouse River	14	360	Palouse hawthorn	51%	2.84	5	2,000	6,000	40%	3.47	5	2,000	7,000	1,000	-11%
002_03	SF Palouse River	15	180	Palouse hawthorn	51%	2.84	5	900	3,000	60%	2.32	5	900	2,000	(1,000)	0%
002_03	SF Palouse River	16	630	Palouse hawthorn	51%	2.84	5	3,000	9,000	80%	1.16	5	3,000	3,000	(6,000)	0%
002_03	SF Palouse River	17	390	Palouse hawthorn	51%	2.84	5	2,000	6,000	40%	3.47	5	2,000	7,000	1,000	-11%
							Totals		140,000					180,000	39,000	

Table C-19. Existing and target solar loads for the 2nd order portion South Fork Palouse River watershed (ID17060108CL003_02).

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
003_02	SF Palouse River	1	370	St Joe Group B	98%	0.12	1	400	50	90%	0.58	1	400	200	200	-8%
003_02	SF Palouse River	2	1300	St Joe Group B	98%	0.12	1	1,000	100	80%	1.16	1	1,000	1,000	900	-18%
003_02	SF Palouse River	3	740	St Joe Group B	98%	0.12	2	1,000	100	90%	0.58	2	1,000	600	500	-8%
003_02	SF Palouse River	4	690	St Joe hardwood	93%	0.41	2	1,000	400	80%	1.16	2	1,000	1,000	600	-13%
003_02	SF Palouse River	5	670	St Joe Group B	98%	0.12	2	1,000	100	90%	0.58	2	1,000	600	500	-8%
003_02	SF Palouse River	6	570	St Joe hardwood	85%	0.87	3	2,000	2,000	90%	0.58	3	2,000	1,000	(1,000)	0%
003_02	SF Palouse River	7	930	St Joe hardwood	85%	0.87	3	3,000	3,000	80%	1.16	3	3,000	3,000	0	-5%
003_02	1st trib to SF	1	860	St Joe hardwood	94%	0.35	1	900	300	90%	0.58	1	900	500	200	-4%
003_02	1st trib to SF	2	230	St Joe hardwood	94%	0.35	1	200	70	60%	2.32	1	200	500	400	-34%
003_02	1st trib to SF	3	880	St Joe hardwood	94%	0.35	1	900	300	90%	0.58	1	900	500	200	-4%
003_02	1st trib to SF	4	320	St Joe hardwood	94%	0.35	1	300	100	80%	1.16	1	300	300	200	-14%
003_02	1st trib to SF	5	150	St Joe hardwood	94%	0.35	1	200	70	90%	0.58	1	200	100	30	-4%
003_02	Crumarine Creek	1	1900	St Joe Group B	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
003_02	Crumarine Creek	2	630	St Joe Group B	98%	0.12	1	600	70	80%	1.16	1	600	700	600	-18%
003_02	Crumarine Creek	3	3100	St Joe Group B	98%	0.12	2	6,000	700	90%	0.58	2	6,000	3,000	2,000	-8%
003_02	Crumarine Creek	4	110	St Joe hardwood	85%	0.87	3	300	300	80%	1.16	3	300	300	0	-5%
003_02	Crumarine Creek	5	92	St Joe hardwood	85%	0.87	3	300	300	60%	2.32	3	300	700	400	-25%
003_02	Crumarine Creek	6	2200	St Joe hardwood	85%	0.87	3	7,000	6,000	80%	1.16	3	7,000	8,000	2,000	-5%
003_02	trib to Crumarine	1	270	St Joe Group B	98%	0.12	1	300	30	90%	0.58	1	300	200	200	-8%
003_02	trib to Crumarine	2	310	St Joe Group B	98%	0.12	1	300	30	80%	1.16	1	300	300	300	-18%
003_02	trib to Crumarine	3	250	St Joe Group B	98%	0.12	1	300	30	90%	0.58	1	300	200	200	-8%
003_02	3rd trib to SF	1	400	St Joe hardwood	94%	0.35	1	400	100	90%	0.58	1	400	200	100	-4%
003_02	3rd trib to SF	2	240	St Joe hardwood	94%	0.35	1	200	70	70%	1.74	1	200	300	200	-24%
003_02	3rd trib to SF	3	200	St Joe hardwood	94%	0.35	1	200	70	90%	0.58	1	200	100	30	-4%
003_02	3rd trib to SF	4	550	St Joe hardwood	94%	0.35	1	600	200	70%	1.74	1	600	1,000	800	-24%
003_02	3rd trib to SF	5	830	St Joe hardwood	94%	0.35	1	800	300	80%	1.16	1	800	900	600	-14%
003_02	3rd trib to SF	6	130	St Joe hardwood	93%	0.41	2	300	100	70%	1.74	2	300	500	400	-23%
003_02	3rd trib to SF	7	410	St Joe hardwood	93%	0.41	2	800	300	80%	1.16	2	800	900	600	-13%
003_02	3rd trib to SF	8	150	St Joe hardwood	93%	0.41	2	300	100	70%	1.74	2	300	500	400	-23%
003_02	3rd trib to SF	9	190	St Joe hardwood	93%	0.41	2	400	200	80%	1.16	2	400	500	300	-13%
003_02	3rd trib to SF	10	640	St Joe hardwood	93%	0.41	2	1,000	400	90%	0.58	2	1,000	600	200	-3%
003_02	3rd trib to SF	11	720	St Joe hardwood	93%	0.41	2	1,000	400	80%	1.16	2	1,000	1,000	600	-13%
003_02	4th trib to SF	1	200	St Joe hardwood	94%	0.35	1	200	70	90%	0.58	1	200	100	30	-4%
003_02	4th trib to SF	2	370	St Joe hardwood	94%	0.35	1	400	100	60%	2.32	1	400	900	800	-34%
003_02	4th trib to SF	3	260	St Joe hardwood	94%	0.35	1	300	100	70%	1.74	1	300	500	400	-24%
003_02	4th trib to SF	4	720	St Joe hardwood	94%	0.35	1	700	200	60%	2.32	1	700	2,000	2,000	-34%
003_02	4th trib to SF	5	410	St Joe hardwood	93%	0.41	2	800	300	80%	1.16	2	800	900	600	-13%
003_02	4th trib to SF	6	260	Palouse hawthorn	88%	0.69	2	500	300	70%	1.74	2	500	900	600	-18%
003_02	4th trib to SF	7	340	Palouse hawthorn	88%	0.69	2	700	500	40%	3.47	2	700	2,000	2,000	-48%
							Totals		18,000					38,000	20,000	

Table C-20. Existing and target solar loads for the South Fork Palouse River (ID17060108CL003_03).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
003_03	SF Palouse River	1	220	St Joe hardwood	85%	0.87	3	700	600	80%	1.16	3	700	800	200	-5%
003_03	SF Palouse River	2	330	St Joe hardwood	85%	0.87	3	1,000	900	80%	1.16	3	1,000	1,000	100	-5%
003_03	SF Palouse River	3	230	St Joe hardwood	85%	0.87	3	700	600	70%	1.74	3	700	1,000	400	-15%
003_03	SF Palouse River	4	100	St Joe hardwood	85%	0.87	3	300	300	80%	1.16	3	300	300	0	-5%
003_03	SF Palouse River	5	460	St Joe hardwood	85%	0.87	3	1,000	900	60%	2.32	3	1,000	2,000	1,000	-25%
003_03	SF Palouse River	6	560	St Joe hardwood	85%	0.87	3	2,000	2,000	70%	1.74	3	2,000	3,000	1,000	-15%
003_03	SF Palouse River	7	1000	Palouse hawthorn	71%	1.68	3	3,000	5,000	60%	2.32	3	3,000	7,000	2,000	-11%
							Totals		10,000					15,000	4,700	

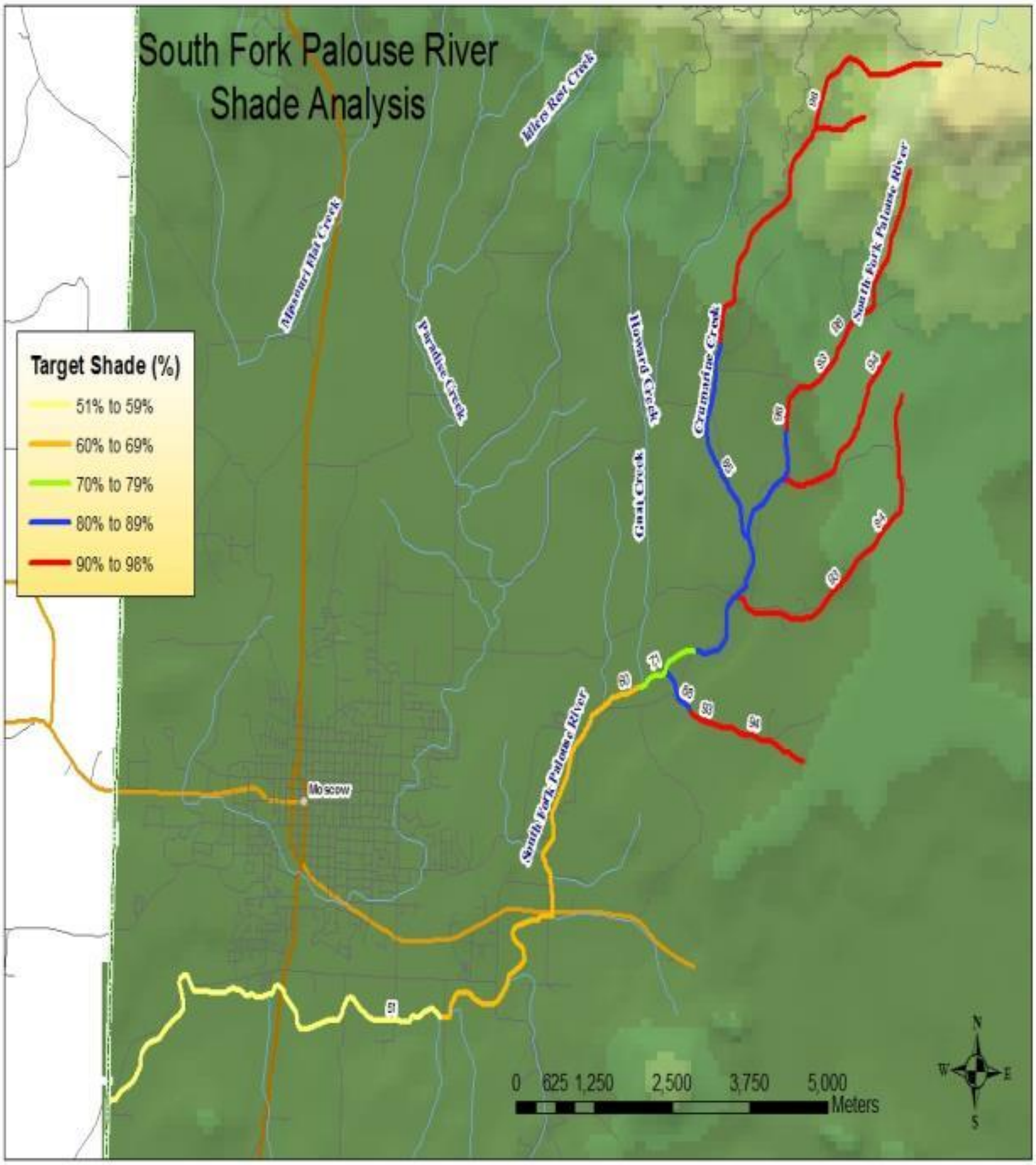


Figure C-22. Target shade for the South Fork Palouse River watershed.

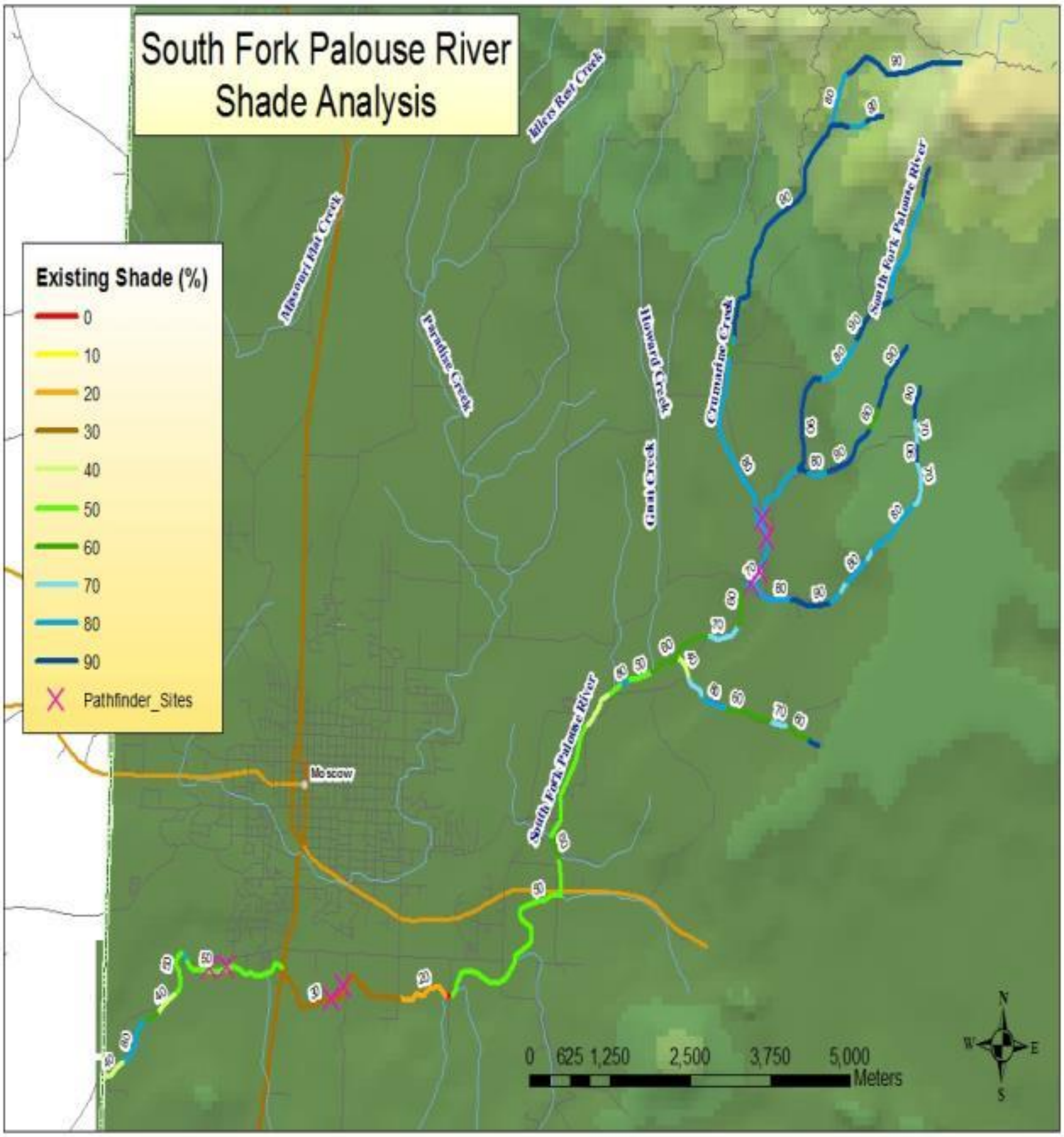


Figure C-23. Existing shade estimated for the South Fork Palouse River watershed by aerial photo interpretation.

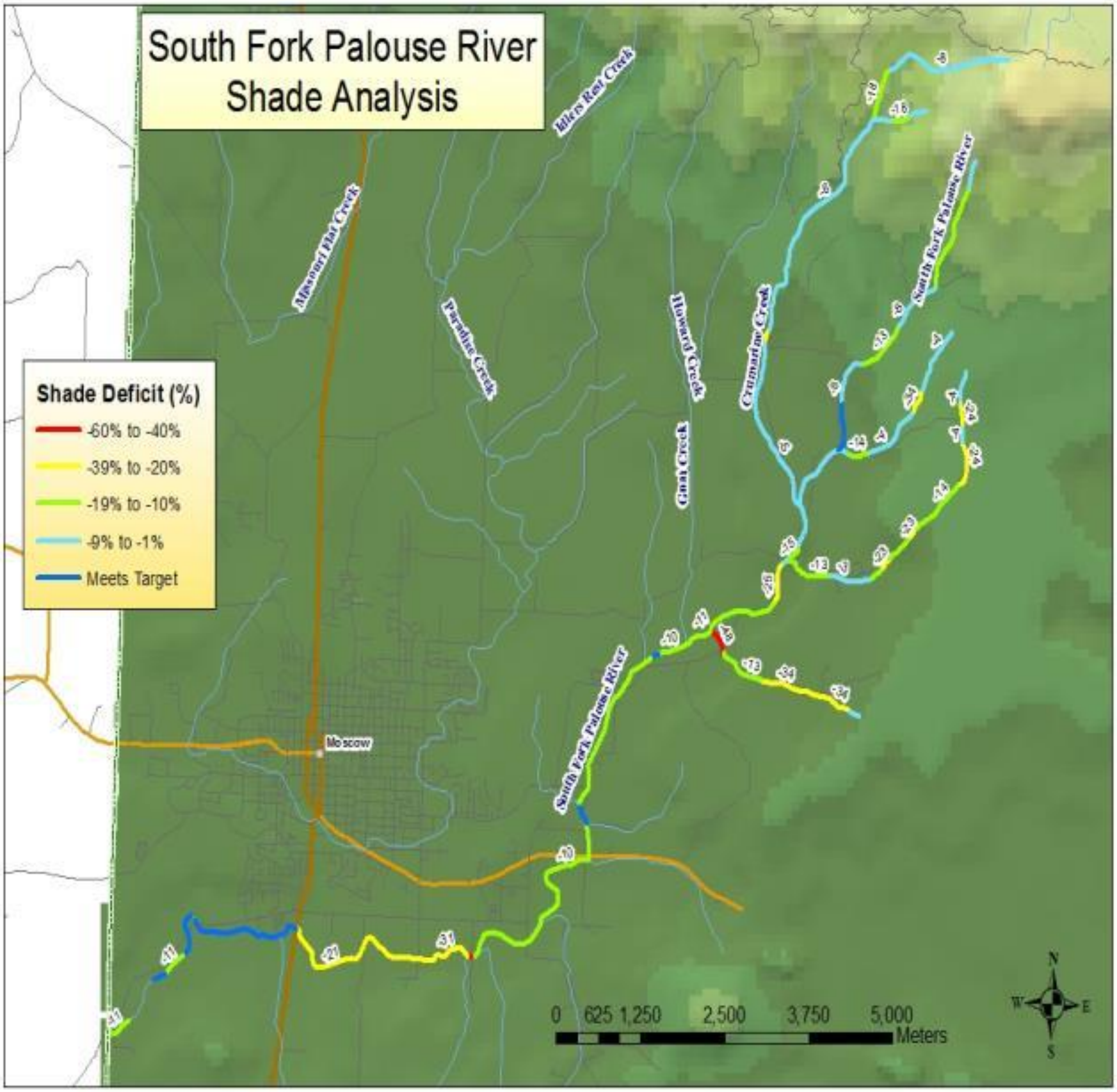


Figure C-24. Shade deficit (difference between existing and target) for the South Fork Palouse River watershed.

Appendix D. Public Participation and Public Comments

This total maximum daily load (TMDL) was developed with participation from the Palouse River Subbasin Watershed Advisory Group (WAG).

The Palouse River Subbasin WAG voted to provide a 30-day public comment period for a public comment draft of the Palouse River Subbasin TMDL during the February 2016 WAG meeting. Notice was provided to the general public through the *Moscow-Pullman Daily News* and the DEQ website of the opportunity to comment from January 27, 2017 through February 27, 2017. Copies of the document were made available through the DEQ Lewiston Regional Office and were available for download on the website.

The comments received were reviewed by the WAG. The WAG provided the agency advice on the following responses and actions to the comments received.

Written comments were received from the following:

- US Environmental Protection Agency
  Region 10, Idaho Operations Office
  Boise, Idaho
- Idaho Conservation League
  Sandpoint, Idaho
- Electronic Review for the Environment, Inc.
  Berkeley, California

Responses to comments received are provided below.

US Environmental Protection Agency

Comment 1: On the very first page of the report (page ix) the wording of the first sentence of the fourth paragraph seems awkward. You might want to revise that one.

Response: It has been revised.

Comment 2: There are several small communities along the Palouse River that have not received wasteload allocations for temperature in this document. I am referring to Potlatch, Onaway, Hampton, Princeton and Harvard. Is it true that none of these communities discharge to impaired, listed waters for temperature? If this is true they should be identified and where they discharge should be explained in the document.

Response: These communities do not have wastewater treatment systems that discharge into listed waters, as the Palouse River is not listed as impaired and is in Category 3 of Idaho's Integrated Report. The city of Potlatch wastewater treatment facility serves both Potlatch and Onaway and discharges to the Palouse River. The cities of Princeton and Hampton share a facility that discharges to the Palouse River and had an NPDES reconnaissance inspection completed in 2011 but has not been issued an NPDES permit at this time. The city of Harvard operates using a large soil absorption system (LSAS) that do not discharge to streams.

Comment 3: In section 5.4.6 Construction Stormwater, you should refer to the subsequent sections under 5.4.6.3 where you explain the state's interpretation of the Construction General Permit with regard to TMDL wasteload allocations.

Response: Section 5.4.6 has been updated to clarify that this pertains to all the components of stormwater.

Comment 4: In Table 15. NPDES permitted facilities within the Palouse subbasin on page 35, it is stated that the Syringa Mobile Home Park is currently not a permitted discharge. It is then stated that the WLA is "in reserve." If you are going to hold a WLA in reserve for a site it needs to be stated what the WLA will be if a permit is awarded. The TMDL states that there is no reserve for growth so where would the WLA come from for the mobile home park?

Response: This has been updated in this document; please see Section 5.4.7 Reserve for Growth.

Idaho Conservation League

Comment 1: Climate Change[1]

We were very disappointed and concerned to see that this draft TMDL did not consider or evaluate the potential impacts of climate change on water temperatures in the Palouse Subbasin. Creating an effective TMDL that will ensure Idaho Water Quality Standards are achieved cannot be done without acknowledging and internalizing the fact that the climate is changing. To account for this and to fulfill state and federal obligations under the Clean Water Act and the Idaho Administrative Code, this draft TMDL must anticipate and respond to climate change, especially given the likely impact climate change will have on water temperature.

For example, the temperature records for the Pacific Northwest indicate that the air temperature in this region has warmed by 1.8 degrees Fahrenheit since 1900.[1]

Moreover, continued warming in this region in the 21st century is projected to range from 0.2 to 1.1 degrees Fahrenheit per decade.[2] Increasing temperatures not only impact surface water temperature directly but also indirectly, as more frequent wildfires may destroy the streamside vegetation shading the water.

Water temperatures may also be impacted based on predictions and trends, which indicate that warmer air temperatures will lead to more frequent precipitation falling as rain rather than snow.[3]

[1] Bisson, Pete. 2008. Salmon and Trout in the Pacific Northwest and Climate Change. (June, 2008). U.S.

[2] Id.

[3] Id.

With less snowpack, spring runoff timing may occur earlier in the year and may not sustain high, cold flows for as long, leading to increasing summer water temperatures.

We request that DEQ consider, evaluate, and plan for climate change in this draft TMDL. If DEQ declines this request, we further request DEQ to provide a response explaining the basis for its decision.

Response: DEQ recognizes that climate change is a factor that may impact water temperature in the future in Idaho streams. The methodology used in this TMDL addresses temperature by looking at maximum potential shade in the watershed. By increasing shade through riparian planting not only will the stream temperature be reduced but there are added benefits of bank stabilization, reducing erosion and runoff to the stream, and providing habitat for wildlife. This TMDL will lead to cooler water by achieving shade that would be expected in natural conditions and water temperatures resulting from that shade. To what extent the climate will change and how it will change is unknown to us. However, we feel confident that a healthy riparian system with abundant shade is our best defense against any ramifications to stream temperature from climate change.

Comment 2: Critical Condition for Stream Temperature

To ensure water quality standards are met, it is essential that the load capacity of a TMDL be based on critical conditions – the condition when water quality standards are most likely to be violated. If the TMDL is not developed based on critical conditions, the probability that certain river and stream segments will violate water quality standards increases. This TMDL, as drafted, failed to develop its load allocation based on critical conditions and should be revised accordingly.

The draft TMDL uses natural bankfull width to calculate target shade. In so doing, DEQ acknowledges that bankfull width may not reflect widths present under potential natural vegetation (PNV) due to environmental impacts that tend to increase width-to-depth ratios, making streams wider and shallower. Moreover, existing bankfull width is not always discernible from aerial photo interpretation, so the natural bankfull widths in this TMDL are estimates based on regional curves from major basins in Idaho.

Using natural bankfull width to calculate target shade in this way fails to capture rivers and streams in the Palouse Subbasin in critical conditions. Relying on estimates based data points from a regional curve inevitably will overlook certain stream segments more vulnerable to solar radiation because of higher width-to-depth ratios.

Width-to-depth ratio is the best means for evaluating water bodies under critical conditions. Moreover, a host of electronic tools and data exist to develop load capacity based on the highest width-to-depth ratio, including: digital elevation models, geographic information systems, and the Army Corps of Engineers' Hydrologic Engineering Center River Analysis System.

We request that DEQ consider and utilize width-to-depth ratio, rather than natural bankfull width, in determining load capacity. If DEQ declines to act on this request, we further request DEQ provide a response, explaining its basis for evaluating load capacity based on natural bankfull width rather than width-to-depth ratio.

Response: Bankfull width is used in the shade analysis because that is where the riparian plant community begins on the banks of the stream. While some minor plant growth can occur within the bankfull channel during the growing season, it is generally small, not shade producing, and unreliable for shade production. The PNV temperature TMDL process uses the bankfull margin to indicate the start of shade producing perennial plant community. Regional curves tell us in general what are expected channel widths based on climate and geology. We look for situations where an individual stream has a width that is wider than what is typical for the region. Such a stream would be considered out of proportion with regional hydrology and climate. While width/depth ratio includes the width component, the ratio can vary widely due to a variety of local conditions, some of which are human-caused, some not. Additionally, width/depth ratio information is more difficult to come by, and we do not have a methodology to predict adequate ratios based on regional or watershed information.

Comment 3: Margin of Safety

When developing TMDLs, the Water Quality and Planning Management federal regulations require a margin of safety be included, which takes into account any lack of knowledge concerning the development of thermal water quality criteria for protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in the identified waters or parts thereof. 40 CFR 130.7(c)(2). Section 5.4.2 of the draft TMDL indicates that a margin of safety was not included in this TMDL because the margin of safety is implicit in the design of the TMDL. In DEQ’s view, because target shade levels are established at natural background levels, it would be unrealistic to set higher shade targets. Although natural background levels of shade may create a logical baseline condition for evaluating load capacity and setting waste and waste load allocations, it fails to account for the lack of knowledge concerning the development of thermal water quality, as required by the federal regulations cited above. 40 CFR 130.7(c)(2).

DEQ lacks full knowledge concerning the development of thermal water quality criteria in several respects. For example, a natural background level of shade, itself, is an estimate and not based on complete knowledge of these conditions or how they impact thermal water quality criteria.

In addition, although the majority of trends indicate that climate change is and will continue to alter characteristics of the environment, such as water temperatures, these trends cannot yet predict how climate change will specifically affect particular water bodies. The data and analysis may suggest a range of outcomes over the next 5, 10, or 100 years, but we lack the capacity to plan on particular future water temperatures, for particular water bodies. It may also be the case that natural background shade levels are insufficient or unattainable depending on the effects of climate change.

The deficiencies in our knowledge of developing thermal water quality criteria cited above do not exhaust all of the deficiencies of our knowledge in this respect. Accordingly, DEQ must fully consider the full extent to which we lack knowledge to develop appropriate thermal water quality criteria and include a margin of safety into this TMDL that accounts for these deficiencies. If DEQ declines to include such a margin of safety, we request DEQ provide the basis for its decision.

Response: The margin of safety is implicit in the TMDL design because the shade targets for the stream are a maximum amount of shade, not an average amount of shade, nor a minimum shade level. Because shade levels are established at approximately system potential levels, it is unrealistic to set shade targets that are beyond the expectations for the plant community. Additionally, existing shade levels are represented as the lowest level of a 10% shade class, which likely underestimates actual shade in the loading analysis.

The PNV approach estimates target shade quantities from reference land types that have a range of shade targets under natural conditions. The majority of the forest shade curves we use represent the upper 90% of a closed forest system as opposed to an open forest of the same type. This margin of safety allows the target to compensate for other deficiencies. We expect resulting targets to often exceed the natural condition for a given plant community. The targets are reasonable goals to work towards at this time. During the TMDL review process, those targets and goals may be updated.

Comment 4: Progress, Interim Limits, and Triggers

As indicated throughout the introductory portions of the draft TMDL, the Palouse River Tributaries and the South Fork of the Palouse River have been listed under the § 303(d) list as impaired for temperature since 1998. Despite approving TMDLs for these water bodies in 2005 and 2007, respectively, the current draft TMDL reports that most of the assessment units have not improved over the past 10 to 12 years. This is concerning because outside of incorporating newer and more accurate data, the draft TMDL lacks any sort of innovative approach or action-forcing strategies to ensure that this TMDL will prove more effective than its predecessors. Based on this, we strongly encourage DEQ to revise this TMDL to include enforcement strategies and requirements that will ensure appropriate thermal temperatures are restored in the Palouse Subbasin.

If DEQ does not include additional strategies to ensure water temperature is reduced in the Palouse Subbasin, we request that interim goals and triggers be set to ensure that the primary means of achieving the TMDL, streamside and riparian restoration, is effective and showing progress. The time frame for achieving water quality standards in this TMDL is 10-20 years, given that the TMDL relies on riparian area management practices that will restore canopy cover. Although the TMDL indicates that DEQ and the designated Watershed Assessment Group (WAG) will continue to reevaluate the TMDL on a 5-year cycle, we recommend DEQ set interim goals and trigger points, at which DEQ, the WAG, and the public can clearly tell whether, and how much, progress is being made.

Using a 15-year time frame for achieving water quality standards, DEQ and its partners should be 1/3 of the way towards achieving water quality standards by the first 5-year review of this TMDL. DEQ should determine what “progress” at this stage means, as it will depend on the how restoration projects are organized and implemented. In conjunction with this goal, DEQ should also set a trigger point, at which a certain lack of progress will indicate when new strategies and approaches are needed. We request DEQ consider and incorporate interim goals and trigger points into this TMDL. If DEQ declines this request, we further request DEQ provide an explanation of the basis for its decision

Response: The goal of the TMDL document is to set limits on pollutant levels that, when implemented and achieved, correct water quality impairments and achieve beneficial uses of water bodies by attaining water quality standards. Because DEQ is not a designated land management agency, the TMDL does not provide details of the actions needed to achieve those load reductions. Those details are provided in the implementation plan for the watershed or subbasin. The implementation plan is a document that is guided by an approved TMDL which provides the details of the actions needed to achieve load reductions, outlines a schedule for those actions, and specifies monitoring needs. Implementation plans are developed by a variety of stakeholders including government agencies, local citizens, and the WAG. Designated land management agencies and the WAG are responsible for identifying appropriate implementation measures.

Electronic Review for the Environment, Inc.

Comment 1: Table of Contents – The list of tables relies heavily on shade data but doesn't show data for temperature. Please consider adding water temperature data; it may help validate the other data, show useful information and potentially help identify inconsistencies or areas of special concern.

Response: This comment will be considered in future temperature TMDL reviews in the subbasin.

Comment 2: Page 18 Sec 5.1.1 - Turbidity can be a factor that increases temperature from solar radiation due to suspended sediment absorbing heat from sunlight. This is a target factor of the Palouse Clearwater Environmental Institute projects that should be restated here for the purpose of explaining the importance of erosion control and riparian restoration pursuant to decreasing sediment load. Since it is unclear from this document how significant the turbidity affects temperature, the relative significance of this factor should be discussed. The discussion of the load capacity equation shown on page 17 section 5.0 should also consider the absorbance of heat attributable to this factor. If controlling turbidity is significant compared to shading, that information would be important for making decisions for priority-based allocation of resources (i.e. balancing efforts toward reducing turbidity and increasing shade).

Response: This TMDL is written looking at system potential vegetation; we acknowledge that turbidity can be a factor that can add to the increase of stream temperature. However, by implementing riparian planting and other land management practices that increase shade, turbidity will also be reduced through stabilization of banks, filtering of runoff, etc.

Comment 3: Pages 25-26 - The design conditions for the Palouse River tributaries and South Fork Palouse River have no mention of measures to sustain the proposed potential natural vegetation (PNV) recommendations. Sustainable management strategies should reduce over-grazing in low shade areas and possibly utilize small net fencing to block grazing herbivores. A comprehensive ecological approach may improve sustainability for plant growth, foster beneficial animals, shade, and decreased water temperature.

Response: DEQ works with land management agencies in the subbasin to develop implementation plans that include sustainable management strategies for the assessment units in the TMDL. Assessment units in this TMDL are included in implementation plans that can be found at *www.deq.idaho.gov/water-quality/surface-water/tmdls/table-of-sbas-tmdls/palouse-river-subbasin.aspx*. DEQ is working with the Palouse River Subbasin WAG and additional land management agencies to review and update the implementation plans in the Palouse River subbasin.

Comment 4: Page 37 section 5.5 – This section discussed implementation strategies for increasing shade along the Palouse River to bring the temperature down to be more conducive for salmon habitat. One strategy which should be considered includes coordination with wildlife management agencies adjust wildlife management plans in ways that may improve the overall ecosystem in ways that may reduce the river temperature. For example as shown on the website for Yellowstone Park, the reintroduction of wolves into the park had a positive effect on improving willow stands which in turn created more shade along creeks and rivers (which is a primary goal for this project):

> "Healthier Willow Stands in Yellowstone: This created a counterintuitive situation. Back in 1968, said Smith, when the elk population was about a third what it is today, the willow stands along streams were in bad shape. Today, with three times as many elk, willow stands are robust. Why? Because the predatory pressure from wolves keeps elk on the move, so they don't have time to intensely browse the willow. Indeed, a research project headed by the U.S. Geological Survey in Ft. Collins found that the combination of intense elk browsing on willows and simulated beaver cuttings produced stunted willow stands. Conversely, simulated beaver cutting without elk browsing produced verdant, healthy stands of willow. In the three-year experiment, willow stem biomass was 10 times greater on unbrowsed plants than on browsed plants. Unbrowsed plants recovered 84 percent of their pre-cut biomass after only two growing seasons, whereas browsed plants recovered only 6 percent. With elk on the move during the winter, *willow stands recovered from intense browsing*, and beaver rediscovered an abundant food source that hadn't been there earlier. As the beavers spread and built new dams and ponds, the cascade effect continued, said Smith. Beaver dams have multiple effects on stream hydrology. They even out the seasonal pulses of runoff; store water for recharging the water table; and provide cold, shaded water for fish, while the now robust willow stands provide habitat for songbirds. "What we're finding is that ecosystems are incredibly complex," he said. In addition to wolves changing the feeding habits of elk, the rebound of the beaver in Yellowstone may also have been affected by the 1988 Yellowstone fires, the ongoing drought, warmer and drier winters and other factors yet to be discovered, Smith said."

See full article *http://www.yellowstonepark.com/wolf-reintroduction-changes-ecosystem/*

On February 15, 2015 the Lewiston Tribune reported that wildlife agencies have been killing wolves in the Lolo region and that a motion is before a court requesting consideration of alternatives under the National Environmental Policy Act (NEPA). The case study of the reintroduction of wolves to Yellowstone Park cited above and the killing of wolves in the Lolo region suggest that perhaps wolves could be relocated to the Palouse River Subbasin. That might limit grazing of elk and deer along the creeks and river to improve the tree stands and shade as occurred at Yellowstone Park.

Response: DEQ is not a land management agency, nor are we experts in specific implementation. DEQ does not suggest best management practices for implementation. DEQ works with land management agencies on implementation plans that include suggested best management practices to be implemented on private lands on a voluntary basis.

Appendix E. Distribution List

Clearwater Basin Advisory Group

Palouse Subbasin Watershed Advisory Group

Idaho Department of Environmental Quality: DEQ State Office and Lewiston Regional Office

United States Environmental Protection, Agency, Idaho Operations Office