Cascade Reservoir Watershed

TMDL Five-Year Review

Hydrologic Unit Code 17050123

State of Idaho
Department of Environmental Quality
February 2018

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Acknowledgments

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Abbreviations, Acronyms, and Symbols

§303(d)	refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
µ	micro, one-one thousandth
µS/cm	microsiemens per centimeter
AU	assessment unit
BMP	best management practice
C	Celsius
COLD	use designation for cold water aquatic life
CFR	Code of Federal Regulations
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
EPA	United States Environmental Protection Agency
EQIP	Environmental Quality Incentive Program
IDAPA	refers to citations of Idaho administrative rules
kg	kilograms
m	meter
mg/L	milligrams per liter
NTU	nephelometric turbidity unit
SEI	streambank erosion inventory
SpC	specific conductivity
TMDL	total maximum daily load
TP	total phosphorus
US	United States
WAG	watershed advisory group
WLA	wasteload allocation

Executive Summary

The federal Clean Water Act requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to §303 of the Clean Water Act, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the Clean Water Act establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards).

States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently, this list is published every 2 years as the list of Category 5 water bodies in Idaho's Integrated Report (DEQ 2017). For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants set at a level to achieve water quality standards. This document reviews the water bodies within the Cascade Reservoir watershed in Category 4a of Idaho's most recent federally approved Integrated Report (DEQ 2017). This 5-year review has been developed to comply with Idaho Code §39-3611(7). The review describes the existing TMDLs, beneficial use support status, current water quality data, and pollution control actions in the Cascade Reservoir watershed located in west central Idaho. Table A shows the TMDLs subject to 5-year review.

Table A. Assessment units and pollutants for water bodies in Category 4a of Idaho's 2014 Integrated Report (DEQ 2017).

Water Body	Assessment Unit	Pollutants
Boulder Creek	ID17050123SW011_03	TP, sediment
Boulder/Willow Creek	ID17050123SW011_02	TP
West Mountain tributaries	ID17050123SW007_02	TP
Cascade Reservoir	ID17050123SW007L_0L	TP, pH
Gold Fork River	ID17050123SW007_05	TP, pH
Gold Fork River	ID17050123SW008_05	TP
Gold Fork River	ID17050123SW008_05a	TP, sediment
Mud Creek	ID17050123SW015_02	TP, sediment
Mud Creek	ID17050123SW015_03	TP, sediment

Subbasin at a Glance

Cascade Reservoir is located in the North Fork Payette River subbasin (HUC 17050123) in west central Idaho (Figure A). Major tributaries to the reservoir include the North Fork Payette River, Mud Creek, Lake Fork, Boulder Creek, Willow Creek, and Gold Fork River, all which discharge into the northern end of the reservoir. The overall watershed is divided into separate subwatersheds based on drainage areas to these tributaries. In addition, the West Mountain subwatershed drains into the west side of the reservoir. As listed in the Phase II TMDL, 12 subwatersheds are located within the Cascade Reservoir watershed, seven of which drain into the Cascade Reservoir (DEQ 1998).

The Cascade Reservoir watershed is located in a moderately high elevation valley between the West Mountain and the Salmon River Mountains. The area of direct drainage to Cascade Reservoir included in this watershed management plan covers approximately 276,000 acres. Much of the watershed is steeply sloped forestland, while the area immediately adjacent to the reservoir and major tributaries is predominately shallow-sloped agricultural land. The valley floor and reservoir elevation is approximately 4,850 feet.

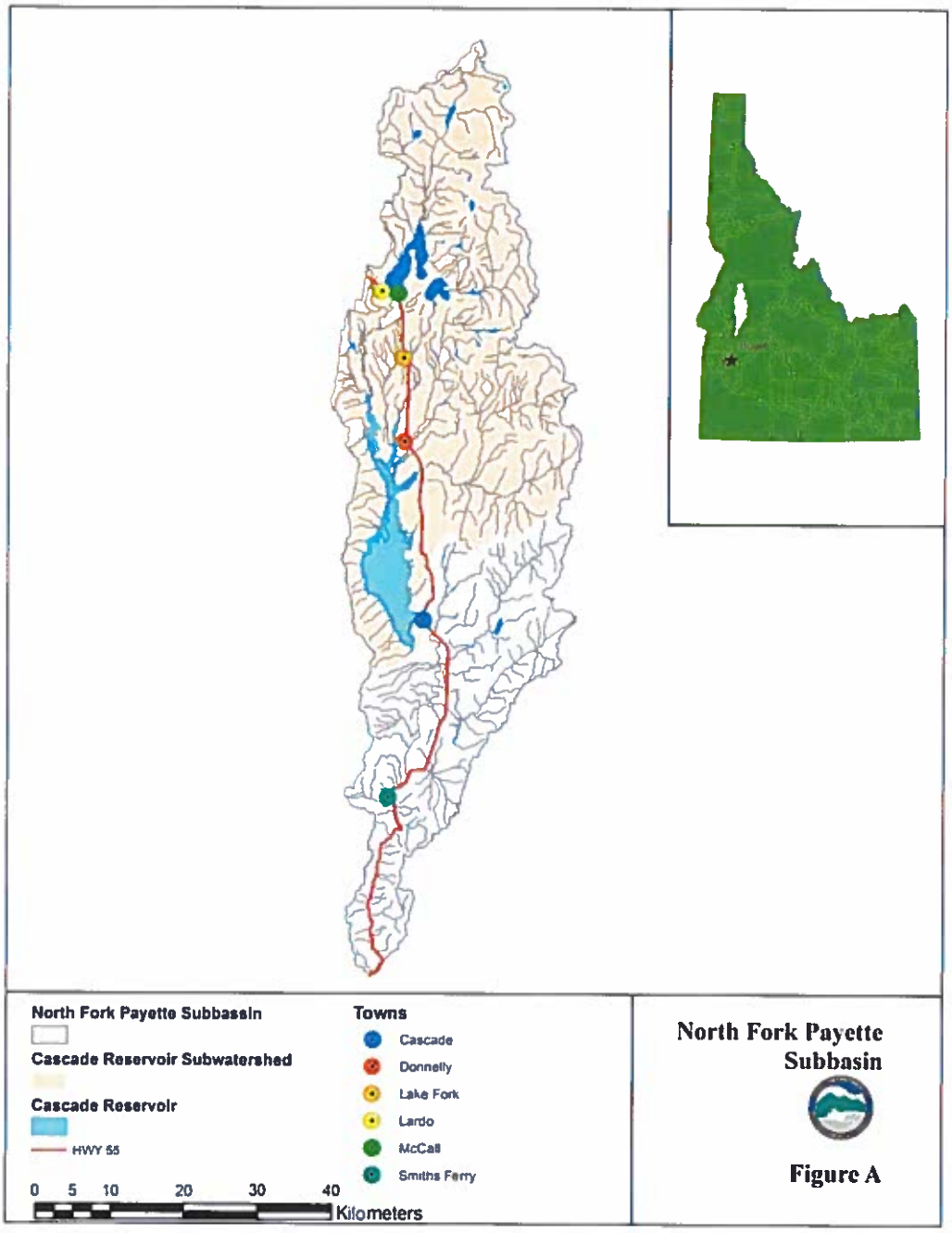

Figure A. North Fork Payette River subbasin.

In Idaho's most recently approved Integrated Report (DEQ 2017), nine assessment units (AUs) have total phosphorus (TP) TMDLs and four AUs have sediment TMDLs in the Cascade Reservoir watershed (Table B). The original TMDLs for TP were developed for Cascade Reservoir and its major tributaries in 1996 and 1998. The *Cascade Reservoir Watershed Phase III Water Quality Management Plan and TMDL Five-Year Review* (DEQ 2009) identified impairments caused by excess sediment. Sediment TMDLs were developed in 2011 to address the sediment-caused impairments.

Key Findings

Cascade Reservoir was placed on the 1994 §303(d) list of impaired waters for reasons associated with excessive algal growth and violations of the state's dissolved oxygen and pH criteria. In 1993 and 1994, excessive algal growth impacted all beneficial uses of Cascade Reservoir. In 1996 and 1998, the Idaho Department of Environmental Quality (DEQ) developed TP TMDLs to reduce primary productivity and increase dissolved oxygen concentrations in Cascade Reservoir. The 1996 TP TMDL developed wasteload allocations for point sources and load allocations for nonpoint sources in the Cascade Reservoir. Reducing TP loads by 37% was required to meet the wasteload allocations and load allocations of the original TP TMDL. Since developing the original TP TMDLs, point sources of TP have been eliminated or greatly reduced through the National Pollutant Discharge Elimination System permitting process.

During the 2009 Cascade Reservoir watershed 5-year review, DEQ recommended developing sediment TMDLs on Boulder Creek, Gold Fork River, and Mud Creek due to low Beneficial Use Reconnaissance Program (BURP) scores. In 2011, DEQ developed the *Cascade Reservoir Tributary TMDL Addendum* (DEQ 2011) to address excess sediment loads to the sediment-impaired streams. The 2011 TMDL sediment addendum set targets for bank stability of 80% or greater.

This 5-year review only reviews current Category 4a-listed water bodies. Other water bodies in the Cascade Reservoir watershed listed in Category 5 will be addressed in future TMDL addendums. Figure B illustrates all Category 4a-listed water bodies addressed in the document, and Table B summarizes assessment outcomes.

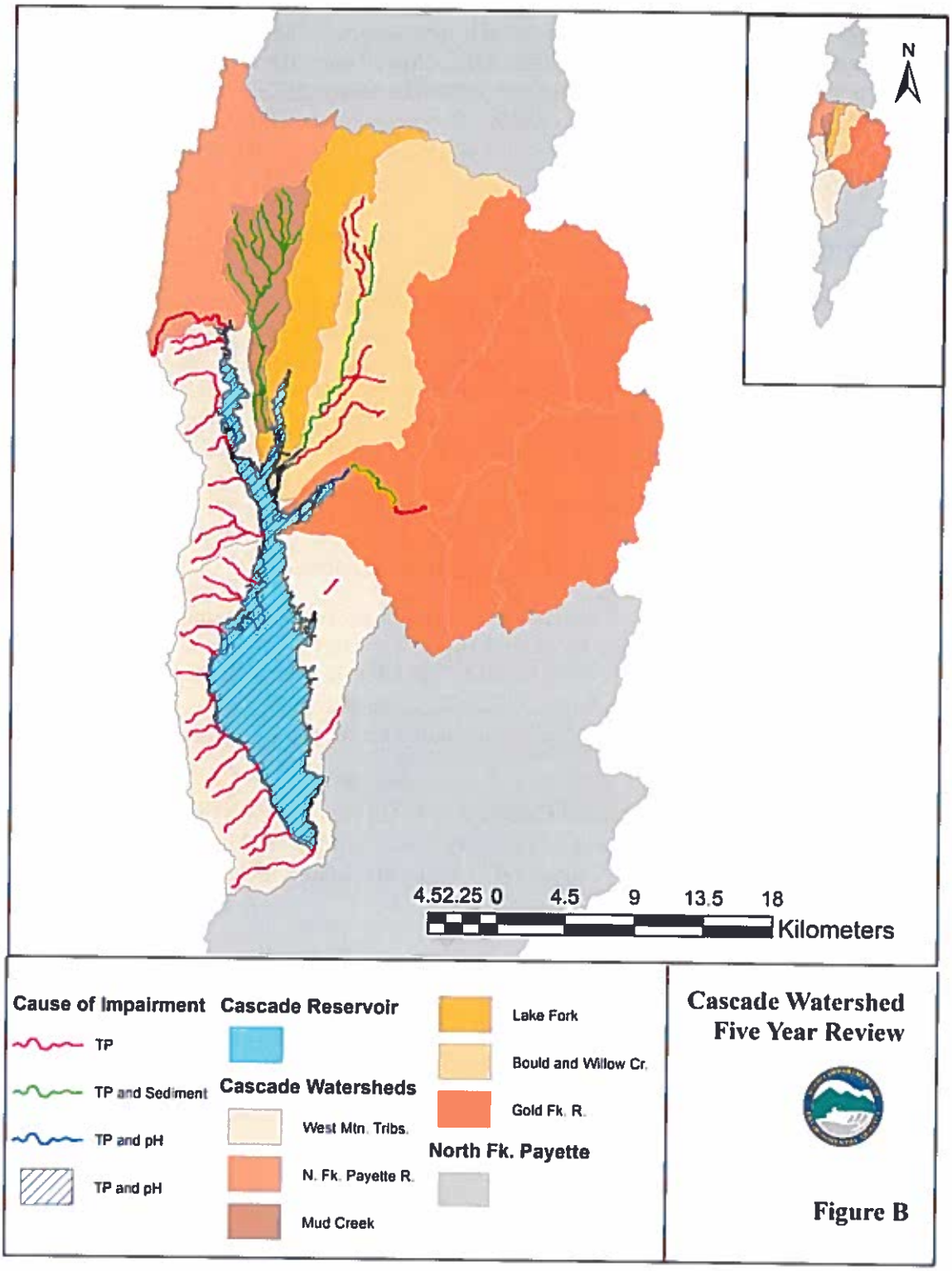

Figure B. Cascade Reservoir watershed Category 4a listings.

Table B. Summary of assessment outcomes for Category 4a-listed assessment units.

Assessment Unit Name	Assessment Unit Number	Pollutants	Recommended Changes to Next Integrated Report	Justification
Boulder Creek—3rd order (Louis Creek to mouth)	ID17050123SW011_03	TP, sediment	Remain in Category 4a	Excess nutrient and sediment load
Boulder/Willow Creek—1st and 2nd order irrigated sections	ID17050123SW011_02	TP	Remain in Category 4a	Excess nutrient load
Cascade Reservoir	ID17050123SW007L_0L	TP, pH	Remain in Category 4a	Excess nutrient load
Gold Fork—upper 5th order, above Gold Fork Ditch	ID17050123SW008_05	TP	Remain in Category 4a	Excess nutrient load
Gold Fork, 5th order, between high and low water lines	ID17050123SW007_05	TP, pH	Remain in Category 4a	Excess nutrient load
Gold Fork—lower 5th order, below Gold Fork Ditch	ID17050123SW008_05a	TP, sediment	Remain in Category 4a	Excess nutrient and sediment load
Mud Creek—1st and 2nd order	ID17050123SW015_02	TP, sediment	Remain in Category 4a	Excess nutrient and sediment load
Mud Creek—3rd order (Norwood to Reservoir)	ID17050123SW015_03	TP, sediment	Remain in Category 4a	Excess nutrient and sediment load
West Mountain tributaries to Cascade Reservoir[a]	ID17050123SW007_02	TP	Remain in Category 4a	Excess nutrient load

[a]Poison Creek

Public Participation

This 5-year review was developed with participation from the North Fork Payette River Watershed Advisory Group (WAG).

1 Introduction

This document reviews nine assessment units (AUs) in the Cascade Reservoir watershed placed in Category 4a of Idaho's most recent federally approved Integrated Report (DEQ 2017). This review examines water quality conditions of the Category 4a water bodies, compares current water quality conditions to the goals of the total maximum daily loads (TMDLs) for each AU, and examines implementation activities in the Cascade Reservoir watershed. This document also provides information that satisfies the requirements of a 5-year review of the original TMDL.

1.1 Regulatory Requirements

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

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

The Clean Water Act requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to §303 of the Clean Water Act, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. DEQ must review those standards every 3 years, and EPA must approve Idaho's water quality standards. Idaho adopts water quality standards to protect public health and welfare, enhance water quality, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

Section 303(d) of the Clean Water Act establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently, this list is published every 2 years as the list of Category 5 waters in Idaho's Integrated Report. For waters identified on this list, states and tribes must develop a TMDL for the pollutants set at a level to achieve water quality standards.

DEQ monitors waters, and for those not meeting water quality standards, DEQ must establish a TMDL for each pollutant impairing the waters. However, some conditions that impair water quality do not require TMDLs. EPA considers certain unnatural conditions—such as flow

alteration, human-caused lack of flow, or habitat alteration—that are not the result of discharging a specific pollutant as "pollution." TMDLs are not required for water bodies impaired by pollution rather than a specific pollutant. A TMDL is only required when a pollutant can be identified and in some way quantified.

2 Watershed Assessment—Watershed Characterization

The Cascade Reservoir watershed is located in the North Fork Payette River subbasin of west central Idaho. Major tributaries to the reservoir include the North Fork Payette River, Mud Creek, Lake Fork, Boulder Creek, Willow Creek, and Gold Fork River, all which drain into the northern end of the reservoir (Figure 1). The Cascade Reservoir watershed is located in a moderately high elevation valley between West Mountain and the Salmon River Mountains. The area directly draining to the Cascade Reservoir is approximately 276,000 acres. The water bodies in the Cascade Reservoir watershed have historically been impacted by anthropogenic activities related to agriculture, forestry, and urbanization. Figure 2 shows the North Fork Payette River subbasin and the location of Cascade Reservoir and surrounding towns. For more information on the physical, biological, and cultural characteristics of the subbasin, see the previous 5-year review (DEQ 2009).

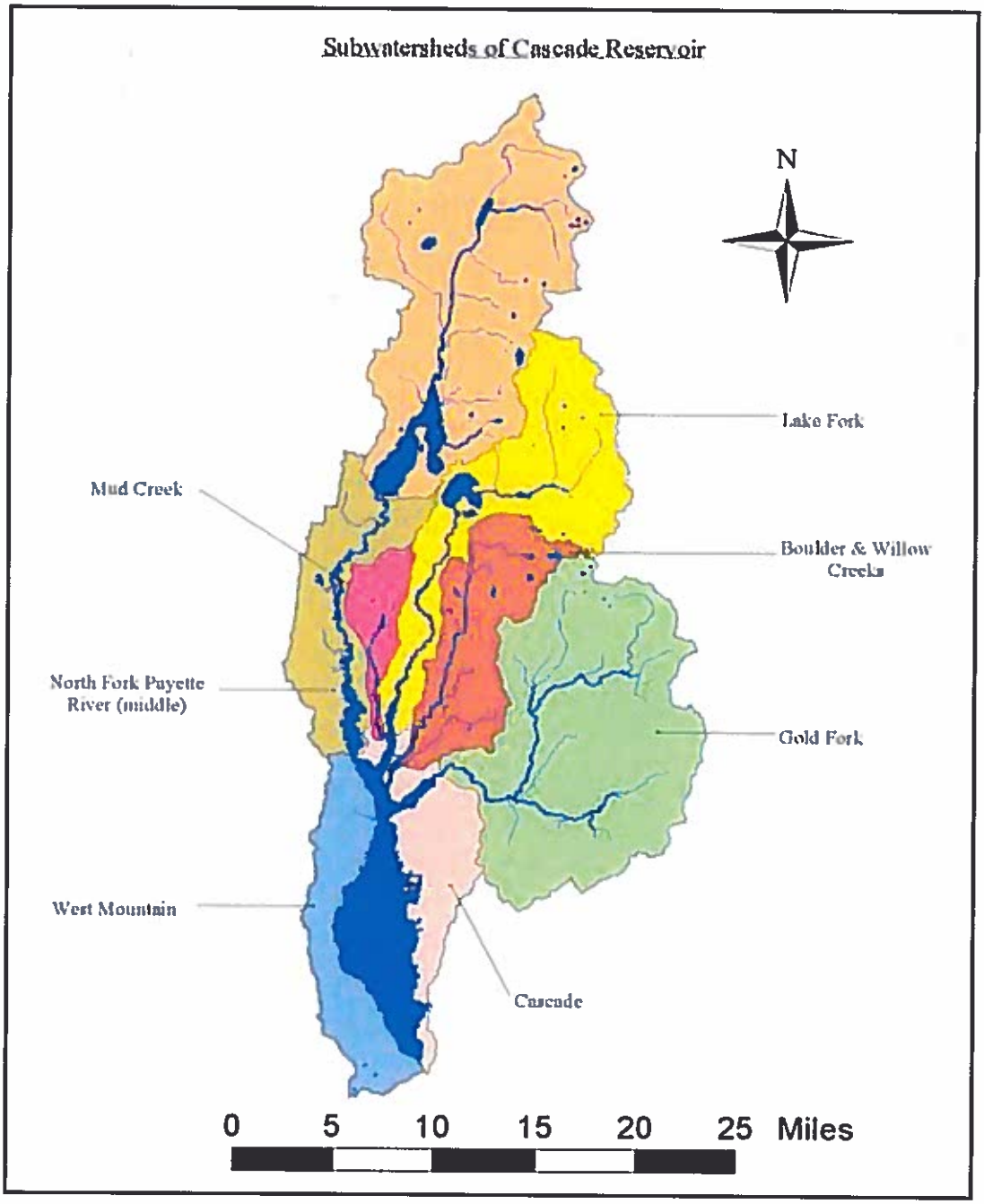

Figure 1. Subwatersheds of Cascade Reservoir (DEQ 2009).

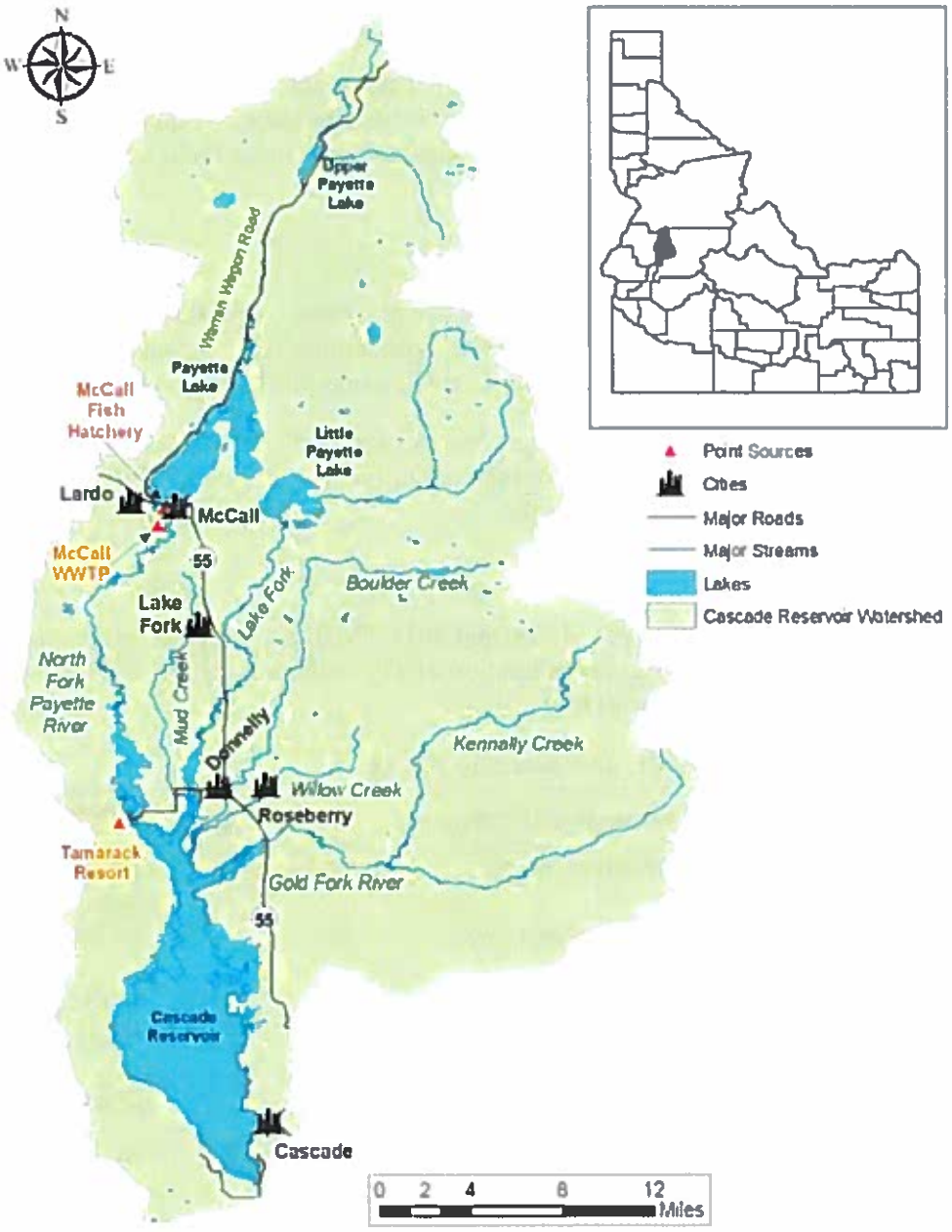

Figure 2. Cascade Reservoir location (DEQ 2009).

3 TMDL 5-Year Review and Status

This section covers the AUs occurring in the Cascade Reservoir watershed and applicable water quality standards and beneficial uses. It also includes a summary and analysis of existing water quality data.

3.1 Water Quality Limited Assessment Units Occurring in the Watershed

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

3.1.1 Assessment Units

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

Using AUs 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.

3.1.2 Listed Waters

Table 1 shows the AUs addressed in the 1996, 1998, and 2011 TMDLs and TMDL addendum (DEQ 1996, 1998, 2011). The waters have a combination of TP, sediment, and pH TMDLs and are in Category 4a of the Integrated Report (DEQ 2017).

Table 1. Cascade Reservoir watershed AUs addressed by TMDLs.

Assessment Unit Name	Assessment Unit Number	Listed Pollutants	Associated TMDLs
Boulder Creek—3rd order (Louie Creek to mouth)	ID17050123SW011_03	TP, sediment	TP: 1996 Sediment: 2011
Boulder/Willow Creek—1st and 2nd order irrigated sections	ID17050123SW011_02	TP	TP: 1996
Cascade Reservoir	ID17050123SW007L_0L	TP, pH	TP and pH: 1998
Gold Fork—upper 5th order, above Gold Fork Ditch	ID17050123SW008_05	TP	TP: 1996
Gold Fork, 5th order, between high and low water lines	ID17050123SW007_05	TP, pH	TP and pH: 1998
Gold Fork—lower 5th order, below Gold Fork Ditch	ID17050123SW008_05a	TP, sediment	TP: 1998 Sediment: 2011
Mud Creek—1st and 2nd order	ID17050123SW015_02	TP, sediment	TP: 1996 Sediment: 2011
Mud Creek—3rd order (Norwood to Reservoir)	ID17050123SW015_03	TP, sediment	TP: 1996 Sediment: 2011
West Mountain tributaries to Cascade Reservoir[a]	ID17050123SW007_02	TP	TP: 1996

[a]Poison Creek

3.2 Applicable Water Quality Standards and Beneficial Uses

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

Beneficial uses include the following:

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

3.2.1 Beneficial Uses in the Watershed

Cascade Reservoir and Gold Fork River are designated for salmonid spawning and cold water aquatic life along with primary contact recreation and drinking water supply. Boulder Creek, Willow Creek, Mud Creek, and the West Mountain tributaries do not have any use designations and are therefore protected for the presumed uses of cold water aquatic life and secondary contact recreation. Table 2 contains designated and presumed uses for all Category 4a water bodies in the Cascade Reservoir watershed.

Table 2. Cascade Reservoir watershed beneficial uses of Category 4a-listed water bodies.

Assessment Unit Name	Assessment Unit Number	Beneficial Uses	Type of Use
Boulder Creek—3rd order (Louie Creek to mouth)	ID17050123SW011_03	COLD, SCR	Presumed
Boulder/Willow Creek—1st and 2nd order irrigated sections	ID17050123SW011_02	COLD, SCR	Presumed
Cascade Reservoir	ID17050123SW007L_0L	SS, COLD, PCR, DWS	Designated
Gold Fork River—upper 5th order, above Gold Fork Ditch	ID17050123SW008_05	SS, COLD, PCR, DWS	Designated
Gold Fork River, 5th order, between high and low water lines	ID17050123SW007_05	SS, COLD, PCR, DWS	Designated
Gold Fork River—lower 5th order, below Gold Fork Ditch	ID17050123SW008_05a	SS, COLD, PCR, DWS	Designated
Mud Creek—1st and 2nd order	ID17050123SW015_02	COLD, SCR	Presumed
Mud Creek—3rd order (Norwood to Reservoir)	ID17050123SW015_03	COLD, SCR	Presumed
West Mountain tributaries to Cascade Reservoir	ID17050123SW007_02	COLD, SCR	Presumed

[a] Cold water (COLD), salmonid spawning (SS), primary contact recreation (PCR), secondary contact recreation (SCR), domestic water supply (DWS)

3.2.2 Water Quality Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of water quality criteria, which include *numeric* criteria for pollutants such as bacteria, dissolved oxygen (DO), pH, ammonia, temperature, and turbidity, and *narrative* criteria for pollutants such as sediment and nutrients (IDAPA 58.01.02.250–251) (Table 3).

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

Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning
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	—	—
Temperature	—	—	22 °C or less daily maximum; 19 °C or less daily average[c]	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[a c]
Turbidity	—	—	Turbidity shall not exceed background by more than 50 nephelometric turbidity units (NTUs) instantaneously or more than 25 NTUs for more than 10 consecutive days.	—
Dissolved oxygen (DO)	—	—	DO concentrations exceeding 6 milligrams per liter (mg/L) at all times. In lakes and reservoirs, this standard does not apply to the bottom 20% of water depth in natural lakes and reservoirs where depths are 35 meters or less. The bottom 7 meters of water depth in natural lakes and reservoirs where depths are greater than 35 meters. Those waters of the hypolimnion in stratified lakes and reservoirs.	—
pH	—	—	Hydrogen ion concentration (pH) values within the range of 6.5 to 9.0	—

Note: Degrees Celsius (°C)

[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 90th 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 (IDAPA 58.01.02.080.03).

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.050.02. The procedure relies heavily upon biological parameters and is presented in detail in the *Water Body Assessment Guidance* (DEQ 2016, or previous editions). This guidance requires DEQ to use the most complete data available to make beneficial use support status determinations.

3.3 Summary and Analysis of Existing Water Quality Data

DEQ began routine reservoir monitoring in 1989 and increased in frequency with the recognition of harmful algal blooms (HABs) in 1993. From 1993 to 2003 and 2007 to 2008, monthly samples were collected on Cascade Reservoir and its major tributaries. Sampling included TP, chlorophyll *a,* DO, and pH. Monthly sampling continued after 2008 and included multiple years leading up to this 5-year review. Since 1993, Cascade Reservoir sampling shows a small decrease in average TP, and a significant decrease in average chlorophyll *a* concentrations. Additionally, the tributaries to the reservoir have shown little to no change in average TP since 1993.

3.3.1 Cascade Reservoir TMDL Targets

Table 4 shows the target concentrations for TP, chlorophyll *a*, DO, and pH identified in the original TMDLs (DEQ 1996, 1998) to meet applicable water quality standards in the Cascade Reservoir watershed. To attain and protect water quality within the watershed, numeric targets for nutrients and chlorophyll *a* were identified and load reductions required to meet these targets were determined. The findings from the Phase I and II TMDLs (DEQ 1996, 1998) showed that TP was the nutrient of concern for the reservoir. Attaining these targets will likely support beneficial uses within the reservoir and tributary segments and will contribute to attaining beneficial use support in the Cascade Reservoir watershed. Additionally, attaining TP and chlorophyll *a* targets will help achieve DO and pH criteria.

Targets for the tributaries with TMDLs (West Mountain tributaries, Gold Fork River, Mud Creek, and Boulder Creek) were never explicitly defined in the Cascade Reservoir TMDLs (DEQ 2009). The reservoir target of 0.025 milligrams per liter (mg/L) of TP is being used for the tributaries, and the TP target and pH criteria are being used for the West Mountain tributaries.

Table 4. Targets for Cascade Reservoir.

Pollutant	Concentration Target
Dissolved oxygen	Greater than 6.0 mg/L, except in hypolimnion stratified lakes and reservoirs and the bottom 20% of water depth in lakes and reservoirs with less than 35 meters in depth (IDAPA 58.01.02 250.02.a).
Nutrients	Surface waters shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses. No greater than 0.025 mg/L TP in-reservoir water column concentration (IDAPA 58.01.02.200.06 [narrative] and target established by the Phase I and II TMDL [numeric] DEQ, 1996 and 1998). Chlorophyll *a* in-reservoir water column concentration no greater than 10 µg/L (target established by the Phase I and II TMDL [numeric] DEQ, 1996 and 1998).
pH	No less than 6.5 and no greater than 9.0 standard units (IDAPA 58.01.02. 250.01.a).

Note: micrograms per liter (µg/L)

3.3.2 Sediment Addendum TMDL Targets

The *Cascade Reservoir Tributary TMDL Addendum* (DEQ 2011) established sediment targets for Boulder Creek, Gold Fork River, and Mud Creek. Sediment targets were selected to accomplish the narrative criteria for Idaho's "Water Quality Standards":

> Sediment: Sediment shall not exceed quantities specified in Sections 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Section 350. (IDAPA 58.01.02. 200.08)

When the sediment addendum was developed in 2011, the state of science was not precise enough to estimate the sediment load that would translate into characteristics known to support beneficial uses for cold water aquatic life and salmonid spawning and meet Idaho's narrative criterion for sediment (DEQ 2011). Since estimating a sediment load that would support Idaho's narrative criterion was not feasible, a bank stability target was used as a surrogate for sediment load (i.e., the lower the bank stability, the higher the sediment load). The 2011 sediment TMDL addendum established an 80% bank stability target, which correlates to natural background sediment loading (Overton et al. 1995). Table 5 shows TMDL targets for each Category 4a AU in the Cascade Reservoir watershed.

Table 5. Cascade Reservoir watershed TMDL targets.

Assessment Unit Name	Assessment Unit Number	Pollutant	Numeric Target	Critical Period
Boulder Creek—3rd order (Louie Creek to mouth)	ID17050123SW011_03	TP	TP ≤0.025 mg/L	May–September
		Sediment	80% bank stability or 0.62 tons per day	Year round
Boulder/Willow Creek— 1st and 2nd order irrigated sections	ID17050123SW011_02	TP	TP ≤0.025 mg/L	May–September
West Mountain tributaries to Cascade Reservoir[a]	ID17050123SW007_02	TP	0.025 mg/L	May–September
Cascade Reservoir	ID17050123SW007L_0L	TP	TP ≤0.025 mg/L	May–September
			Chlorophyll *a* ≤10 µg/L	May–September
			DO ≥6.0 mg/L	Year round
			6.5 ≤ pH ≤ 9.5	Year round
Gold Fork, 5th order, between high and low water lines	ID17050123SW007_05	TP	TP ≤0.025 mg/L	May–September
			DO ≥6.0 mg/L	Year round
			6.5 ≤ pH ≤ 9.5	Year round
Gold Fork—upper 5th order, above Gold Fork Ditch	ID17050123SW008_05	TP	0.025 mg/L	May–September
Gold Fork— lower 5th order, below Gold Fork Ditch	ID17050123SW008_05a	TP	0.025 mg/L	May–September
		Sediment	80% bank stability or 0.56 tons per day	Year round
Mud Creek—1st and 2nd order	ID17050123SW015_02	TP	0.025 mg/L	May–September
		Sediment	80% bank stability or 0.44 tons per day	Year round
Mud Creek—3rd order (Norwood to Reservoir)	ID17050123SW015_03	TP	0.025 mg/L	May–September
		Sediment	80% bank stability or 0.44 tons per day	Year round

Note: micrograms per liter (µg/L)
[a]Poison Creek

3.3.3 Cascade Reservoir Water Column Data

In 2015 and 2016, DEQ collected TP, dissolved phosphorus, total nitrogen, and chlorophyll *a* samples at two historic sampling locations near the Dam (GAR053) and Sugar Loaf (GAR052) (Figure 3). Depth profiles were conducted with a YSI EXO2 multiparameter water quality sonde. The EXO2 sonde measures DO (mg/L), temperature (°C), pH, and conductivity (µS/cm). In addition to reservoir monitoring, Gold Fork River, Boulder Creek, Mud Creek, and Poison Creek (West Mountain tributaries) were sampled for TP and sediment (suspended solids and streambank erosion inventories [SEIs]).

Figure 3. Cascade Reservoir sampling locations—Sugar Loaf (GAR052) and Dam (GAR053) (DEQ 2009).

During the 2015 and 2016 sampling seasons (May–October), the water column average TP concentrations in the reservoir were 0.059 mg/L and 0.051 mg/L, respectively. The 2015 and 2016 mean TP concentrations were calculated by averaging TP concentrations from the euphotic zone and hypolimnion (1 meter off the bottom of the reservoir). When TP concentrations from the hypolimnion are excluded from the calculations (i.e., euphotic zone TP average), average TP concentrations for 2015 and 2016 were 0.027 mg/L and 0.031 mg/L, respectively. Average reservoir TP concentrations from samples collected near the bottom of the reservoir were 0.092 mg/L in 2015 and 0.072 mg/L in 2016. TP concentrations in the hypolimnion peaked during August, which is also associated with the lowest DO concentrations in the reservoir. The elevated TP concentrations in the hypolimnion indicate the redox conditions induced by anoxic conditions are likely causing dissolved inorganic phosphorus to be released from particles at the bottom of the reservoir. The internal nutrient cycling in Cascade Reservoir is not well understood

at this time and should be examined further during the next 5-year review cycle. Refer to Table 6 and Table 7 for 2015 TP concentrations and Table 8 and Table 9 for 2016 TP concentrations.

Table 6. Cascade Reservoir total phosphorus concentrations (May 2015–September 2015).

Site	Date Collected	Total Phosphorus Concentrations (mg/L)
Dam bottom (GAR053)	05/21/2015	0.031
	06/24/2015	0.093
	07/21/2015	0.14
	08/18/2015	0.26
	09/25/2015	0.047
Dam top (GAR053)	05/21/2015	0.027
	06/24/2015	0.021
	07/21/2015	0.022
	08/18/2015	0.035
	09/25/2015	0.028
Sugar Loaf bottom (GAR052)	05/21/2015	0.022
	06/24/2015	0.015
	07/21/2015	0.076
	08/18/2015	0.17
	09/25/2015	0.061
Sugar Loaf top (GAR052)	05/21/2015	0.028
	06/24/2015	0.016
	07/21/2015	0.022
	08/18/2015	0.037
	09/25/2015	0.033

Table 7. Cascade Reservoir average and median total phosphorus concentrations (2015).

Site	Average Total Phosphorus Concentrations (mg/L)	Median Total Phosphorus Concentrations (mg/L)
Dam bottom (GAR053)	0.114	0.093
Dam top (GAR053)	0.027	0.027
Dam (GAR053)	0.070	0.033
Sugar Loaf bottom (GAR052)	0.069	0.061
Sugar Loaf top (GAR052)	0.027	0.028
Sugar Loaf (GAR052)	0.048	0.031

Table 8. Cascade Reservoir total phosphorus concentrations (May 2016–October 2016).

Site	Date Collected	Total Phosphorus Concentrations (mg/L)
Dam bottom (GAR053)	05/18/2016	0.035
	06/23/2016	0.027
	07/19/2016	0.083
	08/16/2016	0.22
	09/14/2016	0.037
	10/17/2016	0.064
Dam top (GAR053)	05/18/2016	0.022
	06/23/2016	0.018
	07/19/2016	0.018
	08/16/2016	0.021
	09/14/2016	0.039
	10/17/2016	0.056
Sugar Loaf bottom (GAR052)	05/18/2016	0.03
	06/23/2016	0.026
	07/19/2016	0.048
	08/16/2016	0.18
	09/14/2016	0.037
	10/17/2016	0.075
Sugar Loaf top (GAR052)	05/18/2016	0.026
	06/23/2016	0.018
	07/19/2016	0.019
	08/16/2016	0.02
	09/14/2016	0.038
	10/17/2016	0.071

Table 9. Cascade Reservoir average and median total phosphorus concentrations (2016).

Site	Average Total Phosphorus Concentrations (mg/L)	Median Total Phosphorus Concentrations (mg/L)
Dam bottom (GAR053)	0.078	0.051
Dam top (GAR053)	0.029	0.022
Dam (GAR053)	0.053	0.036
Sugar Loaf bottom (GAR052)	0.066	0.043
Sugar Loaf top (GAR052)	0.032	0.023
Sugar Loaf (GAR052)	0.049	0.034

Chlorophyll *a* samples were collected from the euphotic zone at each sampling location in 2015 (May–July) and 2016 (May–October). Average chlorophyll *a* concentrations in the reservoir were 1.28 micrograms per liter (µg/L) and 1.8 µg/L in 2015 and 2016, respectively. The chlorophyll *a* average calculated for 2015 may be skewed lower as high chlorophyll *a* concentrations are expected later during the growing season. Table 10 and Table 11 show all

chlorophyll *a* concentrations for the 2015 and 2016 sampling seasons. Table 12 shows historical average TP and chlorophyll *a* concentrations.

Table 10. Cascade Reservoir chlorophyll *a* concentrations (May 2015–July 2015).

Site	Date Collected	Chlorophyll *a* Concentrations (µg/L)
Dam (GAR053)	05/21/2015	2.3
	06/24/2015	1.1
	07/21/2015	0.84
Sugar Loaf (GAR052)	05/21/2015	1.8
	06/24/2015	0.93
	07/21/2015	0.72

Table 11. Cascade Reservoir chlorophyll *a* concentrations (May 2016–October 2016).

Site	Date Collected	Chlorophyll *a* Concentrations (µg/L)
Dam (GAR053)	05/18/2016	1.7
	06/23/2016	0.84
	07/19/2016	1.1
	08/16/2016	2.2
	09/14/2016	2.1
	10/17/2016	3
Sugar Loaf (GAR052)	05/18/2016	0.72
	06/23/2016	0.66
	07/19/2016	1.1
	08/16/2016	2.2
	09/14/2016	2.4
	10/17/2016	3.6

Table 12. Average Cascade Reservoir total phosphorus and chlorophyll *a* concentrations.

Measurement	Year				
	1993	2000	2008	2015	2016
Average total phosphorus concentrations (mg/L)	0.05	0.03	0.03	0.03	0.03
Mean chlorophyll *a* concentrations (µg/L)	29.15	20.50	16.50	1.02	1.80

Note: Average total phosphorus concentrations in 2015 and 2016 are an average of all total phosphorus samples collected from the euphotic zone. Phosphorus concentrations from the hypolimnion were excluded from these averages.

DO, pH, and temperature depth profiles conducted during the 2015 and 2016 sampling seasons were collected with a multiparameter sonde. Depth profiles were collected at Sugar Loaf (GAR052) and the Dam (GAR053). In 2015 and 2016, departures from Idaho's water quality criteria were documented for DO and pH (Table 13). Due to the stratified nature of Cascade Reservoir and limited temporal data, it is not appropriate to use these data for determining

beneficial use support; however, it does provide insight into water quality trends. Additional depth profile data can be found in Appendix B.

Table 13. Dissolved oxygen and pH criteria departures in Cascade Reservoir.

Site	Date	Dissolved Oxygen Departure	pH Departure
GAR052	06/24/2015	x	x
GAR052	08/18/2015	x	
GAR052	08/16/2016	x	
GAR053	06/24/2015	x	
GAR053	07/21/2015	x	x
GAR053	08/18/2015	x	
GAR053	09/25/2015	x	
GAR053	07/19/2016	x	
GAR053	08/16/2016		x

Note: Dissolved oxygen concentrations were only compared to Idaho's water quality criteria in the epilimnion of Cascade Reservoir.

3.3.4 Cascade Reservoir Tributary Water Quality

TP samples were collected from Boulder Creek, Gold Fork River, Mud Creek, Poison Creek, and Willow Creek during the 2015 and 2016 field seasons. Average TP for all monitored tributaries was 0.064 mg/L and 0.050 mg/L in 2015 and 2016, respectively. Figure 4 shows the distribution of the tributary TP concentrations during the 2015 and 2016 sampling seasons. In 2015 and 2016, average tributary TP concentrations were approximately 31% and 12% higher than the average TP concentrations in 2007. Table 14 shows historical and present average tributary TP concentrations in the Cascade Reservoir watershed.

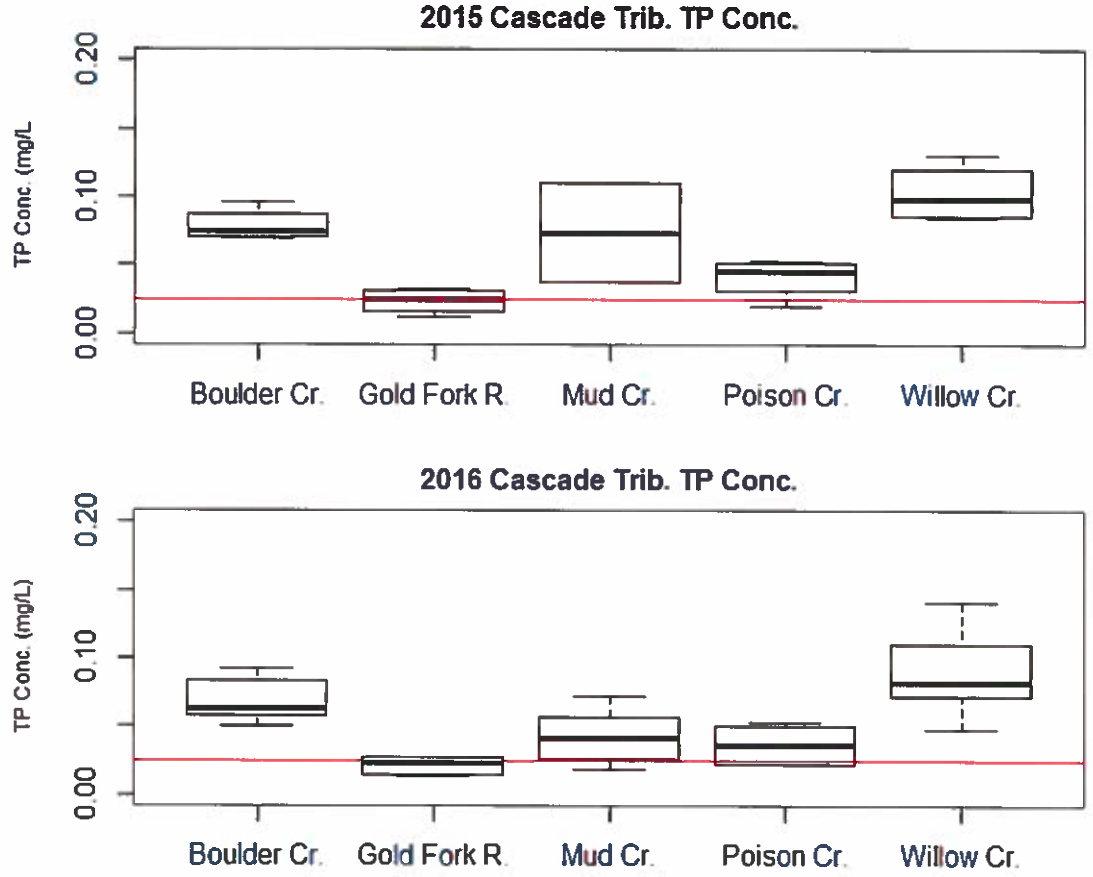

Figure 4. Total phosphorus concentrations for Cascade Reservoir tributaries in 2015 and 2016. The red line denotes the total phosphorus concentration target of 0.025 mg/L for these tributaries.

Table 14. Historical tributary total phosphorus concentrations.

Measurement	Year				
	1993	2000	2007	2015	2016
Average total phosphorus concentrations (mg/L)	0.063	0.056	0.044	0.064	0.05
Total phosphorus concentration range (mg/L)	0.033–0.270	0.016–0.21	0.007–0.155	0.012–0.13	0.014–0.22

3.3.5 Streambank Erosion Inventories and Suspended Sediment

In 2016, SEIs were conducted on Mud Creek (ID17050123SW015_03) and Boulder Creek (ID17050123SW011_03) (Table 15). DEQ staff attempted to conduct an SEI on Gold Fork (ID17050123SW008_05a) but was unable to complete the inventory because the sediment-impaired AU of Gold Fork River was inaccessible. The SEI on Mud Creek indicated the streambank cover at 70% with an average daily load of 0.43 tons per day. The current estimated sediment load on Mud Creek is approximately 0.03 tons per day greater than the load capacity developed in the TMDL addendum. The Boulder Creek SEI showed streambank cover at 87%

with an average daily load of 0.68 tons per day. While the streambank cover target is being met on Boulder Creek, the estimated current daily load of 0.68 tons per day is approximately 0.12 tons per day higher than the load capacity developed in the TMDL addendum for sediment (DEQ 2011). Personal communications between DEQ staff and land managers in the Cascade Reservoir watershed indicated that high flows during spring 2017 denuded vegetation from larger portions of the Gold Fork River's banks. The Gold Fork River is likely not meeting targets established by the TMDL addendum for sediment.

Table 15. 2016 streambank erosion inventory results.

Assessment Unit	Target Cover (%)	Actual Stream Bank Cover (%)	Average Annual Load Capacity (tons/day)	SEI Estimated Load (tons/day)
Gold Fork—lower 5th order, below Gold Fork Ditch (ID17050123SW008_05a)	80	—	0.50	—
Mud Creek—3rd order (Norwood to Reservoir) (ID17050123SW015_03)	80	70	0.40	0.43
Boulder Creek—3rd order (Louie Creek to mouth) (ID17050123SW011_03)	80	87	0.56	0.68

3.3.6 Status of Beneficial Uses

Water bodies in the Cascade Reservoir watershed are designated for salmonid spawning, cold water aquatic life, primary contact recreation, and drinking water. The remaining undesignated water bodies in the watershed are protected for the presumed beneficial uses of cold water aquatic life and secondary contact recreation. At this time, all beneficial uses appear to be appropriate.

Water bodies for which TMDLs were developed in 1996, 1998, and 2011 remain impaired for the original pollutants. Cascade Reservoir TP concentrations trended down during 2007 and trended up during 2015 and 2016. Chlorophyll *a* concentrations met the target concentrations during critical time periods in 2015 and 2016. While chlorophyll *a* concentrations are trending down, violations of Idaho's water quality criteria were documented for DO and pH in 2015 and 2016. SEIs indicated that cover on Mud Creek and Boulder Creek have improved since the original surveys in 2008. Due to the limited access points on Gold Fork River, no SEI was conducted. The large runoff events during spring 2017 have had a significant impact on the Cascade Reservoir tributaries' bank stability, and they need to be resurveyed during the next review cycle.

Water quality improvement projects have improved the watershed, but opportunities exist to improve water quality further. Additionally, the role in internal nutrient cycling needs to be examined further. Internal loading of phosphorus trapped in the reservoir's sediment may lead to eutrophication of the reservoir even as external nutrient loads are reduced.

Water quality improvements have not yet positively affected the status of beneficial uses. Future beneficial uses can only be attained by aggressively implementing water quality improvement projects and understanding the interaction between eutrophication and internal nutrient loading.

3.3.7 Assessment Unit Summary

Table 16 shows a summary of the AUs assessed during this 5-year review. There has been no change in the support of beneficial uses, and no changes to the Integrated Report are recommended as a result of the data collected in this review.

Table 16. Summary of recommended changes for AUs evaluated.

Assessment Unit Name	Assessment Unit Number	Pollutant	Recommended Changes to Next Integrated Report
Boulder Creek—3rd order (Louie Creek to mouth)	ID17050123SW011_03	TP, sediment	No change
Boulder/Willow Creek—1st and 2nd order irrigated sections	ID17050123SW011_02	TP	No change
West Mountain tributaries to Cascade Reservoir[a]	ID17050123SW007_02	TP	No change
Cascade Reservoir	ID17050123SW007L_0L	TP, pH	No change
Gold Fork, 5th order, between high and low water lines	ID17050123SW007_05	TP, pH	No change
Gold Fork, upper 5th order, above Gold Fork Ditch	ID17050123SW008_05	TP	No change
Gold Fork—lower 5th order, below Gold Fork Ditch	ID17050123SW008_05a	TP, sediment	No change
Mud Creek—1st and 2nd order	ID17050123SW015_02	TP, sediment	No change
Mud Creek—3rd order (Norwood to Reservoir)	ID17050123SW015_03	TP, sediment	No change

[a]Poison Creek

4 Review of Implementation Plan and Activities

The *Implementation Plan for the Cascade Reservoir Phase II Watershed Management Plan* was developed in June 2000 (DEQ 2000). To meet the goals of the Cascade Reservoir Phase II TMDL, the implementation plan established goals to reduce nonpoint sources of phosphorus by 40% or 10,895 kilograms per year (kg/year) of TP. Additionally, the implementation plan called for the elimination of phosphorus loading from the City of McCall's wastewater treatment plant. The Phase II TMDL also developed a wasteload allocation for the Idaho Department of Fish and Game hatchery (DEQ 1998, 2000).

Since the Phase II TMDL and implementation plan were completed, effluent from McCall's wastewater treatment plant was eliminated to the North Fork Payette River, and the Idaho Department of Fish and Game implemented a feeding management program to reduce the hatchery's effluent below the wasteload allocation established by the Phase II TMDL. These two point source reductions meet 100 % reductions needed to meet the Phase II TMDL wasteload allocations. Since the original TMDL did not incorporate a reserve for growth, new dischargers will be required to offset phosphorus loads from the land on which the facility is located in addition to the no-net-increase in phosphorus loading. In 2004, the Jug Mountain Ranch Facility

(ID0028029) was permitted under EPA's National Pollutant Discharge Elimination System program. The Jug Mountain Ranch Facility was able to offset its phosphorus load and meet the no-net-increase requirement through a grazing management plan, streambank stability, and riparian habitat improvements. The projects implemented by Jug Mountain Ranch should reduce TP by 470 kg/year.

During the previous Cascade Reservoir 5-year review, approximately 6,421 kg/year (58% of the total nonpoint source reduction) of TP has been reduced by implementing nonpoint source best management practices (BMPs) (DEQ 2009). For a comprehensive review of implementation projects from 2000 to 2009, refer to the *Cascade Reservoir Watershed Phase III Water Quality Management Plan and TMDL Five-Year Review* (DEQ 2009). Since the previous Cascade Reservoir 5-year review, an additional 2,129 kg/year TP has been reduced through §319-funded nonpoint source BMP implementations. Approximately 78% of the required nonpoint source TP load has been met.

4.1 Accomplished Projects

Since the previous Cascade Reservoir 5-year review, the Valley County Soil and Water Conservation District has received five §319 grants for implementing nonpoint source BMPs. Additionally, other agencies such as the Natural Resources Conservation Service and United States Forest Service have implemented projects through other federal funding resources.

4.1.1 §319-Funded Projects

Since 2009, six §319 grants have been awarded in the Cascade Reservoir watershed. The money from those six grants has funded 11 projects with an estimated TP reduction of 2,129 kg/year. Additionally, 3,063 tons per year of sediment has been removed from the Cascade Reservoir and its tributaries through implementing those 11 projects. For a complete list of projects in the Cascade Reservoir watershed, see Table 17.

Table 17. §319-funded BMPs in the Cascade Reservoir watershed (2011–2017).

HUC6NAME	Implementation Year	BMP	Load Reduction Estimate	
			TP (kg/year)	Sediment/Silt (tons/year)
Boulder Creek (170501230207)	2011	Cut bank stabilization	146	200
Boulder Creek (170501230207)	2012	Tree/shrub establishment	713	982
	2015	Stream habitat improvement and management		
Willow Creek (170501230207)	2012	Tree/shrub establishment	20	27
North Fork Payette River (1705012302)	2013	Rock barrier	544	779
	2013	Water and sediment control basin		
	2015	Seeding (revegetation)		
	2015	Streambank and shoreline protection		
	2015	Channel bank vegetation		
	2013	Fence		
	2013	Tree/shrub establishment		
	2015	Erosion and sediment control		
	2015	Culvert armoring		
Hartsell Creek–North Fork Payette (170501230204)	2016	Stream channel stabilization	120	166
Boulder Creek (170501230207)		Stream channel stabilization	241	332
Duck Creek–Cascade Reservoir (170501230400)		Road ditch creation/improvements	79	110
Pearsol Creek–North Fork Payette River (170501230503)		Stream channel stabilization	—	5.62
		Windbreak/shelterbelt renovation		
Lower Big Creek (170501230504)		Stream channel stabilization	—	31.5
Hartsell Creek–North Fork Payette (170501230204)	2017	Channel bank vegetation	122	198
		Critical area planting		
		Stream channel stabilization		
		Stream habitat improvement and management		
Boulder Creek (170501230207)		Channel bank vegetation	143	232
		Critical area planting		
		Stream channel stabilization		
		Stream habitat improvement and management		

4.1.2 Other Projects (Non-§319 Funded Projects)

The Natural Resources Conservation Service funded projects through its Environmental Quality Incentive Program (EQIP). While EQIP project load reduction estimates were not calculated, Table 18 provides a full list of projects installed through EQIP in the Cascade Reservoir watershed. The US Forest Service did not complete any projects in the Cascade Reservoir watershed during this review cycle.

Table 18. Cascade Reservoir watershed EQIP projects.

Practice Name	Applied Amount	Units
Channel bank vegetation	2.0	Acre
Fence	40,789.0	Feet
Fuel break	73.0	Acre
Integrated pest management	40.0	Acre
Livestock pipeline	50.0	Feet
Pumping plant	4.0	No.
Sprinkler system	246.8	Acre
Tree/shrub establishment	14.5	Acre
Watering facility	1.0	No.
Forage and biomass planting	75.0	Acre
Forest management plan—written	1.0	No.
Irrigation pipeline	4,840.0	Feet
Irrigation water conveyance	40.0	Feet
Irrigation water management	325.7	Acre
Prescribed grazing	752.3	Acre
Forest stand improvement	52.9	Acre
Herbaceous weed control	25.0	Acre
Irrigation system, microirrigation	0.1	Acre
Nutrient management	370.4	Acre
Seasonal high tunnel system for crops	4,818.0	Square feet
Streambank and shoreline protection	1,392.0	Feet
Tree/shrub pruning	16.0	Acre
Tree/shrub site preparation	7.0	Acre
Woody residue treatment	115.0	Acre

4.2 Planned Activities

Water quality implementation projects must continue toward TP and sediment load reduction goals established by the TMDLs. Several agencies in the Cascade Reservoir watershed have planned activities that will help achieve those load reduction goals.

4.2.1 Valley County Soil and Water Conservation District

In October 2017, the Valley County Soil and Water Conservation District submitted a §319 grant application for implementing additional water quality projects in the Cascade Reservoir watershed. The grant application proposed two projects that will directly impact TP and sediment

loads to Cascade Reservoir and its tributaries. The first is a riparian restoration project on the North Fork Payette River, above the dam, with an off-stream watering component. This riparian restoration project should reduce 362 kg/year of TP and 498 tons/year of sediment. The second proposed project involves road drainage improvements in the West Mountain tributaries subwatershed. This project should reduce approximately 79 kg/year of TP and 110 tons/year of sediment.

4.2.2 Natural Resources Conservation Service

The Valley County Natural Resources Conservation Service Regional Office funded six EQIP contracts in federal fiscal year 2017 for approximately $38,000. Some of these projects will benefit water quality in Cascade Reservoir and its tributaries.

4.2.3 US Forest Service

The US Forest Service is planning a fuel reduction project in the West Mountain tributaries watershed in fiscal year 2019. Road maintenance and reconstruction will take place in conjunction with the fuel management project, which is expected to reduce phosphorus and sediment loads to the reservoir. At this time, no load reduction estimates have been made for this project.

4.2.4 Idaho Department of Fish and Game

Volunteers organized by the Idaho Department of Fish and Game are scheduled to plant riparian vegetation in the North Fork Payette River subbasin during spring 2018. The project will target the North Fork Payette River, Boulder Creek, and other tributaries.

5 Conclusions and Recommendations

While many water quality improvement projects have been implemented in the Cascade Reservoir watershed, instream water quality targets established by the Phase II TMDL are not being met for TP. Cascade Reservoir's chlorophyll *a* concentrations in 2015 and 2016 were below the target established by the Phase II TMDL, but departures from DO and pH criteria are assumed to be associated with excess biological growth in Cascade Reservoir. The relationship between anoxic conditions in the hypolimnion and resuspension of dissolved phosphorus is also not well understood at this time. The ratio of internal phosphorus to external loading should be examined during the next 5-year review cycle. DEQ is also proposing to monitor Cascade Reservoir annually in conjunction with other monitoring in the North Fork Payette River subbasin. Monitoring Cascade Reservoir on an annual basis during peak productivity months will provide a more detailed picture of water quality trends in the reservoir.

The Cascade Reservoir tributaries of Boulder Creek, Mud Creek, and Gold Fork River addressed in the TMDL sediment addendum will remain in Category 4a. The SEIs conducted on Boulder Creek showed an increase in cover from the previous surveys. Only a short stretch of Boulder Creek was surveyed compared to the total water body length. The SEI conducted on Mud Creek indicated the cover was not adequate to meet the 80% target established in the TMDL addendum. Due to private ownership and limited public access, the sediment-impaired portion of Gold Fork

River was not surveyed. During the next 5-year review cycle, a more concentrated effort to gain landowner permission will be needed, which may require DEQ to work with local agencies to make introductions to landowners willing to participate in the SEIs.

At this time, DEQ is not recommending any changes to the Category 4a-listed water bodies in the Cascade Reservoir watershed. Table 19 summarizes assessment outcomes, including recommended changes to listings status in the next Integrated Report.

Table 19. Summary of assessment outcomes.

Assessment Unit Name	Assessment Unit Number	Pollutants	Recommended Changes to Next Integrated Report
Boulder Creek—3rd order (Louis Creek to mouth)	ID17050123SW011_03	TP, sediment	No change
Boulder/Willow Creek—1st and 2nd order irrigated sections	ID17050123SW011_02	TP	No change
West Mountain tributaries to Cascade Reservoir[a]	ID17050123SW007_02	TP	No change
Cascade Reservoir	ID17050123SW007L_0L	TP, pH	No change
Gold Fork, 5th order, between high and low water lines	ID17050123SW007_05	TP, pH	No change
Gold Fork—upper 5th order, above Gold Fork Ditch	ID17050123SW008_05	TP	No change
Gold Fork—lower 5th order, below Gold Fork Ditch	ID17050123SW008_05a	TP, sediment	No change
Mud Creek—1st and 2nd order	ID17050123SW015_02	TP, sediment	No change
Mud Creek—3rd order (Norwood to Reservoir)	ID17050123SW015_03	TP, sediment	No change

[a]Poison Creek

This document was prepared with input from the public as described in Appendix C.

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GIS Coverages

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USDA – FSA Aerial Photography Field Office - 2013 National Agricultural Imagery Program (NAIP) 0.5m imagery

USDA – FSA Aerial Photography Field Office - 2015 National Agricultural Imagery Program (NAIP) 1.0m imagery

Glossary

§303(d)	Refers to section 303 subsection "d" of the Clean Water Act. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to US Environmental Protection Agency approval.
Ambient	General conditions in the environment (Armantrout 1998). In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations or specific disturbances such as a wastewater outfall (EPA 1996).
Anthropogenic	Relating to, or resulting from, the influence of human beings on nature.
Assessment Unit (AU)	A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses, and any associated causes and sources must be applied to the entirety of the unit.
Beneficial Use	Any of the various uses of water, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics, that are recognized in water quality standards.
Beneficial Use Reconnaissance Program (BURP)	A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, wadeable streams, and rivers.
Exceedance	A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.
Fully Supporting	In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (DEQ 2016).
Load Allocation (LA)	A portion of a water body's load capacity for a given pollutant that is allocated to a particular nonpoint source (by class, type, or geographic area).
Load(ing)	The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.
Load Capacity (LC)	How much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, a margin of safety, and natural background contributions, it becomes a total maximum daily load.
Margin of Safety (MOS)	An implicit or explicit portion of a water body's loading capacity set aside to allow for uncertainty about the relationship between the pollutant loads and the

	quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.
Natural Condition	The condition that exists with little or no anthropogenic influence.
Nonpoint Source	A dispersed source of pollutants generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point of origin. They include, but are not limited to, irrigated and nonirrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.
Not Assessed (NA)	A concept and an assessment category describing water bodies that have been studied but are missing critical information needed to complete a use support assessment.
Not Fully Supporting	Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (DEQ 2016).
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment that alter the functioning of natural processes and produce undesirable environmental and health effects. These changes include human-induced alterations of the physical, biological, chemical, and radiological integrity of water and other media.
Potential Natural Vegetation (PNV)	A.U. Küchler (1964) defined potential natural vegetation as vegetation that would exist without human interference and if the resulting plant succession were projected to its climax condition while allowing for natural disturbance processes such as fire. Our use of the term reflects Küchler's definition in that riparian vegetation at PNV would produce a system potential level of shade on streams and includes recognition of some level of natural disturbance.
Riparian	Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A 1st-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher-order streams result from the joining of two streams of the same order.

Total Maximum Daily Load (TMDL)	A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual basis. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.
Wasteload Allocation (WLA)	The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.
Water Body	A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.
Water Quality Criteria	Levels of water quality expected to render a water body suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.
Water Quality Standards	State-adopted and US Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Appendix A. Beneficial Uses

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

Existing Uses

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

Designated Uses

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

Undesignated Surface Waters

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

designation (rulemaking) to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Appendix B. Cascade Reservoir Sonde Depth Profile Data

Date	Site	Depth (m)	Temperature (°C)	SpC (µS/cm)	pH (Units)	ODO (mg/L)
05/23/2015	GAR052	0.0	13.95	35.70	7.91	10.30
05/23/2015	GAR052	1.0	13.59	35.70	7.98	10.40
05/23/2015	GAR052	2.0	13.46	35.60	7.95	10.38
05/23/2015	GAR052	3.0	13.40	35.60	7.85	10.29
05/23/2015	GAR052	4.0	13.34	35.60	7.68	10.19
05/23/2015	GAR052	5.0	13.03	35.60	7.31	9.56
05/23/2015	GAR052	6.0	12.88	35.60	7.25	9.40
05/23/2015	GAR052	7.0	12.83	35.70	7.20	9.15
05/23/2015	GAR052	8.0	12.70	35.60	7.15	9.07
05/23/2015	GAR052	9.0	12.47	35.10	7.10	8.96
05/23/2015	GAR052	10.0	12.34	34.90	7.00	8.47
05/23/2015	GAR052	11.0	12.12	34.60	6.94	8.06
05/23/2015	GAR052	12.0	12.05	34.50	7.01	7.86
06/24/2015	GAR052	1.0	20.60	36.30	8.70	9.50
06/24/2015	GAR052	2.0	20.40	36.30	8.70	9.50
06/24/2015	GAR052	3.0	20.20	36.20	8.40	9.30
06/24/2015	GAR052	4.0	19.80	36.30	8.00	9.00
06/24/2015	GAR052	5.0	19.50	36.30	8.00	8.70
06/24/2015	GAR052	6.0	18.50	36.80	7.00	7.60
06/24/2015	GAR052	7.0	17.70	37.20	6.90	6.70
06/24/2015	GAR052	8.0	15.90	38.00	6.60	5.10
06/24/2015	GAR052	9.0	14.80	38.80	6.50	3.30
06/24/2015	GAR052	10.0	14.40	39.20	6.45	2.60
06/24/2015	GAR052	11.0	14.20	39.50	6.66	2.30
07/21/2015	GAR052	1.0	21.90	39.60	8.85	9.76
07/21/2015	GAR052	2.0	21.90	39.60	8.84	9.73
07/21/2015	GAR052	3.0	21.20	39.60	8.90	9.81
07/21/2015	GAR052	4.0	20.80	39.60	8.94	9.86
07/21/2015	GAR052	5.0	20.50	39.60	8.88	9.82
07/21/2015	GAR052	6.0	19.90	38.50	8.04	8.80
07/21/2015	GAR052	7.0	19.95	38.60	7.30	7.77
07/21/2015	GAR052	8.0	18.95	38.80	7.12	6.63
07/21/2015	GAR052	9.0	15.90	47.00	6.97	1.47
07/21/2015	GAR052	10.0	15.53	168.00	7.25	0.32
08/18/2015	GAR052	1.0	19.96	38.80	7.75	6.67
08/18/2015	GAR052	2.0	19.94	38.70	7.73	6.66
08/18/2015	GAR052	3.0	19.93	38.80	7.60	6.57
08/18/2015	GAR052	4.0	19.87	38.70	7.33	6.11
08/18/2015	GAR052	5.0	19.43	39.20	6.69	4.29
08/18/2015	GAR052	6.0	18.60	41.30	6.59	1.11

Date	Site	Depth (m)	Temperature (°C)	SpC (µS/cm)	pH (Units)	ODO (mg/L)
08/18/2015	GAR052	7.0	17.20	48.90	6.54	0.10
08/18/2015	GAR052	8.0	16.95	50.30	6.56	0.14
08/18/2015	GAR052	9.0	16.31	53.10	6.64	0.23
09/25/2015	GAR052	1.0	16.40	34.70	8.94	11.60
09/25/2015	GAR052	2.0	16.30	34.70	8.90	11.50
09/25/2015	GAR052	3.0	16.00	34.50	8.60	11.12
09/25/2015	GAR052	4.0	15.80	34.00	8.10	10.20
09/25/2015	GAR052	5.0	15.60	34.10	7.11	8.49
09/25/2015	GAR052	6.0	15.10	36.60	7.05	4.90
09/25/2015	GAR052	7.0	15.00	34.80	7.50	4.20
05/17/2016	GAR052	0.3	11.552	53.7	7.25	9.3
05/17/2016	GAR052	1.3	10.927	53.5	7.23	9.39
05/17/2016	GAR052	2.3	10.772	53.3	7.19	9.3
05/17/2016	GAR052	3.3	10.765	53.7	7.18	9.28
05/17/2016	GAR052	4.3	10.302	54.8	7.1	9.01
05/17/2016	GAR052	5.3	9.971	55.7	7.01	8.81
05/17/2016	GAR052	6.3	9.599	55.6	6.93	8.27
05/17/2016	GAR052	7.3	9.56	55.4	6.86	8.11
05/17/2016	GAR052	8.3	9.428	55.6	6.82	7.54
05/17/2016	GAR052	9.3	9.19	55.5	6.74	7.04
05/17/2016	GAR052	10.3	8.51	56.3	6.61	5.49
05/17/2016	GAR052	11.3	8.397	56.7	6.54	0.2
06/23/2016	GAR052	1.0	16.636	34.1	8.09	8.98
06/23/2016	GAR052	2.0	16.625	34.5	8.09	8.99
06/23/2016	GAR052	3.0	14.972	34.4	7.69	8.91
06/23/2016	GAR052	4.0	14.681	34.1	7.07	8.61
06/23/2016	GAR052	7.0	13.462	33.9	6.54	5.88
06/23/2016	GAR052	10.0	12.928	26.4	6.47	2.78
06/23/2016	GAR052	11.0	12.246	37.4	6.43	2.1
07/19/2016	GAR052	1.0	18.1	32.2	8.64	8.73
07/19/2016	GAR052	3.0	18	32.2	8.58	8.65
07/19/2016	GAR052	6.0	17.9	32.1	8.12	8.41
07/19/2016	GAR052	11.0	15.2	34.4	8	3.34
08/16/2016	GAR052	0.0	19.913	49.6	9.11	9.26
08/16/2016	GAR052	1.4	18.62	49.6	9.12	9.15
08/16/2016	GAR052	3.1	18.434	49.5	8.98	8.98
08/16/2016	GAR052	6.6	16.614	50	8.03	2.64
08/16/2016	GAR052	9.6	13.362	62.2	7	0.18
09/14/2016	GAR052	0.0	13.676	53.8	7.95	8.09
09/14/2016	GAR052	1.1	13.682	54.3	7.95	8.06
09/14/2016	GAR052	2.0	13.684	54	7.98	8.08

Date	Site	Depth (m)	Temperature (°C)	SpC (µS/cm)	pH (Units)	ODO (mg/L)
09/14/2016	GAR052	3.1	13.687	54.1	8	8.07
09/14/2016	GAR052	3.7	13.689	54.1	8.06	7.93
09/14/2016	GAR052	5.8	13.591	54.4	9.13	7.01
09/14/2016	GAR052	6.1	13.58	53.9	9.31	7.1
10/17/2016	GAR052	0.0	8.031	54.4	7.69	9.21
10/17/2016	GAR052	1.5	8.03	54	7.71	9.2
10/17/2016	GAR052	2.7	8.026	54	7.73	9.19
10/17/2016	GAR052	3.5	8.025	53.8	7.76	9.17
10/17/2016	GAR052	4.5	8.028	53.9	7.79	9.14
10/17/2016	GAR052	5.4	7.984	54.3	7.81	9.13
10/17/2016	GAR052	6.6	7.929	54.3	7.84	9.07
10/17/2016	GAR052	7.4	8.111	59.1	8.05	8.62
10/17/2016	GAR052	7.7	8.002	55.7	7.61	8.98
05/23/2015	GAR053	0.0	14.10	36.10	8.39	10.58
05/23/2015	GAR053	1.0	14.26	36.10	8.39	10.60
05/23/2015	GAR053	2.0	14.15	36.10	8.38	10.59
05/23/2015	GAR053	3.0	14.81	36.10	8.34	10.56
05/23/2015	GAR053	4.0	13.49	36.00	8.25	10.48
05/23/2015	GAR053	5.0	12.76	35.90	7.21	9.15
05/23/2015	GAR053	6.0	12.62	36.00	6.94	8.40
05/23/2015	GAR053	7.0	12.34	36.10	6.89	7.79
05/23/2015	GAR053	8.0	12.29	35.90	6.91	7.80
05/23/2015	GAR053	9.0	12.24	35.90	6.91	8.16
05/23/2015	GAR053	10.0	12.23	36.30	6.90	7.74
05/23/2015	GAR053	11.0	12.21	35.90	6.93	8.11
05/23/2015	GAR053	12.0	12.16	36.00	6.89	7.88
05/23/2015	GAR053	13.0	12.12	36.10	6.87	7.72
05/23/2015	GAR053	14.0	12.11	36.10	6.85	7.68
05/23/2015	GAR053	15.0	12.05	36.40	6.81	7.17
05/23/2015	GAR053	16.0	12.05	36.40	6.78	7.11
05/23/2015	GAR053	17.0	12.00	36.60	6.75	6.95
05/23/2015	GAR053	18.0	11.98	36.60	6.78	6.96
06/24/2015	GAR053	1.0	21.70	37.20	8.50	9.00
06/24/2015	GAR053	2.0	21.40	37.30	8.70	9.50
06/24/2015	GAR053	3.0	20.80	37.20	8.60	9.40
06/24/2015	GAR053	4.0	20.40	36.80	8.00	8.80
06/24/2015	GAR053	5.0	20.10	36.70	7.50	8.50
06/24/2015	GAR053	6.0	19.60	37.50	7.10	7.50
06/24/2015	GAR053	7.0	19.00	37.70	7.00	7.10
06/24/2015	GAR053	8.0	16.00	39.50	6.70	4.10
06/24/2015	GAR053	9.0	15.10	39.20	6.60	3.70

Date	Site	Depth (m)	Temperature (°C)	SpC (µS/cm)	pH (Units)	ODO (mg/L)
06/24/2015	GAR053	10.0	14.40	40.60	6.50	2.10
06/24/2015	GAR053	11.0	13.80	40.60	6.50	1.80
06/24/2015	GAR053	12.0	13.60	40.70	6.50	1.40
06/24/2015	GAR053	13.0	13.60	40.70	6.50	1.40
06/24/2015	GAR053	14.0	13.50	40.70	6.50	1.40
06/24/2015	GAR053	15.0	13.40	40.70	6.50	1.40
06/24/2015	GAR053	16.0	13.30	41.00	6.60	1.20
06/24/2015	GAR053	17.0	13.30	41.70	7.00	1.20
07/21/2015	GAR053	1.0	22.00	40.10	9.05	9.95
07/21/2015	GAR053	2.0	22.00	40.10	9.05	9.93
07/21/2015	GAR053	3.0	22.00	40.10	9.05	9.93
07/21/2015	GAR053	4.0	21.90	40.10	9.05	9.93
07/21/2015	GAR053	5.0	21.90	40.10	9.04	9.91
07/21/2015	GAR053	6.0	21.85	40.10	9.04	9.90
07/21/2015	GAR053	7.0	21.60	40.00	9.04	9.79
07/21/2015	GAR053	8.0	18.60	39.30	8.69	8.60
07/21/2015	GAR053	9.0	16.60	50.10	6.64	0.46
07/21/2015	GAR053	10.0	15.60	48.40	6.69	0.22
07/21/2015	GAR053	11.0	15.30	49.70	6.99	0.55
07/21/2015	GAR053	12.0	14.90	51.10	6.69	0.16
07/21/2015	GAR053	13.0	14.10	52.10	6.67	0.18
07/21/2015	GAR053	14.0	14.40	52.30	6.66	0.19
07/21/2015	GAR053	15.0	13.70	52.90	6.77	0.37
08/18/2015	GAR053	1.0	20.97	39.80	8.79	8.24
08/18/2015	GAR053	2.0	20.92	39.80	8.77	8.18
08/18/2015	GAR053	3.0	20.86	39.60	8.70	8.02
08/18/2015	GAR053	4.0	20.84	39.50	8.67	7.91
08/18/2015	GAR053	5.0	20.83	39.40	8.68	7.86
08/18/2015	GAR053	6.0	20.83	39.60	8.69	7.87
08/18/2015	GAR053	7.0	20.83	39.60	8.69	7.84
08/18/2015	GAR053	8.0	20.81	39.50	8.57	7.66
08/18/2015	GAR053	9.0	20.63	39.20	8.05	6.76
08/18/2015	GAR053	10.0	16.74	52.60	6.53	0.03
08/18/2015	GAR053	11.0	15.15	56.70	6.49	0.03
08/18/2015	GAR053	12.0	15.02	57.10	6.51	0.05
08/18/2015	GAR053	13.0	14.80	59.00	6.58	0.09
08/18/2015	GAR053	14.0	14.71	59.60	6.65	0.13
09/25/2015	GAR053	1.0	16.20	34.80	8.99	11.50
09/25/2015	GAR053	2.0	16.00	34.80	8.92	11.50
09/25/2015	GAR053	3.0	15.90	34.40	8.72	11.00
09/25/2015	GAR053	4.0	15.40	33.60	7.12	8.66

Date	Site	Depth (m)	Temperature (°C)	SpC (µS/cm)	pH (Units)	ODO (mg/L)
09/25/2015	GAR053	5.0	15.30	33.70	7.48	7.57
09/25/2015	GAR053	6.0	15.20	35.00	6.97	5.46
09/25/2015	GAR053	7.0	15.20	35.50	6.90	4.35
09/25/2015	GAR053	8.0	15.10	36.10	6.91	2.40
09/25/2015	GAR053	9.0	15.00	36.50	6.96	2.03
09/25/2015	GAR053	10.0	15.00	37.00	6.98	1.38
09/25/2015	GAR053	11.0	15.00	37.30	7.03	0.79
09/25/2015	GAR053	12.0	15.00	38.20	7.13	0.24
09/25/2015	GAR053	13.0	15.00	38.00	7.67	0.85
05/17/2016	GAR053	0.2	13.099	55.8	8.07	9.86
05/17/2016	GAR053	1.2	12.551	55.3	8.07	9.9
05/17/2016	GAR053	2.2	12.213	55.2	8.01	9.89
05/17/2016	GAR053	3.2	11.981	55.9	7.97	9.88
05/17/2016	GAR053	4.2	11.914	56.2	7.87	9.79
05/17/2016	GAR053	5.2	11.649	55.6	7.58	9.62
05/17/2016	GAR053	6.2	11.567	55.4	7.57	9.52
05/17/2016	GAR053	7.2	10.862	55.6	7.05	9.21
05/17/2016	GAR053	8.2	10.528	56	6.95	8.63
05/17/2016	GAR053	9.2	9.778	56.3	6.83	7.37
05/17/2016	GAR053	10.2	9.463	56.9	6.74	6.18
05/17/2016	GAR053	11.2	9.027	56.4	6.69	6.85
05/17/2016	GAR053	12.2	8.658	56.9	6.66	5.36
05/17/2016	GAR053	13.2	8.545	57.1	6.66	5.31
05/17/2016	GAR053	14.2	8.334	57.2	6.68	4.68
06/23/2016	GAR053	1.0	17.081	34.2	8.13	8.93
06/23/2016	GAR053	2.0	16.878	34.7	8.09	8.89
06/23/2016	GAR053	3.0	16.751	34.4	8.2	9.01
06/23/2016	GAR053	5.0	15.787	34.9	7.67	8.55
06/23/2016	GAR053	7.0	13.344	35.5	6.7	4.86
06/23/2016	GAR053	12.0	12.395	36.7	6.62	3.57
06/23/2016	GAR053	17.0	11.445	38.4	6.7	1.49
07/19/2016	GAR053	0.0	18.9	32.3	8.51	8.54
07/19/2016	GAR053	1.0	18.7	32.1	8.56	8.56
07/19/2016	GAR053	3.5	18.3	32.3	8.59	8.6
07/19/2016	GAR053	6.5	15.8	33.1	7.89	6.35
07/19/2016	GAR053	8.0	15.4	33.9	7.49	4.89
07/19/2016	GAR053	13.0	13.7	35.5	6.86	0.7
07/19/2016	GAR053	18.0	13.4	35.7	6.5	0.18
08/16/2016	GAR053	0.0	20.105	50	9.27	9.27
08/16/2016	GAR053	0.7	20.021	50	9.3	9.32
08/16/2016	GAR053	4.2	19.606	50	9.13	8.94

Date	Site	Depth (m)	Temperature (°C)	SpC (µS/cm)	pH (Units)	ODO (mg/L)
08/16/2016	GAR053	4.9	19.515	49.2	8.94	8.63
08/16/2016	GAR053	6.0	17.709	49.1	7.61	6
08/16/2016	GAR053	8.1	13.834	59.9	7.49	0.22
08/16/2016	GAR053	9.1	13.56	59.8	7.61	0.23
08/16/2016	GAR053	9.2	13.565	-	8.01	0.53
09/14/2016	GAR053	0.0	14.114	54.4	8.01	7.98
09/14/2016	GAR053	1.0	14.169	53.1	7.93	7.51
09/14/2016	GAR053	1.0	14.194	53.5	7.68	7.3
09/14/2016	GAR053	2.0	14.187	53.2	7.8	7.42
09/14/2016	GAR053	3.0	14.199	53.3	7.76	7.36
09/14/2016	GAR053	5.0	14.193	53.6	7.65	7.29
09/14/2016	GAR053	6.0	14.186	53.4	7.6	7.14
09/14/2016	GAR053	7.0	14.182	53.2	7.59	7.11
09/14/2016	GAR053	8.0	14.16	53.4	7.57	7.01
09/14/2016	GAR053	9.0	14.149	53.3	7.54	6.93
09/14/2016	GAR053	10.0	14.109	53.6	7.5	6.88
09/14/2016	GAR053	11.0	14.059	53.8	7.47	6.75
09/14/2016	GAR053	12.0	13.957	53.9	7.4	5.51
10/17/2016	GAR053	7.5	8.949	54.2	7.56	8.97
10/17/2016	GAR053	12.1	8.95	54	7.49	8.72
10/17/2016	GAR053	11.3	8.956	54.3	7.46	8.88
10/17/2016	GAR053	10.2	8.988	53.9	7.46	8.89
10/17/2016	GAR053	9.0	9.02	53.8	7.45	8.9
10/17/2016	GAR053	8.0	9.057	54.5	7.45	8.92
10/17/2016	GAR053	7.1	9.114	54.2	7.45	8.92
10/17/2016	GAR053	6.0	9.161	54	7.44	8.92
10/17/2016	GAR053	5.0	9.174	54.3	7.43	8.93
10/17/2016	GAR053	4.1	9.19	54	7.43	8.94
10/17/2016	GAR053	3.1	9.204	54.1	7.43	8.96
10/17/2016	GAR053	2.1	9.199	54.1	7.43	8.99
10/17/2016	GAR053	1.1	9.203	54.1	7.43	9
10/17/2016	GAR053	0.0	-	53.8	7.43	9.03

Notes: meter (m), specific conductivity (SpC), microsiemens per centimeter (µS/cm)

Appendix C. Public Participation and Public Comments

This 5-year review was developed with participation from the North Fork Payette River Watershed Advisory Group (WAG). On April 6, 2017, the WAG met with DEQ staff to discuss the initial results of the Cascade Reservoir monitoring. On December 12, 2017, the WAG discussed the results and provided input on the draft of the *Cascade Reservoir Watershed Five-Year Review*. WAG comments have been incorporated into the final version of this document.