

Upper and Lower Henry's Fork Total Maximum Daily Loads:

Addendum to the Upper Henry's Fork Subbasin Assessment and TMDLs



Final



**Department of Environmental Quality
June 2010**

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Cover photo of Icehouse Creek by Heather Bohac (DEQ) taken on September 24, 2008.

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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	MOS	margin of safety
§	Section (usually a section of federal or state rules or statutes)	NB	natural background
AU	assessment unit	ppm	part(s) per million
BLM	United States Bureau of Land Management	SBA	subbasin assessment
BMP	best management practice	TMDL	total maximum daily load
C	Celsius	U.S.	United States
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)	U.S.C.	United States Code
CWA	Clean Water Act	USFS	United States Forest Service
DEQ	Department of Environmental Quality	USGS	United States Geological Survey
EPA	United States Environmental Protection Agency	WAG	Watershed Advisory Group
F	Fahrenheit	WLA	wasteload allocation
GIS	Geographical Information Systems	WQS	water quality standard
HUC	Hydrologic Unit Code		
IDAPA	Refers to citations of Idaho administrative rules		
IDL	Idaho Department of Lands		
LA	load allocation		
LC	load capacity		
m	meter		
m³	cubic meter		
mi	mile		
mi²	square miles		
mg/L	milligrams per liter		

Executive Summary

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

This TMDL analysis has been developed to comply with Idaho's TMDL schedule.

This document addresses fourteen water bodies and their associated assessment units (AUs) in the Upper and Lower Henry's Fork Subbasin that have been placed on Idaho's 2008 Integrated Report, finalized May 22, 2009. For more information about most of these watersheds, see the Upper Henry's Fork Subbasin Assessment (IDEQ, 1998).

The first part of this document, the subbasin assessment (SBA), is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's current §303(d) list of water quality limited water bodies. The SBA examines the current status of §303(d)-listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance

The Upper and Lower Henry's Fork subbasins (17040202 and 17040203) are located in eastern Idaho near Yellowstone National Park. No streams were originally listed on the Idaho 1998 303d list for temperature pollution in this subbasin. However, the Environmental Protection Agency (EPA) added streams to Idaho's 1998 303d list of impaired waters that potentially exceeded Idaho's temperature criteria. Among those EPA additions, the streams in the Upper Henry's Fork Subbasin were Duck Creek, Howard Creek, Targhee Creek, Timber Creek, and Warm River. Other streams were listed as impaired due to low bioassessment scores as determined by the Idaho Department of Environmental Quality (DEQ). Figure 1 displays Upper and Lower Henry's Fork impaired streams listed in the 2008 Integrated Report as not supporting beneficial uses due to flow alteration, sediment, bacteria, and temperature.

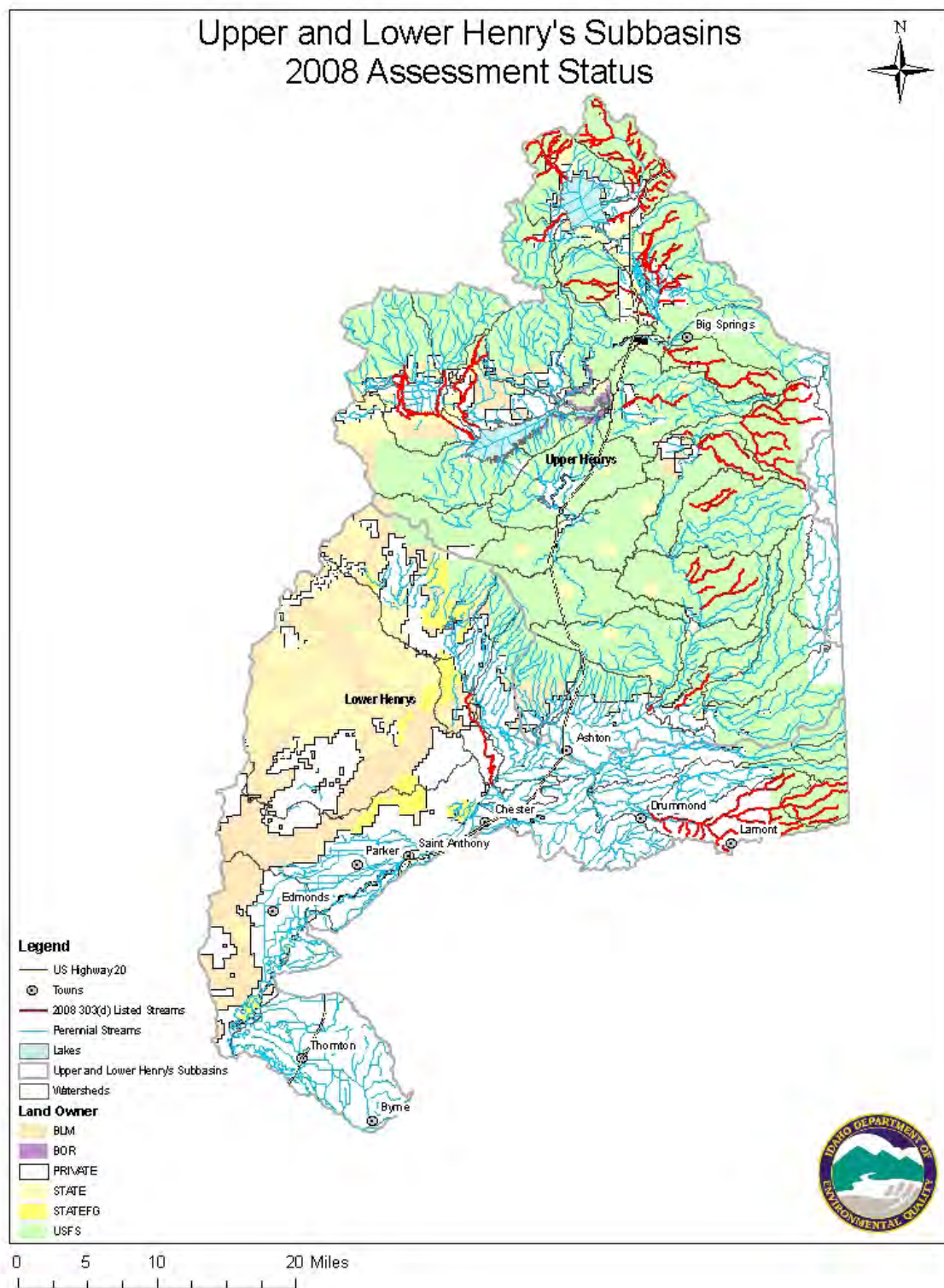


Figure 1. Upper and Lower Henry's subbasins 2008 impaired streams.

Key Findings

Streams listed as impaired waters in Section 5 of the 2008 Integrated Report that have TMDLs developed in this document are listed in Table 1. Water bodies in the Upper and Lower Henry's Fork subbasins are designated for cold water aquatic life, salmonid spawning, primary contact recreation, domestic water supply and special resource water. Table 2 displays the outcomes of all waters evaluated in this assessment.

Table 1. Streams and pollutants for which TMDLs were developed.

Stream	Pollutant(s)
Upper Henry's 17040202	
Warm River	Temperature
Buffalo River	Sediment
Howard Creek	Temperature
Targhee Creek	Temperature
Timber Creek	Temperature
Duck Creek	Temperature, Sediment
Sheridan Creek	Sediment
Lower Henry's 17040203	
Conant Creek (Squirrel Creek)	Bacteria (E-coli)

Table 2. Summary of assessment outcomes.

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to 2010 Integrated Report	Justification
Upper Henry's 17040202				
Warm River/ ID17040202SK002_05 ID17040202SK005_02	Temperature	Yes	Move to section 4a ¹	Shade lacking, stream temp exceedance
Warm River/ ID17040202SK002_04 ID17040202SK005_03 ID17040202SK005_04	Temperature	Yes	Move to section 4a	Unlisted but impaired for temperature
Buffalo River/ ID17040202SK018_03	Listed for Combined biota/habitat assessment; determined to be Sediment	Yes	Move to section 4a; delist combined biota/habitat assessment	Stream bank erosion
Twin Creek/ ID17040202SK030_02	Combined biota/habitat bioassessment	No	Move to section 2 ²	Bioassessment shows no impairment
Howard Creek/ ID17040202SK033_02	Temperature	Yes	Move to section 4a	Shade lacking, stream temp exceedance

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to 2010 Integrated Report	Justification
Upper Henry's 17040202				
Targhee Creek/ ID17040202SK034_02	Temperature	Yes	Move to section 4a	Shade lacking, stream temp exceedance
Targhee Creek/ ID17040202SK034_03	Temperature	Yes	Move to Section 4a	Unlisted but impaired for temperature
Timber Creek/ ID17040202SK035_02 ID17040202SK035_03	Temperature	Yes	Move to section 4a	Shade lacking, stream temp exceedance
Duck Creek/ ID17040202SK036_03	Temperature, Sediment	Yes	Move to section 4a	Shade lacking, stream temp exceedance; stream bank erosion
Icehouse Creek/ ID17040202SK044_02	Sediment	No	Move to section 2	Meets sediment target
Sheridan Creek/ ID17040202SK045_03	Sediment	Yes	Move to section 4a	Stream bank erosion
Willow Creek/ ID17040202SK046_04	Fish kills, Sediment	No	Move to section 2	Bioassessment shows no impairment
Lower Henry's 17040203				
Conant Creek (Squirrel Creek)/ ID17040203SK007_02 ID17040203SK007_03	E. coli; Combined biota/habitat bioassessments	Yes	Move to section 4a, delist combined biota/habitat bioassessment	Excess bacteria load, bioassessment shows no other impairments
1. Section 4a lists waters that are impaired but have TMDLs completed 2. Section 2 identifies “waters of the state attaining most standards”				

1. Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act (CWA). The goal of this act was to “restore and maintain the chemical, physical, and biological integrity of the Nation’s waters” (Water Environment Federation 1987, p. 9). The act and the programs it has generated have changed over the years, as experience and perceptions of water quality have changed.

The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure “swimmable and fishable” conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

1.1 Background

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

Section 303 of the CWA requires DEQ to adopt water quality standards and to review those standards every three years. Idaho’s water quality standards must be approved by the EPA. Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters that do not meet standards, DEQ must establish a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses.

Complying with these requirements results in a list of impaired waters, called the “§303(d) list.” This list describes water bodies that do not meet water quality standards. Waters identified on this list require further analysis. A subbasin assessment (SBA) and total maximum daily load (TMDL) provide a summary of the water quality status and allowable pollutant loads for water bodies on the §303(d) list. This document provides a summary for the currently listed waters in the Upper and Lower Henry’s Fork Subbasin.

The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, for each pollutant that is impairing a water body, a TMDL is an estimation of the maximum amount of that pollutant that can be present and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging those pollutants.

Some conditions that impair water quality do not receive TMDLs. The EPA does consider certain unnatural conditions, such as flow alteration, human-caused lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants to be “pollution.” However, TMDLs are not required for water bodies impaired by pollution but not by specific pollutants. A TMDL is only required when a pollutant can be identified and in some way quantified.

1.2 Idaho's Role

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

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

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

The Idaho legislature establishes designated uses for water bodies. By default, industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then CWAL and primary or secondary contact recreation are used as additional default designated uses when water quality is assessed for any water body.

This report entails analyzing and integrating multiple types of water body data, such as biological, physical, chemical, and landscape data, to address several objectives:

- Determine the degree to which the water body supports its designated beneficial uses water body (i.e., does it attain water quality standards or not)
- Determine the degree to which the water body achieves biological integrity
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources
- Determine the causes and extent of the impairment when water bodies are not attaining water quality standards

1.3 Subbasin Characterization

The Upper and Lower Henry's Fork subbasins are located in northeastern Idaho and are the origin of the Henry's Fork of the Snake River. The Upper Henry's subbasin encompasses 1,077 square miles (mi²) and the Lower covers 683.2 mi². Their hydrologic unit codes (HUCs) are 17040202 (Upper) and 17040203 (Lower). The division between them is the Ashton Reservoir: the Lower Henry's Fork subbasin comprises all water bodies below the Ashton Reservoir and the Upper Henry's Fork subbasin includes all waters above it. Figure 2 displays the Upper and Lower Henry's Fork subbasins and identifies the surface waters that are listed as impaired ("303(d)-listed") in the 2008 Integrated Report.

The majority of the land in these two subbasins is managed by the U.S. Forest Service (USFS). The economy of the region has historically been based on livestock grazing, timber production, and cultivated agriculture. Irrigated agricultural lands outside the subbasins are supplied with water stored in two reservoirs: Henry's Lake and Island Park. The Henry's Fork fishery has an international reputation among fly fishers, and anglers drawn to the area are increasingly important to the local economy.

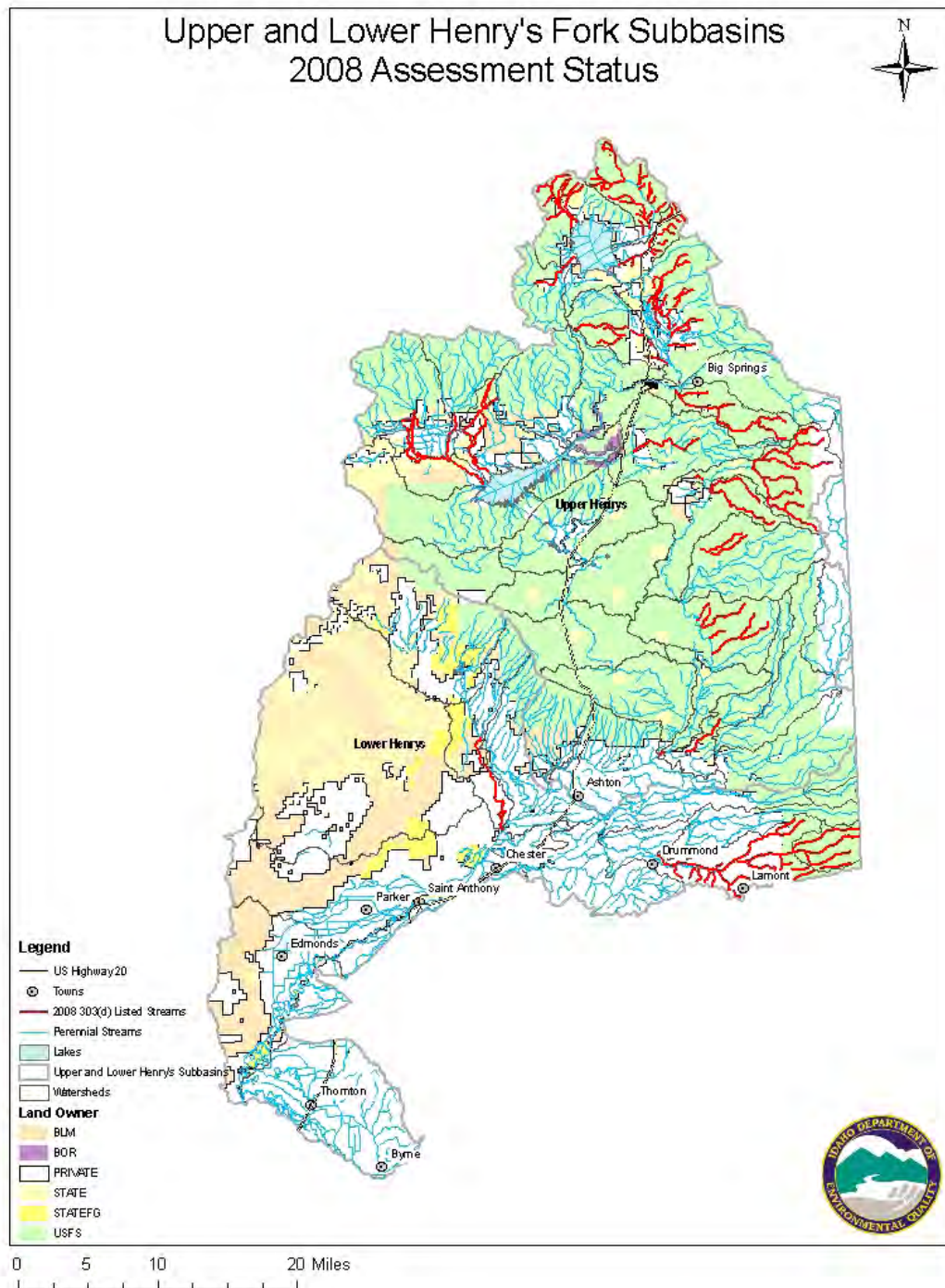


Figure 2. Upper and Lower Henry's Subbasins and 2008 Assessment Status.

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2. Water Quality Limited Assessment Units Occurring in the Subbasin

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

2.1 About Assessment Units

Assessment units (AUs) define all the waters of the state of Idaho. These units and the methodology used to describe them can be found in the water body assessment guidance (Grafe et al 2002).

Assessment units are groups of similar streams that have similar land use practices, ownership, or land management. Stream order, however, is the main basis for determining AUs; an AU remains the same even if ownership and land use change significantly.

Using AUs to describe water bodies offers many benefits, the primary benefit being that all the waters of the state are now defined consistently. In addition, using AUs fulfills the fundamental requirement of EPA's 305(b) report, wherein states report on the condition of all the waters of the state, which is required under the Clean Water Act. Because AU numbers are extensions of the water body identification numbers used in the water quality standards, there is now a direct tie to the water quality standards for each AU, so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

However, the new framework of using AUs for reporting and communicating needs to be reconciled with the legacy of 303(d)-listed streams. Due to the nature of the court-ordered 1994 303(d) listings, and the subsequent 1998 303(d) list, all segments were added with boundaries from "headwater to mouth." To deal with the vague boundaries in the listings, and to complete TMDLs at a reasonable pace, DEQ set about writing TMDLs at the watershed scale (HUC), so that all the waters in the drainage are and have been considered for TMDL purposes since 1994.

The boundaries from the 1998 303(d) listed segments have been transferred to the new AU framework, using an approach quite similar to how DEQ has been writing SBAs and TMDLs. All AUs contained in the listed segment were carried forward to the 2002 303(d) listings in Section 5 of the Integrated Report. The AUs not wholly contained within a previously listed segment, but partially contained (even minimally), were also included on the 303(d) list. This approach was necessary to maintain the integrity of the 1998 303(d) list and to maintain continuity with the TMDL program. These new AUs will lead to better assessment of water quality listing and de-listing.

When assessing new monitoring data that indicate full support, only the AU represented by the data will be removed (de-listed) from the 303(d) list (Section 5 of the Integrated Report.).

2.1.1 Listed Waters

Table 3 shows the pollutant or pollutants and the listing basis for each impaired AU in both Upper and Lower Henry's Fork subbasins. Not all of the water bodies require a TMDL, as will be discussed later; however, a thorough investigation using the available data was performed before this conclusion was made for any AU. This investigation, along with a presentation of the evidence of non-compliance with standards for several other tributaries, is contained in the following sections. The Beneficial Use Reconnaissance Program (BURP) protocol is DEQ's bioassessment method.

Table 3. Assessment units in the Upper and Lower Henry's Fork Subbasins listed as impaired waters in section 5 of the 2008 Integrated Report.

Water Body Name	Assessment Unit ID Number	2008 §303(d) Boundaries	Pollutants	Listing Basis
Upper Henry's 17040202				
Warm River	ID17040202SK002_05	Warm River Spring to mouth	Temperature	1998 EPA temperature addition
Warm River	ID17040202SK005_02	Source to Warm River Spring	Temperature	1998 EPA temperature addition
Buffalo River	ID17040202SK018_03	Source to Elk Creek	Combined Biota/Habitat Bioassessments	Low BURP score
Twin Creek	ID17040202SK030_02	Source to mouth	Combined Biota/Habitat Bioassessments	Low BURP score
Howard Creek	ID17040202SK033_02	Source to mouth	Temperature	1998 EPA temperature addition
Targhee Creek	ID17040202SK034_02	Source to mouth	Temperature	2002 Integrated Report
Timber Creek	ID17040202SK035_02	Source to mouth	Temperature	2002 Integrated Report
Timber Creek	ID17040202SK035_03	Source to mouth	Temperature	2002 Integrated Report
Duck Creek	ID17040202SK036_03	Source to mouth	Sediment/ Temperature	Low BURP score/1998 EPA temperature addition
Icehouse Creek	ID17040202SK044_02	Source to Island Park Reservoir	Sediment	Low BURP score
Sheridan Creek	ID17040202SK045_03	Kilgore Road to mouth	Sediment	Low BURP score
Willow Creek	ID17040202SK046_04	Source to mouth	Fish Kills/Sediment	Low BURP score
Lower Henry's 17040203				
Conant Creek (Squirrel Creek)	ID17040203SK007_02	Idaho/Wyoming border to mouth	Combined Biota/Habitat Bioassessments and fecal coliform	Bacteria Standards Violation

Water Body Name	Assessment Unit ID Number	2008 §303(d) Boundaries	Pollutants	Listing Basis
Conant Creek (Squirrel Creek)	ID17040203SK007_03	Idaho/Wyoming border to mouth	Combined Biota/Habitat Bioassessments	Low BURP score

Warm River, Howard Creek, Targhee Creek, Timber Creek, and Duck Creek are listed on the 2008 Integrated Report as impaired by temperature by EPA. EPA justified this listing based on instantaneous temperature measurements during Idaho’s beneficial use reconnaissance program (BURP) monitoring. Temperature TMDLs were done for these AUs as well as associated AUs that had been determined to be impaired by temperature in previous assessment cycles.

Buffalo River, Twin Creek and Conant Creek are listed for combined biota/habitat bioassessment. After further investigation, DEQ has determined the biota and habitat scored low in Buffalo River due to sediment and in Conant Creek due to bacteria. The bioassessment scores in Twin Creek show that all beneficial uses are being supported. Load allocations were calculated for sediment in Buffalo River and for *E. coli* in Conant Creek. Twin Creek will be moved to Section 2, “waters of the state attaining most standards,” of the 2010 Integrated Report because it fully supports all beneficial uses that have been assessed.

Icehouse Creek and Sheridan Creek are listed in section 5 of the 2008 Integrated Report for sediment. A sediment load allocation was calculated for Sheridan Creek, but data for Icehouse Creek show no impairment for sediment. Icehouse Creek will be moved to Section 2, “waters of the state attaining most standards,” of the 2010 Integrated Report because it fully supports all beneficial uses that have been assessed.

Willow Creek is listed for sediment, but DEQ’s investigation determined the low BURP scores were due to inappropriate site selection. Monitoring data showed no impairment for sediment, so DEQ did not complete a sediment TMDL for this stream. Willow Creek is also listed as impaired by “fish kills” on the 2008 §303d list. DEQ believes this is a listing error because no documented fish kill information was found and fish kills are not a cause but rather a symptom. Willow Creek will be moved to Section 2, “waters of the state attaining most standards,” of the 2010 Integrated Report because it fully supports all beneficial uses that have been assessed.

Conant Creek (named Squirrel Creek in the 2008 Integrated Report) is listed for combined biota/habitat bioassessments and fecal coliform due to elevated bacteria numbers in the 1997 BURP data. Conant Creek AUs ID17040203SK007_02 and ID17040203SK007_03 were sampled and had a geometric mean of 131 colony forming units per 100 mL (cfu/100mL) and a load allocation for *E. coli* was set in this document.

2.2 Applicable Water Quality Standards

The Upper and Lower Henry’s subbasins are comprised of 71 water body AUs; 14 of these AUs have been listed as not fully supporting beneficial uses in the current (2008) Integrated Report. Beneficial uses designated in these subbasins include cold water aquatic life, salmonid spawning, primary contact recreation, secondary contact recreation, domestic water supply, and special resource water.

2.2.1 Beneficial Uses

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

Existing Uses

Existing uses under the CWA are “those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards”. The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, .02.051.01, and .02.053). Existing uses include uses that are actually occurring, whether or not the level of quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

Designated Uses

Designated uses under the CWA are “those uses specified in water quality standards for each water body or segment, whether or not they are being attained.” Designated uses are those officially recognized by the state. In Idaho, these include uses such as aquatic life support, recreation, domestic water supply, and agricultural. For any given water body, more than one use may be designated and water quality must be maintained to fully support the most sensitive use. Designated uses may be added or removed using specific procedures in state law, but the effect must not be to preclude protection of an existing higher quality use. Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.003.27 and .02.109-.02.160, in addition to citations for existing uses).

Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses will be designated later. In the interim, and without information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called “presumed uses”, DEQ will apply the numeric 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 because of the requirement to protect levels of water quality for existing uses, the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature).

Presumed uses in the Upper and Lower Henry’s Fork subbasins include cold water aquatic life, salmonid spawning and secondary contact recreation. Designated uses in the subbasins include cold water aquatic life, salmonid spawning, primary and secondary contact

recreation, domestic water supply and special resource water. Table 4 displays the presumed or designated uses associated with each water body.

Table 4. Upper and Lower Henry's Fork Subbasins, beneficial uses of §303(d)-listed streams.

Water Body	Presumed Uses^a	Designated Uses
Warm River		CWAL, SS, PCR, DWS, SRW
Buffalo River		CWAL, SS, PCR, DWS, SRW
Twin Creek	CWAL, SS, SCR	None Listed
Howard Creek		CWAL, SS, SCR
Targhee Creek		CWAL, SS, SCR
Timber Creek	CWAL, SS, SCR	None Listed
Duck Creek		CWAL, SS, SCR
Icehouse Creek		CWAL, SS, SCR
Sheridan Creek		CWAL, SS, SCR
Willow Creek	CWAL, SS, SCR	None Listed
Conant Creek (Squirrel Creek)	CWAL, SS, SCR	None Listed

^a CWAL – Cold water aquatic life, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, DWS – domestic water supply, SRW- special resource water

2.2.2 Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for some pollutants, including sediment and *numeric* criteria for other pollutants including bacteria and temperature (IDAPA 58.01.02.250).

Excess sediment is described by narrative criteria (IDAPA 58.01.02.200.08): “Sediment shall not exceed quantities specified in Sections 250 and 252 or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Section 350.”

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.053. 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 the use of the most complete data available to make beneficial use support status determinations.

Table 5 includes the numeric criteria used in the analyses presented in this TMDL document.

Table 5. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards, IDAPA 58.01.02.250.

Designated and Existing Beneficial Uses				
Water Quality Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)
Bacteria	Less than 126 <i>E. coli</i> /100 ml ^a as a geometric mean of five samples over 30 days; no sample greater than 406 <i>E. coli</i> organisms/100 ml	Less than 126 <i>E. coli</i> /100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 <i>E. coli</i> /100 ml		
Temperature^b			22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °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	

^a *Escherichia coli* per 100 milliliters

^b Temperature Exemption - Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetyth percentile of the seven-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.

2.3 Pollutant/Beneficial Use Support Status Relationships

Most of the pollutants that impair beneficial uses in streams are naturally occurring stream characteristics that have been increased due to human alteration. That is, streams naturally have sediment and nutrients, but when anthropogenic sources cause these to reach unnatural levels, they are considered “pollutants” and can impair the beneficial uses of a stream.

2.3.1 Sediment

Both suspended sediment (floating in the water column) and bedload sediment (moving along the stream bottom) can have negative effects on aquatic life communities. Many fish species can tolerate elevated suspended sediment levels for short periods of time, such as during natural spring runoff, but longer durations of exposure are detrimental. Elevated suspended sediment levels can interfere with feeding behavior by causing difficulty in finding food due to visual impairment, damage gills, reduce growth rates, and eventually lead to death in extreme cases.

Newcombe and Jensen (1996) reported the effects of suspended sediment on fish, summarizing 80 published reports on streams and estuaries. For rainbow trout, physiological stress, which includes reduced feeding rate, is evident at suspended sediment concentrations of 50 to 100 mg/L when those concentrations are maintained for 14 to 60 days. Similar

effects are observed for other species, although the data sets are less reliable. Adverse effects on spawning and rearing habitat from sediment deposition were noted at similar concentrations of suspended sediment.

Organic suspended materials can also settle to the bottom and, due to their high carbon content, lead to low intergravel dissolved oxygen through decomposition.

In addition to these direct effects on the habitat and spawning success of fish, detrimental changes to food sources may also occur. Aquatic insects, which serve as a primary food source for fish, are affected by excess sedimentation. Increased sedimentation leads to a macroinvertebrate community that is adapted to burrowing, thereby making the macroinvertebrates less available to fish. Diversity of the aquatic macroinvertebrate community is diminished due to the reduction of coarse substrate habitat.

Settleable solids are defined as the volume (milliliters [ml]) or weight (milligrams [mg]) of material that settles out of a liter of water in one hour (Franson et al. 1998). Settleable solids may consist of large silt, sand, and organic matter. The amount of total suspended solids (TSS) is defined as the material collected by filtration through a 0.45- μ m (micrometer) filter (Standard Methods 1975, 1995). Settleable solids and TSS both contain nutrients that are essential for aquatic plant growth. Settleable solids are not as nutrient-rich as TSS, which typically includes smaller particles, but settleable solids do affect river depth and substrate nutrient availability for macrophytes. In low flow situations, settleable solids can accumulate on a stream bottom, thus decreasing water depth. This increases the area of substrate that is exposed to light, facilitating additional macrophyte growth.

2.3.2 Temperature

Temperature is a water quality factor integral to the life cycle of fish and other aquatic species. Different temperature regimes also result in different aquatic community compositions. Water temperature dictates whether a warm, cool, or cold water aquatic community is present. Many factors, natural and human-influenced, affect stream temperatures. Natural factors include altitude, aspect, climate, weather, riparian vegetation (shade), and channel morphology (width and depth). Human-influenced factors include heated discharges (such as those from point sources), riparian alteration, channel alteration, and flow alteration.

Elevated stream temperatures can be harmful to fish at all life stages, especially if they occur in combination with other habitat limitations such as low dissolved oxygen or poor food supply. Acceptable temperature ranges vary for different species of fish, with cold water species being the least tolerant of increased water temperatures. Temperature as a chronic stressor to adult fish can result in reduced body weight, reduced oxygen exchange, increased susceptibility to disease, and reduced reproductive capacity. Acutely high temperatures can result in death if they persist for an extended length of time. Juvenile fish are even more sensitive to temperature variations than adult fish, and can exhibit retarded growth rates at a lower threshold value than adults. High temperatures also affect embryonic development of fish before they even emerge from the substrate. Similar kinds of effects may occur to aquatic invertebrates, amphibians, and mollusks, although less is known about them.

2.3.3 Bacteria

Escherichia coli or *E. coli*, a species of fecal coliform bacteria, is used by the state of Idaho as the indicator for the presence of pathogenic microorganisms. Pathogens are a small subset of microorganisms such as bacteria, viruses, and protozoa, which, if taken into the body through contaminated water or food, can cause sickness or even death. Some pathogens are also able to cause illness by entering the body through the skin or mucous membranes.

Direct measurement of pathogen levels in surface water is difficult because pathogens usually occur in very low numbers and analysis methods are unreliable and expensive. Consequently, indicator bacteria, which are often associated with pathogens but which generally occur in higher concentrations and are thus more easily measured, are assessed.

Coliform bacteria are unicellular organisms found in feces of warm-blooded animals such as humans, domestic pets, livestock, and wildlife. Coliform bacteria are commonly monitored as part of point source discharge permits (National Pollution Discharge Elimination System [NPDES] permits), but may also be monitored in nonpoint source arenas. The human health effects from pathogenic coliform bacteria range from nausea, vomiting, and diarrhea to acute respiratory illness, meningitis, ulceration of the intestines, and even death. Coliform bacteria do not have a known effect on aquatic life.

Coliform bacteria from both point and nonpoint sources impact water bodies, although point sources are typically regulated under an NPDES permit and offer some level of bacteria-reducing treatment prior to discharge. Nonpoint sources of bacteria are diffuse and difficult to characterize. Unfortunately, nonpoint sources often have the greatest impact on bacteria concentrations in water bodies. This is particularly the case in urban storm water and agricultural areas. *E. coli* is often measured in colony forming units (cfu) per 100 ml.

3. Sources of Pollutants of Concern

Pollutants of concern include point sources, nonpoint sources, and pollutant transport, each of which is discussed in the following. Knowledge about these sources is constrained by gaps in the existing data, and the impact of such data gaps is discussed as well.

3.1 Point Sources

There are no discreet point sources of pollution, such as Superfund or Resource Conservation Recovery Act (RCRA) sites, in either the Upper or Lower Henry's Fork subbasins. Nor are there known unpermitted point sources in this area.

Point sources with National Pollution Discharge Permits (NPDES) include the City of Ashton and the City of St. Anthony wastewater treatment plants and the Fish and Game fish hatchery in Ashton, Idaho. The receiving waters for these facilities are not listed as impaired waters in the 2008 Integrated Report.

3.2 Nonpoint Sources

Land uses in the Upper and Lower Henry's Fork subbasins consist mainly of grazing and recreation. Nonpoint sources of pollution associated with these land uses include sediment delivery and increased temperature loading. This type of non point source pollution occurs over a wide area of the subbasins.

There is a direct relationship between stream bank erosion and loss of riparian vegetation. As stabilizing vegetation is removed, stream banks become unstable and bank erosion follows. As stream bank erosion progresses, depositional features form in the channel that redirect current and further reduce bank stability. This process continues until the stream forms a new floodplain and deposition forms new stream banks that become colonized with stabilizing vegetation. This process can take many years to play out once channel alteration begins.

In addition, as riparian vegetation is removed, the shade provided by the vegetation decreases, and stream banks often begin to erode. The reduction in shade further decreases the stability of stream banks and increases thermal loading to the stream. Channel morphology is highly influenced by land cover, or the lack of it, resulting in changes in bank stability, stream substrate composition, and sedimentation.

3.3 Pollutant Transport

The bulk of the sediment comes from stream bank erosion during several weeks of high spring streamflow. However, in some instances, the transport and delivery of pollutants within and between perennial streams is limited because of the lack of connectivity between streams; Some streams infiltrate the substrate or are diverted before they converge with other surface waters, even during snowmelt. Ground water transport of pollutants has not been shown to be a significant conduit of pollutants.

As riparian vegetation is removed from the stream, the stream cooling capability of the remaining vegetation is reduced, and solar radiation increases. Increases in stream

temperatures are cumulative where the conditions at a site allow further heating of already heated water.

3.4 Data Gaps

Additional data collection should include more quantitative trend monitoring related to interface areas between rangeland and riparian areas along perennial streams. The greatest risks would be from sediment inputs related to extreme hydrologic events and the cumulative impacts from stream bank erosion. Additionally, data related to trends in geomorphology and riparian vegetation physical structure would be useful to determine long-term risks associated with grazing. There is very little actual stream temperature data, so deploying continuous temperature loggers could help with understanding how shade, or lack of shade, influences actual stream temperatures.

4. Permitting and Status of Water Quality Improvements

Point source permits in Fremont County within Upper and Lower Henry's Fork subbasins include wastewater treatment plants in the cities of Ashton and St. Anthony and the Fish and Game fish hatchery in Ashton, Idaho. These facilities monitor constituents in their outflow that could affect surface water quality. The City of Ashton Wastewater Treatment Plant has a draft NPDES permit that will be issued. The City of St. Anthony Wastewater Treatment Plant received an updated NPDES permit (number ID-0020401) from EPA, effective December 1, 2009, for which the receiving water is Henry's Fork of the Snake River. Ashton Fish Hatchery discharges to Black Springs Creek, the receiving water, under permit number IDG-131011, which is covered by a general permit for aquaculture facilities subject to wasteload allocations. Black Springs Creek is not listed on the 303(d) list therefore the general permit for the Ashton Fish Hatchery has no effect on the TMDL. None of the receiving waters are listed as being water quality-impaired, so neither of these facilities will be given an individual wasteload allocation.

Watershed improvement projects in these subbasins include the Ashton Groundwater Protection Project funded in part by DEQ's watershed protection program. This project consists of providing groundwater protection education and application of watershed improvement projects. Nitrate load reductions are being evaluated in numerous areas around and near Ashton.

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5. Total Maximum Daily Load

A total maximum daily load (TMDL) prescribes an upper limit on discharge of a pollutant from all sources, to ensure water quality standards are met, known as a load capacity (LC). It 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 (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL. In practical terms, the margin of safety is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human made pollutant sources.

The relation of load capacity to amounts allowed for margin of safety, natural background amounts, and allocations for wasteloads and loads can be represented by this equation: $LC - MOS - NB - WLA(s) - LAs = 0$ or reserve

The equation's sum being equal to "0 or reserve" reflects the fact that either the entire load capacity amount is accounted for by the natural background plus the allocations and margin of safety; or an amount is reserved that can be allocated to any new sources that might come into existence later.

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: the necessary margin of safety is determined and subtracted; then natural background, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. Allocating the remainder among pollutant sources generally starts with any NPDES-permitted point sources if they are permitted to discharge a certain amount of the pollutant; typically, they are assigned that same amount as a wasteload allocation. After Wasteload allocations have been made for point sources, the remainder is allocated to any identified nonpoint sources. When the breakdown and allocation are completed, the result is a TMDL, which must equal the load capacity.

Another step in a load analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. 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, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period, 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 “other appropriate measures” to be used when necessary. These “other measures” must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow “gross allotment” as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads. However, due to recent court decisions, daily loads are also expressed.

5.1 Sediment TMDLs

Since sediment is a pollutant regulated by a narrative surface water quality criterion, numeric targets must be determined for each impaired AU. In this region of Idaho, 80% bank stability is used as a surrogate target for maintaining less than 30% subsurface fine sediment in salmonid spawning habitat. It is presumed that if this target is achieved, beneficial uses are supported.

5.1.1 In-stream Water Quality Targets

In-stream water quality targets are selected to restore full support of designated beneficial uses. Important considerations in target selection include critical periods, recovery time for the water body, and appropriateness of surrogate water quality targets.

Design Conditions

To quantify the seasonal and annual variability and critical timing of sediment loading, climate and hydrology must be considered. This sediment analysis characterizes sediment loads using average annual rates determined from empirical characteristics that developed over time within the influence of peak flow and base flow conditions. Annual erosion and sediment delivery are functions of a climate in which wet water years typically produce the highest sediment loads. Additionally, the annual average sediment load is not distributed equally throughout the year. Erosion typically occurs during a few critical months.

Methods for determining surrogate water quality targets based on stream bank erosion inventory are presented in Appendix C. These methods determine the existing sediment load, desired future sediment load, and monitoring needed to guide implementation of best management practices to restore full support of beneficial uses related to cold water aquatic life and salmonid spawning. The stream bank inventory is intended for waters determined to be degraded primarily by sediment or the combination of sediment and elevated temperature. The primary supposition is that as stream banks are managed for stability to meet the sediment target, the morphological and riparian changes involved will facilitate reduced thermal loading. The erosion inventory was developed to identify sediment loading at existing erosion rates and to identify future sediment loading that can be expected based on erosion rates predicted to occur after best management practices (BMPs) have been implemented.

Target Selection

Selection of sediment targets is dependent on existing narrative criteria of IDAPA

58.01.02.200.08. Sediment targets are based on surrogate targets of stream bank erosion quantitative allocations in tons/mile/year. The reduction in stream bank erosion prescribed in this TMDL is directly linked to expected improvement in riparian vegetation density that can armor stream banks and thereby reduce their lateral recession, which will cause trapping of sediment and reduction of stream energy, which in turn will reduce stream erosivity and in-stream sediment loading.

It is assumed reducing chronic sediment will decrease subsurface fine sediment and ultimately improve the status of beneficial uses. It is also assumed that, under natural background conditions, sediment loading rates from bank erosion equate to 80% bank stability as described in Overton and others (1995), where lineal footage of stream banks are expressed as a percentage of the total estimated bank length. Natural condition stream bank stability potential is generally 80% or greater for Rosgen A, B, and C channel types in plutonic, volcanic, metamorphic, and sedimentary geology types. Therefore, an 80% bank stability target based on stream bank erosion inventories shall be the target for sediment.

Surface erosion from unimproved/unsurfaced roads does not occur naturally; therefore, natural background sediment loading rates from road impacts are 0%. A target of 50% of the current loading has been established based on a reasonable expectation of reduced loading that can result from implementation of BMPs.

Unnatural size composition of streambed sediments can directly impair spawning success, egg survival to emergence, rearing habitat, and fish escapement from the stream. Research has shown that subsurface fine sediment composition is important to egg and fry survival (Hall 1986; Reiser and White 1988). It is necessary to reduce the component of subsurface fine sediment (defined as particles smaller than 6.35 mm in diameter) to below 28% of total subsurface sediment. This sediment particle size parameter should be considered as part of target monitoring to evaluate any significant shift in subsurface fine particle frequency distribution.

Monitoring Points

It is recommended that stream bank erosion inventories and other assessments be conducted on sediment-impaired streams to evaluate overall bank stability. Stream bank erosion assessments were made on the following locations:

- One reach was assessed near the mouth of Duck Creek
- Three reaches were assessed on Sheridan Creek—one on Harriman State Park land, one at an Idaho Department of Lands location, and another on Sheridan Ranch
- Willow Creek was assessed below the Yale/Kilgore Road
- Icehouse Creek was also assessed below the Yale/Kilgore Road

The monitoring points depicted in Figure 3 were assessed in September of 2008. Ten percent of the AU was assessed through stream bank erosion inventory. Extrapolation was then used from this assessed reach for the rest of the AU. This type of extrapolation was used for each 303(d) listed AU.

Data for these stream bank erosion inventories are provided in Appendix C.

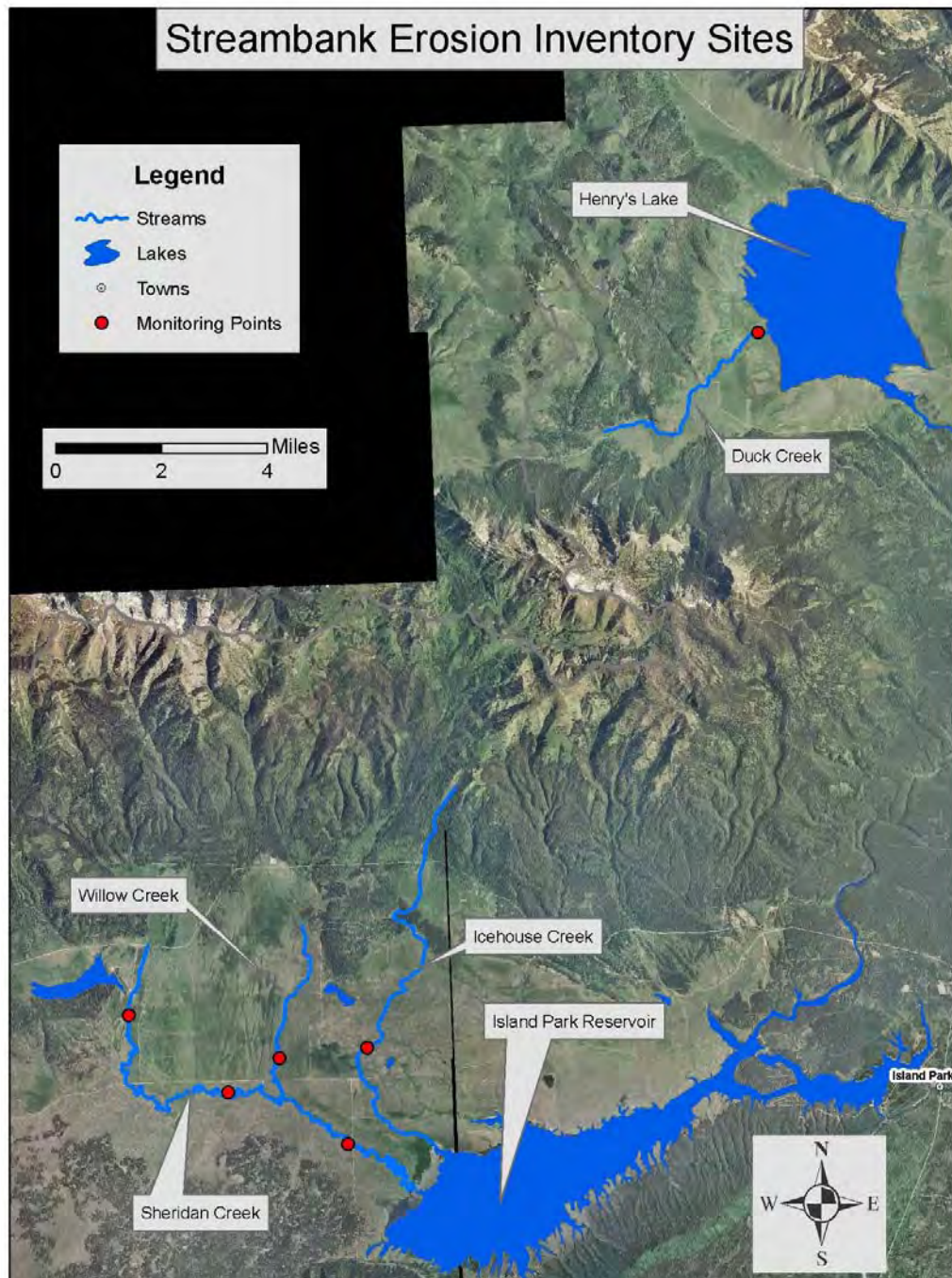


Figure 3. Stream bank Erosion Inventory Sites.

5.1.2 Load Capacity

A load capacity is “the greatest loading a water body can receive without violating water quality standards” (40 CFR §130.2.) This capacity must be at a level to meet “...water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge...” (Clean Water Act § 303(d)(C)). Likely sources of uncertainty include level of assimilative capacity, uncertainty about the relationship between selected targets and beneficial uses, and variability in target measurement. The load capacity for sediment from stream bank erosion shall be based on assumed natural stream bank stabilities of greater than or equal to 80% (Overton et al 1995). Because it is presumed that beneficial uses were or would be supported at natural background sediment loading rates, the loading capacity lies somewhere between the current loading level and sediment loading that would result from natural stream bank erosion.

- Natural background loading rates are not necessarily the loading capacities and adaptive management approach will be used to provide reductions in sediment loading based on best management practice (BMP) usage coupled with data collection and monitoring to determine the loading point at which beneficial uses are supported.
- The estimated capacity is directly related to the improvement of riparian vegetation density and structure as well as maintenance of roads and stream crossings. Increased vegetative cover provides a protective covering of stream banks, reduces lateral recession, traps sediment, and reduces erosive energy of the stream.

A large degree of uncertainty exists regarding the percentage of sediment loading that can occur before beneficial uses are no longer supported. It is difficult to determine a road erosion target at which beneficial uses would be supported. The load capacity for sediment from road erosion shall be an average annual load based on the assumption that BMP improvements will reduce sedimentation to an acceptable level. It is reasonable to suggest that beneficial use support may be obtained at a load capacity equal to one-half (50%) the current erosion rate.

5.1.3 Estimates of Existing Pollutant Loads

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

In the Upper Henry’s Fork subbasin, the primary source of sediment is bank erosion. Existing sediment loads were determined using the bank erosion inventory process. This method provides an estimation of erosion rates within the sampling reaches. The erosion rate was then used to calculate the current in-stream delivery of sediment within the system. Existing loads were determined using the average peak discharge volume and the average sediment concentration during the period when sediment loads are elevated by human-influenced factors (July through September).

5.1.4 Daily Sediment Load Allocations

The daily load sediment allocations were derived from historical flow data. Flow-weighted daily load allocations were generated from flow duration curves for five different flow averages including high flow, moist conditions, mid-range flows, dry conditions, and low flows. Figure 4 through Figure 6 illustrate the kind of flow curves used to determine sediment allocations. Data for the curves can be found in Appendix J .

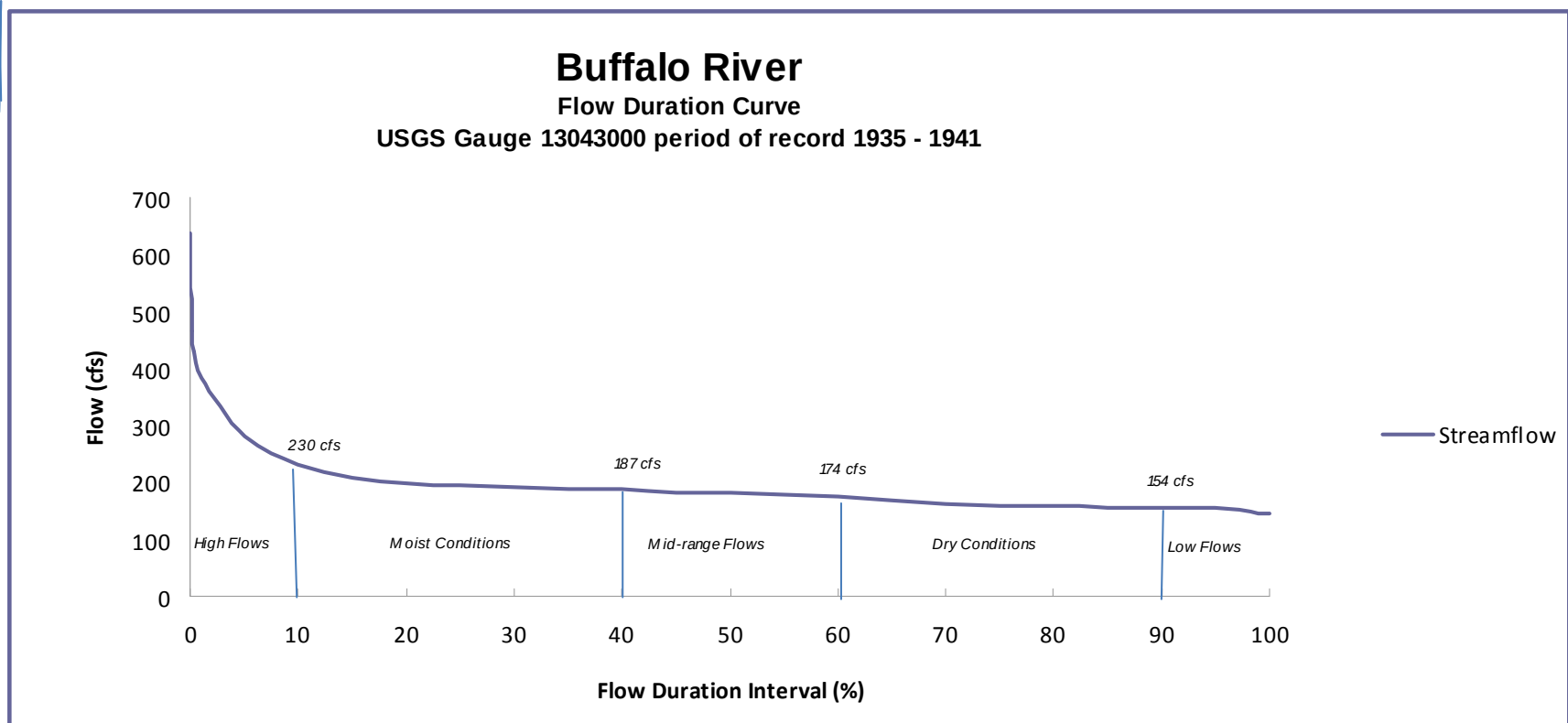


Figure 4. Buffalo River Flow Duration Curve.

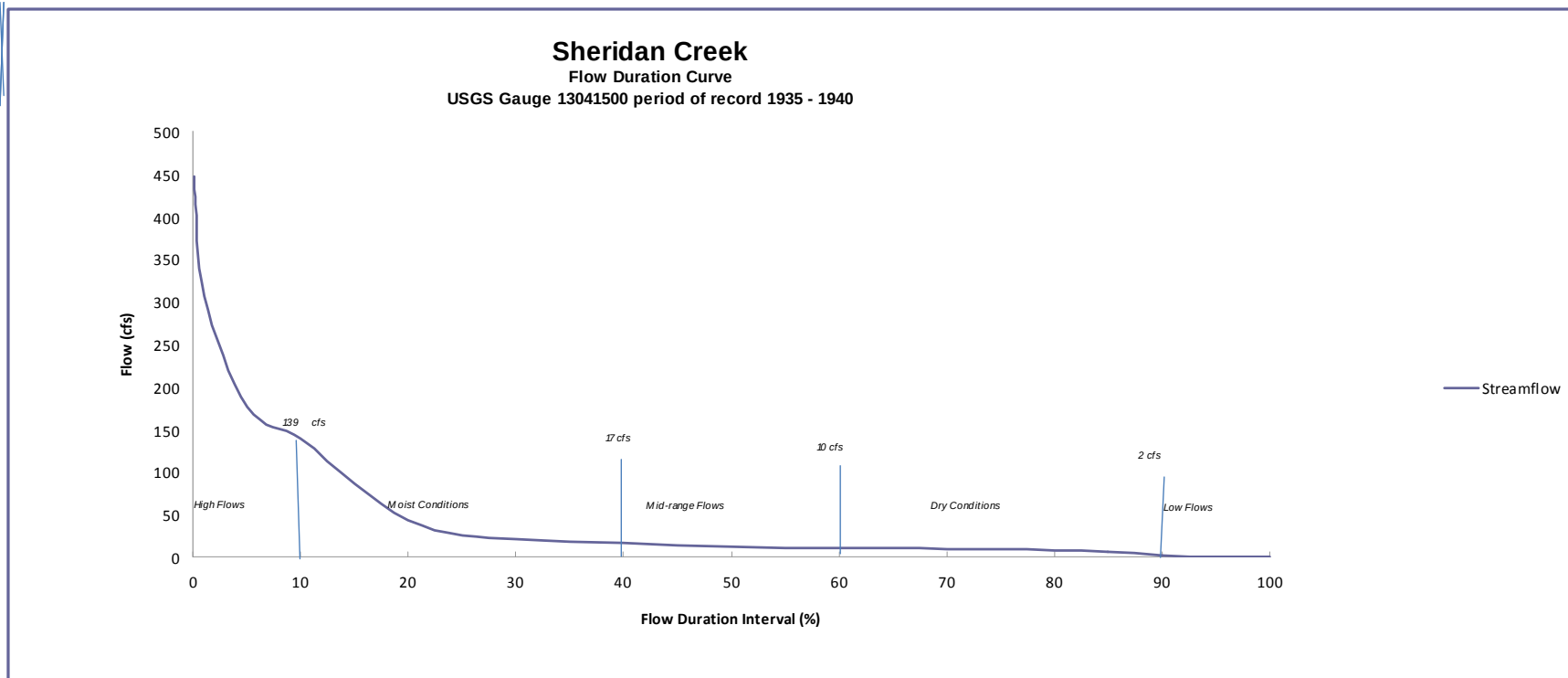


Figure 5. Sheridan Creek Flow Duration Curve

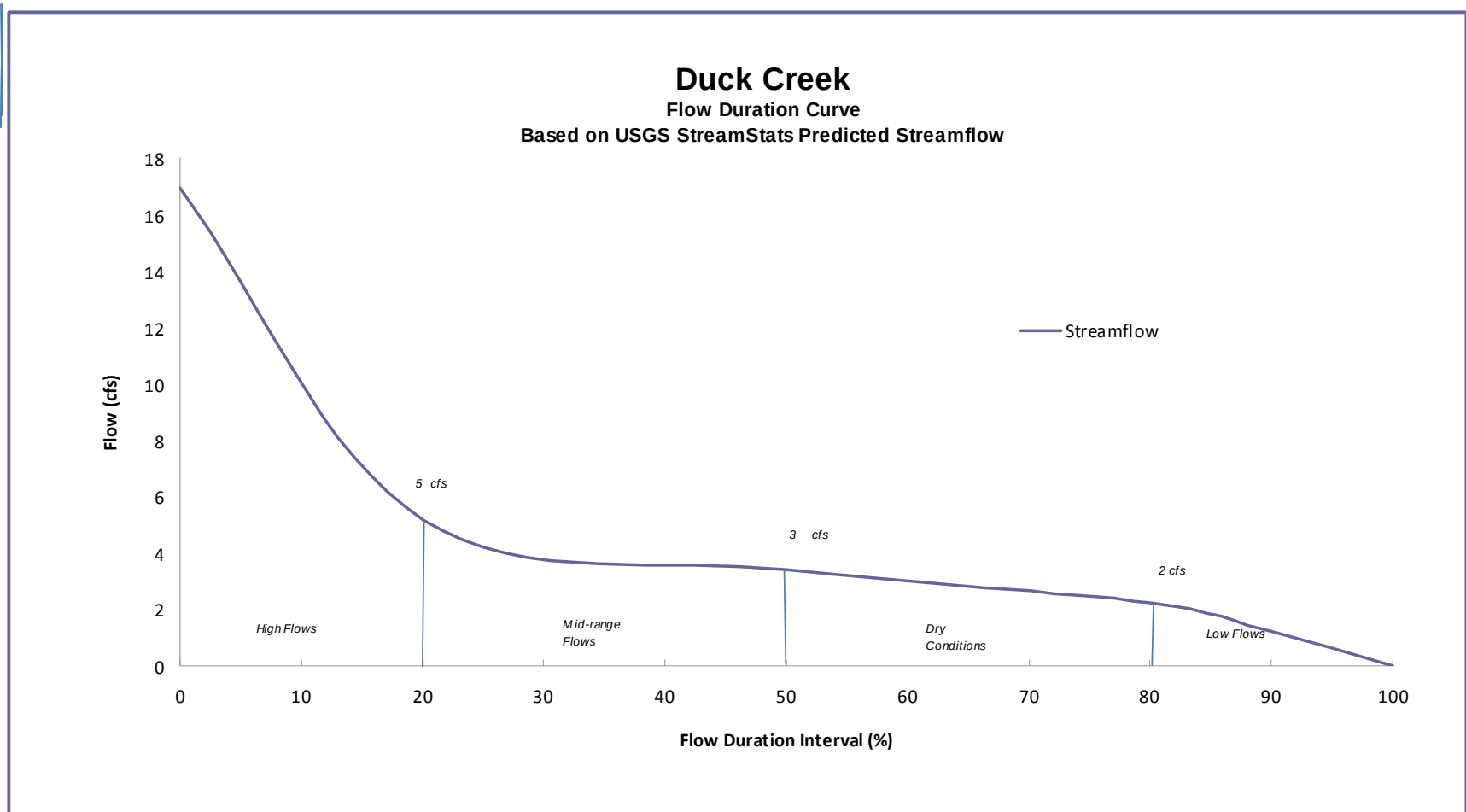


Figure 6. Duck Creek Flow Duration Curve

5.1.5 Wasteload Allocations

Ashton and St. Anthony Wastewater Treatment Plants are placed under effluent limitations and monitoring requirements for *E. coli* bacteria based on their NPDES permits. The Ashton facility permit is pending at this time. For St. Anthony, the current effluent limitation for total suspended solids is 300 pounds average monthly limit and 434 pounds average weekly limit. Eight-hour composite samples are taken two times per month. The wasteload allocation should remain at the technology based limit as the stream bank erosion is isolated and not influenced by point sources.

5.1.6 Load Allocations

For the Upper and Lower Henry's Fork Subbasins, sediment load allocations are shown in Table 6. The load allocation is the amount of loading capacity allocated to a given source that is not expected to result in exceedances of water quality criteria. Estimated existing pollutant loads for stream bank sediment are based on stream bank erosion inventories conducted by DEQ in 2008. Current sediment loading rates for streams in the Upper Henry's Subbasin are quantitatively estimated in tons/mile/year (t/mi/yr).

Table 6. Sediment load allocations for Upper Henry's Subbasin.

Stream/ Assessment Unit	CURRENT LOAD Existing Erosion Rate (t/mi/yr)	LOAD CAPACITY Erosion Rate (t/mi/yr)	LOAD REDUCTION REQUIRED Total Erosion Rate Reduction (t/mi/yr)	Total Erosion % Reduction to Meet Load Capacity
Buffalo River ID17040202SK018_03	23	4	19	83
Duck Creek ID17040202SK036_03	53	15	38	71
Sheridan Creek ID17040202SK045_03	25	5	20	80

DEQ has reached an agreement with the Forest Service for implementing road maintenance to improve stream bank stability in the entire watershed:

- The load allocation for Buffalo River was based on a half-mile reach where the width/depth ratio has been altered due to historical recreational access. A direct volume calculation of the eroding stream banks in the altered reach shows that the load allocation would be 18 tons of sediment per mile per year for a reduction to the load capacity of 4 tons of sediment per mile per year DEQ determined the river would be able to assimilate without impairing beneficial uses. Thus, a 76% reduction is needed in the Buffalo River watershed to meet the stream bank stability target.
- The load allocations for Duck Creek and Sheridan Creek were developed from stream bank erosion inventories conducted by DEQ, in accordance with methods outlined in Appendix C of this document. Duck Creek requires a 71% reduction in current loading to meet its load capacity, while Sheridan Creek requires a 79% reduction.

After stream bank erosion inventories and investigations were conducted on Icehouse and Willow Creeks (Table 7), DEQ determined that erosion from adjacent land use activities is not the source of the low BURP scores that precipitated the §303(d) listing. DEQ will move these AUs to Section 2 of the next Integrated Report cycle, for waters of the state attaining most standards. Significant erosion could occur before the streams in these AUs would exceed their load capacities. DEQ does not suggest the streams be subjected to this level of degradation, rather, DEQ relies on these data to support our claim that erosional sediment does not impair the streams and that these AUs are in full support of their beneficial uses.

Table 7. Current loading for Icehouse Creek and Willow Creek.

Stream	CURRENT LOAD Existing Erosion Rate (t/mi/yr)	LOAD CAPACITY Erosion Rate (t/mi/yr)	Total Erosion % Reduction to meet Load Capacity
Icehouse Creek ID17040202SK044_02	0.5	2	No reduction needed to meet TMDL target
Willow Creek ID17040202SK046_04	3	5	No reduction needed to meet TMDL target

Margin of Safety

The margin of safety (MOS) factored into sediment load allocations includes the conservative assumptions used to develop existing sediment loads. Conservative assumptions in the sediment loading analysis include that the desired bank erosion rates are representative of assumed natural background conditions. Additionally, the water quality target for subsurface fine sediment is consistent with values measured and is set by local land management agencies based on established values found in the literature, incorporating an adequate level of fry survival to provide for stable salmonid production.

Seasonal Variation

Seasonal variability was accounted for using annual average rates for runoff events and peak flow and base flow conditions. Stream bank erosion inventories assume most bank recession occurs during peak flow, when the banks are saturated. The estimated annual average sediment delivery is a function of bankfull discharge. It is assumed that the accumulation of sediment within dry channels is continuous until peak flow is reached again and the accumulated sediment is transported and deposited.

Load duration curves were not developed for the sediment TMDLs in these watersheds. Key components needed to develop meaningful load duration curves, such as relevant data, sets of flow measurements, and corresponding water quality information were not available. Commonly, USGS gage stations installed in the streams of interest, or in analogous streams, provide this data, but in the Upper and Lower Henry's subbasins, small streams do not have gages, and no streams analogous to the streams evaluated had gages. All USGS gages in these subbasins are on large rivers, such as the Henry's Fork, or are installed on rivers or lakes that are artificially manipulated for water delivery, such as the Henry's Lake Outlet.

However, Figure 7 displays hydrograph information for the Henry's Fork at St. Anthony. Note that even in the highly regulated system, peak flows, occur in May and June; therefore, associated peak stream bank erosion is expected during May and June. Base flow conditions, when erosion is expected to be least severe, occur August through January. The assumption can then be made that high water events related to snowmelt have a higher impact on sediment delivery than do storm events. While an individual daily estimate cannot be determined, the seasonality can easily be seen for the sediment TMDLs.

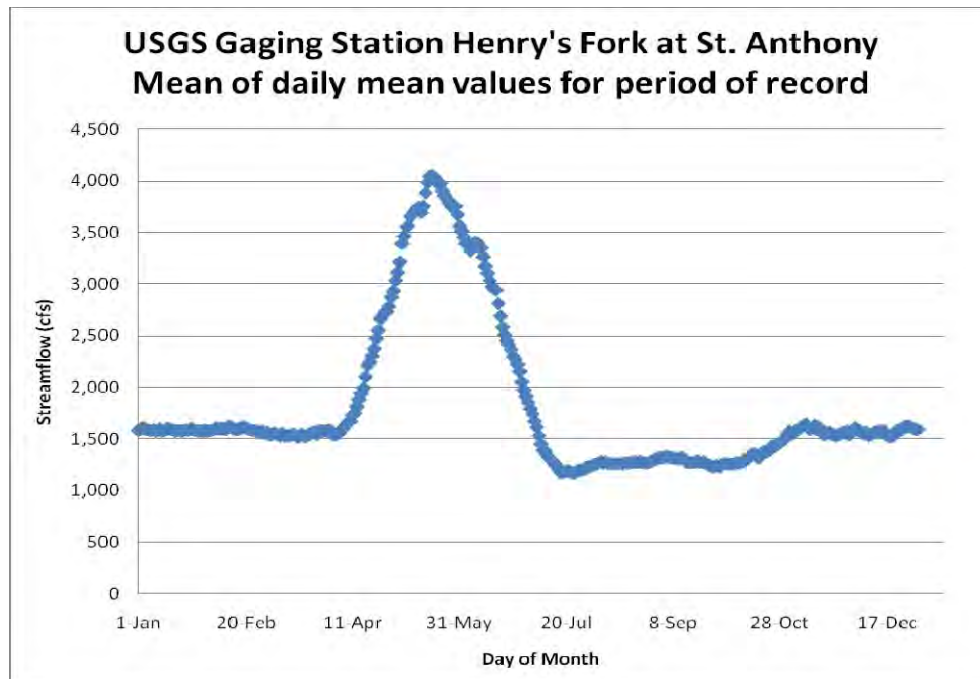


Figure 7. Mean of daily mean values of flow in the Henry's Fork at St. Anthony (USGS gage 13050500) for period of record from 1918 to 2008.

Reasonable Assurance

The reasonable assurance for each water body is based on the time when beneficial uses must be protected and when pollutant loads or the stress on the beneficial uses are the highest. Each TMDL was developed such that the water quality standards will be achieved year-round, yet the reasonable assurance defines when loading reductions must occur.

Background

Natural background loading rates are assumed to be the natural sediment loading capacity of 80% or greater stream bank stability and 28% or less subsurface fine sediment (Reiser and White 1988; Hall 1986). Therefore, natural background is accounted for in the load capacity.

5.2 Temperature TMDLs

Several streams identified by EPA as being impaired for temperature were added to Idaho's 1998 § 303 (d) list based on instantaneous measurements and limited data. Additional data was not available in most cases leading DEQ to complete temperature

TMDLs for all temperature listed streams as well as related unlisted reaches of the same stream.

DEQ utilizes a method for estimating shade and the daily heat load that will bring the stream back to its “potential natural vegetation” state, thus mimicking the best achievable water quality condition. The potential natural vegetation (PNV) approach was used for the Upper Henry’s Fork temperature TMDLs. The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09), which establishes that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered to be a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and the natural level of shade and channel width become the target of the TMDL. The instream temperature that results from attainment of these conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria.

See Appendix B for further discussion of water quality standards and background provisions.

5.2.1 In-stream Water Quality Targets

The procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in this section. For a more complete discussion of shade and its effects on stream water temperature, the reader is referred to the *South Fork Clearwater Subbasin Assessment and TMDL* (IDEQ, 2004) and *The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual* (Shumar and De Varona, 2009).

Potential Natural Vegetation for Temperature TMDLs

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 likely to be controlled or manipulated. The parameters that affect or control 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 affects how closely together the riparian vegetation grows and the amount of water stored in the alluvial aquifer. Streamside vegetation and channel morphology are factors influencing shade that are most likely to have been influenced by human-influenced activities, and which can be most readily corrected and addressed by a TMDL.

Depending on how much vertical elevation also surrounds the stream, vegetation further away from the riparian corridor may provide shade; however, riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. We can measure the amount of shade that a stream enjoys in a number of ways. Effective shade, the shade provided by all objects that intercept the sun as it makes its way across the sky, can be measured in a given spot with a solar pathfinder or with 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 the stream’s 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 on aerial photographs. All of these methods tell us information about how much the stream is covered and how much of it is exposed to direct solar radiation.

Potential natural vegetation (PNV) along a stream is the riparian plant community that has grown to an overall mature state, although some level of natural disturbance is usually included in our development and use of shade targets. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural level of solar loading to the stream without any anthropogenic removal of shade producing vegetation. Anything less than PNV results in the stream heating up from anthropogenically created additional solar inputs.

We can estimate PNV from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving and what potential there is to decrease solar gain. Streams disturbed by wildfire require their own time to recover. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery.

To estimate existing shade for five streams in the Upper Henry's Fork subbasin, we made visual observations of aerial photos. These estimates were field-verified by measuring shade with a solar pathfinder at systematically located points along the streams (see below for methodology).

PNV targets were determined by determining what vegetation (and vegetation communities) would probably exist under natural conditions at the streams and comparing that to shade curves developed for streams where similar vegetation communities are present. A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. As the vegetation (plant community) gets taller, the more shade the plant community is able to provide at any given channel width.

Existing shade and PNV shade values were converted to solar load values using data collected on flat plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations—in this case, an average of the values recorded at the Pocatello, Idaho and Helena, Montana stations was used. The difference between existing solar load and potential solar load, assuming existing load is higher, is the amount of load reduction necessary to bring the stream back into compliance with water quality standards (see Appendix B).

PNV shade and loads are assumed to be the natural condition; thus, stream temperatures under PNV conditions are assumed to be natural (so long as there are no point sources or any other human-influenced sources of heat in the watershed) and are thus considered to be consistent with the Idaho water quality standards, even though they may exceed numeric criteria.

Pathfinder Methodology

The solar pathfinder is a device that shows the shadow outline of shade-producing objects on monthly solar path charts, allowing the user to trace the outline. Once the outline is traced, the percentage of the sun's path covered by these objects, which is the effective shade on the stream at the spot where the tracing is made, can be identified. To adequately characterize the effective shade on a reach of stream, ten traces should be taken at systematic or random intervals along the length of the stream in question.

At each sampling location, the solar pathfinder should be placed in the middle of the stream about the bankfull water level. Follow the manufacturer's instructions (orient to south and level) for taking traces. Systematic sampling is easiest to accomplish and still not bias the location of sampling. Start at a unique location such as 50 to 100 m from a bridge or fence line and then proceed upstream or downstream, stopping to take additional traces at fixed intervals (e.g., every 50m, every 50 paces, etc.). One can also randomly locate points of measurement by generating random numbers to be used as interval distances.

It is a good idea to measure bankfull widths and take notes while taking solar pathfinder traces, and to photograph the landscape of the stream at several unique locations. Pay special attention to changes in riparian plant communities and what kinds of plant species (the large, dominant, shade-producing ones) are present. Additionally, or as a substitution, one can take readings from a convex and/or concave densiometer at the same locations as solar pathfinder traces are made. If both are used, it provides the potential for developing relationships between canopy cover (based on concave densiometer readings) and effective shade (based on solar pathfinder traces) for a given stream.

Aerial Photo Interpretation

For estimates of shade level, the stream is not divided into uniform lengths, instead it is divided between natural breaks in vegetation density, based on plant type and density, and these segments are marked out on a 1:100K or 1:250K hydrography. Each stream segment (interval) is assigned a single-integer value representing the bottom of a 10%-shade class, as described below (adapted from the *CWE process*, IDL, 2000). For example, if the estimate of shade for a particular stream segment is somewhere between 50% and 59%, we assign the value of 50% to that segment. The estimate is based on observations about the kind of vegetation present, its density, and the width of the stream. Streams where the banks and water are clearly visible usually are in low-shade classes (10 to 30%). Streams with dense forest or heavy brush where no portion of the stream is visible usually are in high-shade classes (70 to 90%). More open canopies, where portions of the stream may be visible, usually fall into moderate-shade classes (40 to 60%).

It is important to note that the visual estimates made from the aerial photos are strongly influenced by canopy cover. It is not always possible to visualize or anticipate shade characteristics resulting from topography and landform. The estimate of shade made visually from an aerial photo does not always take into account topography or any shading that may occur from physical features other than vegetation. Our assumption that canopy cover and shade measurements are remarkably similar is based on research conducted by Oregon DEQ (OWEB 2001), reinforcing the idea that riparian vegetation

and objects proximal to the stream provide the most shade. The visual estimates of shade used in this TMDL are field-verified with a solar pathfinder. The pathfinder measures effective shade and accounts for other physical features that block the sun from hitting the stream surface (e.g. hillsides, canyon walls, terraces, man-made structures).

Stream Morphology

Measures of current bankfull width or near-stream disturbance zone (NSDZ) width may not reflect widths that were present under PNV conditions. As impacts to streams and riparian areas occur, streams become wider and shallower, which is reflected in increased width-to-depth ratios. Shadow length 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 been eroded away.

The only factor used in developing this TMDL that was not developed from the aerial photo interpretation methods described above is channel width (i.e., the NSDZ value or Bankfull Width value). Therefore, this parameter must be estimated from available information, so we primarily use regional curves (Figure 8) for the major basins in Idaho, based on data compiled by Diane Hopster of Idaho Department of Lands.

For each stream evaluated in the loading analysis, we compared its drainage area to the corresponding drainage area for the Upper Snake and Salmon Basin curves from Figure 8 to find a curve-based estimate of bankfull width. The Upper Snake regional curve produced estimates of bankfull width that were smaller than those produced by the Salmon Basin curve. The meadow-dominated streams such as Duck Creek, Howard Creek, Timber Creek, and upper Warm River tended to have existing widths similar to the Upper Snake curve. Lower Warm River and the forest-dominated Targhee Creek were more similar to the Salmon Basin curve. The lower portion of Warm River is heavily influenced by large springs that double the river's volume. Lower Warm River is larger, and is similar to streams in the Salmon basin than it is to streams in the drier Upper Snake basin.

Additionally, existing width as measured in the field is evaluated from available data, to see whether curve-based estimated width or existing width as measured should be used as natural width in the loading analysis. If the stream's existing width is equal to or wider than that predicted by the regional curves examined in Figure 8, then the curve-based estimate of bankfull width is used in the loading analysis for natural width. If existing width is smaller, then existing width is used in the loading analysis for natural width. For Duck Creek, Howard Creek, Timber Creek, and upper Warm River existing estimates of bankfull width were as small as or smaller than those values estimated based on the Upper Snake curve (Table 8). Thus, existing widths were used in the loading analysis for natural width in these areas. For Targhee Creek and lower Warm River, the estimates based on the Salmon Basin curve were as small as or smaller than existing widths and were used in the loading analysis for natural width.

Table 8. Bankfull widths for streams evaluated based on Upper Snake (US) and Salmon (Salm) Basin regional curves and from existing measurements.

Location	area ¹ (sq mi)	US (m)	Salm (m)	existing (m)
Targhee Creek @ mouth	21.6	6	10	10
Duck Creek @ mouth	17.3	5	9	5.1
Warm R. ab Partridge Cr.	70.4	10	15	8
Warm R. bl Partridge Cr.	115.6	13	18	10.2
Warm R. bl Moose Cr.	159.2	15	21	~26
Warm R. ab Robinson Cr.	175.9	15	21	~24
Warm R. @ mouth	300.3	19	26	~32
Howard Creek @ mouth	7.3	4	6	4.3
Timber Creek @ mouth	9.9	4	7	1.2

1. Area = drainage area

Data indicated as approximate (~) are estimated from aerial photos.

Idaho Regional Curves - Bankfull Width

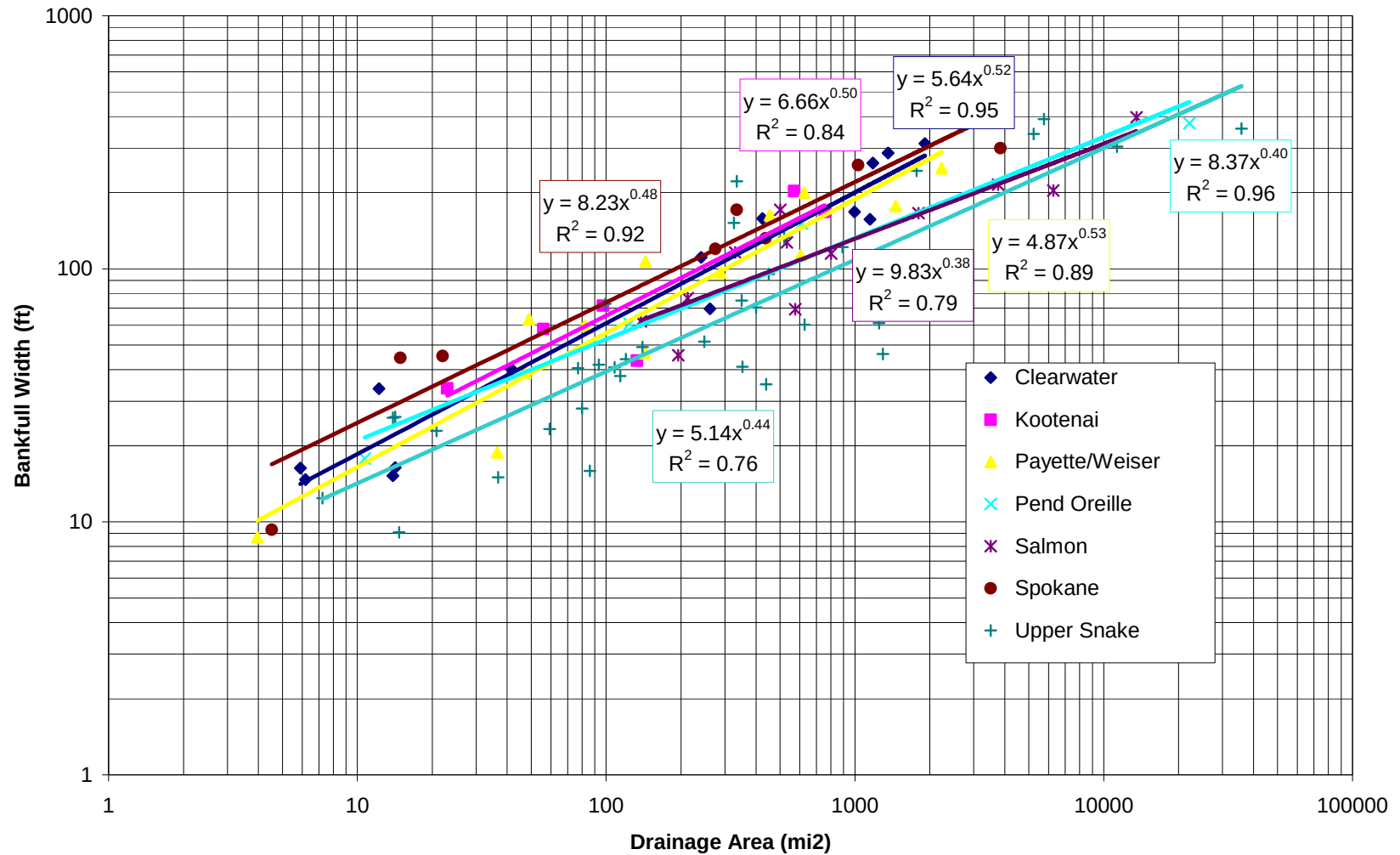


Figure 8. Bankfull width as a function of drainage area.

Design Conditions

Each stream evaluated in this subbasin is somewhat different regarding the combination or sequence of riparian plant communities. To determine appropriate shade targets for these streams, we evaluated the locations of various ecological units as described by the Targhee National Forest Ecological Unit Inventory (Bowerman et al., 1999). We have developed shade curves for these specific Targhee ecological units based on species compositions (cover and constancy data) provided in the inventory (see Shumar and De Varona, 2009).

Howard Creek had perhaps the most diverse set of vegetation types of the four Henry's lake tributaries examined. Howard Creek originates as a capped spring in a mixed coniferous forest near Highway 20. This headwaters location is within a cool, subalpine fir forest known as Ecological Unit (EU) #1594. After a short distance, the stream crosses under the highway and transitions to a more open willow/meadow type where trees are fewer and grasses and low shrubs dominate the understory. Often these meadows contain beaver ponds or are of multiple channels. The upland portion of this region of Howard Creek is described as the Douglas fir/sagebrush EU#1760 (Bowerman et al., 1999). However, the riparian area which was not described separately is more similar to the grass/willow riparian community of EU#2020. We have classified this middle portion of Howard Creek as #2020 until it reaches the willow/grass meadow (EU#2606) area that surrounds the lake.

Duck Creek was evaluated from the confluence of the NF Duck Creek and SF Duck Creek to Henry's Lake. Duck Creek contains primarily willow riparian communities of medium stature, although there are more grass dominated-shrub meadow stretches closer to the lake shoreline. We have classified Duck Creek below the forks entirely as willow/grass EU#2606, consistent with the Targhee ecological unit inventory.

Timber Creek is considerably smaller than the other streams, and the upper half of the stream showed a dry ephemeral channel. Timber Creek originates as springs and seeps lower down in grass/shrub meadows closer to Henry's Lake. This portion of Timber Creek is also completely within the willow/grass EU#2606.

Targhee Creek is in a roadless, mixed coniferous forest-dominated area near the border with Montana. The creek originates in an alpine lake and there are reaches that alternate between meadow and forest vegetation. Near its outlet into Henry's Lake, Targhee Creek passes through deciduous shrub vegetation of a taller stature and may contain some aspens or cottonwoods. According to the ecological unit inventory Targhee Creek alternates between the spruce riparian unit EU#2609 and the willow/grass unit EU#2606.

Warm River is a long stream that extends some 26+ miles from the Island Park area to just east of Ashton, Idaho. The upper half of the stream flows through slow moving meadows that are often dominated by beaver ponds. These meadows seem to alternate between wide open shrub meadows where the forest is some distance away from the stream to meadows that are more narrow and the coniferous forest (mostly lodgepole pine) plays more of a role in casting shadows on the stream. Warm River begins in cool, moist whitebark pine/subalpine fir forest (EU#1225), then extends into cool lodgepole pine forest (EU#1700) and lodgepole pine riparian (EU#2040). As the river widens it leaves the lodgepole pine riparian to briefly pass through a section of grass/willow (EU#2020) to more willow dominated EU#2606. The lower half of the river is in canyon with conifers on the canyon hillsides and grass meadows dominating the near-stream vegetation. In this canyon, region the forested topography plays

the dominant role in providing shade on the river; thus, shade is provided by a warm subalpine fir/Douglas fir forest type (EU#1224).

Target Selection

To determine potential natural vegetation shade targets for the five streams evaluated, effective shade curves developed specifically for the above-mentioned ecological units as described in Shumar and De Varona (2009) were employed. These shade curves, presented in Appendix E, were developed from vegetation community modeling of cover and constancy data provided by Bowerman et al. (1999). Effective shade curves include the shade percentage (“percent shade”) on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation type loses its ability to shade wider and wider streams.

Shade Curves

Shade curves for the various ecological units (EUs) are presented in Appendix E. The Targhee Ecological Units encountered in this analysis are described below in numerical order.

EU#1224 is found on dissected tablelands in the warm portion of the forested zone (Bowerman et al., 1999). The topography is described as a parallel pattern of summits with rolling to hilly slopes and incised drainages with short, steep sideslopes. Subalpine fir/blue huckleberry is the dominant potential natural vegetation with some Douglas fir/whortleleaf snowberry and mountain big sagebrush types typical on south-facing slopes and shoulders. Vegetation data that was used to develop the shade curve were dominated by lodgepole pine, subalpine fir, and Douglas fir (Shumar and De Varona, 2009). Common shrubs included snowberry, Utah honeysuckle, and ceanothus.

EU#1225 is found on escarpments of plateaus in the cold, moist portion of the forested zone (Bowerman et al., 1999). This landscape is steep with closed canopy forests. Low spur ridges and shallow draws dissect sideslopes in a parallel pattern. Potential natural vegetation is dominated by whitebark pine and elk sedge or grouse whortleberry. Subalpine fir/grouse whortleberry is also common on north-facing slopes and all footslopes. Vegetation data show that lodgepole pine, Utah honeysuckle, and graminoids are the dominant shade-producing plants in this landscape (Shumar and De Varona, 2009).

EU#1594 is a subalpine fir/blue huckleberry PNV-dominated landscape on foothills, mountains, dissected tablelands, and plateau escarpments in the cool portion of the forested zone (Bowerman et al., 1999). Douglas fir/common snowberry also occurs as potential natural vegetation on south-facing slopes. Douglas fir, lodgepole pine and subalpine fir all contribute to shade in the PNV data (Shumar and De Varona, 2009).

EU#1700 is an ecological unit found on dissected tablelands in the cool portion of the forested zone (Bowerman et al., 1999). Summits are dominated by subalpine fir/grouse whortleberry PNV and lodgepole pine with pinegrass, elk sedge, or grouse whortleberry are in the bottoms of drainageways. Lodgepole pine and various willows are the dominant shade-producing plants (Shumar and De Varona, 2009).

EU#1760 is found on alluvial fans and stream terraces in a narrow transition zone between cool, moist portions of the shrub steppe zone and cool forested regions (Bowerman et al.,

1999). The potential natural vegetation in this landscape is an ecotone of Douglas fir/whortleleaf snowberry, mountain big sagebrush/Idaho fescue, and subalpine big sagebrush/California brome. Shade would be produced primarily by Douglas fir, snowberry, and mountain big sagebrush without any typical riparian shrubs (e.g., willows). Although mapped for the middle reaches of Howard Creek, we have chosen to use EU#2020 instead for that region because of its present day domination by willows and grasses.

EU#2020 is found on moist outwash plains in the cool portion of the forested zone (Bowerman et al., 1999). Streams through this landscape are typically low gradient (C3 or C4 Rosgen type), perennial, with a wide range in widths and beaver pond presence. The potential natural vegetation community is either graminoid (grass and sedge)-dominated or willow/grass-dominated. Some lodgepole pine communities can also occur as inclusions on higher elevation gravel bars. The shade-producing vegetation is dominated by various willows including Geyer's willow and plainleaf willow, bog birch, and graminoids (Shumar and De Varona, 2009).

EU#2040 is also located on moist outwash plains in the cool portion of the forested zone (Bowerman et al., 1999). The topography is described as nearly level to undulating stream terraces and overflow channels that are typically dominated by conifers and grasses. The potential natural vegetation is predominantly lodgepole pine and either pinegrass, elk sedge, or grouse whortleberry. Also common are subalpine fir/bluejoint grass and willow/grass dominated riparian areas. The dominant shade-producing vegetation includes lodgepole pine, Bebb's willow, and graminoids (Shumar and De Varona, 2009).

EU#2606 is a riparian unit dominated by willows and grasses (Bowerman et al., 1999). It is found throughout the shrub steppe and forested zones on moist floodplains. The topography can be flat bottom valleys with low to moderate gradient, narrow to broad width floodplains in foothills, and dissected tablelands. Channel incisement and beaver activity strongly influence the hydrology of these systems. The dominant shade-producing vegetation include Booth's willow, Geyer's willow, Drummond's willow, coyote willow, Lemmon's willow, and graminoids (Shumar and De Varona, 2009).

EU#2609 is a forested riparian unit on cold, moist floodplains (Bowerman et al., 1999). These systems are typically higher gradient with narrow U-shaped valleys. Streams can be small with intermittent to perennial flow, seasonally variable and snow-melt driven. The potential natural vegetation is primarily Engelmann spruce with fragrant bedstraw or field horsetail, or occasionally subalpine fir/bluejoint grass. The shade-producing vegetation is primarily Engelmann spruce with some subalpine fir, lodgepole pine, and Douglas fir. Shrubs typically include mountain alder, Drummond's willow, Bebb's willow, serviceberry, dogwood, and a variety of smaller shrubs (Shumar and De Varona, 2009).

Monitoring Points

The accuracy of the aerial photo interpretations was field-verified with 103 solar pathfinder traces at 15 sites. Five sites on upper Warm River showed that the original aerial photo interpretation was too high by about two 10% classes, with an average difference between photo estimate and field-verified value at $20\% \pm 3.58$ (mean $\pm$ 95% C.I.). Verification at three sites on lower Warm River was more consistent, at $-3\% \pm 2.92$ (mean $\pm$ 95% C.I.). Aerial photo interpretation averaged a little high, at slightly more than one 10% class, on Howard Creek, with a difference of $12\% \pm 5.54$ (mean $\pm$ 95% C.I.). Duck Creek and Targhee

Creek had only one field-verification site each. The photo-based estimate at Duck Creek was 20% greater than the field-verified value; however, the photo-based estimate at the Targhee Creek site was verified correct by the pathfinder. With the exception of lower Warm River and Targhee Creek, all other aerial photo-based estimates had to be reduced to match field-verified measurements. Existing shade estimates presented in this document represent these adjusted shade values.

Future monitoring of effective shade can be conducted on any reach throughout the Henry's Fork tributaries and the results can be compared to estimates of existing shade seen on Figure 10 and Figure 13 and described in Table 9 through Table 13. Those areas with the largest disparity between existing shade estimates and shade targets should be monitored with solar pathfinders to verify or correct the existing shade estimates and to determine progress toward meeting shade targets. It is important to note that many existing shade estimates have not been field-verified, and may require adjustment during the implementation process. There is no uniform length for the stream segments that have been assigned different estimated shade levels, rather, they vary in length depending on land use or landscape that has affected the shade level. It is appropriate to monitor within a given existing shade segment to see if existing shade in that segment has increased toward the target level. Solar pathfinder measurements taken at ten equally-spaced intervals within a segment and averaged together should suffice to determine new shade levels in the future.

5.2.2 Load Capacity

Next, for each stream, you will enter solar load values corresponding to each existing and target shade percentage into the load analysis table. These load values are determined by multiplying the solar load recorded on a flat plate collector (under full sun), for a given period, by the fraction of the solar radiation that is not blocked by shade. The fraction of solar radiation not blocked by shade is the "percent open," and is equal to 100% minus the "percent shade" ($\%open = 100\% - \%shade$). In other words, if a shade target level is 60% (or 0.6), then the solar load that would hit the stream (the percent open) under that target is 40% (or 0.4) of the total possible solar load (as recorded on the flat plate collector).

In our TMDL load analyses, we use solar load data recorded on a flat plate collector under full sun (i.e., no portion of the plate is shaded) at the nearest National Renewable Energy Laboratory (NREL) weather station that collects and reports these data. In this case, average data from the Pocatello, Idaho and Helena, Montana stations was used. The solar loads used in this TMDL are spring/summer averages; thus, we use an average load for the six-month period from April through September. These months coincide with the part of the year that stream temperatures are increasing and when deciduous vegetation is in leaf. Table 9 through Table 13 and Figure 9 and Figure 12 show the PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer loads, expressed both on an area bases ($kWh/m^2/day$) and as a total load (kWh/day), that serve as the load capacities for the streams.

The effective shade calculations are based on the same six-month period from April through September, which coincides with the critical time period when temperatures affect beneficial uses such as spring and fall salmonids spawning and when cold water aquatic life criteria may be exceeded during summer months. The period from late July through early August typically represent a period of highest stream temperatures. Solar gains can begin early in the

spring and affect not only the highest temperatures reached later on in the summer, but this solar loading can affect salmonids spawning temperatures in spring and fall. Thus, solar loading in these streams is evaluated from spring (April) to early fall (September).

Load capacities varied from just a little over 3 million kWh/day for 26m-wide Warm River to as low as 15,967 kWh/day on 2m-wide Timber Creek.

5.2.3 Estimates of Existing Pollutant Loads

Existing loads in this temperature TMDL are based on estimates of existing shade as determined from aerial photo interpretations. Like target shade, existing shade was converted to a solar load by multiplying the fraction of stream that is open (the “percent open”) by the solar radiation recorded on a flat plate collector at the NREL weather stations. Existing shade data are presented in Table 9 through Table 13 and Figure 10 and Figure 13. Like load capacities (potential loads), existing loads in Table 9 through Table 13 are presented on an area basis (kWh/m²/day) and as a total load (kWh/day).

Existing and potential 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. The difference between potential load and existing load is also summed for the entire table. Should existing load exceed potential load, this difference becomes the excess load to be discussed next, in the load allocation section.

Table 9. Existing and potential solar loads for Duck Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Duck Creek
400	0.7	1.782	0.58	2.4948	0.71	2	2	800	1425.6	800	1995.84	570.24	0	EU#2606 willow/grass riparian
580	0.6	2.376	0.58	2.4948	0.1188	2	2	1160	2756.16	1160	2893.968	137.808	0	
1760	0.7	1.782	0.58	2.4948	0.7128	2	2	3520	6272.64	3520	8781.696	2509.056	0	
800	0.4	3.564	0.43	3.3858	-0.1782	3	3	2400	8553.6	2400	8125.92	-427.68	-3	
180	0.3	4.158	0.43	3.3858	-0.7722	3	3	540	2245.32	540	1828.332	-416.988	-13	
670	0.5	2.97	0.43	3.3858	0.4158	3	3	2010	5969.7	2010	6805.458	835.758	0	
150	0.4	3.564	0.43	3.3858	-0.1782	3	3	450	1603.8	450	1523.61	-80.19	-3	
250	0.1	5.346	0.35	3.861	-1.485	4	4	1000	5346	1000	3861	-1485	-25	
510	0	5.94	0.35	3.861	-2.079	4	4	2040	12117.6	2040	7876.44	-4241.16	-35	
950	0.1	5.346	0.35	3.861	-1.485	4	4	3800	20314.8	3800	14671.8	-5643	-25	
590	0.3	4.158	0.29	4.2174	0.0594	5	5	2950	12266.1	2950	12441.33	175.23	0	
160	0	5.94	0.29	4.2174	-1.7226	5	5	800	4752	800	3373.92	-1378.08	-29	
760	0.1	5.346	0.29	4.2174	-1.1286	5	5	3800	20314.8	3800	16026.12	-4288.68	-19	
						Total		25,270	103,938	25,270	90,205	-13,733	-12	

Table 10. Existing and potential solar loads for Howard Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	Howard Creek
250	0.6	2.376	0.73	1.6038	-0.77	1	1	250	594	250	400.95	-193.05	-13	EU#1594-cool subalp fir
70	0.9	0.594	0.53	2.7918	2.1978	1	1	70	41.58	70	195.426	153.846	0	EU#2020
130	0.4	3.564	0.32	4.0392	0.4752	2	2	260	926.64	260	1050.192	123.552	0	grass/willow
750	0.3	4.158	0.32	4.0392	-0.1188	2	2	1500	6237	1500	6058.8	-178.2	-2	riparian
280	0.1	5.346	0.32	4.0392	-1.3068	2	2	560	2993.76	560	2261.952	-731.808	-22	
1180	0.2	4.752	0.32	4.0392	-0.7128	2	2	2360	11214.72	2360	9532.512	-1682.208	-12	
800	0.1	5.346	0.32	4.0392	-1.3068	2	2	1600	8553.6	1600	6462.72	-2090.88	-22	
350	0.2	4.752	0.23	4.5738	-0.1782	3	3	1050	4989.6	1050	4802.49	-187.11	-3	
1100	0.1	5.346	0.23	4.5738	-0.7722	3	3	3300	17641.8	3300	15093.54	-2548.26	-13	
270	0	5.94	0	5.94	0	3	3	810	4811.4	810	4811.4	0	0	pond
890	0.2	4.752	0.18	4.8708	0.1188	4	4	3560	16917.12	3560	17340.048	422.928	0	EU#2606 willow/grass riparian
690	0.1	5.346	0.35	3.861	-1.485	4	4	2760	14754.96	2760	10656.36	-4098.6	-25	
2100	0	5.94	0.29	4.2174	-1.7226	5	5	10500	62370	10500	44282.7	-18087.3	-29	
860	0.1	5.346	0.29	4.2174	-1.1286	5	5	4300	22987.8	4300	18134.82	-4852.98	-19	
						Total		32,880	175,034	32,880	141,084	-33,950	-11	

Table 11. Existing and potential solar loads for Targhee Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	
1130	0.7	1.782	0.96	0.2376	-1.54	1	1	1130	2013.66	1130	268.488	-1745.172	-26	Targhee Creek spruce riparian
750	0.8	1.188	0.96	0.2376	-0.9504	1	1	750	891	750	178.2	-712.8	-16	
1599	0.9	0.594	0.95	0.297	-0.297	2	2	3198	1899.612	3198	949.806	-949.806	-5	
600	0.9	0.594	0.95	0.297	-0.297	2	2	1200	712.8	1200	356.4	-356.4	-5	
959	0.8	1.188	0.94	0.3564	-0.8316	3	3	2877	3417.876	2877	1025.3628	-2392.5132	-14	
1864	0.7	1.782	0.91	0.5346	-1.2474	4	4	7456	13286.592	7456	3985.9776	-9300.6144	-21	
499	0.2	4.752	0.29	4.2174	-0.5346	5	5	2495	11856.24	2495	10522.413	-1333.827	0	EU#2606 willow/grass riparian
160	0.4	3.564	0.29	4.2174	0.6534	5	5	800	2851.2	800	3373.92	522.72	0	
240	0.2	4.752	0.29	4.2174	-0.5346	5	5	1200	5702.4	1200	5060.88	-641.52	0	
710	0.4	3.564	0.29	4.2174	0.6534	5	5	3550	12652.2	3550	14971.77	2319.57	0	
1025	0.2	4.752	0.26	4.3956	-0.3564	6	6	6150	29224.8	6150	27032.94	-2191.86	0	EU#2609 spruce riparian
1006	0.7	1.782	0.76	1.4256	-0.3564	6	6	6036	10756.152	6036	8604.9216	-2151.2304	-6	
455	0.8	1.188	0.69	1.8414	0.6534	7	7	3185	3783.78	3185	5864.859	2081.079	0	
533	0.7	1.782	0.69	1.8414	0.0594	7	7	3731	6648.642	3731	6870.2634	221.6214	0	EU#2606 willow/grass riparian
3710	0.6	2.376	0.64	2.1384	-0.2376	8	8	29680	70519.68	29680	63467.712	-7051.968	-4	
840	0.4	3.564	0.18	4.8708	1.3068	9	9	7560	26943.84	7560	36823.248	9879.408	0	
910	0.2	4.752	0.18	4.8708	0.1188	9	9	8190	38918.88	8190	39891.852	972.972	0	
370	0.4	3.564	0.16	4.9896	1.4256	10	10	3700	13186.8	3700	18461.52	5274.72	0	
1120	0	5.94	0.16	4.9896	-0.9504	10	10	11200	66528	11200	55883.52	-10644.48	-16	
						Total		104,088	321,794	104,088	303,594	-18,200	-6	

Table 12. Existing and potential solar loads for Timber Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	
470	0.2	4.752	0.58	2.4948	-2.2572	2	2	940	4466.88	940	2345.112	-2121.768	-38	EU#2606 willow/grass riparian
2020	0.3	4.158	0.58	2.4948	-1.6632	2	2	4040	16798.32	4040	10078.992	-6719.328	-28	
480	0.4	3.564	0.58	2.4948	-1.0692	2	2	960	3421.44	960	2395.008	-1026.432	-18	
230	0.2	4.752	0.58	2.4948	-2.2572	2	2	460	2185.92	460	1147.608	-1038.312	-38	
						Total		6,400	26,873	6,400	15,967	-10,906	-31	

Table 13. Existing and potential solar loads for Warm River.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m ² /day)	Potential Shade (fraction)	Potential Summer Load (kWh/m ² /day)	Potential Load minus Existing load (kWh/m ² /day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m ²)	Existing Summer Load (kWh/day)	Natural Segment Area (m ²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	
950	0.6	2.376	0.62	2.2572	-0.12	1	1	950	2257.2	950	2144.34	-112.86	-2	Warm River
2860	0.8	1.188	0.62	2.2572	1.0692	1	1	2860	3397.68	2860	6455.592	3057.912	0	EU#1225 cool, moist whitebark/subalpine fir
1490	0.6	2.376	0.56	2.6136	0.2376	2	2	2980	7080.48	2980	7788.528	708.048	0	EU#1700 cool - lodgepole pine
400	0.7	1.782	0.56	2.6136	0.8316	2	2	800	1425.6	800	2090.88	665.28	0	
200	0.3	4.158	0.56	2.6136	-1.5444	2	2	400	1663.2	400	1045.44	-617.76	-26	
1120	0.6	2.376	0.46	3.2076	0.8316	3	3	3360	7983.36	3360	10777.536	2794.176	0	
1120	0.6	2.376	0.5	2.97	0.594	3	3	3360	7983.36	3360	9979.2	1995.84	0	EU#2040 lodgepole pine riparian
980	0.4	3.564	0.5	2.97	-0.594	3	3	2940	10478.16	2940	8731.8	-1746.36	-10	
650	0.6	2.376	0.5	2.97	0.594	3	3	1950	4633.2	1950	5791.5	1158.3	0	
600	0.4	3.564	0.42	3.4452	-0.1188	4	4	2400	8553.6	2400	8268.48	-285.12	-2	
250	0.2	4.752	0.42	3.4452	-1.3068	4	4	1000	4752	1000	3445.2	-1306.8	-22	
380	0	5.94	0.42	3.4452	-2.4948	4	4	1520	9028.8	1520	5236.704	-3792.096	-42	
1020	0.3	4.158	0.42	3.4452	-0.7128	4	4	4080	16964.64	4080	14056.416	-2908.224	-12	
670	0.4	3.564	0.42	3.4452	-0.1188	4	4	2680	9551.52	2680	9233.136	-318.384	-2	
1010	0.3	4.158	0.42	3.4452	-0.7128	4	4	4040	16798.32	4040	13918.608	-2879.712	-12	
380	0.1	5.346	0.37	3.7422	-1.6038	5	5	1900	10157.4	1900	7110.18	-3047.22	-27	
450	0.2	4.752	0.37	3.7422	-1.0098	5	5	2250	10692	2250	8419.95	-2272.05	-17	
360	0.3	4.158	0.37	3.7422	-0.4158	5	5	1800	7484.4	1800	6735.96	-748.44	-7	
130	0.1	5.346	0.37	3.7422	-1.6038	5	5	650	3474.9	650	2432.43	-1042.47	-27	
1450	0.3	4.158	0.37	3.7422	-0.4158	5	5	7250	30145.5	7250	27130.95	-3014.55	-7	
380	0.1	5.346	0.37	3.7422	-1.6038	5	5	1900	10157.4	1900	7110.18	-3047.22	-27	
1160	0	5.94	0.32	4.0392	-1.9008	6	6	6960	41342.4	6960	28112.832	-13229.568	-32	
1280	0.2	4.752	0.32	4.0392	-0.7128	6	6	7680	36495.36	7680	31021.056	-5474.304	-12	
600	0.1	5.346	0.32	4.0392	-1.3068	6	6	3600	19245.6	3600	14541.12	-4704.48	-22	
530	0.3	4.158	0.32	4.0392	-0.1188	6	6	3180	13222.44	3180	12844.656	-377.784	-2	
1830	0.1	5.346	0.11	5.2866	-0.0594	7	7	12810	68482.26	12810	67721.346	-760.914	-1	EU#2020 grass/willow
770	0.2	4.752	0.22	4.6332	-0.1188	7	7	5390	25613.28	5390	24972.948	-640.332	-2	EU#2606 willow/grass riparian
2200	0.1	5.346	0.22	4.6332	-0.7128	7	7	15400	82328.4	15400	71351.28	-10977.12	-12	
2190	0	5.94	0.2	4.752	-1.188	8	8	17520	104068.8	17520	83255.04	-20813.76	-20	
610	0.2	4.752	0.2	4.752	0	8	8	4880	23189.76	4880	23189.76	0	0	
550	0	5.94	0.2	4.752	-1.188	8	8	4400	26136	4400	20908.8	-5227.2	-20	
1040	0.1	5.346	0.16	4.9896	-0.3564	10	10	10400	55598.4	10400	51891.84	-3706.56	-6	
1690	0.3	4.158	0.14	5.1084	0.9504	12	12	20280	84324.24	20280	103598.352	19274.112	0	
1610	0.1	5.346	0.12	5.2272	-0.1188	14	14	22540	120498.84	22540	117821.088	-2677.752	-2	
160	0.2	4.752	0.12	5.2272	0.4752	14	14	2240	10644.48	2240	11708.928	1064.448	0	
1900	0.1	5.346	0.1	5.346	0	16	16	30400	162518.4	30400	162518.4	0	0	
750	0.2	4.752	0.1	5.346	0.594	16	16	12000	57024	12000	64152	7128	0	
2070	0.1	5.346	0.1	5.346	0	18	18	37260	199191.96	37260	199191.96	0	0	
200	0.2	4.752	0.09	5.4054	0.6534	20	20	4000	19008	4000	21621.6	2613.6	0	
400	0.1	5.346	0.09	5.4054	0.0594	20	20	8000	42768	8000	43243.2	475.2	0	
340	0.2	4.752	0.09	5.4054	0.6534	20	20	6800	32313.6	6800	36756.72	4443.12	0	
2690	0.1	5.346	0.08	5.4648	0.1188	21	21	56490	301995.54	56490	308706.552	6711.012	0	
4300	0.1	5.346	0.16	4.9896	-0.3564	26	21	111800	597682.8	90300	450560.88	-147121.92	-6	EU#1224 warm - subalpine fir/
2470	0.2	4.752	0.16	4.9896	0.2376	16	21	39520	187799.04	51870	258810.552	71011.512	0	
330	0.1	5.346	0.16	4.9896	-0.3564	23	21	7590	40576.14	6930	34577.928	-5998.212	-6	
190	0.2	4.752	0.16	4.9896	0.2376	21	21	3990	18960.48	3990	19908.504	948.024	0	
3210	0.1	5.346	0.16	4.9896	-0.3564	24	21	77040	411855.84	67410	336348.936	-75506.904	-6	
3670	0	5.94	0.13	5.1678	-0.7722	32	26	117440	697593.6	95420	493111.476	-204482.124	-13	
						Total		700,680	3,665,140	659,220	3,260,351	-404,790	-8	

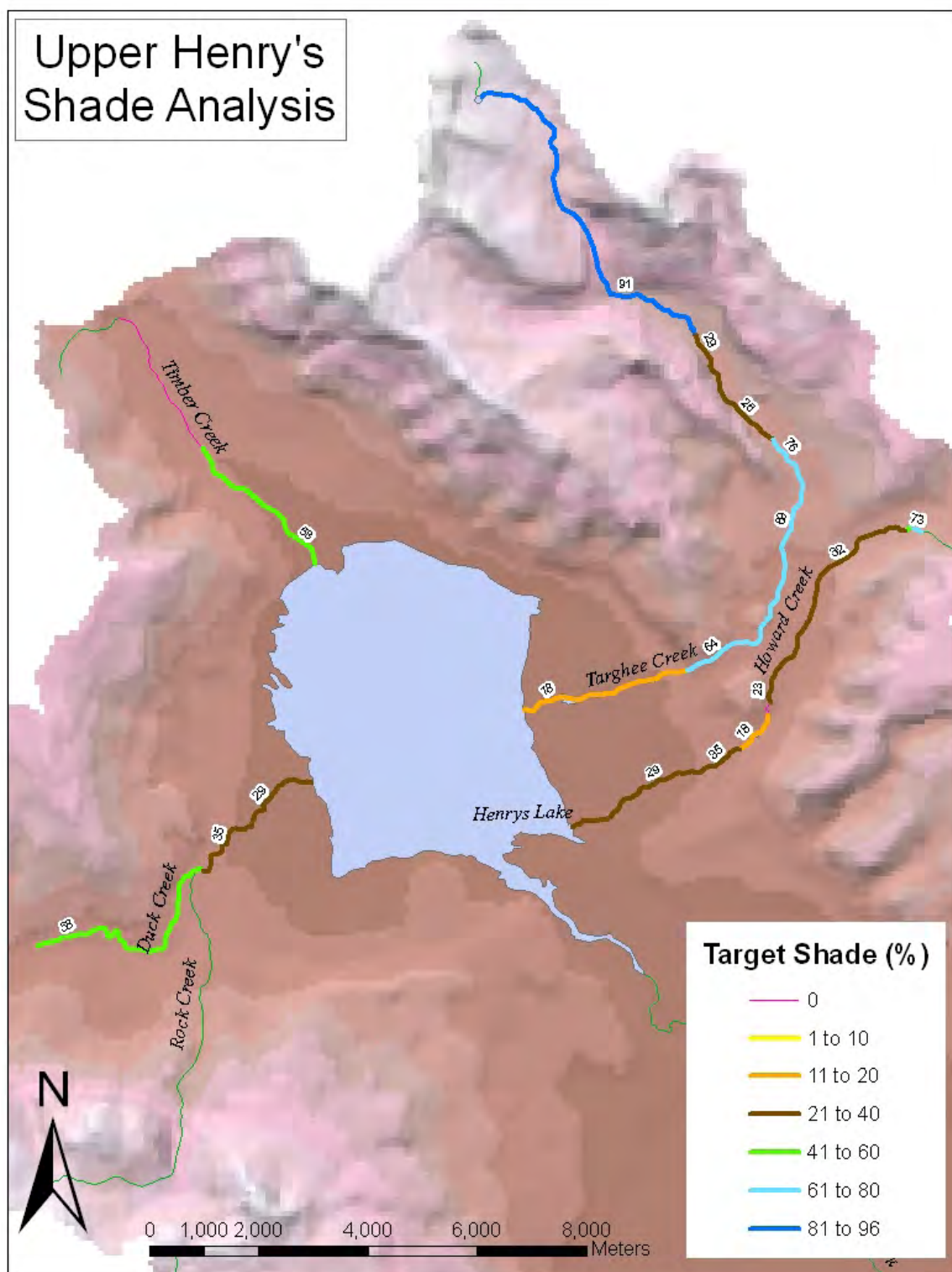


Figure 9. Target shade for tributaries to Henry's Lake.

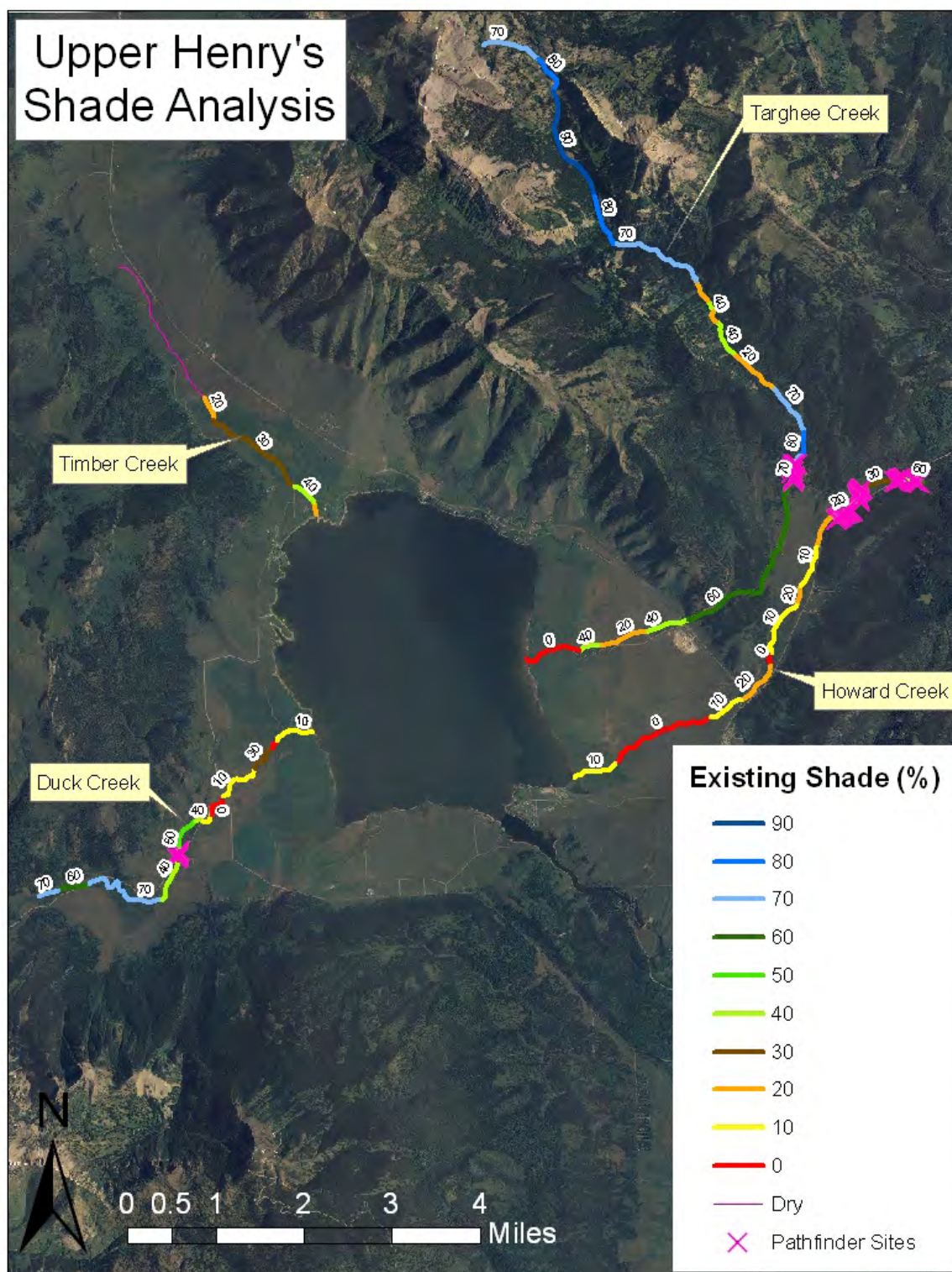


Figure 10. Existing shade estimated for tributaries to Henry's Lake by aerial photo interpretation.



Figure 11. Lack of shade (difference between existing and target) for tributaries to Henry's Lake.

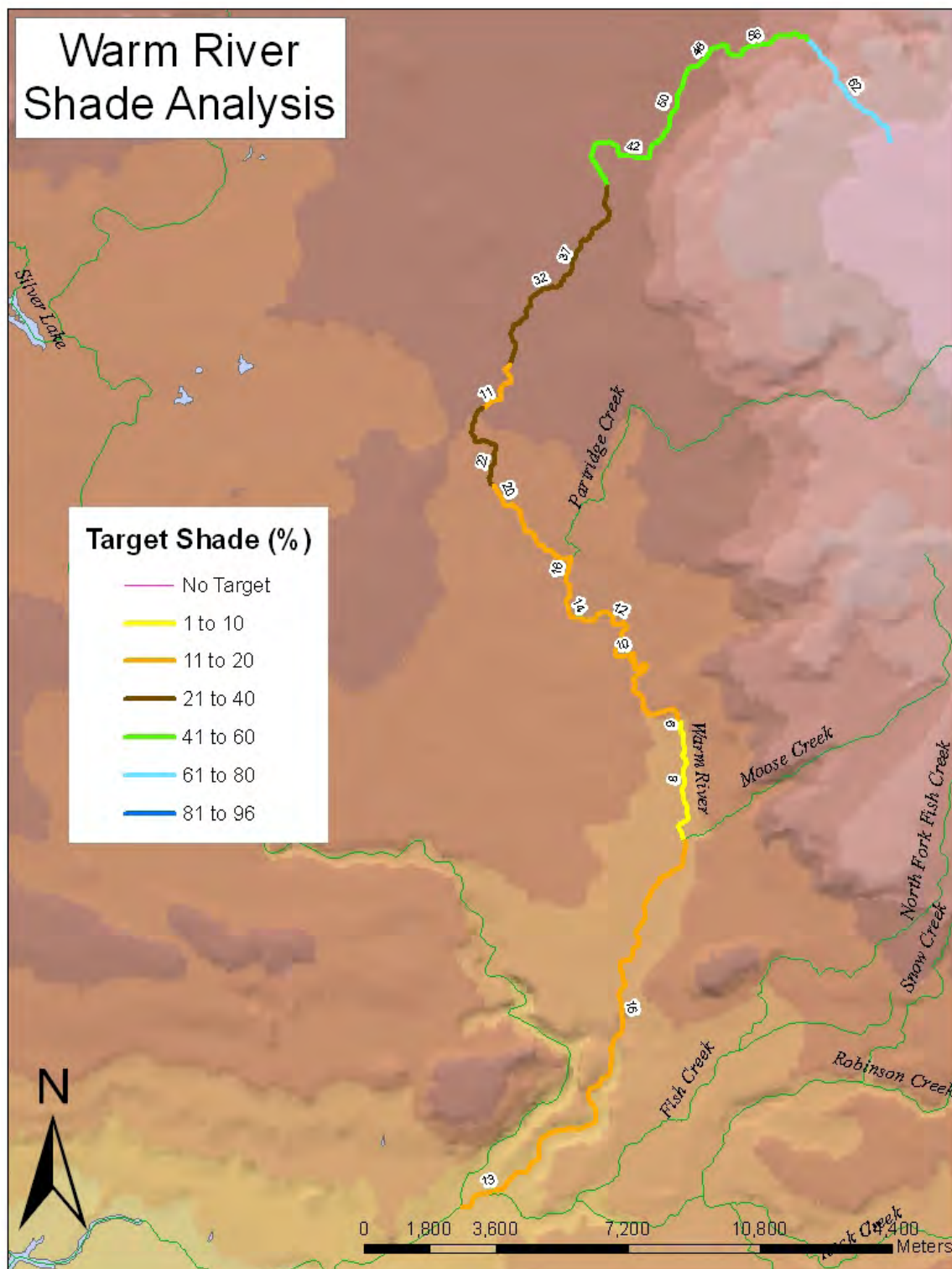


Figure 12. Target shade for Warm River.

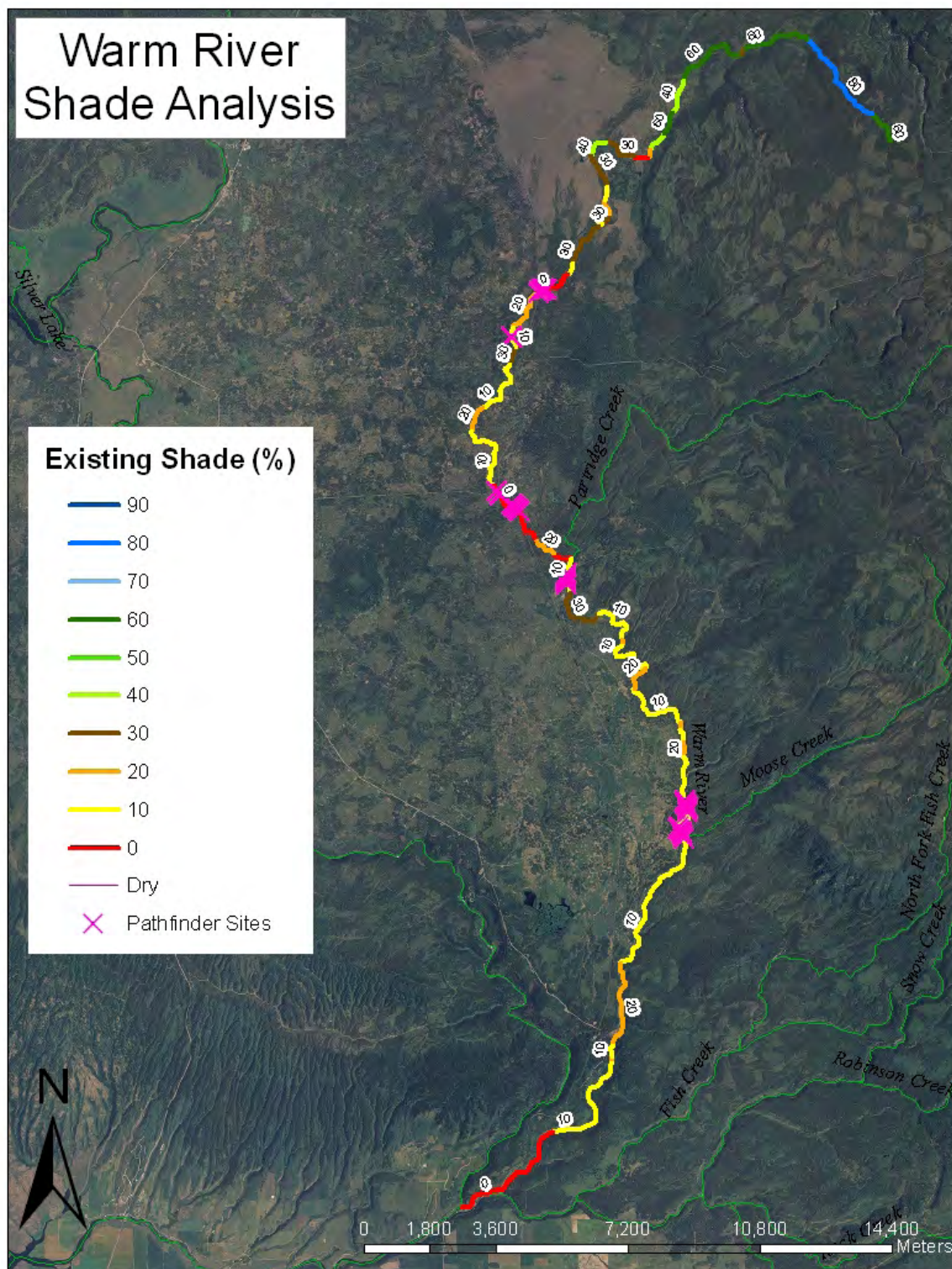


Figure 13. Existing shade estimated for Warm River by aerial photo interpretation.

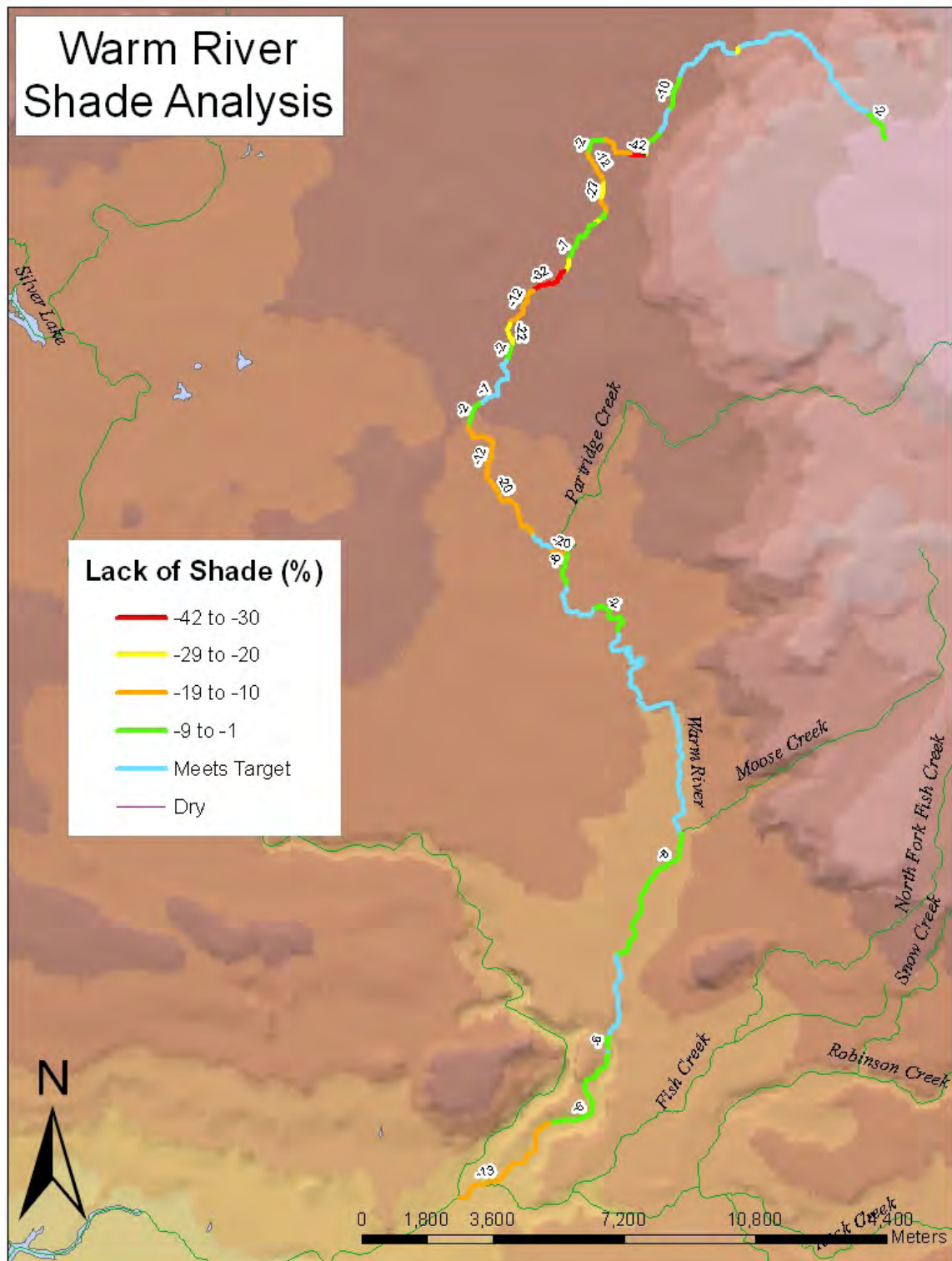


Figure 14. Lack of shade (difference between existing and target) for Warm River.

5.2.4 Wasteload Allocation

If a new point source were to be proposed that would have thermal consequence on these waters, then background provisions in the Idaho water quality standards that address such discharges (IDAPA 58.01.02.200.09 & IDAPA 58.01.02.401.03) should be involved (see Appendix B).

5.2.5 Load Allocation

Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation essentially represents the desire to achieve background conditions. In order to reach that objective, load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade as a whole. Load allocations are therefore stream reach-specific and are dependent upon the target load for a given reach. Table 9 through Table 13 show the target or potential shade which is converted to a potential summer load in the manner described. That equals the load capacity of the stream and reducing the amount of existing load until it matches load capacity is necessary to achieve background conditions. There is no opportunity to remove any more shade from the stream, by any activity, without exceeding its load capacity.

Table 14 shows the total existing, target, and excess heat (solar) loads (kWh/day) experienced in each stream segment examined and the percent reduction (lack of shade) necessary to bring that water body back to its target load level. 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 as compared to smaller streams. Table 14 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 the following analysis dwells on total heat loads for streams in this TMDL, it is important to note that differences between existing shade and target shade, as depicted in the figures showing lack of shade (Figure 11 and Figure 14), are the key to successfully restoring these waters to achieving WQS. Achieving target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on locations with the largest differences between existing and target shade as places to prioritize implementation efforts. Each load analysis table contains a final column that lists the lack of shade on the stream. It is derived from subtracting the target shade from the existing shade for each segment. Thus, stream segments with the greatest lack of shade are in the worst condition. The average lack of shade listed at the bottom of that last column in each load analysis table is also listed in the table below and represents a general level of condition for comparison among streams.

Warm River is the largest of the five water bodies examined, with total existing and target loads greater than 3 million kWh/day. Despite these high solar loads, Warm River's total excess load is only 11% of its total existing load and its average lack of shade is 8%. Targhee Creek is almost three times larger than Howard Creek; however, Targhee Creek had a little more than half the excess load. In fact, Targhee Creek's excess load is only 6% of its total existing load as is its average lack of shade, consistent with the watershed's substantial roadless nature. Headwaters locations on Targhee Creek show a lack of shade; however, this is likely an artifact of alpine locations with lower vegetation density, which do not always

match data for the higher-density forested areas that are reflected in the shade curves that are chosen to represent them. Howard Creek, on the other hand, had an excess load that was 19% of its total existing load, with an average lack of shade of 11%. Howard Creek appears to lack a substantial shrub component in its lowest ecological unit, resulting in substantial grass-dominated meadows that appear to lack shade that would meet targets. The portion of Duck Creek examined in this analysis (below the forks) had an excess load that was 13% of its total existing load and a 12% average lack of shade, with problems similar to those of Howard Creek. Timber Creek, which is in the same willow/grass riparian zone as lower Duck Creek and lower Howard Creek, lacked considerable shade, with an excess load amounting to 41% of its total existing load and a 31% average lack of shade. Timber Creek is likely heavily influenced by water retention and use for livestock grazing.

Table 14. Excess solar loads and percent reductions for all tributaries.

Water Body	Total Existing Load (kWh/day)	Total Target Load (kWh/day)	Excess Load (kWh/day)	Average Lack of Shade (%)
Warm River	3,665,140	3,260,351	404,790	-8
Howard Creek	175,034	141,084	33,950	-11
Targhee Creek	321,794	303,594	18,200	-6
Duck Creek	103,938	90,205	13,733	-12
Timber Creek	26,873	15,967	10,906	-31

A certain amount of excess load, and hence, percentage reduction required, is potentially created only by the difference between existing shade and target shade that is inherent in the load analysis. Because existing shade is reported as an integer that represents an entire 10% class interval, but target shade is reported as a specific integer, there is usually a difference between them. For example, say a particular stretch of stream has a target shade of 86% based on its vegetation type and natural bankfull width. If existing shade on that stretch of stream were at target level, it would be recorded as 80% existing shade in the load analysis because it falls into the 80% existing shade class. In this example, a difference of 6% would be automatically included in the load analysis, indicating a 6% lack of shade even though no difference exists. The automatic difference of 6% could be attributed to the margin of safety.

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% class interval, 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 NPS activities, and can be adjusted as more information is gathered from the stream environment.

Seasonal Variation

This TMDL is based on average summer loads. All loads have been calculated to be inclusive of the six month period from April through September. This time period was chosen because it represents the time period when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical period is June when spring salmonids spawning is occurring, July and August when maximum temperatures exceed cold water aquatic life criteria, and September during fall salmonids spawning. Water temperature is not likely to be a problem for beneficial uses outside of this period because of cooler weather and lower sun angle.

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the loading tables presented in this TMDL. These tables need to be updated, first with field-verifications of the existing shade levels that have not yet been field-verified, and second, to monitor progress toward achieving required reductions and the goals of the TMDL. 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 further include solar pathfinder monitoring to simultaneously field-verify the TMDL and mark progress towards achieving desired reductions in solar loads.

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

5.3 Bacteria TMDL

The Idaho water quality standards have numeric criteria for *E.coli*. for both primary and secondary contact recreation. Conant Creek is an undesignated water body; so it is afforded protection for cold water aquatic life and primary or secondary contact recreation according to IDAPA 58.01.02.101.01.a. After a review of the physical properties of the impaired streams DEQ has determined that likely recreational activities include fishing, wading, and infrequent swimming. These recreational activities are descriptive of the existing uses consistent with secondary contact recreation. As a result, the water quality bacteria targets will be those water quality criteria for secondary contact recreation. Thus, the number of colonies of *E.coli*. shall not exceed either the single instantaneous measure of 576 cfu/100 mL or the geometric mean of 126 cfu/100 mL for five samples collected in a 30 day period.

Background bacteria colonies enter the stream from many sources not controllable through watershed improvement projects. Generally, these sources are from the wildlife that use the stream. Studies have indicated that skunks, ground squirrels, and other small mammals may be significant contributors. No work has been done in Conant Creek to partition these sources from the overall counts. This would entail genetic differentiation of the *E.coli*. found within each watershed. Rather than a detailed genetic study of the *E. coli*, DEQ opted to make some

simple assumptions about the sources. The first of these is that the contributions from wildlife sources of *E.coli* are similar throughout the year. The second assumption is that human-caused sources are more heavily concentrated during the summer. These sources may include recreation as well as grazing. If these two assumptions are true, the uncontrollable portion from wildlife sources could be identified as the average bacterial count for the period when anthropogenic sources are minimized.

An essential assumption in the method we used to calculate loads is that the water quality standard is the load capacity of the stream. By using a percentage of the target or “load capacity”, the calculations become unitless percentages, which overcome the inherent problem of calculating loads from a parameter that does not lend itself to loading calculations. This percentage of the load can then be allocated according to land use in the watershed during critical periods (May through October). Grazing comprises 80% of the load allocation. Specifically, 460 col/100mL of the target will be distributed to grazing. The remaining 20% will be distributed between the MOS (10%) and the wildlife (natural background) component of 10%.

5.3.1 In-stream Water Quality Targets

In-stream water quality targets for the Conant Creek AU were set from the Idaho Water Quality Standards. The water quality standards relate beneficial use impairment to a numeric standard (e.g., IDAPA 58.01.02.251.01 “...Waters designated for recreation are not to contain *E.coli* bacteria...”). The target developed for bacteria is the *E. Coli*. water quality standard.

Critical Time Periods and Design Conditions

Bacteria impact the creek throughout the summer months into the fall. The critical period for the recreational beneficial uses is May through October. Recreation activities occurring within the watershed during this period include hiking, biking, fishing, and hunting. It is equally likely that water would be ingested at any time these activities occur, but the highest concentrations of bacteria typically occur later in the season due to lower water flow. With no known sources of human-induced bacteria loading, it is assumed the *E.coli* levels observed (Table 14) are a combination of wildlife, waterfowl, and livestock. To be protective of the beneficial use, the design conditions should fall within the critical period when the bacteria contamination is most likely to occur. In Conant Creek May through October is the critical time period for grazing. The design flow for the TMDL will be the lowest flow at which water quality standards apply, which is 0.142 cubic meters per second (5 cubic feet per second [cfs]) for recreational uses (IDAPA 58.01.02.070.06).

Monitoring Points

Conant Creek will be monitored for *E.coli* bacteria at the bridge crossing just before the creek enters Warm River. Because the major exceedances occur primarily during the grazing season (April through September), monitoring should occur primarily during the grazing season, although year-round monitoring may be conducted so that comparisons between the grazing and non-grazing seasons can be assessed.

5.3.2 Load Capacity

The CWA requires that a TMDL be developed from a load capacity. A load capacity is the greatest amount of load that a water body can carry without violating water quality standards. In those instances where there are numeric water quality standards, the load capacity of a water body for different pollutants can be very straightforward. In this case, numeric water quality standards will be used. Table 15 and Table 16 show the load capacities and load reductions that are need to meet water quality standards. Data supporting the geometric mean for Conant Creek is presented in Appendix F.

Table 15. Load capacities and critical periods.

Stream Name	Parameter	Critical Period	Load Capacity
Conant Creek (Squirrel Creek)	Bacteria	May through October	126 col/100 mL

Table 16. Conant Creek *E. coli* TMDL from geometric mean.

Stream	Load Capacity	Back-ground	Total Existing Load	MOS	Load Allocation	Load Reduction	Percent Reduction Required	Units
Conant Creek (Squirrel Creek)	126	13	950	13	328	824	87	cfu/ 100 mL

5.3.3 Estimates of Existing Pollutant Loads

Natural background will be estimated from average bacteria counts collected during the noncritical period.. The nonpoint source load will be estimated from the difference in the average non critical bacteria counts and average bacteria counts collected during the critical period (months May through October).

5.3.4 Waste Load Allocation

Ashton and St. Anthony Wastewater Treatment Plants are placed under effluent limitations and monitoring requirements for *E. coli* bacteria based on their NPDES permits. The Ashton facility permit is pending at this time. For St. Anthony, the effluent limitation for *E. coli* concentration is not to exceed an average monthly limit of the geometric mean of 126 organisms per 100 mL and a maximum daily limit of 406 organisms per 100 mL. These effluent limitations are based on 5 grab samples within 30 days.

5.3.5 Load Allocations

In Conant Creek, all load allocations are made using watershed area. If finer resolution is needed, the load allocations can be made based on land use within each watershed.

Margin of Safety

For the Conant Creek bacteria TMDL, an explicit MOS will be set at 10 percent (58 cfu/ 100 mL). In addition, any conservative approaches used in the various calculations required by a TMDL will be included as an implicit component of the MOS.

Seasonal Variation

In Conant Creek, the summer growing season is when concentrations of bacteria are the highest. This is also when water flow is lowest. With lower water flow, bacteria concentrations typically increase. The increase in bacteria is due to the combination of agricultural diversion and return flow. Seasonal variation as it relates to development of this TMDL is addressed by ensuring that loads are reduced during the critical period (when beneficial uses are impaired and loads are controllable). Thus, the effects of seasonal variation are built into the load allocations.

Reserve

For Conant Creek, little discussion with the local stakeholders has occurred with regard to a reserve load. Further discussions with the Conant Creek stakeholders are desirable.. Reserves are not typically recommended for bacteria due to public health concerns.

5.4 Construction Storm Water and TMDL Wasteload Allocations

5.4.1 Construction Storm Water

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past, storm water was treated as a nonpoint source of pollutants. However, because storm water can be managed on-site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

5.4.2 The Construction General Permit (CGP)

If a construction project disturbs more than one acre of land (or is part of larger common development that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

5.4.3 Storm Water Pollution Prevention Plan (SWPPP)

In order to obtain the Construction General Permit, operators must develop a site-specific Storm Water Pollution Prevention Plan. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically, and maintain the best management practices (BMPs) through the life of the project

5.4.4 Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed, DEQ may incorporate a gross wasteload allocation (WLA) for anticipated construction storm water activities if one is quantifiable. TMDLs that do not have a numeric WLA for construction storm water activities will be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate best management practices.

Typically, there are specific requirements to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site-specific standards that are applicable.

5.5 Implementation Strategies

The purpose of this implementation strategy is to outline the pathway by which a larger, more comprehensive, implementation plan will be developed 18 months after TMDL approval. The comprehensive implementation plan will provide details of the actions needed to achieve load reductions, provide a schedule of those actions, and specify monitoring needed to document actions and progress toward meeting state water quality standards. These details are typically set forth in the plan that follows approval of the TMDL. In the meantime, a cursory implementation strategy is developed to identify the general issues such as responsible parties, a time line, and a monitoring strategy for determining progress toward meeting the TMDL goals outlined in this document.

5.5.1 Time Frame

The expected time frame for attaining the water quality standard and restoring beneficial use is a function of management intensity, climate, ecological potential, and natural variability of environmental conditions. If implementation of best management practices is embraced enthusiastically, some improvements may be seen in as little as several years. Even with aggressive implementation, however, some natural processes required for satisfying the requirements of this TMDL may not be seen for many years. The deleterious effects of historic land management practices have accrued over many years and recovery of natural systems may take longer than administrative needs allow for.

5.5.2 Approach

It is anticipated that by improving riparian management practices, overall riparian zone recovery will precipitate stream bank stabilization, reduce sedimentation, increase canopy cover, and lower stream temperatures, all of which will precipitate overall stream habitat improvements. Such improvements will contribute to an overall improvement in stream morphology and habitat, shifting stream health towards beneficial use attainment.

5.5.3 Responsible Parties

Several designated land management agencies are involved where watershed implementation is concerned. The largest portion of the watershed with perennial water consists of private and forest service land. The Idaho Association of Soil Conservation Districts (IASCD) and the USFS will provide implementation strategies for riparian management for their respective jurisdictions. Much smaller portions of the watershed are made up of land administered by BLM and the State of Idaho, both of whom are responsible for developing an implementation plan. DEQ recognizes that implementation strategies for TMDLs may need to be modified if

monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals. In summary, the IASCD, IDL, BLM, and USFS are identified as the federal and state entities that will be involved in or responsible for implementing the TMDL.

5.5.4 Monitoring Strategy

The objectives of a monitoring effort are to demonstrate long-term recovery, better understand natural variability, track implementation of projects and BMPs, and track effectiveness of TMDL implementation. This monitoring and feedback mechanism is a major component of the “reasonable assurance of implementation” for the TMDL implementation plan.

The implementation plan will be tracked by accounting for the numbers, types, and locations of watershed improvement projects, educational activities, or other actions taken to improve or protect water quality. The mechanism for tracking specific implementation efforts will be by reports submitted to DEQ.

The “monitoring and evaluation” component has two basic categories:

- Tracking the implementation progress of specific watershed improvement plans
- Tracking the progress of improving water quality through monitoring physical, chemical, and biological parameters

Monitoring plans will provide information on progress being made toward achieving TMDL allocations and achieving water quality standards and will help in the interim evaluation of progress as described under the adaptive management approach.

While DEQ has the primary responsibility for watershed monitoring, other agencies and entities have shown an interest in such monitoring. In these instances, data sharing is encouraged. The designated agencies have primary responsibility for BMP monitoring.

5.5.5 Public Participation/Watershed Advisory Group (WAG) Activities

On September 10, 2009, DEQ conducted a preliminary meeting with the Henry’s Fork Watershed Council, which serves as the authorized watershed advisory group (WAG) and explained the PNV methods and TMDL process. DEQ also requested field sampling locations and field assistance from WAG members.

On October 9, 2009, DEQ held a meeting where approval was granted from the WAG to conduct a public comment opportunity for this TMDL once the document has met DEQ state office approval.

Public Comment for the document started February 18th and ended April 30th 2010.

A Public Comment meeting was held in Island Park, ID on March 18th, 2010.

On March 30th, 2010 a meeting was held with Fremont County and representatives to discuss Water Quality monitoring.

On April 20th, 2010 DEQ presented the document to the Henry’s Fork Watershed Council.

5.6 Conclusions

Table 17 displays the summary of assessment outcomes for the Upper and Lower Henry's Fork subbasins. Temperature TMDLs were written for Warm River, Howard Creek, Targhee Creek, Timber Creek, and Duck Creek. Sediment TMDLs were completed for Buffalo River, Duck Creek, and Sheridan Creek, with respective reductions of 76%, 71% and 79% required to meet targets. Bacteria load allocations were made for the two assessment units in Lower Henry's Fork subbasin on Conant Creek. Twin Creek, Icehouse Creek, and Willow Creek show no water quality impairment and fully support all beneficial uses that have been assessed.

Table 17. Summary of assessment outcomes.

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to 2010 Integrated Report	Justification
Upper Henry's 17040202				
Warm River/ ID17040202SK002_05 ID17040202SK005_02	Temperature	Yes	Move to section 4a ¹	Shade lacking, stream temp exceedance
Warm River/ ID17040202SK002_04 ID17040202SK005_03 ID17040202SK005_04	Temperature	Yes	Move to section 4a	Unlisted but impaired for temperature
Buffalo River/ ID17040202SK018_03	Listed for Combined biota/habitat assessment; determined to be Sediment	Yes	Move to section 4a; delist combined biota/habitat assessment	Stream bank erosion
Twin Creek/ ID17040202SK030_02	Combined biota/habitat bioassessment	No	Move to section 2 ²	Bioassessment shows no impairment
Howard Creek/ ID17040202SK033_02	Temperature	Yes	Move to section 4a	Shade lacking, stream temp exceedance
Targhee Creek/ ID17040202SK034_02	Temperature	Yes	Move to section 4a	Shade lacking, stream temp exceedance
Targhee Creek/ ID17040202SK034_03	Temperature	Yes	Move to Section 4a	Unlisted but impaired for temperature
Timber Creek/ ID17040202SK035_02 ID17040202SK035_03	Temperature	Yes	Move to section 4a	Shade lacking, stream temp exceedance
Duck Creek/ ID17040202SK036_03	Temperature, Sediment	Yes	Move to section 4a	Shade lacking, stream temp exceedance; stream bank erosion
Icehouse Creek/ ID17040202SK044_02	Sediment	No	Move to section 2	Meets sediment target

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to 2010 Integrated Report	Justification
Upper Henry's 17040202				
Sheridan Creek/ ID17040202SK045_03	Sediment	Yes	Move to section 4a	Stream bank erosion
Willow Creek/ ID17040202SK046_04	Fish kills, Sediment	No	Move to section 2	Bioassessment shows no impairment
Lower Henry's 17040203				
Conant Creek (Squirrel Creek)/ ID17040203SK007_02 ID17040203SK007_03	E. coli; Combined biota/habitat bioassessments	Yes	Move to section 4a, delist combined biota/habitat bioassessment	Excess bacteria load, bioassessment shows no other impairments

1. Section 4a lists waters that are impaired but have TMDLs completed
2. Section 2 identifies "waters of the state attaining most standards"

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GIS Coverages

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Glossary

§303(d)

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

Aquatic

Occurring, growing, or living in water.

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, which are recognized in water quality standards.

Best Management Practices (BMPs)

Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

Clean Water Act (CWA)

The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation’s water resources.

Criteria

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

Cubic Feet per Second

A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per

second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Discharge

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

E. coli

Short for *Escherichia coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans, but their presence in water is often indicative of fecal contamination. *E. coli* are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.

Environment

The complete range of external conditions, physical and biological, that affect a particular organism or community.

Erosion

The wearing away of areas of the earth's surface by water, wind, ice, and other forces.

Exceedance

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

Flow

See *Discharge*.

Geographical Information Systems (GIS)

A georeferenced database.

Geometric Mean

A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.

Gradient

The slope of the land, water, or streambed surface.

Ground Water

Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.

Habitat

The living place of an organism or community.

Headwater

The origin or beginning of a stream.

Hydrologic Unit

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

Hydrologic Unit Code (HUC)

The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.

Hydrology

The science dealing with the properties, distribution, and circulation of water.

Instantaneous

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

Limnology

The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.

Load Allocation (LA)

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

Margin of Safety (MOS)

An implicit or explicit portion of a water body's loading capacity set aside to allow the 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.

Mean

Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then

dividing by the number of items) is the statistic most familiar to most people.

Milligrams per Liter (mg/L)

A unit of measure for concentration. In water, it is essentially equivalent to parts per million (ppm).

Monitoring

A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a water body.

Mouth

The location where flowing water enters into a larger water body.

Natural Condition

The condition that exists with little or no anthropogenic influence.

Nitrogen

An element essential to plant growth, and thus is considered a nutrient.

Nonpoint Source

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

Nutrient

Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.

Parameter

A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.

pH

The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very

alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.

Pollutant

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

Pollution

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

Riparian

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

River

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

Runoff

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

Sediments

Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.

Stream

A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.

Subbasin

A large watershed of several hundred thousand acres. This is the name commonly given to 4th field hydrologic units (also see Hydrologic Unit).

Subbasin Assessment (SBA)

A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

Subwatershed

A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6th field hydrologic units.

Total Maximum Daily Load (TMDL)

A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. 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 loading 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 Pollution

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

Water Quality

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

Water Quality Criteria

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

Water Quality Limited

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

Water Quality Standards

State-adopted and U.S. 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.

Watershed

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

Wetland

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

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Appendix A. Unit Conversion Chart

A-1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft ²) Square Miles (mi ²)	Hectares (ha) Square Meters (m ²) Square Kilometers (km ²)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft ² = 0.09 m ² 1 m ² = 10.76 ft ² 1 mi ² = 2.59 km ² 1 km ² = 0.39 mi ²	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft ² = 0.28 m ² 3 m ² = 32.29 ft ² 3 mi ² = 7.77 km ² 3 km ² = 1.16 mi ²
Volume	Gallons (gal) Cubic Feet (ft ³)	Liters (L) Cubic Meters (m ³)	1 gal = 3.78 L 1 L = 0.26 gal 1 ft ³ = 0.03 m ³ 1 m ³ = 35.32 ft ³	3 gal = 11.35 L 3 L = 0.79 gal 3 ft ³ = 0.09 m ³ 3 m ³ = 105.94 ft ³
Flow Rate	Cubic Feet per Second (cfs) ^a	Cubic Meters per Second (m ³ /sec)	1 cfs = 0.03 m ³ /sec 1 m ³ /sec = 35.31 cfs	3 ft ³ /sec = 0.09 m ³ /sec 3 m ³ /sec = 105.94 ft ³ /sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L ^b	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 lb
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 °C = 37.4 °F

^a 1 cfs = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 cfs.

^b The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

Appendix B. Data Sources

Table B-1 Data Sources.

Water Body	Data Source	Type of Data	When Collected
All	Western Regional Climate Center (www.wrcc.dri.edu)	Climate	Period of Record
All	Agrimet Station Data (www.mac1.usbr.gov/agrimet/location.html)	Air	Period of Record
All	Snotel (www.wrcc.dri.edu)	Snow Water Content	Period of Record
Henry's Fork	USGS (www.waterdata.usgs.gov/id/nwis/peak)	Streamflow	Period of Record
All	EPA, 1998 Temperature Additions	Temperature	1997-1998
All	DEQ-Idaho Falls, Steve Robinson	BURP Monitoring, Pathogen	1993-2006
All	IDFG- Damon Keen	Restoration Monitoring and fisheries data	1998-2008
All	USFS- Brad Higginson	Restoration Projects	1998-2008
Sheridan, Icehouse, and Duck Creeks	DEQ-Idaho Falls, Aaron Swift, Jack Rainey, Heather Bohac, HFF - Jim Derito	Stream bank Erosion Inventory	2008
Warm River, Howard Creek, Duck Creek, Targhee Creek, Timber Creek	DEQ State Technical Services Office	Pathfinder effective shade and stream width	August 2006
Warm River, Howard Creek, Duck Creek, Targhee Creek, Timber Creek	DEQ State Technical Services Office	Aerial Photo Interpretation of existing shade and stream width estimation	July 2006

Henry's Lake Outlet, Icehouse Creek, Sheridan Creek, Willow Creek	DEQ State Technical Services Office	Pathfinder effective shade and stream width	August 2007
Henry's Lake Outlet, Buffalo River Icehouse Creek, Sheridan Creek, Willow Creek	DEQ State Technical Services Office	Aerial Photo Interpretation of existing shade and stream width estimation	July-October 2007
	DEQ IDASA Database	Temperature	

Appendix C. Stream bank Erosion Inventory Method and Data Sheets

Stream bank Erosion Inventory

The stream bank erosion inventory used to estimate background and existing stream bank erosion followed methods outlined in the proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (NRCS, 1983). Using the direct volume method, sub-sections of 1996 §303(d)-listed watersheds were surveyed to determine the extent of chronic bank erosion and estimate the needed sediment reductions.

The NRCS Stream Bank Erosion Inventory is a field-based methodology that measures stream bank/channel stability, length of active eroding banks, and bank geometry (Stevenson, 1994). The stream bank/channel stability inventories were used to estimate the long-term lateral recession rate. The recession rate is determined from field evaluation of six stream bank characteristics (categories), each of which is assigned a categorical rating ranging from 0 to 3, which are combined into a cumulative rating. The six categories of rating factors (characteristics) plus the cumulative rating and the rating score assignments used in each are:

Bank Stability:

- Do not appear to be eroding - 0
- Erosion evident - 1
- Erosion and cracking present - 2
- Slumps and clumps sloughing off - 3

Bank Condition:

- Some bare bank, few rills, no vegetative overhang - 0
- Predominantly bare, some rills, moderate vegetative overhang - 1
- Bare, rills, severe vegetative overhang, exposed roots - 2
- Bare, rills and gullies, severe vegetative overhang, falling trees - 3

Vegetation / Cover On Banks:

- Predominantly perennials or rock-covered - 0
- Annuals / perennials mixed or about 40% bare - 1
- Annuals or about 70% bare - 2
- Predominantly bare - 3

Bank / Channel Shape:

- V - Shaped channel, sloped banks - 0
- Steep V - Shaped channel, near vertical banks - 1
- Vertical Banks, U - Shaped channel - 2
- U - Shaped channel, undercut banks, meandering channel - 3

Channel Bottom:

- Channel in bedrock / noneroding - 0

Soil bottom, gravels or cobbles, minor erosion - 1
Silt bottom, evidence of active downcutting - 2

Deposition:

No evidence of recent deposition - 1
Evidence of recent deposits, silt bars - 0

Cumulative Rating

Slight (0-4) Moderate (5-8) Severe (9+)

From the Cumulative Rating, the lateral recession rate is assigned.

0.01 - 0.05 feet per year **Slight**
0.06 - 0.15 feet per year **Moderate**
0.16 - 0.3 feet per year **Severe**
0.5+ feet per year **Very Severe**

Stream bank stability can also be characterized as stable or unstable and covered or uncovered according to the following definitions and for each definition, the corresponding stream bank erosion condition rating from the Bank Stability or Vegetation/Cover category as identified above and shown in italics here.

Stream banks are considered stable if they do not show indications of any of the following features:

- **Breakdown** - Obvious blocks of bank broken away and lying adjacent to the bank breakage. *Bank Stability Rating 3*
- **Slumping or False Bank** - Bank has obviously slipped down, cracks may or may not be obvious, but the slump feature is obvious. *Bank Stability Rating 2*
- **Fracture** - A crack is visibly obvious on the bank indicating that the block of bank is about to slump or move into the stream. *Bank Stability Rating 2*
- **Vertical and Eroding** - The bank is mostly uncovered and the bank angle is steeper than 80 degrees from the horizontal. *Bank Stability Rating 1*

Stream banks are considered covered if they show any of the following features:

- Perennial vegetation ground cover is greater than 50%. *Vegetation/Cover Rating 0*
- Roots of vegetation cover more than 50% of the bank (deep rooted plants such as willows and sedges provide such root cover). *Vegetation/Cover Rating 1*
- At least 50% of the bank surfaces are protected by rocks of cobble size or larger. *Vegetation/Cover Rating 0*
- At least 50% of the bank surfaces are protected by logs of 4-inch diameter or larger. *Vegetation/Cover Rating 1*

Stream bank stability is estimated using a simplified modification of Platts, Megahan, and Minshall (1983, p. 13) as stated in *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams* (Bauer and Burton, 1993). The modification allows for measuring stream bank stability in a more objective fashion. The lengths of banks on both sides of the stream throughout the entire linear distance of the representative reach are measured and proportioned into four stability classes as follows:

- **Mostly covered and stable (non-erosional).** Stream banks are over 50% covered as defined above. Stream banks are stable as defined above. Banks associated with gravel bars having perennial vegetation above the scourline are in this category. *Cumulative Rating 0 - 4 (slight erosion) with a corresponding lateral recession rate of 0.01 - 0.05 feet per year.*
- **Mostly covered and unstable (vulnerable).** Stream banks are over 50% covered as defined above. Stream banks are unstable as defined above. Such banks are typical of “false banks” observed in meadows where breakdown, slumping, and/or fracture show instability yet vegetative cover is abundant. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*
- **Mostly uncovered and stable (vulnerable).** Stream banks are less than 50% covered as defined above. Stream banks are stable as defined above. Uncovered, stable banks are typical of stream banks trampled by concentrations of cattle. Such trampling flattens the bank so that slumping and breakdown do not occur even though vegetative cover is significantly reduced or eliminated. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*
- **Mostly uncovered and unstable (erosional).** Stream banks are less than 50% covered as defined above. They are also unstable as defined above. These are bare eroding stream banks and include ALL banks mostly uncovered, which are at a steep angle to the water surface. *Cumulative Rating 9+ (severe erosion) with a corresponding lateral recession rate of over 0.5 feet per year.*

Stream banks were inventoried to quantify bank erosion rate and annual average erosion. These data were used to develop a quantitative sediment budget to be used for TMDL development.

Site Selection

The first step in the bank erosion inventory is to identify key problem areas. Stream bank erosion tends to increase as a function of watershed area (NRCS, 1983). The larger the watershed the greater the potential for stream banks to erode. As a result, the lower stream segment of larger watersheds tend to be problem areas due to sediment settling out from the water column and bank calving at higher flows because of excess soil saturation.. These stream segments tend to be alluvial streams. commonly classified as response reaches (Rosgen B and C channel types) (Rosgen,1996).

Because it is often unrealistic to try to survey every stream segment, sampled reaches were used and bank erosion rates are extrapolated over a larger stream segment. The length of the sampled reach is a function of stream type variability where streams segments with highly

variable channel types need a large sample, whereas segments with uniform gradient and consistent geometry need less. Typically, the amount of stream bank that needs to be inventoried is between 10 and 30%. Often, the location of some stream inventory reaches is more dependent on land ownership than watershed characteristics. For example, private land owners are sometimes unwilling to allow access to stream segments within their property. Stream reaches are subdivided into *sites* with similar channel and bank characteristics. Breaks between sites are made where channel type and/or dominant bank characteristics change substantially. In a stream with uniform channel geometry, there may be only one site per stream reach, whereas in an area with variable conditions there may be several sites. Subdivision of stream reaches is at the discretion of the leader of the field crew conducting the inventory.

Field Methods

These stream bank erosion or channel stability inventory field methods were originally developed by the USDA USFS (Pfankuch, 1975). Further development of channel stability inventory methods are outlined in Lohrey (1989) and NRCS (1983). As stated above, the NRCS (1983) document outlines field methods used in this inventory. However, slight modifications to the field methods were made and are documented.

Field crews typically consist of two to four people that are trained as a group to ensure quality control or consistent data collection. Field crews survey selected stream reaches measuring bank length, slope height, bankfull width and depth, and bank content. In most cases, a global positioning system (GPS) is used to locate the upper and lower boundaries of inventoried stream reaches. Additionally, while surveying, field crews photograph key problem areas.

Bank Erosion Calculations

The direct volume method is used to calculate average annual erosion rates for a given stream segment based on bank recession rate determined in the survey (NRCS, 1983). The erosion rate (tons/mile/year) is used to estimate the total bank erosion of the selected stream corridor.

The direct volume method is summarized in the following equations:

$$E = [A_E * R_{LR} * _B] / 2000 \text{ (lbs/ton)}$$

where:

E = bank erosion over sampled stream reach
(tons/yr/sample reach)

A_E = eroding area (ft²)

R_{LR} = lateral recession rate (ft/yr)

$_B$ = bulk density of bank material (lbs/ft³)

The bank erosion rate (E_R) is then calculated by dividing the sampled bank erosion (E) by the total stream length sampled:

$$E_R = E/L_{BB}$$

where:

E_R = bank erosion rate (tons/mile/year)

E = bank erosion over sampled stream reach
(tons/yr/sample reach)

L_{BB} = bank to bank stream length over sampled reach

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are greatly a function of soil moisture and stream discharge (Leopold et al, 1964). Because channel erosion events typically result from above-average flow events, the annual average bank erosion value should be considered a long-term average. For example, a 50-year flood event might cause 5 feet of bank erosion in one year and over a 10 year period this single event accounts for the majority of bank erosion. These factors have less of an influence where bank trampling is the major cause of channel instability.

The *eroding area* (A_E) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights are measured while walking along the stream channel. Pacing is used to measure horizontal distance, and bank slope heights are continually measured and averaged over a given reach or site. The horizontal length is the length of the right or left bank, not both. Typically, one bank along the stream channel is actively eroding; For example, the bank on the outside of a meander. However, both banks of channels with severe headcuts or gullies will be eroding and are to be measured separately and eventually summed.

Determining the *lateral recession rate* (R_{LR}) is one of the most critical factors in this methodology (NRCS, 1983). Several techniques are available to quantify bank erosion rates including: aerial photo interpretation, anecdotal data, bank pins and measured channel cross-sections.

To facilitate consistent data evaluation, the NRCS developed rating factors used to estimate lateral recession rate. Similar to methods developed by Pfankuch (1975), the NRCS method measures bank and channel stability, and then uses the ratings as surrogates for bank erosion rates.

The *bulk density* (B) of bank material is measured visually in the field. Soil bulk density is the weight of material divided by its volume, including the volume of its pore spaces. A table of typical soil bulk densities can be used, or soil samples can be collected and soil bulk density measured in the laboratory.

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STREAMBANK EROSION INVENTORY WORKSHEET

Stream: Duck Creek	Stream Segment Location (DD)	Elevation (ft)
Section: Empey Property	<i>Upstream:</i> N 44° 37.730'	W 111° 26.292'
Date Collected: 9/25/2008	<i>Downstream:</i> N 44° 37.577'	W 111° 26.377'
Field Crew: AS and HB	Landuse and Notes:	Grazing
Data Reduced By: AS		

Streambank Erosion Calculations	
Average Bank Height	1.5 ft
Total Inventoried Bank Length	1410 ft
Inventoried Bank to Bank Length	2820 ft
Erosive Bank Length	981 ft
Bank to Bank Eroding Segment Length	1962 ft
Percent Eroding Bank	69.57% %
Eroding Area	2943 ft^2
Recession Rate	0.12
Bulk Density	80 lb/ft^2
Bank Erosion over Sampled Reach (E)	14.1264 tons/year/sample reach
Erosion Rate (Er)	52.8988596 tons/mile/year
Feet of similar stream type	14100 ft
Eroding Bank Extrapolation	21582 ft
Total Streambank Erosion	155.3904 tons/year

Summary for Load Reductions				
Existing		Proposed		
Erosion Rate (t/mi/yr)	Total Erosion (t/y)	Erosion Rate (ton/mi/yr)	Total Erosion (t/yr)	
52.89885957	155.3904	15.2064	44.6688	71.25382263

Streambank Erosion Reduction Calculations	
Eroding Area With Load Reductions	846 ft^2
Erosion over sampled reach (with load reduction (20%))	4.0608 tons/yr/sample
Erosion Rate	15.2064 tons/mile/year
Feet of Similar Stream Type	14100 ft
Eroding Bank Extrapolation (with reduction)	6204 ft
Total Streambank Erosion	44.6688 tons/year

Recession Rate Calculation Worksheet

Slope Factor	Rating
Bank Stability (0-3)	2
Bank Condition (0-3)	1
Vegetative/cover on Banks (0-3)	2
Bank/Channel Shape - downcutting (0-3)	0
Channel Bottom (0-2)	1
Deposition (0-1)	1
Total = Slight (0-4); Moderate (5-8); Severe (9+)	7
Recession Rate	0.12

Figure 15. Duck Creek stream bank erosion inventory.

STREAMBANK EROSION INVENTORY WORKSHEET

Stream: Sheridan Creek	Stream Segment Location (DD)	Elevation (ft)
Section: Sheridan Ranch Property	Upstream: N 44° 27.277'	W 111° 40.793'
Date Collected: 9/24/2008	Downstream: N 44° 27.062'	W 111° 40.893'
Field Crew: AS and JR	Landuse and Notes:	Grazing
Data Reduced By: AS		

Streambank Erosion Calculations	
Average Bank Height	0.53 ft
Total Inventoried Bank Length	1401 ft
Inventoried Bank to Bank Length	2802 ft
Erosive Bank Length	160 ft
Bank to Bank Eroding Segment Length	320 ft
Percent Eroding Bank	0.11420414 %
Eroding Area	169.6 ft ²
Recession Rate	0.01
Bulk Density	80 lb/ft ³
Bank Erosion over Sampled Reach (E)	0.06784 tons/year/sample reach
Erosion Rate (Er)	0.25567109 tons/mile/year
Feet of similar stream type	14010 ft
Eroding Bank Extrapolation	3520 ft
Total Streambank Erosion	0.74624 tons/year

Summary for Load Reductions				
Existing		Proposed		% reduction
Erosion Rate (t/mi/yr)	Total Erosion (t/yr)	Erosion Rate (ton/mi/yr)	Total Erosion (t/yr)	
0.255671092	0.74624	0.447744	1.3068528	-75.125

Streambank Erosion Reduction Calculations	
Eroding Area With Load Reductions	297.012 ft ²
Erosion over sampled reach (with load reduction (20%))	0.118805 tons/yr/sample
Erosion Rate	0.447744 tons/mile/year
Feet of Similar Stream Type	14010 ft
Eroding Bank Extrapolation (with reduction)	6164.4 ft
Total Streambank Erosion	1.306853 tons/year

Recession Rate Calculation Worksheet

Slope Factor	Rating
Bank Stability (0-3)	0
Bank Condition (0-3)	0
Vegetative/cover on Banks (0-3)	0
Bank/Channel Shape - downcutting (0-3)	0
Channel Bottom (0-2)	0
Deposition (0-1)	0
Total = Slight (0-4); Moderate (5-8); Severe (9+)	0
Recession Rate	0.01

Figure 16. Sheridan Creek at Sheridan Ranch erosion inventory.

STREAMBANK EROSION INVENTORY WORKSHEET

Stream: Sheridan Creek	Stream Segment Location (DD)	Elevation (ft)
Section: Idaho Department of Lands Property	<i>Upstream:</i> N 44° 25.815'	W 111° 40.991'
Date Collected: 9/24/2008	<i>Downstream:</i> N 44° 25.735'	W 111° 40.736'
Field Crew: AS and JR	Landuse and Notes:	Grazing
Data Reduced By: AS		

Streambank Erosion Calculations	
Average Bank Height	1 ft
Total Inventoried Bank Length	1500 ft
Inventoried Bank to Bank Length	3000 ft
Erosive Bank Length	1486 ft
Bank to Bank Eroding Segment Length	2972 ft
Percent Eroding Bank	0.99066667 %
Eroding Area	2972 ft ²
Recession Rate	0.06
Bulk Density	80 lb/ft ³
Bank Erosion over Sampled Reach (E)	7.1328 tons/year/sample reach
Erosion Rate (Er)	25.107456 tons/mile/year
Feet of similar stream type	15000 ft
Eroding Bank Extrapolation	32692 ft
Total Streambank Erosion	78.4608 tons/year

Summary for Load Reductions				
Existing		Proposed		% reduction
Erosion Rate (t/mi/yr)	Total Erosion (t/y)	Erosion Rate (ton/mi/yr)	Total Erosion (t/yr)	
25.107456	78.4608	5.0688	15.84	79.8115747

Streambank Erosion Reduction Calculations	
Eroding Area With Load Reductions	600 ft ²
Erosion over sampled reach (with load reduction (20%))	1.44 tons/yr/sample
Erosion Rate	5.0688 tons/mile/year
Feet of Similar Stream Type	15000 ft
Eroding Bank Extrapolation (with reduction)	6600 ft
Total Streambank Erosion	15.84 tons/year

Recession Rate Calculation Worksheet

Slope Factor	Rating
Bank Stability (0-3)	2
Bank Condition (0-3)	1
Vegetative/cover on Banks (0-3)	1
Bank/Channel Shape - downcutting (0-3)	0
Channel Bottom (0-2)	0
Deposition (0-1)	1
Total = Slight (0-4); Moderate (5-8); Severe (9+)	5
Recession Rate	0.06

Figure 17. Sheridan Creek on IDL property erosion inventory.

STREAMBANK EROSION INVENTORY WORKSHEET

Stream: Sheridan Creek	Stream Segment Location (DD)	Elevation (ft)
Section: Harriman State Park	Upstream: N 44° 24.046'	W 111° 34.557'
Date Collected: 9/24/2008	Downstream: N 44° 24.072'	W 111° 34.762'
Field Crew: AS and JR	Landuse and Notes:	Grazing
Data Reduced By: AS		

Streambank Erosion Calculations	
Average Bank Height	1.8 ft
Total Inventoried Bank Length	1209 ft
Inventoried Bank to Bank Length	2418 ft
Erosive Bank Length	541 ft
Bank to Bank Eroding Segment Length	1082 ft
Percent Eroding Bank	0.44747725 %
Eroding Area	1947.6 ft ²
Recession Rate	0.09
Bulk Density	80 lb/ft ³
Bank Erosion over Sampled Reach (E)	7.01136 tons/year/sample reach
Erosion Rate (Er)	30.6203315 tons/mile/year
Feet of similar stream type	12090 ft
Eroding Bank Extrapolation	11902 ft
Total Streambank Erosion	77.12496 tons/year

Summary for Load Reductions				
Existing		Proposed		% reduction
Erosion Rate (t/mi/yr)	Total Erosion (t/y)	Erosion Rate (ton/mi/yr)	Total Erosion (t/yr)	
30.62033151	77.12496	13.68576	34.471008	55.30499076

Streambank Erosion Reduction Calculations	
Eroding Area With Load Reductions	870.48 ft ²
Erosion over sampled reach (with load reduction (20%))	3.133728 tons/yr/sample
Erosion Rate	13.68576 tons/mile/year
Feet of Similar Stream Type	12090 ft
Eroding Bank Extrapolation (with reduction)	5319.6 ft
Total Streambank Erosion	34.47101 tons/year

Recession Rate Calculation Worksheet

Slope Factor	Rating
Bank Stability (0-3)	3
Bank Condition (0-3)	1
Vegetative/cover on Banks (0-3)	1
Bank/Channel Shape - downcutting (0-3)	0
Channel Bottom (0-2)	0
Deposition (0-1)	1
Total = Slight (0-4); Moderate (5-8); Severe (9+)	6
Recession Rate	0.09

Figure 18. Sheridan Creek at Harriman State Park erosion inventory.

Streambank Erosion Reduction Calculations	
Eroding Area With Load Reductions	446.16 ft ²
Erosion over sampled reach (with load reduction (20%))	0.535392 tons/yr/sample
Erosion Rate	1.64736 tons/mile/year
Feet of Similar Stream Type	17160 ft
Eroding Bank Extrapolation (with reduction)	7550.4 ft
Total Streambank Erosion	5.889312 tons/year

Recession Rate Calculation Worksheet	
Slope Factor	Rating
Bank Stability (0-3)	1
Bank Condition (0-3)	0
Vegetative/cover on Banks (0-3)	0
Bank/Channel Shape - downcutting (0-3)	0
Channel Bottom (0-2)	0
Deposition (0-1)	1
Total = Slight (0-4); Moderate (5-8); Severe (9+)	2
Recession Rate	0.03

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Streambank Erosion Calculations				
Average Bank Height	1.5	ft		
Total Inventoried Bank Length	1632	ft		
Inventoried Bank to Bank Length	3264	ft		
Erosive Bank Length	194	ft		
Bank to Bank Eroding Segment Length	388	ft		
Percent Eroding Bank	0.11887255	%		
Eroding Area	582	ft^2		
Recession Rate	0.04			
Bulk Density	80	lb/ft^2		
Bank Erosion over Sampled Reach (E)	0.9312	tons/year/sample reach		
Erosion Rate (Er)	3.01270588	tons/mile/year		
Feet of similar stream type	16320	ft		
Eroding Bank Extrapolation	4268	ft		
Total Streambank Erosion	10.2432	tons/year		
Summary for Load Reductions				
Existing		Proposed		% reduction
Erosion Rate (t/mi/yr)	Total Erosion (t/y)	Erosion Rate (ton/mi/yr)	Total Erosion (t/yr)	
3.012705882	10.2432	5.0688	17.23392	
				-68.24742268

Streambank Erosion Reduction Calculations		
Eroding Area With Load Reductions	979.2	ft^2
Erosion over sampled reach (with load reduction (20%))	1.56672	tons/yr/sample
Erosion Rate	5.0688	tons/mile/year
Feet of Similar Stream Type	16320	ft
Eroding Bank Extrapolation (with reduction)	7180.8	ft
Total Streambank Erosion	17.23392	tons/year
Recession Rate Calculation Worksheet		
Slope Factor	Rating	
Bank Stability (0-3)	1	
Bank Condition (0-3)	1	
Vegetative/cover on Banks (0-3)	0	
Bank/Channel Shape - downcutting (0-3)	0	
Channel Bottom (0-2)	0	
Deposition (0-1)	1	
Total = Slight (0-4); Moderate (5-8); Severe (9+)	3	
Recession Rate	0.04	

Figure 20. Willow Creek—meets sediment target.

Appendix D. 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 with species. For spring spawning salmonids, the default spawning and incubation period recognized by DEQ is generally from March 15th to July 1st each year (Grafe et al., 2002). Fall spawning can occur as early as August 15th and continue with incubation on into the following spring up to June 1st. As per IDAPA 58.01.02.250.02.e.ii., the water quality criteria that need to be met during that time period are:

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 highest annual MWMT 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 these 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. As per IDAPA 58.01.02.200.09:

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, pollutant levels shall not exceed the natural background conditions, except that temperature levels may be increased above natural background conditions when allowed under Section 401.

Section 401 relates to point source wastewater treatment requirements. In this case if temperature criteria for any aquatic life use is exceeded due to natural conditions, then a point source discharge cannot raise the water temperature by more than 0.3°C (IDAPA 58.01.02.401.03.a.v.).

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Appendix E. Data Sources and Shade Curves

Table E-1. Data sources for Upper Henry's Fork TMDLs.

Water Body	Data Source	Type of Data	When Collected
Warm River, Howard Creek, Duck Creek, Targhee Creek, Timber Creek	DEQ State Technical Services Office	Pathfinder effective shade and stream width	August 2006
Warm River, Howard Creek, Duck Creek, Targhee Creek, Timber Creek	DEQ State Technical Services Office	Aerial Photo Interpretation of existing shade and stream width estimation	July 2006
	DEQ IDASA Database	Temperature	

Shade Curves from Shumar and De Varona (2009)

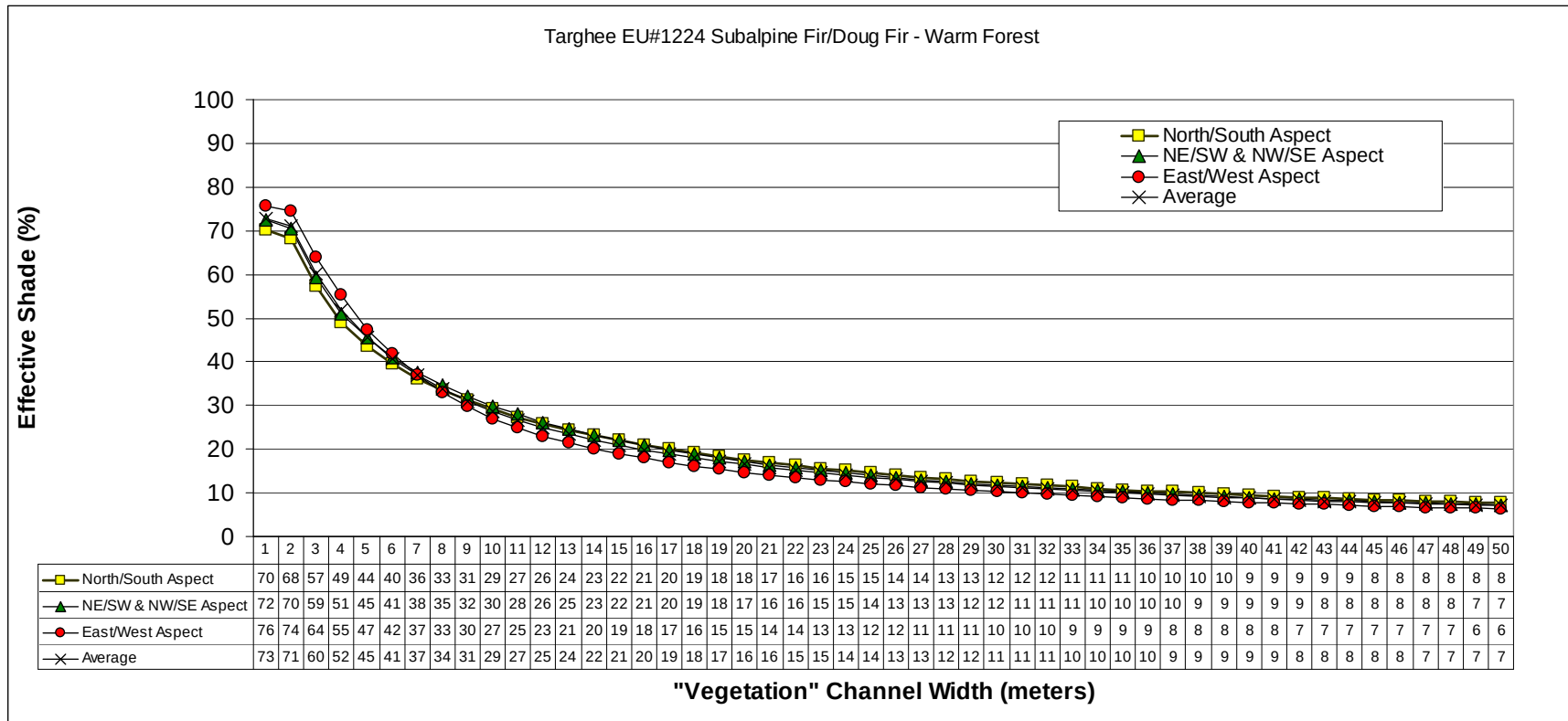


Figure 21. Shade curve for EU # 1224.

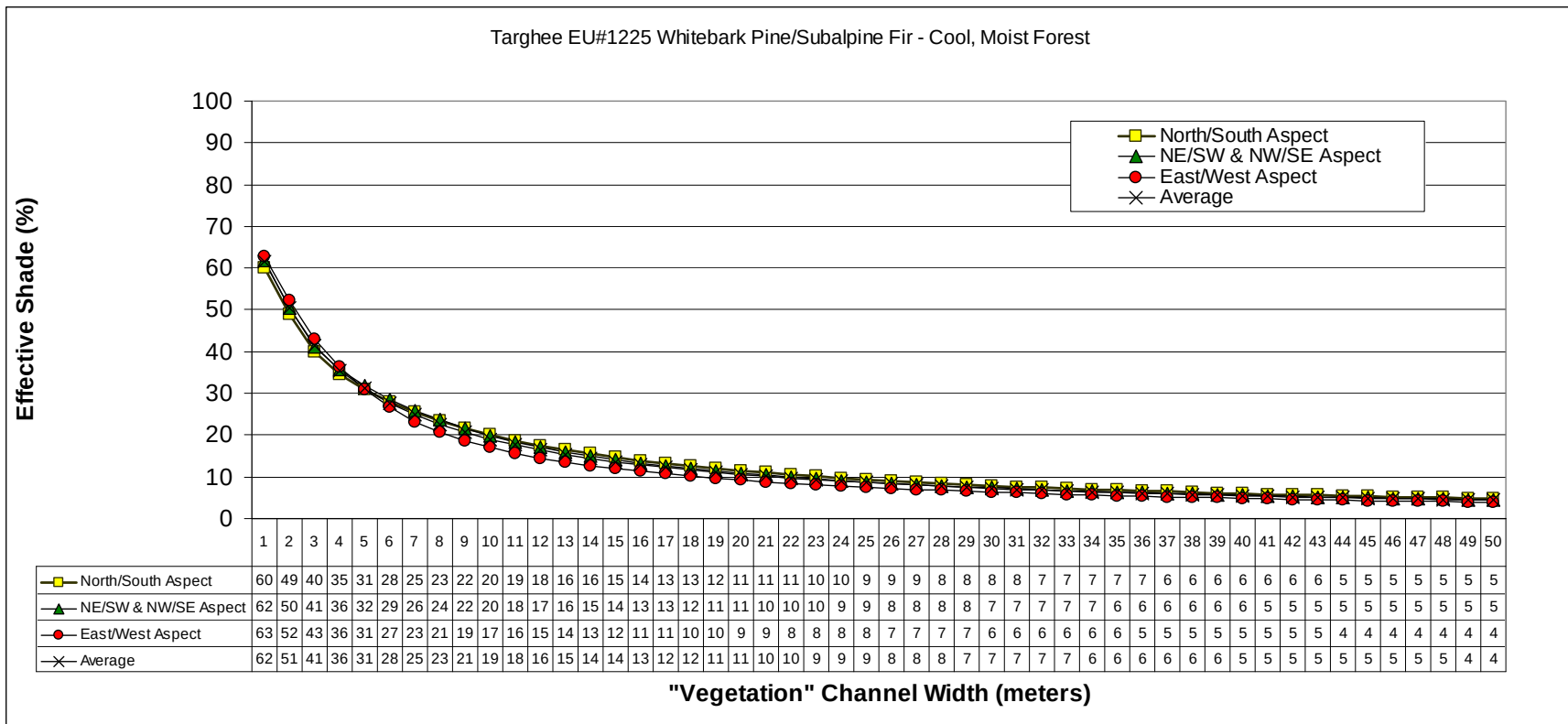


Figure 22. Shade curve for EU# 1225.

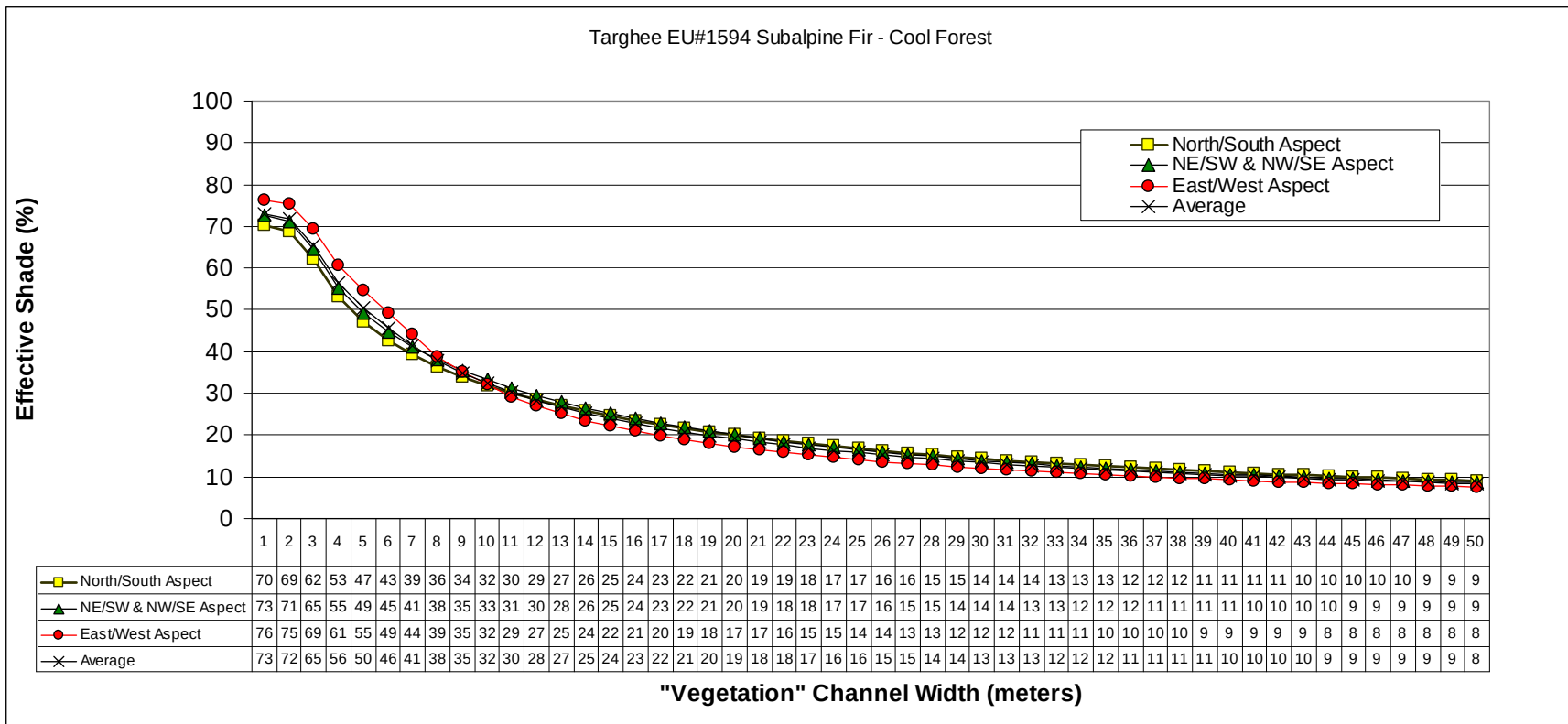


Figure 23. Shade curve for EU# 1594.

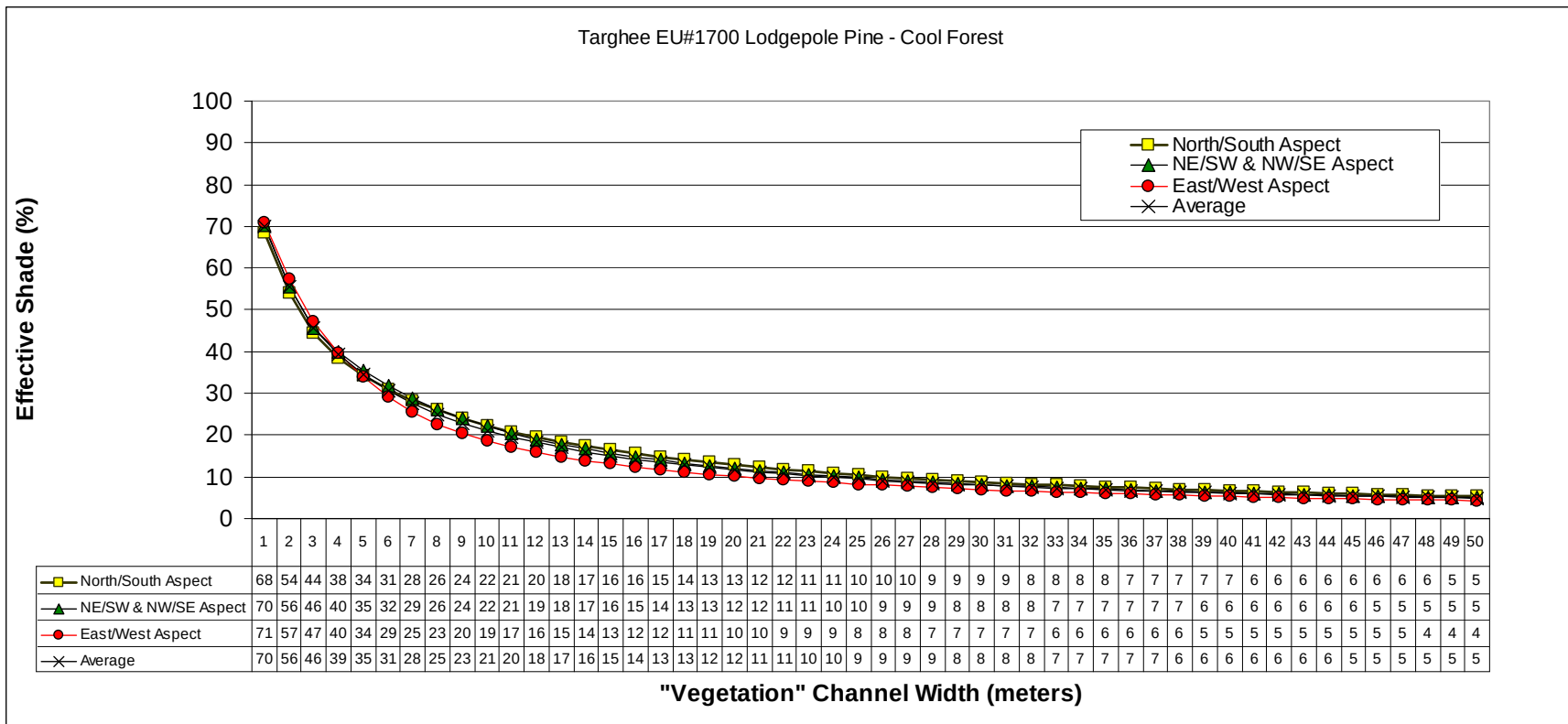


Figure 24. Shade curve for EU# 1700.

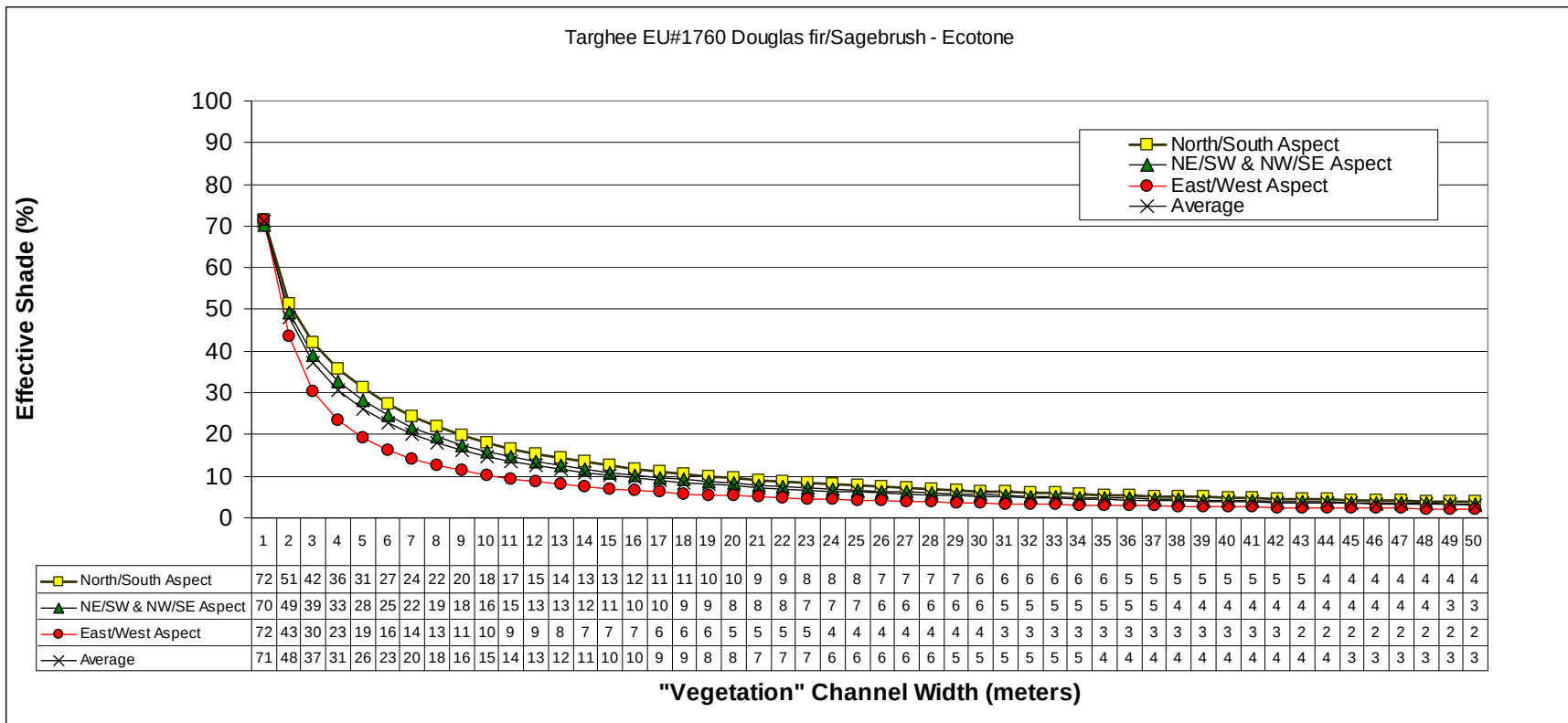


Figure 25. Shade curve for EU# 1760.

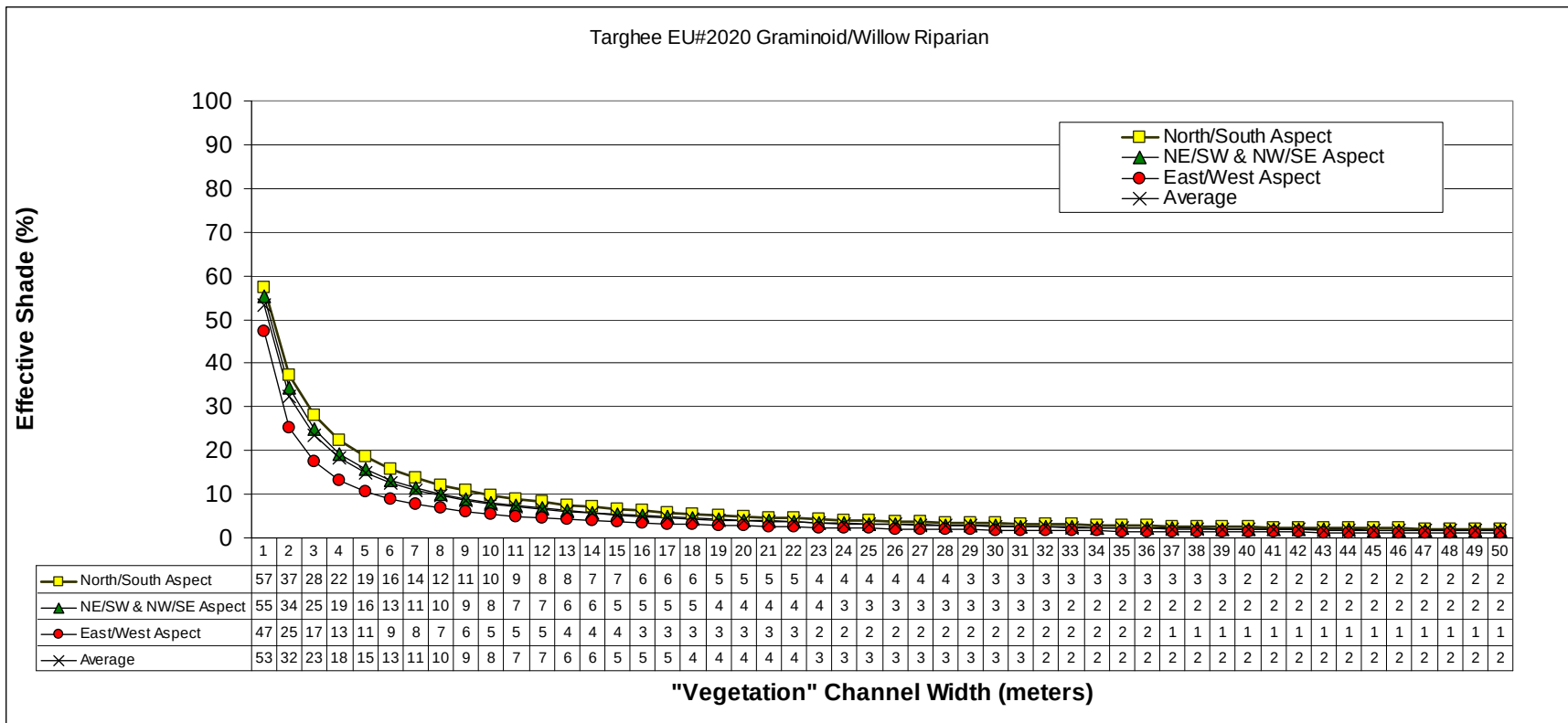


Figure 26. Shade curve for EU# 2020.

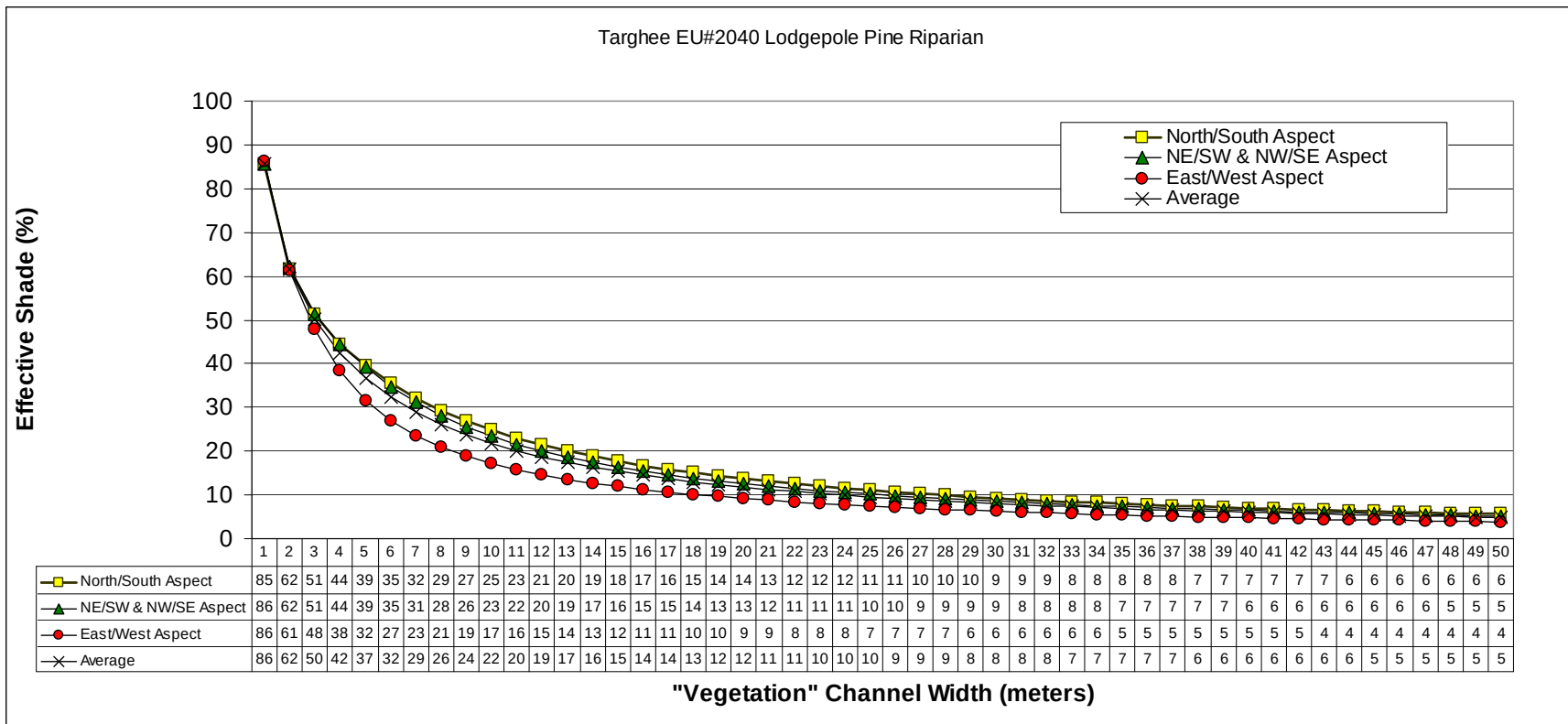


Figure 27. Shade curve for EU# 2040.

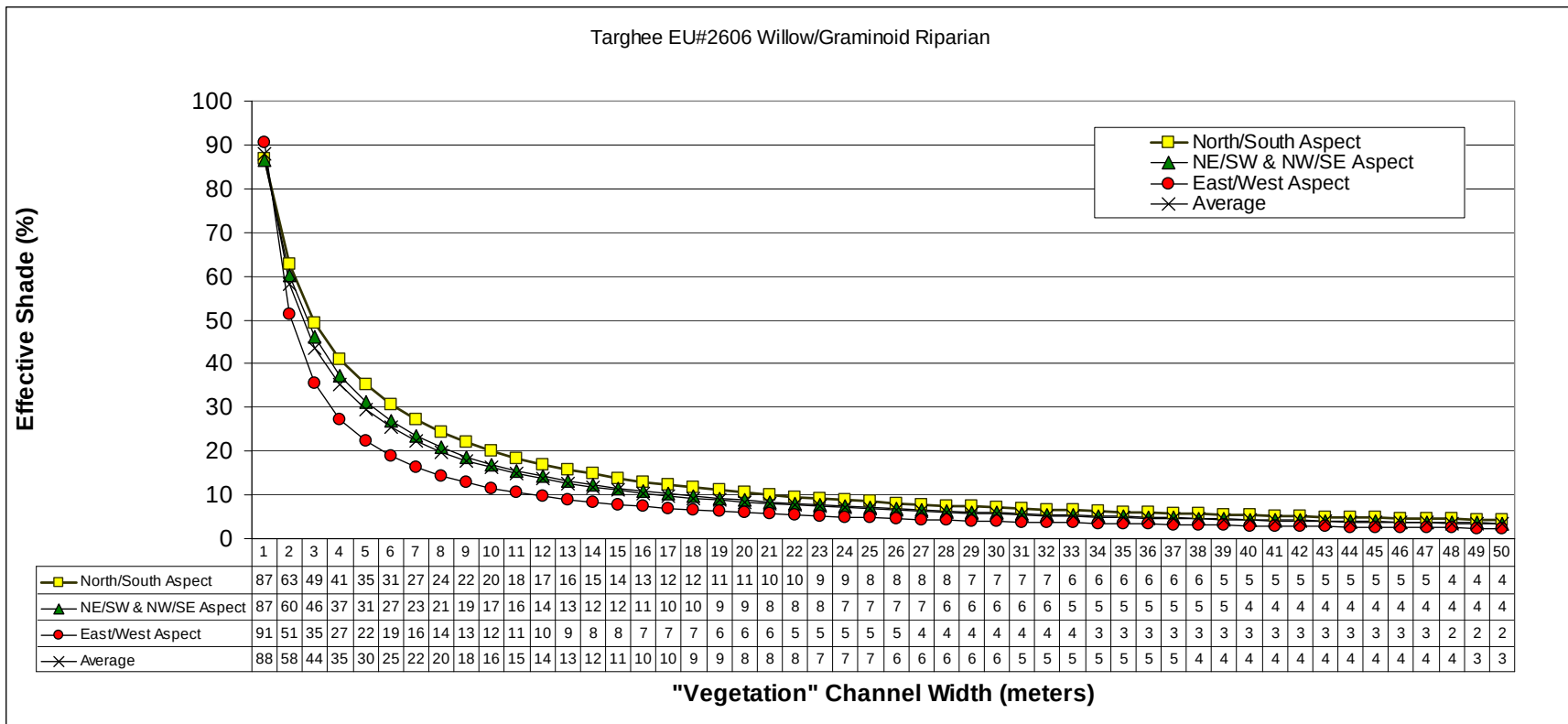


Figure 28. Shade curve for EU# 2606.

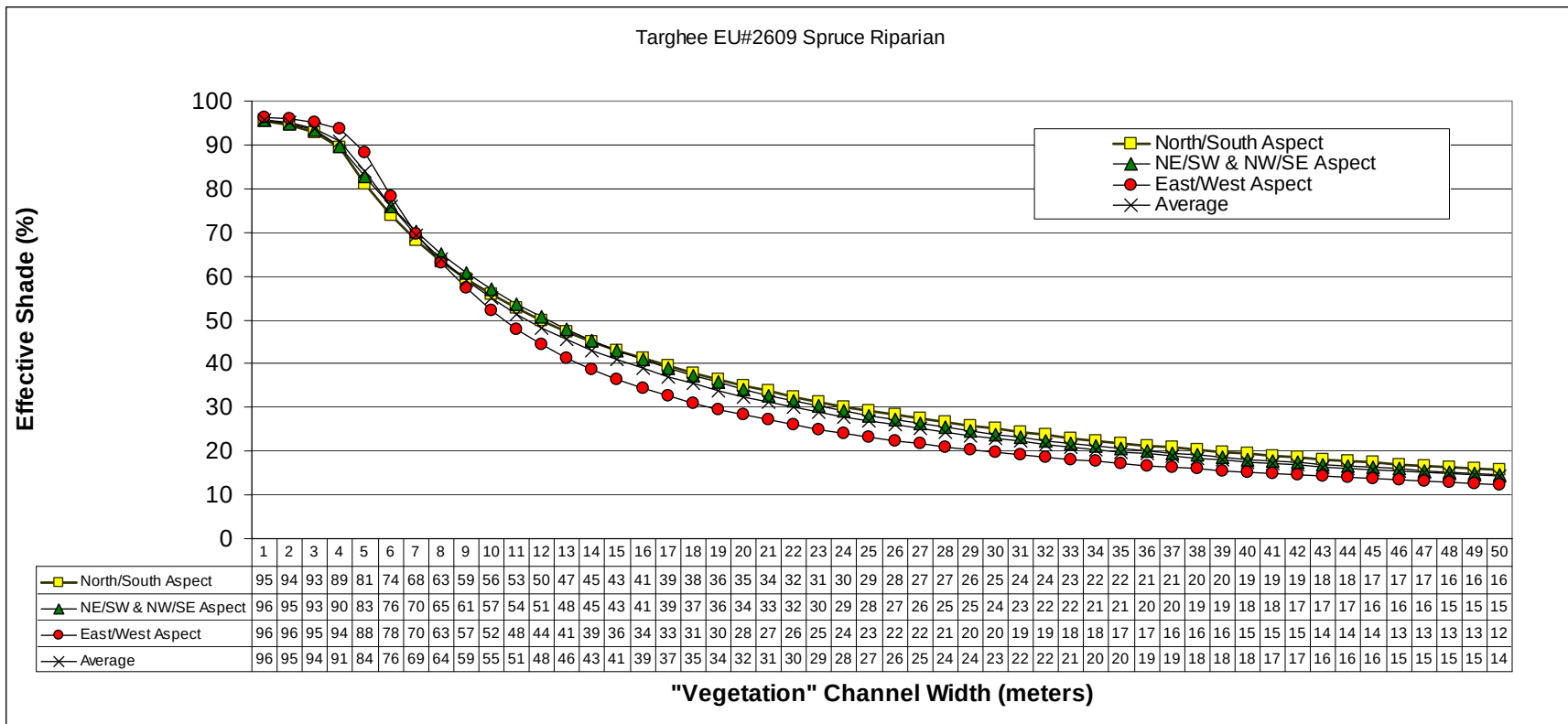


Figure 29. Shade curve for EU# 2609.

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Appendix F. Geometric Mean Data for Conant Creek



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Idaho DEQ
Aaron Swift
900 N. Skyline Dr. Suite B
Idaho Falls, ID 83402

Date Submitted: 9/1/2009

Date Reported: 9/8/2009

Certificate of Analysis

Sample Description: Conant Cr.
Sampling Date: 09-01-2009
Sampling Time: 9:10
Date Received: 09-01-2009
Lab Tracking #: 109091369

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	517.2	MPN/100ml	Quantitray	09/01/09	BN

G. Ryan Pattie/la
Lab Director

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Idaho DEQ
Aaron Swift
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Idaho Falls, ID 83402

Date Submitted: 9/9/2009
Date Reported: 9/18/2009

Certificate of Analysis

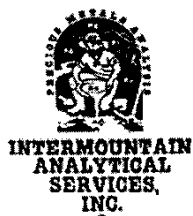
Sample Description: Conant Cr.
Sampling Date: 09-09-2009
Sampling Time: 9:05
Date Received: 09-09-2009
Lab Tracking #: 109091554

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	613.1	MPN/100ml	Quantitray	09/09/09	BN

G. Ryan Pattie/la
Lab Director

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Idaho DEQ
Aaron Swift
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Date Submitted: 9/16/2009
Date Reported: 9/22/2009

Certificate of Analysis

Sample Description: Conant Cr
Sampling Date: 09-16-2009
Sampling Time: 8:49
Date Received: 09-16-2009
Lab Tracking #: 109091723

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	816.4	MPN/100ml	Quantitray	09/16/09	BN

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Aaron Swift
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Date Submitted: 9/23/2009
Date Reported: 9/24/2009

Certificate of Analysis

Sample Description: Conant Cr.
Sampling Date: 09-23-2009
Sampling Time: 9:25
Date Received: 09-23-2009
Lab Tracking #: 109091931

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	1732.9	MPN/100ml	Quantitray	09/23/09	BN

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Idaho DEQ
Aaron Swift
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Date Submitted: 9/29/2009
Date Reported: 9/30/2009

Certificate of Analysis

Sample Description: Conant Cr.
Sampling Date: 09-29-2009
Sampling Time: 8:23
Date Received: 09-29-2009
Lab Tracking #: 109092125

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	1732.9	MPN/100ml	Quantitray	09/29/09	BN

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Appendix G. Fremont County 2009 Water Sampling Report

Attached is a summary of the 2009 Fremont County Water Sampling Report performed by Keller Associates. A complete version of Keller Associates report can be found at Fremont Counties website: <http://www.co.fremont.id.us/>. The report details water sampling results, site summaries, precipitation results and conclusion. Further questions concerning the report should be directed to Fremont County.

1.0 Introduction

1.1 Background

Fremont County has been monitoring several points throughout their surface water system since 2005 during the months of July, August, and September to determine if the groundwater in Island Park is being impacted due to the numbers of developed homes in the region. The sample dates for 2009 were July 1st, August 5th, and September 16th. The same sampling locations were used in all years except in the year 2007 sites 3, 6, and 12 were discontinued and sites 13, 14, 15, and 16 were added. In each year sampling points were tested for the same contaminants as the previous years. However, West Buffalo, Site #9, was tested for Human Bacteroidetes ID for the 2009 year. Samples for this test were collected at the Elk Creek Site #10 in 2008, which tested positive for presence of Human DNA.

The groundwater testing from the three local wells in the area were not tested this year due to insignificant data results from 2008.

1.2 Objectives

The objectives for this sample plan are as follows:

- Evaluate the water quality sampling results to establish surface and groundwater quality trends of the Island Park area. See Appendix D for site locations.
- Examine the possibility that increased contamination is due to human influences.
- Determine if contamination will increase incrementally each year or if there are only occasional spikes for unknown reasons.

2.0 Island Park Water Sampling Results

This section describes each testing constituent and the possible causes of each in the local environment. 13 sites were selected to provide information and quantify potential surface water contamination throughout the Island Park area. The samples were analyzed for the presence of Fecal Coliform, Fecal Strep, *E. Coli*, Nitrate as Nitrogen, Total Phosphorus as Phosphorus, and Ortho Phosphate as Phosphorus. A summary and discussion of each of these water contaminants are listed below.

2.1 Fecal Coliform

Fecal coliform is a facultatively-anaerobic, rod-shaped, gram-negative, non-sporulating class of bacteria. They are used to determine the presence of contamination in aquatic environments of fecal matter passed from humans, animals, and/or agriculture. High quantities (>200 CFU/100mL) of fecal coliform bacteria in water may indicate a higher risk of pathogens present in the water. Some waterborne pathogenic diseases include ear infections, dysentery, typhoid fever, viral and bacterial gastroenteritis, and Hepatitis A. The

presence of fecal coliform bacteria tends to affect humans more often than aquatic animals. (http://en.wikipedia.org/wiki/Fecal_coliforms)

2.2 Fecal Strep

Fecal Strep (Fecal Streptococcus) is found in the gastrointestinal tract of warm-blooded animals. Fecal Strep has been used with Fecal Coliform to identify human fecal contamination from that of other warm-blooded animals. This is known as the FC/FS ratio. A ratio greater than four was considered indicative of human contamination, while a ratio lower than 0.7 was considered non-human contamination. The value of this ratio has been questioned for its significance as it has been found that the survival rate of fecal streptococcus group species is variable.

(http://filebox.vt.edu/users/chagedor/biol_4684/mfstrep.html)

2.3 *E. Coli*

E. Coli (Escherichia Coli) is a gram negative bacterium that is commonly found in the lower intestine of warm blooded animals. Most *E. Coli* strains are harmless but some, such as serotype, can cause serious food poisoning in humans. It is not always contained in the intestines and it has the ability to survive outside the body. This makes it an ideal indicator organism to test environmental samples for fecal contamination.

(http://en.wikipedia.org/wiki/Escherichia_coli)

The Environmental Protection Agency (EPA) has set limits for exposure to *E. Coli* in public waters. These are described in IDAPA 58.01.02.251. Secondary contact recreation has a maximum limit of 576 organisms/100mL, primary contact recreation has a maximum limit of 406 organisms/100 mL, and those areas that are primary contact recreation areas that are specified as public swimming areas have a maximum limit of 235 organisms/100mL.

2.4 Nitrate as Nitrogen

Nitrate (NO₃) is highly soluble in water and is easily transported in streams and groundwater. Nitrates feed plankton, aquatic plants, and algae, which are then eaten by fish. Excessive amounts of nitrate and/or nitrite can be harmful to humans and wildlife. Nitrate mostly concerns the health of humans as it is broken down in our intestines to become nitrite. Nitrite reacts with the hemoglobins in our blood to produce methemoglobin, which limits the ability of the red blood cells to carry oxygen. High concentrations of nitrate and/or nitrite can produce brown blood disease in fish, where the nitrite turns the blood a chocolate-brown and doesn't allow the blood to carry sufficient amounts of oxygen throughout the fish. Large amounts of both phosphorus and nitrates in water can cause the production of large quantities of algae known as blooms. The algae use these nutrients as vital components to their growth. An abundance of the nutrients support significant growth which can lead to significant surface water impacts such as Eutrofication.

<http://bcn.boulder.co.us/basin/data/BACT/info/NH3.html>

The EPA has set nitrate limits at 10 part per million (ppm). EPA believes that this limit is low enough to not cause any of the potential health hazards as described above.

<http://bcn.boulder.co.us/basin/data/BACT/info/images/bloodbig.gif>

2.5 Total Phosphorus as Phosphorus

Phosphorus can occur naturally and from man made sources, such as detergents, soaps, shampoo, and fertilizers. Phosphates are not toxic to humans or animals unless they are present in very high levels. Digestive problems could occur if extremely high levels of phosphate are ingested. (<http://epa.gov/safewater/contaminants/ecoli.html>) The primary environmental concern due to phosphorus is as a critical nutrient to plant life. The presence of phosphorus in combination with nitrogen can cause excessive algae growth, which leads to eutrophic waters. EPA has enforced limits on point source discharge to critical surface water to as low as 0.05 mg/L.

2.6 Ortho Phosphate as Phosphorus

Ortho phosphates are also created by natural processes and manmade sources; including partially treated or untreated sewage, and agricultural or industrial runoff. (<http://www.water-research.net/phosphate.htm>)

3.0 Site Summaries

This section reviews important characteristics of each site and how this year's sampling compares with previous years. Please examine the correlating tables and graphs located in Appendix A. Also a figure showing each site's location and its relation to others has been included in Appendix B.

3.1 Site 1 – Rexburg Boat Club

- The 2009 Fecal Coliform levels are comparable to those seen in 2005 and 2006. With levels consistently below 4 CFU/100 ml, the results were lower than some seen in 2007 and 2008. The highest level recorded to date was in July 2008 with Too Numerous to Count (TNTC).
- The 2009 Fecal Strep levels were lower than 2008, with the highest level in 2009 of 2 CFU/100ml. The highest recorded level at this site, greater than 2,419 CFU/100mL, was recorded in July 2008.
- The 2009 E. Coli levels were all less than 1.0 CFU/100ml which is comparable to 2007 and 2008 and lower than 2005 and 2006. The highest recorded levels were in 2005 and 2006 of 4 CFU/100mL.
- The 2009 Nitrate and Ortho Phosphate levels were comparable to all previous years with the majority of the levels less than 1 mg/L.
- The 2009 Total Phosphorus levels were consistent 0.03 mg/l throughout the year. This is generally lower than all previous years' samples and the highest recorded level was 0.17 mg/l in June 2005.

3.2 Site 2 – BIA Boat Dock

- In July 2009, the recorded Fecal Coliform level was 400 CFU/100ml, which is the second highest recorded level at this site. The levels for August and September were

both less than 4 CFU/100mL. This is similar to the pattern and values seen in 2008. The highest recorded level at this site was TNTC in July 2008.

- In July 2009, the Fecal Strep level was recorded as being 547.5 CFU/100mL, the second highest level recorded at this site. The levels then dropped to 1 and 3.1 CFU/100mL in August and September. This is also similar to the pattern and values seen in 2008. The highest recorded value was in July 2008 at greater than 2419 CFU/100ml.
- In July 2009, the E.Coli level was recorded as 14.6 CFU/100ml. This is the highest level seen to date at this site. The levels from August and September were comparable with previous years.
- The 2009 Nitrate and Ortho Phosphate levels have been consistent each sampled year with very low (<1.0 mg/l, <0.01 mg/l) to non-detectable.
- The 2009 Total Phosphorus levels were consistent to previous years with levels at 0.04 and 0.03 mg/l. The highest recorded level was in September 2007 at 0.28 mg/l.

3.3 Site 4 – Island Park Causeway

- In July 2009, the Fecal Coliform levels were recorded as 800 CFU/100ml, the second highest level recorded at this site. July and August were comparable with previous years with values less than 4 CFU/100ml. The highest recorded level at this site was in July 2008 with TNTC.
- In July 2009, Fecal Strep levels were recorded as 648.8 CFU/100ml, the third highest recorded level. The highest level at this site was in July 2008 at greater than 2419 CFU/100ml.
- In September 2009, the E.Coli level was recorded as 5.2 CFU/100ml, the second highest recorded level at this site. The highest recorded level was 39.9 CFU/100ml in August 2007.
- The 2009 Nitrate and Ortho Phosphate levels were comparable to those of previous years (<1.00 and <0.01 mg/l).
- The 2009 Total Phosphorus levels (0.04 and 0.08 mg/l) were comparable to the levels experienced in previous years with a general trend of increasing values in September. The highest recorded value was experienced in September 2007 of 1.74 mg/L.

3.4 Site 5 – CC Cowen Henry's Fork

- The 2009 Fecal Coliform levels were consistently below 4 CFU/100ml, which is comparable to the levels seen in 2005 and 2006. The levels were lower than those seen 2007 and 2008, with the highest recorded level of 76 CFU/100ml in July 2007.
- The 2009 Fecal Strep levels (2 and 4.1 CFU/100ml) were generally lower than previous year samples. The highest recorded level was 251 CFU/100ml in June 2007
- The 2009 E. Coli levels were consistently 1.0 CFU/100ml or below, comparable to those measured in previous years. The highest recorded level was 13 CFU/100ml in September 2007.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, <0.01 mg/l) are comparable to previous years.
- The 2009 Total Phosphorus levels (0.07, 0.03, 0.05 CFU/100ml) were comparable to previous years. The highest recorded level at this site was 0.22 mg/l in September 2007.

3.5 Site 7 – McCrea Bridge

- The 2009 Fecal Coliform levels were consistently 4 CFU/100ml. The highest recorded level was TNTC in June 2005.
- The 2009 Fecal Strep levels (4.1, 3.1, 1 CFU/100ml) were comparable to those seen in 2008. The highest recorded value was 127.4 CFU/100mL in July 2007.
- The highest 2009 E. Coli level was 14.8 CFU/100ml in August. The highest recorded level at this site was 101.9 CFU/100ml in July 2008.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, <0.01 mg/l) have been comparable to all previous years.
- The 2009 Total Phosphorus levels (0.04, 0.02, 0.01 mg/l) were comparable to those recorded in all previous years.

3.6 Site 8 – East Buffalo

- The highest 2009 Fecal Coliform level was 32 CFU/100ml in August. The highest recorded level at this site was 280 CFU/100mL in July 2007.
- The 2009 Fecal Strep levels (4.1, 7.4, 5.2 CFU/100ml) were comparable to those recorded in 2007 and 2008. The highest recorded level at this site was 26.6 CFU/100mL in July 2007.
- The highest 2009 E. Coli level was 59.1 CFU/100ml in August. In levels were generally higher than those in 2008. The highest recorded level was 124.6 CFU/100mL in July 2007.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, <0.01 mg/l) have been consistent to all previous years.
- In July 2009, the highest level of Total Phosphorus was recorded at this site of 0.05mg/l. The remaining levels are comparable to those recorded in previous years.

3.7 Site 9 – West Buffalo

- The highest 2009 Fecal Coliform level was 50 CFU/100ml in September. The highest recorded level was in July 2005 of 176 CFU/100mL.
- The 2009 Fecal Strep levels (8.5, 6.3, <1 CFU/100ml) were comparable to those recorded in previous years. The highest recorded level was 30.1 CFU/100mL in July 2007.
- The highest 2009 E. Coli level was 41.6 CFU/100ml in August. The levels were generally higher than those measured in 2008. The highest recorded level at this site was 152 CFU/100mL in June 2005.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, <0.01 mg/l) have been consistent to all previous years.
- The 2009 Total Phosphorus levels (0.04, 0.02, 0.01 mg/l) were comparable to those recorded in previous years. No significant trends can be assumed.
- The 2009 Microbial Sourcing performed to detect the Fecal Bacteroidetes Human Gene Biomarker for human fecal contamination was negative.

3.8 Site 10 – Elk Creek

- The highest 2009 Fecal Coliform level was 68 CFU/100ml in July. The levels were generally lower than 2008. The highest recorded level was TNTC in July 2008 and August 2008.
- The highest 2009 Fecal Strep level was 90.5 CFU/100ml in September. The highest recorded value was 1203 CFU/100mL in July 2008.
- The 2009 E. Coli levels were 160.7 CFU/100ml in July and 186 CFU/100ml in August, which are the second and third highest recorded levels at this site. The highest recorded level is 205 CFU/100ml in July 2005.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, <0.01 mg/l) were consistent with previous years.
- The 2009 Total Phosphorus levels (<0.05 mg/l) were comparable to those recorded in all previous years.

3.9 Site 11 – Buffalo Summer Homes

- The highest 2009 Fecal Coliform level was 8 CFU/100mL in July. The highest recorded value was in July 2007 of 320 CFU/100mL.
- The highest 2009 Fecal Strep level was 10.9 CFU/100ml in September. The highest recorded value was in August 2007 of 18.3 CFU/100mL
- The highest 2009 E. Coli level was 83.3 CFU/100ml in September, which is the second highest recorded level at this site. The highest recorded level was 185 CFU/100ml in July 2005.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, <0.01 mg/l) have been consistent to previous years.
- The 2009 Total Phosphorus levels (0.04, 0.02, 0.01 mg/l) were comparable to those recorded in previous years.

3.10 Site 13 – Mack’s Inn Bridge

- The highest 2009 Fecal Coliform level was 20 CFU/100ml in August. The highest recorded level was 120 CFU/100 ml in July 2007.
- The 2009 Fecal Strep levels were recorded as 2 CFU/100ml, which is generally lower than those recorded in 2008. The highest recorded level was 9.3 CFU/100ml in August 2008.
- The highest 2009 E. Coli level was 71.7 CFU/100ml in August. This is also the highest recorded level to date at this site.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, <0.01 mg/l) were comparable to previous years.
- The 2009 Total Phosphorus levels (0.03, 0.02, 0.01 mg/l) were comparable to previous years.

3.11 Site 14 – Henry’s Lake Outlet US 20 Bridge

- The highest 2009 Fecal Coliform levels was 548 CFU/100mL in August. This is also the highest recorded level to date at this site. The levels were generally higher than those in 2008.

- The highest 2009 Fecal Strep level was 95.9 CFU/100mL in August. This is also the highest recorded level to date at this site. The levels were generally higher than those from previous years.
- The highest 2009 E. Coli level was 437 CFU/100mL in August 2009. This is also the highest recorded level to date at this site. The levels were generally higher than those from previous years.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, <0.01 mg/l) were comparable to previous years.
- The 2009 Total Phosphorus levels (0.04, 0.02, 0.02 mg/l) were comparable to previous years.

3.12 Site 15 – Hotel Creek

- The highest 2009 Fecal Coliform level was 12 CFU/100ml in July. The levels were generally lower than previous years. The highest recorded level at this site was 240 CFU/100ml in July 2007.
- The highest 2009 Fecal Strep level was 95.9 CFU/100mL in August. This is also the highest recorded level to date at this site. The levels were generally higher than those from previous years.
- The highest 2009 E. Coli level was 27.5 CFU/100ml in September. The levels were generally higher than those measured in 2008. The highest recorded level was 152.9 CFU/100mL in June 2007.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, 0.02 mg/l) were comparable to previous years.
- In July 2009, the highest level of Total Phosphorus was recorded at this site of 0.06mg/l. The remaining levels are comparable to those recorded in previous years.

3.13 Site 16 – Yale Creek

- The highest 2009 Fecal Coliform level was 12 CFU/100ml in July. The levels were generally lower than previous years. The highest recorded level at this site was 480 CFU/100ml in July 2007.
- The highest 2009 Fecal Strep level was greater than 2419.2 CFU/100ml in August. This ties for the highest recorded level as recorded in July 2008. September 2009 also had an elevated level of Fecal Strep at 378.4 CFU/100mL, which is the fourth highest recorded level at this site.
- The highest 2009 E. Coli level was 66.3 CFU/100ml in September. The highest recorded level at this site was 178.5 CFU/100ml in July 2007.
- The 2009 Nitrate and Ortho Phosphate levels (<1.00, 0.03 mg/l) were comparable to previous years.
- The 2009 Total Phosphorus levels (0.05 and 0.03 mg/l) were comparable to previous years.

3.14 Section Summary

For the majority of the sites there is five years worth of sampling data. There is only three years worth of data for sites 13-16. It is anticipated that through continued sampling that trends will be determined that will assist the water quality decision making process for the Island Park area. It is noticeable from the individual site summaries that the sites are

experiencing either elevated or comparable sample values. This trend can be identified in the graphs in Appendix B. A clear conclusion cannot be drawn from this data at this time whether the indicator levels are a reflection of the increasing human usage around the rivers, lakes, and reservoirs or if these values will decline again. Only through the continuation of sampling can a clear conclusion be made.

In addition to the normal sampling, West Buffalo was sampled using an alternate technology called Microbial Source Tracking. This method distinguishes between human and animal contamination. The sampling for West Buffalo in 2009 provided negative analytical results. However, the human gene biomarker was detected in the samples collected at Elk Creek in 2008.

4.0 Precipitation Results

In order to help determine the effect that precipitation has on the sampling process precipitation values were collected for the periods that surface water samples in Island Park were performed. Through the knowledge of past and present contaminant level trends as described in previous sections, it was discovered that annual precipitation levels could be a contributing factor to these fluctuations. Contaminant sampling performed in the years 2005 through 2008 has shown that levels are fluctuating and are steadily increasing.

The 2009 precipitation values have not been updated on the Natural Resources Conservation Services (NRCS) Island Park SNOTEL site. Therefore, the 2008 results have been included in Appendix C for reference. The precipitation values are divided by month and year dating from 1982 up to 2008. From the total precipitation values it can be seen that during the sampling dates, 2006 had the highest precipitation of 33.8 inches and 2007 had the lowest at 22.3 inches. It is illustrated through the graphs in Appendix B that a predominant portion of the sampling data for fecal coliform and E. Coli were higher in 2005, lowest in 2006, elevated again in 2007, and lower in 2008 and 2009.

Through the few years of collected data, it appears that the amount of precipitation does play an important role in the amount of contamination detected. It appears that on wet years the contamination levels are lower due to higher dilution and flushing of the soil profile. With contaminant levels being affected by precipitation, the conclusion could be made that contaminants are located in more shallow waters where precipitation has a greater influence on the amount of dilution and flushing.

5.0 Conclusion

Through the use of continued consistent water sampling, the trends between human influences and precipitation levels will become clearer. This established baseline along with continued water sampling will aid in establishing contamination trends throughout the Island Park area. We recommend the County continue the sampling program to establish a trend to help guide future actions. It appears that the Microbial Source Tracking technology to identify contamination as human fecal matter was beneficial. Through the use of this technology, future sampling of fecal strep may not be necessary as the FC/FS ratio is not confirmed to indicate human contamination, unlike this new technology.

We conclude that the performed sampling has created a firm beginning to an accurate trend line and that further sampling will help confirm some of the hypothesis' as to the occurrence of contaminant fluctuations.

Appendix H. Public Comments

The Watershed Advisory Group voted to provide a 30-day public comment period for the January 2010 draft of the *Upper and Lower Henry's Fork Subbasin Assessment and TMDLs* document during the February 10, 2010 Watershed Advisory Group meeting. Notice Copies of the document were made available through the Idaho Falls office of the Idaho Department of Environmental Quality as well as the Island Park, Ashton, St. Anthony, and Rexburg libraries

A public meeting was held at Pond's Lodge in Island Park, ID on March 18, 2010 between 7:00 and 9:00 PM to discuss the document.

Written comments were received from:

- Martha Turvey, Watershed Unit, U.S. Environmental Protection Agency, Region 10
- Larry Zuckerman, Central Idaho Director, Western Watersheds Project, Salmon, Idaho
- Elizabeth Laden, Island Park News, Island Park, Idaho
- Jeff and Linda Paine, Concerned Citizens, Island Park, Idaho

Comments received are summarized and addressed below in the order above.

Comment: *Section 4, page 14: I suggest referring to this section as a discussion on Permitting and Water Quality Improvements. This section should make it as clear as possible that there are no individual WLA's in this TMDL. The discussion on the Ashton Fish Hatchery should be expanded to include what parameters will be subject of a wasteload allocation from the general permit and how that relates to the TMDL. For instance, describe where the discharge point is and how that relates to the listed waters. This may help to clarify this section.*

Response: Inserted more language to clarify how the wasteload allocation of the general permit for the Ashton fish hatchery will not affect the TMDL.

Comment: *Page 17, Monitoring Points: This section could be improved with a map locating the points that were monitored and discussing the time frame of monitoring events. This seems like a sampling of the problem considering the size of the study area. I recommend including a statement on how representative this information is.*

Response: Inserted a map showing all monitoring points that were conducted.

Comment: *Page 19, Table 4: For the purposes of the TMDL you will need to translate all allocations to a daily load. You can keep the yearly, monthly or weekly limits in the document for the purposes of discussion but the additional translation should be included in the final document.*

Response: Calculated a daily load allocation for all TMDLs.

Comment: Page 46, Critical Time Periods and Design Conditions: This paragraph seems to be saying that the second critical period is during the low flow season which may be beyond the May-October time frame. If that is the case, then the critical period should include this low flow time frame as well.

Response: Language was change to clarify that the critical time period is between May and October.

Comment: Page 46-47 Bacteria Targets and Loading Capacity: The Loading Capacity for Bacteria is based on the single sample maximum of 576 cfu/100 ml which is different than what the other TMDLs in the state of Idaho adhere to. The single sample 576 cfu/100 ml value is just a trigger in the Idaho WQS to do more monitoring and is not actually the E.coli criteria. The E.coli water quality criteria which EPA approved (June 4, 2007) is the 126 cfu/100 ml geometric mean. The excerpts below are taken from the EPA's 2007 approval letter on Revisions to the Water Quality Standards for Bacteria for Protection of Recreational Uses, and addresses the 126 geomean criteria, and the 406 and 576 single sample maximum values.

"In addition, the revisions include clarification of Idaho's bacteria criteria for the protection of recreational uses, at 58.01.02.251.01, which establish a geometric mean for E. coli of 126 organisms per 100 ml based on five samples taken every three to seven days over a thirty day period. The geometric mean applies to all waters protected for recreational use in Idaho, which includes those designated for primary contact recreation, secondary contact recreation and those primary contact recreation waters additionally specified as public swimming beaches.

Federal water quality standards regulation at 40 CFR 131.11 states in part that in established criteria States should establish numerical values based on 304(a) Guidance. EPA's 304(a) Guidance for Bacteria as established in Ambient Water Quality Criteria for Bacteria-1986, (1986 Bacteria Criteria document) recommended a geometric mean of 126 per 100 ml of E.coli based on statistically sufficient number of samples (generally not less than 5 samples equally spaced over a 30-day period). Idaho numerical criterion for bacteria for the protection of contact recreation is the same as the EPA recommendation contained in 1986 Bacteria Criteria document. Therefore, EPA approves 58.01.02.251.01 and 01.a.

Language which was previously contained in Section 58.0102.080.03 and titled "E.coli Standard Violation" has been moved into 58.01.02.251.01.b. The specific language is as follows: "A water sample exceeding the E.coli single sample maximums below indicates likely exceedance of the geometric mean criterion, but is not alone a violation of water quality standards." EPA is not acting on this language because it has been determined not to be a water quality standard subject to review under Section 303© of the CWA, but rather a provision regarding the state's use of its enforcement discretion."

Since TMDLs must be established to achieve water quality standards, E.coli TMDLs in Idaho must ensure that the 126 cfu/100 ml criteria is achieved, at a minimum, as a basis for determining the loading capacity in order for the TMDL to be approvable. I understand that

the State may at times have difficulty collecting 5 samples within 30 days needed to calculate the 5 sample geomean. However, that should not effect how the load capacity and TMDL targets are calculated. In a recently approved TMDL, IDEQ estimated existing concentrations by calculating geometric means with less than 5 samples.

This brings up another concern in that the TMDL does not contain adequate data to support the critical time periods selection. It appears that there is only one sample in Table 14 to represent the timeframe of concern. The discussion in this section is more about planning for a bacterial investigation rather than a TMDL discussion on observed conditions. In addition, the bacteria data should be provided in an appendix to the TMDL.

Response: DEQ calculated the bacteria TMDL for E.Coli based on the geometric mean and subsequent target of 126cfu/100mL.

Comment: *Subbasin Assessment, Henry's Lake pages 55-66: Henry's Lake had been included in the 1996 303(d) list for nutrients and dissolved oxygen but was not included in the 1998 303(d) list. For reasons described in this section the EPA approved the 1998 list and the decision to delist these segments. What is lacking in this section is any current information on the conditions of the lake and what are the current inputs that are contributing to nutrient and dissolved oxygen problems. What specific steps have been taken to address nutrient inputs and follow the remediation recommendations that were made twelve years ago? Assumptions on nutrient management have changed significantly over the past decade. How does current perspectives affect the decision to not pursue a TMDL for dissolved oxygen or nutrients? How have the inputs to the water body changed in terms of land use practices since the 1998 assessment? Planning in 1996 called for 14.8 miles of riparian area restoration. What has been accomplished as of 2010? I recommend a comprehensive updating of this section be done.*

Response: Inserted water quality projects that have been completed by various agencies and organizations.

Comment: *We support the IDEQ's addendum to the Upper Henry's Fork Subbasin Assessment and TMDLs with regards to establishment of new TMDLs to control excess sediments in Buffalo River, Duck Creek, and Sheridan Creek; bacteria in Conant Creek, and elevated water temperatures associated with riparian habitat destruction for Warm River, Howard Creek, Targhee Creek, Timber Creek, and Duck Creek. We do not, however, support the removal of Twin Creek, Icehouse Creek and Willow Creek from Idaho's 303(d) list for impaired surface waters because IDEQ has determined that the state water quality standards are met and the all water uses (designated and presumed) are believed met.*

Western Watersheds Project, a nonprofit, membership, environmental organization, based in Clayton, Idaho, with offices in Boise, Hailey, McCall, and Salmon, Idaho, and in Wyoming, Utah, Arizona, Montana, and California. WWP is dedicated to protecting and conserving the public lands and natural resources of watersheds in the American West. This includes the aquatic, riparian, and terrestrial fish and wildlife species that depend on our watersheds, including native cutthroat trout subspecies, such as Yellowstone cutthroat trout and Snake

River fine-spotted cutthroat trout as well as significant concerns for grizzly bear, wolverine, American bison, gray wolf, sage-grouse, American beaver, and pygmy rabbit.

Western Watersheds Project has dedicated much of its efforts on trying to improve the West's watersheds while reducing the adverse effects and take associated with livestock grazing and the associated irrigation, dewatering, spread of noxious weeds, creation of barriers to fish passage, entrainment in unscreened diversions, and other adverse effects on public and private lands associated with the livestock industry.

Like IDEQ, WWP is very concerned about the direct effects livestock grazing has on stream bank stability, bacteria levels, reductions in shade, but also the indirect effects caused by livestock-supporting instream flow reductions and loss of connectivity of streams with their floodplains. We find IDEQ's approach of separating flow-related habitat problems from pollutants such as increased sediment, bacteria loads, and temperature loads as artificial and this separation, makes the success of remedying impaired waters less likely.

We also recognize the local and regional economic values of the Henry's Fork fisheries, but also the potential natural scenic and ecological values of the Upper and Lower Henry's Fork subbasin.

WWP would like to be involved in IDEQ's implementation and monitoring of the Upper and Lower Henry's Fork and requests to be added to lists for notifications of upcoming meetings, availability of data, and publication of reports.

We suggest using some of the aquatic and riparian monitoring protocols established by the PACFISH/INFISH Biological Opinion ("PIBO") Aquatic Monitoring Team from Ogden, Utah to establish environmental baselines and to evaluate the effectiveness of the implementation, once established. We request to participate and to review the implementation plans as they are developed and question IDEQ in general on the delay of other implementation plans in other Idaho subbasins.

Thank you very much for providing us this opportunity to comment on your addendum.

Response: In regards to your comment about “DEQ’s approach to separating flow-related habitat problems from pollutants such as increased sediment, bacteria loads, and temperature loads as artificial and this separation, makes the success of remedying impaired waters less likely.” Idaho State Water Quality standards state that TMDLs will not be written for flow alteration or minimum stream flow.

<http://www.legislature.idaho.gov/idstat/Title39/T39CH36SECT39-3618.htm>. EPA also does not recognize flow alteration as a pollutant, therefore the State of Idaho does not prescribe TMDLs for flow alteration.

DEQ will inform you of monthly meetings the Henry’s Fork Watershed Council conducts and you are more than welcome to attend these meetings. DEQ’s role in implementation plans has been limited. Implementation plan development is carried out by the WAGs with Designated Management Agencies (DMA’s) to remedy water quality problems.

Comment: Thank you for holding a discussion session at Pond's Lodge last week to inform the community about the Addendum to the Upper Henry's Fork Subbasin Assessment.

To review, DEQ identified the primary sources of nonpoint source pollution to streams in the Upper and Lower Henry's Fork subbasins as sediment from stream bank erosion and solar radiation from riparian habitat degradation.

DEQ proposes steps to control excess sediment in the Buffalo River and Duck and Sheridan creeks. In Warm River and Howard, Targhee, Timber and Duck creeks, TMDLs are proposed to address elevated temperatures. Also, a TMDL is proposed to address bacteria in Conant Creek.

The goal of the actions is to restore conditions supporting coldwater aquatic life, salmonid spawning, swimming and water skiing and other recreation where people are in the water, domestic water supplies, and "special resource" water.

In addition, DEQ is proposing to remove Twin, Icehouse, and Willow creeks from the list of impaired water bodies, since it was determined that these water bodies meet state water quality standards for sediment.

And, in the meeting here, at my request when we spoke on the phone, you said DEQ will attach the Fremont County 2009 Water Sampling Report commissioned by the Fremont County Commissioners.

Our county commissioners are taking a proactive approach with their ongoing water testing, hoping to identify and solve problems before they reach levels that will cause DEQ to enforce water quality regulations.

It is my wish that DEQ also take a proactive approach and notify local governments when a problem appears to be developing in a water body. In many cases, cities and counties, private citizens, and organization such as the Henry's Fork Foundation, the Master Naturalists, and even the scouts, may want to initiate a project that would keep a stream or lake from reaching the impaired level. I realize that DEQ regulations do not take this approach, but I think it's important to have this feedback as part of the record.

Response: At your request DEQ has attached the Fremont County 2009 Water Quality Sampling Report. DEQ would also encourage voluntary monitoring groups as a proactive approach to keep water quality standards from being violated. Please, do not hesitate to contact DEQ with a plan to coordinate a voluntary monitoring group.

Comment: We are unable to attend the March 18th meeting, but as a long time property owner we are very concerned about water quality in Island Park. We wish to submit the following for your consideration. An important fact that we think may be being overlooked regarding the protection of the Upper Henry's Fork sub-basin is the transportation of hazardous materials (HAZMAT) that is taking place on Highway 20 through Island Park and along Highway 87 around Henry's Lake. There is an enormous amount of this type of

material being transported on these roads. This route is apparently used by truckers in lieu of using Interstate 15 because it is said to be faster (there is very little enforcement of speed limits), there are no weigh stations, and it is a little bit shorter so saves them both time and money.

Ultimately there will be an accident that, if it does not take lives, has a high likelihood of resulting in a spill that will release hazardous material pollutants into this watershed. It is only a matter of time. This type of traffic has been using Highway 20 and U.S. 191 to Bozeman for many years. It is now going along highway 87 on the north side of Henry's Lake because the transport of this material was banned from National Parks in recent years and highway 191 passes through Yellowstone Park's west edge for a distance of about 20 miles.

To minimize the possibility of such an event, trucks hauling HAZMAT loads should be required to use Interstate 15. The merits are clear. Interstate 15 is a multi-lane highway with restricted access and with resources which include ready availability of equipment and knowledgeable personnel along the entire route to handle the spill of HAZMAT materials. Should such an accident occur along either Highway 20 or Highway 87, there is little if any capability to respond to a serious HAZMAT spill. The impacts of a spill of materials that are classified as hazardous, which includes so many different chemicals, into this critical watershed are incalculable. Any plan to assure the protection of this precious watershed must include resolution of this issue. The reasons they are banned from passing through Yellowstone Park are the same reasons they should not be running through such critical watersheds when there is a better alternative.

In Idaho, we tend to be a little parochial about this but these same HAZMAT loads link up to Montana Highway 287 going north through Ennis. It follows the Madison River that we all know is another extremely important watershed. A concerted effort to minimize the potential of such an accident by limiting the transportation of HAZMAT loads, except as required to directly supply the products essential to the local communities, must be a part of any plan to protect this watershed.

Response: DEQ does not have the authority or control of State highways or Interstates. We did however forward your letter of concern to the Idaho Department of Transportation, Region 6 District Engineer.

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Appendix I. Upper and Lower Henry's Fork Progress Report

Due to the fact that the 1998 Upper Henry's Fork subbasin assessment did not have any TMDLs to implement, no implementation plan was written. However, several water quality improvement projects have been completed in the subbasin. These include the Sheridan Creek 319 nonpoint restoration project as well as several others administered by the IDFG, USFS and HFF. Several new projects were implemented in the Upper and Lower Henry's Fork Subassins which will be broken out into different agencies and foundations that have completed these projects. Sheridan Creek did not appear on the 1994 §303(d) list, but it was identified by the Henry's Fork Watershed Council as a high priority for restoration. The Henry's Fork Watershed Council implemented a habitat restoration project on Sheridan Creek which is intended to restore aquatic life beneficial uses, potentially eliminating the need for development of a TMDL in the future. Independent of the restoration efforts, Sheridan Creek appears on the 2008 Integrated Report and DEQ is drafted TMDL to address continued pollutant delivery to the creek.

To view detailed information about past history, completed projects and continuing projects in the Upper and Lower Henry's subbasin's please see *Upper and Lower Henry's Five Year Review* document at:

http://www.deq.idaho.gov/water/data_reports/surface_water/tmdls/snake_river_henrys_fork/upper_lower_henrys_fork_snake_river_five_year_review.pdf

Summary and Analysis of Current Water Quality Data and Accomplished Projects

Data Summary

Idaho Department of Environmental Quality

Since, the 1998 SBA thirty-five locations were monitored in the Upper Henry's subbasin and four in the Lower Henry's subbasin. DEQ's Beneficial Use Reconnaissance Program protocols were followed. The data was evaluated using DEQ's Water Body Assessment Guidance version 2 (WBAG2). Eighteen of these locations were determined to be fully supporting beneficial uses and seventeen locations were determined to not be supporting beneficial uses in the Upper Henry's subbasin. In the Lower Henry's one site was fully supporting and three sites were not supporting. All of this data was incorporated into the 2008 Integrated Report to help determine the 303(d) and 305(b) listings. The 2008 303(d) listed streams listed as impaired have TMDLs drafted and are due to go to public comment in early 2010.

Henry's Fork Foundation

Shotgun Valley Assessment

In the summer months of 2001 the Henry's Fork Foundation (HFF) assessments were carried out in the Shotgun Valley on portions of Sheridan Creek, Hotel Creek, Sheep Creek and an unnamed tributary to Sheep Creek. A portion of Targhee Creek was also assessed. For most of these reaches the assessment consisted of basic channel and riparian description, vegetation survey, and erosion inventory study. To finalize the study suspected causes of stream condition were noted and rehabilitation recommendations were provided.

In the summer months of 2003 a similar assessment as the 2001 study of a 6.5 mile portion of Willow Creek, between New Shotgun Road and the confluence of Sheridan Creek was completed. This stretch of the creek ran through both public (Targhee National Forest) and private (Sheridan Ranch) lands.

Idaho Department of Fish and Game

Dissolved oxygen monitoring was completed during the winter months of 2003 and 2004 on Henry's Lake to predict dissolved oxygen depletion rates and anticipate possible fish winterkill events. Dissolved oxygen monitoring consisted of five sites on Henry's Lake and recordings were taken at various depths. According to data provided, nine measurements were less than the water quality standard of 6.0 mg/l of dissolved oxygen.

Project Summary

Henry's Fork Watershed Council

In 1995 the Henry's Fork Watershed Council determined Sheridan Creek was its highest priority for restoration in the Upper Henry's Fork watershed. A committee was formed to develop a restoration plan and build relationships among private landowners, public land and grazing permittees, and land management agencies. In 1996, the Watershed Council designated the Idaho Department of Environmental Quality (IDEQ) as the Watershed Advisory Group (WAG) for the Henry's Fork watershed. With the help from IDEQ the Watershed Council determined restoration priorities and actions needed to reduce nonpoint pollution sources. In 1997, the Sheridan Creek Restoration Committee and technical team developed a restoration plan involving all landowners and agencies in the Sheridan Creek drainage. The goals of the Sheridan Creek restoration project were to restore stream hydrology, improve riparian and aquatic habitat, restore resident and migratory fisheries in Sheridan Creek and improve water quality in Island Park Reservoir. Those goals were to be accomplished by repairing and replacing deteriorated diversion structures, implementing improved riparian grazing management practices, revegetating stream banks and installing an off-stream livestock watering facility. The project began on June 6, 1996 and was completed in December of 2003. All together \$142,000 was spent on the restoration project along with hard work between private landowners and multiply state and federal agencies and the Henry's Fork Foundation.

United States Forest Service

The following are several different projects the Caribou-Targhee National Forest performed in the past five years. All projects include some sort of Best Management Practice to help improve water quality in the Upper Henry's subbasin.

2009 Projects

Howard Creek Passage Project: More of Howard Creek was connected to Henry's Lake with the replacement of a barrier culvert with a bridge, 200 yards upstream from Highway

87. This allows for passage of Yellowstone cutthroat trout from Henrys Lake further up the stream. The Nature Conservancy led the project, and other partners included the private landowner and Eastern Idaho Resource Advisory Committee. Two smaller culverts that are partial barriers remain upstream and are scheduled for replacement in 2010.



The impassable culvert was replaced with a bridge to restore Yellowstone cutthroat trout passage.



The impassable culvert was replaced with a bridge to restore Yellowstone cutthroat trout passage.

Passage Progress at Duck Creek: In 2009 the Forest Fisheries Program, in partnership with Eastern Idaho Resource Advisory Committee, U.S. Fish and Wildlife Service, and Henrys Lake Foundation, initiated the Duck Creek fish passage project, restoring upstream passage at one out of the four fish passage barriers on Duck Creek, a tributary to Henrys Lake. This project benefits Henrys Lake Yellowstone cutthroat trout. Work on the other 3 crossings is expected to occur in 2010.



Pre- (left) and post- (right) construction at Duck Creek crossing site. The impassable, under-capacity culvert was replaced by a bottomless arch with a natural stream bottom.

2008 Projects

Lyle Springs Improvement (5 acres improve): The purpose of this project was to improve Lyle Springs ability to capture spring runoff and keep water off road and running into adjacent dispersed camping area. Additional pond area was excavated to increase holding capacity. Excavated material was used to raise road system approximately 1 foot in elevation. Wildlife habitat was improved as water holding capacity was increased. Public safety in the dispersed camping areas was also improved. The work was completed by the Caribou-Targhee Road Crew.



Lyle Spring Area: center is where ponds were connected.

Elk Creek Willow Planting and Fence Construction (2 acres): Willows were planted in the fall of 2007 along a 200 foot section of Elk Creek where cattle have historically used as a watering point. Buck and rail fence was installed for additional bank protection. The project was completed by Forest Service staff. Thanks to Brad Higginson (forest hydrologist) and Kyle Moore (district range management specialist) for their help on this project.



Elk Creek and fenced off area where willows were planted along bank.



Typical willow planting results along Elk Creek (estimated 85% success first year).

Bootjack Pond Outlet Protection (1 acre): The purpose of this project was to protect the outlet area from livestock. This area is typically used as a watering point for cattle. Kyle Moore, district range management specialist, completed the work.



Hominy Peak, Hidden Lake, and Conant Creek Trail Work (5 acres): Existing water-bars were re-habilitated and new ones were installed to control: water run off, sediment control, and public safety. The work was accomplished by District Staff and crew. Funding was provided through Recreation Fee Collections.

2007 Projects

Closures of illegal roads and ATV trails (12 Acres Improved): In 2007 the district closed numerous illegal roads and ATV trails that have impacted water quality, soil productivity and other resource values with the use of boulder and signs. Work was completed on the Continental Divide Trail near Blair Lake to close an illegal road from Keg Springs to a hilltop by placing rocks and obliterating parts of the road with a dozer. More illegal ATV access in the Bootjack area was also closed with boulders and signs as shown below in the photo protecting and improving about 7.5 acres. Additional boulder closures and obliteration work was completed in the Yale Creek area improving approximately 1.5 acres from illegal ATV trails.



Barrier boulders & signs placed in the Bootjack Area to stop illegal ATV use.

Partnership/Funding: Internal FS collaboration with recreation and watershed staff identified and implemented the ground work with the aid of district trail money and funding from the Eastern Idaho Resource Advisory Council (RAC).

Henry's Fork/Last Chance Fence Project (14 plus Acres Improved): This project replaces 7 miles of 20 year-old, non-functioning fence on both federal and state lands with high-quality, low maintenance barbed wire fence. Currently, cattle grazing USFS allotments and state lands in Harriman State Park get through the existing fence virtually daily during the grazing season. These animals trample stream banks and degrade water quality in a heavily-used and world-famous stretch of the Henry's Fork, creating a constant source of conflict between forest/park recreators, the cattle, and land managers, not to mention a daily maintenance requirement and cost for USFS, park, and HFF personnel. The new fence will keep cattle off stream banks and out of the river, thus protecting and improving watershed health.

Partners: The project is a cooperative effort between the HFF (whose members and volunteers constructed much of the existing fence in the 1980s and work to maintain sections of it to this day), the USFS, and the Park.

2006 Projects

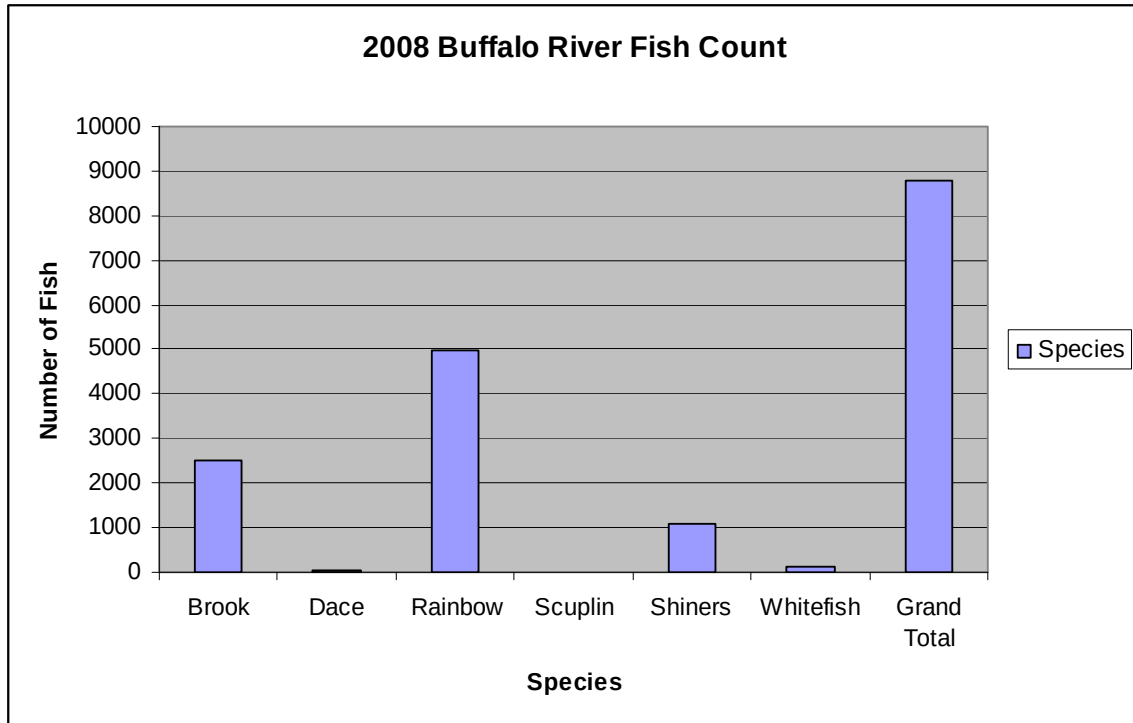
Native Fish Returned to Sawtell Creek: Forest Fisheries Personnel have been working with their partners on the Sawtell Creek Yellowstone Cutthroat Trout Reintroduction Project in the upper Henry's Fork for the last couple of years. The previous years' activities included eradication of non-native brook trout and improvement of habitat in the system. The multi year restoration project achieved its primary objective in 2006 with the transplanting of over 700 Yellowstone cutthroat trout from Tygee and Corral Creeks. Tygee Creek is a nearby tributary of the Henry's Fork and Corral Creek is in the neighboring Sinks Drainage. These

two streams are believed to have populations of Yellowstone cutthroat trout that are remnants of historic Henry's Fork Yellowstone cutthroat trout populations. The fish reintroduction in Sawtell Creek adds approximately 6 more stream miles in the Henry's Fork system inhabited by Yellowstone cutthroat trout. This project was a partnership between Idaho Department of Fish and Game, Henry's Fork Foundation, and Natural Resources Conservation Service.

2005 Projects

Buffalo River Dam Fish Passage: Fish can now effectively migrate past the Buffalo River hydroelectric dam on the Henry's Fork, thanks to the efforts of Lee Mabey and his partners in the hydropower dam relicensing effort. The dam was built in 1936 to provide electricity to construct Island Park Dam. When it was originally constructed, no environmental reviews were required. Today, fisheries biologists on the Forest participate in hydroelectric relicensing processes because it is an excellent way of accomplishing meaningful fisheries conservation. Lee Mabey participated in the Buffalo River hydro negotiations with Fall River Rural Electric and several C-T Fisheries Program partners, including Henry's Fork Foundation and Idaho Department of Fish and Game.

The resulting settlement agreement included a fish ladder and fish screens on the turbine intake system. The new ladder is designed to allow migrating adult fish to spawn in the Buffalo River and allow young trout migrating from the Henry's Fork to find more favorable over-wintering areas above the dam. The weirs in the ladder allow fish to swim through or jump over each weir. A layer of river rocks was provided for resting areas at the bottom of the fishway. The screening of the water intake to the powerhouse will exclude all but the smallest of fish. This project will benefit the Buffalo River and Henry's Fork fisheries.



2008 Buffalo River Fish Count

The chart above represents the number of fish that passed through the Buffalo River fish ladder during 2008. According to State and Federal agencies fish numbers increased considerably since the new fish ladder has been installed.



Buffalo River Powerhouse



Newly constructed Fish Ladder



Fish Ladder



View of Raceway

Howard & Targhee Creek Fish Passage: Howard and Targhee Creeks were reconnected to Henry's Lake as the Idaho Transportation Department (ITD) replaced the existing culverts that have been in place since the 1970's with full span bridges. For the last 35 years, Yellowstone cutthroat trout migrating upstream from Henry's Lake, met barriers at these highway crossings. The speed at which this project came together is a testament of how important everyone involved felt this project was. This project went from hope and desire to completion in one year, and emphasizes the importance of partnerships. The Transportation Department provided the funding and design, and the other partners (Idaho Department of Fish and Game, Greater Yellowstone Coalition, Henry's Fork Foundation, Henry's Lake Foundation, and Senator Crapo's office) provided the motivation and environmental work. The Forest provided the biological assessment, cultural resource report and clearance, and wetland delineation. Most importantly Yellowstone cutthroat trout, native to Henry's Lake, are once again able to access the largest and most important spawning tributaries to Henry's Lake.



Targhee Creek Culvert under Highway 20 before replacement was a barrier to upstream-migrating Yellowstone cutthroat trout.



The Targhee Creek crossing at Highway 20 after construction. The impassable culvert was replaced by a fish-friendly bridge.

With the help from the Caribou-Targhee National Forest these projects will help mitigate sediment and sustain migratory habitat for Yellowstone cutthroat trout. For more information on the Caribou-Targhee NF's Watershed and Fisheries programs, please visit these websites.

<http://www.fs.fed.us/r4/caribou-targhee/watershed/>

<http://www.fs.fed.us/r4/caribou-targhee/fisheries/index.shtml>

Idaho Department of Fish and Game

The following habitat improvement projects at Henrys Lake and tributaries feeding into Henry's Lake include fencing projects, fish screen installation, and riparian improvements. All of these projects improve the water quality and fisheries of Henry's Lake and its tributaries.

Empey Property Duck Creek Fencing Project: Approximately .5 miles of electric fencing was installed along the riparian buffer area of Duck Creek during the fall of 2008. One rock-hardened water gap was installed within this fence boundary. The fencing completes riparian protection from grazing along Duck Creek from the mouth to the junction with Henrys Lake road.

In addition, this project also included installation of a rock weir to facilitate fish passage at an irrigation lateral located with the aforementioned project boundary.

Empey Property Kelly Springs Fencing Project: Approximately .75 miles of electric fencing was installed along the riparian buffer area of Kelly Springs during the fall of 2008. Two rock-hardened water gaps were installed within this boundary and one flat-bottomed culvert was installed at a designated crossing. The fencing completes riparian protection from grazing along Duck Creek from the mouth to the junction with Henrys Lake road.

Howard Creek Fish Screen Installation: A modular fish screen was installed at a previously unscreened irrigation lateral on Howard Creek on the Tom Cole property during the fall of 2008. This screen installation completes screening of all irrigation laterals from the mouth of Howard Creek to its junction with highway 87.

Targhee Creek Fish Screen Installation: A modular fish screen was installed at a previously unscreened irrigation lateral on Targhee Creek on the Ray Clement property during the fall of 2008. This screen installation completes screening of all irrigation laterals on Targhee Creek.

Shoreline Buffer Fencing near County Boat Dock: Approximately .5 miles of electric fencing was installed north and south of the county boat dock during 2005. The electric

fencing prevents shoreline grazing of this area and facilitates improved water quality at this site.

Ongoing Projects: Approximately 10 miles of riparian electric fencing is maintained on an annual basis on tributaries of Henry's Lake. Riparian fencing is maintained on tributaries including: Targhee, Duck, Howard, Timber and Kelly Springs. Additionally, 11 drum type fish screens are maintained on an annual basis.

Bureau of Land Management

The Bureau of Land Management was responsible for two fencing projects completed in 2003. The first on Kinney Creek in which the BLM fenced approximately ¼ mile of the stream and used the riparian area to filter sediment before entering Henry's Lake. The second project included fencing off livestock from entering the lakes' riparian area in the surrounding Kinney Creek watershed.

Chester Diversion Hydroelectric Project **(Information provided by Symbiotics, LLC)**

On July 23, 2008, a license was issued by the Federal Energy Regulatory Commission (FERC) for the construction and operation of the Chester Diversion Hydroelectric Project (Project). The 3.3 megawatt (mW) run-of-river Project is located on the Henry's Fork of the Snake River in Fremont County, Idaho. The Project was "shovel ready" and began construction April 1, 2009 and commenced commercial operation on or before December 31, 2010. The Project proposes to improve the surrounding recreation area as well as the sportsman access, which should benefit those visiting the area. Measures have been taken to fully protect and mitigate for impacts of the Project on fish, wildlife, recreation and aesthetic resources associated with the surrounding area. Project representatives have worked diligently with state and federal agencies and various private interest groups to establish a Settlement Agreement (SA) regarding environmental issues associated with the proposed Project. State agencies that participated include the Idaho Department of Fish and Game, Idaho Department of Environmental Quality and Idaho Department of Parks and Recreation. Federal agencies include the U.S. Fish and Wildlife Service and the U.S. Forest Service. Trout Unlimited, the Henry's Fork Foundation and the Greater Yellowstone Coalition, collectively referred to as the Conservation Groups in the SA, and are also participants. This SA has recently been finalized to the satisfaction of all parties.

To address fish migration issues, fish screens will be put in place at the entrances to both the Crosscut and Last Chance canals and a pathway will be provided to allow downstream passage. Boat ramps will be constructed upstream and downstream of the dam and gravel parking areas will be added. Restrooms will also be built to benefit those recreational users in the area. The Conservation Groups agreed to provide all necessary funding for a fish ladder to be designed, engineered, and constructed upstream of the dam. The Project has addressed

all environmental issues and believes this Project to be a benefit to the area and its users upon its completion.



View of Old Dam



Construction of Chester Dam



Construction of Dam

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Appendix J. Flow Duration Curve Data

Buffalo River Data.

Flow-weighted Daily Load Allocations With Proportionality Assumptions Based on Flow Season					
	80% Load delivery	15% Load delivery	5% Load delivery		
	High Flows 230 to 638 cfs	Moist Conditions 187 to 229 cfs	Mid-range Flows 174 to 186 cfs	Dry Conditions 154 to 173 cfs	Low Flows 146 to 153 cfs
	14.4 ton/year reduction	2.7 ton/year reduction	0.9 ton/year reduction		
	Average dates from USGS Daily Water Statistics	4/18 - 4/30 5/1 - 5/25	4/13 - 4/17 5/26 - 5/31 6/1 - 6/30 7/1 - 7/20	3/27 - 3/31 4/1 - 4/12 7/21 - 7/31 8/1 - 8/31 9/1 - 9/6 10/14 - 10/20 10/26 - 11/5	1/1 - 1/31 2/1 - 2/29 3/1 - 3/26 9/7 - 9/30 10/1 - 10/13 10/21 - 10/26 11/6 - 11/30 12/1 - 12/31
	38 days 758 lbs/day reduction	61 days 89 lbs/day reduction	266 days 7 lbs/day reduction		

18 ton per year Load Allocation

Dates	Daily Load Allocation
July 21 through April 12	7 lbs/day
April 13 through April 17th	89 lbs/day
April 18th through May 25th	758 lbs/day
May 26th through July 20th	89 lbs/day

Sheridan Creek Data.

Flow-weighted Daily Load Allocations With Proportionality Assumptions Based on Flow Season				
Average dates from USGS Daily Water Statistics	80% Load delivery	15% Load delivery	5% Load delivery	
	High Flows 139 to 447 cfs	Moist Conditions 17 to 138 cfs	Mid-range Flows 10 to 16 cfs	Dry Conditions and Low Flows 0 to 9 cfs
	12	2.25		0.75
	ton/year reduction	ton/year reduction	ton/year reduction	
	4/19 - 4/24	4/1 - 4/9	1/1 - 1/31	4/10 - 4/13
	5/1 - 5/7	4/14 - 4/18	2/1 - 2/28	8/13
	5/12 - 5/19	4/25 - 4/30	3/1 - 3/31	8/29 - 8/31
	5/26 - 5/28	5/8 - 5/11	7/24 - 7/27	9/1 - 9/30
		5/20 - 5/25	7/30 - 7/31	10/1 - 10/5
		5/29 - 5/31	8/1 - 8/12	10/13
		6/1 - 6/30	8/14 - 8/17	10/19 - 10/25
		7/1 - 7/23	8/21	
		7/28 - 7/29	8/24 - 8/28	
		8/18 - 8/20	10/6 - 10/12	
		8/22 - 8/23	10/14 - 10/18	
			10/26 - 10/31	
			11/1 - 11/30	
			12/1 - 12/31	
24 days		93 days	248 days	
1000		48	6	
lbs/day		lbs/day		
reduction		reduction	lbs/day reduction	

15 ton per year Load Allocation

Dates	Daily Load Allocation
August 24 through March 31	6 lbs/day
April 1 through April 9	48 lbs/day
April 10 through April 13	6 lbs/day
April 14 through April 18	48 lbs/day
April 19 through April 24	1000 lbs/day
April 25 through April 30	48 lbs/day
May 1 through May 7	1000 lbs/day
May 8 through May 11	48 lbs/day
May 12 through May 19	1000 lbs/day
May 20 through May 25	48 lbs/day
May 26 through May 28	1000 lbs/day
May 29 through July 23	48 lbs/day
July 24 through July 27	6 lbs/day
July 28 through July 29	48 lbs/day
July 30 through August 17	6 lbs/day
August 18 through August 20	48 lbs/day
August 21	6 lbs/day
August 22 through August 23	48 lbs/day

Duck Creek Data.**15 ton per year Load Allocation**

Dates	Daily Load Allocation
May 1st through May 31st	1.35 lbs/day
June 1st through April 31st	13 lbs/day

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Appendix H. Distribution List

Copies of the final report will be provided to the Idaho Department of Environmental Quality State Office, U.S. Environmental Protection Agency Region 10, and Henry's Fork Watershed Council technical advisory participants including as well as other public commentators:

Jim DeRito
Henry's Fork Foundation
Ashton, ID

Gary Vecellio
Idaho Department of Fish and Game
Idaho Falls, ID

Brad Higginson
Caribou-Targhee National Forest
Idaho Falls, ID

Lee Mabey
Caribou-Targhee National Forest
Idaho Falls, ID

Liz Laden
Island Park News
Island Park, ID

Jeff and Linda Paine
Concern Citizens
Island Park, ID

Larry Zuckerman
Western Watersheds Projects
Salmon, ID