Cascade Reservoir

Tributary TMDL Addendum

Final

Department of Environmental Quality
November 2011

Cascade Reservoir Tributary TMDL Addendum

November 2011

Prepared by:
Boise Regional Office
Department of Environmental Quality
1445 North Orchard St.
Boise, ID 83706

This page intentionally left blank for correct double-sided printing.

Acknowledgments

Special thanks to the Valley Soil and Water Conservation District and Idaho Soil and Water Conservation Commission for their assistance in prioritizing BMPs for implementation.

This page intentionally left blank for correct double-sided printing.

Contents

List of Tables

List of Figures

Abbreviations, Acronyms, and Symbols

§303(d) Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section

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

AU assessment unit

BMP best management practice

BURP Beneficial Use Reconnaissance Program

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

cfs cubic feet per second

CWA Clean Water Act

CWAL cold water aquatic life

DEQ Department of Environmental Quality

DO dissolved oxygen

EPA United States Environmental Protection Agency

HUC Hydrologic Unit Code

I.C. Idaho Code

IDAPA Refers to citations of Idaho administrative rules

LA load allocation

LC load capacity

m meter

mi mile

mi^2 square miles

MOS margin of safety

n.a. not applicable

NB natural background

nd no data (data not available)

NFS not fully supporting

NRCS Natural Resources Conservation Service

SBA subbasin assessment

TMDL total maximum daily load

t/y tons per year

U.S. United States

U.S.C. United States Code

WAG Watershed Advisory Group

This page intentionally left blank for correct doubled-sided printing.

Executive Summary

This TMDL addendum was developed to address water bodies in the Cascade Reservoir Subbasin that are on Idaho's 2010 §303(d) list.

Regulatory Requirements

This document has been prepared in accordance with federal and state regulations, as described in the following.

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

The SBA is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's current §303(d) list of water quality limited water bodies. Five Assessment Units in the Cascade Reservoir Subbasin were determined to be impaired in the Cascade Five Year Review (DEQ 2009). The SBA examined the status of §303(d) listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance

Cascade Reservoir is located in the Payette River Basin of west central Idaho. (See Figure 1; subwatersheds are shown in Figure 2). Major tributary subwatersheds to the reservoir include the North Fork Payette River (NFPR), Mud Creek, Lake Fork, Boulder Creek, Willow Creek, and Gold Fork River, all of which discharge into the northern end of the reservoir.

The Cascade Reservoir Watershed (part of HUC 17050123) is located in a moderately high elevation valley between 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. A major portion of the watershed is steeply-sloped forested land, while the area immediately adjacent to the reservoir and major tributaries is predominantly shallow-sloped agricultural land. Elevation of the valley floor and reservoir lies at about 4,850 feet.

Cascade Reservoir was created in the spring of 1949 by the Bureau of Reclamation to provide storage for irrigation and flood control. The reservoir is 21 miles long, 4.5 miles wide at the widest point and is relatively shallow, measuring 26.5 feet in average depth.

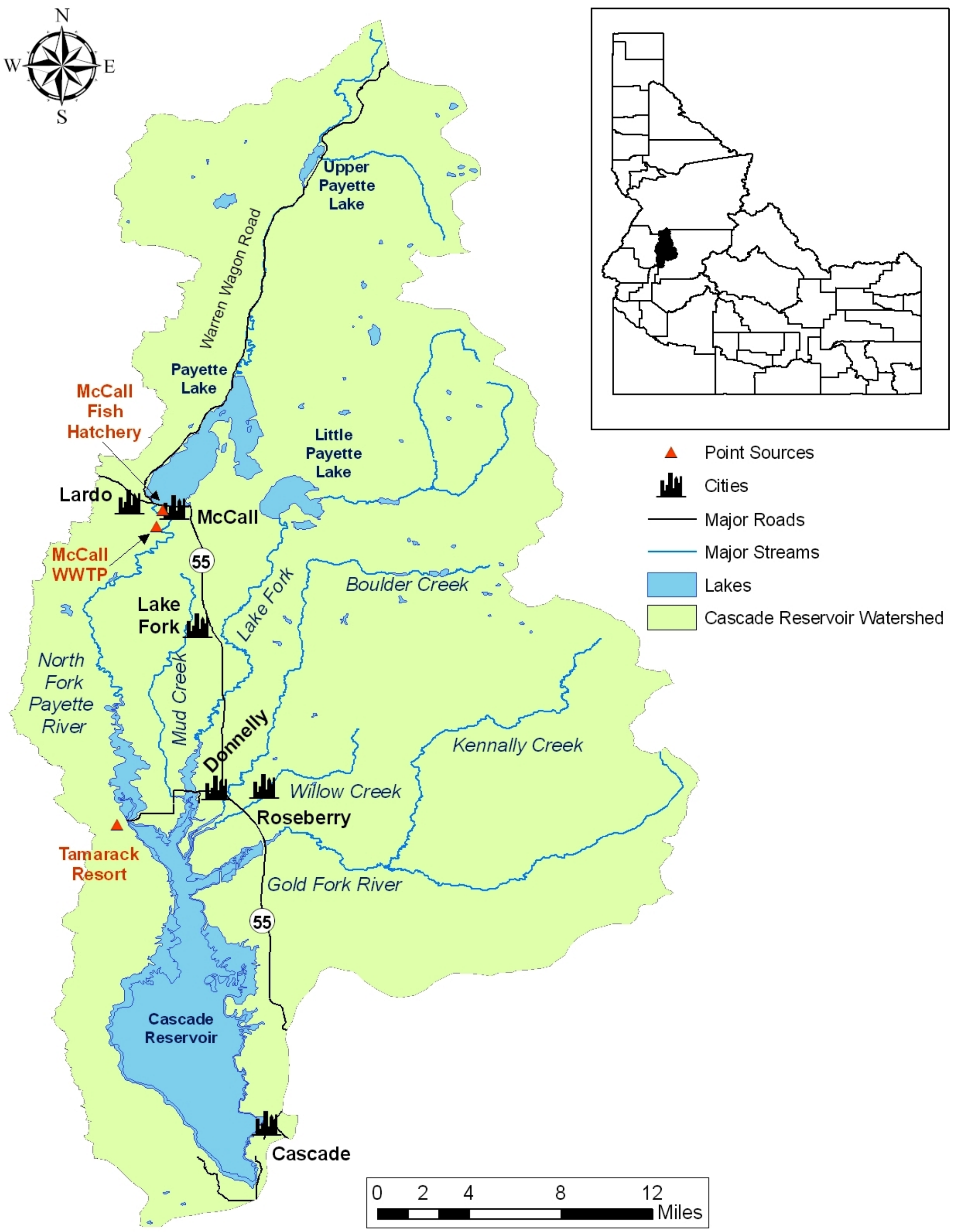

Figure 1. Cascade Reservoir watershed.

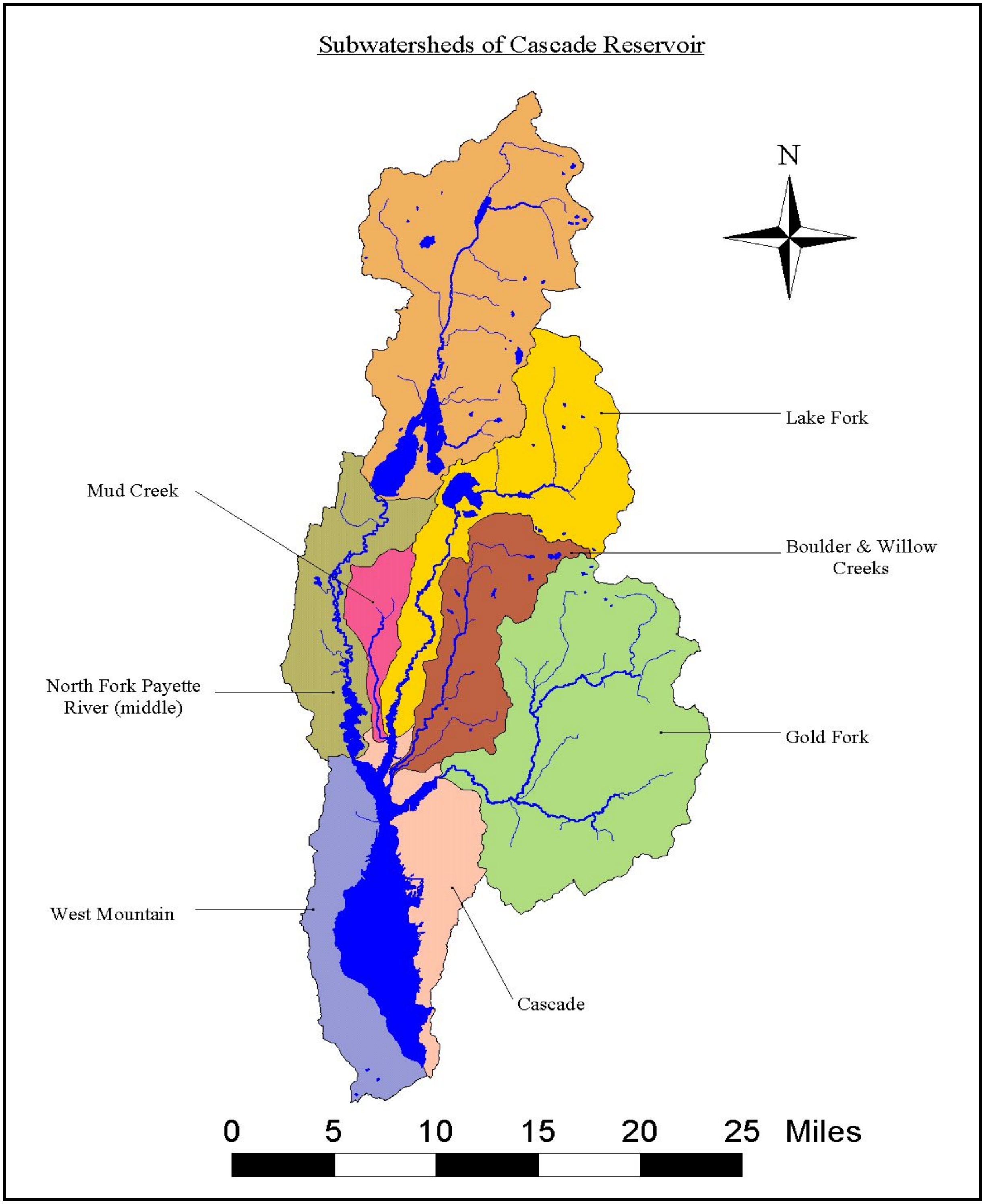

Figure 2. Cascade Reservoir Subbasin subwatersheds.

Ownership

The watershed is predominantly forested (approximately 65%), with both public (US Forest Service and State of Idaho) and private ownership. Much of the private land is used for agricultural purposes, predominantly cattle ranching. Only a small amount of private land is used for crops. Urban and residential areas make up roughly 13% of the total land area.

Key Findings

Based on data and recommendations from the Cascade Reservoir Watershed Five Year TMDL Review, sediment TMDLs were developed for assessment units (AU) in the Gold Fork River, Boulder Creek, and Mud Creek subwatersheds (Table 1).

Table 1. Summary of assessment outcomes.

Water Body Segment/AU	Pollutant	TMDL(s) Completed	Recommended Changes to the Next §303(d) List
Gold Fork River (from below Gold Fork ditch to mouth) 17050123SW008_5a	Sediment	Yes	Move to Category 4a
Boulder Creek 17050123SW011_3	Sediment	Yes	Move to Category 4a
Mud Creek 17050123SW015_02	Sediment	Yes	Move to Category 4a
Mud Creek 17050123SW015_03	Sediment	Yes	Move to Category 4a

1. Subbasin Assessment–Watershed Characterization

This document presents an addendum for the **Cascade Reservoir** SBA/TMDL. This document addresses water bodies in the Cascade Reservoir Subbasin that have been placed on Idaho's current §303(d) list and require a TMDL. Information on the watershed characteristics of this subbasin can be found in the Cascade Reservoir Phase I Watershed Management Plan (DEQ 1996), Cascade Reservoir Phase II Watershed Management Plan (DEQ 1998), and Cascade Reservoir Watershed Five Year Review and Phase III Water Quality Management Plan (DEQ 2009):

http://www.deq.idaho.gov/water/data_reports/surface_water/tmdls/cascade_reservoir/cascade_reservoir.cfm

1.1. Introduction—Regulatory Requirements

This document was prepared in compliance with both federal and state regulatory requirements, as described in the following.

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible.

Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. 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 addresses water bodies in the **Cascade Reservoir** Subbasin that have been placed on Idaho's current §303(d) list.

1.2. Public Participation and Comment Opportunities

The development of the Cascade Reservoir Tributary Tributary TMDL Addendum included the following public participation:

- The Valley Soil and Water Conservation District was consulted in 2009 regarding agricultural implementation strategies to meet the new TMDLs
- The Cascade Reservoir WAG reviewed the document from April-June 2010. The WAG voted on June 29, 2010 to send this document out for public comment. Public comment was held from June 2, 2011 to July 5, 2011.

1.3. Physical and Biological Characteristics

A detailed discussion of the physical and biological characteristics of the Cascade Reservoir Subbasin is provided in the Cascade Reservoir Phase and Phase II Watershed Management Plans approved by EPA in1996 and1999 respectively (DEQ 1996, DEQ 1998).

2. Subbasin Assessment–Water Quality Concerns and Status

2.1. Water Quality Limited Assessment Units Listing Basis

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

Table 2 shows the pollutants listed and the basis for listing for each §303(d) listed AU in the Cascade Reservoir Subbasin that a TMDL is developed for in this document. These are a subset of all the assessment units listed on the 2010 303(d) list. TMDLs were developed for these AUs because the necessary data to develop a TMDL was available.

More information on other AUs on the 303(d) list can be found at the following:

http://www.deq.idaho.gov/water/data_reports/surface_water/monitoring/integrated_report.cfm

Table 2. §303(d) Listing Basis for TMDL AUs in the Cascade Reservoir Subbasin.

Water Body Name	Assessment Unit ID Number	2010 §303(d) Boundaries	Pollutants	Listing Basis
Gold Fork River	ID17050123SW008_05a	5th order Gold Fork River below Gold Fork Ditch	Not Listed	NA
Boulder Creek	ID17050123SW0011_03	Louie Creek to Cascade Reservoir	Sediment	Low BURP Scores
Mud Creek	ID17050123SW015_02	Mud Creek- 1st and 2nd order	Sediment	Low BURP Scores
Mud Creek	ID17050123SW015_03	Mud Creek- 3rd order	Sediment	Low BURP Scores

2.2. Applicable Water Quality Standards and Beneficial Uses

Idaho water quality standards, defined in IDAPA 58.01.02, designate beneficial uses, and set water quality goals for the 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 briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (Grafe et al. 2002) gives a more detailed description of beneficial use identification for use assessment purposes.

2.2.1. Existing Uses

Existing uses under the CWA are "those uses actually attained in the waterbody on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, .02.051.01, and .02.053). Existing uses include uses actually occurring, whether or not the level of quality to support fully the

uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that could support salmonid spawning, but salmonid spawning is not occurring due to other factors, such as dams blocking migration.

2.2.2. Designated Uses

Designated uses under the CWA are “those uses specified in water quality standards for each water body or segment, whether or not they are being attained.” Designated uses are simply uses officially recognized by the state. In Idaho, these designated uses include aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use.

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 specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (see IDAPA 58.01.02.110 - 160).

2.2.3. Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses are to be designated. 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 will apply the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters.

If in addition to these presumed uses, an additional existing use, (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would additionally apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water aquatic life is not found to be an existing use, an use designation 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). Table 3 shows the beneficial uses of the assessment units for which TMDLs have been developed.

Table 3. Beneficial uses of Section 303(d) listed streams.

Water Body/Assessment Unit	Beneficial Uses	Type of Use
Gold Fork River ID17050123SW008_05a	Cold water aquatic life, domestic water supply, salmonid spawning, primary contact recreation, special resource water	designated
Boulder Creek ID17050123SW0011_03	Cold water aquatic life, primary contact recreation	presumed
Mud Creek ID17050123SW015_02 ID17050123SW015_03	Cold water aquatic life, primary contact recreation	presumed

2.3. Criteria to Support Beneficial Uses

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, ammonia, temperature, and turbidity (IDAPA 58.01.02.250).

Table 4 includes the most common numeric criteria used in TMDLs.

Figure 3 provides an outline of the stream assessment process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

Table 4. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Designated and Existing Beneficial Uses				
Water Quality Parameter	**Primary Contact Recreation**	**Secondary Contact Recreation**	**Cold Water Aquatic Life**	**Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)**
Water Quality Standards: IDAPA 58.01.02.250 - 251				
Bacteria, ph, and Dissolved Oxygen	Less than 126 *E. coli*/100 ml[a] as a geometric mean of five samples over 30 days; no sample greater than 406 *E. coli* organisms/100 ml	Less than 126 *E. coli*/100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 *E. coli*/100 ml	pH between 6.5 and 9.0 DO[b] exceeds 6.0 mg/L[c]	pH between 6.5 and 9.5 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 one day minimum and exceeds 6.0 mg/L for a seven day average
Temperature			22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average
Turbidity			Turbidity shall not exceed background by more than 50 NTU[e] 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] *Escherichia coli* per 100 milliliters
[b] dissolved oxygen
[c] milligrams per liter
[d] 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 seven-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.
[e] Nephelometric turbidity units

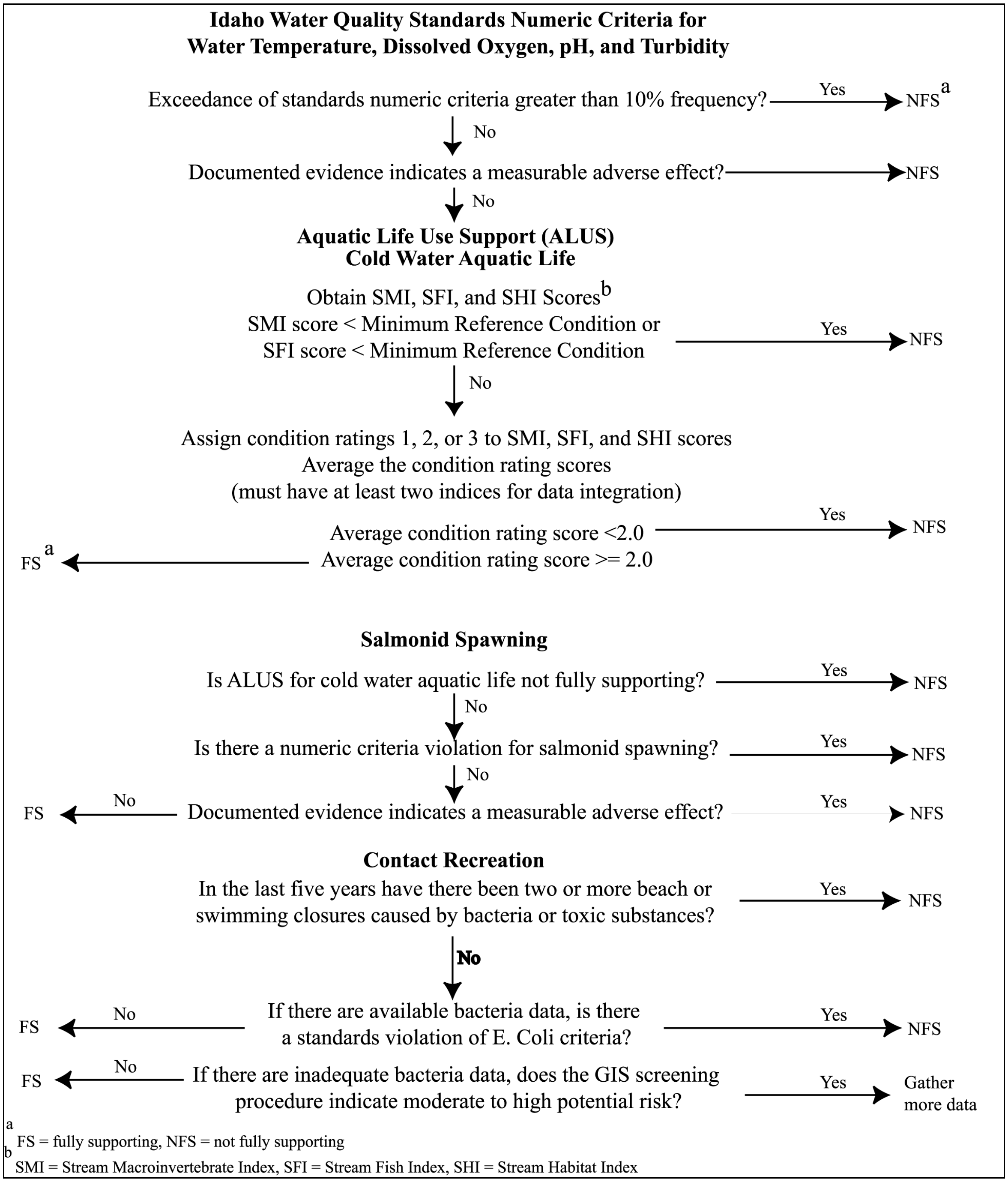

Figure 3. Determination Steps and Criteria for Determining Support Status of Beneficial Uses in Wadeable Streams: Water Body Assessment Guidance, Second Addition (Grafe et al. 2002)

2.4. Summary and Analysis of Existing Water Quality Data

A detailed summary and analysis of existing water quality data for the Cascade Reservoir Subbasin is provided in the Cascade Reservoir Phase I, Phase II, and Five Year Review SBA/TMDL reports:

www.deq.idaho.gov/water/data_reports/surface_water/tmdls/cascade_reservoir/cascade_reservoir.cfm

2.4.1. Flow Characteristics

A detailed discussion of flow characteristics for the Cascade Reservoir is provided in the Cascade Reservoir Phase I and Phase II Watershed Management Plan reports approved by EPA in 1996 and 1999.

2.4.2. Water Column Data

A detailed discussion of water column data for the Cascade Reservoir Subbasin is provided in the Cascade Reservoir Phase I, Phase II and Five Year SBA/TMDL reports.

2.4.3. Biological and Other Data

A detailed discussion of biological and other data for the Cascade Reservoir Subbasin is provided in the Cascade Reservoir Phase I, Phase II and Five Year Review SBA/TMDL reports.

In 2008, DEQ personnel investigated stream bank stability in the 5th order section of Gold Fork Creek. Banks were 38% stable, which is well below the target level of at least 80%.

In 2008 stream bank stability in the section of Boulder Creek downstream of Louie Creek was estimated at 67%, which is below the recommended target of at least 80%. Willow Creek was also investigated for stream bank stability and showed greater than 80% stable banks, which meets the bank stability target.

A stream bank stability inventory was conducted on parts of Mud Creek in 2008. The results showed that stream banks were 68% stable.

TMDLs were recommended for sediment for Boulder Creek, Gold Fork Creek, and Mud Creek.

2.5. Data Gaps

A detailed discussion of data gaps for the Cascade Reservoir Subbasin is provided in the Cascade Reservoir Phase I and Phase II Watershed Management Plan reports approved by EPA in 1996 and 1999.

This page intentionally left blank for correct double-sided printing.

3. Subbasin Assessment–Pollutant Source Inventory

A detailed discussion of pollutant sources for the Cascade Reservoir Subbasin is provided in the Cascade Reservoir Phase I, Phase II and Five Year Review reports (DEQ 1996, DEQ 1998 and DEQ 2009):

http://www.deq.idaho.gov/water-quality/surface-water/tmdls/table-of-sbas-tmdls/cascade-reservoir.aspx

One source of sediment not mentioned specifically in previous documents is shoreline erosion, including in the arms of the reservoir, by wave action caused by boats as well as naturally by high winds.

This page intentionally left blank for correct doubled-sided printing.

4. Monitoring and Status of Water Quality Improvements

A detailed discussion of monitoring and the status of water quality improvements is found in the Cascade Reservoir Five Year Review and Phase III Water Quality Management Plan (DEQ 2009).

4.1. Boulder Creek, Mud Creek, and Gold Fork River

Water quality improvement efforts have occurred in Boulder Creek, Mud Creek and Gold Fork River. These efforts have included fencing, stream bank protection, water conveyance improvements and planned grazing. In addition, there has been significant outreach to the development community on erosion control practices. However, there is opportunity for further implementation, because these water bodies still show signs of impairment and/or contribute large amounts of pollutants to Cascade Reservoir. The following best management practices are recommended for these watersheds to ensure that the TMDLs for nutrients and sediment are met:

- Stream bank Protection
- Stream Channel Stabilization
- Riparian vegetation enhancement (vegetative buffer of 50 feet on either side of stream is recommended)
- Fencing
- Livestock Exclusion
- Planned Grazing System

4.2. Recent Boulder Creek Water Quality Improvement Project

To facilitate implementation, a more focused outreach program was implemented in Boulder Creek. Boulder Creek delivers high nutrient loads to the reservoir and has sediment and temperature issues. There is an existing nutrient TMDL for Boulder Creek.

While there is uncertainty about specific nonpoint sources of phosphorus from agricultural lands, phosphorus is generally assumed to be transported with sediment or runoff from livestock activities. Those activities and problem areas that contribute sediment to the stream due to runoff or bank erosion are assumed to provide the largest sources of phosphorus.

The Idaho Association of Soil Conservation Districts and Idaho Soil and Water Conservation Commission personnel have already prioritized the areas directly adjacent to the stream as being the top priority for implementation areas. These are considered Tier I lands and a more detailed discussion of this topic can be found in the Cascade Reservoir Phase II Watershed Management Plan (DEQ 1998) and also in the Cascade Reservoir Implementation Plan (DEQ 2000).

Recently, the Lake Cascade WAG focused implementation and outreach efforts on Boulder Creek to reduce the pollutant contribution to Cascade Reservoir and improve water quality in Boulder Creek itself. By focusing on one watershed, implementation efforts will be less patchy and a more demonstrable improvement in water quality will be seen in a shorter timeframe in the Boulder Creek watershed. It is important to identify areas that could be improved to substantially reduce nutrient/sediment/heat loading to the stream.

Examples of the recommended implementation strategies already taking place in the watershed include the following:

- In Fall 2009 and Summer 2010, a private landowner on Boulder Creek worked with Idaho Fish and Game to stabilize several hundred feet of stream bank.
- In Summer 2010, another landowner downstream of Donnelly Elementary School fenced off a quarter-mile of stream and worked with Idaho Fish and Game's volunteer crew to plant several hundred shrubs and stabilize the bank.
- At Donnelly Elementary School, Trout Unlimited obtained 319 grant funds to stabilize a steeply eroding stream bank using a log grid structure and enhance 750' of riparian area. This project finished in Fall 2010.
- In Fall 2010, riparian restoration began on another half mile of Boulder Creek and will finish in 2012.

The goal is to improve approximately a half mile of stream per year.

5. Total Maximum Daily Loads

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL.

Practically, the margin of safety is a reduction in the load capacity that is available for allocation to pollutant sources. The natural background load is also effectively a reduction in the load capacity available for allocation to human-made pollutant sources. This can be summarized symbolically as the equation: LC = MOS + NB + LA + WLA = TMDL. The equation is written in this order because it represents the logical order in which a loading analysis is conducted. First, the load capacity is determined. Then the load capacity is broken down into its components: the necessary margin of safety is determined and subtracted; then natural background, if relevant, is quantified and subtracted; and then the remainder is allocated among pollutant sources. When the breakdown and allocation are completed, the result is a TMDL, which must equal the load capacity.

Another step in a loading analysis is the quantification of current pollutant loads by source. This allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary in order for pollutant trading to occur. The load capacity must be based on critical conditions–the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determination of critical conditions can be more complicated than it may appear on the surface.

A load is fundamentally a quantity of a pollutant discharged over some period of time, and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for “other appropriate measures” to be used when necessary. These “other measures” must still be quantifiable, and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways.

5.1. Boulder Creek, Mud Creek, and Gold Fork River Sediment TMDLs

The following sections describe the total maximum daily load for sediment necessary to support beneficial uses in Boulder Creek, Mud Creek, and the Gold Fork River.

5.2. In-stream Water Quality Targets

Tributary water quality targets are based on bank stability of 80%, which is presumed to be close to natural background loading rates. These targets are presumed to meet the goal of the TMDL to restore full support of designated beneficial uses on all 303(d) listed streams. Full support shall be established by demonstrating a declining trend in sediment in conjunction with stream inventory scores that indicate full support of beneficial uses. The AUs for which TMDLs were developed are those in which bank stability was determined to be less than 80% and evidence existed that showed beneficial uses were not supported.

5.2.1. Design Conditions

The Cascade Reservoir watershed is in the Idaho Batholith Level III ecoregion, comprising the following:

- High glacial drift-filled ecoregion in the valley floor
- Southern forested mountains ecoregion surrounding the valley
- High Idaho Batholith in the peaks of West Mountain

The geology and coarse-textured soils of the region are influenced by the Idaho Batholith, which is granitic rock.

Annual erosion and sediment delivery are functions of climatic variability where above average water years typically produce higher erosion and subsequently higher sediment loads from unstable stream banks. Stable stream banks that allow peak flow access to the flood plain are able to withstand extreme hydrologic events without becoming unstable. The annual average sediment load is not distributed equally throughout the year. Erosion typically occurs during a few critical months during spring runoff when bankfull (high) flow occurs.

5.2.2. Target Selection

Sediment targets are selected to accomplish the narrative criterion of 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.)

It is assumed that natural background sediment loading rates from bank erosion equate to 80% or greater bank stability as described in Overton and others (1995). Therefore, 80% has been selected as the target for stream bank stability. Eroding stream banks of the 303(d) listed streams were measured and rated for stability using NRCS methods. The length and

height of eroding stream bank is measured for at least 10% of the total length of the stream. Rate of erosion is developed by qualitative measures of bank condition. Where possible, aerial photographs were investigated to corroborate extrapolation to the rest of the stream. The erosivity of the soil type is entered into the calculation for a total evaluation of eroding area, rate of erosion, and soil erosivity.

The current state of science does not allow precise statement of a sediment load or load capacity that would translate into characteristics (e.g. TSS percent depth fines) known to support beneficial uses for cold water aquatic life and salmonid spawning and thus meet Idaho's narrative criterion for sediment. The load capacity lies somewhere between current loading and levels that relate to natural stream bank erosion levels. It is assumed that beneficial uses would be fully supported at natural background sediment loading rates. These rates were assumed to equate to the 80 percent bank stability regimes and thereby meeting state water quality standards.

Aquatic life uses may be supported at higher or lower rates of sediment loading. The strategy is to establish a declining trend in sediment load as measured by increasing bank stability, and to monitor these water quality indicator targets as well as the stream biota (biomonitoring). If it is established that aquatic life uses are supported at an intermediate sediment load above natural background levels, then Idaho's narrative sediment standard is met and the TMDL will be revised accordingly.

5.2.3. Monitoring Points

Monitoring locations for the 303(d) listed streams were based on where access was granted by landowners, as most of the land adjacent was privately owned.

5.3. Load Capacity

A load capacity is ". . .the greatest loading a waterbody can receive without violating water quality standards" [40 CFR §130.2]. This must be at a level to meet ". . .water quality standards with seasonal variations and a margin of safety which takes into account any lack of knowledge. . ." (Clean Water Act § 303(d)(C)). Likely sources of uncertainly include lack of knowledge of assimilative capacity, uncertain relation of selected target(s) to beneficial use(s), and variability in target measurement.

The load capacity of sediment from stream bank erosion shall be based on assumed natural stream bank stability of greater than or equal to 80% (Overton et al 1995). It is presumed that beneficial uses would be supported with natural background loading rates. Therefore, the loading capacity lies somewhere between the current conditions and sediment loading from natural stream bank erosion. An adaptive management approach will provide reductions in sediment loading based on best management practice (BMP) implementation. Further monitoring will determine the loading rate at which beneficial uses are supported. Load capacities are presented in Table 5.

Table 5. Calculated load capacities for 303(d) listed streams.

Watershed	Load Capacity (tons/day)	Estimation Method
Gold Fork River	.56	Calculated at 80% stability
Boulder Creek	.62	Calculated at 80% stability
Mud Creek	.44	Calculated at 80% stability

Load capacities are calculated using a lateral recession rate that would be equivalent to very slight erosion, which is 0.03 feet per year. It is also assumed that the load capacity is based on 80% stable and covered stream banks. It is understood that the natural background condition and the load capacity may differ, but 80% bank stability has been described as a natural background sediment loading rate in Overton and others (1995):

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

5.4. Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). Current sediment delivery in this watershed (Table 6) has been calculated by measuring the eroding stream banks and evaluating their condition.

Table 6. Current loads from nonpoint sources in Cascade Reservoir watershed.

Watershed	Current Sediment Delivery (tons/day)	Estimation Method
Gold Fork River	.95	Measured bank erosion data
Boulder Creek	1.03	Measured bank erosion data
Mud Creek	2.30	Measured bank erosion data

Gold Fork River is a meandering stream with eroding stream banks of an average height of 2.3 feet with a lateral recession rate of 0.08 feet per year. Much of the excess sediment is deposited as point bars in the channel. Point bars alternating with scoured stream banks exist through the entire inventoried reach and throughout most of the rest of the channel as indicated by aerial photo interpretation. It is most likely that most of the excess sediment is deposited at the lower end of the river where Cascade Reservoir often backs up the channel, slowing the water velocity and allowing the sediment to drop out.

The Boulder Creek location monitored had a 2.3-foot average eroding stream bank height and a lateral recession rate of 0.15 feet per year. Part of this reach, near the reservoir, was too deep to wade and sluggish with swampy edges and no defined stream banks.

Mud Creek is entirely on private land used mainly for agriculture. Eroding stream banks averaged 3.3 feet high with a lateral recession rate of 0.15 feet per year. Most of the streambed consists of sand (particles <¼-inch diameter), but there were some gravels in the ¼-inch class and fewer in the ½-inch class.

5.5. Load Allocation

5.5.1. Load Allocation Basis

The load allocation (Table 7) was based on occurrence of North Fork Payette River historic flows apportioned over quarters to account for seasonal variation and the fact that at higher flows, greater sediment loads can be expected and conversely during low flow periods, significantly less erosion is expected (percent of flows occurring in each quarter not actual flows were used in these calculations). The entire load allocation is allocated to nonpoint sources and includes natural background. A 10% Margin of Safety is added to the load reduction to ensure beneficial use restoration.

Table 7. Load allocations for 303(d) listed assessment units.

Assessment Unit	Current Sediment Delivery (tons/day)	Average Annual Load Capacity (tons/day)	MOS (10% of load capacity)	Ave Annual Load Capacity + MOS (tons/day)	Load Allocation with margin of safety shown on a seasonal flow basis(tons/day)				Ave. Annual Load Reduction (Ton/day)	% Decrease of Load Capacity over Current Sediment Delivery
					Jan-Mar	April-June	July-Sept	Oct-Dec		
Gold Fork River (SW008_05a)	.95	.56	.056	.50	.139	1.468	.264	.146	.446	47%
Boulder Creek (SW011_03, 011_0L)	1.03	.62	.062	.56	.153	1.627	.293	.159	.470	46%
Mud Creek (SW015_02, SW015_03)	2.3	.44	.044	.40	.109	1.155	.208	.112	1.9	83%

5.5.2. Margin of Safety

A 10 % margin of safety (MOS) is applied to ensure that beneficial uses will be restored. This MOS is applied by subtracting an additional 10% from the load capacity and the load reductions are determined by subtracting the load capacity minus a 10 percent margin of safety from the current load.

5.5.3. Seasonal Variation

It is recognized that most of the total annual sediment load erodes from the stream banks during the spring high flow caused by snowmelt or rain-on-snow events when the streams are at or near bankfull. Stream bank erosion inventory measures erosive stream banks at their bankfull level to account for this sediment load. Monitoring stream bank erosion is done during base flow conditions.

5.5.4. Construction Storm Water and TMDL Waste Load Allocations

Construction Storm Water

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

The Construction General Permit (CGP)

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

Storm Water Pollution Prevention Plan (SWPPP)

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

Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed DEQ may incorporate a gross WLA for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a Construction General Permit (CGP) under the NPDES program and implement the appropriate Best Management Practices.

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

5.5.5. Remaining Available Load/Reserve for Growth

No reserve for growth is incorporated into this load, because future activities should not impact the stream channel.

5.6. Pollution Trading

Pollutant trading (also known as *water quality trading*) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way

of helping to solve water quality problems by focusing on cost effective local solutions to problems caused by pollutant discharges to surface waters.

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

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

Pollutant trading is recognized in Idaho's Water Quality Standards at IDAPA 58.01.02.055.06. Currently, DEQ's policy is to allow for pollutant trading as a means to meet total maximum daily loads (TMDLs), thus restoring water quality limited water bodies to compliance with water quality standards. The *Pollutant Trading Guidance* document sets forth the procedures to be followed for pollutant trading:

http://www.deq.idaho.gov/water-quality/surface-water/pollutant-trading.aspx

5.6.1. Trading Components

The major components of pollutant trading are *trading parties* (buyers and sellers) and *credits* (the commodity being bought and sold). Additionally, *ratios* are used to ensure environmental equivalency of trades on water bodies covered by a TMDL. All trading activity must be approved by DEQ. Both point and nonpoint sources may create marketable credits, which are a reduction of a pollutant beyond a level set by a TMDL:

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

5.6.2. Watershed-Specific Environmental Protection

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

5.6.3. IV. Trading Framework

For pollutant trading to be authorized, it must be specifically mentioned within a TMDL document. After adoption of an EPA approved TMDL, DEQ, in concert with the Watershed Advisory Group (WAG), must develop a pollutant trading framework document as part of an implementation plan for the watershed that is the subject of the TMDL.

The elements of a trading document are described in DEQ's Pollutant Trading Guidance: http://www.deq.idaho.gov/water/prog_issues/waste_water/pollutant_trading/pollutant_trading_guidance_entire.pdf.

5.7. Public Participation

House Bill 145 (HB145) has brought about changes in how WAGs are involved in TMDL development and review. The basic process for developing TMDLs and implementation plans is as follows:

1. BAG members are appointed by DEQ's director for each of Idaho's basins.
2. An "Integrated Report" is developed by DEQ every two years that highlights which water bodies in Idaho appear to be degraded.
3. DEQ prepares to begin the SBA and TMDL process for individual degraded watersheds.
4. A WAG is formed by DEQ (with help from the BAG) for a specific watershed/TMDL.
5. With the assistance of the WAG, DEQ develops an SBA and any necessary TMDLs for the watershed.
6. The WAG comments on the SBA/TMDL.
7. WAG comments are considered and incorporated, as appropriate, by DEQ into the SBA/TMDL.
8. The public comments on the SBA/TMDL.
9. Public comments are considered and incorporated, as appropriate, by DEQ into the SBA/TMDL.
10. DEQ sends the document to the U.S. Environmental Protection Agency (EPA) for approval.
11. DEQ and the WAG develop, then implement, a plan to reach the goals of the TMDL.

DEQ will provide the WAG with all available information pertinent to the SBA/TMDL, when requested, such as monitoring data, water quality assessments, and relevant reports. The WAG will also have the opportunity to actively participate in preparing the SBA/TMDL documents.

Once a draft SBA/TMDL is complete, it is reviewed first by the WAG, then by the public. If, after WAG comments have been considered and incorporated, a WAG is not in agreement with an SBA/TMDL, the WAG's position and the basis for it will be documented in the public notice of public availability of the SBA/TMDL for review. If the WAG still disagrees with the SBA/TMDL after public comments have been considered and incorporated, DEQ must incorporate the WAG's dissenting opinion.

The Cascade Reservoir WAG reviewed this document and revisions were made in response to their comments.

5.8. Implementation Strategies

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

5.8.1. Time Frame

A schedule for implementation of best management practices, pollution control strategies, assessment reporting dates, and evaluation of progress will be developed with appropriate designated management agencies. The expected time frame for meeting water quality standards and/or beneficial uses is within 5-10 years, depending upon how quickly implementation projects are put on the ground. Participation in implementation is voluntary so implementation can take longer if participation is limited.

5.8.2. Approach

This TMDL focuses on implementation of load allocations for sediment. Both the biological and numeric water quality data analyzed for this project suggests that poor habitat conditions are impairing the designated beneficial uses in some of the assessed water bodies.

Instream channel erosion is remedied using riparian restoration and bank stabilization techniques. Other factors may need to be evaluated including whether culverts are sized correctly for flows.

5.8.3. Responsible Parties

Idaho Code 39-3612 states designated management agencies are to use TMDL processes for achieving water quality standards. The Department of Environmental Quality will rely on the designated management agencies to implement pollution control measures or best management practices for pollutant sources they identify as priority.

DEQ also recognizes the authorities and responsibilities of local city and county governments as well as applicable state and federal agencies and will enlist their involvement and authorities for protecting water quality through implementation of Idaho Administrative Procedures Act 58.01.02 and Clean Water Act Section 401.

The designated state agencies listed below are responsible for assisting and providing technical support for the development of specific implementation plans and other appropriate support to water quality projects. General responsibilities for Idaho designated management agencies are as follows:

- Idaho Soil and Water Conservation Commission: grazing and agriculture.
- Idaho State Department of Agriculture: aquaculture and animal feeding operations.
- Idaho Transportation Department: public roads.
- Idaho Department of Lands: timber harvest, oil and gas exploration, and mining.
- Idaho Department of Water Resources: stream channel alteration activities.
- Department of Environmental Quality: all other activities.

5.8.4. Monitoring Strategy

Idaho Code 39-3611 requires the Department of Environmental Quality to review and evaluate each Idaho TMDL, supporting assessment, implementation plan, and all available data periodically, at intervals no greater than five years. Such reviews are to be conducted using the Beneficial Use Reconnaissance Program protocol and the Water Body Assessment Guidance methodology to determine beneficial use attainability and status and whether state water quality standards are being achieved. A channel erosion analysis will be done as part of the Five Year Review process.

5.9. Reasonable Assurance

Load allocations (LAs) were developed to reduce sediment from nonpoint source activities. Sediment LAs were calculated from stream bank erosion inventories. A basic implementation strategy to address nonpoint source sediment reduction is outlined in this document in Section 4. Boulder Creek is being addressed first then Mud Creek then Gold Fork. In addition, the 319 program provides an avenue for nonpoint source pollution reduction project funding. 319 and WQPA funding were recently secured for ½ mile of stream bank stabilization and riparian restoration on Boulder Creek.

Future monitoring will include stream bank erosion inventories to assess changes in the sediment load. The combination of implementation activities and monitoring to determine progress toward reducing sediment loads provides reasonable assurance that the targets will be met in a ten-year period.

5.10. Conclusions

The TMDLs developed as part of this report are shown in Table 8.

Table 8. TMDL Summary Table.

Water Body Name/Assessment Unit	Boundaries	Pollutant	TMDL(s) Completed	Recommended Changes to the Next Integrated Report
Gold Fork River 17050123SW008_5a	Diversion Dam to Mouth	Sediment	Yes	Move to Category 4a
Boulder Creek 17050123SW011_3	3rd order section	Sediment	Yes	Move to Category 4a
Mud Creek 17050123SW015_02	2nd order section	Sediment	Yes	Move to Category 4a
Mud Creek 17050123SW015_03	3rd order section	Sediment	Yes	Move to Category 4a

References Cited

American Geological Institute. 1962. Dictionary of geological terms. Doubleday and Company. Garden City, NY. 545 p.

Armantrout, N.B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society. Bethesda, MD. 136 p.

Batt, P.E. 1996. Governor Philip E. Batt's Idaho bull trout conservation plan. State of Idaho, Office of the Governor. Boise, ID. 20 p + appendices.

Clean Water Act (Federal water pollution control act), 33 U.S.C. § 1251-1387. 1972.

EPA. 1996. Biological criteria: technical guidance for streams and small rivers. EPA 822-B-96-001. U.S. Environmental Protection Agency, Office of Water. Washington, DC. 162 p.

Franson, M.A.H., L.S. Clesceri, A.E. Greenberg, and A.D. Eaton, editors. 1998. Standard methods for the examination of water and wastewater, twentieth edition. American Public Health Association. Washington, DC. 1,191 p.

Grafe, C.S., C.A. Mebane, M.J. McIntyre, D.A. Essig, D.H. Brandt, and D.T. Mosier. 2002. The Idaho Department of Environmental Quality water body assessment guidance, second edition-final. Department of Environmental Quality. Boise, ID. 114 p.

Hughes, R.M. 1995. Defining acceptable biological status by comparing with reference condition. In: Davis, W.S. and T.P. Simon, editors. Biological assessment and criteria: tools for water resource planning and decision making. CRC Press. Boca Raton, FL. p 31-48.

Idaho Code § 39.3611. Development and implementation of total maximum daily load or equivalent processes.

Idaho Code § 39.3615. Creation of watershed advisory groups.

Idaho Department of Environmental Quality (DEQ); 1998; *Cascade Reservoir Phase 1I Watershed Management Plan*; Idaho Department of Environmental Quality, Boise Regional Office, Boise, Idaho.

Idaho Department of Environmental Quality (DEQ); 2000 (June); *Implementation Plan for the Cascade Reservoir Phase 1I Watershed Management Plan*; Idaho Department of Environmental Quality, Boise Regional Office, Boise, Idaho.

Idaho Division of Environmental Quality (DEQ); 1996 (January); *Cascade Reservoir Phase 1 Watershed Management Plan*; Idaho Division of Environmental Quality, Boise Regional Office, Boise, Idaho; 86p + appendices.

Idaho Division of Environmental Quality (DEQ); 1996; *Cascade Reservoir Data Summary - Water Year 1995*; Idaho Division of Environmental Quality, Boise Regional Office, Boise, Idaho.

Idaho Division of Environmental Quality (DEQ); 1998; *Cascade Reservoir Data Summary - Water Year 1996*; Idaho Division of Environmental Quality, Boise Regional Office, Boise, Idaho.

IDAPA 58.01.02. Idaho water quality standards and wastewater treatment requirements.

Karr, J.R. 1991. Biological integrity: a long-neglected aspect of water resource management. Ecological Applications 1:66-84.

Rand, G.W., editor. 1995. Fundamentals of aquatic toxicology: effects, environmental fate, and risk assessment, second edition. Taylor and Francis. Washington, DC. 1,125 p.

Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. Transactions American Geophysical Union 38:913-920.

USGS. 1987. Hydrologic unit maps. Water supply paper 2294. United States Geological Survey. Denver, CO. 63 p.

Water Environment Federation. 1987. The Clean Water Act of 1987. Water Environment Federation. Alexandria, VA. 318 p.

Water Quality Act of 1987, Public Law 100-4. 1987.

Water quality planning and management, 40 CFR Part 130.

GIS Coverages

Restriction of liability: Neither the state of Idaho nor the Department of Environmental Quality, nor any of their employees make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness or usefulness of any information or data provided. Metadata is provided for all data sets, and no data should be used without first reading and understanding its limitations. The data could include technical inaccuracies or typographical errors. The Department of Environmental Quality may update, modify, or revise the data used at any time, without notice.

Glossary

§303(d)

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

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.

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

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, and wadeable streams and rivers

Best Management Practices (BMPs)

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

.

Clean Water Act (CWA)

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

Criteria

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

Cubic Feet per Second

A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

disturbance of natural drainages; the excess of erosion over the normal for an area (also see Erosion).

Depth Fines

Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 millimeters depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 centimeters).

Designated Uses

Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.

E. coli

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

Erosion

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

Exceedance

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

Existing Beneficial Use or Existing Use

A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).

Fully Supporting

In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Fully Supporting Cold Water

Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions.

The living place of an organism or community.

Hydrologic Unit

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

Hydrologic Unit Code (HUC)

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

Hydrology

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

Load Allocation (LA)

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

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(ing) Capacity (LC)

A determination of 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, and a margin of safety, it becomes a total maximum daily load.

Macroinvertebrate

An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen.

.

Margin of Safety (MOS)

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

Mean

Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.

Metric

1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.

Monitoring

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

Nonpoint Source

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

Not Fully Supporting

Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Phosphorus

An element essential to plant growth, often in limited supply, and thus considered a nutrient.

Pollutant

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

Pollution

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

Reach

A stream section with fairly homogenous physical characteristics.

Reconnaissance

An exploratory or preliminary survey of an area.

Reference

A physical or chemical quantity whose value is known and thus is used to calibrate or standardize instruments.

Riparian

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

Runoff

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

Sediments

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

Subbasin

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

Subbasin Assessment (SBA)

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

Subwatershed

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

Total Maximum Daily Load (TMDL)

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

Wasteload Allocation (WLA)

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

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

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

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

Water Quality Management Plan
A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act.

Water Quality Modeling
The prediction of the response of some characteristics of lake or stream water based on mathematical relations of input variables such as climate, stream flow, and inflow water quality.

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

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

This page intentionally left blank for correct doubled-sided printing.

Appendix A. Unit Conversion Chart

This page intentionally left blank for correct double-sided printing.

Table 9. Metric - English unit conversions.

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

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

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

This page intentionally left blank for correct doubled-sided printing.

Appendix B. Data Sources

Table 10. Data sources for Cascade Reservoir TMDL Addendum

Water Body	Data Source	Type of Data	When Collected
Boulder Creek	DEQ	Bank erosion	2008
Gold Fork River	DEQ	Bank erosion	2008
Mud Creek	DEQ	Bank erosion	2008

This page intentionally left blank for correct doubled-sided printing.

Appendix C. Distribution List

Cascade Reservoir WAG

Bill Stewart, EPA Region 10, Idaho Operations Office

This page intentionally left blank for correct double-sided printing.

Appendix D. Public Comments

William Stewart, EPA	There appears to be no real water quality data associated with this TMDL other than the BURP sampling discussed on page3. It would be helpful to include more information on the BURP sampling and results to better understand the basis for listing and the selection of sediment as the focus of the TMDL.	Data is discussed in the Cascade Five Year Review, which is referenced in this document.
	This TMDL addendum clearly shows that there has been a lot of effort and good work on improving these tributaries to Cascade Reservoir. It is clear that streambank stabilization is an important factor in the sediment issues in these tributaries.	Comment noted.
	Mud Creek clearly has lots of agricultural use (cattle ranching) and that is most likely having an effect of streambank stability in the watershed. There are also development pressures and unpaved roads in the watershed which are possibly having an effect on sediment loading. Were roads considered in the development of this TMDL.	Road were initially looked at due to the presence of road crossings over Mud Creek in several locations. However, road crossings were not determined to be a significant source of sediment delivery when compared to the extent of contributions from instream bank erosion.
	Boulder Creek also has development issues with accompanying roads and logging in the upper end of the tributary. There is no mention of any source of sediment except streambank stability in the TMDL.	Suspended sediment data for Boulder Creek where the meadowed area starts does not show transport of sediment into the meadowed reach. In addition, the reaches above this AU are full support. Again, the greater contribution of sediment is from streambank erosion.
	Gold Fork Creek has had considerable logging activity and there are many logging roads on steep topography. There is some agricultural use and development in this watershed as well. Have sediment sources besides streambank stability been considered in Gold Fork Creek and if so, why aren't they included in the TMDL.	The Forestry Implementation plan for the Cascade Watershed indicates that a substantial amount of BMPs for roads were implemented in this watershed, exceeding the implementation goals. AU's higher in the watershed show full support of beneficial uses and do not appear to be delivering excess sediment to this downstream AU.

	On page 13 of the document, in the last sentence is stated "For certain pollutants whose effects are long terms, such as sediment and nutrients, EPA allows for seasonal or annual loads." This statement is incorrect since the "Anacostia Decision' in the First Circuit. This court decision makes it clear that the TMDL requires a 'daily load' for all parameters. This EPA position is clearly spelled out in the Memo from Ben Grumbles dated November 15, 2006.	This section has been revised.
	Table 7 on page 17 is difficult to understand. The columns titled "Current Sediment Delivery" and "load Reduction" don't relate very well to the seasonal allocations in the 'load allocation/load capacity' column. Perhaps the first two columns mentioned need to be seasonal as well. The allocations are expressed in tons/day which seems to be appropriate.	This table has been revised to include an overall load capacity.
	The statement in section 5.5.2 does not constitute a margin of safety at all. There is nothing in this section of the document to explain why these allocations would represent an implicit margin of safety.	A 10% margin of safety will be added.
	Throughout these three tributaries watersheds are rich and diverse wetland resources. Some of these have been altered or drained in the past. Consideration should be given to restoration or protection of these valuable wetlands for water quality improvements in streams. Healthy wetland systems can reduce peak flows and the accompanying erosion and sediment problems. Has wetland conservation been considered as part of watershed implementation plans.	The Valley Soil and Water Conservation District and NRCS office provide outreach to landowners on the value of wetlands as well as the opportunity to sign up for programs such as the wetland reserve program.
Bob Allen	Not having a No Wake Zone at least 100 ft. from shore lines causes bank erosion and contributes to the poor water quality. County commissioners have refused to pass a law requiring a no wake zone.	Wave action from boats can cause excessive bank erosion. Wave action as a source of erosion has been added into section 3 of this document.
Becky Johnstone	You attribute the majority of phosphorus in this basin to agriculture. I think you need to look hard at the amount coming from burning forests. Sources and Receptors of Mercury in Idaho, prepared by ICIE and IACI and presented to DEQ during mercury negotiated rule making in 2009 includes the following: Another consequence of fire involves changes in nutrient loads, which in turn affect mercury uptake. For example, the 5-fold increases in whole-body mercury levels reported in rainbow trout in partially burned vs. unburned catchments in Moab Lake in Jasper	Your point regarding the need to look at all sources of pollutants is an important one. However, in this particular watershed, a significant amount of effort went into delineating sources of phosphorus. Long term monitoring watershed results show low levels of phosphorus at monitoring sites from forested reaches

	National Park, Alberta, Canada were attributed to increases in phosphorus and nitrogen in addition to the increased mercury. These nutrient increases persist for several years, and can influence trophic structure and productivity in lakes which affect mercury uptake. Kelly, Erin N., Schindler, David W., St. Louis, Vincent L., Donald, David B., and Vladicka, Katherine E. 2006. Forest fire increases mercury accumulation by fishes via food web restructuring and increased mercury inputs. Proceedings of the National Academy of Sciences, Vol. 103, No. 51. http://www.pnas.org/content/103/51/19380.full. I think you need to take a hard look at just how much of the phosphorus reaching Lake Cascade comes, not from agriculture but from controlled and uncontrolled burns conducted by the Forest Service. I do not think those amounts can be ignored. They are probably more significant than the sources you cite. Idaho DEQ should become more involved in Forest Planning in the state in order to reduce phosphorus and mercury in our waters and fish.	and significantly higher levels of phosphorus in meadowed streams, which tend to flow in agricultural and urban/suburban land use areas. The exception to this is in the Gold Fork watershed, which has high levels of phosphorus associated with its soils. The original Cascade TMDL shows an apportionment of phosphorus from sources based on land use data.

This page intentionally left blank for correct double-sided printing.