Upper and Lower Henrys Fork

TMDL Five-Year Review

Hydrologic Unit Codes 17040202 and 17040203

Final

State of Idaho
Department of Environmental Quality

May 2017

Printed on recycled paper, DEQ May 2017, PID TM22, CA code 72070. Costs associated with this publication are available from the State of Idaho Department of Environmental Quality in accordance with Section 60-202, Idaho Code.

Upper and Lower Henrys Fork

TMDL Five-Year Review

May 2017

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Acknowledgments

Many permanent and temporary staff members at the Idaho Department of Environmental Quality (DEQ) collected and provided data used in this 5-year review. Individual contributors of particular note include Jack McClaren, Indiana State University and Mark Shumar, DEQ. Entities that contribute to water quality improvements, research, and restoration in the Henrys Fork subbasins include the Caribou-Targhee National Forest District, Fremont-Madison Irrigation District, Henry’s Fork Foundation, Henry’s Fork Watershed Council, and Idaho Department of Fish and Game.

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Executive Summary

This document presents a 5-year review of the *Upper and Lower Henry's Fork Total Maximum Daily Loads: Addendum to the Upper Henry's Fork Subbasin Assessment and TMDLs* (DEQ 2010a). It addresses the water bodies in the Upper and Lower Henrys Fork subbasins that are in Category 4a of Idaho's most recent Integrated Report (DEQ 2014a). This 5-year review complies with Idaho Code §39-3611(7) and describes current water quality status, pollutant sources, and recent pollution control efforts in the Upper and Lower Henrys Fork subbasins, located in eastern Idaho.

The total maximum daily loads (TMDLs) subject to 5-year review are shown in Table A. Sixteen TMDLs were approved in 2010. One assessment unit (AU) has TMDLs for two separate pollutants (Duck Creek). Within the Upper Henrys Fork subbasin, sediment TMDLs were completed for Buffalo River, Duck Creek, and Sheridan Creek. All sediment TMDLs were approved in 2010. Temperature TMDLs were approved for Warm River (5 AUs), Howard Creek (1 AU), Targhee Creek (2 AUs), Timber Creek (2 AUs), and Duck Creek (1 AU). Bacteria TMDLs were developed for Conant Creek (2 AUs), located in the Lower Henrys Fork subbasin.

Table A. General status of existing 2010 TMDLs.

Stream Name	Assessment Unit Number	Pollutant	Improvement Activities	Water Quality Trend
		Upper Henrys Fork		
Warm River	ID17040202SK002_04 ID17040202SK002_05 ID17040202SK005_02 ID17040202SK005_03 ID17040202SK005_04	Temperature	Riparian restoration, intensive riparian management	Improving
Buffalo River	ID17040202SK018_03	Sediment	Improving fish passage, riparian restoration, intensive riparian management	Improving
Howard Creek	ID17040202SK033_02	Temperature	Riparian restoration, intensive riparian management	Static
Targhee Creek	ID17040202SK034_02 ID17040202SK034_03	Temperature	Riparian restoration, intensive riparian management	Improving
Timber Creek	ID17040202SK035_03	Temperature	Riparian restoration, intensive riparian management	Static
Duck Creek	ID17040202SK036_03	Sediment Temperature	Riparian restoration, intensive riparian management	Improving
Sheridan Creek	ID17040202SK045_03	Sediment	Riparian restoration, intensive riparian management	Degrading
		Lower Henrys Fork		
Conant Creek	ID17040203SK007_02 ID17040203SK007_03	Bacteria (*Escherichia coli*)	Intensive riparian management	Improving

Subbasin at a Glance

Some improvements have taken place in the Upper and Lower Henrys Fork subbasins. Despite changes in riparian management and improvements to habitat conditions, few of these AUs are meeting their TMDLs. As more restoration projects are implemented and changes in land management activities continue, these streams will slowly improve over time. The AUs with TMDLs subject to this review should remain in Category 4a for sediment and/or temperature until excess loads improve (Table B).

Table B. Subbasin at a glance.

Approved TMDLs	**Pollutants**	**Assessment Units Moving from Category 4a to 2**
Warm River—temperature Buffalo River—sediment Howard Creek—temperature Targhee Creek—temperature Timber Creek—temperature Duck Creek—sediment and temperature Sheridan Creek—sediment Conant Creek—bacteria	Sediment, temperature, and bacteria	All AUs with TMDLs will remain listed in Category 4a, except Conant Creek, which is proposed for delisting from Category 4a for bacteria and moved to Category 2.
Implementation Plans	**Improvement Actions**	**Assessment Units Moving from Category 3 to 5**
None	Fish barrier removals, riparian exclosures, intensive riparian management	Seven listed AUs remain in Category 5 of the 2012 Integrated Report (addressed in separate TMDL). **Estimated Percent of Subbasin in Category 4a or 5** Upper Henrys Fork: 15% Lower Henrys Fork: 10%

1 Introduction

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters (33 USC §1251). 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. 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.

Idaho Code §39-3611(7) requires a 5-year cyclic review process for Idaho TMDLs:

> The director shall review and reevaluate each TMDL, supporting subbasin assessment, implementation plan(s) and all available data periodically at intervals of no greater than five (5) years. Such reviews shall include the assessments required by section 39-3607, Idaho Code, and an evaluation of the water quality criteria, instream targets, pollutant allocations, assumptions and analyses upon which the TMDL and subbasin assessment were based. If the members of the watershed advisory group, with the concurrence of the basin advisory group, advise the director that the water quality standards, the subbasin assessment, or the implementation plan(s) are not attainable or are inappropriate based upon supporting data, the director shall initiate the process or processes to determine whether to make recommended modifications. The director shall report to the legislature annually the results of such reviews.

To meet the intent and purpose of Idaho Code §39-3611(7), this report documents the review of an approved Idaho TMDL and implementation plan, considers the most current and applicable information in conformance with Idaho Code §39-3607, evaluates the appropriateness of the TMDL to current watershed conditions, implements plan evaluation, and provides for watershed advisory group (WAG) consultation. An evaluation of the recommendations presented is provided. Final decisions for TMDL modifications are decided by the Idaho Department of Environmental Quality (DEQ) director. Approval of TMDL modifications is decided by the US Environmental Protection Agency (EPA), with consultation by DEQ.

1.1 Assessment Units

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

Using AUs to describe water bodies offers many benefits primarily that all waters of the state are defined consistently. AUs are a subset of water body identification numbers, which allows them to relate directly to the water quality standards.

2 TMDL Review and Status

A complete characterization of the Upper Henrys Fork subbasin is found in the *Upper Henry's Fork Subbasin Assessment* (IDHW 1998). A characterization of the Lower Henrys Fork subbasin is included in *Upper and Lower Henry's Fork Total Maximum Daily Loads: Addendum to the Upper Henry's Fork Subbasin Assessment and TMDLs* (DEQ 2010a). This current subbasin description provides a background that frames issues within the Upper and Lower Henrys Fork TMDLs and §303(d)-listed tributaries.

The Upper Henrys Fork (hydrologic unit code [HUC] 17040202) and Lower Henrys Fork (HUC 17040203) subbasins are located in Idaho and Wyoming, with portions residing in Yellowstone National Park (Figure 1). The majority of acreage in the subbasins is located within public lands. The United States Forest Service (USFS) is the largest land-management agency in the subbasins, presiding over approximately 45% of the total area. The westernmost portion of the subbasin lies within Wyoming. However, 97% of the total acreage of the Upper Henrys Fork and 70% of the Lower Henrys Fork resides in Idaho. The total area for the Upper Henrys Fork subbasin is 701,567 acres, while the Lower Henrys Fork is 720,598 acres.

Historically, the economy of the region has been based on livestock grazing, timber production, and cultivated agriculture. Two reservoirs provide storage for irrigated agricultural lands both inside and outside the bounds of the subbasins: Henrys Lake and Island Park. The Henrys Fork fishery has an international reputation among fly fishers, and anglers drawn to the area are becoming increasingly important to the local economy. Cold water salmonid fisheries are found within both subbasins, and many of the streams are active recreation sites (DEQ 2010a).

Elevation ranges from over 10,000 feet along the Centennial Mountains on the north side of the subbasin to 4,800 feet near the Henrys Fork confluence with the Snake River to the south. The average elevation in the subbasin is 6,700 feet above sea level (Whitehead 1978.

Precipitation in the subbasin varies with elevation, with annual averages of 43 inches near the headwaters and 14 inches near the confluence with the Snake River. The minimum annual average temperatures range from 22ºF near the headwaters to 30ºF at the confluence. Maximum average annual temperatures range from 52ºF at the headwaters and 57ºF at the confluence (BOR 2015). Vegetation cover includes mixed conifer, subalpine fir, lodgepole pine, and grass/shrub types. Geologically, the subbasins are composed of Pre-Cambrian metamorphics, Mesozoic, and Paleozoic sedimentary rocks, glacial deposits, and a variety of volcanic deposits (Good and Pierce 1996).

Population density within both the upper and lower subbasins is generally low. Fremont County, which covers the majority of both subbasins, averages only seven people per square mile. Within the upper subbasin, population centers are Island Park, Warm River, and the Henrys Lake area. A large and growing population of rural summer residents is concentrated in the Henrys Lake and Island Park regions. In the lower subbasin, permanent residents provide a greater presence due to the agricultural capacity of the Snake River Plain. The main population centers are St. Anthony and Ashton, both of which are ranching and agricultural communities of 3,542 and 1,127 people, respectively.

In 2010, EPA approved TMDLs for sediment, temperature, and bacteria. Fourteen of the 16 approved TMDLs are for AUs located in the Upper Henrys Fork, with the remaining residing in the Lower Henrys Fork (Figure 2). Table 1 provides the targets during critical periods for each of the TMDL AUs.

All of Idaho's subbasin assessments, TMDLs, and implementation plans can be accessed at *http://www.deq.idaho.gov/water-quality/surface-water/tmdls/table-of-sbas-tmdls.aspx*.

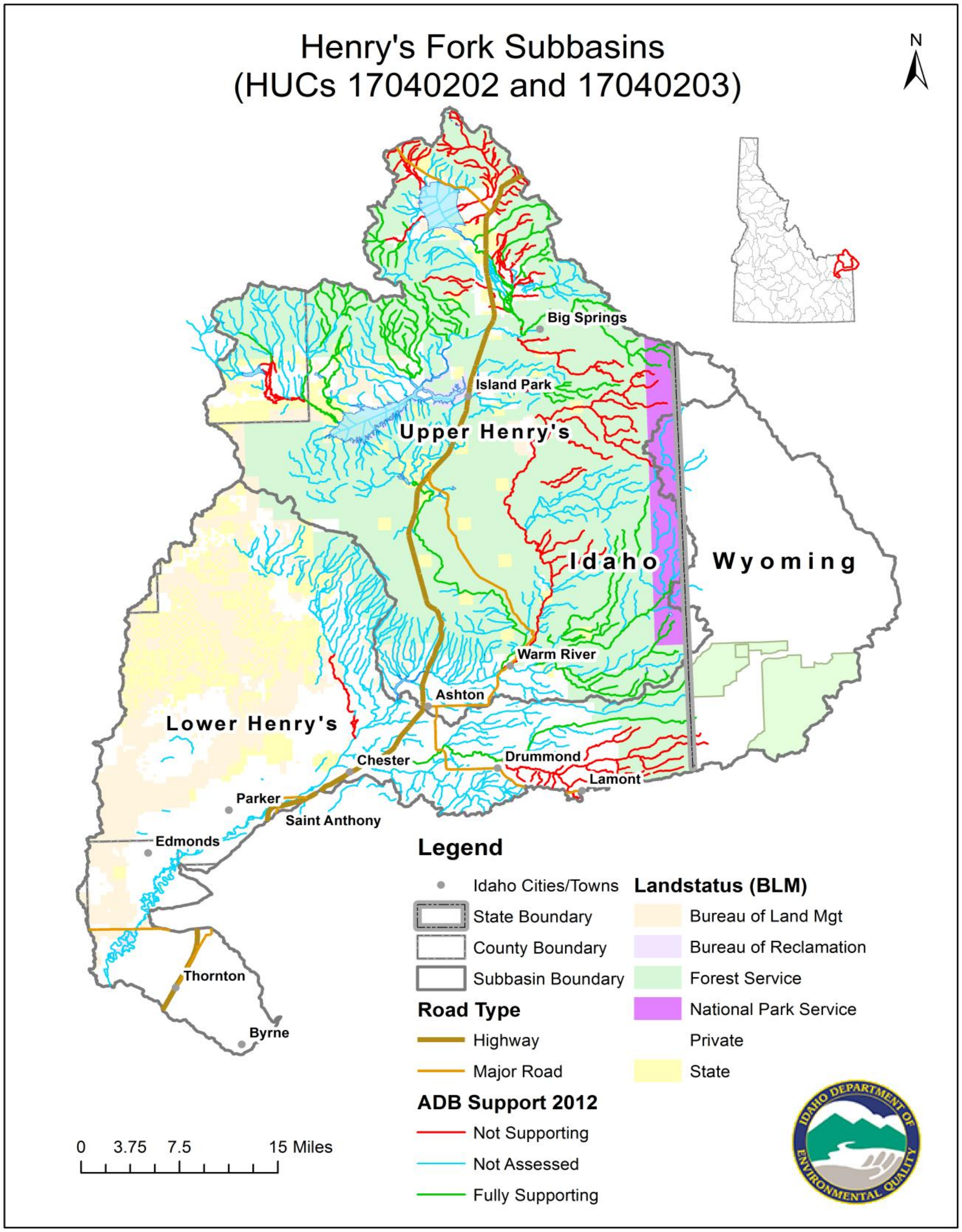

Figure 1. Upper and Lower Henrys Fork subbasins.

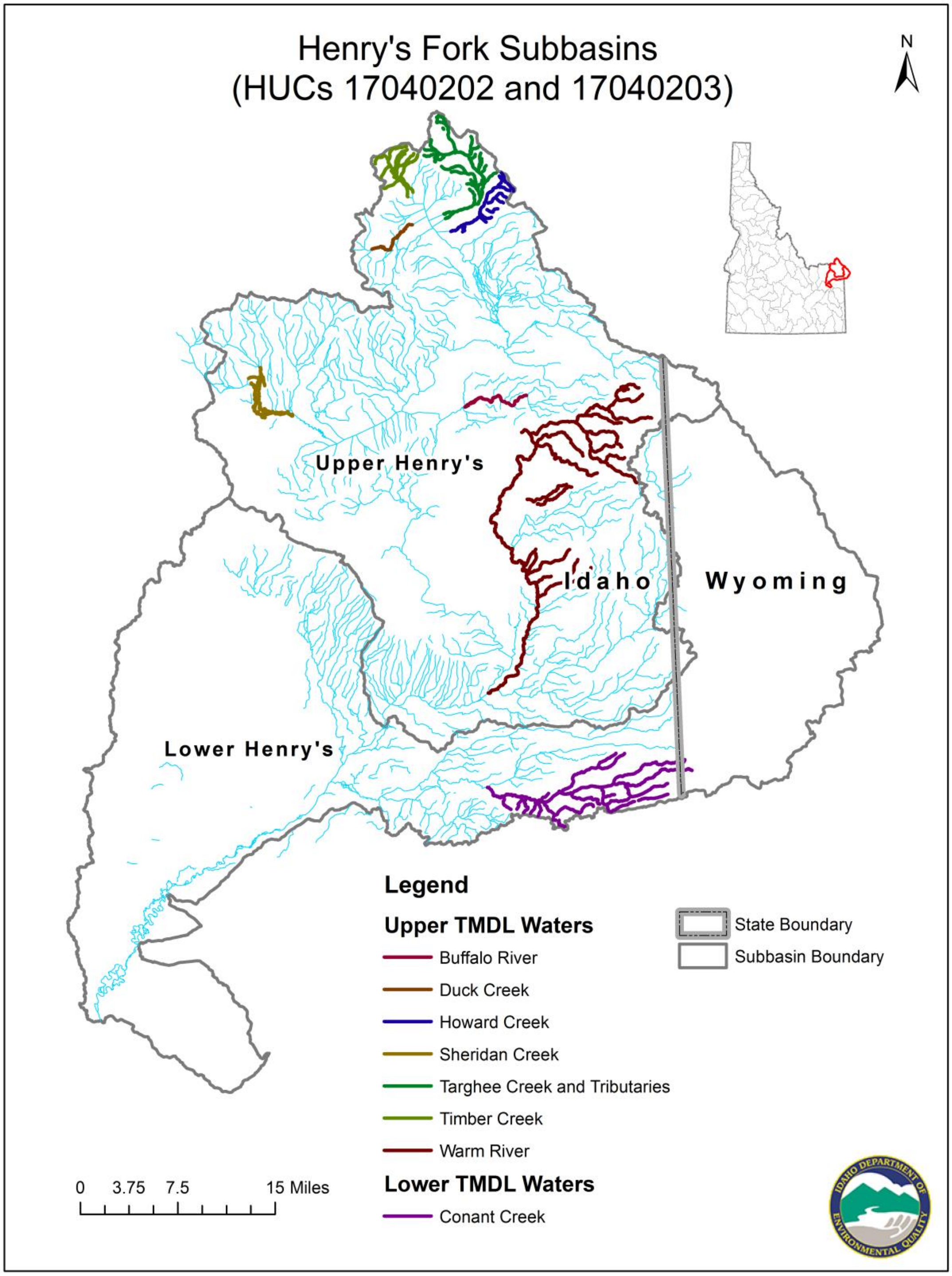

Figure 2. Water bodies in the Henrys Fork subbasins with TMDLs.

Table 1. Targets during critical periods.

Stream	Assessment Unit Number	Pollutant	Numeric Criteria	Narrative Target	Critical Period	Relevant TMDL Document
			Upper Henrys Fork			
Warm River	ID17040202SK002_04 ID17040202SK002_05 ID17040202SK005_02 ID17040202SK005_03 ID17040202SK005_04	Temperature (CWAL and SS)	Less than 22 °C daily maximum; less than 19 °C daily average. For SS, less than 13 °C daily maximum; less than 9 °C daily average.	N/A	Summer months; SS periods	2010 Henrys Fork TMDL
Buffalo River	ID17040202SK018_03	Sediment	N/A	80% streambank stability	Year-round	2010 Henrys Fork TMDL
Howard Creek	ID17040202SK033_02	Temperature (CWAL and SS)	Less than 22 °C daily maximum; less than 19 °C daily average. For SS, less than 13 °C daily maximum; less than 9 °C daily average.	N/A	Summer months; SS periods	2010 Henrys Fork TMDL
Targhee Creek	ID17040202SK034_02 ID17040202SK034_03	Temperature (CWAL and SS)	Less than 22 °C daily maximum; less than 19 °C daily average. For SS, less than 13 °C daily maximum; less than 9 °C daily average.	N/A	Summer months; SS periods	2010 Henrys Fork TMDL
Timber Creek	ID17040202SK035_02 ID17040202SK035_03	Temperature (Presumed CWAL and SS)	Less than 22 °C daily maximum; less than 19 °C daily average. For SS, less than 13 °C daily maximum; less than 9 °C daily average	N/A	Summer months; SS periods	2010 Henrys Fork TMDL
Duck Creek	ID17040202SK036_03	Sediment Temperature (CWAL and SS)	Less than 22 °C daily maximum; less than 19 °C daily average. For SS, less than 13 °C daily maximum; less than 9 °C daily average.	80% streambank stability	Year-round (sediment) Summer months; SS periods (temperature)	2010 Henrys Fork TMDL
Sheridan Creek	ID17040202SK045_03	Sediment	NA	80% streambank stability	Year-round	2010 Henrys Fork TMDL

Stream	Assessment Unit Number	Pollutant	Numeric Criteria	Narrative Target	Critical Period	Relevant TMDL Document
			Lower Henrys Fork			
Conant Creek	ID17040203SK007_02 ID17040203SK007_03	E. coli	Secondary contact recreation: <126 cfu/100 mL (geometric mean) or <576 cfu/100 mL (instantaneous)	NA	Grazing season	2010 Henrys Fork TMDL

Notes: cold water aquatic life (CWAL); salmonid spawning (SS); colony forming units (cfu); milliliter (mL); *Escherichia coli* (*E. coli*); Not applicable (NA). Summer months = June, July August, SS periods include spring spawning = March-July and fall spawning = September to March, Grazing season = March to November.

Two point sources are present within the Henrys Fork subbasins, but neither of them discharges to an impaired stream, so no wasteload allocations were necessary in the 2010 TMDL (Table 2). The Ashton Fish Hatchery closed several years after the TMDLs were developed, so it is no longer considered a point source.

Table 2. Current NPDES permits in the Henrys Fork subbasins.

Facility	Permit Number	Wasteload Allocation
City of Ashton Wastewater Treatment Plant (WWTP)	ID0023710	Does not discharge to impaired stream
City of St. Anthony WWTP	ID0020401	Does not discharge to impaired stream

2.1 Pollutant Targets

Idaho's "Water Quality Standards" (IDAPA 58.01.02) for sediment is narrative; no specific quantitative value is established in Idaho code. Numeric targets for the TMDLs were set using a collection of literature sources that provided information relating numeric values to the attainment of beneficial uses. Table 3 outlines numeric targets set for the TMDLs in the Henrys Fork subbasins.

Table 3. Pollutant targets established for the Henrys Fork subbasins.

Pollutant	Parameter	Numeric Target
Sediment	Streambanks	>80% stability
Temperature	Potential natural vegetation	Dependent on vegetation and stream width
Bacteria	*E. coli* geometric mean	126 cfu/100 mL

Notes: *Escherichia coli* (*E. coli*), colony forming unit (cfu), milliliter (mL)

2.1.1 Sediment

The current state of the science does not allow specification of a sediment load or load capacity that is well known in advance to meet the narrative criteria for sediment and to fully support beneficial uses for cold water aquatic life (CWAL) and salmonid spawning (SS). However, we assume the load capacity is met at levels where streambank erosion is at natural levels. We define the natural state as a bank stability target level of at least 80%. We presume that beneficial uses are, or would be, fully supported at natural background sediment load rates that are at or better than this target.

The critical time for sedimentation in the Henrys Fork subbasins occurs during times of peak flow from runoff. Higher discharge through the rivers and creeks allows more sediment to be carried downstream and deposited. Bare banks from overgrazing and anthropogenic factors are easily washed out and heavily eroded during peak flow events. It is difficult to sample sediment quantities during these high flow events, especially in remote areas. Therefore, we rely upon an estimate of annual erosion from banks based on streambank erosion inventory (SEI) sampling protocols.

2.1.2 Temperature

The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09) that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and for temperature TMDLs, the natural level of shade and channel width become the TMDL target. The instream temperature that results from attaining these conditions is consistent with the water quality standards, even if it exceeds numeric temperature criteria.

The potential natural vegetation (PNV) approach is used to determine if a stream is currently within its natural shade level based on width and vegetation types. The procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in detail in *The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual* (Shumar and de Varona 2009). The manual also provides a more complete discussion of shade and its effects on stream water temperature.

2.1.3 Bacteria

Instream water quality targets for the bacteria (*Escherichia coli* [*E. coli*]/fecal coliform) listed waters were set from the Idaho water quality standards. The water quality standards prescribe *E. coli* criteria for both primary and secondary contact recreation. To support the beneficial use of primary or secondary contact recreation, a geometric mean of 126 colony forming units (cfu)/100 milliliters (mL) for 5 samples collected every 3 to 7 days within a 30-day period is required to determine exceedance of the standard. An *E. coli* single instantaneous sample of 576 cfu/100 mL for secondary contact recreation is not a violation of the water quality standards but acts as a trigger for more monitoring (IDAPA 58.01.02.251.01).

2.2 Control and Monitoring Points

The 2010 TMDL did not specifically address monitoring objectives for impaired streams. For this 5-year review, all data collected on AUs will serve as a monitoring point for the TMDL. Beneficial Use Reconnaissance Program (BURP) data will be used to assess beneficial use support status since development of the 2010 TMDL.

The objectives of these monitoring efforts are to evaluate long-term recovery, better understand natural variability, track implementation of projects and best management practices once they are developed, and oversee the effectiveness of TMDL implementation.

Monitoring points for the TMDLs were chosen in areas that are accessible and representative of the watershed.

2.2.1 Sediment

In the approved TMDLs (DEQ 2010a), at least one streambank erosion monitoring area was chosen on each impaired AU: Duck, Icehouse, Sheridan, and Willow Creeks. Both Icehouse Creek and Willow Creek did not require sediment TMDLs according to the completed SEIs. The previous 2010 5-year review assessed other streams in addition to those for which new TMDLs were written (DEQ 2010b):

Monitoring to assess sediment-impaired waters in the Henrys Fork subbasins took place in 2015. SEI sites were chosen for both AUs newly listed as impaired for sediment and those for which TMDLs have already been written: Buffalo River (Category 4a), Moose Creek (Category 5), Henrys Lake Outlet tributaries (Category 5), Twin Creek (Category 5), Duck Creek (Category 4a), Sheridan Creek (Category 4a), Conant Creek tributaries (Category 5), Conant Creek (Category 5), and Sand Creek (Category 5). Using SEI data, we calculated the current sediment load based on bank erosion for each AU and compared it to load rates and target levels seen in the 2010 TMDL. Data gained from these measurements allowed us to determine whether conditions for beneficial uses are declining, improving, or meeting targets. For streams in Category 5 for sediment, we assessed whether they should be prioritized for TMDL development.

The repeated monitoring approach used in the 5-year review should steer us towards the goal of fully meeting the streams’ beneficial uses. If riparian damage has decreased since the 2010 TMDLs were written, the SEIs should yield evidence of reduced erosion that would lead to the encroachment of healthy riparian vegetation such as willows. Willow roots hold streambanks together reducing erosion, while the shade from their branches and leaves decreases the amount of direct solar radiation entering the stream and reduces its temperature.

2.2.2 Temperature

The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09) that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and for temperature TMDLs, the natural level of shade and channel width become the TMDL target. The instream temperature that results from attaining these conditions is consistent with the water quality standards, even if it exceeds numeric temperature criteria.

EPA approved temperature TMDLs (DEQ 2010a) developed using PNV shade analysis on five water bodies in the Upper Henrys Fork subbasin: Warm River (5 AUs), Howard Creek (1 AU), Targhee Creek (2 AUs), Timber Creek (1 AU), and Duck Creek (1 AU). It was determined that all streams in the TMDL analysis lacked shade to some degree and required reductions in excess heat from solar load.

In 2015, seven sites on the five 2010 temperature TMDL water bodies were visited and assessed using the PNV method (Shumar and de Varona 2009).

2.2.3 Bacteria

Instream water quality targets for the bacteria (*E. coli*/fecal coliform)-listed waters were set from the Idaho water quality standards. The water quality standards prescribe *E. coli* criteria for both primary and secondary contact recreation. To support the beneficial use of primary or secondary contact recreation, a geometric mean of 126 cfu/100 mL for 5 samples collected every 3 to 7 days within a 30-day period is required to determine exceedance of the standard. An *E. coli* single instantaneous sample of 576 cfu/100 mL for secondary contact recreation is not a violation of the water quality standards but acts as a trigger for more monitoring (IDAPA 58.01.02.251.01).

E. coli monitoring was satisfied through annual BURP single instantaneous sampling on the TMDL waters and newly listed waters in both the Upper and Lower Henrys Fork subbasins: Timber Creek (Category 5–Upper Henrys Fork), Conant Creek tributaries (Category 4a–Lower Henrys Fork), and Conant Creek (Category 4a–Lower Henrys Fork).

2.3 Load Capacity

The load capacity estimates the quantity of pollutant a water body is believed to be able to receive and still maintain support of beneficial uses and meet water quality standards. Load capacities for specific pollutants are listed below.

2.3.1 Sediment

Load capacities for sediment as determined in the 2010 TMDLs were based on streambank erosion target levels. The bank stability target of 80% was set to represent the minimum level of stability that would occur naturally. Any stability less than 80% would create eroded loads that exceed load capacities. No additional margin of safety (MOS) was built into the estimates. Current SEI protocols (DEQ 2014b) add an additional 10% MOS to the estimate of excess load, thus present SEI calculations are different from those performed in 2010. Additionally, the SEI technique has evolved. Presently, we estimate two lateral recession rates, one for the load capacity and one for current conditions. These rates result in load capacity estimates that are different from 2010 TMDL levels and create new load allocations for each AU to which current loads are compared. Percent load reduction and bank stability estimates then become the only method to compare changes since the previous TMDLs.

2.3.2 Temperature

The load capacity for temperature for a stream under PNV is essentially the solar load under shade targets specified for reaches within the stream.

2.3.3 Bacteria

For bacteria, the numeric water quality standard is used as the load capacity when developing TMDLs.

2.4 Load Allocations

Sediment, temperature, and bacteria load allocations were developed and approved in 2010 as shown in Table 4, Table 5, and Table 7 (DEQ 2010a)

2.4.1 Sediment

Previously, sediment loads in some Idaho TMDL documents were expressed in tons per year; however, more recently, documents must express loads in units per day. For the purposes of comparison, the 2010 sediment TMDL values and newer load calculation are expressed in tons per year. Additionally, the previous load allocation values do not include the 10% MOS that we presently implement in our calculations.

Load allocations were determined in the 2010 TMDL by calculating the load of sediment to the stream from eroding streambanks when 80% of the banks are stable with no erosion (natural condition or load capacity) and under current bank conditions. Comparing these two loads shows how much excess sediment is entering the stream from the banks both in terms of tons per year and as a percent reduction to meet target loads. Table 4 summarizes sediment loads and load allocations set for water bodies in the Upper Henrys Fork subbasin.

Table 4. Upper Henrys Fork subbasin sediment load allocations.

Water Body	Assessment Unit Number	Current Load	Load Capacity	Load Reduction Required	% Reduction
		(tons/mil/year)			
Buffalo River	ID17040202SK018_03	23	4	19	83
Duck Creek	ID17040202SK036_03	53	15	38	71
Sheridan Creek	ID17040202SK045_03	25	5	20	80

2.4.2 Temperature

The Upper Henrys Fork temperature TMDLs (DEQ 2010a) were developed based on PNV and estimate of background load. TMDL load allocation is essentially the desire to achieve natural background conditions. To achieve that objective, load allocations were assigned to nonpoint source activities that have impacted or may impact riparian vegetation. Load allocations are stream reach specific and depend on the target load for a given reach. Table 5 shows the excess solar loads experienced by AUs in the Upper Henrys Fork.

Table 5. Upper Henrys Fork excess solar loads and percent reduction estimates.

Water Body	Assessment Unit Number	Total Existing Load	Total Target Load	Excess Load	Average Lack of Shade
		Kilowatt hour per day			
Warm River	ID17040202SK002_04 ID17040202SK002_05 ID17040202SK005_02 ID17040202SK005_03 ID17040202SK005_04	3,665,140	3,260,351	404,790	-8%
Howard Creek	ID17040202SK033_02	175,034	141,084	33,950	-11%

Water Body	Assessment Unit Number	Total Existing Load	Total Target Load	Excess Load	Average Lack of Shade
		Kilowatt hour per day			
Targhee Creek	ID17040202SK034_03	321,794	303,594	18,200	-6%
Timber Creek	ID17040202SK035_03	26,873	15,967	10,906	-31%
Duck Creek	ID17040202SK036_03	103,938	90,205	13,733	-12%

Stream temperature may be affected by diversions of water for water rights purposes. Diversion of flow reduces the amount of water exposed to a given level of solar radiation in the stream channel, which can result in increased water temperature in that channel. Loss of flow in the channel also affects the ability of the near-stream environment to support shade-producing vegetation, resulting in an increase in solar load to the channel. This aspect of temperature influence was not taken into account in the 2010 temperature TMDLs; however, TMDLs may not supersede any water appropriation in the affected watershed.

The Upper Henrys Fork subbasin contains 1,120 surface water rights (1,532 including ground water rights). The Lower Henrys Fork contains 888 surface water rights (2,383 including ground water rights). Figure 3 and Figure 4 show the locations of these points of diversion within the Upper and Lower Henrys Fork subbasins, respectively.

2.4.3 Bacteria

A bacteria TMDL was developed for one AU in the Lower Henrys Fork subbasin in 2010 (DEQ 2010a). The load capacity is simply the water quality standard for bacteria (geometric mean of 126 cfu/100 mL). The 2010 TMDL allocation accounts for both natural background and MOS values. Presently, DEQ subtracts a 10% MOS from the load capacity to determine the load allocation but does not include a natural background value, as the water quality standard should be sufficient to account for natural bacteria levels.

Table 6 and Table 7 describe the load capacity for Conant Creek and load values from the 2010 TMDL (DEQ 2010a).

Table 6. Load capacity and critical period for bacteria in the Lower Henrys Fork subbasin.

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

Table 7. Conant Creek *E. coli* results from TMDL (DEQ 2010a).

Stream Name	Load Capacity	Total Existing Load	Natural Background	Margin of Safety	Load Allocation	Load Reduction	% Reduction Required
	Colony forming units per 100 milliliters						
Conant Creek (Squirrel Creek)	126	950	13	13	328	824	87

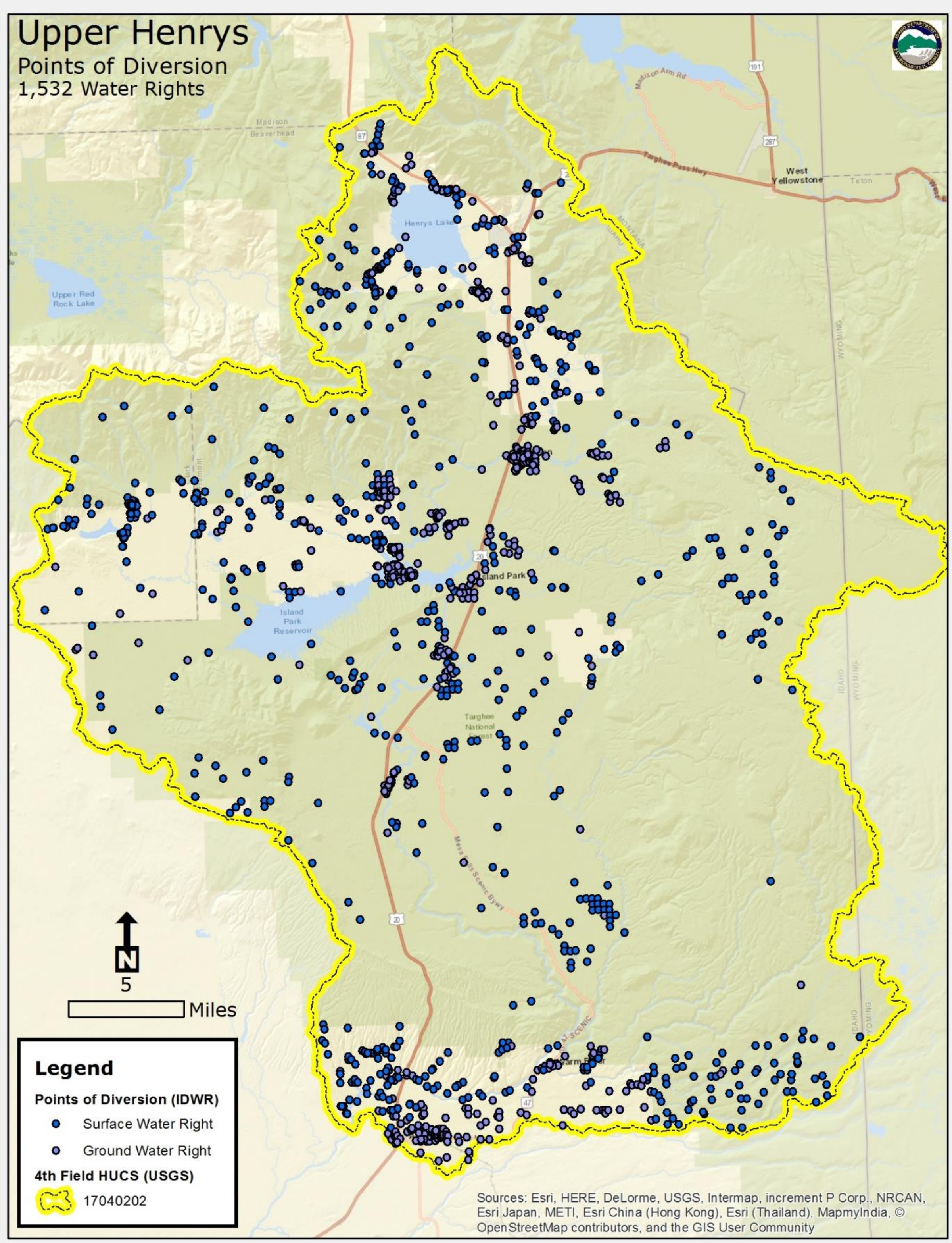

Figure 3. Water rights diversions in the Upper Henrys Fork subbasin.

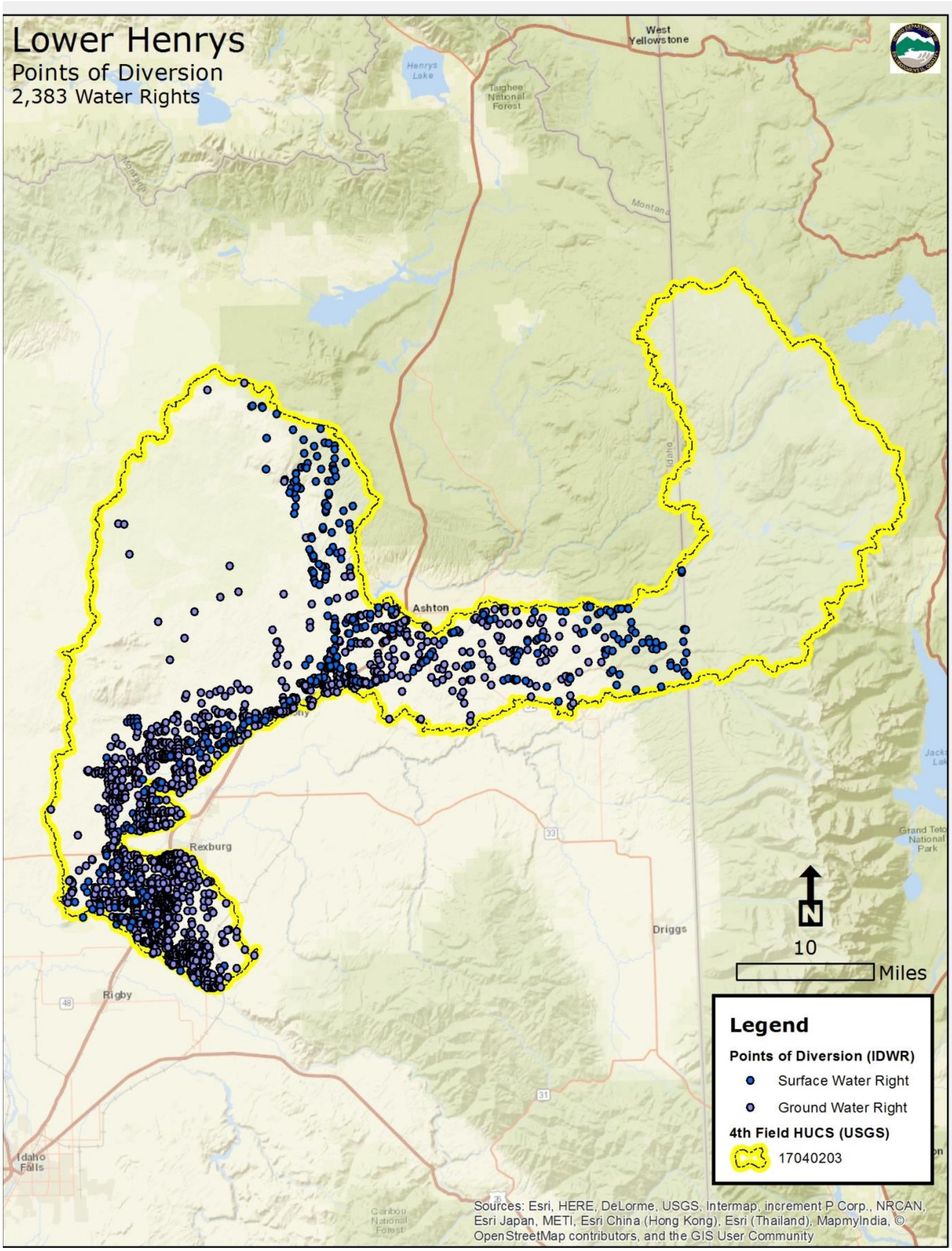

Figure 4. Water rights diversions in the Lower Henrys Fork subbasin.

2.5 Margin of Safety

No additional MOS was used in the streambank erosion estimates from the 2010 TMDL. MOS was considered implicit. Our current SEI protocols (DEQ 2014b) add an additional 10% MOS to the estimate of excess load.

The MOS for the temperature TMDLs (DEQ 2010a) is considered implicit in the design. Since the target is equivalent to background conditions, loads (shade levels) are allocated to lands adjacent to the TMDL waters at natural background levels. It is unrealistic to set shade targets at higher or more conservative levels than what can realistically be achieved by natural conditions. Additionally, existing shade levels were reduced to the next lower 10% shade class interval, which likely underestimated the actual shade in the load analysis.

Bacteria TMDLs include a 10% explicit MOS.

2.6 Seasonal Variation

Season variation was built into the sediment TMDLs by developing loads using annual average rates determined from empirical characteristics that developed over time within the influence of runoff events and peak and base flow conditions. SEIs take into account that most bank recession occurs during peak flow event, when the banks are saturated. The annual delivery of sediment is a function of bankfull discharge. It is assumed that sediment accumulation within dry channels is continuous until flow resumes and the accumulated sediment is transported and deposited.

The temperature TMDL was based on average summer loads. All loads were calculated to be inclusive of the 6-month period from April through September. This time period was chosen because it represented when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical time period is May when spring SS occurs, July and August when maximum temperatures exceed CWAL criteria, and October during fall SS. Water temperature is not likely to be a problem for beneficial uses outside of this time period due to cooler weather and a lower sun angle.

Bacteria concentrations generally vary as a function of grazing activity and streamflow. Bacteria TMDLs are developed based on these periods with the highest *E. coli* concentrations, which generally occurs during August.

2.7 Reserve

There were no reserve set asides in the 2010 TMDL.

3 Beneficial Use Status

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. The 2002 *Water Body Assessment Guidance*

(WBAG) (Grafe et al. 2002) describes beneficial use identification for use assessment purposes. The 2016 WBAG will only be applied to 2016 and future assessments (DEQ 2016).

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." Designated uses are specifically listed for Idaho water bodies in tables in the Idaho water quality standards (IDAPA 58.01.02) in addition to citations for existing and presumed uses.

Undesignated uses are to be designated. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support CWAL 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 CWAL criteria and primary or secondary contact recreation criteria to undesignated waters.

3.1 Beneficial Uses

In the Henrys Fork subbasins, the Henrys Fork itself is designated for CWAL, SS, primary contact recreation, and domestic water supply. Smaller undesignated tributaries are presumed to support CWAL and secondary contact recreation. Many of these streams are known to contain viable populations of salmonids and possess SS as an existing use.

Table 8 and Table 9 provide the beneficial uses for §303(d)-listed streams and streams with TMDLs.

Beneficial uses are protected by a set of criteria, which include narrative criteria for pollutants such as sediment and nutrients and numeric criteria for pollutants such as bacteria, dissolved oxygen, pH, toxics, ammonia, temperature, and turbidity (IDAPA 58.01.02.250–251) (Table 10). Figure 5 provides the steps in the stream assessment process for determining support status of the beneficial uses of CWAL, SS, and contact recreation.

Table 8. Henrys Fork subbasins beneficial uses of §303(d)-listed streams.

Assessment Unit Name	Assessment Unit Number	Beneficial Uses[a]	Type of Use
Upper Henrys Fork			
Moose Creek	ID17040202SK022_02	CW, SCR	Presumed
Henrys Lake Outlet tributaries	ID17040202SK025_02	CW, SS, PCR, DWS	Designated
Twin Creek	ID17040202SK030_02	CW, SCR	Presumed
Timber Creek	ID17040202SK035_03	CW, SCR	Presumed
Lower Henrys Fork			
Conant Creek tributaries	ID17040203SK007_02	CW, SCR	Presumed
Conant Creek	ID17040203SK007_03	CW, SCR	Presumed
Sand Creek	ID17040203SK013_04	CW, SCR	Presumed

a. Cold water (CW), salmonid spawning (SS), primary contact recreation (PCR), secondary contact recreation (SCR), domestic water supply (DWS)

Table 9. Upper Henrys Fork subbasins beneficial uses of waters with TMDLs.

Assessment Unit Name	Assessment Unit Number	Beneficial Uses[a]	Type of Use
Warm River	ID17040202SK002_04	CW, SS, PCR, DWS	Designated
Warm River	ID17040202SK002_05	CW, SS, PCR, DWS	Designated
Warm River	ID17040202SK005_02	CW, SS, PCR, DWS	Designated
Warm River	ID17040202SK005_03	CW, SS, PCR, DWS	Designated
Warm River	ID17040202SK005_04	CW, SS, PCR, DWS	Designated
Buffalo River	ID17040202SK018_03	CW, SS, PCR, DWS	Designated
Howard Creek	ID17040202SK033_02	CW, SS, SCR	Designated
Targhee Creek Tributaries	ID17040202SK034_02	CW, SS, SCR	Designated
Targhee Creek	ID17040202SK034_03	CW, SS, SCR	Designated
Timber Creek and Tributaries	ID17040202SK035_02	CW, SS, SCR	Presumed
Duck Creek	ID17040202SK036_03	CW, SS, SCR	Designated
Sheridan Creek	ID17040202SK045_03	CW, SS, SCR	Designated
Sheridan Creek	ID17040202SK046_04	CW, SS, SCR	Presumed

a. Cold water (CW), salmonid spawning (SS), primary contact recreation (PCR), secondary contact recreation (SCR), domestic water supply (DWS)

Table 10. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning[a]
Water Quality Standards: IDAPA 58.01.02.250–251				
Bacteria				
• Geometric mean	<126 *E. coli*/100 mL[b]	<126 *E. coli*/100 mL	—	—
• Single sample	≤406 *E. coli*/100 mL	≤576 *E. coli*/100 mL	—	—
pH	—	—	Between 6.5 and 9.0	Between 6.5 and 9.5
Dissolved oxygen (DO)	—	—	DO exceeds 6.0 milligrams/liter (mg/L)	**Water Column DO**: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater **Intergravel DO**: DO exceeds 5.0 mg/L for a 1-day minimum and exceeds 6.0 mg/L for a 7-day average
Temperature[c]	—	—	22 °C or less daily maximum; 19 °C or less daily average **Seasonal Cold Water**: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average **Bull Trout**: Not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June–August; not to exceed 9 °C daily average in September and October
Turbidity	—	—	Turbidity shall not exceed background by more than 50 nephelometric turbidity units (NTU) instantaneously or more than 25 NTU for more than 10 consecutive days.	—
Ammonia	—	—	Ammonia not to exceed calculated concentration based on pH and temperature.	—
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131				
Temperature	—	—	—	7-day moving average of 10 °C or less maximum daily temperature for June–September

[a] During spawning and incubation periods for inhabiting species
[b] *Escherichia coli* per 100 milliliters
[c] Temperature exemption: Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the 7-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.

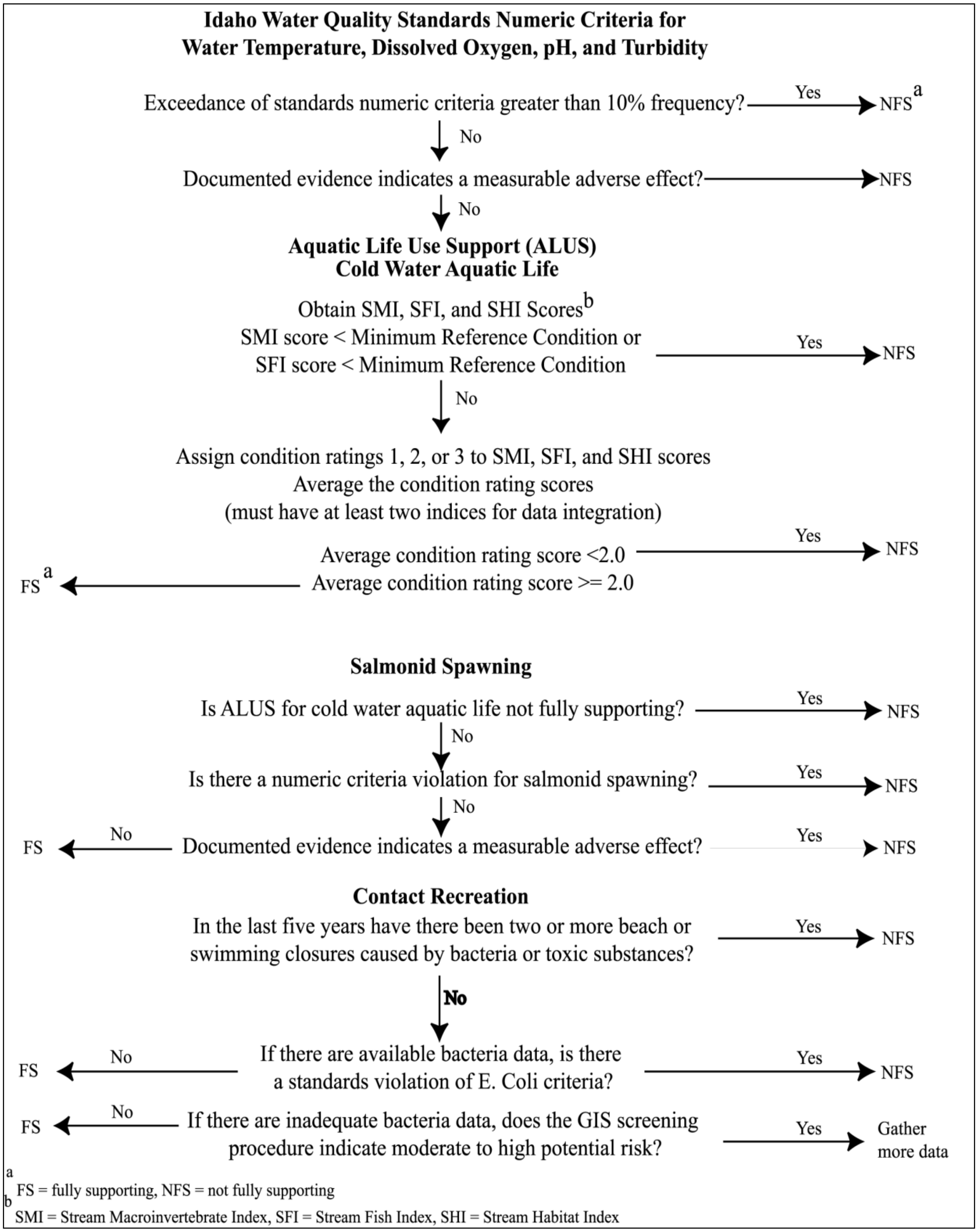

Figure 5. Determination steps and criteria for determining support status of beneficial uses in wadeable streams (Grafe et al. 2002).

3.2 Changes to Subbasin Characteristics

Since the 2010 TMDL was completed, no substantive changes have been made to the population, political boundaries, economy, landownership, land use, nor roads within Upper and Lower Henrys Fork subbasins. Improvement projects have primarily been aimed at improving fish migration and habitat and improving grazing management, which are discussed in section 4.

3.3 Summary and Analysis of Current Water Quality Data

3.3.1 Beneficial Use Reconnaissance Program Data

Data collections in the Upper and Lower Henrys Fork subbasins since the 2010 TMDL have included periodic BURP assessment-level sampling and specific sediment and temperature sampling for TMDL purposes. Table 11 provides the BURP sampling results.

DEQ's BURP collects data on AUs to determine support of beneficial uses in subbasins throughout the state. Evaluations of BURP data are based on three facets of ecology of wadeable streams: macroinvertebrates, stream habitat, and fish. Individual metrics within each category are used to generate multimetric index scores. The index scores are the stream macroinvertebrate index (SMI), stream fish index (SFI), and stream habitat index (SHI). From those scores, condition rankings of 0, 1, 2, or 3 are assigned to sites based on percentile categories of reference conditions. At least two scores are needed to evaluate a stream's support status; those scores must average 2 or greater (scale of 0 to 3) for beneficial uses to be considered supported.

In general, each stream in the Henrys Fork subbasins with a TMDL has a range of scores that indicate both fully and not fully supporting beneficial uses throughout the years of the program. Certain streams are difficult to assess for water quality trends over time using BURP data due to infrequent visits, as several streams have only been visited once or have yet to be visited since the outset of the program (i.e., Buffalo River and Timber Creek). Additionally, specific BURP sites are not repeated, so it is difficult to distinguish whether differing scores for the same AU are due to changing watershed conditions or site-specific attributes. Proper site selection that is characteristic of the AU is important in providing a representative assessment of water quality.

Warm River's (ID17040202SK005_03) BURP scores have been improving since 2011. Howard Creek has remained static in terms of average score between the 2003 and 2014 site visits, while Targhee and Duck Creeks have been improving throughout the past decade. Conant Creek has variable water quality from year to year, but it has received passing scores during the last two site visits. The only stream that appears to be degrading based on average BURP score alone is Sheridan Creek, which has only been visited in 1995 (2 different sites) and 2010 (1 site), with one failing score in 1995 and a lower failing score in 2010.

Table 11. BURP scores for AUs with approved TMDLs in the Henrys Fork subbasins (DEQ 2010a).

Year	Assessment Unit Number	BURP ID	SMI Score	SMI Rating	SFI Score	SFI Rating	SHI Score	SHI Rating	Average Score	Macroinvertebrates (count)
Upper Henrys Fork										
Warm River										
1997	ID17040202SK002_04	1997SIDFM075	68.84	3	66.25	1	70	3	2.33	581
1997	ID17040202SK005_03	1997SIDFM071	27.05	0	45.26	1	54	1	0	228
1997	ID17040202SK005_03	1997SIDFM074	62.29	3	56.29	1	59	2	2	528
2003	ID17040202SK005_03	2003SIDFA005	71.07	3	72.50	2	48	1	2	543
2003	ID17040202SK005_03	2003SIDFA006	67.34	3	64.94	1	48	1	1.67	532
2011	ID17040202SK005_03	2011SIDFA036	47.91	1	29.25	0	62	2	0	567
2013	ID17040202SK005_03[a]	2013SIDFA048	36	1	100	3	67	2	2	507
2004	ID17040202SK005_04	2004SIDFA012	58.17	2	73.28	2	63	2	2	575
Buffalo River										
	ID17040202SK018_03	No BURP data								
Howard Creek										
1994	ID17040202SK033_02	1994SIDFA008	45.30	2	-	-	63	3	2.5	265
2003	ID17040202SK033_02	2003SIDFA004	55.93	2	80.36	2	43	1	1.67	581
2014	ID17040202SK033_02[a]	2014SIDFA008	31	1	97	3	56	1	1.67	511
Targhee Creek										
1994	ID17040202SK034_03	1994SIDFA006	57.15	3	-	-	73	3	3	293
1994	ID17040202SK034_03	1994SIDFA007	43.75	2	-	-	36	1	1.5	547
2003	ID17040202SK034_03	2003SIDFA003	66.45	3	37.20	1	64	2	2	484
2004	ID17040202SK034_03	2004SIDFA124	76.65	3	54.01	1	70	3	2.33	545
2010	ID17040202SK034_03	2010SDEQA1949	64.85	3	-	-	59	2	2.5	546
2014	ID17040202SK034_03[a]	2014SIDFA009	68	2	-	-	82	3	2.5	496
Timber Creek[b]										
2003	ID17040202SK035_03	2003SIDFA002	57.25	2	34.51	1	57	1	1.33	656

Year	Assessment Unit Number	BURP ID	SMI Score	SMI Rating	SFI Score	SFI Rating	SHI Score	SHI Rating	Average Score	Macroinvertebrates (count)
Duck Creek										
1994	ID17040202SK036_03	1994SIDFA009	49.87	2	-	-	53	1	1.5	440
2003	ID17040202SK036_03	2003SIDFA001	58.77	2	71.18	2	41	1	1.67	560
2006	ID17040202SK036_03	2006SIDFA079	43.67	1	52.95	1	36	1	1	528
2013	ID17040202SK036_03[a]	2013SIDFA001	54	2	99	3	58	2	2.33	545
Sheridan Creek										
1995	ID17040202SK045_03	1995SIDFA062	69.72	3	50.97	1	56	2	2	582
1995	ID17040202SK045_03	1995SIDFA063	45.76	2	-	-	26	1	1.5	472
2010	ID17040202SK045_03	2010SDEQA1981	50.14	2	39.13	1	28	1	1.33	539
Lower Henrys Fork										
Conant Creek[b]										
1997	ID17040203SK007_02	1997SIDFL060	48.75	1	47.11	1	75	3	1.67	506
1997	ID17040203SK007_02	1997SIDFL062	15.40	0	-	-	47	1	0	937
1993	ID17040203SK007_03	1993SIDFA025	56.34	3	-	-	-	-	3	85
1996	ID17040203SK007_03	1996SIDFZ127	56.05	2	13.40	0	50	1	0	314
1997	ID17040203SK007_03	1997SIDFL061	74.37	3	53.04	1	68	3	2.33	503
1997	ID17040203SK007_03	1997SIDFL068	62.94	3	23.91	0	55	1	0	611
2013	ID17040203SK007_03[a]	2013SIDFA047	65	3	-	-	74	3	3	538
2014	ID17040203SK007_03[a]	2014SIDFA035	57	2	96	2	68	2	2	505

a. Assessed using WBAG (DEQ 2016) (SMI2, SFI2, and SHI2 scores in place of SMI, SFI, and SHI).
b. Stream is also listed in Category 5 (impaired) of the most recent Integrated Report (DEQ 2014a).

In addition to collecting data in support of DEQ's multimetric indices, BURP crew members also completed *E. coli* sampling of targeted streams in the Upper and Lower Henrys Fork. Table 12 summarizes these efforts from 2006 through 2015.

Table 12. *E. coli* sampling results in the Henrys Fork subbasins (2006–2015).

Assessment Unit Number	Latitude	Longitude	Sample Date	Concentration (MPN/100 mL)
Upper Henrys Fork				
Moose Creek				
ID17040202SK003_02	44.19988	-111.252850	8/25/2014	20.9
Warm River				
ID17040202SK005_03	44.318740	-111.306980	8/24/2011	119.8
	44.287900	-111.313780	8/20/2013	290.9
Robinson Creek				
ID17040202SK006_04	44.11251	-111.250750	8/25/2014	4.1
Rock Creek				
ID17040202SK008_03	44.10041	-111.172910	8/25/2014	46.7
Sawtell Creek				
ID17040202SK025_02	44.55697	-111.363010	8/25/2014	60.9
Reas Pass Creek				
ID17040202SK027_03	44.546680	-111.243900	8/20/2013	4.1
Twin Creek				
ID17040202SK030_02	44.61245	-111.296320	8/25/2014	5.2
Howard Creek				
ID17040202SK033_02	44.66892	-111.298430	8/25/2014	<1.0
Targhee Creek				
ID17040202SK034_03	44.66946	-111.315960	8/25/2014	4.1
Timber Creek				
ID17040202SK035_03[a]	44.669436	-111.427408	8/20/2015	214.2
	44.669436	-111.427408	8/20/2015	191.8
	44.669436	-111.427408	8/20/2015	<1.0
	44.669436	-111.427408	8/26/2015	133.3
Duck Creek				
ID17040202SK036_03	44.608000	-111.461937	8/22/2006	613.0
			8/25/2006	1120
			8/30/2006	1203
			9/6/2006	613.0
			9/13/2006	17.0
			Geometric mean	386.3
ID17040202SK036_03	44.614300	-111.459330	8/20/2013	285.1

Assessment Unit Number	Latitude	Longitude	Sample Date	Concentration (MPN/100 mL)
Lower Henrys Fork				
Conant Creek				
ID17040203SK007_03[b]	44.004540	-111.151740	8/20/2013	32.3
	44.00602	-111.141470	8/25/2014	29.5
	44.00594	-111.141474	8/18/2015	56.3

a. Category 5 for bacteria.
b. Category 4a for bacteria in the Integrated Report (DEQ 2014a)
Note: most probable number (MPN), milliliter (mL)

Based on *E. coli* samples taken in 2013, 2014, and 2015, Conant Creek did not exceed the single sample threshold for secondary contact recreation during the critical time period; therefore, no geometric mean sampling was necessary. Geometric mean sampling in 2009 resulted in a value of 950 cfu/100 mL, with the lowest single sample value being 517.2 cfu/100 mL. Comparing the most recent single sample value of 56.3 cfu/100 mL, Conant Creek has significantly improved its bacteria load since the 2010 TMDL.

Although Duck Creek does not have a bacteria TMDL, geometric mean sampling that took place in 2006 indicated that the stream was impaired for bacteria. A more recent site visit during the critical time period in 2013 did not exceed the single sample threshold, so additional sampling did not take place.

Overall, streams in the Henrys Fork subbasins have remained well under the *E. coli* threshold for both primary and secondary contact recreation (single sample values of 406 cfu/100 mL and 576 cfu/100 mL, respectively).

3.3.2 Streambank Erosion Inventory Data

In 2010, DEQ conducted SEIs on AUs in the Upper and Lower Henrys Fork subbasin (Table 13 and Table 14). SEIs were conducted on seven AUs, with attempts on several additional AUs that were either inaccessible or deemed unnecessary. SEIs attempt to document streambank erosion conditions within an AU by measuring the length of eroding and noneroding streambanks. Additionally, when eroding banks are encountered, the height of the bank subject to erosion is measured. SEIs ideally incorporate at least 10% of an AU, and attempts are made to be as representative as possible.

Percent bank stability measures progress toward reaching a surrogate sediment target of at least 80% bank stability. This target has been established in many of DEQ’s EPA-approved sediment TMDLs, such as the *Lemhi River Watershed TMDL* (IDHW 1999). Increasing streambank stability is a means of reducing subsurface fine sediment, which affects CWAL and SS habitats.

In 2015, DEQ field investigations monitored sediment impairment of TMDL waters in the Upper Henrys Fork subbasin. The §303(d)-listed waters will be addressed in a separate TMDL. Ongoing sediment monitoring is part of the 5-year review process for checking progress toward meeting the sediment targets identified in the 2010 TMDL (DEQ 2010a). The SEI calculation worksheets are included in Appendix A. Table 14 summarizes the results, showing the current sediment load calculated from the SEIs and load capacities, which are the natural background assimilative capacities of each monitored stream. Load reductions allocated in the 2010 TMDL are provided for comparison to current conditions. DEQ does not issue additional sediment load allocations with this 5-year review. The sediment load allocations in the 2010 TMDL will remain in effect. Both the old SEI technique and the one have the same bank stability target of 80%. Thus, 20% of the banks are allowed to be eroding as a natural phenomenon. The old technique however, had no way to calculate a "natural" lateral recession rate, hence loads may have been skewed. We are still testing the new technique which allows the user to come up with a natural lateral recession rate to be applied towards the 20% eroding banks. We are reluctant at this time to make wholesale changes to TMDLs until we gain confidence. So for now the old loads in the approved TMDL stand. The results in this five-year review suggest that the old technique under-estimated natural loads and hence over-estimated excess loads. Time will tell if this holds true.

Table 13. 2015 SEI locations.

Stream	Assessment Unit Number	Upstream Latitude	Upstream Longitude	Downstream Latitude	Downstream Longitude
Conant Creek 1	ID17040203SK007_03	44.00515	-111.14908	44.00439	-111.15376
Conant Creek 2	ID17040203SK007_03	44.00631	-111.14221	44.00752	-111.14375
Duck Creek	ID17040202SK036_03	44.61069	-111.46046	44.61361	-111.46001
Moose Creek 1 Lower	ID17040202SK022_02	44.48516	-111.28602	44.4856	-111.28756
Moose Creek 2 Upper	ID17040202SK022_02	44.45818	-111.23131	44.4597	-111.23093
Sand Creek 1	ID17040203SK013_04	44.10648	-111.58437	44.1044	-111.58171
Sand Creek 2	ID17040203SK013_04	44.12882	-111.59673	44.12603	-111.59728
Sheridan Creek 1	ID17040202SK045_03	44.42788	-111.63493	44.42935	-111.63138
Sheridan Creek 2	ID17040202SK046_04	44.41302	-111.59856	44.412	-111.59735
Twin Creek 1	ID17040202SK025_02	44.58997	-111.31412	44.5885	-111.31587
Twin Creek 2	ID17040202SK025_02	44.5909	-111.31496	44.59033	-111.31598
Twin Creek 3	ID17040202SK025_02	44.59033	-111.31598	44.5894	-111.31757

Table 14. TMDL load allocations based on SEI (2015 versus 2010).

Water Body	Assessment Unit Number	2015 Load Capacity (tons/mi/yr)	2015 Current Load (tons/mi/yr)	2015 Reductions		2010 Reductions		Condition
				Tons/mi/yr	%	Tons/mi/yr	%	
Buffalo River	ID17040202SK018_03	NA	NA	NA	NA	19	83	Improper assessment
Duck Creek	ID17040202SK036_03	1.8	0.2	NA	NA	38	71	Potentially Improving
Sheridan Creek	ID17040202SK045_03	3.9	30	27	88	20	80	No change

Notes: mile (mi), year (yr), Not applicable (NA)

Based on new SEIs, Duck Creek's sediment impairments are considered improving. DEQ staff noted that field evidence supports a complete lack of sediment impairment in Buffalo River, as there were no eroding banks on which to complete an SEI. This AU was likely listed in error for sediment due to inappropriate assessment techniques. Buffalo River is a spring fed low gradient water body that does not have the typical gravel bottom of a mountain stream. This river should not have been monitored and assessed with BURP methods. Ideally, the water should go to Category 3 in the Integrated Report as an unassessed water until such time that appropriate assessment protocols are developed for these soft bottom systems.

The new SEI methods have determined that Duck Creek is currently meeting its sediment load capacity and requires no reductions. Further SEI and BURP analysis is needed before we commit to delisting this water body. Sheridan Creek, however, appears to have degraded since the 2010 TMDL and requires an 88% sediment load reduction compared to the previous 80% reduction. However, multiple SEIs were completed on each stream, and the highest required reduction was used to provide the most cautious approach. Regardless, the declining BURP scores in section 3.3.1 combined with degrading SEI measurements indicate that Sheridan Creek requires additional work before it can meet its sediment load goals.

The 2010 TMDL identified recreational access as the predominant pollutant source in the Buffalo River. Sources for sediment impairment of Duck and Sheridan Creeks are related to land uses within the subbasin, including grazing and recreation (DEQ 2010a).

3.3.3 Potential Natural Vegetation Temperature Analysis

EPA-approved temperature TMDLs (DEQ 2010a) involved the PNV analysis of shade on five water bodies in the Upper Henrys Fork subbasin: Warm River (5 AUs), Howard Creek (1 AU), Targhee Creek (2 AUs), Timber Creek (1 AU), and Duck Creek (1 AU). It was determined that all streams in the TMDL analysis lacked shade to some degree and required reductions in excess heat from solar load (Table 15).

Table 15. Water body heat loads from the Upper Henrys Fork TMDL (DEQ 2010a).

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

In this 5-year review, we performed additional field verification of shade for these streams to add to our knowledge about existing shade on these streams and to determine if shade levels are improving. Seven sites on the five streams were visited in 2015 where shade was measured with a Solar Pathfinder following protocol described in the DEQ PNV manual (Shumar and de Varona 2009) and in the 2010 TMDL. The results of that Solar Pathfinder analysis (Table 16) show that existing shade as represented in the 2010 TMDL is correct at three sites (Duck Creek #1, Targhee Creek, and Warm River #2), was overestimated at two sites (Duck Creek #2 and Timber Creek), and was underestimated at two sites (Howard Creek and Warm River #1).

Table 16. Solar Pathfinder field verification results from 2015 sampling.

aerial class	pathfinder actual	pathfinder class	delta	aerial estimate	Site Name
50	51.4	50	0	correct	Duck Cr #1
70	61.6	60	1	over	Duck Cr #2
30	74.5	70	-4	under	Howard Cr
70	74.8	70	0	correct	Targhee Cr
40	27.7	20	2	over	Timber Cr
10	20	20	-1	under	Warm R #1
10	13.6	10	0	correct	Warm R #2
			-0.29	average	
			1.89	std dev	
			1.40	95%CI	

Of the two sites where aerial interpretation of existing shade presented in the 2010 TMDL overestimates shade, Timber Creek had not received any previous Solar Pathfinder field verification. These data suggest that Timber Creek shade needed to be reevaluated, and a new load table is presented in this 5-year review. The Duck Creek #2 site also shows overestimation by one shade class. The Duck Creek #1 site is a location that was field verified during development of the 2010 TMDL. Current shade levels remain unchanged there. The Duck Creek #2 site requires a minor adjustment to the existing shade levels and load table.

The Howard Creek site showed a large underestimate of shade in an area that previously had not been field verified. The underestimate may have resulted from an error with the original aerial interpretation in 2010, or it could result from improved shade conditions. With this new information, existing shade and solar loads have been reevaluated for Howard Creek. A minor underestimate occurred for existing shade on the Warm River #1 site as well. The new Solar Pathfinder site was in a new location that had not been previously field verified.

New load tables have been developed for this 5-year review using appropriate significant figure rounding that had not been done previously. Because channel width is the smallest number (least significant figures) in the load calculations, rounding to one or two significant figures results. A comparison between loads generated with rounding can lead to substantial differences between those loads that were not rounded. The load comparison discussed in the next paragraph is subject to interpretation because of this rounding phenomenon.

A comparison of loads between 2010 TMDL estimates and the corrections made as a result of 2015 Solar Pathfinder sampling (Table 17) shows a reduction in excess loads for three of the five water bodies examined. Only Timber Creek had an increase in excess load because of reductions in shade estimates. New load tables for 2015 data (Appendix B, Tables B-1–B-6) round numbers to whole thousands due to a lack of significant figures. Sometimes rounding errors can exacerbate load differences. A good example of this phenomenon occurred with Howard Creek loads where the resultant excess load after rounding is 43,000 kWh/day or 10,000 more kWh/day over 2010 estimates despite an improvement in shade. To illustrate, we also show Howard Creek load numbers without rounding internal to the load table (Appendix B, Table B-3). However, the lack of significant figures means that we cannot have confidence in those more exacting numbers.

Table 17. Comparison of heat loads (kWh/day) between 2010 TMDL and 2015 review.

Water Body	Total Existing Load 2010	Total Target Load 2010	Excess Load 2010	Total Existing Load 2015	Total Target Load 2015	Excess Load 2015
Warm River	3,665,140	3,260,351	404,790	3,600,000	3,300,000	380,000
Howard Creek	175,034	141,084	33,950	180,000	140,000	43,000
Targhee Creek	321,794	303,594	18,200	320,000	310,000	10,000
Duck Creek	103,938	90,205	13,733	97,000	93,000	4,000
Timber Creek	26,873	15,967	10,906	30,000	10,000	20,000

3.3.4 Upper Henrys HOBO Temperature Logger Data

During the 2015 field season, DEQ installed HOBO temperature loggers within temperature-impaired AUs (and AUs suspected of temperature impairment) to track temperature trends (Table 18). Figure 6 shows the deployment locations of eight temperature loggers within the Upper Henrys Fork subbasin. Loggers 10102544 and 10102536 were deployed at the same location for quality assurance purposes, so the two markers overlap on the map.

Table 18. Locations of HOBO temperature loggers.

Stream Name	Assessment Unit Number	Category 4a Listing	Logger #	Latitude	Longitude
Warm River	ID17040202SK002_04	Temperature	10349111	44.12199	-111.30849
Warm River	ID17040202SK005_03	Temperature	10685686	44.3217	-111.30547
Warm River	ID17040202SK005_03	Temperature	10102544	44.25968	-111.29076
Warm River (quality assurance duplicate)	ID17040202SK005_03	Temperature	10102536	44.25968	-111.29076
Targhee Creek	ID17040202SK034_02	Temperature	10685678	44.67221	-111.31542
Timber Creek	ID17040202SK035_03	Temperature	10685682	44.66932	-111.42786
Duck Creek	ID17040202SK036_03	Sediment and temperature	10349110	44.61352	-111.46002
Sheridan Creek	ID17040202SK045_03	Sediment	10685683	44.4258	-111.62812

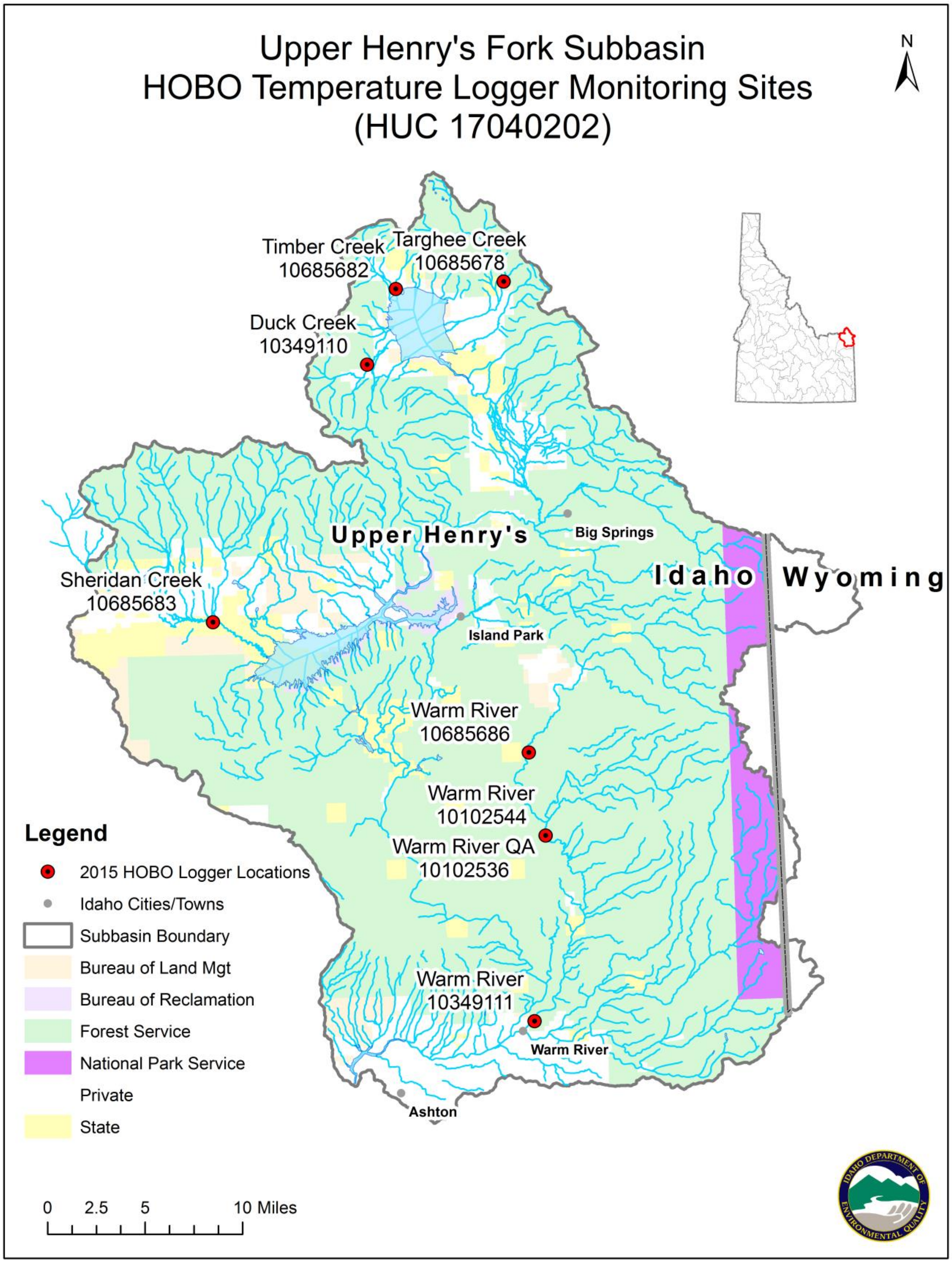

Figure 6. HOBO temperature logger deployment locations within the Upper Henrys Fork subbasin.

According to Idaho water quality standards for CWAL, “water temperatures shall be 22 °C or less with a maximum daily average temperature of no greater than 19 °C.” The standards for SS state that “waters designated for salmonid spawning, in areas used for spawning and during the time spawning and incubation occurs, are not to vary from… water temperatures of 13 °C or less with a maximum daily average no greater than 9 °C.” Table 19 lists the common salmonid species and their general spawning periods within Idaho streams and lakes.

Table 19. Salmonids of the Henrys Fork subbasins.

Species	Scientific Name	General Spawning Period in Idaho
Native		
Yellowstone Cutthroat Trout	*Oncorhynchus clarki bouvieri*	Mid-March to early July
Mountain Whitefish	*Prosopium williamsoni*	December to February
Nonnative		
Rainbow Trout	*O. mykiss*	Mid-March to early June
Brown Trout	*Salmo trutta*	October to mid-December
Eastern Brook Trout	*Salvelinus fontinalis*	September to November
Kokanee Salmon	*O. nerka*	August to mid-December
Montana Arctic Grayling	*Thymallus arcticus montanus*	April to early June
Rainbow x Yellowstone Cutthroat Trout	*O. mykiss x O. clarki bouvieri*	Mid-March to early July

Temperature Logger Data Analysis

HOBO logger temperature data are provided in Appendix C, which summarizes each temperature dataset with a graph that illustrates maximum, minimum, and average daily temperatures throughout the deployment period. The raw data graph for each logger is also provided. Table 20 and Table 21 summarize the temperature logger data.

Table 20. Summary of HOBO temperature logger data.

Assessment Unit Name	Assessment Unit Number	Logger Number	MDMT (°C)	MDAT (°C)
Warm River	ID17040202SK002_04	10349111	19.6	14.7
Warm River	ID17040202SK005_03	10102544	24.4	16.6
Warm River (quality assurance duplicate)	ID17040202SK005_03	10102536	24.4	16.6
Warm River	ID17040202SK005_03	10685686	25.5	20.3
Targhee Creek	ID17040202SK034_03	10685678	14	10.1
Timber Creek	ID17040202SK035_03	10685682	22.5	18.1
Duck Creek	ID17040202SK036_03	10349110	18.8	14.3
Sheridan Creek	ID17040202SK045_03	10685683	29.8	23.3

Notes: Maximum daily maximum temperature (MDMT); maximum daily average temperature (MDAT)

Table 21. Number and percentage of days exceeding average daily temperature criteria.

Assessment Unit Name	Assessment Unit Number	Logger Number	SS (9°C)	CWAL (13°C)
Warm River	ID17040202SK002_04	10349111	76/76 (100%)	0
Warm River	ID17040202SK005_03	10102544	67/76 (88%)	0
Warm River (quality assurance duplicate)	ID17040202SK005_03	10102536	67/76 (88%)	0
Warm River	ID17040202SK005_03	10685686	67/76 (88%)	8/96 (8%)
Targhee Creek	ID17040202SK034_03	10685678	12/96 (13%)	0
Timber Creek	ID17040202SK035_03	10685682	63/76 (83%)	0
Duck Creek	ID17040202SK036_03	10349110	50/76 (66%)	0
Sheridan Creek	ID17040202SK045_03	10685683	48/48 (100%)	32/68 (47%)

Notes: e.g. 76/76 = 76 sampling days exceeded criteria out of 76 total sampling days. Spring Salmonid Spawning (SS); Cold Water Aquatic Life (CWAL)

Warm River—Warm River (ID17040202SK002_04) meets the CWAL standards throughout the deployment period, which encompasses the overall critical time period for temperature. However, this site frequently exceeded the SS standard of 13 °C and exceeded the maximum daily average temperature criterion of 9 °C 100% of sample days.

Brown Trout spawning is reported to occur in October and November within Warm River, so the deployment period is insufficient for assessing temperature exceedances for this period (DEQ et al. 2014). However, successful spawning is recorded in Warm River.

The temperature loggers deployed in other reaches of Warm River (ID17040202SK005_03) appear to recorded warmer temperatures than the logger deployed in AU ID17040202SK002_04, however had fewer days exceeding salmonid spawning criteria. With MDATs of 16.6 °C and 20.3 °C, one site met the MDAT standard of 19 °C for CWAL, while the other exceeded it. Both sites (one of which included a quality assurance duplicate temperature logger) consistently exceeded the CWAL instantaneous temperature from June through early August. Since the SS standards are more stringent, exceeding the CWAL standards indicates that the SS standards were also exceeded. The northernmost deployment on Warm River (logger 10685686) recorded the overall highest temperatures of the Warm River loggers, and was the only logger to exceed the CWAL daily average criterion (8% of days sampled).

Targhee Creek—The Targhee Creek (ID17040202SK034_03) logger recorded the lowest overall temperatures of all the deployed loggers. Temperatures never exceeded the CWAL instantaneous standard throughout the deployment period; however, SS standards were exceeded 12 of 96 days in June and July.

Timber Creek—Timber Creek (ID17040202SK035_03) has a less than 10% exceedance of maximum CWAL criterion and no exceedances of the daily average criterion, but the SS standards are exceeded throughout most of the deployment period (83% of sampled days).

Duck Creek—Duck Creek (ID17040202SK036_03) did not exceed CWAL standards at any point during the deployment period, but SS standards were exceeded throughout much of the study period (66% of sampled days).

Sheridan Creek—Sheridan Creek (ID17040202SK045_03) was the warmest of all the deployment sites throughout the Upper Henrys Fork subbasin. It is clearly exceeding CWAL and SS standards consistently during the spring and summer months. These exceedances are supported by the lack of salmonids present within the stream.

To better assess broader temperature trends and improving/declining water quality, a larger dataset consisting of multiple years of HOBO temperature logger data is necessary. The present study confirms that Warm River remains impaired for temperature. Further supporting data and analysis of fish populations and spawning periods in Targhee, Timber, and Duck Creeks are necessary to consider delisting these AUs from Category 4a for temperature. Additionally, improved BURP scores would provide supplementary evidence required to delist. Currently, Sheridan Creek is not listed for temperature, but it is clear that it requires a temperature TMDL.

3.4 Beneficial Uses

Current assessment data suggest that support of beneficial uses in the Henrys Fork subbasins still has room for improvement. Some AUs remain impaired for temperature and sediment, but improvements have been noted. Duck Creek is currently meeting its sediment load, and bacteria levels in Conant Creek have improved considerably since the 2010 TMDL. Table 22 notes the recommendations resulting from this 5-year review.

Table 22. Summary of recommended changes for AUs evaluated.

Assessment Unit Name	Assessment Unit Number	Pollutant (Category 4a)	Recommended Changes to Next Integrated Report	Justification
		Upper Henrys Fork		
Warm River	ID17040202SK002_04 ID17040202SK002_05 ID17040202SK005_02 ID17040202SK005_03 ID17040202SK005_04	Temperature	Keep in Category 4a	Updated PNV analysis and HOBO temperature logger data
Buffalo River	ID17040202SK018_03	Sediment	Delist from Category 4a; AU is not impaired for sediment	Updated SEI data
Howard Creek	ID17040202SK033_02	Temperature	Keep in Category 4a	Updated PNV analysis
Targhee Creek	ID17040202SK034_02 ID17040202SK034_03	Temperature	Keep in Category 4a	Updated PNV analysis and HOBO temperature logger data
Timber Creek	ID17040202SK035_03	Temperature	Keep in Category 4a	Updated PNV analysis and HOBO temperature logger data
Duck Creek	ID17040202SK036_03	Sediment Temperature	Delist from Category 4a for sediment; keep in Category 4a for temperature	Updated SEI data; updated PNV analysis and HOBO temperature logger data
Sheridan Creek	ID17040202SK045_03	Sediment	Keep in Category 4a for sediment; move to Category 5 for temperature	Updated SEI data; HOBO temperature logger data
		Lower Henrys Fork		
Conant Creek	ID17040203SK007_02 ID17040203SK007_03	Bacteria (*E. coli*)	Delist from Category 4a for bacteria	*E. coli* sampling

4 Review of Implementation Plan and Activities

The TMDLs for the Henrys Fork subbasins do not have an official implementation plan, but several agencies and organizations have undertaken studies and restoration projects. Their efforts and accomplishments are discussed in section 4.3.

4.1 Responsible Parties

Without an implementation plan, there are no official designated responsible parties; however, statewide-designated management agencies are identified in the *Idaho Nonpoint Source Management Plan* (DEQ 2015).

4.2 Planned Activities

No official activities are planned due to the lack of an implementation plan.

4.3 Accomplished Activities

Numerous research and restoration activities have been completed or are currently being implemented in the Henrys Fork subbasins. Some of the projects that have taken place since the 2010 5-year review (DEQ 2010b) and TMDL (DEQ 2010a) are described below.

4.3.1 USFS Caribou-Targhee National Forest

Caribou-Targhee National Forest (CTNF) personnel have completed or are currently working on numerous projects and data collection efforts in the Henrys Fork subbasins. Details can be obtained from their office and/or website; however, some projects are highlighted in this section to illustrate the ongoing efforts to improve water quality and habitat.

Bear Gulch Road Closure (Forest Road 159)—A proposal to close Bear Gulch Road 159 and create a trail was approved in 2012 to protect resource values.

Fish Creek Restoration Project—USFS restored this tributary to the Henrys Fork by placing native sedge mats within the stream to create new banks. The intention was to narrow the channel to increase flow velocities and sediment transport, which, in turn, will improve trout spawning, rearing, and overwintering.

Harriman Fish Pond—This project rehabilitated the recreational Harriman Fish Pond site, improved access roads, defined parking areas, and closed approximately 250 feet of road located in a wetland area.

Horseshoe Lake, Sheep Falls, Harriman Fish Pond, and Coffee Pot—This project rehabilitated dispersed recreation sites, improved access roads, rebuilt trails, and defined parking areas at various locations on the Ashton/Island Park District.

Projects in Development

Ashton/Island Park Eight Allotment Range Grazing Analysis (2018)—This proposed project will analyze and disclose the effects of livestock grazing activities on the Fogg Butte, Ripley Butte, Bootjack, Grandview, Gerritt Meadows, West Lake, Antelope Park and Fall River Cattle and Horse allotments.

Warm River Platform—CTNF is proposing to replace the existing handicap-accessible fishing platform adjacent to Warm River campground with a similar platform to improve recreation user accessibility and fishing access, and to protect the riparian resources along Warm River.

4.3.2 Henry's Fork Foundation

Long-Term Monitoring

In 1996, the Henry's Fork Foundation (HFF) began the Habitat Assessment Project, which collected information on aquatic and riparian habitat conditions, fish populations, and aquatic invertebrates on every reach of the Henrys Fork and most of its tributaries. That project required 5 years to complete and provided a set of information that could serve as a baseline to compare with future conditions.

In 2000, a set of nine "indicator" sites were selected for long-term monitoring. Six of these are located on the main stem of Henrys Fork from Mack's Inn to Rexburg, and one each on three tributaries: Henrys Lake Outlet, Sheridan Creek, and Fall River. These sites were monitored each year from 2001 through 2005, adding to the data collected during the 1990s.

The next round of monitoring is presently under way, providing a 20-year comparison with data collected during the initial habitat assessment and a 10-year comparison with conditions in 2005. The latest project is Henrys Fork water quality monitoring.

Ecological processes and physical properties of water critical to growth and survival of wild trout are being studied as part of the latest monitoring project. The placement of study sites allows identification of how water quality changes along the course of the Henrys Fork as reservoirs, irrigation withdrawal and return-flow points, tributaries, and natural ecological boundaries affect physical, chemical, and biological processes. This knowledge will help river managers to optimize not only water quantity but water quality as well.

After a successful first year of installing and monitoring four stations along the Henrys Fork upstream of Ashton Reservoir, HFF expanded its water quality monitoring network into the lower watershed during summer 2015. They installed automated data sondes near Ora Bridge, St. Anthony, and Salem-Parker highway, complementing those installed in 2014 at Flatrock Club, Island Park Dam, Pinehaven, and Marysville.

The HFF sondes record temperature, dissolved oxygen, depth, dissolved solids, turbidity, chlorophyll, and blue-green algae at 15-minute intervals. At each sonde site, staff regularly collects water samples, which are analyzed for phosphorus and suspended sediment concentrations.

The results from field sampling will be used to develop statistical relationships between constituents that cannot be measured by the sondes and those that can, so that in the future, the sonde data can be used to infer information about a wide range of water quality parameters.

In 2015, HFF focused intensive water quality sampling at Island Park Dam to identify the cause of high turbidity events observed immediately downstream of the dam during the past few summers. This study paired a water quality sonde on the west side of the river with the existing HFF sonde on the east side. In addition, water quality samples were taken at various depths in the reservoir immediately upstream of the dam in cooperation with DEQ and Idaho Department of Fish and Game (IDFG).

Four more sondes are scheduled for installation in 2016 in tributaries to the Henry's Fork. The HFF is pursuing potential partnerships that would allow installation of additional sondes in the Teton River watershed in future years, resulting in a network of a dozen or more stations used to monitor water quality throughout the watershed for the next 20 years or more.

HFF and DEQ are presently conducting weekly depth profiling of the Island Park Reservoir to continue the sampling that occurred in 2015 and to characterize the detailed water quality of the reservoir over time.

Presently, HFF is also working with a graduate student from Indiana University who will be conducting his master's thesis on research related to water quality in Island Park Reservoir. The research project with Royer Laboratory and HFF will study how climate change and reservoir age influence water quality in reservoirs and their tailwaters. He will focus on collecting and examining water quality data to see if nutrient and sediment levels in the reservoir and its tailwater have changed over time and if any connection exists to climate change or the age of Island Park Dam.

Caldera Project: Restoring Wild Trout Fisheries

The Caldera, named for the 28-mile section of river from Island Park Dam to Mesa Falls, includes the Ranch, Box Canyon, and many other popular stretches. Through the Caldera Project, HFF coordinates a team of scientific experts to build on existing research in understanding the unique aquatic habitat of the Caldera.

The Caldera Project also identifies restoration projects to improve the legendary Caldera fisheries. The Caldera Project includes the following projects:

Habitat-Use Study: What Fish Want—In spring 2013, HFF and partnering agencies embarked on a 3-year study to find the ultimate link between the trout population and fishing experience in the famed Harriman State Park section of the Henrys Fork. The study is assessing the habitat preferred by adult Rainbow Trout in the Harriman State Park reach throughout the fishing season, with a long-term goal of improving adult trout habitat in the Harriman reach.

Thurmon Creek Study: The Value of Small Tributaries—The 9-mile Ranch section of the Henrys Fork through Harriman State Park is legendary for fly-fishing. The reputation and popularity of the Ranch have made it the focus of research for over 30 years. Dozens of completed studies have created a wealth of knowledge about the fishery and significant efforts to improve it. The Ranch is the product of a complex set of natural and human-made influences, and the quality of angling has varied over the years.

Since 2008, HFF has examined how small tributaries like Thurmon Creek in Harriman State Park contribute to the survival of trout in their first winter of life. Through the use of Passive Integrated Transponder (PIT) tags, HFF marks each trout migrating into Thurmon Creek with a unique code that provides insight on survival, winter growth rates, and most importantly, when the trout use habitat in the creek.

An automated PIT-tag detection system was operated over winter 2012–2013 to record the migration of fish out of Thurmon Creek and back into the Henrys Fork. These migration data will be used to quantify the number of young fish that successfully winter in Thurmon Creek and determine future habitat and/or fish passage improvements that will enhance the contribution of Thurmon Creek to the Henrys Fork population.

Project partners and contributors include Harriman State Park, Cross Charitable Foundation, Fall River Electric Co-op, IDFG, Parts Service, Kast Gear, Snake River Prototype, and individual donors.

Buffalo Fish Ladder: Monitoring the Contribution to Fisheries—As of summer 2013, over 30,000 Rainbow Trout have migrated upstream through a fish ladder at the Buffalo River Hydroelectric Project. A large number of Brook Trout, whitefish, and nongame fish species have also used the ladder. Use of the fish ladder has generally increased since it was installed, and the next phase of monitoring will allow us to quantify the contribution of the Buffalo River to the wild trout population in the Henrys Fork.

The hydroelectric project was relicensed in 2004 and several fish passage improvements were made at the facility in 2005. These fish passage improvements were made to allow juvenile Rainbow Trout from the Henrys Fork to access crucial winter habitat. Offspring from spawning Rainbow Trout in the Buffalo River and juvenile trout migrating from the Henrys Fork are able to spend their first winter in the Buffalo River watershed upstream of the dam. After their first winter, these juvenile trout move to the Henrys Fork where they can grow and contribute to the fishery from Box Canyon through Harriman State Park.

Project partners and contributors include CTNF, IDFG, and Fall River Rural Electric Cooperative (hydroelectric project owner).

Survival and movement of adult Rainbow Trout during winter and spring in the Henrys Fork of the Snake River—Radio telemetry was used to evaluate the survival and winter movement of adult Rainbow Trout in the Caldera section of the Henrys Fork of the Snake River under low and extremely low early winter flow conditions. Spring movement was also evaluated to assess whether the population estimates conducted in Box Canyon each spring represent fish from adjacent reaches of the river, and how emigration between mark and recapture periods may affect the population estimate.

Survival of radio-tagged trout was nearly 100% during early winter under both low and extremely low flow conditions, and winter movement did not differ between the two years. Few radio-tagged Rainbow Trout from downriver were present in the monitoring reach during the time when the population estimate is normally conducted, indicating that large fluctuations in fish numbers in downstream reaches would likely be undetected based on population estimates conducted in the monitoring area. Establishing a regular population monitoring area in downstream reaches was recommended. Emigrations from the monitoring reach between the mark and recapture period were determined to have a minimal effect on the population estimate. However, it was noted that all the radio-tagged trout that moved out of the monitoring reach during May moved into a short section of river between the monitoring reach and Island Park Dam. Therefore, emigration could largely be accounted for by extending the monitoring reach upstream to Island Park Dam.

This project was conducted with the assistance of Gregory Aquatics with funding from the HFF and Marine Ventures Foundation.

4.3.3 Egin, Idaho Aquifer Recharge Project

The Egin Lakes area has historically been considered a potential ground water recharge site. Previous investigations, including a pilot recharge project, concluded that more detailed investigations were needed to determine recharge feasibility and benefit to the Eastern Snake River Plain Aquifer. Further studies completed by the Idaho Water Resources Research Institute and Idaho Department of Water Resources proved that the area was a viable site for aquifer recharge. A recently completed canal in the Egin Bench area will funnel water from the Henrys Fork to a porous basin during high water years, which will help contribute to slowly refilling the depleted Eastern Snake River Plain Aquifer over the coming decades.

4.4 Future Strategy

Various agencies and nonprofits involved in the subbasin have plans for continued water quality improvement activities and research, which include plans to analyze grazing allotments, general improvements in recreational areas, and continued monitoring of water quality.

4.5 Planned Time Frame

Substantial accomplishments have been achieved within the last 7 years since the sediment, temperature, and bacteria TMDLs were approved (DEQ 2010a). It is reasonable to consider that continued improvements will help these streams attain their TMDL targets within the next 10–15 years.

5 Summary of Five-Year Review

This 5-year TMDL review complies with Idaho Code §39-3611(7) to reevaluate the *Upper and Lower Henry's Fork Total Maximum Daily Loads: Addendum to the Upper Henry's Fork Subbasin Assessment and TMDLs* (DEQ 2010a) approved by EPA in 2010. This review describes current water quality status and recent pollution control efforts in the subbasin. The assessment of instream targets, pollutant allocations, and analysis of the 2010 TMDL is conducted with input and support from the WAG and basin advisory group.

This section provides a summary of the review process; changes to subbasin conditions since the last assessment; analysis, assumptions, and allocations for TMDLs; appropriateness of use designations; and water quality criteria.

5.1 Review Process

For the 5-year review, DEQ data were the primary source of information. BURP data were used to assess the current biological condition of AUs included in the 2010 TMDL (DEQ 2010a). DEQ reviewed the activities of the federal land management agencies, HFF, other state agencies, and private landowners in the subbasin since the TMDL was approved. A number of important projects have restored fish habitat and reduced impacts on riparian areas. DEQ also collected monitoring data during these projects and conducted periodic reconnaissance-level biological/habitat monitoring. DEQ conducted specific sediment, temperature, and *E. coli* monitoring for this review.

5.2 Changes in Subbasin

To our knowledge, no significant changes have occurred in the subbasin with regard to population and land use.

5.3 TMDL Analysis

A TMDL document is currently being developed that will contain analysis of §303(d)-listed streams and new TMDLs for the Upper and Lower Henrys Fork subbasins. Sediment loads to streams were based on streambank stability and the amount of sediment delivered to streams from streambank erosion. The process by which SEIs are conducted has changed over the years; therefore, current load rates may be different from load rates measured in the past. It is not anticipated changes in actual loads will affect our ability to determine change in the watersheds. PNV methodology for temperature and *E. coli* sampling for bacteria have not changed significantly since the 2010 TMDL. However, DEQ no longer includes a 10% natural background component when calculating bacteria loads due to the lack of data to support this assumption.

5.4 Review of Beneficial Uses

No changes to the list of beneficial uses were found within the subbasin. Some improvement towards supporting beneficial uses in TMDL streams has been noted. BURP monitoring shows that some reaches are achieving passing multimetric scores of 2 or above, while others are remaining the same or declining. Sediment load may not be appropriate in two of the AUs with sediment TMDLs; however, Sheridan Creek appears to have an consistent sediment load problem.

PNV temperature analysis shows that excess solar load is reduced in three of the five streams with temperature TMDLs. HOBO temperature logger data indicate that high existing temperature conditions likely affect the ability to meet CWAL and SS criteria. Temperature improvements will be more difficult to discern until more ambient water temperature data are collected over a longer time period. Bacteria levels in Conant Creek have decreased significantly because of improved grazing management.

5.5 Water Quality Criteria

No changes have occurred to temperature, sediment, or bacteria water quality criteria.

5.6 Watershed Advisory Group Consultation

The Henry's Fork Watershed Council acts as the WAG for the Upper and Lower Henrys Fork subbasins, representing HFF, IDFG, USFS, and other interest groups.

The current iteration of this 5-year review will be presented to the WAG for their review before submittal to EPA.

5.7 Recommendations for Further Action

Overall, biological and habitat conditions within the subbasins still have room for improvement. However, some improvements have occurred in terms of sediment, temperature, and bacteria loads. These improvements have resulted from restoration projects and good resource management. It is recommended that these activities continue within the subbasin (Table 23). Over time, these projects and changes in land management will lead to overall water quality improvements.

Table 23. Summary of recommended actions.

Recommended Action	Schedule	Responsibility	Justification
Continue intensive riparian management	Next 5 years	Land management	Has clearly decreased sediment, temperature, and bacteria loads
Continue to restore riparian areas and fish habitat as much as possible	Next 5 years	Land management	Will improve fish scores, reduce sediment loads, and help with temperature conditions

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Appendix A. SEI Worksheets

Conant Creek – Site 1

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Conant Creek	Stream Segment Location (DD)	
Assessment Unit:	ID 17040203SK007_03	*Upstream N*	44.005150
Segment Inventoried:	downstream of Granite Creek	*W*	-111.149080
Total Reach:	617 meters (2024 ft)	*Downstream N*	44.004390
Date Collected:	16-Jun-15	*W*	-111.153760
Field Crew:	Jack M. & M. Shumar	Notes:	Rosgen C channel
Data Reduced By:	M. Shumar		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	2024.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	6939	ft	Total Reach
Estimated Distance inventoried	4048.00	ft	"
Total Erosive Bank Length	211.70	ft	"
Percent Erosive Bank	5.2	%	"
Eroding Area (AE)	404.15	ft^2	"
Lateral Recession Rate (RLR)	0.0525		"
Bank Erosion (E)	0.90	tons/year	"
Total Bank Erosion Rate (ER)	2.35	tons/mile/year	Reach and Segment
Total Bank Erosion	3.09	tons/year	"

Recession Rate Calculations

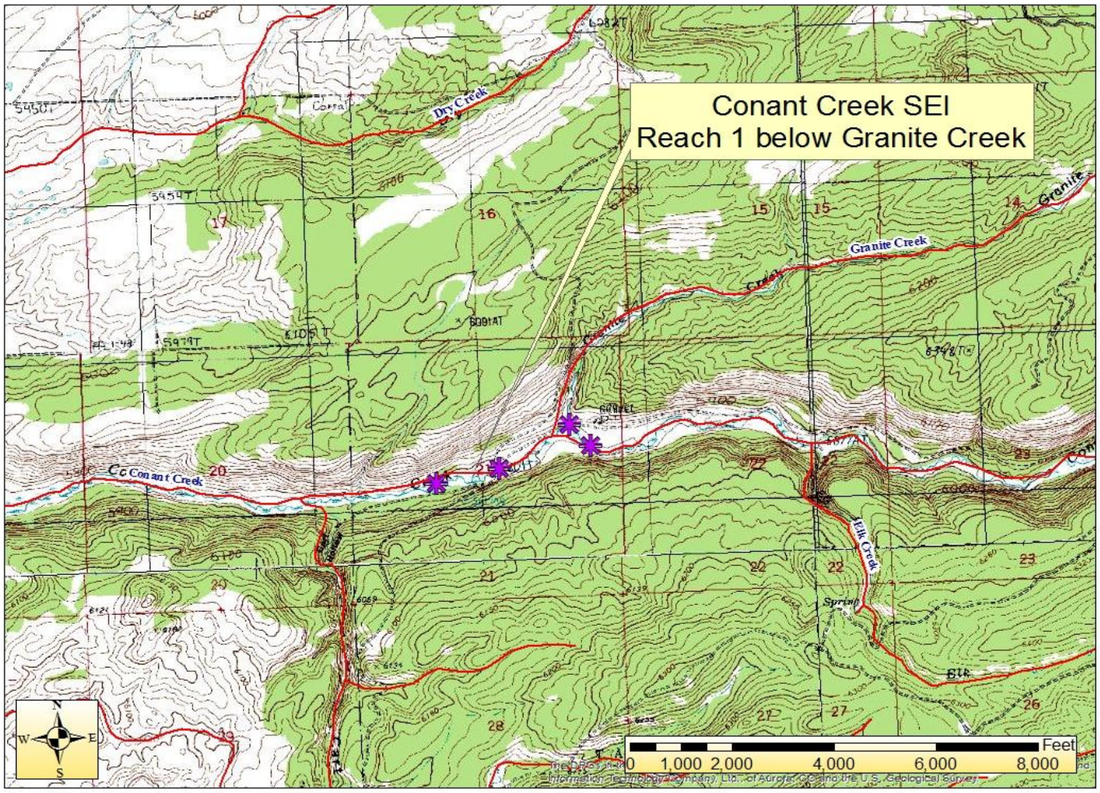
Factor	Field Stability Score	Erosion Severity Reduction
Bank Erosion Evidence (0 to 3)	1.25	0.25
Bank Stability Condition (0 to 3)	1	0.25
Bank Cover/Vegetation(0 to 3)	0.5	0.25
Lateral Channel Stability (0 to 3)	1	0.25
Channel Bottom Stability (0 to 2)	0	0.25
In-Channel Deposition (-1 to 1)	0.5	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	4.25	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.0525**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	1545.58	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	1.48	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	3.86	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	5.07	tons/year	Total Reach

Summary of Loads

Current Load		Load Capacity			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
2.4	**3.1**	**3.9**	**5.1**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Conant Creek SEI
Reach 1 below Granite Creek
Dry Creek
Granite Creek
Conant Creek
Elk Creek
Feet
0 1,000 2,000 4,000 6,000 8,000
N
S
E
W

Conant Creek – Site 2

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Conant Creek	**Stream Segment Location (DD)**	
Assessment Unit:	ID 17040203SK007_03	***Upstream N***	44.006310
Segment Inventoried:	upstream of Granite Creek	***W***	-111.142210
Total Reach:	295 meters (968 ft)	***Downstream N***	44.007520
Date Collected:	16-Jun-15	***W***	-111.143750
Field Crew:	Jack M. & M. Shumar	**Notes:**	Rosgen C channel
Data Reduced By:	M. Shumar		

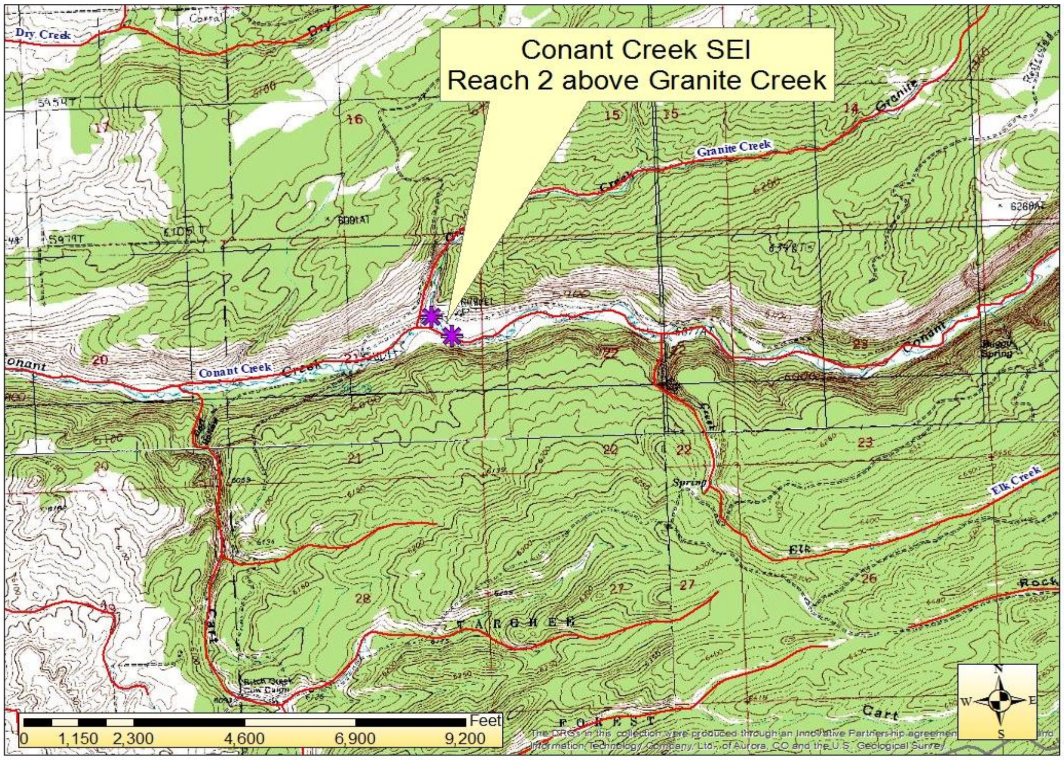
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	968.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	27231	ft	Total Reach
Estimated Distance inventoried	1936.00	ft	"
Total Erosive Bank Length	99.50	ft	"
Percent Erosive Bank	5.1	%	"
Eroding Area (AE)	219.21	ft^2	"
Lateral Recession Rate (RLR)	0.045		"
Bank Erosion (E)	0.42	tons/year	"
Total Bank Erosion Rate (ER)	2.29	tons/mile/year	Reach and Segment
Total Bank Erosion	11.79	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0.5	0.25
Bank Stability Condition (0 to 3)	1	0.25
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	1.25	0.25
Channel Bottom Stability (0 to 2)	0	0.25
In-Channel Deposition (-1 to 1)	0.5	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	3.5	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.045**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	853.05	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.82	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	4.45	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	22.95	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
2.3	**11.8**	**4.4**	**22.9**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Conant Creek SEI
Reach 2 above Granite Creek
Dry Creek
Granite Creek
Conant Creek
Elk Creek
Feet
0 1,150 2,300 4,600 6,900 9,200
N
S
W
E

Duck Creek

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Duck Creek	**Stream Segment Location (DD)**	
Assessment Unit:	ID17040202SK036_03	***Upstream N***	44.610690
Segment Inventoried:	BLM reach	***W***	-111.460460
Total Reach:	426m (1397 ft)	***Downstream N***	44.613610
Date Collected:	17-Jun-15	***W***	-111.460010
Field Crew:	Jack M. & M. Shumar	**Notes:**	C Channel, willow meadow.
Data Reduced By:	M. Shumar		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	1397.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	6183	ft	Total Reach
Estimated Distance inventoried	2794.00	ft	"
Total Erosive Bank Length	38.40	ft	"
Percent Erosive Bank	1.4	%	"
Eroding Area (AE)	34.57	ft^2	"
Lateral Recession Rate (RLR)	0.035		"
Bank Erosion (E)	0.05	tons/year	"
Total Bank Erosion Rate (ER)	0.19	tons/mile/year	Reach and Segment
Total Bank Erosion	0.23	tons/year	"

Recession Rate Calculations

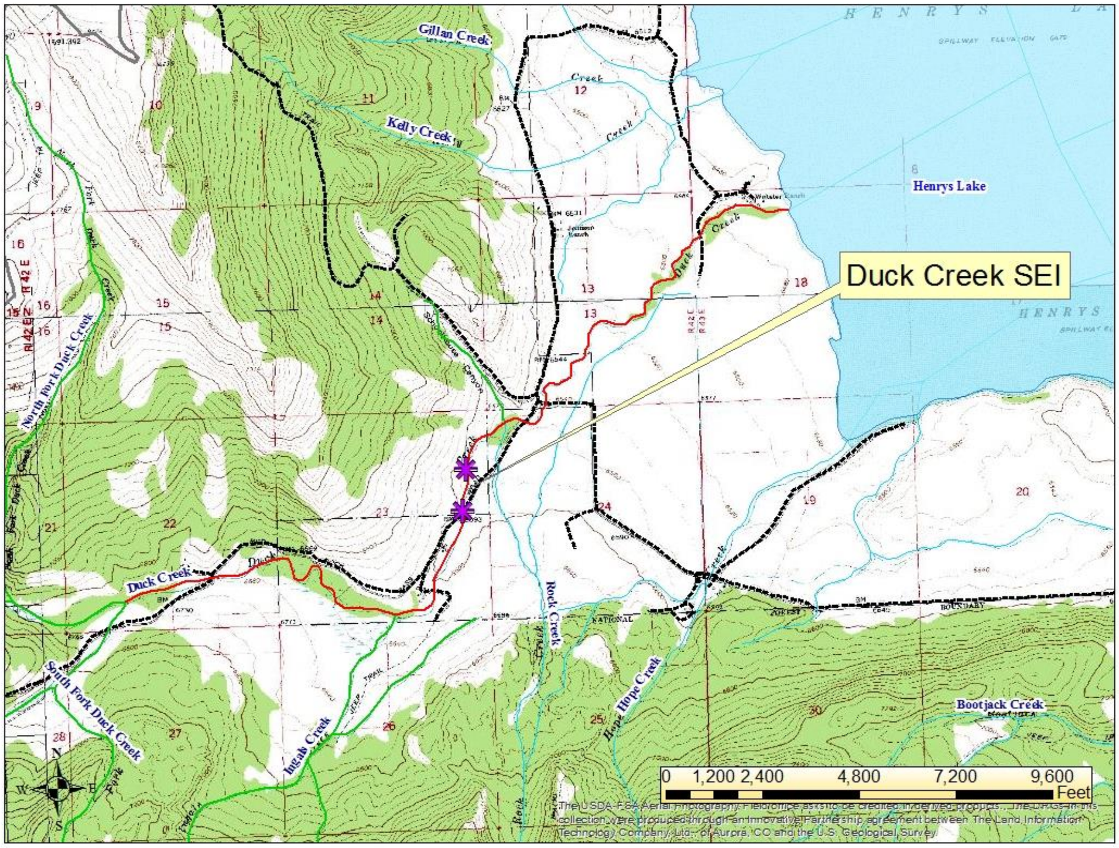
Factor	Field Stability Score	Erosion Severity Reduction
Bank Erosion Evidence (0 to 3)	0.25	0.25
Bank Stability Condition (0 to 3)	0.5	0.25
Bank Cover/Vegetation(0 to 3)	0	0.25
Lateral Channel Stability (0 to 3)	0.75	0.25
Channel Bottom Stability (0 to 2)	0	0.25
In-Channel Deposition (-1 to 1)	1	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	2.5	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.035**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	503.12	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.48	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	1.82	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	2.13	tons/year	Total Reach

Summary of Loads

Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
0.2	**0.2**	**1.8**	**2.1**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Duck Creek SEI
Henrys Lake
Gillan Creek
Kelly Creek
Duck Creek
North Fork Duck Creek
South Fork Duck Creek
Rock Creek
Hope Creek
Bootjack Creek
Ingals Creek
0 1,200 2,400 4,800 7,200 9,600
Feet

Moose Creek – Lower

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Moose Creek	**Stream Segment Location (DD)**	
Assessment Unit:	ID17040202SK022_02	***Upstream N***	44.485160
Segment Inventoried:	Reach 1	***W***	-111.286020
Total Reach:	219m (718.5 ft)	***Downstream N***	44.485600
Date Collected:	16-Sep-15	***W***	-111.287560
Field Crew:	Jack M. & M. Shumar	**Notes:**	low gradient depositional, E channel: no eroding banks measured.
Data Reduced By:	M. Shumar		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	718.50	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	5305	ft	Total Reach
Estimated Distance inventoried	1437.00	ft	"
Total Erosive Bank Length	0.00	ft	"
Percent Erosive Bank	0.0	%	"
Eroding Area (AE)	0.00	ft^2	"
Lateral Recession Rate (RLR)	0.04		"
Bank Erosion (E)	0.00	tons/year	"
Total Bank Erosion Rate (ER)	0.00	tons/mile/year	Reach and Segment
Total Bank Erosion	0.00	tons/year	"

Recession Rate Calculations

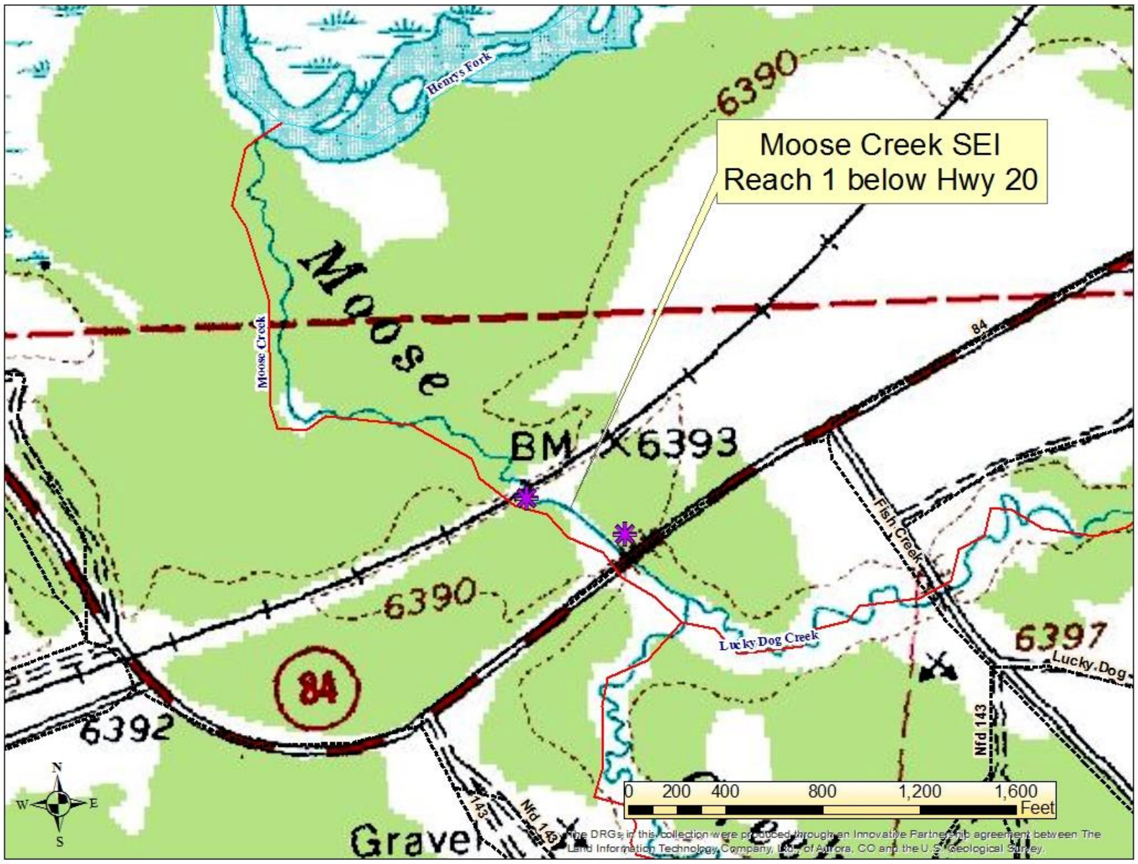
Factor	Field Stability Score	Erosion Severity Reduction
Bank Erosion Evidence (0 to 3)	0.25	0.25
Bank Stability Condition (0 to 3)	0.25	0.25
Bank Cover/Vegetation(0 to 3)	0	0.25
Lateral Channel Stability (0 to 3)	1	0.25
Channel Bottom Stability (0 to 2)	0.5	0.25
In-Channel Deposition (-1 to 1)	1	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	3	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.04**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	#DIV/0!	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	#DIV/0!	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	#DIV/0!	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	#DIV/0!	tons/year	Total Reach

Summary of Loads

Current Load		Load Capacity			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
0.0	**0.0**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**

Percent Erosion Reduction (%)	**#DIV/0!**
Total Erosion Reduction (tons/yr)	**#DIV/0!**


Moose Creek SEI
Reach 1 below Hwy 20
Henrys Fork
Moose
Moose Creek
BM X6393
6390
6390
6392
6397
84
Lucky Dog Creek
Fish Creek
Nfd 143
Gravel
0 200 400 800 1,200 1,600
Feet

Moose Creek – Upper

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Moose Creek	**Stream Segment Location (DD)**	
Assessment Unit:	ID17040202SK022_02	***Upstream N***	44.458180
Segment Inventoried:	Reach 2 on Chick Cr Flat Road	***W***	-111.231310
Total Reach:	230m (754.5 ft)	***Downstream N***	44.459700
Date Collected:	16-Jun-15	***W***	-111.230930
Field Crew:	Jack M & M. Shumar	**Notes:**	low gradient, depositional meadow, E channel. No eroding banks measured.
Data Reduced By:	M. Shumar		

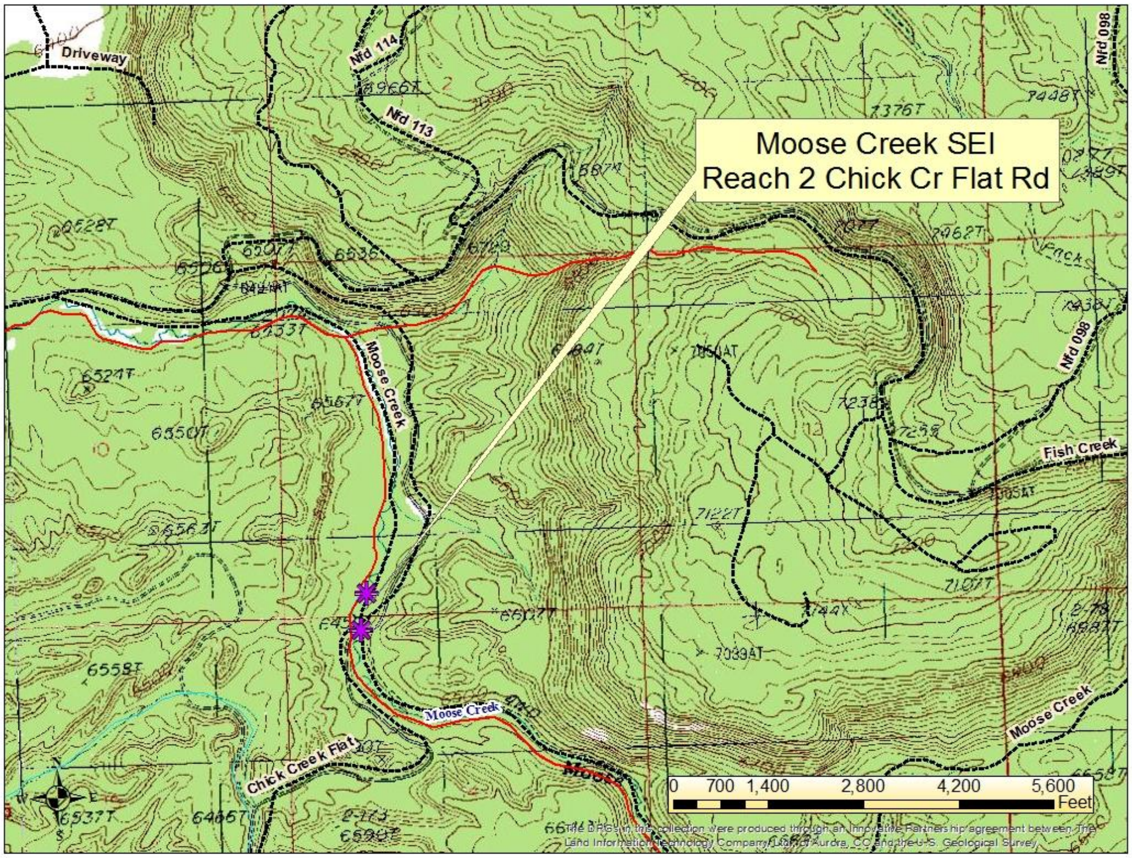
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	754.50	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	10925	ft	Total Reach
Estimated Distance inventoried	1509.00	ft	"
Total Erosive Bank Length	0.00	ft	"
Percent Erosive Bank	0.0	%	"
Eroding Area (AE)	0.00	ft^2	"
Lateral Recession Rate (RLR)	0.025		"
Bank Erosion (E)	0.00	tons/year	"
Total Bank Erosion Rate (ER)	0.00	tons/mile/year	Reach and Segment
Total Bank Erosion	0.00	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0	0.25
Bank Stability Condition (0 to 3)	0.25	0.25
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	0.25	0.25
Channel Bottom Stability (0 to 2)	0.5	0.25
In-Channel Deposition (-1 to 1)	0.25	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	1.5	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.025**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	#DIV/0!	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	#DIV/0!	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	#DIV/0!	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	#DIV/0!	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
0.0	**0.0**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**	**#DIV/0!**

Percent Erosion Reduction (%)	**#DIV/0!**
Total Erosion Reduction (tons/yr)	**#DIV/0!**


Moose Creek SEI
Reach 2 Chick Cr Flat Rd
Driveway
Nfd 114
Nfd 113
Nfd 098
Moose Creek
Fish Creek
Chick Creek Flat
0 700 1,400 2,800 4,200 5,600
Feet

Sand Creek – Site 1

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Sand Creek	Stream Segment Location (DD)	
Assessment Unit:	ID17040203SK013_04	*Upstream N*	44.106480
Segment Inventoried:	Reach 1	*W*	-111.584370
Total Reach:	348m (1142 ft)	*Downstream N*	44.104400
Date Collected:	15-Jun-15	*W*	-111.581710
Field Crew:	Jack M. & M. Shumar	Notes:	Rosgen C, St Anthony Sand Dunes
Data Reduced By:	M. Shumar		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	1142.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	105	lb/ft^3	Total Reach
Length of Similar Stream	8707	ft	Total Reach
Estimated Distance inventoried	2284.00	ft	"
Total Erosive Bank Length	72.80	ft	"
Percent Erosive Bank	3.2	%	"
Eroding Area (AE)	127.72	ft^2	"
Lateral Recession Rate (RLR)	0.0375		"
Bank Erosion (E)	0.25	tons/year	"
Total Bank Erosion Rate (ER)	1.16	tons/mile/year	Reach and Segment
Total Bank Erosion	1.92	tons/year	"

Recession Rate Calculations

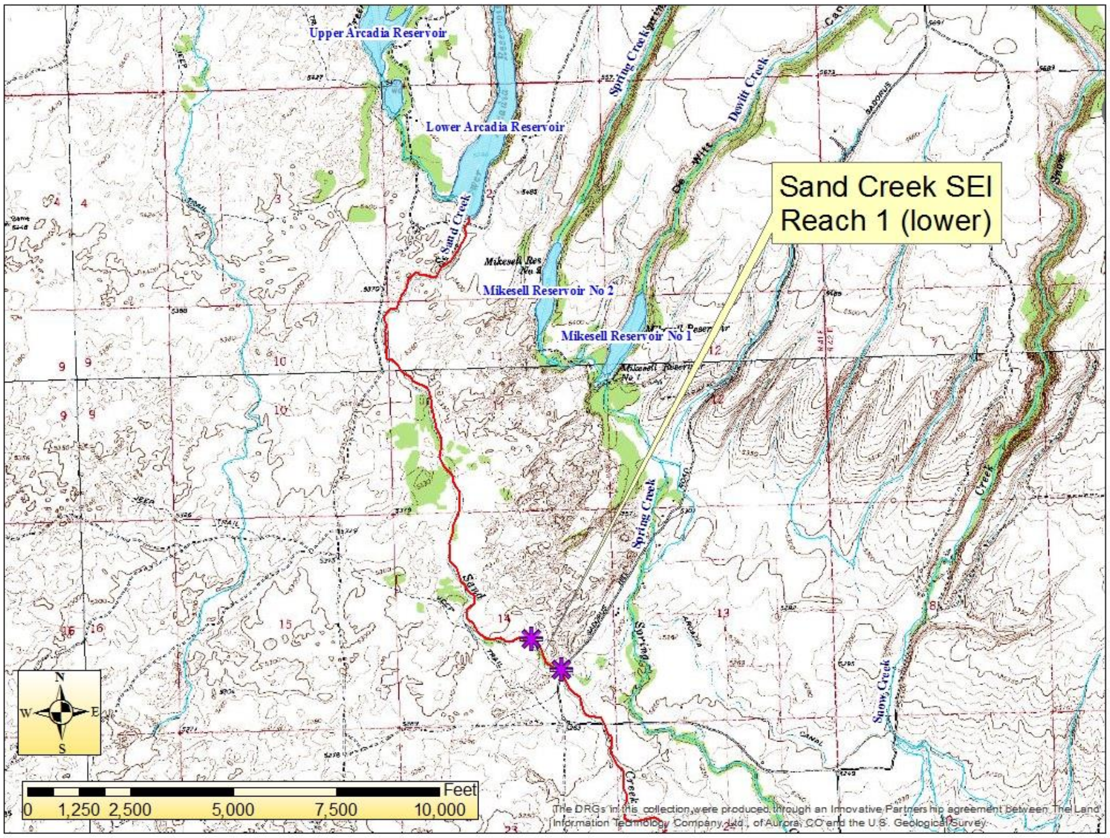
Factor	Field Stability Score	Erosion Severity Reduction
Bank Erosion Evidence (0 to 3)	0.25	0.25
Bank Stability Condition (0 to 3)	0.75	0.25
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	0.5	0.25
Channel Bottom Stability (0 to 2)	0	0.25
In-Channel Deposition (-1 to 1)	1	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	2.75	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.0375**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	801.41	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.95	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	4.38	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	7.22	tons/year	Total Reach

Summary of Loads

Current Load		Load Capacity			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
1.2	**1.9**	**4.4**	**7.2**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Upper Arcadia Reservoir
Lower Arcadia Reservoir
Sand Creek SEI
Reach 1 (lower)
Mikesell Reservoir No 2
Mikesell Reservoir No 1
Spring Creek
N
S
W
E
Feet
0 1,250 2,500 5,000 7,500 10,000
The DRGs in this collection were produced through an Innovative Partnership agreement between The Land Information Technology Company, Ltd., of Aurora, CO and the U.S. Geological Survey

Sand Creek – Site 2

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Sand Creek	Stream Segment Location (DD)	
Assessment Unit:	ID17040203SK013_04	*Upstream N*	44.128820
Segment Inventoried:	Reach 2 (upper)	*W*	-111.596730
Total Reach:	459m (1506 ft)	*Downstream N*	44.126030
Date Collected:	15-Jun-15	*W*	-111.597280
Field Crew:	Jack M. & M. Shumar	Notes:	Rosgen C, St Anthony Sand Dunes
Data Reduced By:	M. Shumar		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	1506.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	105	lb/ft^3	Total Reach
Length of Similar Stream	5787	ft	Total Reach
Estimated Distance inventoried	3012.00	ft	"
Total Erosive Bank Length	305.40	ft	"
Percent Erosive Bank	10.1	%	"
Eroding Area (AE)	6967.82	ft^2	"
Lateral Recession Rate (RLR)	0.05		"
Bank Erosion (E)	18.29	tons/year	"
Total Bank Erosion Rate (ER)	64.13	tons/mile/year	Reach and Segment
Total Bank Erosion	70.28	tons/year	"

Recession Rate Calculations

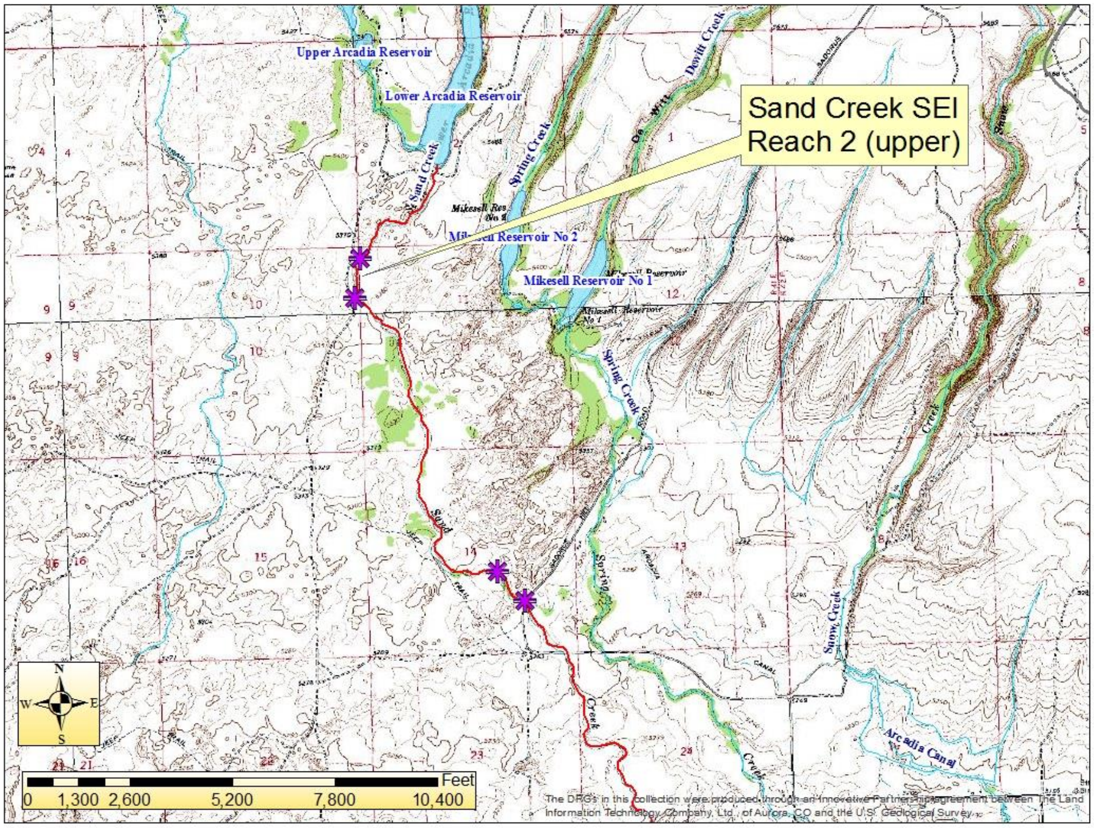
Factor	Field Stability Score	Erosion Severity Reduction
Bank Erosion Evidence (0 to 3)	1	0.25
Bank Stability Condition (0 to 3)	0.75	0.25
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	1	0.25
Channel Bottom Stability (0 to 2)	0	0.25
In-Channel Deposition (-1 to 1)	1	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	4	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.05**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	13743.99	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	16.24	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	56.92	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	62.39	tons/year	Total Reach

Summary of Loads

Current Load		Load Capacity			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
64.1	**70.3**	**56.9**	**62.4**	YES	**7**

Percent Erosion Reduction (%)	**19**
Total Erosion Reduction (tons/yr)	**15**


Sand Creek SEI
Reach 2 (upper)
Upper Arcadia Reservoir
Lower Arcadia Reservoir
Mikesell Reservoir No 1
Spring Creek
Arcadia Canal
N
S
E
W
Feet
0 1,300 2,600 5,200 7,800 10,400
The DRGs in this collection were produced through an Innovative Partnership agreement between the Land Information Technology Company, Ltd., of Aurora, CO and the U.S. Geological Survey.

Sheridan Creek – Site 1

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Sheridan Creek	Stream Segment Location (DD)	
Assessment Unit:	ID17040202SK045_03	*Upstream N*	44.427880
Segment Inventoried:	Reach 1 above Willow Creek	*W*	-111.634930
Total Reach:	424m (1391 ft)	*Downstream N*	44.429350
Date Collected:	16-Jun-15	*W*	-111.631380
Field Crew:	Jack M. & M. Shumar	Notes:	C Channel, meadow.
Data Reduced By:	M. Shumar		

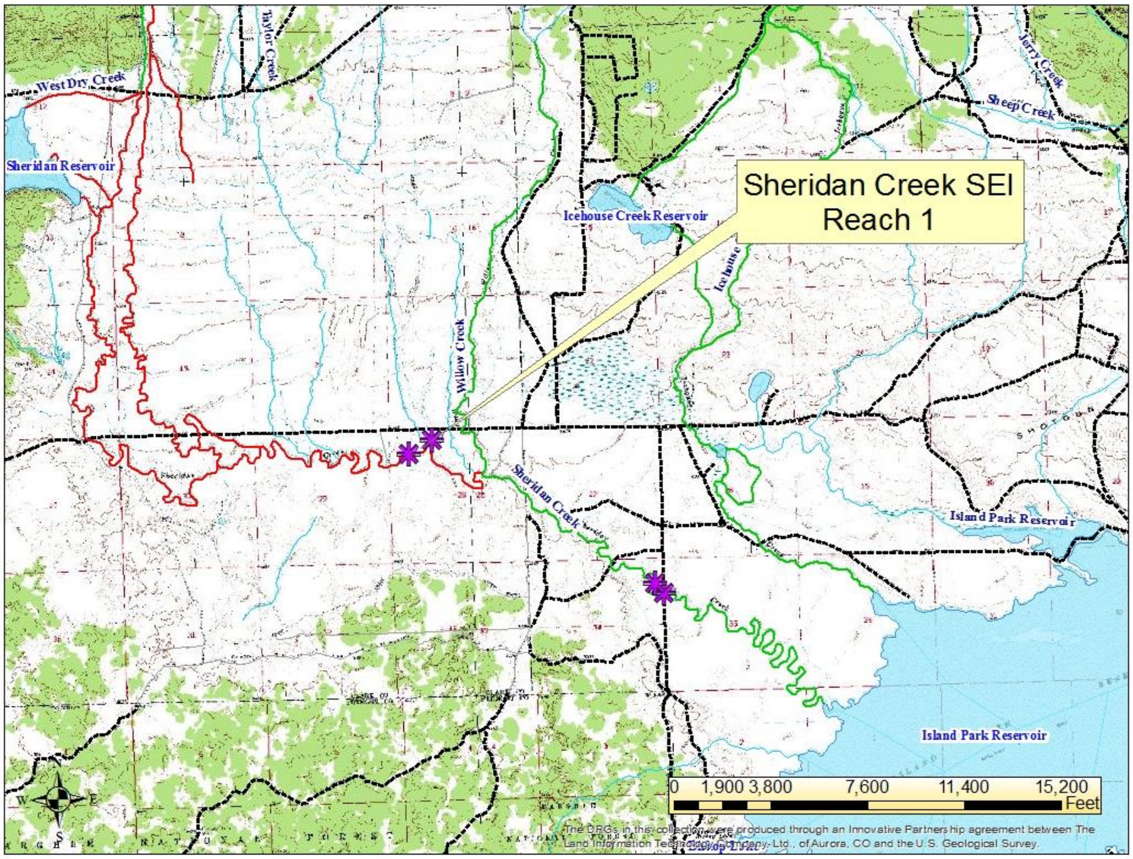
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	1391.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	36580	ft	Total Reach
Estimated Distance inventoried	2782.00	ft	"
Total Erosive Bank Length	638.10	ft	"
Percent Erosive Bank	22.9	%	"
Eroding Area (AE)	1239.87	ft^2	"
Lateral Recession Rate (RLR)	0.15		"
Bank Erosion (E)	7.90	tons/year	"
Total Bank Erosion Rate (ER)	30.00	tons/mile/year	Reach and Segment
Total Bank Erosion	207.86	tons/year	"

Recession Rate Calculations		
Factor	Field Stability Score	Erosion Severity Reduction
Bank Erosion Evidence (0 to 3)	2.5	0.25
Bank Stability Condition (0 to 3)	1.5	0.25
Bank Cover/Vegetation(0 to 3)	1	0.25
Lateral Channel Stability (0 to 3)	2	0.25
Channel Bottom Stability (0 to 2)	0	0.25
In-Channel Deposition (-1 to 1)	1	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	8	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.15**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	1081.12	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	1.03	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	3.92	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	27.19	tons/year	Total Reach

Summary of Loads					
Current Load		Load Capacity			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
30.0	**207.9**	**3.9**	**27.2**	YES	**21**

Percent Erosion Reduction (%)	**88**
Total Erosion Reduction (tons/yr)	**201**


Sheridan Creek SEI
Reach 1
West Dry Creek
Taylor Creek
Sheridan Reservoir
Icehouse Creek Reservoir
Icehouse
Willow Creek
Sheep Creek
Jerry Creek
Sheridan Creek
Island Park Reservoir
Island Park Reservoir
0 1,900 3,800 7,600 11,400 15,200
Feet

Sheridan Creek – Site 2

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Sheridan Creek	**Stream Segment Location (DD)**	
Assessment Unit:	ID17040202SK046_04	***Upstream N***	44.413020
Segment Inventoried:	Reach 2 below Willow Creek	***W***	-111.598560
Total Reach:	454m (1489 ft)	***Downstream N***	44.412000
Date Collected:	16-Jun-15	***W***	-111.597350
Field Crew:	Jack M. & M. Shumar	**Notes:**	C Channel, meadow.
Data Reduced By:	M. Shumar		

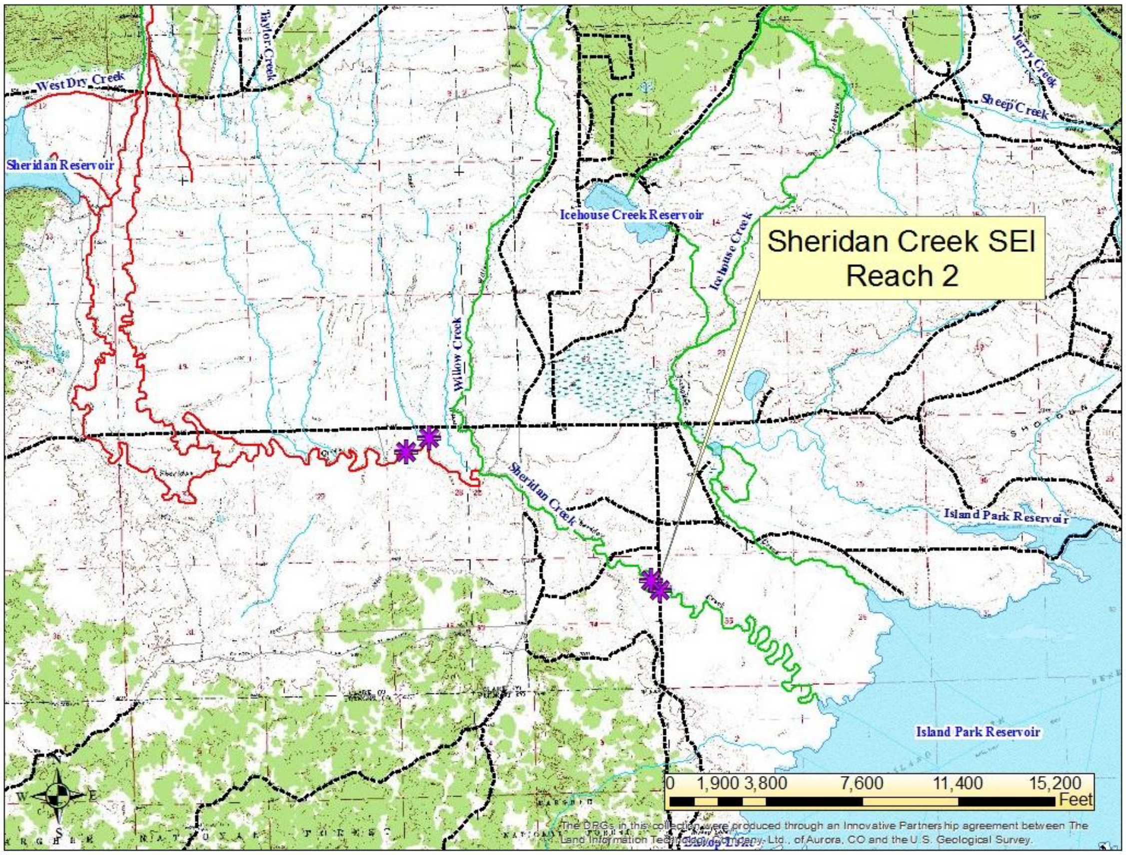
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	1489.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	32345	ft	Total Reach
Estimated Distance inventoried	2978.00	ft	"
Total Erosive Bank Length	326.40	ft	"
Percent Erosive Bank	11.0	%	"
Eroding Area (AE)	694.52	ft^2	"
Lateral Recession Rate (RLR)	0.055		"
Bank Erosion (E)	1.62	tons/year	"
Total Bank Erosion Rate (ER)	5.76	tons/mile/year	Reach and Segment
Total Bank Erosion	35.27	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1.5	0.25
Bank Stability Condition (0 to 3)	1	0.25
Bank Cover/Vegetation(0 to 3)	0.5	0.25
Lateral Channel Stability (0 to 3)	1	0.25
Channel Bottom Stability (0 to 2)	0.25	0.25
In-Channel Deposition (-1 to 1)	0.25	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	4.5	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.055**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	1267.33	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	1.21	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	4.30	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	26.33	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
5.8	**35.3**	**4.3**	**26.3**	YES	**4**

Percent Erosion Reduction (%)	**32**
Total Erosion Reduction (tons/yr)	**12**


Sheridan Creek SEI
Reach 2
West Dry Creek
Sheridan Reservoir
Taylor Creek
Icehouse Creek Reservoir
Icehouse Creek
Willow Creek
Sheridan Creek
Sheep Creek
Jerry Creek
Island Park Reservoir
Island Park Reservoir
0 1,900 3,800 7,600 11,400 15,200
Feet
The DRGs in this collection were produced through an Innovative Partnership agreement between The Land Information Technology Company, Ltd., of Aurora, CO and the U.S. Geological Survey.

Twin Creek – Site 1

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Twin Creek	**Stream Segment Location (DD)**	
Assessment Unit:	ID17040202SK025_02	***Upstream N***	44.589970
Segment Inventoried:	Reach 1 East Branch FS boundary	***W***	-111.314120
Total Reach:	281m (922 ft)	***Downstream N***	44.588500
Date Collected:	17-Jun-15	***W***	-111.315870
Field Crew:	Jack M. & M. Shumar	**Notes:**	C Channel on forest edge
Data Reduced By:	M. Shumar		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	922.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	3280	ft	Total Reach
Estimated Distance inventoried	1844.00	ft	"
Total Erosive Bank Length	65.00	ft	"
Percent Erosive Bank	3.5	%	"
Eroding Area (AE)	96.89	ft^2	"
Lateral Recession Rate (RLR)	0.035		"
Bank Erosion (E)	0.14	tons/year	"
Total Bank Erosion Rate (ER)	0.83	tons/mile/year	Reach and Segment
Total Bank Erosion	0.51	tons/year	"

Recession Rate Calculations

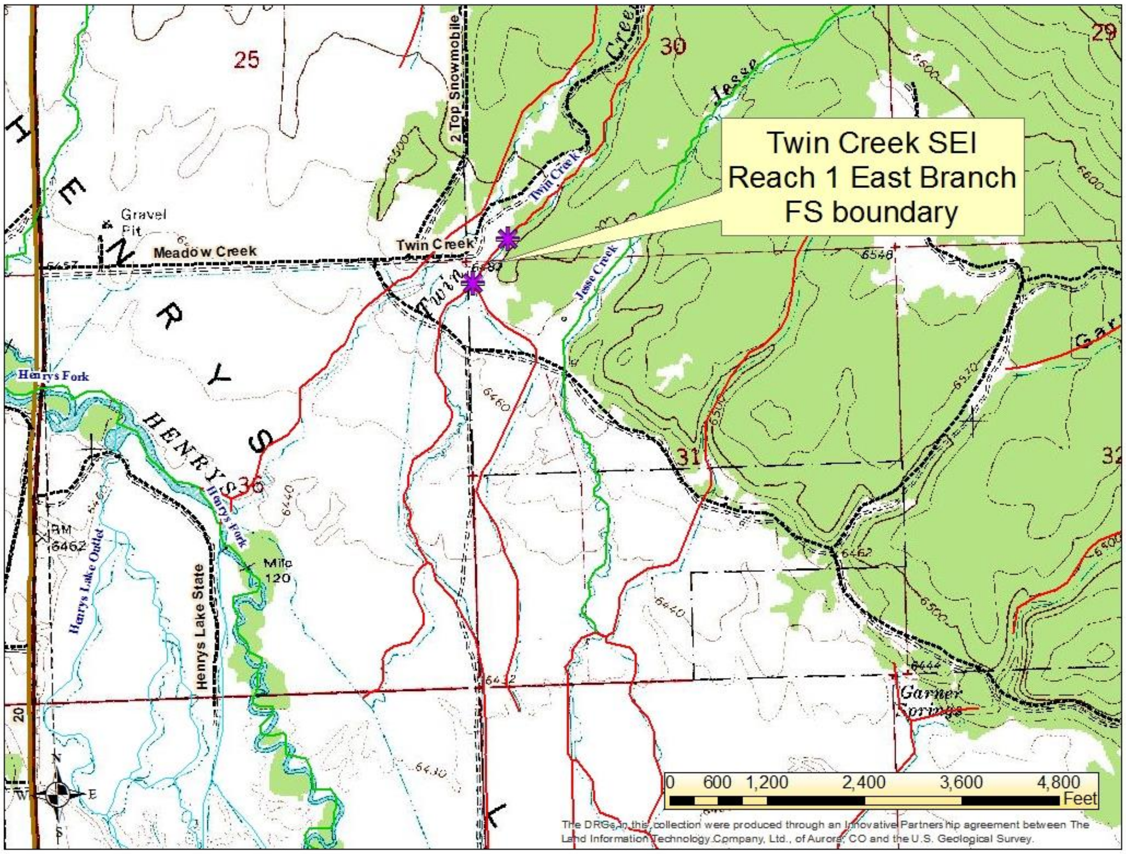
Factor	Field Stability Score	Erosion Severity Reduction
Bank Erosion Evidence (0 to 3)	0.25	0.25
Bank Stability Condition (0 to 3)	0.5	0.25
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	1	0.25
Channel Bottom Stability (0 to 2)	0	0.25
In-Channel Deposition (-1 to 1)	0.5	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	2.5	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.035**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	549.74	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.53	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	3.01	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	1.87	tons/year	Total Reach

Summary of Loads

Current Load		Load Capacity			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
0.8	**0.5**	**3.0**	**1.9**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Twin Creek SEI
Reach 1 East Branch
FS boundary
Meadow Creek
Twin Creek
Jesse Creek
Henrys Fork
Henrys Lake Outlet
Henrys Lake State
Garner Springs
Mile 120
2 Top Snowmobile
0 600 1,200 2,400 3,600 4,800 Feet
The DRGs in this collection were produced through an Innovative Partnership agreement between The Land Information Technology Company, Ltd., of Aurora, CO and the U.S. Geological Survey.

Twin Creek – Site 2

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Twin Creek	**Stream Segment Location (DD)**	
Assessment Unit:	ID17040202SK025_02	***Upstream N***	44.590900
Segment Inventoried:	Reach 2 West Branch FS boundary	***W***	-111.314960
Total Reach:	150m (492 ft)	***Downstream N***	44.590330
Date Collected:	17-Jun-15	***W***	-111.315980
Field Crew:	Jack M. & M. Shumar	**Notes:**	C channel forest edge
Data Reduced By:	M. Shumar		

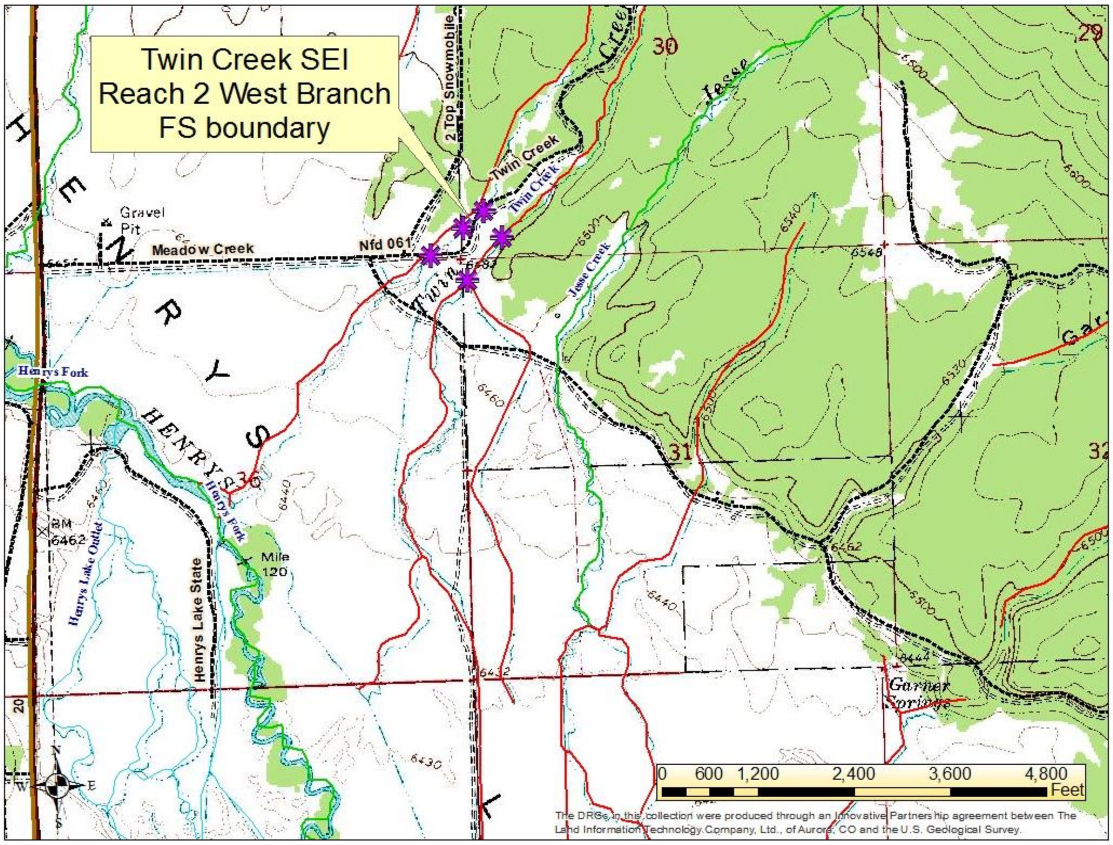
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	492.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	4015	ft	Total Reach
Estimated Distance inventoried	984.00	ft	"
Total Erosive Bank Length	13.10	ft	"
Percent Erosive Bank	1.3	%	"
Eroding Area (AE)	16.04	ft^2	"
Lateral Recession Rate (RLR)	0.02		"
Bank Erosion (E)	0.01	tons/year	"
Total Bank Erosion Rate (ER)	0.15	tons/mile/year	Reach and Segment
Total Bank Erosion	0.11	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0.25	0.25
Bank Stability Condition (0 to 3)	0.25	0.25
Bank Cover/Vegetation(0 to 3)	0.25	0.25
Lateral Channel Stability (0 to 3)	0.25	0.25
Channel Bottom Stability (0 to 2)	0	0.25
In-Channel Deposition (-1 to 1)	0	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	1	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.02**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	240.97	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.23	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	2.47	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	1.88	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
0.1	**0.1**	**2.5**	**1.9**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Twin Creek SEI
Reach 2 West Branch
FS boundary
Twin Creek
Jesse
Gravel Pit
Meadow Creek
Nfd 061
Jesse Creek
Henrys Fork
Henrys Lake State
Henrys Lake Outlet
Mile 120
BM 6462
Garner Springs
30
29
31
32
36
20
0 600 1,200 2,400 3,600 4,800 Feet
The DRGs in this collection were produced through an Innovative Partnership agreement between The Land Information Technology Company, Ltd., of Aurora, CO and the U.S. Geological Survey.

Twin Creek – Site 3

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Twin Creek	Stream Segment Location (DD)	
Assessment Unit:	ID17040202SK025_02	*Upstream N*	44.590330
Segment Inventoried:	Reach 3 State Land	*W*	-111.315980
Total Reach:	195m (640 ft)	*Downstream N*	44.589400
Date Collected:	17-Jun-15	*W*	-111.317570
Field Crew:	Jack M. & M. Shumar	Notes:	C Channel, meadow.
Data Reduced By:	M. Shumar		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flowpath distance)	640.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	4796	ft	Total Reach
Estimated Distance inventoried	1280.00	ft	"
Total Erosive Bank Length	341.10	ft	"
Percent Erosive Bank	26.6	%	"
Eroding Area (AE)	394.48	ft^2	"
Lateral Recession Rate (RLR)	0.0675		"
Bank Erosion (E)	1.13	tons/year	"
Total Bank Erosion Rate (ER)	9.34	tons/mile/year	Reach and Segment
Total Bank Erosion	8.48	tons/year	"

Recession Rate Calculations

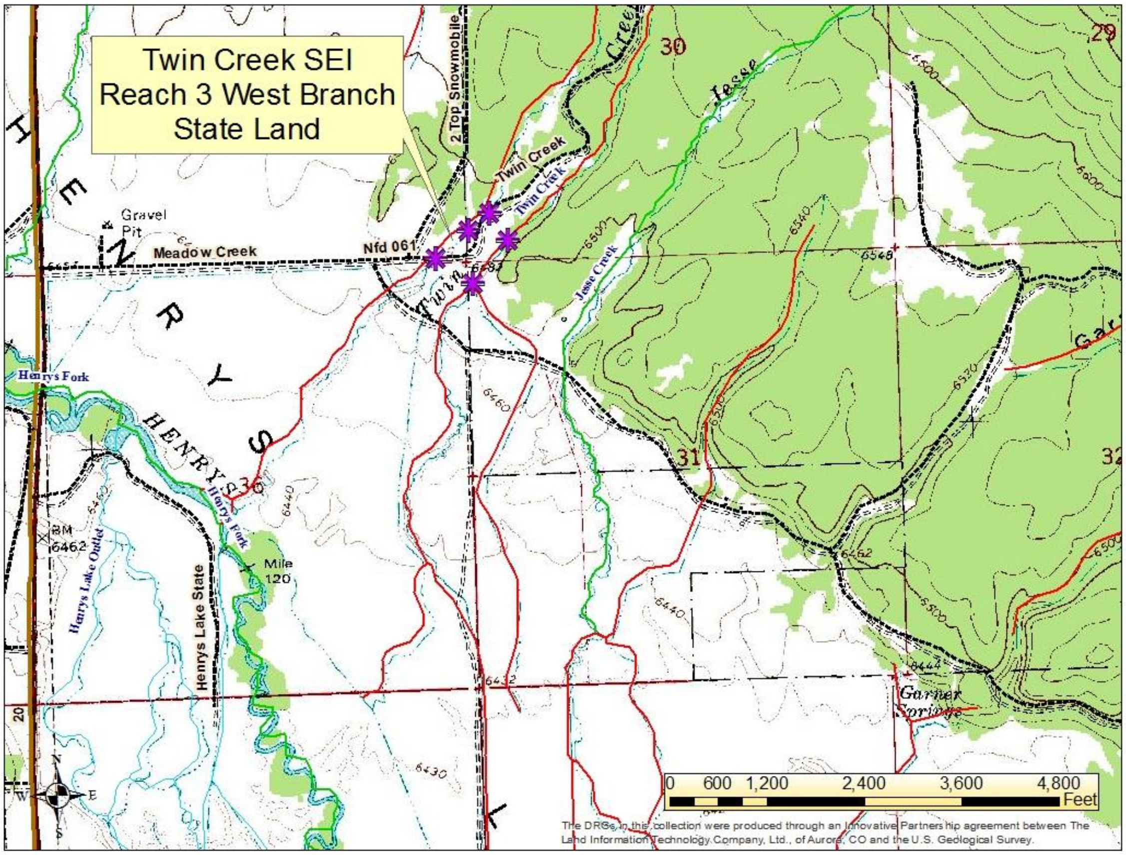
Factor	Field Stability Score	Erosion Severity Reduction
Bank Erosion Evidence (0 to 3)	1.5	0.25
Bank Stability Condition (0 to 3)	1.5	0.25
Bank Cover/Vegetation(0 to 3)	1	0.25
Lateral Channel Stability (0 to 3)	1	0.25
Channel Bottom Stability (0 to 2)	0	0.25
In-Channel Deposition (-1 to 1)	0.25	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	5.25	1.25
Lateral Recession Rate (RLR) (ft/yr)	**0.0675**	**0.0225**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	296.06	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.28	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	2.34	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	2.12	tons/year	Total Reach

Summary of Loads

Current Load		Load Capacity			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
9.3	**8.5**	**2.3**	**2.1**	**YES**	**1**

Percent Erosion Reduction (%)	**77**
Total Erosion Reduction (tons/yr)	**7**


Twin Creek SEI
Reach 3 West Branch
State Land
Twin Creek
Meadow Creek
Nfd 061
Gravel Pit
Jesse Creek
Henrys Fork
Henrys Lake Outlet
Henrys Lake State
Mile 120
Garner Springs
0 600 1,200 2,400 3,600 4,800
Feet
The DRGs in this collection were produced through an Innovative Partnership agreement between The Land Information Technology Company, Ltd., of Aurora, CO and the U.S. Geological Survey.

Appendix B. PNV Data

Table B-1. Solar load calculations for Duck Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
036_03	Duck Creek	1	2700	EU#2606	58%	2.49	2	5,000	10,000	60%	2.38	2	5,000	10,000	0	0%
036_03	Duck Creek	2	800	willow/grass	43%	3.39	3	2,000	7,000	40%	3.56	3	2,000	7,000	0	-3%
036_03	Duck Creek	3	180	riparian	43%	3.39	3	500	2,000	30%	4.16	3	500	2,000	0	-13%
036_03	Duck Creek	4	670		43%	3.39	3	2,000	7,000	50%	2.97	3	2,000	6,000	(1,000)	0%
036_03	Duck Creek	5	150		43%	3.39	3	500	2,000	40%	3.56	3	500	2,000	0	-3%
036_03	Duck Creek	6	250		35%	3.86	4	1,000	4,000	10%	5.35	4	1,000	5,000	1,000	-25%
036_03	Duck Creek	7	510		35%	3.86	4	2,000	8,000	0%	5.94	4	2,000	10,000	2,000	-35%
036_03	Duck Creek	8	950		35%	3.86	4	4,000	20,000	10%	5.35	4	4,000	20,000	0	-25%
036_03	Duck Creek	9	590		29%	4.22	5	3,000	10,000	30%	4.16	5	3,000	10,000	0	0%
036_03	Duck Creek	10	160		29%	4.22	5	800	3,000	0%	5.94	5	800	5,000	2,000	-29%
036_03	Duck Creek	11	760		29%	4.22	5	4,000	20,000	10%	5.35	5	4,000	20,000	0	-19%
							Totals		93,000					97,000	4,000	

Table B-2. Solar load calculations for Howard Creek with significant figure rounding.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
033_02	Howard Creek	1	250	EU#1594-cool	73%	1.60	1	300	500	60%	2.38	1	300	700	200	-13%
033_02	Howard Creek	2	70	EU#2020	53%	2.79	1	70	200	90%	0.59	1	70	40	(200)	0%
033_02	Howard Creek	3	130	grass/willow	32%	4.04	2	300	1,000	40%	3.56	2	300	1,000	0	0%
033_02	Howard Creek	4	350	riparian	32%	4.04	2	700	3,000	30%	4.16	2	700	3,000	0	-2%
033_02	Howard Creek	5	400		32%	4.04	2	800	3,000	70%	1.78	2	800	1,000	(2,000)	0%
033_02	Howard Creek	6	280		32%	4.04	2	600	2,000	10%	5.35	2	600	3,000	1,000	-22%
033_02	Howard Creek	7	1180		32%	4.04	2	2,000	8,000	20%	4.75	2	2,000	10,000	2,000	-12%
033_02	Howard Creek	8	800		32%	4.04	2	2,000	8,000	10%	5.35	2	2,000	10,000	2,000	-22%
033_02	Howard Creek	9	350		23%	4.57	3	1,000	5,000	20%	4.75	3	1,000	5,000	0	-3%
033_02	Howard Creek	10	1100		23%	4.57	3	3,000	10,000	10%	5.35	3	3,000	20,000	10,000	-13%
033_02	Howard Creek	11	270	pond	0%	5.94	3	800	5,000	0%	5.94	3	800	5,000	0	0%
033_02	Howard Creek	12	890		18%	4.87	4	4,000	20,000	20%	4.75	4	4,000	20,000	0	0%
033_02	Howard Creek	13	690	EU#2606	35%	3.86	4	3,000	10,000	10%	5.35	4	3,000	20,000	10,000	-25%
033_02	Howard Creek	14	2100	willow/grass	29%	4.22	5	10,000	40,000	0%	5.94	5	10,000	60,000	20,000	-29%
033_02	Howard Creek	15	860	riparian	29%	4.22	5	4,000	20,000	10%	5.35	5	4,000	20,000	0	-19%
							Totals		140,000					180,000	43,000	

Table B-3. Solar load calculations for Howard Creek without significant figure rounding.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
033_02	Howard Creek	1	250	EU#1594-cool	73%	1.60	1	250	401	60%	2.38	1	250	594	193	-13%
033_02	Howard Creek	2	70	EU#2020	53%	2.79	1	70	195	90%	0.59	1	70	42	(154)	0%
033_02	Howard Creek	3	130	grass/willow	32%	4.04	2	260	1,050	40%	3.56	2	260	927	(124)	0%
033_02	Howard Creek	4	350	riparian	32%	4.04	2	700	2,827	30%	4.16	2	700	2,911	83	-2%
033_02	Howard Creek	5	400		32%	4.04	2	800	3,231	70%	1.78	2	800	1,426	(1,806)	0%
033_02	Howard Creek	6	280		32%	4.04	2	560	2,262	10%	5.35	2	560	2,994	732	-22%
033_02	Howard Creek	7	1180		32%	4.04	2	2,360	9,533	20%	4.75	2	2,360	11,215	1,683	-12%
033_02	Howard Creek	8	800		32%	4.04	2	1,600	6,463	10%	5.35	2	1,600	8,554	2,091	-22%
033_02	Howard Creek	9	350		23%	4.57	3	1,050	4,803	20%	4.75	3	1,050	4,990	187	-3%
033_02	Howard Creek	10	1100		23%	4.57	3	3,300	15,094	10%	5.35	3	3,300	17,642	2,548	-13%
033_02	Howard Creek	11	270	pond	0%	5.94	3	810	4,811	0%	5.94	3	810	4,811	0	0%
033_02	Howard Creek	12	890		18%	4.87	4	3,560	17,340	20%	4.75	4	3,560	16,917	(423)	0%
033_02	Howard Creek	13	690	EU#2606	35%	3.86	4	2,760	10,656	10%	5.35	4	2,760	14,755	4,099	-25%
033_02	Howard Creek	14	2100	willow/grass	29%	4.22	5	10,500	44,283	0%	5.94	5	10,500	62,370	18,087	-29%
033_02	Howard Creek	15	860	riparian	29%	4.22	5	4,300	18,135	10%	5.35	5	4,300	22,988	4,853	-19%
							Totals		140,000					170,000	32,000	

Table B-4. Solar load calculations for Timber Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
035_03	Timber Creek	1	3200	EU#2606	58%	2.49	2	6,000	10,000	20%	4.75	2	6,000	30,000	20,000	-38%
							Totals		10,000					30,000	20,000	

Table B-5. Solar load calculations for Targhee Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
034_02	Targhee Creek	1	1130	EU#2609	96%	0.24	1	1,000	200	70%	1.78	1	1,000	2,000	2,000	-26%
034_02	Targhee Creek	2	750	spruce	96%	0.24	1	800	200	80%	1.19	1	800	1,000	800	-16%
034_02	Targhee Creek	3	1599	riparian	95%	0.30	2	3,000	900	90%	0.59	2	3,000	2,000	1,000	-5%
034_02	Targhee Creek	4	600		95%	0.30	2	1,000	300	90%	0.59	2	1,000	600	300	-5%
034_02	Targhee Creek	5	959		94%	0.36	3	3,000	1,000	80%	1.19	3	3,000	4,000	3,000	-14%
034_03	Targhee Creek	1	1864		91%	0.53	4	7,000	4,000	70%	1.78	4	7,000	10,000	6,000	-21%
034_03	Targhee Creek	2	499	EU#2606	29%	4.22	5	2,000	8,000	20%	4.75	5	2,000	10,000	2,000	-9%
034_03	Targhee Creek	3	160	willow/grass	29%	4.22	5	800	3,000	40%	3.56	5	800	3,000	0	0%
034_03	Targhee Creek	4	240	riparian	29%	4.22	5	1,000	4,000	20%	4.75	5	1,000	5,000	1,000	-9%
034_03	Targhee Creek	5	710		29%	4.22	5	4,000	20,000	40%	3.56	5	4,000	10,000	(10,000)	0%
034_03	Targhee Creek	6	1025		26%	4.40	6	6,000	30,000	20%	4.75	6	6,000	30,000	0	-6%
034_03	Targhee Creek	7	1006	EU#2609	76%	1.43	6	6,000	9,000	70%	1.78	6	6,000	10,000	1,000	-6%
034_03	Targhee Creek	8	455	spruce	69%	1.84	7	3,000	6,000	80%	1.19	7	3,000	4,000	(2,000)	0%
034_03	Targhee Creek	9	533	riparian	69%	1.84	7	4,000	7,000	70%	1.78	7	4,000	7,000	0	0%
034_03	Targhee Creek	10	3710		64%	2.14	8	30,000	60,000	60%	2.38	8	30,000	70,000	10,000	-4%
034_03	Targhee Creek	11	840	EU#2606	18%	4.87	9	8,000	40,000	40%	3.56	9	8,000	30,000	(10,000)	0%
034_03	Targhee Creek	12	910	willow/grass	18%	4.87	9	8,000	40,000	20%	4.75	9	8,000	40,000	0	0%
034_03	Targhee Creek	13	370	riparian	16%	4.99	10	3,700	18,000	40%	3.56	10	3,700	13,000	(5,000)	0%
034_03	Targhee Creek	14	1120		16%	4.99	10	11,000	55,000	0%	5.94	10	11,000	65,000	10,000	-16%
							Totals		310,000					320,000	10,000	

Table B-6. Solar load calculations for Warm River.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
005_02	Warm River	1	950	EU#1225 cool	62%	2.26	1	1,000	2,000	60%	2.38	1	1,000	2,000	0	-2%
005_02	Warm River	2	2900	whitebark/fir	62%	2.26	1	3,000	7,000	80%	1.19	1	3,000	4,000	(3,000)	0%
005_02	Warm River	3	1500	EU#1700	56%	2.61	2	3,000	8,000	60%	2.38	2	3,000	7,000	(1,000)	0%
005_02	Warm River	4	400	cool	56%	2.61	2	800	2,000	70%	1.78	2	800	1,000	(1,000)	0%
005_02	Warm River	5	200	lodgepole pine	56%	2.61	2	400	1,000	30%	4.16	2	400	2,000	1,000	-26%
005_02	Warm River	6	1100		46%	3.21	3	3,000	10,000	60%	2.38	3	3,000	7,000	(3,000)	0%
005_02	Warm River	7	1100	EU#2040	50%	2.97	3	3,000	9,000	60%	2.38	3	3,000	7,000	(2,000)	0%
005_02	Warm River	8	430	lodgepole pine	50%	2.97	3	1,000	3,000	40%	3.56	3	1,000	4,000	1,000	-10%
005_03	Warm River	1	550	riparian	50%	2.97	3	2,000	6,000	40%	3.56	3	2,000	7,000	1,000	-10%
005_03	Warm River	2	650		50%	2.97	3	2,000	6,000	60%	2.38	3	2,000	5,000	(1,000)	0%
005_03	Warm River	3	600		42%	3.45	4	2,000	7,000	40%	3.56	4	2,000	7,000	0	-2%
005_03	Warm River	4	250		42%	3.45	4	1,000	3,000	20%	4.75	4	1,000	5,000	2,000	-22%
005_03	Warm River	5	380		42%	3.45	4	2,000	7,000	0%	5.94	4	2,000	10,000	3,000	-42%
005_03	Warm River	6	1000		42%	3.45	4	4,000	10,000	30%	4.16	4	4,000	20,000	10,000	-12%
005_03	Warm River	7	670		42%	3.45	4	3,000	10,000	40%	3.56	4	3,000	10,000	0	-2%
005_03	Warm River	8	1000		42%	3.45	4	4,000	10,000	30%	4.16	4	4,000	20,000	10,000	-12%
005_03	Warm River	9	380		37%	3.74	5	2,000	7,000	10%	5.35	5	2,000	10,000	3,000	-27%
005_03	Warm River	10	450		37%	3.74	5	2,000	7,000	20%	4.75	5	2,000	10,000	3,000	-17%
005_03	Warm River	11	360		37%	3.74	5	2,000	7,000	30%	4.16	5	2,000	8,000	1,000	-7%
005_03	Warm River	12	130		37%	3.74	5	700	3,000	10%	5.35	5	700	4,000	1,000	-27%
005_03	Warm River	13	1500		37%	3.74	5	8,000	30,000	30%	4.16	5	8,000	30,000	0	-7%
005_03	Warm River	14	380		37%	3.74	5	2,000	7,000	10%	5.35	5	2,000	10,000	3,000	-27%
005_03	Warm River	15	1200		32%	4.04	6	7,000	30,000	0%	5.94	6	7,000	40,000	10,000	-32%
005_03	Warm River	16	1300		32%	4.04	6	8,000	30,000	20%	4.75	6	8,000	40,000	10,000	-12%
005_03	Warm River	17	600		32%	4.04	6	4,000	20,000	10%	5.35	6	4,000	20,000	0	-22%
005_03	Warm River	18	530		32%	4.04	6	3,000	10,000	30%	4.16	6	3,000	10,000	0	-2%
005_03	Warm River	19	1800	EU#2020	11%	5.29	7	10,000	50,000	10%	5.35	7	10,000	50,000	0	-1%
005_03	Warm River	20	770	EU#2606	22%	4.63	7	5,000	20,000	20%	4.75	7	5,000	20,000	0	-2%
005_03	Warm River	21	2200	willow/	22%	4.63	7	20,000	90,000	10%	5.35	7	20,000	100,000	10,000	-12%
005_03	Warm River	22	2200	grass riparian	20%	4.75	8	20,000	100,000	0%	5.94	8	20,000	100,000	0	-20%
005_03	Warm River	23	610		20%	4.75	8	5,000	20,000	20%	4.75	8	5,000	20,000	0	0%
005_03	Warm River	24	550		20%	4.75	8	4,000	20,000	0%	5.94	8	4,000	20,000	0	-20%
005_04	Warm River	1	1000		16%	4.99	10	10,000	50,000	20%	4.75	10	10,000	48,000	(2,000)	0%
005_04	Warm River	2	1700		14%	5.11	12	20,000	100,000	30%	4.16	12	20,000	83,000	(17,000)	0%
005_04	Warm River	3	1600		12%	5.23	14	22,000	110,000	10%	5.35	14	22,000	120,000	10,000	-2%
005_04	Warm River	4	160		12%	5.23	14	2,200	11,000	20%	4.75	14	2,200	10,000	(1,000)	0%
005_04	Warm River	5	1900		10%	5.35	16	30,000	160,000	10%	5.35	16	30,000	160,000	0	0%
005_04	Warm River	6	750		10%	5.35	16	12,000	64,000	20%	4.75	16	12,000	57,000	(7,000)	0%
005_04	Warm River	7	2100		10%	5.35	18	38,000	200,000	10%	5.35	18	38,000	200,000	0	0%
005_04	Warm River	8	200		9%	5.41	20	4,000	22,000	20%	4.75	20	4,000	19,000	(3,000)	0%
005_04	Warm River	9	400		9%	5.41	20	8,000	43,000	10%	5.35	20	8,000	43,000	0	0%
005_04	Warm River	10	340		9%	5.41	20	6,800	37,000	20%	4.75	20	6,800	32,000	(5,000)	0%
005_04	Warm River	11	1900		8%	5.46	21	40,000	220,000	10%	5.35	21	40,000	210,000	(10,000)	0%
002_04	Warm River	1	780		8%	5.46	21	16,000	87,000	10%	5.35	21	16,000	86,000	(1,000)	0%
002_04	Warm River	2	4300	EU#1224	16%	4.99	21	90,000	450,000	10%	5.35	26	110,000	590,000	140,000	-6%
002_04	Warm River	3	2500	warm	16%	4.99	21	53,000	260,000	20%	4.75	16	40,000	190,000	(70,000)	0%
002_04	Warm River	4	330	subalpine fir	16%	4.99	21	6,900	34,000	10%	5.35	23	7,600	41,000	7,000	-6%
002_04	Warm River	5	190		16%	4.99	21	4,000	20,000	20%	4.75	21	4,000	19,000	(1,000)	0%
002_04	Warm River	6	3200		16%	4.99	21	67,000	330,000	10%	5.35	24	77,000	410,000	80,000	-6%
002_04	Warm River	7	2800		13%	5.17	26	73,000	380,000	0%	5.94	32	90,000	530,000	150,000	-13%
002_05	Warm River	1	870		13%	5.17	26	23,000	120,000	0%	5.94	32	28,000	170,000	50,000	-13%
							Totals		3,300,000					3,600,000	380,000	

Appendix C. HOBO Temperature Logger Data

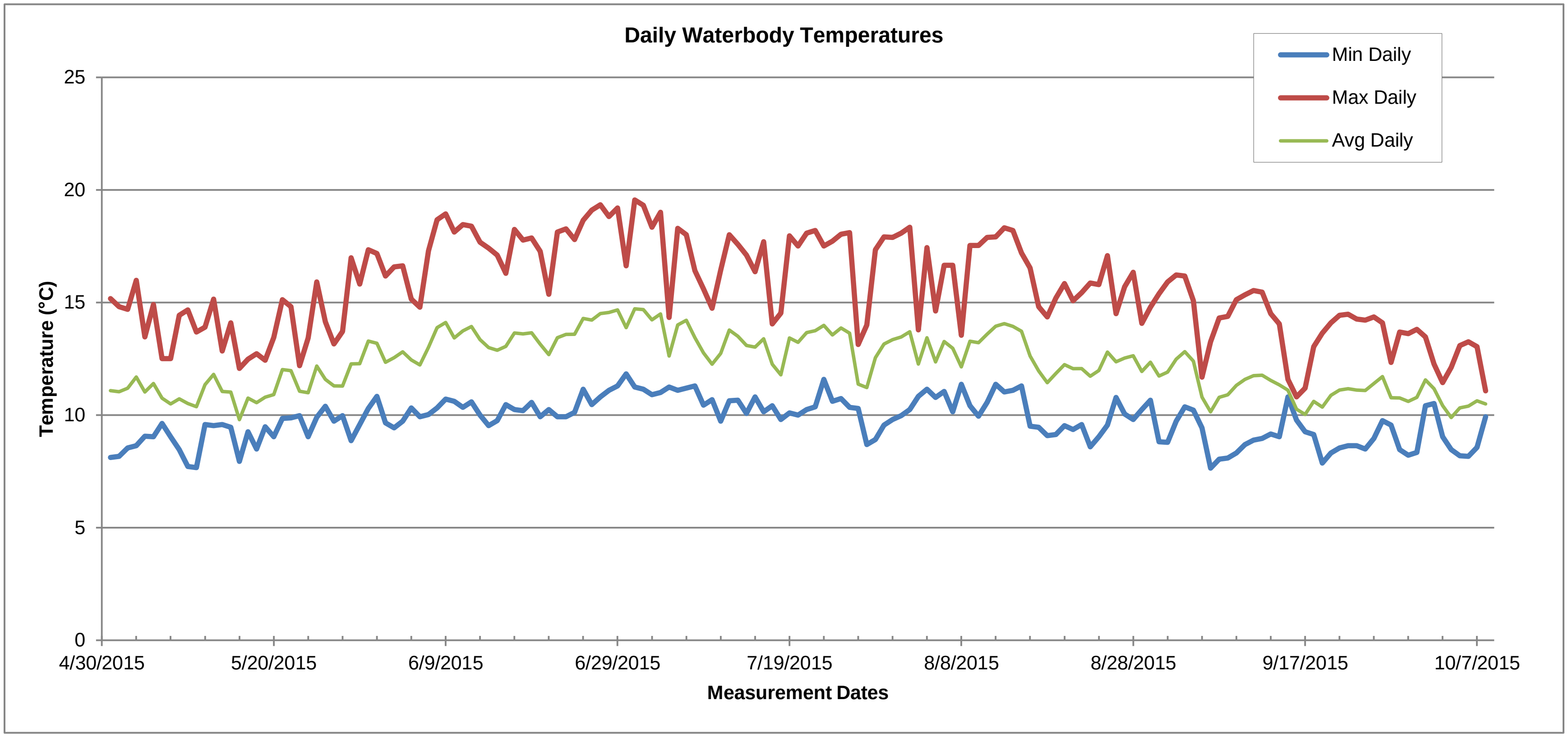
DEQ Summary of Temperature Data

Data Source: DEQ Idaho Falls Regional Office
Water Body: Warm River
Data Collection Site: 44.12199, -111.30849
Data Period: 5/1/2015 – 10/8/2015
HOBO Logger ID: 10349111

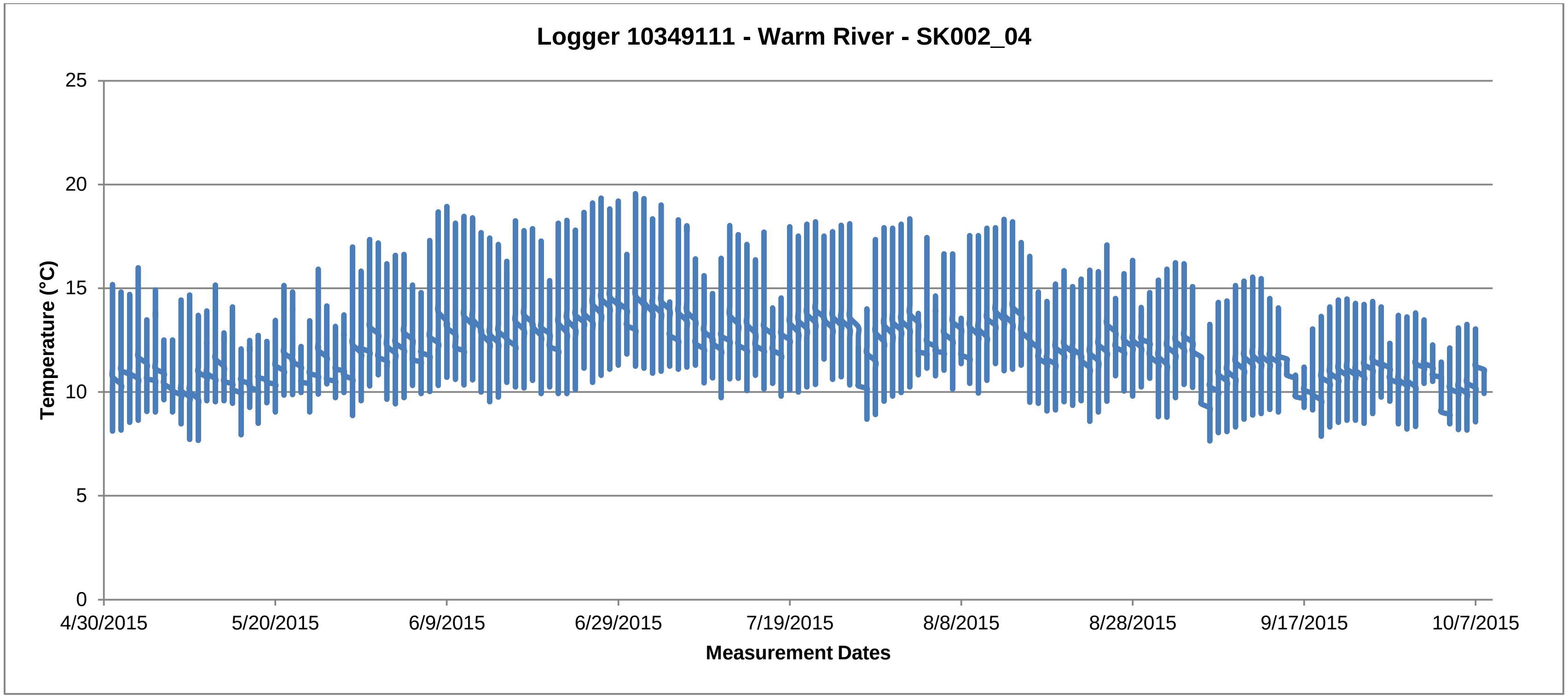
MDMT = 19.6, 01 July
MDAT = 14.7, 01 July

HUC4 Number: 17040202
HUC4 Name: Upper Henrys

Waterbody ID Number: SK002_04



Raw Data Graph (30 min Intervals)



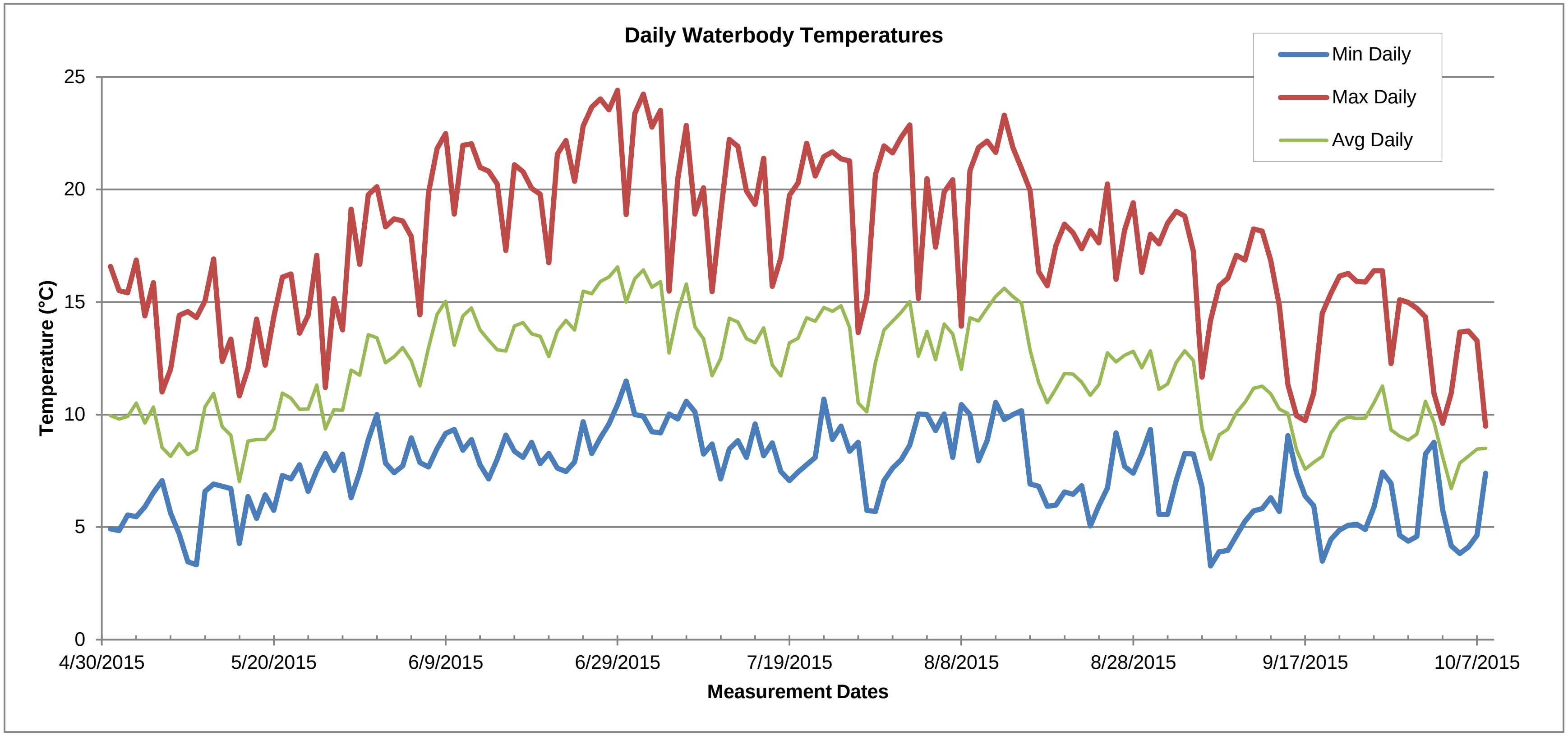
DEQ Summary of Temperature Data

Data Source: DEQ Idaho Falls Regional Office
Water Body: Warm River
Data Collection Site: 44.25968, -111.29076
Data Period: 5/1/2015 – 10/8/2015
HOBO Logger ID: 10102544

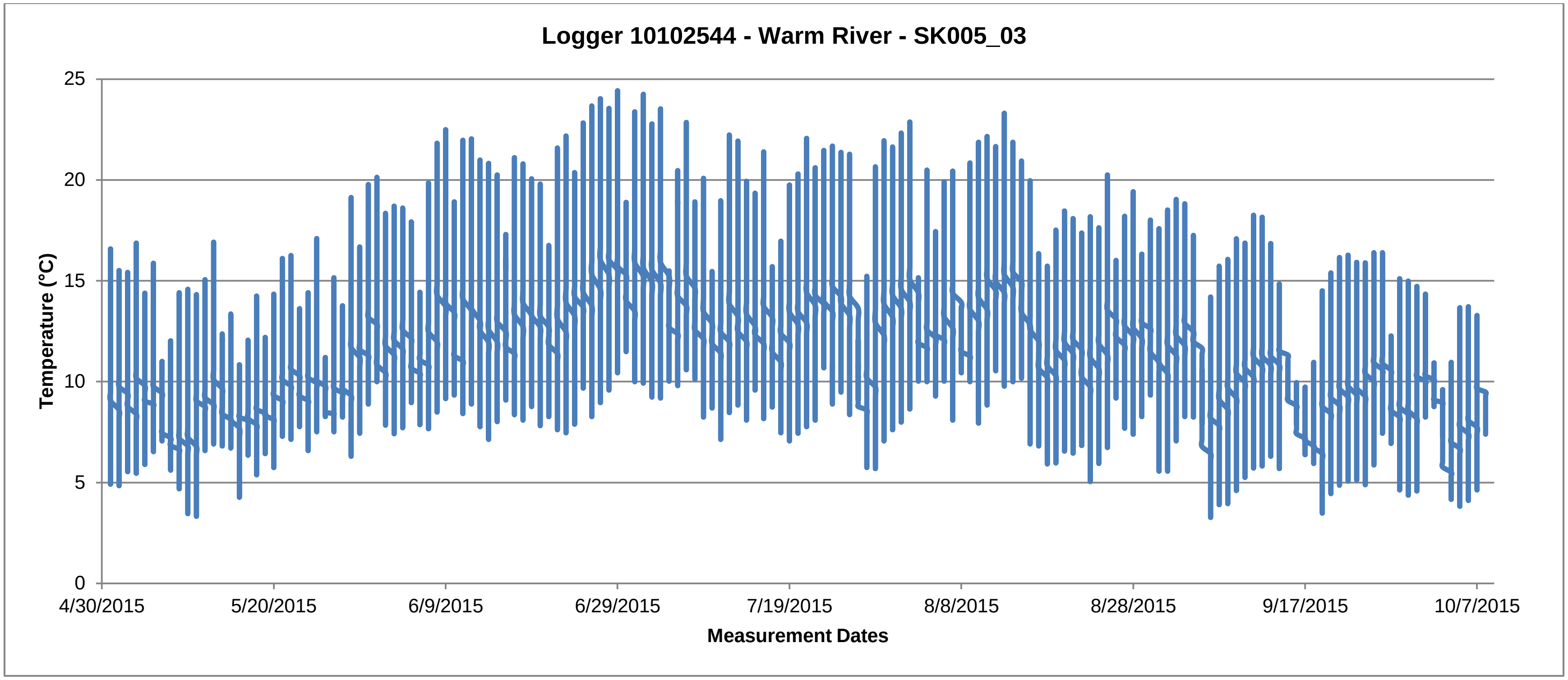
MDMT = 24.4, 29 June
MDAT = 16.6, 29 June

HUC4 Number: 17040202
HUC4 Name: Upper Henrys

Waterbody ID Number: SK005_03



Raw Data Graph (30 min Intervals)



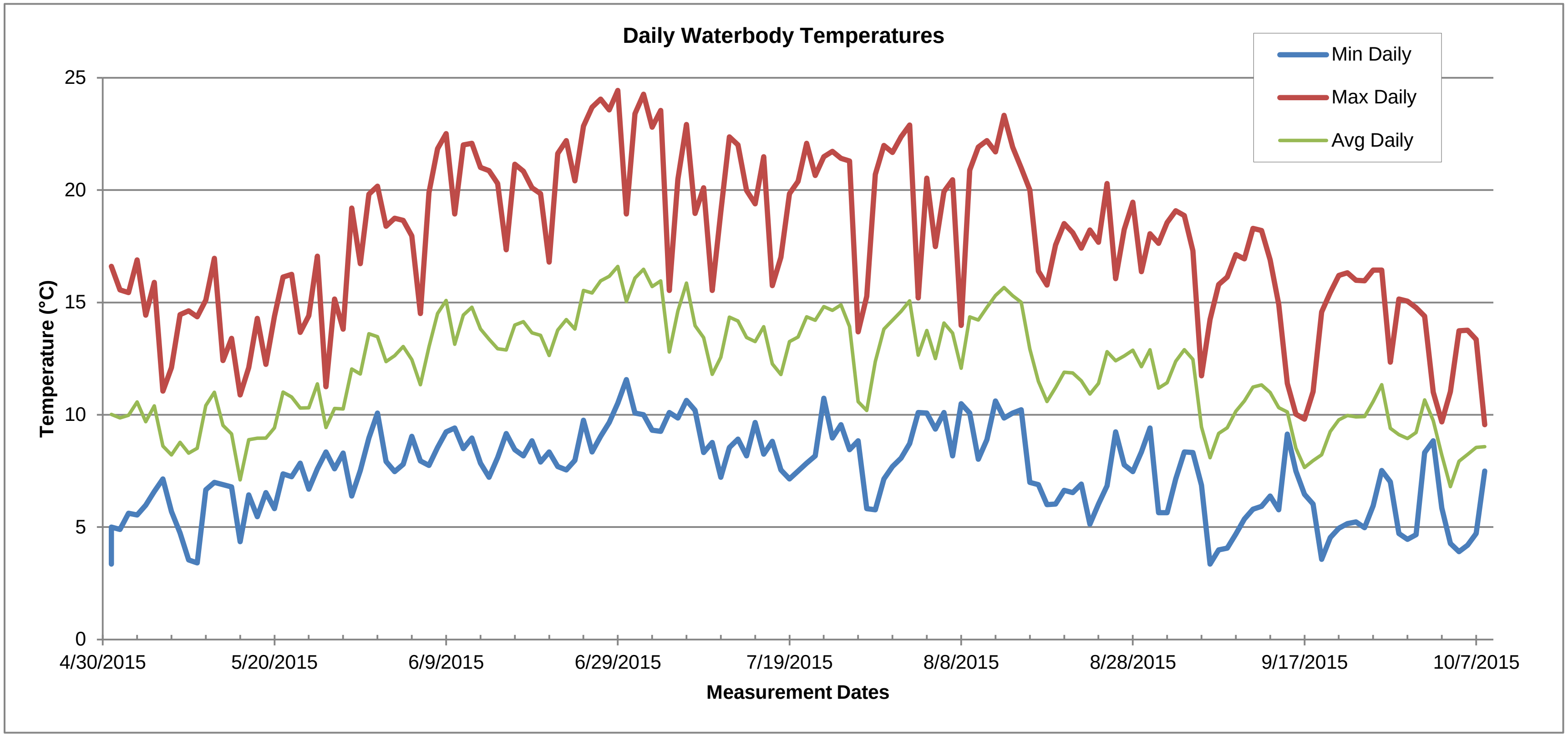
DEQ Summary of Temperature Data

Data Source: DEQ Idaho Falls Regional Office
Water Body: Warm River (QA Duplicate)
Data Collection Site: 44.25968, -111.29076
Data Period: 5/1/2015 – 10/8/2015
HOBO Logger ID: 10102536

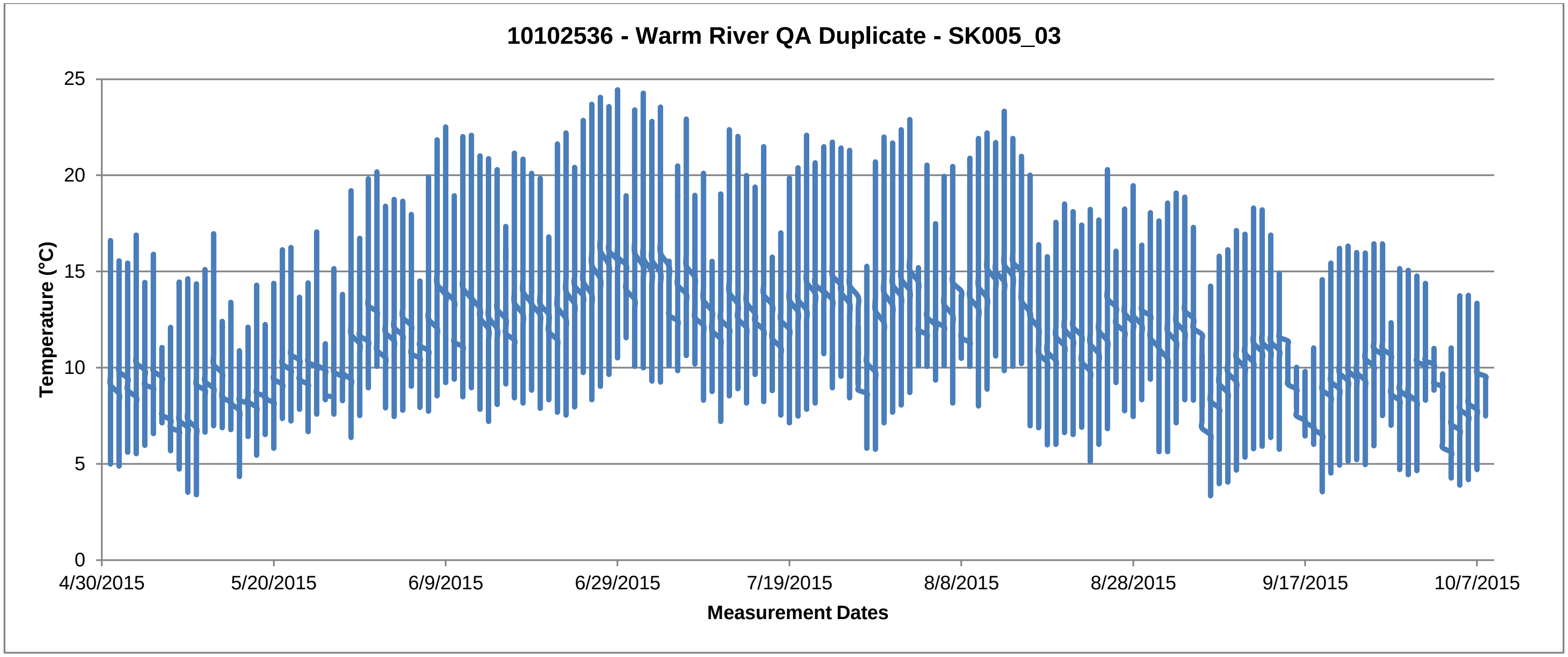
MDMT = 24.4, 29 June
MDAT = 16.6, 29 June

HUC4 Number: 17040202
HUC4 Name: Upper Henrys

Waterbody ID Number: SK005_03



Raw Data Graph (30 min Intervals)



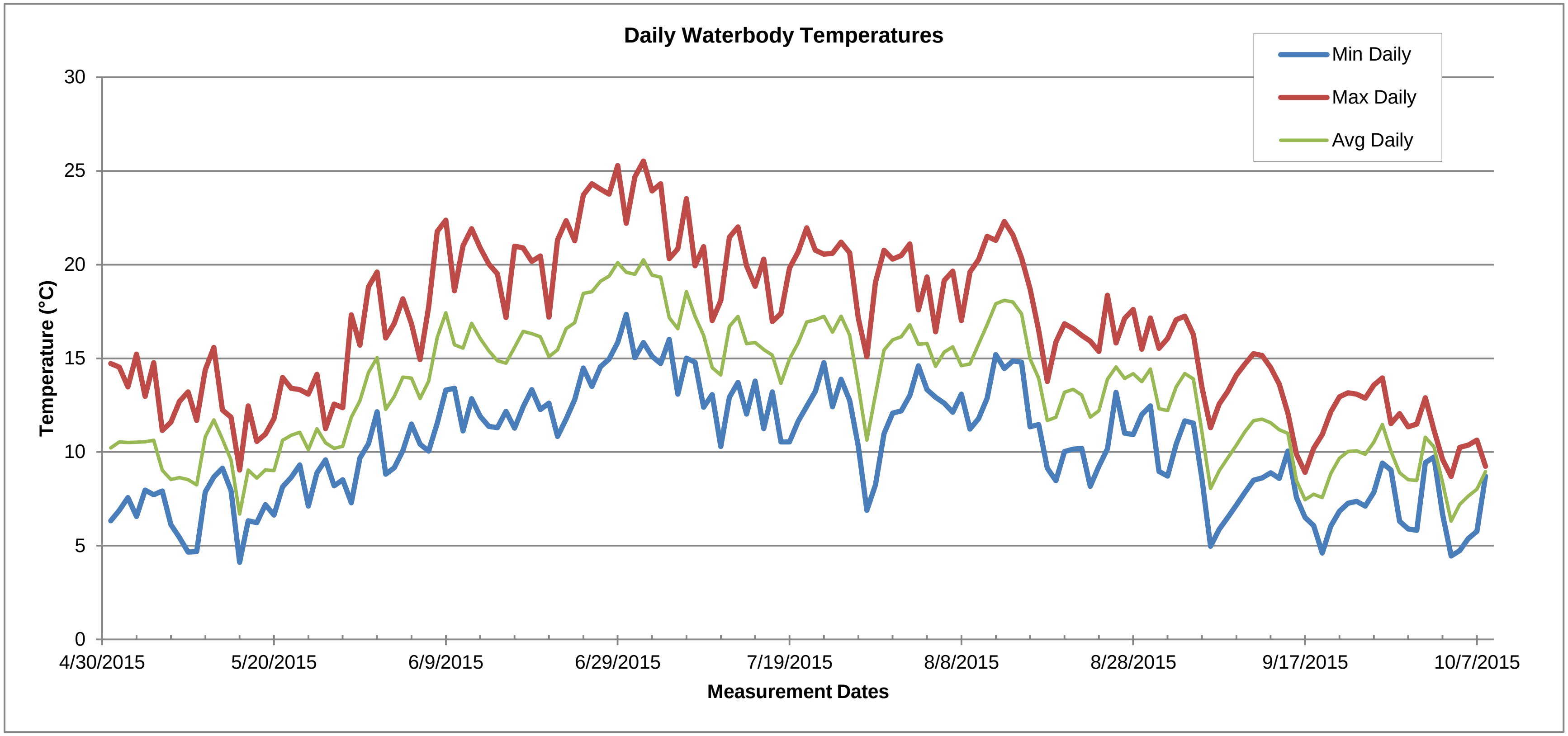
DEQ Summary of Temperature Data

Data Source: DEQ Idaho Falls Regional Office
Water Body: Warm River
Data Collection Site: 44.32170, -111.30547
Data Period: 5/1/2015 – 10/8/2015
HOBO Logger ID: 10685686

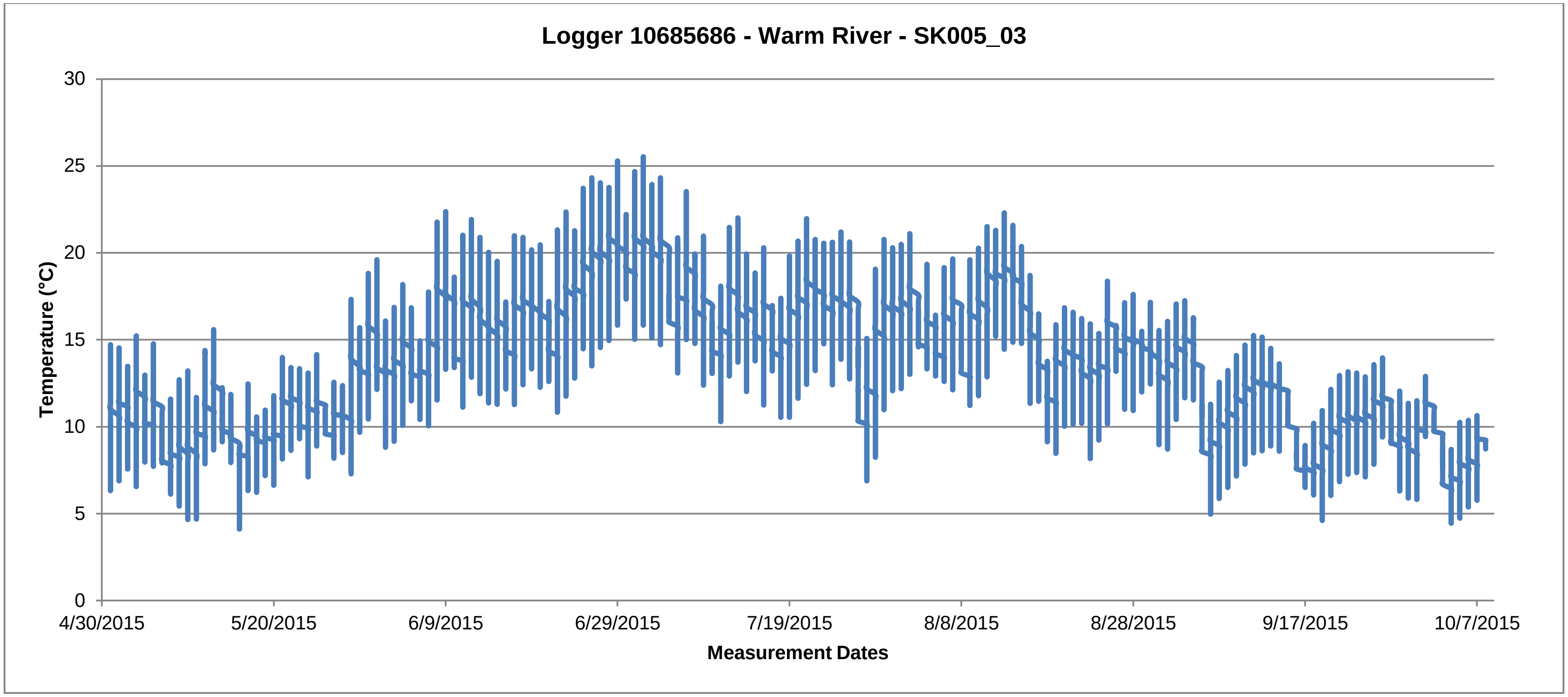
MDMT = 25.5, 02 July
MDAT = 20.3, 02 July

HUC4 Number: 17040202
HUC4 Name: Upper Henrys

Waterbody ID Number: SK005_03



Raw Data Graph (30 min Intervals)



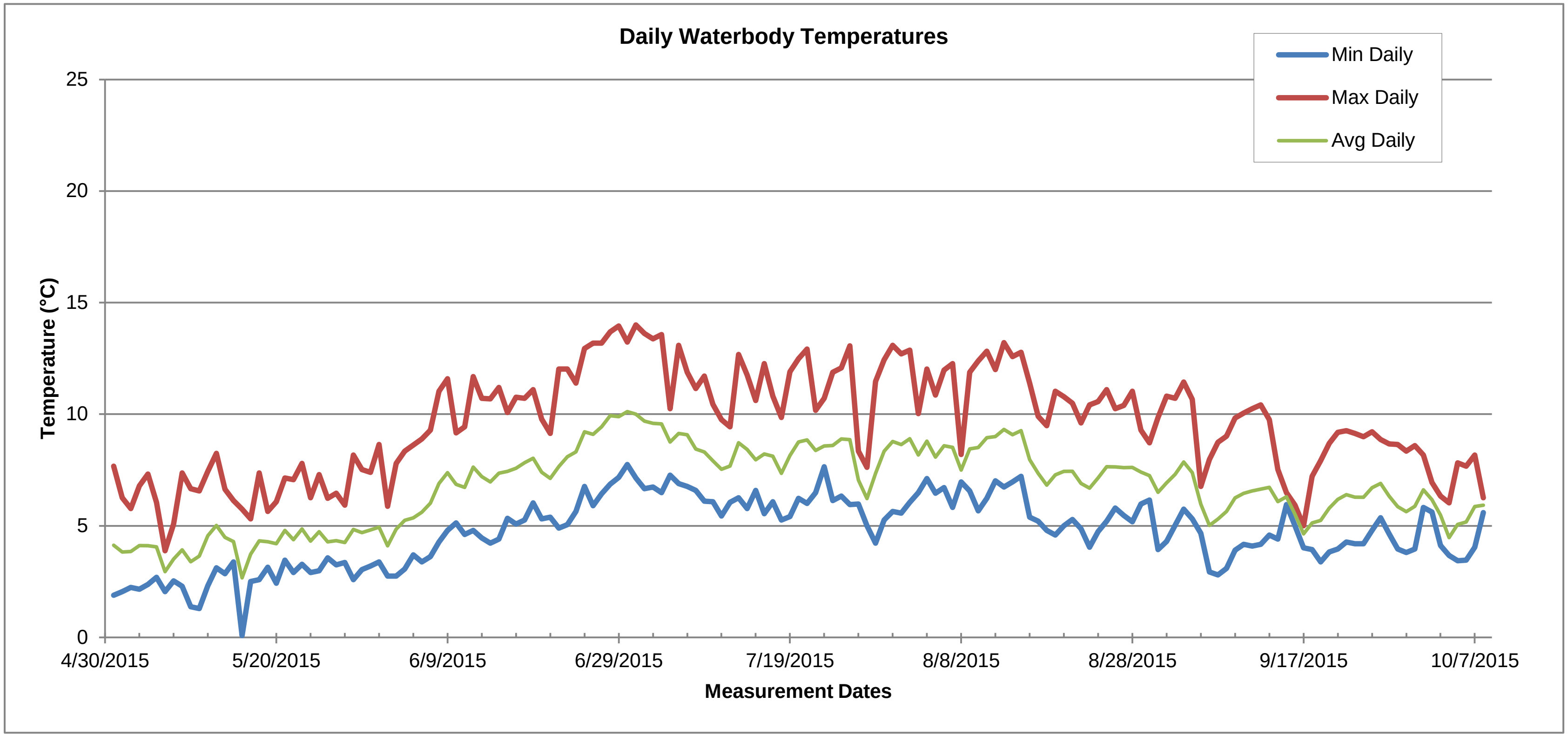
DEQ Summary of Temperature Data

Data Source: DEQ Idaho Falls Regional Office
Water Body: Targhee Creek
Data Collection Site: 44.67221, -111.31542
Data Period: 5/1/2015 – 10/8/2015
HOBO Logger ID: 10685678

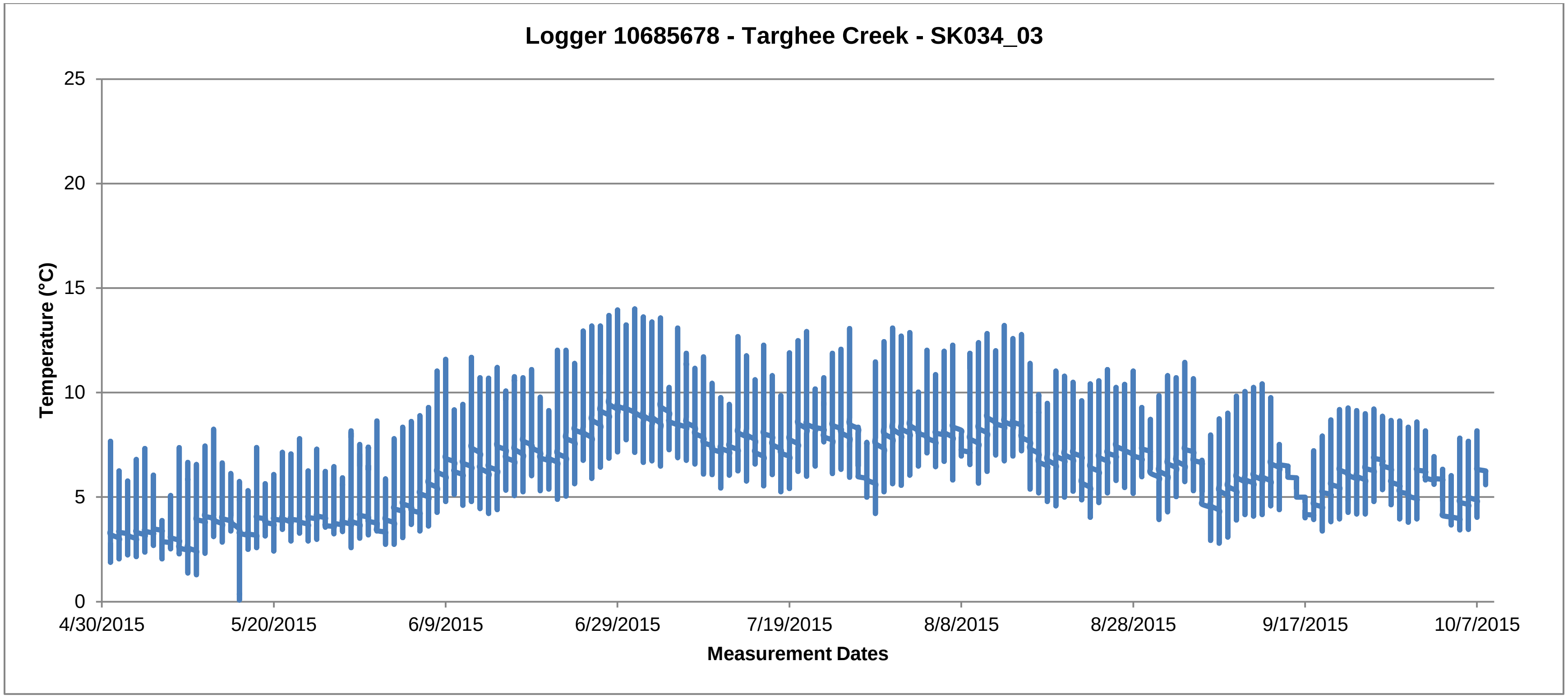
MDMT = 14, 01 July
MDAT = 10.1, 30 June

HUC4 Number: 17040202
HUC4 Name: Upper Henrys

Waterbody ID Number: SK034_03



Raw Data Graph (30 min Intervals)



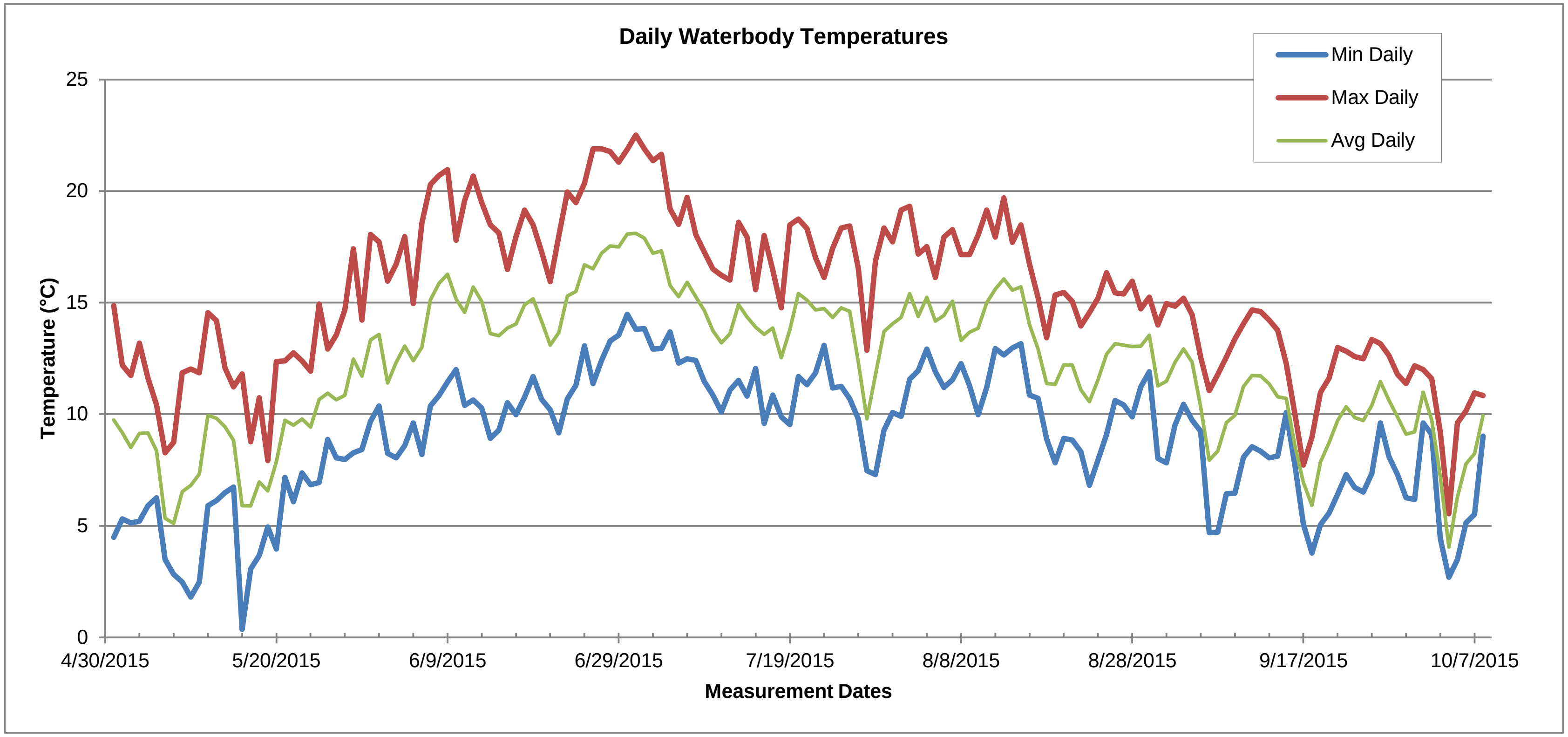
DEQ Summary of Temperature Data

Data Source: DEQ Idaho Falls Regional Office
Water Body: Timber Creek
Data Collection Site: 44.66932, -111.42786
Data Period: 5/1/2015 – 10/8/2015
HOBO Logger ID: 10685682

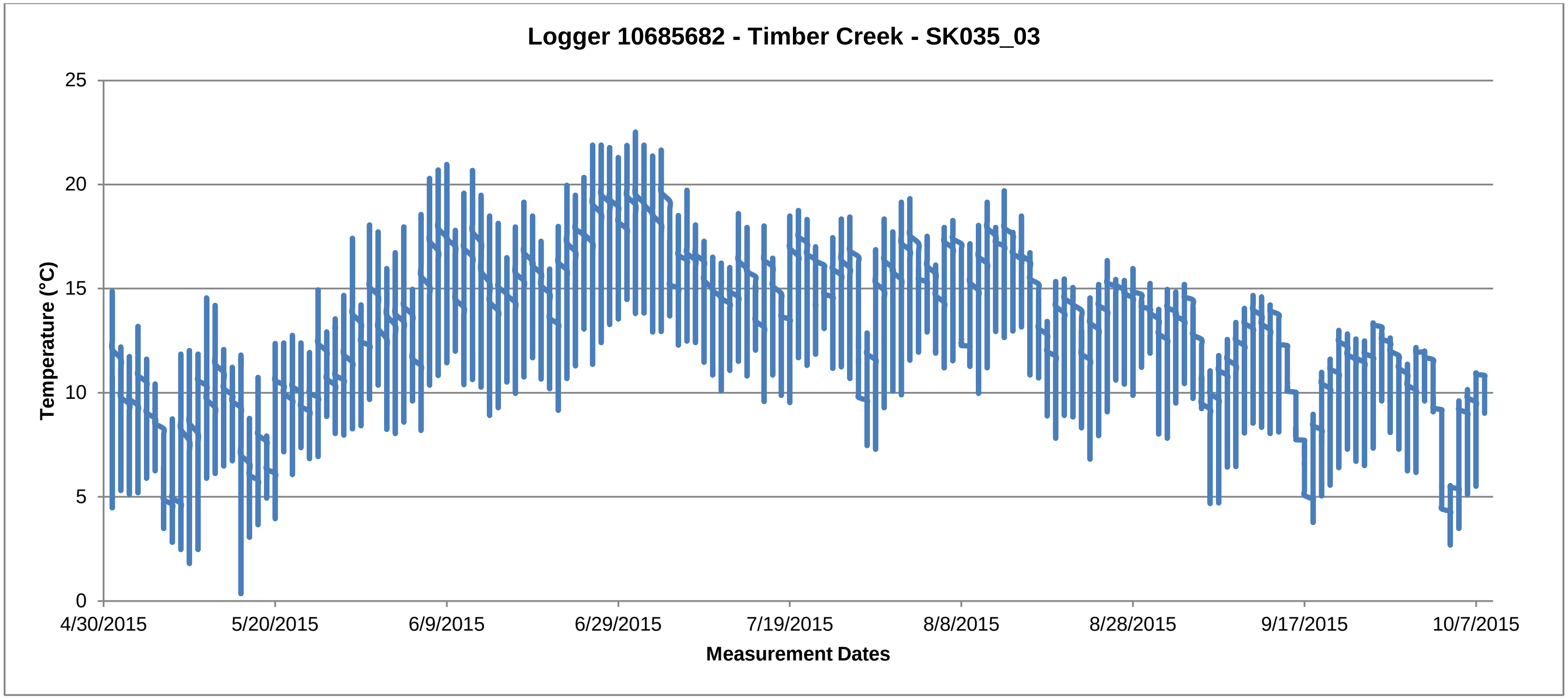
MDMT = 22.5, 01 July
MDAT = 18.1, 01 July

HUC4 Number: 17040202
HUC4 Name: Upper Henrys

Waterbody ID Number: SK035_03



Raw Data Graph (30 min Intervals)



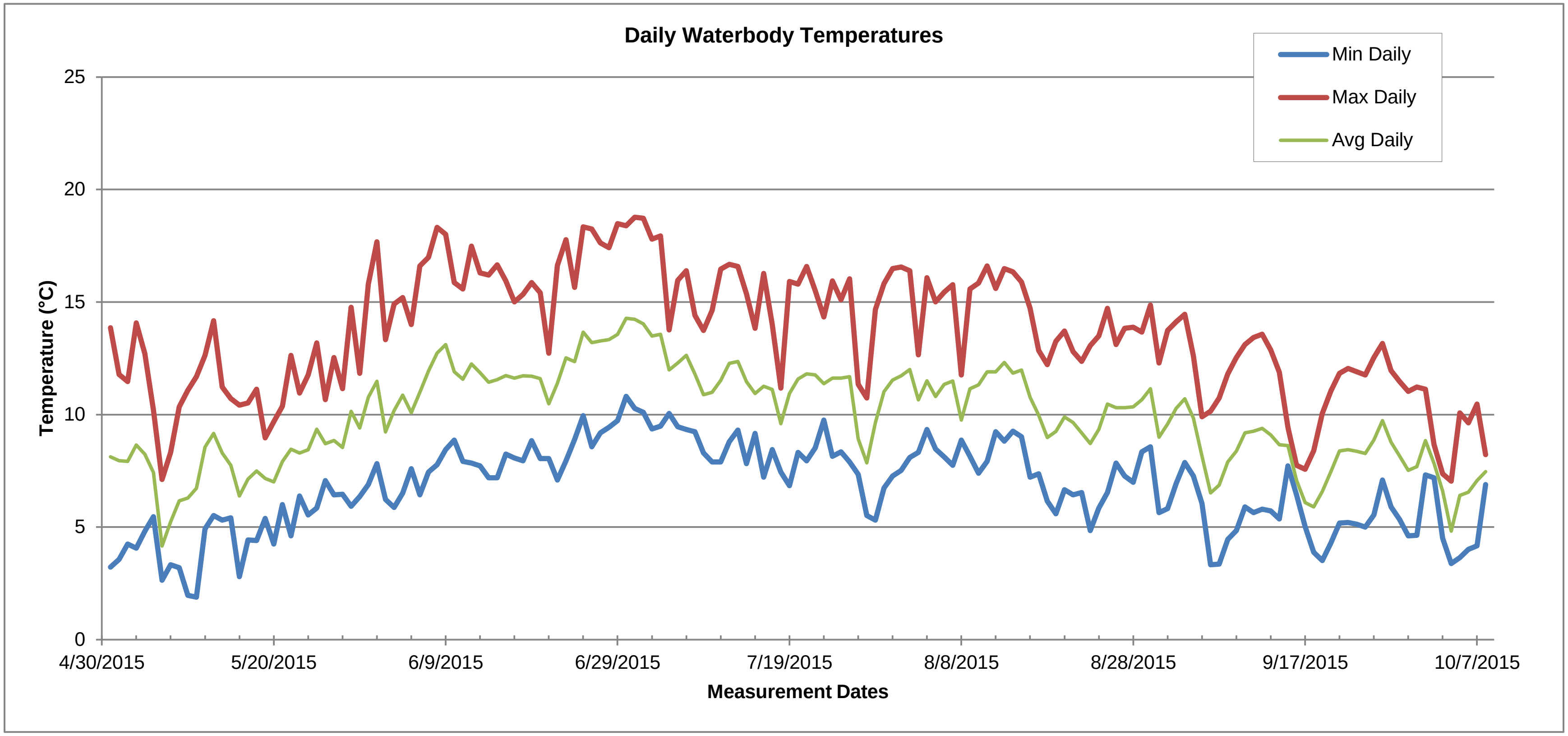
DEQ Summary of Temperature Data

Data Source: DEQ Idaho Falls Regional Office
Water Body: Duck Creek
Data Collection Site: 44.61352, -111.46002
Data Period: 5/1/2015 – 10/8/2015
HOBO Logger ID: 10349110

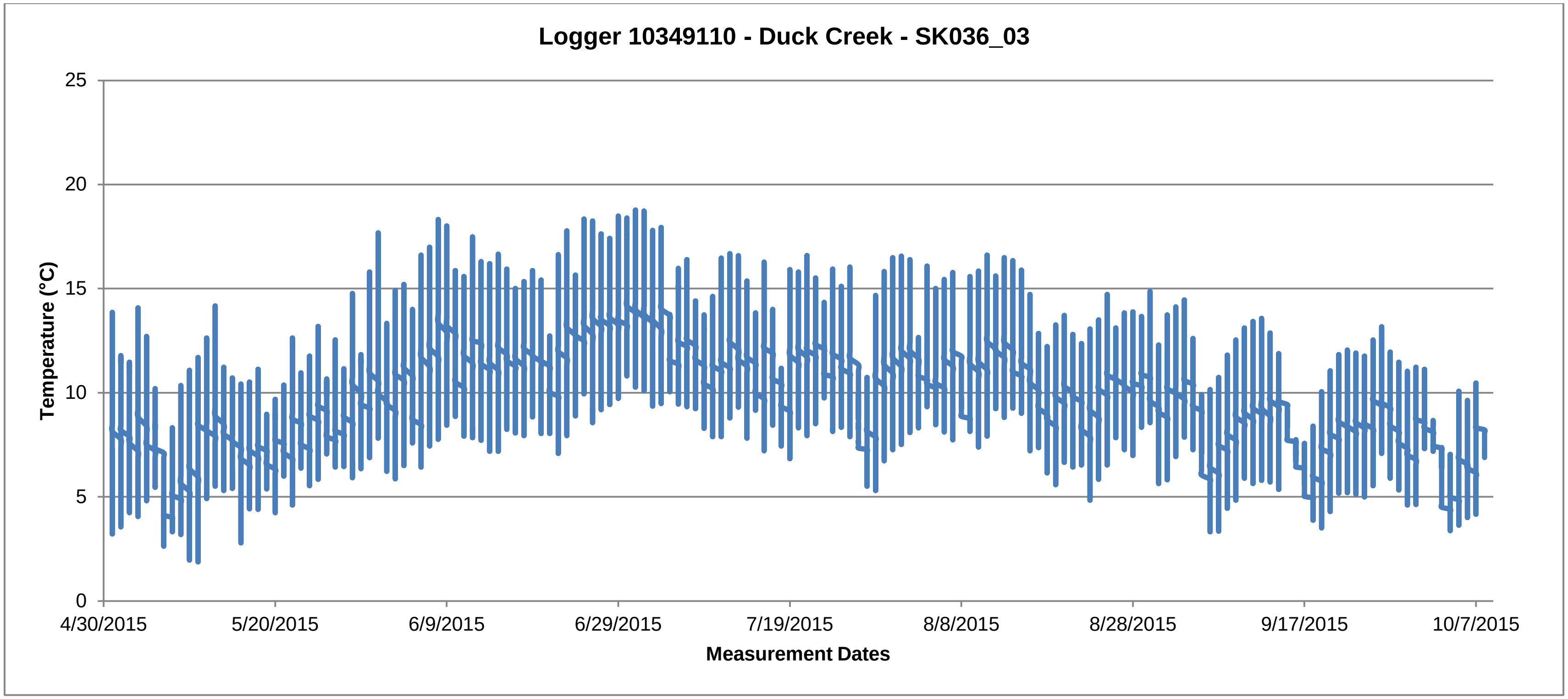
MDMT = 18.8, 01 July
MDAT =14.3, 30 June

HUC4 Number: 17040202
HUC4 Name: Upper Henrys

Waterbody ID Number: SK036_03



Raw Data Graph (30 min Intervals)



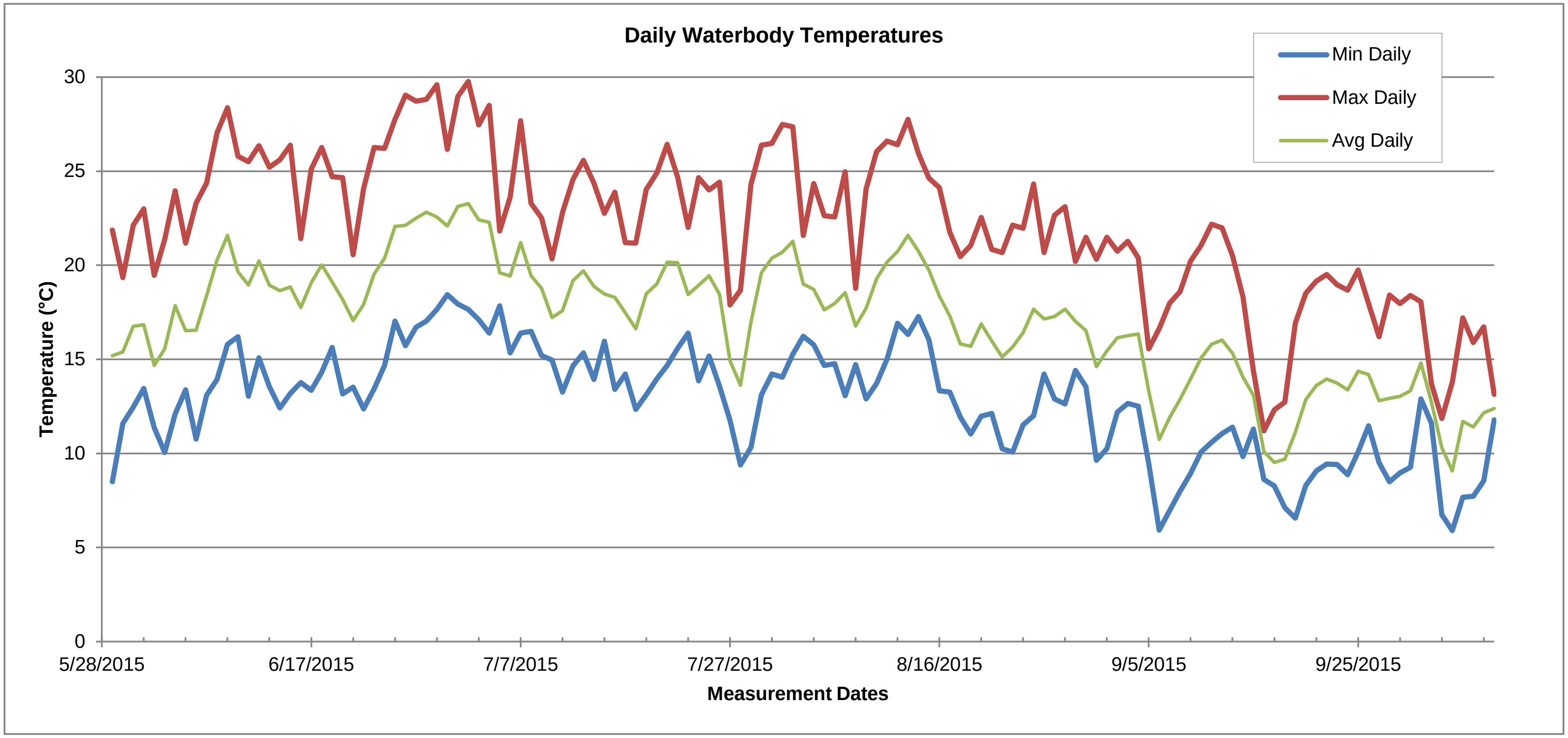
DEQ Summary of Temperature Data

Data Source: DEQ Idaho Falls Regional Office
Water Body: Sheridan Creek
Data Collection Site: 44.42580, -111.62812
Data Period: 5/29/2015 – 10/8/2015
HOBO Logger ID: 10685683

MDMT = 29.8, 02 July
MDAT = 23.3, 02 July

HUC4 Number: 17040202
HUC4 Name: Upper Henrys

Waterbody ID Number: SK045_03



Raw Data Graph (30 min Intervals)