Pack River Nutrients Total Maximum Daily Load

Addendum to the Pend Oreille Lake Nearshore Waters Nutrient SBA and TMDL

Idaho Department of Environmental Quality

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Final

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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

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

AU assessment unit

BLM United States Bureau of Land Management

BMP best management practice

BOD biochemical oxygen demand

BURP Beneficial Use Reconnaissance Program

cfs cubic feet per second

CWA Clean Water Act

CWAL cold water aquatic life

CWE cumulative watershed effects

DEQ Department of Environmental Quality

DO dissolved oxygen

EPA United States Environmental Protection Agency

GIS Geographical Information Systems

HUC Hydrologic Unit Code

IDAPA Refers to citations of Idaho administrative rules

IDFG Idaho Department of Fish and Game

IDL Idaho Department of Lands

LA load allocation

LC load capacity

m meter

m^3 cubic meter

mi mile

MBI Macroinvertebrate Biotic Index

mg/L milligrams per liter

mm millimeter

MOS margin of safety

n.a. not applicable

NA not assessed

NFS not fully supporting

SBA subbasin assessment

SCR secondary contact recreation

SFI DEQ's Stream Fish Index

SHI DEQ's Stream Habitat Index

SMI DEQ's Stream Macroinvertebrate Index

TMDL total maximum daily load

TP total phosphorus

t/y tons per year

U.S. United States

U.S.C. United States Code

USFS United States Forest Service

USGS United States Geological Survey

WAG Watershed Advisory Group

WBAG *Water Body Assessment Guidance*

WLA wasteload allocation

WQS water quality standard

Executive Summary

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

This document addresses the Pack River watershed located in the Pend Oreille Subbasin that have been placed on Idaho's current §303(d) list. This document only addresses the nutrient TMDL developed for the Pack River watershed. For more information regarding the Pend Oreille subbasin please refer to the *Pend Oreille Lake Nearshore Waters Nutrient Subbasin Assessment and Total Maximum Daily Load* (DEQ 2002).

This TMDL analysis have been developed to comply with Idaho's TMDL schedule. This document describes the current pollutant load, the target pollutant load, and the pollutant load reduction required to restore full support of beneficial uses.

Pack River Watershed at a Glance

The Pack River watershed is a portion of the Pend Oreille Lake Subbasin (17010214) located in northern Idaho. The Pack River watershed encompasses approximately 185,600 acres and ranges in elevation from a high of 7,550 feet to a low of 2,050 feet above mean sea level. Land ownership in the Pack River watershed consists of federal, state, and private (Figure A). Land use activities within the watershed include silviculture, agriculture, grazing, rural development, forest and rural roads, and recreational uses (skiing and off-road vehicle).

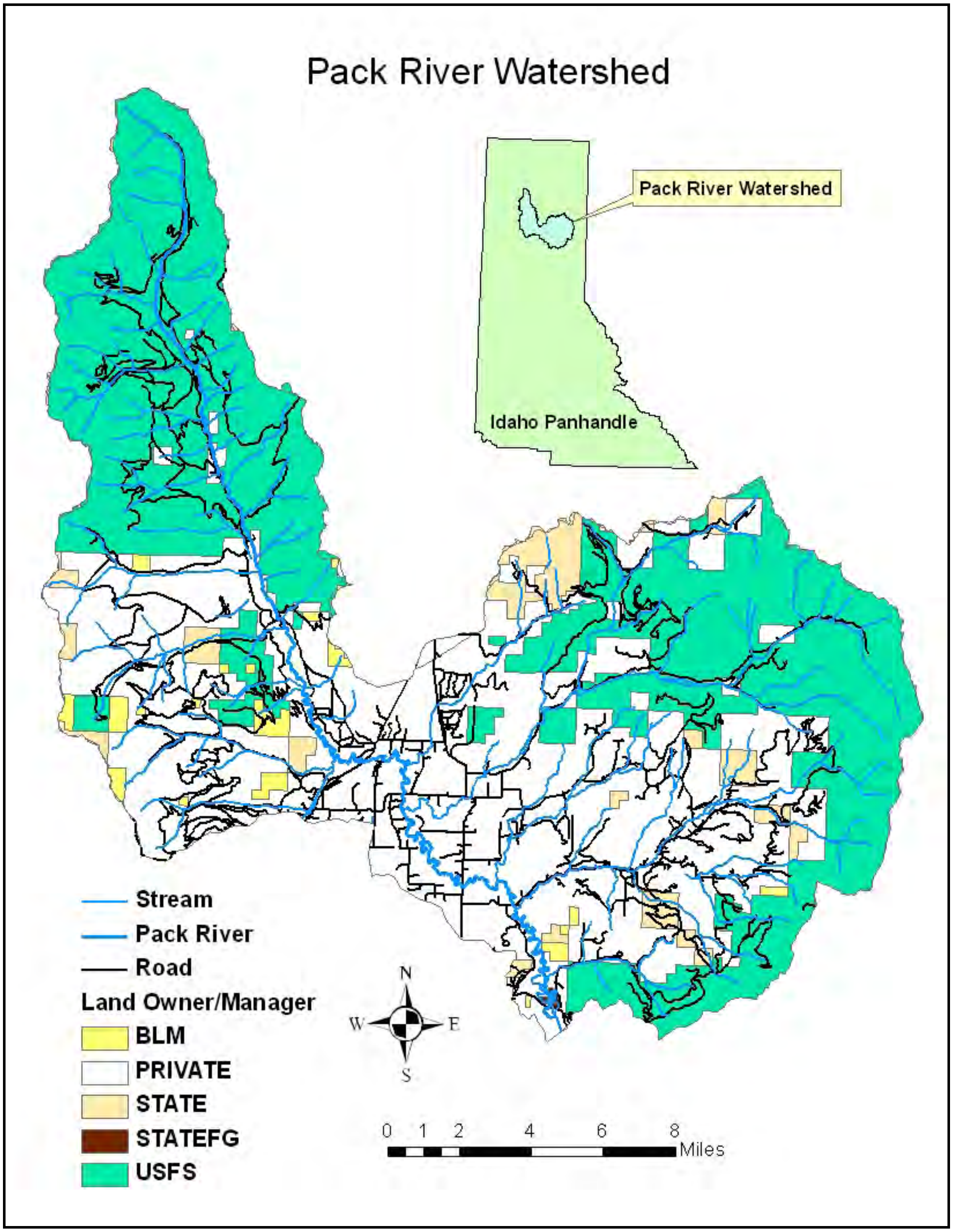

Figure 1. Pack River watershed.

Key Findings

The Pack River and tributaries to the Pack River have been identified as impaired due to causes unknown (Table A1). Stressor Identification reports were completed for all assessment units impaired by causes unknown and potential stressors/pollutants have been identified for each assessment unit (DEQ 2006). For each assessment unit the following stressors/pollutants were evaluated as possible contributors to impairment; low nutrients, altered flow regime, increased sediment, reduction in riparian habitat, increased metals concentrations, increased nutrients, and misuse of sampling protocol. Conclusions from the Stressor Identification reports identified stressors/pollutants for each assessment unit (Table A2).

Table A 1. Unknown listings on Idaho's 2002 Integrated Report.

Stream	Assessment Unit	Pollutant
Gold Creek	ID17010214PN015_02	Cause Unknown
Hellroaring Creek	ID17010214PN044_02	Cause Unknown
McCormick Creek	ID17010214PN042_02	Cause Unknown
Rapid Lightning Creek	ID17010214PN033_03	Cause Unknown
Sand Creek (tributary to Pend Oreille Lake)	ID17010214PN049_03	Cause Unknown
Sand Creek (tributary to Pend Oreille Lake)	ID17010214PN049_02	Cause Unknown
Upper Pack River	ID17010214PN041_02	Cause Unknown

Table A 2. Conclusions from the Stressor Identification reports completed in the Pack River watershed.

Stream	Assessment Unit	Pollutant(s) likely causing impairment
Gold Creek	ID17010214PN015_02	Sediment and Temperature
Hellroaring Creek	ID17010214PN044_02	Sediment, Temperature, and Low Nutrients
McCormick Creek	ID17010214PN042_02	No pollutant identified
Rapid Lightning Creek	ID17010214PN033_03	Sediment and Temperature
Sand Creek (tributary to Pend Oreille Lake)	ID17010214PN049_03	Sediment, Temperature, and Nutrients
Sand Creek (tributary to Pend Oreille Lake)	ID17010214PN049_02	Sediment, Temperature, and Nutrients
Upper Pack River	ID17010214PN041_02	Sediment

Nutrient sampling of the Pack River and tributaries to the Pack River was conducted most recently in the summer of 2006. Results of the sampling effort indicated that total phosphorous (TP) concentrations in the lower Pack River, Sand, Colburn, and Trout Creek are above the TP target set for this TMDL. It was determined by the Watershed Advisory Group (WAG) and DEQ that a nutrient TMDL would be completed for the Pack River watershed based on the results from the completed Stressor Identification reports, the 2006 nutrient sampling effort, and historic knowledge of the watershed. Recommended changes to Idaho's Integrated Report are listed in Table A3. Changes to the report stem from recent data collected, EPA guidance, and assessment outcomes from this report.

Table A 3. Summary of assessment outcomes.

Water Body - Assessment Unit	Pollutant	TMDL Completed	Recommended Changes to Integrated Report	Justification
Sand Creek (tributary to the Pack River) ID17010214PN038_02	Nutrients	Yes	Move to section 4a[1]	TMDL completed
Colburn Creek ID17010214PN047_02 ID17010214PN046_03	Nutrients	Yes	Add to Integrated Report section 5 and then move to section 4a	TMDL completed
Trout Creek ID17010214PN032_02	Nutrients	Yes	Add to Integrated Report section 5 and then move to section 4a	TMDL completed
Pack River – above Rapid Lightning Creek ID17010214PN031_04 ID17010214PN039_03 ID17010214PN039_04 ID17010214PN041_02 ID17010214PN041_03	Nutrients	Yes	Add to Integrated Report section 5 and then move to section 4a	TMDL completed
Pack River – at Colburn Road ID17010214PN031_04	Nutrients	Yes	Add to Integrated Report section 5 and then move to section 4a	TMDL completed

[1] Section 4a of Integrated Report contains assessment unit pollutant combinations with completed TMDLs.

Public Input and Meetings

In compliance with Idaho Code §39-3611(8), the development of the Pack River nutrients TMDL included extensive public participation by the Pend Oreille River TMDL Watershed Advisory Group (WAG), the Pend Oreille River Tributary Work Group, and other interested parties. In October 2006, a Tributary Work Group was formed to assist with the completion of the Pend Oreille River tributary TMDLs. The following is a summary of the public process.

<u>WAG Meetings (relative to the Pack River nutrient TMDL)</u>
May 10, 2007: among topics covered was the role of the Idaho Tributary Work Group in the decision-making process.

June 25, 2007: the WAG formally gave authority to the Work Group to recommend tributary TMDLs (and to proceed with public comment on those TMDLs) to the panhandle Basin Advisory Group.

<u>Tributary Work Group Meetings</u>
October 26, 2006: topics covered were Tributary Work Group interaction with Pend Oreille River mainstem WAG, impaired water bodies in the subbasin, stressor identification reports for water bodies with “unknown” pollutants, and the sediment TMDL.

February 13, 2007: topics covered were sediment modeling results and the nutrient and temperature TMDL progress for the Pend Oreille River tributaries.

March 20, 2007: topics covered were the approach to the nutrient TMDL for the Pack River watershed, the revised land use coverages and sediment model results.

May 23, 2007: topics covered were the approval process and interaction with Pend Oreille River mainstem WAG, regionally specific vegetation types and shade curves, and the potential natural vegetation (PNV) TMDLs.

June 14, 2007: topics covered were the revised sediment TMDL and allocations.

July 19, 2007: topics covered were the nutrient TMDL for the lower Pack River, sediment and temperature TMDLs, and impairments in Sand Creek.

Sept 18, 2007: topics covered were the release of the draft nutrient, temperature and sediment TMDLs released to the public and the meeting was opened up to answer questions by the public.

October 16, 2007: public comments received on the nutrient, temperature and sediment TMDLs were shared and there was a request for a consensus to proceed with submission of the final TMDL for EPA approval.

Public Comment Period for the Pend Oreille Tributary TMDLs

On September 4th, 2007, the Pend Oreille Tributary TMDLs were posted on the DEQ website for public comment, and the comment period closed October 4th, 2007. Copies of the draft TMDLs were also available at the DEQ Coeur d'Alene Regional Office, and provide to the Tributary Working Group and the Pend Oreille River WAG. Public notice of the comment period was posted in local newspapers and on the DEQ webpage. Comments received were individually addressed by DEQ and the draft TMDL was sent for EPA approval in November 2007 (Appendix C).

Idaho DEQ has complied with the WAG consultation requirements set forth in Idaho Code §39-3611. DEQ has provided the WAG with all available information concerning applicable water quality standards, water quality data, monitoring, assessments, reports, procedures, and schedules. All presentations and drafts provided at WAG meetings were made available on the DEQ website devoted to the Pend Oreille River WAG throughout the process.

DEQ utilized the knowledge, expertise, experience, and information of the WAG in developing this TMDL. DEQ also provided the WAG with an adequate opportunity to participate in drafting the TMDL and to suggest changes to the document. Final copies of the TMDL will be made available to the general public and distributed to WAG and Tributary Work Group members (Appendix D).

5. Total Maximum Daily Load

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 humanmade 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. The critical season for this TMDL are the summer months of June, July, and August. If protective under critical conditions, a TMDL will be more than protective under other conditions.

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. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow “gross allotment” as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1 In-stream Water Quality Targets

The numeric nutrient in-stream water quality target was selected so that it will restore full support of all beneficial uses pursuant to Idaho Code 39.3611, 3615 within the Pack River watershed. In-stream water quality targets are variable depending on the nature of the pollutant. Idaho uses a narrative water quality standard for nutrients. Because the standard is narrative a numeric water quality target was selected for this nutrient TMDL. The following provides discussion on design conditions, target selection, and monitoring points.

Design Conditions

Design conditions are those methods which were used to determine the pollutant loads. Multiple scenarios and techniques were utilized to determine the most appropriate numeric nutrient target. The design conditions which were used to quantify the nutrient loads within the subbasin are discussed below.

Target Selection

The in-stream water quality target addressing nutrients was developed to restore full support of all beneficial uses. In the case of nutrients, the warmer summer months, (June, July, and August), are considered the critical time periods to protect recreational, salmonid spawning, and cold water aquatic life beneficial uses. Idaho water quality standards (IDAPA 58.01.02.06) protecting against nutrient enrichment states:

> *"surface waters of the state shall be free from excess nutrients that can cause visible slime growth or other nuisance aquatic growths impairing designated beneficial uses."*

Because the Idaho water quality standard is a narrative standard, a numeric target was adopted to develop this TMDL. Identification of the limiting nutrient is the first step in controlling nutrient enrichment and nuisance algal growth (Smith 1998, Smith et al. 1999). Total phosphorous has been identified as the limiting nutrient in the Pend Oreille Lake subbasin (2002). The target set in this TMDL will be expressed as a total phosphorous (TP) concentration.

Nutrient Discussion

Phosphorous is the essential plant nutrient that most often controls aquatic plant (algae and rooted plant) growth. Phosphorous can be soluble or particulate in water. Two forms of phosphorous commonly measured in laboratories include soluble reactive phosphorous, which is dissolved in water, and total phosphorous, which includes soluble and particulate forms. Unlike nitrogen, there is no atmospheric (vapor) form of phosphorous.

Dissolved nitrogen is much more abundant in natural streams and lakes than is phosphorous, generally by a factor of 10 to 30 or more (Essig 2007). Whether nitrogen (N) or phosphorous (P) is a limiting factor to plant growth depends on the ratio of available N and P compared to the N:P ratio in the growing tissue of the plants needing these nutrients (Essig 2007). When the N:P ratio needed by growing tissue is less than that available in the environment, P will be more limiting to growth than N (Essig 2007). Phosphorous limitation is generally the case in un-enriched waters (Hutchinson 1975).

Developing a Numeric Target

The U.S. Environmental Protection Agency recommends a nutrient target at reference conditions of 10µg/L TP for the Northern Rockies ecoregion. The Lake Pend Oreille near shore TMDL identified a TP target of 9µg/L as protective of the oligotrophic lake water.

Northern Idaho streams containing nutrient information, and located within the same subecoregion (Northern Rockies), were analyzed to help determine an appropriate numeric nutrient target in accordance with EPA nutrient criteria development guidance for rivers and streams (EPA 2000). Twenty one (21) streams with acceptable macroinvertebrate, habitat, and fish index scores, as outlined by the Water Body Assessment Guidance II (Grafe et al. 2002), and nutrient information were evaluated to help determine an appropriate nutrient target for the Pack River watershed. Table 1 contains a list of the streams evaluated and the associated average total phosphorous value for each stream.

Table 1. Streams evaluated during nutrient target selection.

Stream	Total phosphorous (µg/L)	BURP Site ID	Average WBAG II Score	SMI	SHI	SFI
McCormick Creek	3	1998SCDAB024	1.33	1	3	0
Graham Creek	4	2004SCDAA016	2.33	1	3	3
Grass Creek	4	2004SCDAA057	2.33	3	3	1
Martin Creek	4	2003SCDAA019	3	3	3	3
Berry Creek	5	1998SCDAB018[1]	Access denied			
Caribou Creek	5	1998SCDAB021	2.33	2	3	2
Grouse Creek	5	2003SCDAA017	2.67	3	3	2
Jack Creek	5	2004SCDAA052	2.50	2	3	na
Hellroaring Creek	6	1998SCDAB023	1.66	1	3	1
Lost Creek	7	2004SCDAA019	3	3	3	3
Unnamed Tributary to Big Elk Creek	7	2004SCDAA010	2	1	3	2
East Fork Hayden Creek	8	2004SCDAA004	2.67	3	3	2
French Creek	8	2003SCDAA022[1]	Inaccessible site location			
Brown Creek	9	2004SCDAA020	2.33	2	3	2
North Fork Hayden Creek	9	2004SCDAA001	2.67	3	3	2
Hayden Creek	9	2004SCDAA003	2.67	3	3	2
Cone Creek	10	2004SCDAA075	2.33	3	3	1
Cougar Creek	11	2004SCDAA014	2	3	1	2
Trout Creek	13	2005SCDAA022			3	3
East Fork Steamboat Creek	14	2004SCDAA015	2.33	2	3	2
Colburn Creek	28	1998SCDAB017	2.67	2	3	3

[1]Neighboring survey located in similar land use area and similar stream characteristics exhibit passing WBAG II scores.

In accordance with EPA's preferred approach for developing nutrient criteria, the 75th percentile of total phosphorous among of reference sites was calculated. EPA identifies the 75th percentile as a sufficiently protective value that provides an appropriate margin of safety and excludes the effects of outliers (EPA 2000). The 75th percentile of the TP samples in table 1 is 9µg/L total phosphorous. Figure 2 illustrates the distribution of streams with acceptable WBAG II scores and associated nutrient sample information. See table 2 for the percentile categories calculated from reference streams.

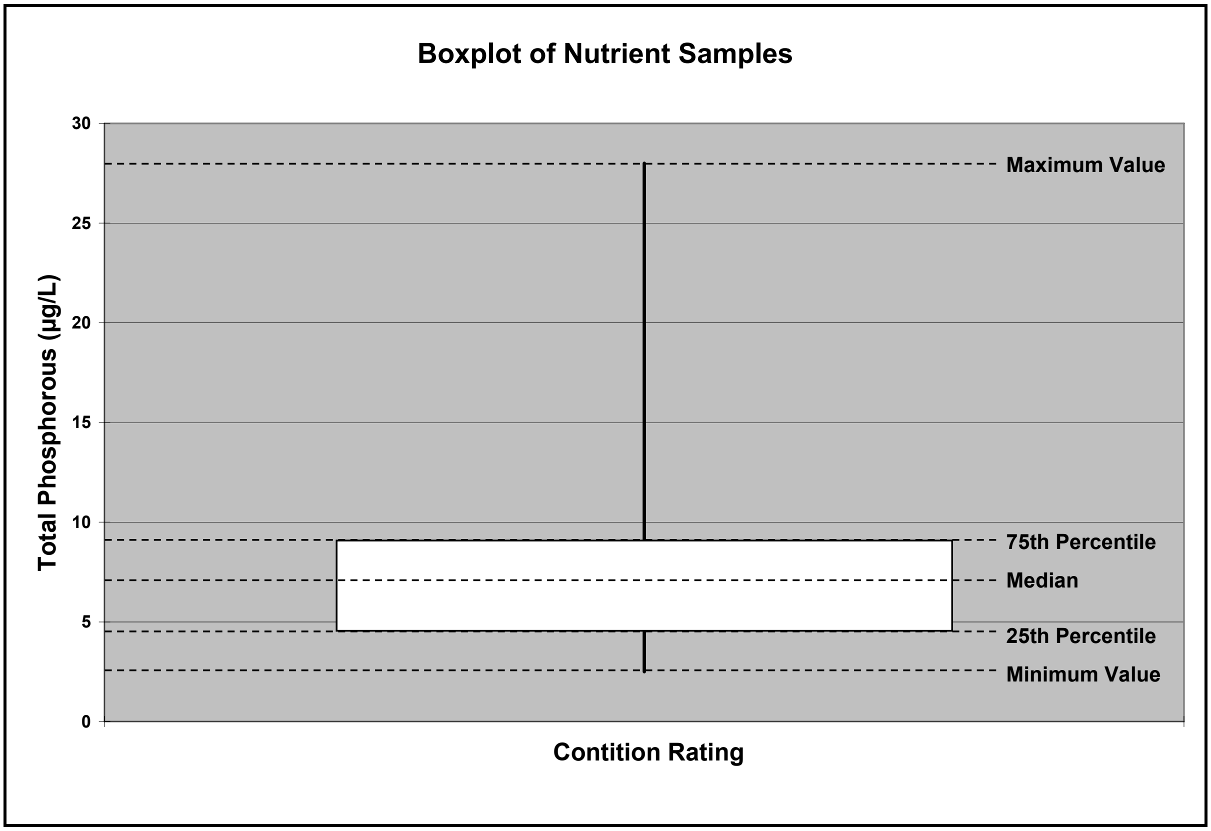

Figure 2. Graphical representation of percentile distribution of reference streams.

Table 2. Percentile categories calculated from reference streams.

General Terminology	Statistical Terminology	TP µg/L
Minimum	0 Percentile	2.5
25% of data is greater than or 75% of data is less than	25th Percentile	4.5
Median	50th Percentile	7.0
75% of data is less than or 25% of data is greater than	75th Percentile	9.0
Maximum	100th Percentile	28.0

EPA recommends a nutrient target of 10µg/L for ecoregion II reference conditions. This target was selected based on the 25th percentile of a sample distribution from an entire population of nutrient samples collected within the Northern Rockies ecoregion. EPA views the method used to derive the 10µg/L ecoregion II reference condition target, the 25th percentile, as a surrogate for the 75th percentile of a sample distribution from reference sites (Figure 3). The similarities between the EPA ecoregion II reference condition total phosphorous target (10µg/L) and the 75th percentile of TP in the Pack River watershed (9µg/L) identifies the 9µg/L TP target as being protective of Pack River tributaries beneficial uses. The Lake Pend Oreille near shore TMDL identified 9µg/L as protective of the oligotrophic lake water, the numeric target for the Pack River was developed independently of the Pend Oreille near shore TMDL. It is anticipated that secondary benefit of this TMDL will be reduced nutrient loading to the near shore lake waters.

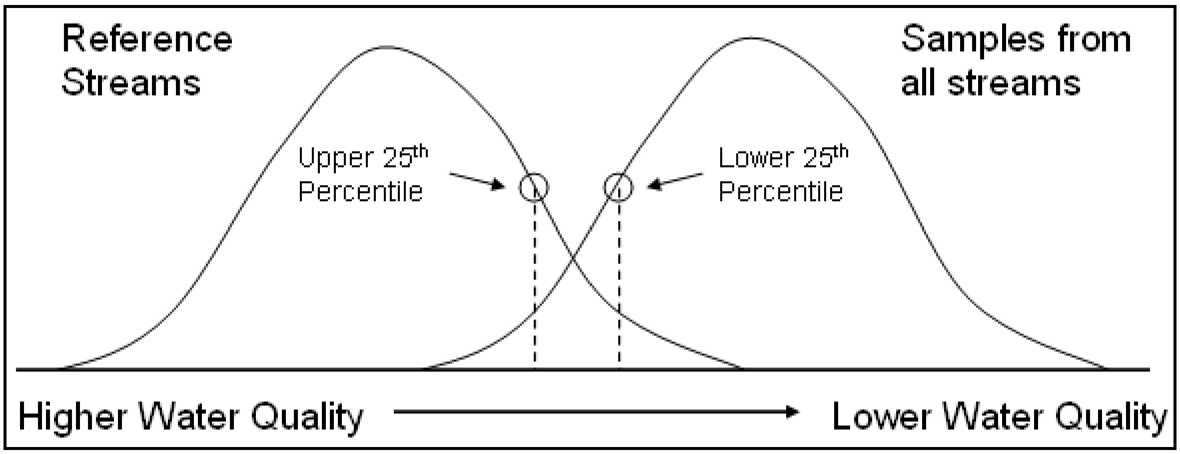

Figure 3. Representation of the similarities between the upper 25th percentile (75th percentile) of reference conditions and the lower 25th percentile (25th percentile) of the entire population.

The Nearshore Pend Oreille Lake TMDL target for the littoral zone is also 9µg/L (DEQ 2002). It was determined through multiple sample locations that a threshold of 9µg/L total phosphorous is protective of the oligotrophic lake water. The consistency between the different approaches at setting a numeric nutrient targets further strengthens the selection of 9µg/L TP for the Pack River watershed.

5.2 Load Capacity

The load capacities set for this TMDL will focus on reducing total phosphorous concentrations. The load capacity is set at a level to meet Idaho water quality standards with seasonal variation and a margin of safety, taking into account any lack of knowledge (Clean Water Act §303 (d)(C)). Reference watersheds that meet Idaho water quality standards were used to help select the TMDL target and evaluate its relationship to beneficial uses.

5.3 Estimates of Existing Pollutant Loads

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

Lake Pend Oreille is identified as a special resource water by the State of Idaho. As a tributary to the lake, the Pack River must not contain point source discharges that will result in a reduction of the ambient water quality of the lake. Because of this, there are no point sources of nutrients to the Pack River and the estimated pollutant loads originate from non-point sources. Non-point sources of nutrients to the Pack River and tributaries to the Pack River include, but are not limited to, the following: areas of urban and rural development, silviculture, and agriculture including cultivated crops for perennial crops and pasture land.

The Pack River watershed contributes the highest ratio of nutrient per unit of land among all watersheds in the Lake Pend Oreille Basin (Golder Inc. 2003). This is likely due to the geology of the watershed and the heavy land use in the lower reaches of the Pack River (Hoelscher et al. 1993).

There were five (5) primary nonpoint sources of pollution identified by the Panhandle Bull Trout Technical Advisory Team as limiting water quality in the Pack River Mainstem watershed (Corsi et al. 1998). These sources are identified and described as follows (Figure 4):

Urbanization – Significant floodplain development, increase urban run-off, stream riparian zone clearing, and stream channel alterations are all factors associated with urban development which currently limit water quality and beneficial uses in the watershed.

Roads – Pack River has an extensive road system on private, state, and federal lands. Because of the sandy soils, fine sediment is readily transported from roads to the stream channel.

Wildfire – The Sundance Fire, which occurred in 1967, was the last major fire in the Pack River watershed. It burned nearly 55,000 acres of mature and second growth timber in the Selkirk Mountains, Pack River and Roman Nose Creek drainages (USDA 1992). The fire burned a large portion of the riparian areas in the upper Pack River drainage. Legacy effects of the Sundance Fire are still visible in the Pack River system.

Agriculture/Livestock Grazing – Use of land for agriculture practices has been ongoing for many years in the Pack River drainage. Grazing occurs in the lower 2/3 of the watershed, and much of the Pack River is considered open range. Crop production occurs in the watershed from below the Highway 95 bridge to the inlet at Lake Pend Oreille. Large cedar trees and riparian vegetation were removed years ago. Impacts to the stream channel in lower reaches have occurred over a long period of time and continue to be a factor in the decreasing habitat condition today.

Timber harvest – Most timber harvest since 1967 has taken place on private and federal lands in the lower 2/3 of the watershed that were not burned by the Sundance Fire. Salvage logging occurred in burned areas, possibly reducing large woody debris recruitment to stream channels. Harvest is currently taking place in areas where merchantable timber was missed by the fire. Timber harvest on private lands is also occurring.

Although the non-point sources identified above were characterized in older reports the same land use practices are still abundant today.

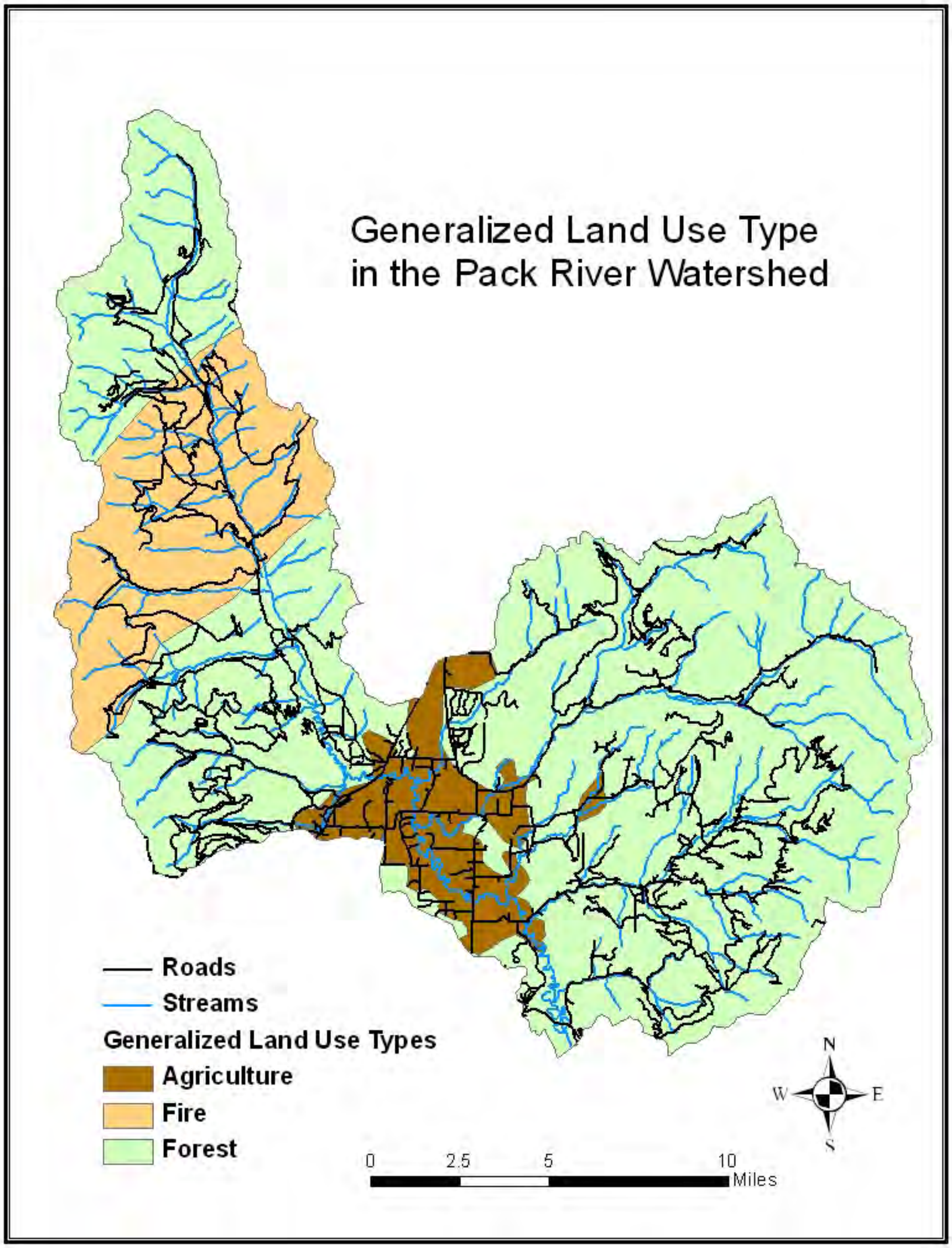

Figure 4. Generalized land use types in the Pack River watershed.

5.4 Load Allocation

Lake Pend Oreille is identified as a special resource water by the state of Idaho. As a tributary to the lake, the Pack River must not contain point source discharges that will result in a reduction of the ambient water quality of the lake. The waste load allocation in this TDML is zero. Because the waste load allocation is zero, the entire nutrient load is available for load allocation. The calculated load allocation is attributed to background loading and nonpoint sources. Sources of nutrients will be allocated by subwatershed. Reduction in nutrient contributions from tributaries will result in reduced nutrient concentrations within the Pack River and attainment of beneficial uses.

The TMDL load allocation is an essential TMDL component and is identified as representing the relationship between the desired condition of the water body and pollutant loading. Once this relationship has been established, it is possible to determine the capacity of the water body to assimilate nutrients without experiencing impairment through eutrophication.

Nutrient monitoring of the Pack River tributaries was conducted in August 2006. Fourteen (14) sites were monitored. TP concentrations at five (5) sites were above the nutrient target of 9µg/L set in this TMDL. Colburn Creek, Sand Creek, Trout Creek, and two sites on the Pack River were above the 9µg/L nutrient target (Table 3).

Table 3. Monitoring results for streams with measured TP values above the TMDL target.

Stream	Date	TP (µg/L)	TP Target (µg/L)	Flow (cfs)
Colburn Creek	8/09/2006	29	9	1.9
	8/23/2006	27	9	1.8
Sand Creek[1]	8/08/2006	26	9	2.0
	8/22/2006	24	9	1.7
Trout Creek	8/08/2006	11	9	2.3
	8/22/2006	14	9	1.7
Pack River[2]	8/08/2006	11	9	35.4
	8/22/2006	16	9	45.2
Pack River[3]	8/08/2006	17	9	37.9
	8/22/2006	15	9	29.1

[1] Sand Creek tributary to the Pack River.
[2] Pack River above Rapid Lightning Creek.
[3] Pack River at Colburn Road.

To reduce overall phosphorous concentrations in the Pack River, load allocations will be established for tributaries and the mainstem Pack River. Load reductions made to the mainstem Pack River are intended to account for additional phosphorous loading attributed to stream bank erosion. Sand, Colburn, and Trout Creek were contributing TP concentrations above the TMDL target. TP concentrations were converted to pounds per day by multiplying the measured concentrations by the discharge recorded during sample collection and a conversion factor (5.396 is the constant used to convert cfs times mg/L to pounds/day). Current load, target load, and load reduction for the Pack River, Sand, Colburn, and Trout Creek are outlined in Table 4.

Table 4. Current, target and total phosphorous load reductions outlined for Sand Creek, Colburn Creek, Trout Creek, and the Pack River.

Stream Name	Month	Current Load (pounds/day)	Target Load (pounds/day)	Load Reduction (pounds/day)
Sand Creek[1]	June	2.4	0.9	1.5
	July	0.8	0.3	0.5
	August	0.3	0.1	0.2
Colburn Creek	June	5.6	1.8	3.8
	July	1.2	0.4	0.8
	August	0.4	0.1	0.3
Trout Creek	June	0.7	0.6	0.1
	July	0.2	0.1	0.1
	August	0.1	0.1	0
Pack River[2]	June	46.6	36.2	10.4
	July	16	12.3	3.7
	August	14.3	4.5	9.8
Pack River[3]	June	71.7	40.3	31.4
	July	15.6	8.8	6.8
	August	4.7	2.6	2.1

[1] Sand Creek tributary to the Pack River.
[2] Pack River above Rapid Lightning Creek.
[3] Pack River at Colburn Road.

Dissolved oxygen concentrations were monitored for a twenty four hour period from August 22 through August 23, 2006. This monitoring event coincides with the critical time periods identified in this TMDL when violations of Idaho water quality standards are most likely to occur. No violations of Idaho water quality standard were recorded.

TP concentrations in the Pack River may be substantially diluted to a point where secondary effects of excess nutrients are not evident near the Pack River's confluence with Lake Pend Oreille. Concentrations in the mainstem Pack River do contribute to exceedances of Idaho water quality standards. Reductions in TP from Pack River tributaries will result in attainment of Idaho water quality standards.

Seasonal target loads were calculated for the Pack River, Sand, Colburn, and Trout Creek. Information from USGS gaging stations, field measurements, and flow modeling were used to predict flow patterns in these ungaged streams (Appendix B). Seasonal target loads for the critical time window (June through August) represent the TMDL TP target concentration of 9µg/L throughout the season when excess TP loads are likely to cause impairment of beneficial uses. Seasonal target loads for the Pack River, Sand, Colburn, and Trout Creeks can be found in Table 5.

Seasonal loads were developed for TP to coincide with the warm months of the year, (June through August) when excess TP is likely to cause beneficial use impairment. Excess TP loads, TP loads above the TMDL target, may be present during the cooler months of the year. Adverse effects of excess TP loads are not anticipated to occur during the cool months of the year because of non-optimal aquatic plant growing conditions. The TP concentrations and target loads set in this TMDL are protective during the critical time period (summer months) consequently these loads are anticipated to also be protective during the cool months.

Table 5. Seasonal target total phosphorous loads by month and day.

Stream	Seasonal Total Phosphorous Target Load (pounds/month)		Seasonal Daily Target Total Phosphorous Load (pounds/day)
Sand Creek[1]	June	26	0.87
	July	9	0.30
	August	3	0.11
Colburn Creek	June	54	1.82
	July	12	0.39
	August	4	0.12
Trout Creek	June	19	0.63
	July	5	0.15
	August	3	0.09
Pack River[2]	June	1087	36
	July	381	12
	August	141	5
Pack River[3]	June	1210	40
	July	272	9
	August	82	3

[1] Sand Creek tributary to the Pack River.
[2] Pack River above Rapid Lightning Creek.
[3] Pack River at Colburn Road.

Monitoring Points

The monitoring locations for TMDL points of compliance for the nutrient TMDLs are set at the mouths of Sand, Colburn, and Trout Creek and the Pack River. At these locations total phosphorous, dissolved oxygen and chlorophyll *a* levels should be monitored routinely during the months of June, July, and August. Monitoring at these locations is an attempt to represent the water quality conditions upstream.

Before data collection efforts a monitoring plan should be developed. A sampling and analysis plan (SAP) and quality assurance project plan (QAPP) shall follow the current monitoring and analysis guidance from EPA. During monitoring and sample collection the SAP and QAPP will be followed to ensure accurate and reliable results.

Margin of Safety

The margin of safety (MOS) is designed to account for uncertainties in TMDL calculations. The MOS in this TMDL is implied. The MOS was included in this TMDL implicitly through a series of conservative assumptions related to the total phosphorous target selection.

A MOS was taken into consideration when using EPA's preferred approach for selecting a numeric nutrient target based on the 75th percentile of reference watersheds. EPA advocates selecting the 75th percentile of a distribution of reference condition values as a recommended target for a sufficiently protective value that provides an appropriate margin of safety and excludes the effects of outliers (EPA 2000).

Seasonal Variation

Secondary impacts (nuisance algal blooms, DO depletion, pH fluctuations) to surface water as a result of nutrient enrichment are highly coupled to seasonal events. The warm summer months of June, July, and August are the most likely times when Idaho water quality standards are anticipated to be violated due to nutrient enrichment.

Elevated nutrients also occur during spring runoff events, however, adverse effects are not anticipated due to cool water and atmospheric temperatures, and less light available for aquatic plant growth.

Reasonable Assurance

Total phosphorous reductions from Pack River tributaries will result in TP reductions in the mainstem Pack River. Increased sediment, due to anthropogenic activities, has also contributed to nutrient enrichment. Because nutrients are often bonded to sediment, excess sediment is often a major source of nutrient pollution. In conjunction with the nutrient TMDL, sediment TMDLs have been completed for the Pack River watershed. Reductions in sediment input will result in a reduction in surface water nutrient concentrations within the Pack River watershed.

In addition to the designated management agencies, the public, through the WAG and other equivalent process or organizations, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical.

The Pack River Watershed Council, consisting of landowners, businesses, and state, federal, and local agencies in partnership with the Natural Resources Conservation Service (NRCS) and the Bonner Soil and Water Conservation District, has been active in the Pack River watershed. The council has implemented a program to improve water quality in the Pack River by:

- developing a water quality monitoring program with students from local high schools,
- informing and educating stakeholders on water quality issues and empowering them to appropriate action with technical assistance,
- developing a cohesive strategy for long-term monitoring and protection,
- coordinating restoration projects and funding with private landowners and agencies, and
- assisting the Pack River Watershed Council to draft a sediment and nutrient TMDL implementation and management plan for the Pack River.

The Tri State Water Quality Council has been working since 2005 to implement the Pend Oreille Nearshore TMDL. The council has been meeting on a regular basis and have implemented and developed projects aimed at reducing nutrient inputs to the lake. Projects have included public education and outreach, and data collection.

Future and ongoing water quality improvement commitments made through cooperative efforts of the public, and state and federal agencies will help attain water quality standards and goals set in this TMDL.

Background

The background TP amount was determined by examining monitoring data from watersheds that have relatively few anthropogenic impacts and located within the Northern Rockies ecoregion. An average of this monitoring data suggests that a background TP load would be approximately 8µg/L. The background load is accounted for in the 9µg/L target selection.

Reserve

No reserve for future pollutant additions have been made in this TMDL. Future activities in the area should be consistent with the water quality goals outlined in this TMDL.

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. 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 now incorporates a gross waste load allocation (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 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 Implementation Strategies

DEQ and designated management agencies (DMA) responsible for TMDL implementation will make every effort to address past, present, and future pollution problems in an attempt to link them to watershed characteristics and management practices designated to improve water quality and restore the beneficial uses of the water body. Any and all solutions to help restore beneficial uses of a stream will be considered as part of a TMDL implementation plan in an effort to make the process as effective and cost efficient as possible. Using additional information collected during the implementation phase of the TMDL, DEQ and the DMAs will continue to evaluate suspect sources of impairment and develop management actions appropriate to deal with these issues.

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.

Time Frame

Reductions in in-stream TP concentrations may be noticeable shortly after implementation actions have been established. Reductions may be seen as soon as one or two seasons after implementation of best management practices (BMP). After completion of BMPs in-stream water quality sampling should be conducted to evaluate effectiveness. If completed projects do not reduce the in-stream TP concentrations BMP(s) should be reevaluated and adjusted accordingly.

Approach

TMDLs will be implemented through continuation of ongoing pollution control activities in the watershed. The designated WAG, DMAs, and other appropriate public process participants, are expected to:

- Develop BMPs to achieve load allocations.
- Give reasonable assurance that management measures will meet load allocations through both quantitative and qualitative analysis of management measures.
- Adhere to measurable milestones for progress.
- Develop a timeline to implementation, with reference to costs and funding.
- Develop a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, if load allocations and waste load allocations are being met and whether or not water quality standards are being met.

The DMAs will recommend specific control actions and will then submit the implementation plan to DEQ. DEQ will act as a repository for approved implementation plans and conduct 5-year reviews of progress toward TMDL goals.

Responsible Parties

In addition to the DMAs, the public, through the WAG and other equivalent processes or organizations, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical.

Monitoring Strategy

Monitoring will be conducted using DEQ-approved monitoring procedures at the time of sampling.

Pollutant Trading

Pollutant trading (aka water quality trading) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost effective, local solutions to problems caused by pollutant discharges to surface waters. Pollutant trading is voluntary. Parties trade only if both are better off as a result of the trade. Trading allows parties to decide how to best reduce pollutant loadings within the limits of certain requirements. 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 recognized in Idaho's Water Quality Standards at IDAPA 58.01.02.054.06. Currently, the Department of Environmental Quality'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.

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 recorded in the trading database through the Idaho Clean Water Cooperative, Inc.

Both point and nonpoint sources may create marketable credits. Credits 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 which are 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.

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 this, hydrologically-based ratios are developed to provide that trades between sources distributed throughout the TMDL water bodies result in environmentally equivalent or better outcomes at the point of environmental concern. In addition, localized adverse impacts to water quality are not allowed.

Trading Framework

In order 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 (currently November 2003 Draft) available on the DEQ website at http://www.deq.idaho.gov/water/prog_issues/waste_water/pollutant_trading/pollutant_trading_guidance_entire.pdf. As of this writing the only two watersheds that have yet developed a pollutant trading framework are the Lower Boise River watershed and the Upper Snake Rock/Mid Snake TMDL watershed.

5.6 Conclusions

Five (5) streams and ten (10) assessment units are addressed in this report (Table 6). TMDLs completed for the five streams are written to address excess total phosphorous (TP). Total phosphorous was identified as a possible pollutant causing impairment by Stressor Identification reports (DEQ 2006) prepared for the Pack River watershed. Sampling conducted in the summer of 2006 substantiated the findings of the Stressor Identification reports. Five of the sampling locations were monitored to have TP concentrations above the ecoregional reference condition TP concentration recommended by EPA and the TP concentration target set in this TMDL. All sources of TP to the Pack River watershed are non-point sources. No point sources of TP are expected to exist within the watershed.

Table 6. Summary of Assessment Outcomes.

Water Body - Assessment Unit	Pollutant	TMDL Completed	Recommended Changes to Integrated Report	Justification
Sand Creek (tributary to the Pack River) ID17010214PN038_02	Nutrients	Yes	Move to section 4a[1]	TMDL completed
Colburn Creek ID17010214PN047_02 ID17010214PN046_03	Nutrients	Yes	Add to Integrated Report section 5 and then move to section 4a	TMDL completed
Trout Creek ID17010214PN032_02	Nutrients	Yes	Add to Integrated Report section 5 and then move to section 4a	TMDL completed
Pack River – above Rapid Lightning Creek ID17010214PN031_04 ID17010214PN039_03 ID17010214PN039_04 ID17010214PN041_02 ID17010214PN041_03	Nutrients	Yes	Add to Integrated Report section 5 and then move to section 4a	TMDL completed
Pack River – at Colburn Road ID17010214PN031_04	Nutrients	Yes	Add to Integrated Report section 5 and then move to section 4a	TMDL completed

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GIS Coverages

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Glossary

305(b)
Refers to section 305 subsection "b" of the Clean Water Act. The term "305(b)" generally describes a report of each state's water quality and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.

§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.

Aeration
A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.

Aerobic
Describes life, processes, or conditions that require the presence of oxygen.

Algae
Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.

Anaerobic
Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen.

Anoxia
The condition of oxygen absence or deficiency.

Anthropogenic
Relating to, or resulting from, the influence of human beings on nature.

Anti-Degradation
Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by

state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.61).

Aquatic
Occurring, growing, or living in water.

Assessment Unit (AU)
A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses, and any associated causes and sources must be applied to the entirety of the unit.

Assimilative Capacity
The ability to process or dissipate pollutants without ill effect to beneficial uses.

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

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

Benthic
Pertaining to or living on or in the bottom sediments of a water body

Best Management Practices (BMPs)
Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

Best Professional Judgment
A conclusion and/or interpretation derived by a trained and/or technically competent individual by applying interpretation and synthesizing information.

Biochemical Oxygen Demand (BOD)
The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time.

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.

Decomposition

The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.

Designated Uses

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

Discharge

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

Dissolved Oxygen (DO)

The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

Disturbance

Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.

Ecological Indicator

A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework.

Effluent

A discharge of untreated, partially treated, or treated wastewater into a receiving water body.

Environment

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

Ephemeral Stream

A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (American Geological Institute 1962).

Erosion

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

Eutrophic

From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.

Eutrophication

1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.

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.

Geographical Information Systems (GIS)

A georeferenced database.

Grab Sample

A single sample collected at a particular time and place. It may represent the composition of the water in that water column.

Habitat

The living place of an organism or community.

Headwater

The origin or beginning of a stream.

Hydrologic Basin

The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed).

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.

Inorganic

Materials not derived from biological sources.

Intermittent Stream

1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the

available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.

Limiting Factor

A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.

Limnology

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

Load Allocation (LA)

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

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.

Luxury Consumption

A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a water body, such that aquatic plants take up and store an abundance in excess of the plants' current needs.

Macroinvertebrate

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

Macrophytes

Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum sp.*), are free-floating forms not rooted in sediment.

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.

Milligrams per Liter (mg/L)

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

Monitoring

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

Mouth

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

National Pollution Discharge Elimination System (NPDES)

A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.

Natural Condition

The condition that exists with little or no anthropogenic influence.

Nitrogen

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

Nonpoint Source

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

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).

Not Fully Supporting Cold Water

At least one biological assemblage has been significantly modified beyond the natural range of its reference condition.

Nuisance	Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.
Nutrient	Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.
Nutrient Cycling	The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).
Oligotrophic	The Greek term for "poorly nourished." This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity.
Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.
Orthophosphate	A form of soluble inorganic phosphorus most readily used for algal growth.
Oxygen-Demanding Materials	Those materials, mainly organic matter, in a water body that consume oxygen during decomposition.
Perennial Stream	A stream that flows year-around in most years.
Periphyton	Attached microflora (algae and diatoms) growing on the bottom of a water body or on submerged substrates, including larger plants.
Phosphorus	An element essential to plant growth, often in limited supply, and thus considered a nutrient.
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 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.
Pretreatment	The reduction in the amount of pollutants, elimination of certain pollutants, or alteration of the nature of pollutant properties in wastewater prior to, or in lieu of, discharging or otherwise introducing such wastewater into a publicly owned wastewater treatment plant.
Protocol	A series of formal steps for conducting a test or survey.
Quantitative	Descriptive of size, magnitude, or degree.
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.
Reference Condition	1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).

Reference Site

A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies.

Representative Sample

A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled.

Runoff

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

Sediments

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

Stream

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

Stream Order

Hierarchical ordering of streams based on the degree of branching. A first-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.

Stressors

Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.

Subbasin

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

Subbasin Assessment (SBA)

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

Subwatershed

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

Surface Water

All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.

Threatened Species

Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

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.

Tributary

A stream feeding into a larger stream or lake.

Trophic State

The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

Tributary

A stream feeding into a larger stream or lake.

Trophic State

The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

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 Column

Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.

Water Quality

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

Water Quality Criteria

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

Water Quality Limited

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

Water Quality 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.

Water Table

The upper surface of ground water; below this point, the soil is saturated with water.

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.

saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

Appendix A. Unit Conversion Chart

Figure 5. Metric – English unit conversions.

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

[a] 1 cfs = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 cfs.
[b] The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

Appendix B. Estimating stream flow

Estimating flow in Colburn, Sand, and Trout Creek

The TP target outlined in this TMDL is a concentration based target and to establish TP loading it is vital to understand flow patterns within the watershed. To help approximate flow within Colburn, Sand, and Trout Creek information collected at USGS gaging stations, data collected in the field, and stream discharge modeling tools were used. Flow is highly variable and prediction of exact flow for a given year or day is impossible. By evaluating flow patterns at down stream gaging stations flow estimates were made to upstream tributaries. The discussion below outlines how flow estimates were made, TP loads derived from flow estimates, and steps taken to check accuracy of flow estimates.

Step 1 Collection of stream flow data

Flow data collected at USGS gaging stations 12392300, 12392390, and 12392450 was obtained from the USGS. Flow data collected at these sites provided a detailed stream flow record from within the Pack River watershed. Data collected at gaging station 12392300 was used to estimate Colburn Creek stream flows, data collected at gaging station 12392300 was used to estimate Sand Creek stream flows, and data collected at gaging station 12392450 was used to estimate Trout Creek stream flows

Step 2 Modeled stream flows from USGS

Stream flow information from USGS StreamStats interactive mapping tool was collected to check estimated stream flows. USGS StreamStats is a modeling tool that was developed to calculate stream statistics for ungaged streams. USGS StreamStats provides the user with mean annual flow, and high and low flow calculations. The outputs from StreamStats were compared to the estimated flow calculations to determine the accuracy of estimated flow.

Step 3 Estimating stream flow on ungaged streams

Flow data collected in the field on Julian day 220 and 235 was compared to flows recorded at gaging stations of the same Julian day. A percentage of flow was calculated when comparing the two measurements and then applied throughout the flow record. The average percent flow difference was calculated to be 4.5%. The difference, 4.5%, was than multiplied by the USGS recorded stream flow to estimate flow patterns in Colburn Creek.

Colburn Creek

Julian Day	USGS Recorded Stream Flow (cfs)	Stream Flow Measured in Field (cfs)	Percent of USGS Measured Flow (%)	Estimated Stream Flow (cfs)
220	43	1.99	4.6	1.94
235	75	1.78	2.4	3.38
220	43	1.99	4.6	1.94
235	28	1.78	6.4	1.26
220	60	1.99	3.3	2.70
235	27	1.78	6.6	1.22
220	59	1.99	3.4	2.66
235	32	1.78	5.6	1.44

220	48	1.99	4.1	2.16
235	34	1.78	5.2	1.53
220	63	1.99	3.2	2.84
235	42	1.78	4.2	1.89
220	57	1.99	3.5	2.57
235	59	1.78	3.0	2.66
220	42	1.99	4.7	1.89
235	28	1.78	6.4	1.26
220	47	1.99	4.2	2.12
235	25	1.78	7.1	1.13
220	41	1.99	4.9	1.85
235	86	1.78	2.1	3.87
220	49	1.99	4.1	2.21
235	36	1.78	4.9	1.62
220	42	1.99	4.7	1.89
235	26	1.78	6.8	1.17
220	54	1.99	3.7	2.43
235	44	1.78	4.0	1.98
220	71	1.99	2.8	3.20
235	77	1.78	2.3	3.47
220	27	1.99	7.4	1.22
235	20	1.78	8.9	0.90
220	73	1.99	2.7	3.29
235	49	1.78	3.6	2.21
220	55	1.99	3.6	2.48
235	62	1.78	2.9	2.79
220	86	1.99	2.3	3.87
235	140	1.78	1.3	6.30
220	27	1.99	7.4	1.22
235	19	1.78	9.4	0.86
220	46	1.99	4.3	2.07
235	76	1.78	2.3	3.42
220	24	1.99	8.3	1.08
235	30	1.78	5.9	1.35
220	38	1.99	5.2	1.71
235	44	1.78	4.0	1.98
220	83	1.99	2.4	3.74
235	51	1.78	3.5	2.30
220	70	1.99	2.8	3.15
235	46	1.78	3.9	2.07

Similar to Colburn Creek flow were estimated for Sand Creek (tributary to the Pack River) using USGS gaging station 12392390. The average percent flow difference was calculated to be 2.4%. The difference, 2.4%, was than multiplied by the USGS recorded stream flow to estimate flow patterns in Sand Creek.

Sand Creek

Julian Day	USGS Recorded Stream Flow (cfs)	Stream Flow Measured in Field (cfs)	Percent of USGS Measured Flow (%)	Estimated Stream Flow (cfs)
8/9/1989	69	2	2.9	1.66

8/22/1989	108	1.75	1.6	2.60
8/9/1990	94	2	2.1	2.26
8/22/1990	100	1.75	1.8	2.41
8/9/1991	121	2	1.7	2.91
8/22/1991	75	1.75	2.3	1.80
8/9/1992	64	2	3.1	1.54
8/22/1992	47	1.75	3.7	1.13
8/9/1993	124	2	1.6	2.98
8/22/1993	101	1.75	1.7	2.43

Similar to Colburn and Sand Creek flow were estimated for Trout Creek using USGS gaging station 12392450. The average percent flow difference was calculated to be 8.3%. The difference, 8.3%, was than multiplied by the USGS recorded stream flow to estimate flow patterns in Trout Creek.

Trout Creek

Julian Day	USGS Recorded Stream Flow (cfs)	Stream Flow Measured in Field (cfs)	Percent of USGS Measured Flow (%)	Estimated Stream Flow (cfs)
220	23	2.28	9.9	2.21
235	21	1.74	8.3	2.02
220	19	2.28	12.0	1.83
235	21	1.74	8.3	2.02

Step 4 Comparison of stream flow statistics

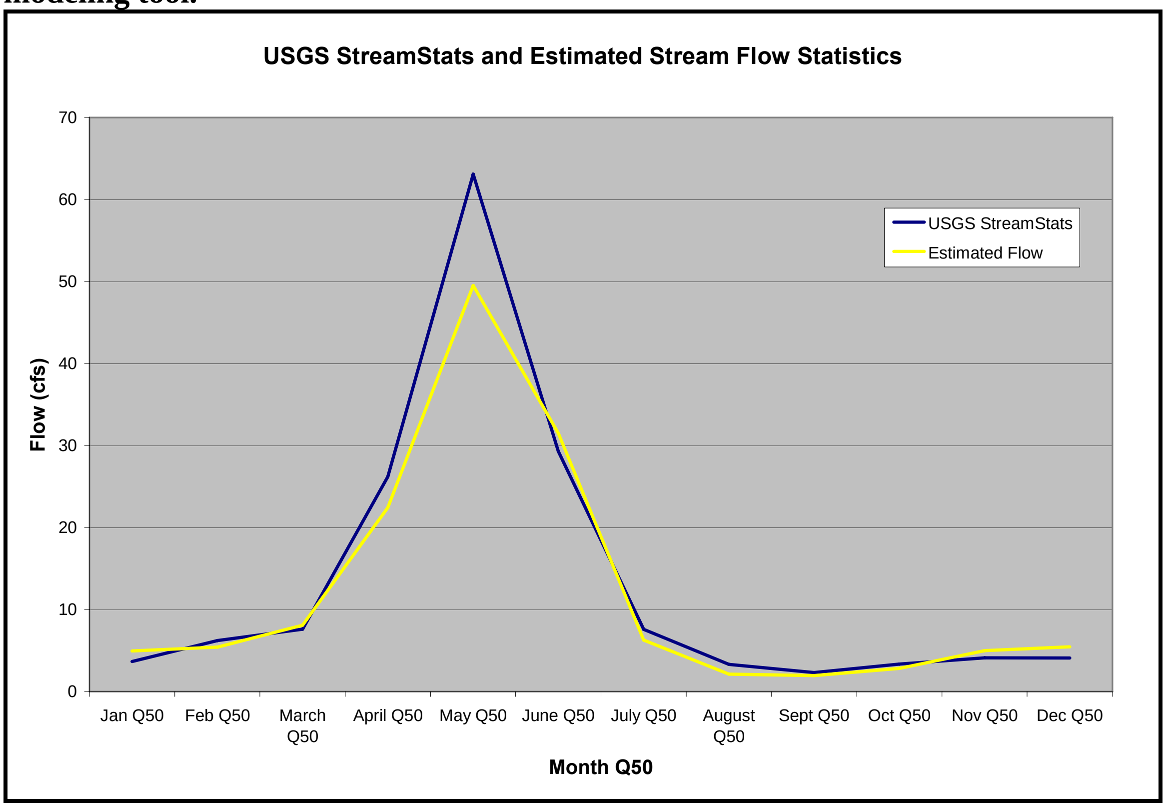
After calculating estimated flow from field measurements and downstream gage station information, flow statistics from estimated flow were compared to flow statistics calculated from USGS StreamStats. Step four was conducted to evaluate applicability and accuracy of the estimated stream flows. Tables and figures below illustrate the consistencies of the estimating methods for Colburn, Sand, and Trout Creek.

Colburn Creek

Month and Flow Statistic Calculated	USGS Flow Statistic from StreamStats	Estimated Flow Statistic
Jan Q20	6.12	8.23
Jan Q50	3.67	4.95
Jan Q80	2.56	3.15
Feb Q20	10.5	11.25
Feb Q50	6.23	5.4
Feb Q80	4.12	3.51
March Q20	15.1	15.1
March Q50	7.61	8.1
March Q80	5.36	4.98
April Q20	44.7	34.27
April Q50	26.2	22.43
April Q80	14.3	14.1
May Q20	86.5	72.9
May Q50	63.1	49.5
May Q80	45.4	35.04

June Q20	48.9	56.25
June Q50	29.3	31.5
June Q80	17.8	17.35
July Q20	12.7	12.47
July Q50	7.57	6.26
July Q80	4.86	3.38
August Q20	5.18	3.15
August Q50	3.33	2.12
August Q80	2.15	1.44
Sept Q20	4.2	3.56
Sept Q50	2.3	1.94
Sept Q80	1.59	1.31
Oct Q20	5.3	5.18
Oct Q50	3.34	2.84
Oct Q80	2.62	2.01
Nov Q20	7.8	8.98
Nov Q50	4.11	5
Nov Q80	2.78	2.74
Dec Q20	7.65	10.64
Dec Q50	4.08	5.45
Dec Q80	2.52	3.15

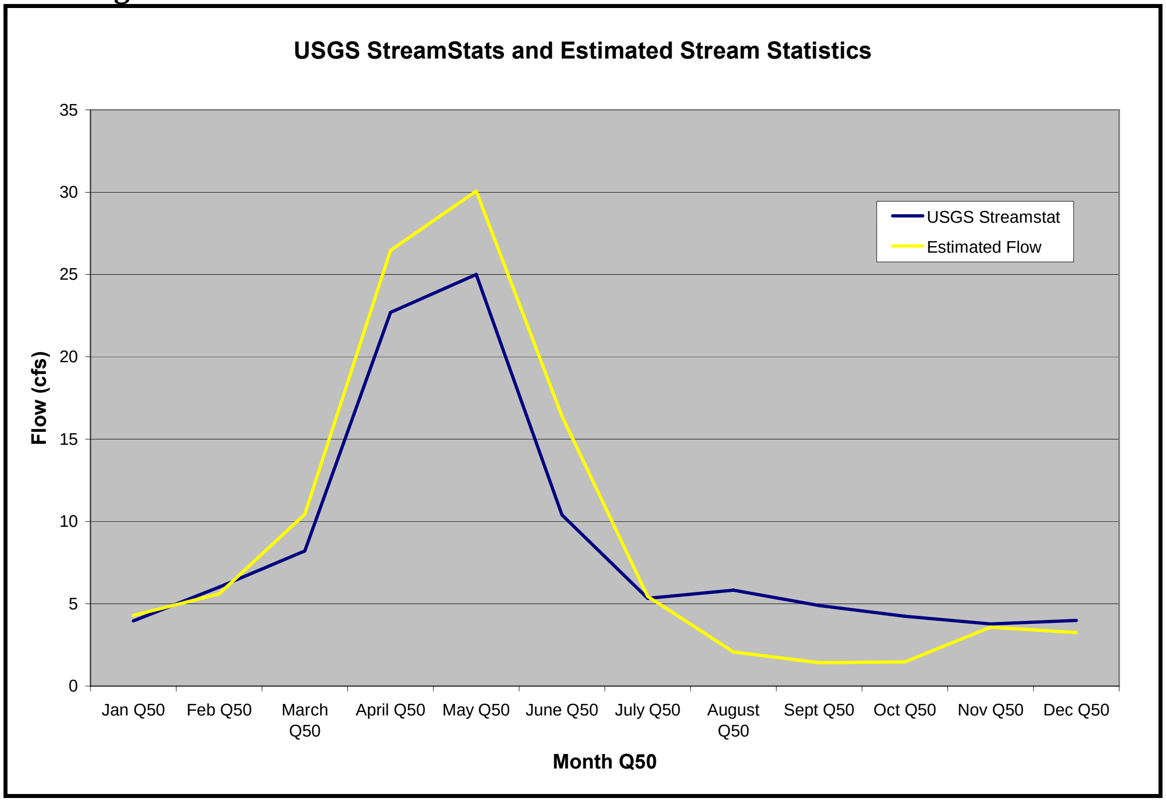
Colburn Creek estimated flow from USGS gaging stations and USGS StreamStats modeling tool.



Sand Creek

Month and Flow Statistic Calculated	USGS Flow Statistic from StreamStats	Estimated Flow Statistic
Jan Q20	5.77	7.21
Jan Q50	3.96	4.29
Jan Q80	3.22	1.73
Feb Q20	10.6	9.96
Feb Q50	6.01	5.61
Feb Q80	3.84	2.72
March Q20	17.8	13.19
March Q50	8.2	10.44
March Q80	5.2	5.29
April Q20	32	38.78
April Q50	22.7	26.46
April Q80	15	19.24
May Q20	32.9	45.76
May Q50	25	30.07
May Q80	19.4	23.14
June Q20	15.3	28.87
June Q50	10.4	16.4
June Q80	8.1	6.94
July Q20	6.63	8.33
July Q50	5.33	5.44
July Q80	4.21	3.48
August Q20	6.96	2.88
August Q50	5.82	2.07
August Q80	4.78	1.54
Sept Q20	5.97	1.73
Sept Q50	4.89	1.42
Sept Q80	4.09	1.2
Oct Q20	4	2.05
Oct Q50	4.24	1.47
Oct Q80	4.06	1.25
Nov Q20	4.72	7.11
Nov Q50	3.78	3.58
Nov Q80	3.72	2.19
Dec Q20	5.71	7.6
Dec Q50	3.99	3.25
Dec Q80	5.77	7.21

Sand Creek estimated flow from USGS gaging stations and USGS StreamStats modeling tool.

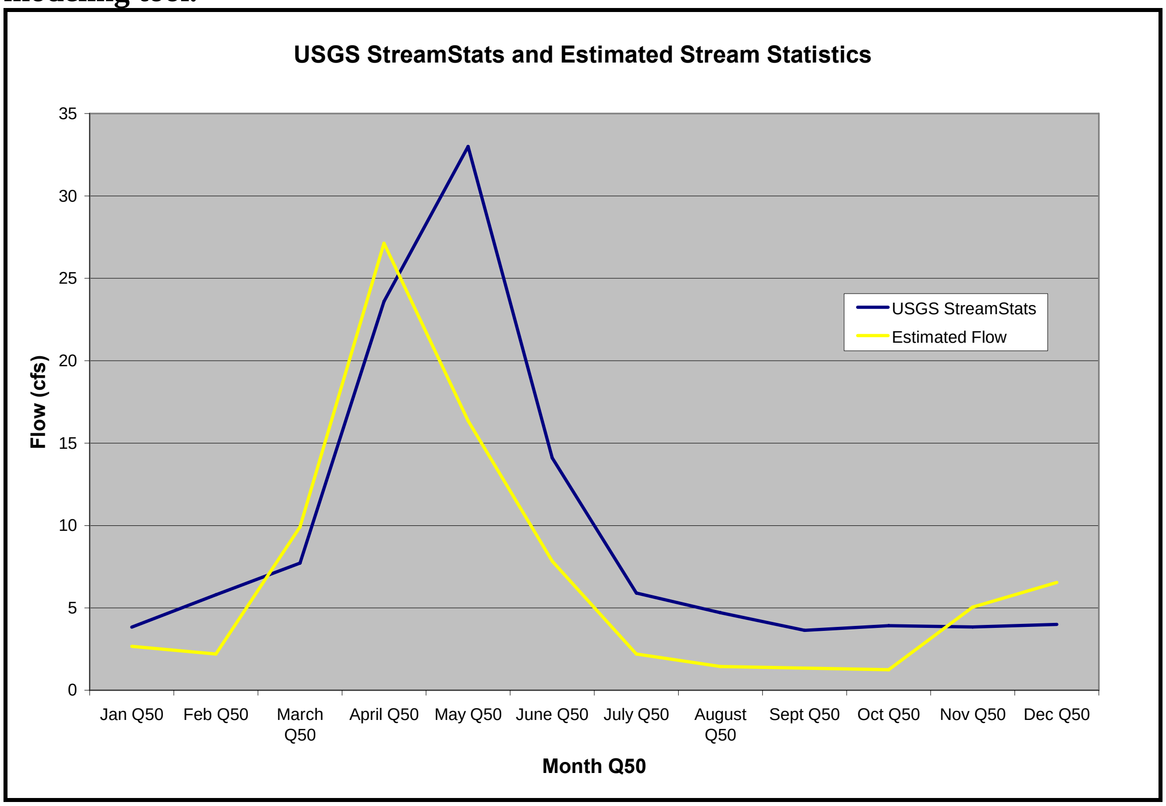


Trout Creek

Month and Flow Statistic Calculated	USGS Flow Statistic from StreamStats	Estimated Flow Statistic
Jan Q20	5.83	3.85
Jan Q50	3.84	2.69
Jan Q80	2.99	2.50
Feb Q20	10.1	2.75
Feb Q50	5.79	2.21
Feb Q80	3.73	2.12
March Q20	16.6	19.05
March Q50	7.72	9.91
March Q80	5	3.56
April Q20	35.2	33.44
April Q50	23.6	27.13
April Q80	14.7	20.84
May Q20	43.9	24.73
May Q50	33	16.36
May Q80	24.9	13.66
June Q20	21.6	12.10
June Q50	14.1	7.84
June Q80	10.2	5.04
July Q20	8.02	2.79

July Q50	5.9	2.21
July Q80	4.37	1.73
August Q20	6.31	2.21
August Q50	4.71	1.44
August Q80	3.48	1.35
Sept Q20	5.3	1.54
Sept Q50	3.64	1.35
Sept Q80	2.8	1.25
Oct Q20	4.33	2.02
Oct Q50	3.92	1.25
Oct Q80	5.35	1.25
Nov Q20	5.46	5.50
Nov Q50	3.85	5.05
Nov Q80	3.39	3.62
Dec Q20	6.2	9.24
Dec Q50	3.99	6.54
Dec Q80	2.96	5.10

Trout Creek estimated flow from USGS gaging stations and USGS StreamStats modeling tool.



The agreement between the stream flow statistics calculated suggests that the estimated stream flows are representative of actual stream flow patterns.

Appendix C. Public Comments

Document Section	Commenter	Comments	Response	Page
Executive Summary, Key Findings	Panhandle BAG	I assume that the Sand Creek that is included in the nutrient TMDL for the Pack River is one that is a tributary to the Pack River. However, the ID number for it is the same as the ID number for the Sand Creek tributary to the lower Pend Oreille. Does this need to be fixed?	Yes, the Sand Creek addressed in this TMDL is a tributary to the Pack River. The assessment unit corresponding to this tributary will be used.	36-38

Appendix D. Distribution List

Pend Oreille River WAG members:

Greg Becker, U.S.D.A. Natural Resources Conservation Service
Lori Blau, Ponderay Newsprint Company
Pat Buckley, Pend Oreille Public Utility District
Lori Burchett, Bonner County Planning Department
Randy Curliss, City of Dover
Jamie Davis, Bonner Soil & Water Conservation District
Kent Easthouse, U.S. Army Corps of Engineers
Glenda Empsall/Marc Brinkmeyer, Riley Creek Lumber Company
Russ Fletcher, Pend Oreille Conservation District
Todd Johnson, Water association and Agriculture
Jon Jones, Washington Department of Ecology
Ray King, City of Newport
Mike Lithgow, Pend Oreille County Public Works Department
Bill Love, Idaho Department of Lands
Don Martin, U.S. Environmental Protection Agency
Jim Martin, City of Priest River
Brock Morgan/Kevin Kinsella, Teck Cominco American Inc.
Christine Pratt, Seattle City Light
Patty Perry, Kootenai Tribe of Idaho
Helen Rueda, U.S. Environmental Protection Agency
Jaime Short, Washing Department of Ecology
Tom Shuhda, U.S. Forest Service, Colville National Forest
Jim Vander Ploeg, Stimson Lumber Company
Kody VanDyk, City of Sandpoint
Paul Van Middlesworth, Golder Associates, Inc.
Ruth Watkins, Tri-State Water Quality Council
Gary Westcott, Southside Water & Sewer District
Michelle Wingert, Kalispel Tribe

Tributary Work Group members (those, which are not on the WAG):
Channing Swan, Stimson Lumber Company
Charlie Holderman,
Ted Runley, City of Priest River
Jessica Erickson,
Kate Wilson, Lakes Commission
Donna DeFrancesco, Golder