

Pend Oreille Tributaries Sediment Total Maximum Daily Loads

Upper Pack River, Hellroaring Creek, Sand Creek,
Schweitzer Creek, Gold Creek, Rapid Lightning Creek,
North Gold Creek



**Idaho Department of Environmental Quality and
U.S. Environmental Protection Agency, Region 10**

December 17, 2007

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Prepared for:
Idaho Department of Environmental Quality and
U.S. Environmental Protection Agency, Region 10

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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	DMA	designated management agency
μ	micro, one-one thousandth	DO	dissolved oxygen
§	Section (usually a section of federal or state rules or statutes)	DWS	domestic water supply
AgPlan	Agricultural Pollution Plan of 1979	EPA	United States Environmental Protection Agency
AU	assessment unit	F	Fahrenheit
BLM	United States Bureau of Land Management	FPA	Idaho Forest Practices Act
BMP	best management practice	GIS	Geographical Information Systems
BURP	Beneficial Use Reconnaissance Program	HUC	Hydrologic Unit Code
C	Celsius	IDAPA	Refers to citations of Idaho administrative rules
CFR	Code of Federal Regulations (refers to citations in the federal administrative rules)	IDFG	Idaho Department of Fish and Game
cfs	cubic feet per second	IDL	Idaho Department of Lands
CGP	construction general permit	INFISH	federal Inland Native Fish Strategy
cm	centimeter	ISCC	Idaho Soil Conservation Commission
CWA	Clean Water Act	ITD	Idaho Transportation Department
CWE	cumulative watershed effects	LA	load allocation
DEQ	Department of Environmental Quality	LC	load capacity
		mg/L	milligrams per liter
		MOS	margin of safety
		NB	natural background

NPDES	National Pollutant Discharge Elimination System	WBAG	<i>Water Body Assessment Guidance</i>
NRCS	Natural Resources Conservation Service	WBAGII	<i>Water Body Assessment Guidance, second edition</i>
PCR	primary contact recreation	WEPP	Water Erosion Prediction Project
RUSLE 2	Revised Universal Soil Loss Equation Version 2	WLA	wasteload allocation
SBA	subbasin assessment		
SFI	DEQ's Stream Fish Index		
SHI	DEQ's Stream Habitat Index		
SMI	DEQ's Stream Macroinvertebrate Index		
SRW	special resource water		
SS	salmonid spawning		
STATSGO	State Soil Geographic Database		
SWPPP	storm water pollution prevention plan		
TDS	total dissolved solids		
TMDL	total maximum daily load		
TSS	total suspended solids		
U.S.C.	United States Code		
USFS	United States Forest Service		
USGS	United States Geological Survey		
WAG	Watershed Advisory Group		

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 2 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. (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.)

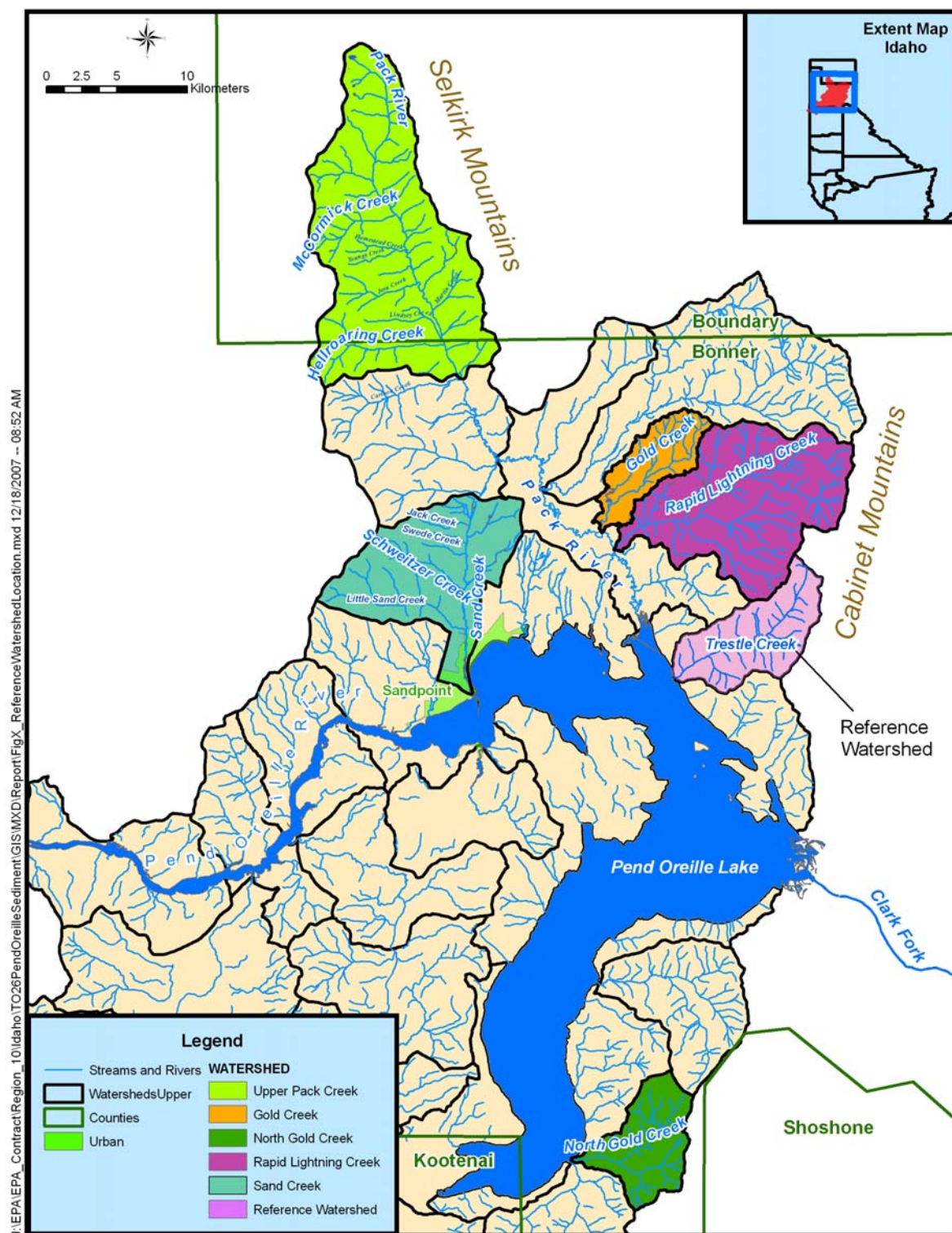
This document addresses selected water bodies in the Pend Oreille Subbasin that are on Idaho's current §303(d) list. The overall purpose of the Pend Oreille Lake Tributaries Sediment TMDLs document is to characterize and document sediment pollutant loads for a select group of tributaries in the Pend Oreille Subbasin. The first portion of this document is the Subbasin Assessment, which is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts. This information was then used to develop sediment TMDL calculations for specific tributaries in the Pend Oreille Subbasin. The TMDL analysis identifies pollutant sources and quantifies sediment load reductions needed to return impaired waters to a condition supporting beneficial uses.

Subbasin at a Glance

The headwaters of the Pend Oreille River Subbasin (hydrologic unit code [HUC] 17010214) are in the Cabinet, Selkirk, and Bitterroot mountains and these tributaries empty into Pend Oreille Lake. The Clark Fork River is the largest tributary to the lake and enters the lake's eastern edge from Montana. The Pend Oreille River, flowing west into Washington, is the only surface water outflow from Pend Oreille Lake.

This report addresses five watersheds in the Pend Oreille Subbasin that include 11 assessment units identified in Idaho's 2002 Integrated Report as water quality limited by an unknown pollutant or excess sediment. These 6th order watersheds are Upper Pack Creek, Gold Creek, North Gold Creek, Rapid Lightning Creek, and Sand Creek (Figure ES-1). The five watersheds addressed in this report comprise 121,927 acres, or approximately 190 square miles of the Pend Oreille Subbasin, and include the following assessment units: the Pack River (17010214PN041_02 and 03), McCormick Creek (17010214PN042_02), HellroaringCreek (17010214PN044_02), Sand Creek (17010214PN049_02 and 03), Schweitzer Creek (17010214PN052_02), Gold Creek (ID17010214PN034_02), Rapid Lightning Creek (ID17010214PN033_03), and North Gold Creek (ID17010214PN025_02 and 03) (Table ES-1).

Figure ES-1. Location of the Pend Oreille River Subbasin and Selected Idaho Tributaries



This report addresses watersheds contained by Boundary and Bonner counties, rural and sparsely populated counties of northern Idaho. Most of the Upper Pack River watershed is within Boundary County, Idaho. The 2006 Boundary County population estimate was 10,831, with very few of these residents in the Upper Pack River watershed (U.S. Census Bureau 2007a). Gold Creek, Rapid Lightning Creek, Sand Creek, North Gold Creek, and Trestle Creek are all located in Bonner County, Idaho. The 2006 U.S. Census Bureau estimate for Bonner County population was 41,275. Sandpoint is the county seat of Bonner County with a population of 6,835, which represents the largest urban area within the watersheds of concern. Urban growth is expected to continue in Sand Creek, Schweitzer Creek and the Pack River watersheds.

The Pend Oreille Subbasin was glacially formed during the ice age and the east side of the lake was in the path of the ancient Missoula Flood. Pend Oreille Lake is a leading recreational fishery destination and, because the lake is one of the deepest in the world, it is used to test submarine prototypes and other research. The Pend Oreille Subbasin supports a diversity of recreational opportunities, including skiing in the Schweitzer Ski Basin, golfing, camping, boating, and hunting. In addition to recreation, other key industries include forestry and textiles. There are National Forests and the Pack River Flats Wildlife Management Area within Boundary and Bonner Counties. Pend Oreille Lake, the City of Sandpoint, and many recreational attractions throughout the Pend Oreille Subbasin make these watersheds a prime location for continued growth and development (PRWC 2006).

The Upper Pack River watershed from the headwaters to the confluence with Caribou Creek covers 76 square miles or 48,466 acres. The watershed includes the 1st and 2nd order portions of Pack River and its tributaries, including Beehive Creek, Slide Creek, Thor Creek, Zuni Creek, West Branch Pack River, McCormick Creek from headwaters to Pack River, and 1st and 2nd order portions of McCormick Creek, Zee Creek, Homestead Creek, Youngs Creek, Jeru Creek, Lindsey Creek, Pearson Creek, Martin Creek, Blanc Creek, Hellroaring Creek, and Tavern Creek. Caribou Creek and Hellroaring Creek are 3rd order tributaries to the Upper Pack River. Lindsey Creek, Jeru Creek, Martin Creek and Homestead Creek are 2nd order tributaries to the Upper Pack River. The Pack River Stream Channel Assessment report (Golder 2003) indicates that the Upper Pack River riparian community is well established.

The Sand Creek watershed covers 38 square miles or 24,209 acres, and includes 1st to 3rd order portions of the creek as well as Jack Creek, Little Sand Creek, Swede Creek, and Schweitzer Creek. Sand Creek generally flows north to south and discharges into Pend Oreille Lake near the southeast corner of Sandpoint. The drinking water for the City of Sandpoint is withdrawn from Little Sand Creek.

The Gold Creek watershed encompasses 12 square miles, or 7,747 acres. Gold Creek flows into the Pack River approximately 4 miles upstream from where State Highway 200 crosses the Pack River (IDL 2003e). The Gold Creek watershed contains the mainstem Gold Creek from the headwaters to its confluence with the Pack River and 1st and 2nd order portions of Gold Creek. Gold Creek is a 3rd order tributary to the Pack River (IDL 2003e).

Table ES-1. Assessment Units Identified as Impaired in the 2002 Integrated Report in the Pend Oreille Subbasin (HUC 17010214)

Watershed Name	Water Body Name	Assessment Unit	Impairment Boundaries	Pollutant of Concern
Upper Pack River	Upper Pack River	ID17010214PN041_02	Upper Pack River – source to Lindsey Creek. First and 2 nd order portions of Pack River, West Branch Pack River, Zuni Creek, Martin Creek, Homestead Creek, Lindsey Creek, Pearson Creek, Youngs Creek, Thor Creek, Beehive Creek, Slide Creek.	Cause Unknown ¹
		ID17010214PN041_03	Mainstem Upper Pack River, source to Lindsey Creek.	Cause Unknown ¹
	McCormick Creek	ID17010214PN042_02	McCormick Creek – Source to Pack River. First and 2 nd order portions of McCormick Creek.	Cause Unknown ²
	Hellroaring Creek	ID17010214PN044_02	Hellroaring Creek – source to Pack River. First and 2 nd order portions of Hellroaring Creek	Cause Unknown ¹
Sand Creek ⁴	Sand Creek	ID17010214PN049_02	First and 2 nd order portions, source to Schweitzer Creek	Cause Unknown ¹
	Sand Creek	ID17010214PN049_03	Sand Creek – Source to Schweitzer Creek. Third order portion of Sand Creek.	Cause Unknown ¹
	Schweitzer Creek	ID17010214PN052_02	Schweitzer Creek – source to Sand Creek. First and 2 nd order portions of Schweitzer Creek.	Sediment
Gold Creek	Gold Creek	ID17010214PN034_02	Gold Creek – Source to Pack River. First and 2 nd order portions of Gold Creek.	Cause Unknown ¹
Rapid Lightning Creek	Rapid Lightning Creek	ID17010214PN033_03	Rapid Lightning Creek – Trapper Creek to Pack River. Third order portion of Rapid Lightning Creek.	Cause Unknown ³

Watershed Name	Water Body Name	Assessment Unit	Impairment Boundaries	Pollutant of Concern
North Gold Creek	North Gold Creek	ID17010214PN025_02	North Gold Creek – Source to Pend Oreille Lake. First and 2 nd order portions of North Gold Creek and Branch North Gold Creek.	Sediment
		ID17010214PN025_03	North Gold Creek – Branch North Gold Creek to Pend Oreille Lake. Third order portion of North Gold Creek.	Sediment

¹The stressor identification and Subbasin Assessment identified sediment as a cause of impairment.

²Stressor identification determined that sediment was not a likely cause of beneficial use impairment (TerraGraphics 2006).

³Although the stressor identification identified sediment as a likely cause of impairment, the Subbasin Assessment determined that sediment was not causing beneficial use impairment.

⁴ The Sand Creek watershed also includes the additional assessment units of Sand Creek (ID17010214PN048_03 and _03a) as well as assessment units for Jack Creek (ID17010214PN050_02), Swede Creek (ID17010214PN051_02), and Little Sand Creek (ID17010214PN053_02).

The Rapid Lightning Creek watershed covers 48 square miles, or 30,985 acres. Vegetation type is similar to the Upper Pack River watershed. Rapid Lightning Creek is a 3rd order tributary to the Pack River. The drainage is predominantly oriented in a westerly direction. Elevation ranges from 2080 to 6,735 feet with an average elevation of 3,612 feet. The average slope throughout the drainage is 24 percent, with a dominant slope of 16 percent. Over 47 percent of the area contains slopes greater than 30 percent. The Beneficial Use Reconnaissance Program (BURP) results documented a lack of stable fish cover (<10%). Sinuosity and width-to-depth ratios for the sub-reaches are medium and 66.5, respectively.

The North Gold Creek on the southeast shore of Pend Oreille Lake covers 16 square miles, or 10,519 acres. North Gold Creek is a 1st order tributary to Pend Oreille Lake. The drainage is predominantly oriented in a southeasterly direction. Elevation ranges from 2,066 to 6,358 feet with an average elevation of 3,933 feet. The average slope throughout the drainage is 47 percent, with a dominant slope of 55 percent. Over 80 percent of the area contains slopes greater than 30 percent. The elevation at the headwater of North Gold Creek is 4,555 feet, and at its outfall into Pend Oreille Lake the elevation is 2,067 feet. The instream cover diminishes from upstream (10-30%) to downstream (<10%). Sinuosity is medium and the average gradient is 4 percent. Width-to-depth ratios for the sub-reaches range from 37.2 (upper portion) to 74.3 (lower portion).

Key Findings

The beneficial uses for water bodies included in this TMDL are cold water aquatic life, salmonid spawning, primary contact recreation, and domestic water supply (Table ES-2). Beneficial uses are typically protected by a set of numeric and narrative criteria. Idaho's water quality standard for sediment is narrative, "*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).

Table ES-2. Pend Oreille Subbasin Beneficial Uses of Select Sediment-Impaired Waterbodies

Water Body	Uses*	Type of Use
Upper Pack River	CWAL, SS, PCR, DWS	Designated
Sand Creek	CWAL, PCR, DWS	Presumed
Schweitzer Creek	CWAL, PCR,	Presumed
Gold Creek	CWAL, PCR, SS**	Presumed
Rapid Lightning Creek	CWAL, PCR	Presumed
North Gold Creek	CWAL, SS, PCR	Existing

*CWAL – cold water aquatic life, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply, SRW – special resource water

**Salmonid spawning was added as a beneficial use August 14, 2007 based on Idaho Department of Fish and Game fisheries data (see page 50).

Idaho DEQ annual stream monitoring data, other stream surveys, and water quality samples were used in an assessment process to determine whether the beneficial uses are being fully supported. Further, DEQ determined whether water quality in the water bodies is meeting Idaho’s water quality standards. The assessment process identified 11 assessment units that are water quality impaired and do not fully support their beneficial uses (Table ES-1). When excess sediment was identified as the pollutant causing impairment, sediment TMDLs were developed in accordance with State of Idaho water quality standards. The TMDLs included in this document address sediment reduction goals to maintain or restore cold water aquatic life and salmonid spawning in impaired tributaries. The TMDLs quantify needed improvements and management actions to address water quality improvement measures and timelines.

The pollutant source inventory did not identify any point sources of sediment within the watersheds of concern. Nonpoint sources of sediment above natural background conditions may include urban or developed land use, livestock grazing, timber harvest, mass wasting, roadway impacts, and in-stream bank erosion. It is extremely difficult to partition current stream bank erosion rates to related factors such as: 1) naturally occurring (background); 2) remnants of effects from historic fires followed by increased flows; 3) remnant effects of historic timber harvesting in the riparian zone and construction of a transportation network; 4) excess stream energy of peak flows related to hydrologic openings from timber harvesting; 5) channel straightening and conversion of wetlands and wet meadows for agriculture purposes; 6) excess current sediment loads which lead to a decrease in stream depth; and 7) the effect of floodplain encroaching roads, as the roads can interfere with the stream’s natural tendency to seek a steady state gradient, and at high discharge periods may cause the stream to erode stream banks and the stream bed. For these reasons, sediment loading from stream bank erosion was not quantified in the TMDL calculations presented in Section 5 of this report.

Past and present pollution control efforts include regulatory and voluntary activities to manage sediment loading. The Forest Practices Act (FPA) governs the harvest and

reforestation of all timberlands in Idaho. These rules are, in part, requirements for BMPs designed to abate erosion and retard sediment delivery to streams. The Idaho Department of Lands (IDL) implemented FPA rules and regulations aggressively over the past 15 years. All harvests managed by the USFS must meet the federal Inland Native Fish Strategy guidelines. These guidelines prescribe 300-foot-wide buffers for streams with fish uses. Current and proposed timber sales within the basin include various road projects aimed at improving water quality. Road projects include road obliteration, resurfacing, slope stabilization, stream crossings, and drainage improvements.

Determination of the sediment load capacity at which full support of beneficial uses is exhibited has been set at various levels in TMDLs developed by the DEQ. These have ranged from an interim load capacity at the natural background level to a load capacity more than 200 percent above background in some areas of the state. Since Idaho sediment criteria are narrative, a critical step in development of sediment TMDLs is development of a numeric translator for narrative criteria to serve as the water quality target. To determine the most appropriate target, each subbasin must be evaluated on an individual basis. Although it is well understood that streams have the ability to process sediment levels above natural background levels, it is not well understood to what level this is possible before impairment occurs. As a result, a reference watershed was chosen to help derive a water quality target or numeric translator. Trestle Creek, a tributary to Pend Oreille Lake, was selected as the reference stream for the development of sediment TMDLs in the Pend Oreille Subbasin. Trestle Creek was chosen as a reference watershed because it supports one of the highest number of bull trout redds in the Pend Oreille Lake system (Corsi, *et al.* 1998), the stream is supports beneficial uses, and because the stream is considered undisturbed or “least impacted.”

A method was developed to estimate the sediment load to select streams within the Pend Oreille Subbasin. Six types of modeling or estimation techniques were used, depending on the source of eroded sediment, and these are described in Section 5.1 and Appendix A of this report. Monitoring points were selected from the existing DEQ BURP network for long-term evaluation of water quality compliance for the assessment units in this TMDL. The load capacity was estimated for the five watersheds (Table ES-3). Existing sediment loads were estimated for each watershed and land type (Table ES-4). Based on the modeling results from the reference watershed (Trestle Creek), a sediment load capacity target of 42 percent above natural background conditions was established.

Table ES-3. Load Capacity Summary

Watershed	Load Type	Area (acres)	Estimated Existing Load (tons/year)	Natural Background Load (tons/year)	Load Capacity at 42% above Background (tons/year)
Gold Creek	Sediment	7,747	390	181	257
North Gold Creek	Sediment	10,519	762	246	349
Rapid Lightning Creek	Sediment	30,985	1,014	717	1,018
Sand Creek	Sediment	24,209	2,039	562	798
Upper Pack River	Sediment	48,467	2,309	970	1,377

Table ES-4. Estimated Annual Average Existing Sediment Loads for Each Watershed by Land Type

Land Type	EXISTING SEDIMENT LOAD ¹ (tons/year)				
	Gold Creek	North Gold Creek	Rapid Lightning Creek	Sand Creek	Upper Pack River
Forest ²	151	210	690	376	584
Forest - Harvested	0	435	4	0	398
Forest - Burned	0	0	0	0	0
Grassland-Agriculture	170	0	78	406	0
Grassland-Permanent	0	3	0	261	386
Shrubland ²	3	1	13	18	241
Urban	18	2	9	465	23
Unpaved Roads	31	72	108	347	255
Paved Roads	0	0	0	73	0
Mass Wasting-Natural ²	0	0	0	0	34
Mass Wasting-Anthropogenic	0	0	0	0	296
Road Encroachment	17	39	112	93	92
Total Existing Load	390	762	1,014	2,039	2,309

¹ Existing Sediment Load = Natural Background Load + Anthropogenic Nonpoint Sources Load

² Sediment sources defined as natural.

All sediment load allocations within the Pend Oreille Subbasin are to nonpoint sources. No allocation is allotted for point sources of sediment. Sediment load allocations were assigned to resource managers and landowners based on the amount of sediment load from their land and the modeled land use types within the watershed. This report provides the required outcomes necessary to meet federal regulations and guidance for TMDLs. The outcomes are summarized in Table ES-5. Since the TMDLs are established based on land use categories and land management responsibilities, the sediment TMDL required for Hellroaring Creek is incorporated within the TMDL calculations for the Upper Pack River. Likewise, while a sediment TMDL for McCormick Creek was deemed unnecessary as an outcome of the stressor identification reports, pollutant load reductions for McCormick Creek are nonetheless included in the sediment TMDL calculations for Upper Pack River since the entire Upper Pack River watershed was modeled as one watershed. Any reductions in sediment loading from the McCormick Creek watershed will further advance the sediment load reductions set by the TMDL for the Upper Pack River.

Based on available data, stressor identification, and the Subbasin Assessment, DEQ has concluded that excessive sediment is not a likely cause of beneficial use impairment for Rapid Lightning Creek. Modeling results show that the existing sediment load for Rapid Lightning Creek is approximately equal to the load capacity target. With regard to sediment, water quality in Rapid Lightning Creek is meeting Idaho water quality standards and a sediment TMDL is not necessary for this assessment unit. Sediment allocations have been established for Rapid Lightning Creek in the 2001 DEQ Clark Fork/Pend Oreille Subbasin Assessment and TMDLs and Rapid Lightning Creek land managers must adhere to these

allocations. Rapid Lightning Creek is on the border of being impaired and additional land disturbance is likely to result in non attainment of the use. While only the mainstem of Sand Creek and Schweitzer Creek were validated as impaired, thus warranting TMDLs, additional TMDLs were established for other assessment units in the Sand Creek watershed including Sand Creek (ID17010214NP048_03 and _03a), Jack Creek (ID17010214NP050_02), Swede Creek (ID17010214NP051_02), and Little Sand Creek (ID17010214NP053_02). Sediment reductions in these assessment units will advance the success of achieving the sediment load allocations established for the Sand Creek watershed.

DEQ, designated management agencies responsible for TMDL implementation, and partners will make every effort to address past, present, and future pollution problems in an attempt to link them to watershed characteristics and management practices designed 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.

Table ES-5. Sediment TMDL Outcomes

Water Body Name	Assessment Unit	Pollutant	TMDL(s) Complete	Recommended Changes to Integrated Report	Justification
Upper Pack River	ID17010214PN041_02 ID17010214PN041_03	Sediment	Yes	Move to Section 4a*	TMDL Completed
McCormick Creek	ID17010214PN042_02	Sediment	No	Remove unknown as pollutant	Stressor ID report verified that sediment was not the cause of nonsupport of CWAL
Hellroaring Creek	ID17010214PN044_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Sand Creek	ID17010214PN049_02 ID17010214PN049_03 ID17010214PN048_03 ID17010214PN048_03a	Sediment	Yes	Move to Section 4a*	TMDL Completed
Jack Creek	ID17010214PN050_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Swede Creek	ID17010214PN051_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Schweitzer Creek	ID17010214PN052_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Little Sand Creek	ID17010214PN053_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Gold Creek	ID17010214PN034_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
North Gold Creek	ID17010214PN025_02 ID17010214PN025_03	Sediment	Yes	Move to Section 4a*	TMDL Completed

*Section 4a of the Integrated Report is "Impaired Waters with a Completed TMDL."

1. Subbasin Assessment – Watershed Characterization

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 2 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. (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.)

This document addresses the water bodies in the Pend Oreille Subbasin that have been placed on Idaho's 2002 §303(d) list.

The overall purpose of the *Pend Oreille Tributaries Sediment TMDLs* document is to characterize and document sediment pollutant loads for a select group of tributaries in the Pend Oreille Subbasin. The first portion of this document is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Sections 1 – 4). This information is to be used to develop TMDL calculations for sediment for specific tributaries in the Pend Oreille Subbasin (Section 5). A wide array of data sources and type were used to support the preparation of this report. Most of the data was collected prior to 2005; however, results from stressor identification reports, watershed specific refinements to land use/landcover data, road coverages, and forest harvest include data acquired between 2005 and 2006.

1.1 Introduction

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

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

Background

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

Section 303 of the CWA requires DEQ to adopt water quality standards and to review those standards every three years (EPA must approve Idaho's water quality standards).

Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses.

These requirements result in a list of impaired waters, formally called the "§303(d) list." This list, now referred to as Section 5 of the Integrated Report, describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. An SBA and TMDL provide a summary of the water quality status and allowable pollutant loads for water bodies on the impaired waters list. The *Pend Oreille Tributaries Sediment TMDLs* provides this summary for the currently listed waters in portion of the Pend Oreille Subbasin.

The subbasin assessment (SBA) section of this document (Sections 1 – 4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Pend Oreille Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging the pollutant.

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

Idaho's Role

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

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards (IDAPA 58.01.02) and include the following:

- Aquatic life support—coldwater, seasonal coldwater, warmwater, salmonid spawning, modified
- Contact recreation—primary (swimming), secondary (boating)
- Water supply—domestic, agricultural, industrial
- Wildlife habitats
- Aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then coldwater aquatic life and primary contact recreation (PCR) are used as additional default designated uses when water bodies are assessed.

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

- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.
- Determine the causes and extent of the impairment when water bodies are not attaining water quality standards.

Public Input and Meetings

In compliance with Idaho Code §39-3611(8), the development of the *Pend Oreille Tributaries Sediment TMDLs* 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 Lake Tributaries TMDLs. The following is a summary of the public process.

WAG Meetings (relative to the *Pend Oreille Tributaries Sediment TMDLs*)

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.

Tributary Work Group Meetings

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 Sediment TMDLs*

On September 4th, 2007, the *Pend Oreille Tributary Sediment 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 provided 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. The public comments received were individually addressed by DEQ and are provided in Appendix E.

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 submitted to EPA Region 10 and made available to the general public and distributed to WAG and Tributary Work Group members who are listed in Appendix D.

1.2 Physical and Biological Characteristics

Climate

Due to its relative proximity to the Pacific Ocean, climatic conditions in the Pend Oreille Subbasin are often influenced by maritime weather patterns. Winter storms pass over the area from November through March causing a wet winter season. Summer storms, however, generally pass farther north, resulting in relatively dry conditions in the summer. Winds typically prevail from the southwest across Pend Oreille Lake creating exceptionally wet conditions (“lake effect”) on the Cabinet Mountains to the northeast.

To provide a general representation of the climatic conditions in the Pend Oreille Subbasin, data from the Western Regional Climate Center, Sandpoint Experiment Station (Station #108137) near Sandpoint, Idaho are summarized. These data are based on the period of record from October 1910 to December 2005. Average monthly temperatures in the area range from 20 degrees Fahrenheit (°F) (-7 degrees Celsius [°C]) to 82°F (28°C) (WRCC 2007). Monthly average precipitation data range from 3.2 inches (July) to 14.8 inches (December), and monthly average snowfall ranges from 0.3 inch (April) to 7.4 inches (January). Average annual precipitation is 32 inches (WRCC 2007). In winter, precipitation falls mainly as snow, with an annual average of 70 inches in Sandpoint, Idaho (WRCC 2007). In the surrounding mountains annual average snowfall exceeds 82 inches. Annual runoff is produced mostly by melting snow in April and May.

Hydrology

The Clark Fork River flows into the northeast corner of Pend Oreille Lake and is the lake’s largest tributary. The Clark Fork River contributes approximately 92 percent of the annual inflow to the lake (Frenzel 1991) and most of the annual suspended sediment load. The Pack River, which originates in the Selkirk Mountains is the second largest tributary to the lake, and is fed by a number of significant tributary watersheds, including Rapid Lightning Creek and Grouse Creek. The Pack River flows approximately 45 miles in a southerly direction to the river’s mouth at the northern tip of Pend Oreille Lake. Numerous other watersheds enter directly, containing both perennial and intermittent streams. Pend Oreille Lake is one of the deepest lakes in the world reaching depths of 1,158 feet in some locations (Sandpoint Online 2007).

The Pend Oreille River is the only surface outflow from Pend Oreille Lake. The river flows from the lake’s northwest corner near Sandpoint for about 27 miles before entering Washington. Pend Oreille Lake is hydraulically connected to the Spokane Valley-Rathdrum Prairie Aquifer at the lake’s most southern end (Scenic Bay and Idlewilde Bay).

Annual runoff in the watersheds of the Pend Oreille Tributaries is produced primarily by melting snow, with peak flows typically occurring in May or June, but occasionally in April or July. Tributaries to the lake may experience one or more runoff events. Midwinter rain-on-snow events can result in a rapid snow melt, and in some years the peak flow from tributary watersheds occurs during these events. The main body of Pend Oreille Lake seldom freezes due to considerable latent heat content (Corsi, *et al.* 1998).

This report divides the study area into five 6th order watersheds that cover the drainage areas for 11 assessment units in the Pend Oreille Lake HUC 17010214 currently identified in

Idaho's 2002 Integrated Report, as being water quality limited as a result of an unknown pollutant or excess sediment. Each watershed displayed in Figure 1-1 is named for the main water body that drains it. For the purposes of this report, the Upper Pack River watershed includes the following assessment units: mainstem river (17010214PN041_02 and 03), McCormick Creek (17010214PN042_02), and Hellroaring Creek (17010214PN044_02). The Sand Creek watershed includes 1st to 3rd order portions of the creek (17010214PN049_02 and 03) as well as Schweitzer Creek (17010214PN052_02). This report also addresses Gold Creek (ID17010214PN034_02), Rapid Lightning Creek (ID17010214PN033_03), and North Gold Creek (ID17010214PN025_02 and 03). McCormick Creek, Hellroaring Creek, Gold Creek, and Rapid Lightning Creek are all tributaries to the Pack River. Sand Creek and North Gold Creek are tributaries draining directly into Pend Oreille Lake. Table 1-1 provides the list of water quality impaired streams addressed in this report.



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Table 1-1. Assessment Units Identified as Impaired in the 2002 Integrated Report in the Pend Oreille Subbasin (HUC 17010214)

Watershed Name	Water Body Name	Assessment Unit	Impairment Boundaries	Pollutant of Concern
Upper Pack River	Upper Pack River	ID17010214PN041_02	Upper Pack River – source to Lindsey Creek. First and 2 nd order portions of Pack River, West Branch Pack River, Zuni Creek, Martin Creek, Homestead Creek, Lindsey Creek, Pearson Creek, Youngs Creek, Thor Creek, Beehive Creek, Slide Creek.	Cause Unknown ¹
		ID17010214PN041_03	Mainstem Upper Pack River, source to Lindsey Creek.	Cause Unknown ¹
	McCormick Creek	ID17010214PN042_02	McCormick Creek – Source to Pack River. First and 2 nd order portions of McCormick Creek.	Cause Unknown ¹
	Hellroaring Creek	ID17010214PN044_02	Hellroaring Creek – source to Pack River. First and 2 nd order portions of Hellroaring Creek	Cause Unknown ¹
Sand Creek ²	Sand Creek	ID17010214PN049_02	First and 2 nd order portions, source to Schweitzer Creek	Cause Unknown ¹
		ID17010214PN049_03	Sand Creek – Source to Schweitzer Creek. Third order portion of Sand Creek.	Cause Unknown ¹
	Schweitzer Creek	ID17010214PN052_02	Schweitzer Creek – source to Sand Creek. First and 2 nd order portions of Schweitzer Creek.	Sediment
Gold Creek	Gold Creek	ID17010214PN034_02	Gold Creek – Source to Pack River. First and 2 nd order portions of Gold Creek.	Cause Unknown ¹
Rapid Lightning Creek	Rapid Lightning Creek	ID17010214PN033_03	Rapid Lightning Creek – Trapper Creek to Pack River. Third order portion of Rapid Lightning Creek.	Cause Unknown ¹
North Gold Creek	North Gold Creek	ID17010214PN025_02	North Gold Creek – Source to Pend Oreille Lake. First and 2 nd order portions of North Gold Creek and Branch North Gold Creek.	Sediment
		ID17010214PN025_03	North Gold Creek – Branch North Gold Creek to Pend Oreille Lake. Third order portion of North Gold Creek.	Sediment

¹Sediment was determined to be the suspected cause of impairment during the Subbasin Assessment process.

²The Sand Creek watershed also includes the additional assessment units of Sand Creek (ID17010214PN048_03 and _03a) as well as assessment units for Jack Creek (ID17010214PN050_02), Swede Creek (ID17010214PN051_02), and Little Sand Creek (ID17010214PN053_02).

Geology

The geologic parent materials in the Pend Oreille Subbasin result from millions of years of sedimentation, metamorphosis, uplift, and intrusion. Belt series and Kaniksu batholith are the major underlying bedrock types. Underlying geology is an important characteristic that influences fish distribution, abundance, and growth. Soil characteristics influence erosion

rates and sediment transport. In general, the soil and topography of the Pack River watersheds cause a high tendency for soil erosion (Golder 2003). Campbell (1987) and Golder (2003) provide the following synopsis of the soil series as defined by the USDA 1982 Bonner County Soil Survey (USDA 1982).

The Soil Survey of Bonner County identified five generalized soil associations in the Pack River drainage. The Pend Oreille–Rock Outcrop and the Priest Lake–Treble soils are deep, well drained soils that are predominantly gravelly-sandy loams with the exception of the silt loams that occupy the lower and cooler north-facing side slopes. These soils range in elevation from 2,100 to 5,000 feet. Above 4,800 to 5,000 feet, the moderately drained, rock outcrop-Prouti-Jeru association is present. The soils in this association are gravelly and /or very stony loams. The Bonner series occupies the lower reaches of the Pack River drainage. These soils developed on former glacial outwash terraces partially reworked by the river. The final soil classification is the Colburn-Selle-Elmira association. These soils range from poorly drained very fine sandy loams in the lower elevations to excessively drained loamy sand in the higher elevations.

Figures 1-2 and 1-3 present the soil series within each watershed based on 1994 State Soil Geographic Database (STATSGO) data. Table 1-2 summarizes the distribution of the major soil types found in each watershed (Schwarz and Alexander 1995).

Streams on the north and east sides of Pend Oreille Lake (watersheds in the Cabinet and Bitterroot Mountains) are primarily within the Belt Series bedrock type (sedimentary), and streams draining the Selkirk Mountains are mainly within the Kaniksu batholith (granitic bedrock type) (Savage 1965).

The Belt Series are metamorphic sedimentary deposits comprised partially by the Bitterroot and Cabinet Mountains. These rocks were formed during the Precambrian period when shallow seas inundated northern Idaho. Sediments of clay, silt, and sand settled out of brackish waters as seas retreated, subsequently metamorphosed, and began to fold and fault. The metamorphosed rocks in the basin include argillite, siltite, quartzite, and dolomite (Hoelscher, *et al.* 1993).

The Kaniksu batholith formed about 70 to 80 million years ago when large masses of granite magma rose into the upper part of the earth's crust. As this mass of granite magma rose, it caused part of the crust to shear off and move easterly, forming a part of the Cabinet Mountains. The rising magma helped form the Selkirk Mountains.

The basin was substantially altered by major glacial events in the late Pleistocene period. The present Clark Fork River valley was alternately plugged and scoured by dams of ice and deposited debris that likely served as the primary feature controlling the level and size of Glacial Lake Missoula. Lake Missoula once covered much of present day western Montana. Existing soil in the watershed is derived from the erosion of Precambrian metasediments and granitic batholith, volcanic deposition, glacial outwash, and alluvium. Most land types have 10 inches or more of surface soil composed of Mt. Mazama volcanic ash, which has very high water infiltration rates.



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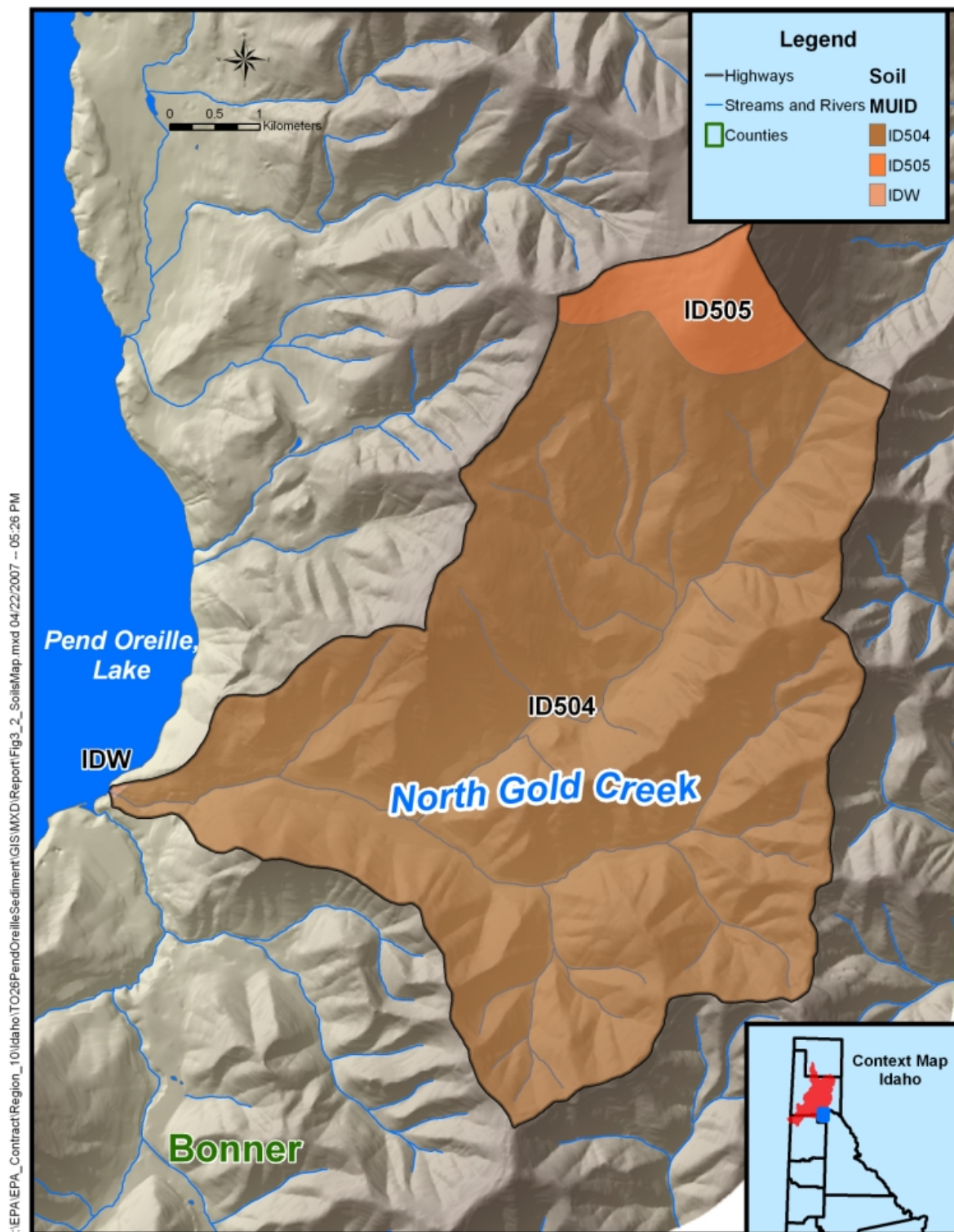


Figure 1-3. Soils for North Gold Creek Watershed,

Table 1-2. Soil Distribution of Selected Watersheds in the Pend Oreille Subbasin

Watershed	Code	Soil Type Classification	Area (acres)	Percentage by Watershed
Upper Pack River	ID489	Prouty-rock outcrop-Jeru	38,629	80
	ID434	Pend Oreille-Rock outcrop-Treble	5,445	11
	ID472	Colburn-Mission-Selle	84	0
	ID473	Vay-Prouty-Jeru	2,299	5
	ID477	Priest Lake-Treble-rock outcrop	2,011	4
Sand Creek	ID434	Pend Oreille-Rock outcrop-Treble	5,395	22
	ID472	Colburn-Mission-Selle	3,076	13
	ID473	Vay-Prouty-Jeru	4,173	17
	ID477	Priest Lake-Treble-rock outcrop	5,367	22
	ID480	Mission-Selle_Odenson	6,198	26
Gold Creek	ID421	Kootenai-Bonner-Rathdrum	120	2
	ID434	Pend Oreille-Rock outcrop-Treble	7,516	97.0
	ID472	Colburn-Mission-Selle	112	1
Rapid Lightning Creek	ID434	Pend Oreille-Rock outcrop-Treble	26,795	87
	ID465	Jeru-Prouty-rock outcrop	4,131	13
	ID472	Colburn-Mission-Selle	59	0.2
North Gold Creek	ID504	Boulder creek-Moss variant Lumberjack variant	9,937	94
	ID505	Vay-Nugget variant Boulder creek	577	6
	IDW	Water	5	0.0

Watersheds in the Cabinet Mountains tend to be more prone to rapid runoff events due to the effects of scour by glacial advances. Glacial advances resulted in highly dissected watersheds (*i.e.*, a high density of streams), shallow soil, and subsoil compaction of glacial tills. The Mt. Mazama ash layer, with its high infiltration rates, is resistant to erosion-causing overland flows. When forest conditions are undisturbed within the Pend Oreille Subbasin, surface erosion is generally low to nonexistent on most upland land types. Mass erosion, however, plays a significant role. Since different layers of till have different water infiltration rates, watersheds draining the Cabinet Mountains tend to have a higher incidence of mass wasting than those in the Pend Oreille Subbasin. As a result of these different till layers, groundwater seeps and springs are more prevalent in tributaries draining the Cabinet Mountains to the north of Pend Oreille Lake. Since glacial outwash makes up most of the valley bottoms in the Cabinet Mountains, and the watersheds are more flashy, in-channel erosion rates are higher than drainages on the east side of Pend Oreille Lake. Activities such as road construction, which intercept groundwater between compacted till layers and the ash layer, can increase surface flow and the potential for mass wasting.

Glaciers acted as ice dams and deposited large amounts of till in the Pend Oreille Subbasin. Ice in the Pack River Valley dammed most of the tributary streams upstream of their confluence with Pack River, creating a lake that surrounded much of the valley. Fine sandy sediments deposited in the dammed water are known as glacial fluvial deposits. These sandy areas today appear on mountain side slopes, and are very erosive.

Generally, streams on the north and east sides tend to be more productive and have much less fine sediment than streams draining the granitic soil of the Selkirk Mountains. Belt Series streams are more likely to have bedload as a limiting habitat factor, whereas streams flowing from the granitic watersheds of the Selkirk Mountains may have fine sediment limiting

habitat condition. Granitic soil tends to be nutrient-poor, and fish growth is typically slower in streams flowing from granitic watersheds. Natural waterfalls are found throughout the basin, and preclude use of several tributaries, or portions of tributaries, by migratory fish. Table 1-3 describes the various types of lithology and the associated acreages observed in each watershed.

Table 1-3. Lithology of Project Watersheds in the Pend Oreille Subbasin

Subwatershed	Symbol	Description	Area (acres)	Contribution (percent by watershed)
Upper Pack River	Kim	Cretaceous metamorphosed granitic intrusive rock	39,539	82
	Qpg	Pleistocene outwash fenglomverate flood and terrace gravel	66	<1
	Qpt	Pleistocene till moraines and similar unsorted glacial debris	8,235	17
	Y1nm	Intermediate Precambrian metasediments generally low-to-medium grade	626	1
Sand Creek	Kif	Cretaceous plutons	59	<1
	Kim	Cretaceous metamorphosed granitic intrusive rock	9,550	39
	Qpg	Pleistocene outwash fenglomverate flood and terrace gravel	9,858	41
	Qpt	Pleistocene till moraines and similar unsorted glacial debris	3,727	15
	Y1nm	Intermediate Precambrian metasediments generally low-to-medium grade	526	2
	Zib	Younger Precambrian dioritic and amphibiotic silt	490	2
Gold Creek	Kif	Cretaceous plutons	1,633	21
	Qa	Quaternary alluvium	314	4
	Qpg	Pleistocene outwash fenglomverate flood and terrace gravel	1,238	16.0
	Qpt	Pleistocene till moraines and similar unsorted glacial debris	4,086	53
	Y1n	Precambrian gray interlaminated siltite and argilite with minor quartzite	477	6
Rapid Lightning Creek	Kif	Cretaceous plutons	1,692	6
	Qa	Quaternary alluvium	172	<1
	Qpt	Pleistocene till moraines and similar unsorted glacial debris	22,529	73
	Y?n	Precambrian gray interlaminated siltite and argilite with minor quartzite	2,629	9
	Y1n	Precambrian gray interlaminated siltite and argilite with minor quartzite	3,344	11
	Zib	Younger Precambrian dioritic and amphibiotic silt	618	2

Table 1-3. Lithology of Project Watersheds in the Pend Oreille Subbasin (*continued*)

Subwatershed	Symbol	Description	Area (acres)	Contribution (percent by watershed)
North Gold Creek	Cmn	Middle Cambrian thinly laminated claystone overlying coarse-grained pebbly	198	2
	Cun	Upper Cambrian dolomitic limestone and claystone of northern Idaho	3,292	31
	Kif	Cretaceous plutons	259	3
	Qpg	Pleistocene outwash fenglomverate flood and terrace gravel	558	5
	Y2n	Precambrian multicolored siltite and argillite overlying quartzite and siltite	95	1
	Y3n	Precambrian dark-colored calcareous and dolomitic argillite and siltite	6,116	58

Topography

The Pend Oreille Subbasin is separated from the Priest River Basin to the west by a north-south running mountain range (Selkirk Mountain Range) that varies in elevation from 7,300 feet in the north to 3,600 feet in the south. To the northeast and separating the Pend Oreille-Clark Fork basins from the Kootenai River Basin, the southwest facing Cabinet Mountains are less than 6,600 feet high. The Purcell Trench is pitched by a gentle divide of less than 2,500 feet near Elmira where Deep Creek runs north to join the Kootenai River and the southern portion drains into the Pack River.

The ridges to the southeast of the lake which separate the Pend Oreille-Clark Fork basins from the Coeur d'Alene River Basin face north and west. The ridges are generally less than 5,000 feet high, although Packsaddle Mountain on the southeast side of the lake reaches an elevation of 6,400 feet. The Hoodoo and Cocolalla valleys are separated from the Rathdrum Prairie and the Spokane River Basin to the south by a gentle arched plain reaching an elevation of approximately 2,500 feet. Between Hoodoo Creek and Cocolalla Creek and between Cocolalla Creek and Pend Oreille Lake are several mountains ranging in elevation from 4,100 feet to 5,000 feet.

Table 1-4 describes the elevation-related characteristics of each watershed. A brief description of these attributes by each watershed is provided in the following subsections.

Table 1-4. Topographic Characteristics of the Project Watersheds in the Pend Oreille Subbasin

Watershed	Area (acres)	Stream Length (miles)	Land Form	Dominant Aspect	Relief Ratio*	Mean Elevation (feet)	Dominant Slope %
Upper Pack River	48,467	21.1	Mountainous	East	0.063	4,462	29
Sand Creek	24,209	10.7 4.9	Mountainous	East	0.132	3,313	35
Gold Creek	7,747	8.7	Mountainous	West	0.029	2,703	12
Rapid Lightning Creek	30,985	13.4	Mountainous	West	0.048	3,612	16
North Gold Creek	10,519	6.2	Mountainous	Southeast	0.076	3,933	55

* $R_h = H/L$, where H is the difference between the highest and the lowest point in the basin and L is the horizontal distance along the longest dimension of the basin parallel to the main stream line.

Vegetation

Historic vegetation patterns were largely influenced by wildfire. Early accounts and photographs of the Pend Oreille Subbasin indicate that old growth stands of western red cedar (*Thuja plicata*) and other species were common in riparian zones and floodplains. Large cedar stumps can still be found in many riparian areas along Pend Oreille Subbasin streams. Watershed uplands were more typically dominated by several species in various stages of succession, with age and composition dependent primarily on fire cycles and slope aspect.

Euro-American settlement of the Pend Oreille Subbasin has been accompanied by forest clearing, agricultural development, logging, introduction of non-native pests, mining, railroad construction, and general urbanization. Forest products are an important commodity from timbered lands which surround the Idaho portion of the subbasin. Present vegetation conditions are a product of all of these factors, as well as natural and human-influenced fires. Forest fires have had a profound impact on vegetation within the Pend Oreille Subbasin during the last century.

Low elevation riparian zones near tributary mouths include areas with and without tree canopy cover. Along stream corridors where tree overstory does not exist or is thin, vegetation includes shrubs and small trees such as thin-leaf alder (*Alnus sinuata*), willows (*Salix spp.*), snowberry (*Symphoricarpos albus*), mountain maple (*Acer glabrum*), red-osier dogwood (*Cornus stolonifera*), blue elderberry (*Sambucus cerulea*), and black hawthorn (*Crataegus douglasii*). Where tree canopy is present, tree species include black cottonwood, (*Populus trichocarpa*) or water birch (*Betula occidentalis*), quaking aspen (*Populus tremuloides*), and a mix of conifer species; including western red cedar, western hemlock (*Tsuga heterophylla*); Douglas-fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), and western white pine (*Pinus monticola*). White pine stands have been significantly impacted by white pine blister rust, an introduced pathogen.

Conifer forests in the subbasin consist of mixed stands, typified by stands of western red cedar/western hemlock; stands of co-dominant Douglas-fir and Ponderosa pine (*Pinus ponderosa*); and stands of Douglas-fir, western larch (*Larix occidentalis*), lodgepole pine (*Pinus contorta*) and western white pine. Dense stands of Douglas-fir, larch, and lodgepole pine are characteristic of slopes with north and east aspects. Relatively open stands of Douglas-fir and Ponderosa pine are typical on the warmer, dryer slopes with south and west aspects.

Representative species of upland shrubs include western serviceberry (*Amelachier alnifolia*), mountain maple, snowberry, mountain balm (*Ceanothus velutinus*), mallow ninebark (*Physocarpus malvaceus*), huckleberry (*Vaccinium spp*), and others.

Vegetation can strongly influence conditions in streams. Canopy cover adjacent to streams provides shade and helps maintain cooler water temperatures during summer months. Conifers may also provide insulation during winter months, reducing freezing and the formation of anchor ice. Large trees that fall into streams and floodplains help shape channels, create pools, provide cover and shade, introduce and store nutrients, dissipate stream energy, and contribute to overall channel stability (Murphy and Meehan 1991). Riparian vegetation also plays an important role in providing stream bank stability through

binding of the soil by roots. The amount, type, and stage of vegetation in a watershed can also influence stream flows. Vegetation removal by fire or timber harvest can result in increased peak flows during storm events and increased summer flows (Harr 1981).

Fisheries

A wide diversity of fish species are present in Pend Oreille Lake and its tributaries. The larger native fish present are westslope cutthroat trout (*Oncorhynchus clarki lewisi*), bull trout (*Salvelinus confluentus*), and mountain whitefish (*Prosopium williamsoni*). Non-native sport fish that have been stocked or found their way into the lake over the years include kokanee salmon (*Oncorhynchus nerka*), rainbow trout (*Oncorhynchus mykiss*), Gerrard (Kamloops) rainbow trout, lake whitefish (*Coregonus clupeaformis*), brook trout (*Salvelinus fontinalis*), brown trout (*Salmo trutta*), lake trout (*Salvelinus namaycush*), yellow perch (*Perca flavescens*), black crappie (*Pomoxis nigromaculatus*), largemouth bass (*Micropterus salmoides*), brown bullhead (*Ameiurus nebulosus*), pumpkinseed sunfish (*Lepomis gibbosus*), and northern pikeminnow (*Ptychocheilus oregonensis*). Other fishes include large-scale sucker (*Catostomus macrocheilus*), longnose sucker (*Catostomus catostomus*), peamouth chub (*Mylocheilus caurinus*), redbelt shiner (*Richardsonius balteatus*), slimy sculpin (*Cottus cognatus*), torrent sculpin (*Cottus rhotheus*), longnose dace (*Rhinichthys cataractae*), pygmy whitefish (*Prosopium coulteri*), and tench (*Tinca tinca*).

In 1889, the U.S. Fish Commission introduced 1.3 million lake whitefish fry into Pend Oreille Lake. Kokanee, the landlocked form of sockeye salmon, appeared in the lake about 1933. The original stock likely migrated into the lake via the Flathead and Clark Fork rivers from Flathead Lake in Montana. During 1937, an unknown cause created a tremendous die-off of lake whitefish. As lake whitefish numbers declined, kokanee became very abundant. In 1941 or 1942, the presence of abundant kokanee prompted the introduction of Gerrard rainbow trout, a top level predator, from Kootanay Lake, British Columbia (Corsi, *et al.* 1998).

Other salmonids have been introduced into the Pend Oreille Lake drainage including brook trout, brown trout, lake trout, and arctic grayling. The arctic grayling introduction apparently failed as there are no catch records for this species. Lake trout and brown trout established populations in the lake and provide some harvest. Brook trout occur primarily in the tributaries. It is not known when yellow perch, black crappie, or largemouth bass were introduced into Pend Oreille Lake. These species compose an important part of the fish community in the shallow bays of the northern and western part of the lake. The westslope cutthroat trout is native to the subbasin, and fishery declined more dramatically than any other Pend Oreille Lake fishery. It is now very reduced and is being supported by fingerling stocking (Hoelscher, *et al.* 1993).

Bull Trout

In the Pend Oreille Subbasin only adfluvial populations of bull trout are known to exist; their movements are now limited by Albeni Falls Dam and Cabinet Gorge Dam. Adfluvial bull trout spawn in tributary waters where the juveniles rear for 1 to 4 years before migrating to the lake where they grow to maturity. In 1998, the U.S. Fish and Wildlife Service listed the bull trout as a threatened species under the Endangered Species Act. In-stream habitat requirements make bull trout exceptionally sensitive to activities that directly or indirectly affect stream channel integrity and natural flow patterns, including groundwater flow (Corsi,

et al. 1998). Increased peak flows during winter months when bull trout eggs are incubating may reduce hatching success. The Pend Oreille Subbasin is identified as a key watershed in the Idaho conservation plan to restore bull trout populations in the state. In 1998, the Technical Advisory Team for the Pend Oreille Watershed Advisory Group (WAG) prepared the *Lake Pend Oreille Key Subbasin Bull Trout Problem Assessment* report to serve as a technical guide to develop and prioritize conservation and/or recovery actions in each Pend Oreille Subbasin (Corsi, *et al.* 1998). The bull trout conservation plan will be a guiding force in all water quality management strategies targeted for the Pend Oreille Subbasin, including implementation of the TMDLs in this SBA report.

Watershed Characteristics

The character and behavior of a river system at any particular location reflect the integrated effect of many upstream variables, with the dominant variables being discharge and sediment (Golder 2003). The hydrologic regime and quantity and type of sediment are determined by a set of independent factors, notably climate, vegetation, soil, geology, basin physiography, and land use (Golder 2003). This SBA evaluates approximately 65 miles of streams (sum of the mainstems of Upper Pack River, Sand Creek, Schweitzer Creek, Gold Creek, Rapid Lightning Creek, and North Gold Creek). Several important and inherent characteristics influence the channel forms of the creeks and streams in the study area, including:

- Arid climate and rain-on-snow, flashy hydrology;
- Geology and high erosivity of hillslope soil;
- Disturbance from fires;
- Steep, confined topography and high valley slope of the upper watershed; and
- Broad alluvial valley and gentle slope of the lower watershed (Golder 2003).

The following subsection provides additional information and description of the physical characteristics of the specific watersheds addressed in this SBA report. Much of the information presented in the following subsection is derived from the 2003 *Pack River Stream Channel Assessment Report* (Golder 2003) and a series of Cumulative Watershed Effects (CWE) assessment reports prepared in 2003 through a cooperative effort among Idaho Department of Lands (IDL), DEQ, and the Panhandle National Forest (PNF). The CWE method is designed to first examine conditions in the watershed surrounding a stream and in the stream itself, and then attempt to identify the causes of any adverse conditions. Finally, it helps identify actions that will correct any identified adverse conditions (IDL 2003a). The CWE “Adverse Conditions Assessment” method was applied to analyze whether significant adverse effects occur in the forested portions of certain watersheds within the Pend Oreille Subbasin (IDL 2003a). From these CWE reports, water bodies are characterized using the Rosgen stream classification based on the morphological features of the stream, including valley types, materials, gradients, shapes, and meander patterns.

The Upper Pack River Watershed

The Upper Pack River watershed from the headwaters to the confluence with Caribou Creek covers 76 square miles or 48,466 acres. The watershed includes the 1st and 2nd order portions of Pack River and its tributaries, including Beehive Creek, Slide Creek, Thor Creek, Zuni Creek, West Branch Pack River, McCormick Creek from headwaters to Pack River, and 1st and 2nd order portions of McCormick Creek, Zee Creek, Homestead Creek, Youngs Creek, Jeru Creek, Lindsey Creek, Pearson Creek, Martin Creek, Blanc Creek, Hellroaring Creek,

and Tavern Creek. Caribou, Creek, Hellroaring Creek are third order tributaries to the Upper Pack River. Lindsey Creek, Jeru Creek, Martin Creek and Homestead Creek are 2nd order tributaries to the Upper Pack River.

The *Pack River Stream Channel Assessment* report (Golder 2003) indicates that the Upper Pack River riparian community is well established. Vegetation varies with elevation, aspect, and landform. Cedar-hemlock habitats are generally observed in the lower elevations, while mixed conifer forests consisting of Douglas-fir, grand fir, western red cedar, larch, hemlock, ponderosa pine, lodgepole pine, and western white pine with the more xeric species dominating south to west facing aspects are observed in the uplands. Subalpine fir and spruce commonly inhabit the higher elevations, and water-loving species such as alder and willow inhabit the very wet areas, especially along riparian zones (IDL 2003a, 2003b and 2003c).

The watershed is dominated by the Prouty-rock outcrop-Jeru soil (Table 1-2), underlain mostly by Cretaceous metamorphosed granitic intrusive rock (Table 1-3). The following paragraph is an excerpt from the *Pack River Stream Channel Assessment* report (Golder 2003), which describes the synthesis of the geomorphic data:

The geomorphology of the Upper Pack River is characteristic of glaciated watersheds with granitic parent geology. Due to the erosive nature of granite and the large sediment sources created by retreating glaciers, these types of systems transport a high volume of coarse and fine sediment. This high sediment transport is evident in the Upper Pack River.

The Upper Pack River watershed above the U.S. 95 bridge crossing is characterized by moderate to steep slopes with a narrow floodplain. Elevations in the watershed range from 2,130 to 7,599 feet with a mean elevation of 4,210 feet (Campbell 1987). Hill slopes average between 20 and 35 percent, but approach 80 percent near the upper boundaries of the watershed. The river gradient is much steeper in the upper watershed, ranging from 1 to 7 percent. The mean elevation of the Upper Pack River watershed is 4,462 feet with a relief ratio of 0.063 (Table 1-4). The drainage is predominantly oriented in an easterly direction with a dominant slope of 29 percent. The elevation of Hellroaring Creek ranges from 2,220 feet at the confluence with the Pack River to 5,720 feet at the headwaters (IDL 2003d).

The CWE survey results for the Upper Pack River indicated that risks of mass failure and total sediment delivery are moderate and low, respectively (IDL 2003a, 2003b and 2003c). Based on the CWE survey results for Hellroaring Creek, the risk of mass failure and total sediment delivery in the Upper Pack River watershed is considered low and the surface erosion hazard is high (IDL 2003d).

Additional useful information characterizing the Upper Pack River watershed from its headwaters to the confluence with Caribou Creek was prepared by Golder Associates Inc. in 2003. In the Golder Associates report, *Pack River Stream Channel Assessment*, the Upper Pack River was subdivided into 30 different subreaches to inventory geomorphic conditions, riparian habitat, and fisheries habitat, which are summarized in Tables 1-5a through 1-5c. Table 1-5a provides valuable summary statistics on the geomorphic conditions of the Upper Pack River from the Zuni Creek confluence to McCormick Creek confluence, and includes Zuni, Thor, Slide, Beehive, Chimney, and McCormick Creeks (Reach A, sub-reaches 1 to 8). This portion of the Upper Pack River watershed is dominated by the Rosgen B type channel,

with slopes ranging from 1.7 percent to 15 percent. Gradients, sinuosity, entrenchment ratios, and width-to-depth ratios for the sub-reaches range from 1.7 percent to 15 percent, 1.0 to 1.3, 1.2 to 6.5, and 20 to 42, respectively. The Upper Pack River watershed generally exhibits relatively steep slopes except for sub-reach 7. The dominant substrate within the watershed changes from bedrock (sub-reach 1) to boulder (sub-reaches 2 to 4) to cobble (sub-reaches 5, 6, 7, and 8).

Table 1-5a. Stream Type Characteristics of Reach A – Upper Pack River

Sub-reach	Bankfull width (ft)	Mean bankfull depth (ft)	Bankfull cross-section area (ft ²)	Width/depth ratio	Max depth (ft)	Width of flood-prone area (ft)	Entrenchment ratio	Channel material size (D50) (in)	Gradient (%)	Channel sinuosity	Stream type
1	47.9	1.12	53.63	42.94	1.97	57.7	1.21	Bedrock	15	1.1	B1a
2	36.4	1.12	40.40	34.41	2.13	55.1	1.44	11.076	5.8	1.2	B2a
3	51.3	1.74	89.31	29.53	3.05	334.2	6.51	7.995	3.8	1.2	C2b
4	37.6	1.87	70.23	20.09	2.79	76.9	2.05	10.2765	4	1.1	B2a
5	31.5	1.54	48.49	20.43	4.13	72.8	2.31	6.4467	7	1.0	B3a
6	38.0	0.95	36.14	40.00	2.33	69.5	1.83	6.2673	4.5	1.3	B3a
7	40.8	1.15	46.96	35.57	1.90	62	1.52	5.3937	1.7	1.3	B3c
8	36.4	1.28	46.60	28.46	2.72	52.2	1.43	4.992	3	1.3	F3b

Source: Golder Associates 2003

Table 1-5b provides valuable summary statistics on the geomorphic conditions of the Upper Pack River from the McCormick Creek confluence to Hellroaring Creek confluence (Reach B, sub-reaches 9 to 21). The watershed was divided into 13 sub-reaches. This portion of the Upper Pack River consists of Rosgen B and C type channels, with two reaches (sub-reaches 11 and 12) classified as F stream type. The substrate within the watershed ranges from small to large cobbles, with large cobbles being the dominant substrate. Gradients, sinuosity, entrenchment ratios, and width-to-depth ratios for the sub-reaches ranged from 2 to 6 percent, 1.0 to 1.5, 1.1 to 3.0, and 19 to 65, respectively. The following paragraph is an excerpt from the *Pack River Stream Channel Assessment Report* (Golder 2003), which describes the synthesis of the geomorphic data:

Upon review of historical aerial photographs the channel morphology of this sub-reach appeared to remain fairly constant. Roughly half the sub-reaches (13, 14, 15, 16, 20, and 21) exhibit a stable channel morphology (B3-type) similar to the reference reach. These channels seem to generally be in balance with their geomorphic setting. These sub-reaches are B stream types, with low-to-moderate gradients, gentle sideslopes, and cobble/boulder-gravel substrates that aid in-channel stability.

Table 1-5b. Stream Type Characteristics of Reach B – Upper Pack River

Sub-reach	Bankfull width (ft)	Mean bankfull depth (ft)	Bankfull cross-section area (ft ²)	Width/depth ratio	Max depth (ft)	Width of flood-prone area (ft)	Entrenchment ratio	Channel material size (D50) (in)	Gradient (%)	Channel sinuosity	Stream type
9	64.6	3.18	205.43	20.31	4.00	195.30	3.02	7.02	4	1	C3b
10	55.6	2.10	116.76	26.48	3.80	170.80	3.07	9.984	3	1.1	C3b
11	47.0	2.39	112.33	19.67	4.10	52.60	1.12	19.968	6	1	F2b
12	61.4	1.81	111.13	33.92	3.00	73.50	1.20	9.984	4	1	F3b

Sub-reach	Bankfull width (ft)	Mean bankfull depth (ft)	Bankfull cross-section area (ft ²)	Width/depth ratio	Max depth (ft)	Width of flood-prone area (ft)	Entrenchment ratio	Channel material size (D50) (in)	Gradient (%)	Channel sinuosity	Stream type
13	67.2	1.67	112.22	40.24	2.60	98.20	1.46	7.02	3	1.1	B3
14	57.0	1.53	87.21	37.25	2.70	91.00	1.60	9.984	2	1.1	B3
15	130.0	1.98	257.40	65.66	3.25	255.00	1.96	4.992	2	1.2	B3
16	68.5	1.65	113.03	41.52	2.70	100.70	1.47	4.992	2	1.5	B3
17	57.5	2.64	151.80	21.78	4.40	143.70	2.50	9.984	4	1.1	C3b
18	74.5	2.96	220.52	25.17	4.50	165.50	2.22	9.984	3	1.2	C3b
19	70.7	2.29	161.90	30.87	3.40	155.80	2.20	9.984	3	1.1	C3b
20	100.8	1.79	180.43	56.31	3.10	143.40	1.42	7.02	2	1.1	B3
21	75.6	2.20	166.32	34.36	3.05	136.10	1.80	9.984	2	1.1	B3

Source: Golder Associates 2003

Table 1-5c provides valuable summary statistics on the geomorphic conditions of the Upper Pack River from the Hellroaring Creek confluence to 2 miles downstream of the Caribou Creek confluence (Reach C, sub-reaches 22 to 30).

Table 1-5c. Stream Type Characteristics of Reach C – Upper Pack River

Sub-reach	Bankfull width (ft)	Mean bankfull depth (ft)	Bankfull X-sect area (ft ²)	Width/depth ratio	Max depth (ft)	Width of flood-prone area (ft)	Entrenchment ratio	Channel material size (D50) (in)	Gradient (%)	Channel sinuosity	Stream type
22	84.5	2.24	189.28	37.72	2.60	101.00	1.20	4.992	1	1.1	F3/D
23	140.5	1.50	210.75	93.67	2.90	435.00	3.10	3.51	2	1.4	C3
24	102.2	2.14	218.71	47.76	2.60	145.50	1.42	3.51	1	1.1	F3/C3
25	76.5	2.45	187.43	31.22	3.80	244.40	3.19	3.51	1	1.1	C3
26	100.3	2.53	253.76	39.64	3.70	490.00	4.89	2.496	1	1.1	C4
27	96.7	2.00	193.40	48.35	2.70	298.00	3.08	2.496	1	1.1	C4
28	93.4	1.48	138.23	63.11	3.45	1000.00	10.71	1.755	1	1.1	C4
29	81.2	2.13	172.96	38.12	3.40	330.00	4.06	1.755	1	1.3	C4
30	111.2	1.44	160.13	77.22	2.60	265.00	2.38	1.248	1	1.2	C4

Source: Golder Associates 2003

Sand Creek Watershed

The Sand Creek watershed covers 38 square miles or 24,209 acres, and includes 1st to 3rd order portions of the creek as well as Schweitzer Creek. Sand Creek generally flows north to south and discharges into Pend Oreille Lake near the southeast corner of Sandpoint.

Table 1-6 summarizes the stream type conditions of the Sand Creek watershed. The substrate within the watershed ranges from fine sediments to cobbles. Percent fine sediment ranges from 0 to 40 percent for Sand Creek, with the highest percent fine sediment observed for the upper portion of Sand Creek. Schweitzer Creek substrate generally contains more cobble and gravel than the mainstem Sand Creek. Sinuosity and width-to-depth ratios for the sub-reaches ranged from low to high, 9.7 to 43.9, respectively.

The most common soil type in the Sand Creek watershed is Mission-Selle Odenson, and the dominant soil type adjacent to the main stem of Sand Creek is Colburn-Mission-Selle (Table 1-2 and Figure 1-2). This watershed is underlain mostly by Pleistocene outwash fenglomverate flood and terrace gravel and Cretaceous metamorphosed granitic intrusive rock (Table 1-3). The mean elevation of the watershed is 3,313 feet with a relief ratio of

0.132 (Table 1-4). The upper watershed is predominantly oriented in an easterly direction with a dominant slope of 35 percent. The elevation ranges from 2,204 feet at the headwater of Sand Creek to 2,066 feet at the confluence with Pend Oreille Lake. For Schweitzer Creek, the elevation ranges from 5,527 feet at the headwater to 2,103 feet at the confluence with Sand Creek. The average gradient of Schweitzer Creek is 12 percent. The average gradient for Sand Creek is less than 1 percent. According to the Sand Creek Stressor Identification Report (TerraGraphics 2006), the channels and the banks within the Sand Creek watershed are relatively stable. In addition, the gradient and the percent rain on snow zone of the watershed is relatively low.

Gold Creek Watershed

The Gold Creek watershed encompasses 12 square miles, or 7,747 acres. Gold Creek flows into the Pack River approximately 4 miles upstream from where State Highway 200 crosses the Pack River (IDL 2003e). The Gold Creek watershed contains the mainstem Gold Creek from the headwaters to its confluence with the Pack River and 1st and 2nd order portions of Gold Creek. Gold Creek is a 3rd order tributary to the Pack River (IDL 2003e). Vegetation varies with elevation and aspect. Lower elevations generally support Cedar-Hemlock habitat types. Uplands support a mixed conifer forest of Douglas-fir, grand fir, red cedar, larch, hemlock, ponderosa pine, lodgepole pine, and western white pine, with more xeric species dominating south to west-facing aspects. Very wet areas, especially along riparian zones, support alder, willow, and other water-loving species (IDL 2003e).

Stream type conditions of the Gold Creek watershed are summarized in Table 1-6. Gold Creek lacks sufficient stable fish cover, with greater percent fines in the upper portion of the stream (60.3%). Sinuosity and width-to-depth ratios for the sub-reaches are medium, 28.3 (upper portion) to 63.2 (lower portion), respectively

Pend Oreille-Rock outcrop-Treble is the dominant soil in this watershed (Table 1-2 and Figure 1-2), and is underlain by mostly Pleistocene till moraines and similar unsorted glacial debris (Table 1-3). The mean elevation of the watershed is 2,703 feet with a relief ratio of 0.029 (Table 1-4). The drainage is predominantly oriented in a westerly direction with a dominant slope of 12 percent. The average slope throughout the drainage is 18 percent, and over 14 percent of the area contains slopes greater than 30 percent. The CWE investigation for the Gold Creek watershed yielded a high surface erosion hazard and high mass failure hazard ratings. However, because there were no mass failures recorded within the drainage, the mass failure sediment delivery rating was low (IDL 2003e).

The following excerpt from the CWE assessment for Gold Creek (IDL 2003e) summarizes the geology of the watershed:

The Gold Creek watershed is a mixture of geologic types. The higher elevations are dominated by Cretaceous granitics associated with the Kaniksu Batholith. Along the lower and middle reaches are Pleistocene glacial outwash, fanglomerates, flood and terrace gravels intermixed with unconsolidated alluvium. Just above the confluence with the Pack River are areas of lacustrine sediments associated with Lake Pend Oreille and the Pack River flood plain.

Rapid Lightning Creek Watershed

The Rapid Lightning Creek watershed covers 48 square miles, or 30,985 acres. Vegetation type is similar to the Upper Pack River watershed. The Pend Oreille-Rock outcrop-Treble is the dominant soil in this watershed (Table 1-2 and Figure 1-2). Rapid Lightning Creek is predominantly underlain by Pleistocene unconsolidated glacial debris, with small contributions of Precambrian sediments at the headwaters and the lower reaches (Table 1-3).

Rapid Lightning Creek is a 3rd order tributary to the Pack River. The drainage is predominantly oriented in a westerly direction. Elevation ranges from 2,080 to 6,735 feet with an average elevation of 3,612 feet. The average slope throughout the drainage is 24 percent, with a dominant slope of 16 percent. Over 47 percent of the area contains slopes greater than 30 percent. Stream type conditions of the Rapid Lightning Creek watershed are summarized in Table 1-6. The Beneficial Use Reconnaissance Program (BURP) results documented a lack of stable fish cover (<10%). Sinuosity and width-to-depth ratios for the sub-reaches are medium and 66.5, respectively.

A CWE investigation for the Upper Rapid Lightning Creek portion of the watershed was prepared in 2005. This assessment yielded the following characteristics:

- moderate channel stability;
- moderate surface erosion hazard;
- low CWE rating for forest roads; and
- high mass failure hazard ratings.

There were no mass failures recorded within the upper watershed; thus, the mass failure sediment delivery rating was low (IDL 2005).

North Gold Creek Watershed

The North Gold Creek on the southeast shore of Pend Oreille Lake covers 16 square miles, or 10,519 acres. The Boulder Creek-Moss Lumberjack variant soil is present in 95 percent of the watershed (Table 1-2 and Figure 1-2), and is predominantly underlain by Precambrian dark-colored calcareous and dolomitic argillite and siltite lithology (Table 1-3).

North Gold Creek is a 1st order tributary to Pend Oreille Lake. The drainage is predominantly oriented in a southeasterly direction. Elevation ranges from 2,066 to 6,358 feet with an average elevation of 3,933 feet. The average slope throughout the drainage is 47 percent, with a dominant slope of 55 percent. Over 80 percent of the area contains slopes greater than 30 percent. The elevation at the headwater of North Gold Creek is 4,555 feet, and at its outfall into Pend Oreille Lake the elevation is 2,067 feet. Stream type conditions of the North Gold Creek watershed are summarized in Table 1-6. The instream cover diminishes from upstream (10-30%) to downstream (<10%). Sinuosity is medium and the average gradient is 4 percent. Width-to-depth ratios for the sub-reaches range from 37.2 (upper portion) to 74.3 (lower portion).

Table 1-6. Stream Type Characteristics of Sand Creek, Schweitzer Creek, Gold Creek, Rapid Lightning Creek, and North Gold Creek

Watershed Name	Water Body Name	Location (BURP ID) (See Figures 2-3 and 2-4)	Average Bankfull Width (inch)	Average Wet Depth (ft)	Average Wet Width (ft)	Width/Depth Ratio (wetted)	Bank Cover Percentage	Bank Stability Percentage	Percent Canopy	Percent Fines ^a	Embeddedness	Pool/Riffle Ratio	Channel Shape	Sinuosity Score	Instream Cover	Zone of Influence ^b
North Gold Creek	North Gold Creek	1997SCDAA009	19,842	0.8	10.1	37.2	96.5	96.5	97	10.5	Gravel, cobble and boulder particles are 0-25% surrounded by fine sediment	0.081	Rectangular, mean bank angle 71-80	10	10-30% mix of cobble, gravel or other stable fish cover. Cover availability is less than desirable	Width of riparian vegetative zone (on each side) is at least 4 times the width of the stream. Human activities have caused no impact at all.
		1994SCDAA014	5,159	0.8	19.9	74.3	90	92.5	80.5	14	Gravel, cobble and boulder particles are 75% surrounded by fine sediment, or bottom is sand, clay or bedrock	0.19	Inverse trapezoidal	10	Less than 10% cobble, gravel or other stable fish cover. Lack of cover is obvious	Little or no riparian vegetation due to man induced activities
Rapid Lightning Creek	Rapid Lightning Creek	1997SCDAA013	19,899	1.6	34.8	66.5	97.5	95	36.5	11.5	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment	0	Rectangular, mean bank angle 81-90	10	Less than 10% cobble, gravel or other stable fish cover. Lack of cover is obvious	Width of riparian vegetative zone (each side) is at least as wide as the stream. Human activities have caused a great deal of impact
Gold Creek	Gold Creek	1998SCDAB031	27,481	0.7	13.5	63.2	95	77.5	31.5	14.8	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment	0.468	Inverse trapezoidal, mean bank angle 21-30	2	Less than 10% cobble, gravel or other stable fish cover. Lack of cover is obvious	Width of riparian vegetative zone (on each side) is at least twice the width of the stream. Human activities have caused minimal impact
		1998SCDAB032	27,485	0.7	6.2	28.3	50	50	60	60.3	Gravel, cobble and boulder particles are 75% surrounded by fine sediment, or bottom is sand, clay or bedrock	0.049	Rectangular, mean bank angle 71-80	2	Less than 10% cobble, gravel or other stable fish cover. Lack of cover is obvious	Width of riparian vegetative zone (each side) is at least as wide as the stream. Human activities have caused a great deal of impact
Sand Creek	Sand Creek	1998SCDAB016	27,327	3.2	17.8	16.6	95	100	34.5	0	Gravel, cobble and boulder particles are 75% surrounded by fine sediment, or bottom is sand, clay or bedrock	0.471	Inverse trapezoidal, mean bank angle 21-30	14	Less than 10% cobble, gravel or other stable fish cover. Lack of cover is obvious	Width of riparian vegetative zone (each side) is at least as wide as the stream. Human activities have caused a great deal of impact
		1997SCDAA016	19,963	1.9	26.8	43.5	87.5	75	18.5	13.4	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment	0.55	Rectangular, mean bank angle 71-80	10	Less than 10% cobble, gravel or other stable fish cover. Lack of cover is obvious	Width of riparian vegetative zone (on each side) is at least twice the width of the stream. Human activities have caused minimal impact

Watershed Name	Water Body Name	Location (BURP ID) (See Figures 2-3 and 2-4)	Average Bankfull Width (inch)	Average Wet Depth (ft)	Average Wet Width (ft)	Width/Depth Ratio (wetted)	Bank Cover Percentage	Bank Stability Percentage	Percent Canopy	Percent Fines ^a	Embeddedness	Pool/Riffle Ratio	Channel Shape	Sinuosity Score	Instream Cover	Zone of Influence ^b
		1997SCDAA017	39,937	3.2	15.7	9.7	98	93	30	40.4	Gravel, cobble and boulder particles are 75% surrounded by fine sediment, or bottom is sand, clay or bedrock	0.398	Rectangular, mean bank angle 61-70	2	10-30% mix of cobble, gravel or other stable fish cover. Cover availability is less than desirable	Width of riparian vegetative zone (on each side) is at least twice the width of the stream. Human activities have caused minimal impact
	Schweitzer Creek	1997SCDAA011	19,865	1.0	14.3	40.3	97.5	88.5	93	7.3	Gravel, cobble and boulder particles are 25-50% surrounded by fine sediment	0	Rectangular, mean bank angle 71-80	10	10-30% mix of cobble, gravel or other stable fish cover. Cover availability is less than desirable	Width of riparian vegetative zone (on each side) is at least twice the width of the stream. Human activities have caused minimal impact
		1998SCDAB020	27,343	1.0	14.9	43.9	100	25	82	6.6	Gravel, cobble and boulder particles are 0-25% surrounded by fine sediment	0.366	Inverse trapezoidal, mean bank angle 41-50	10	10-30% mix of cobble, gravel or other stable fish cover. Cover availability is less than desirable	Width of riparian vegetative zone (on each side) is at least 4 times the width of the stream. Human activities have caused not impact at all.
		1995SCDAA057	8,003	0	10.9	10	20	20	0	0	Gravel, cobble and boulder particles are 75% surrounded by fine sediment, or bottom is sand, clay or bedrock	0.037	Inverse trapezoidal	0	Less than 10% cobble, gravel or other stable fish cover. Lack of cover is obvious	Little or no riparian vegetation due to man induced activities

Note: ^a Particles with sizes lower than 6.3 mm

^b Width of riparian vegetative zone, least buffered side

Trestle Creek Watershed

General information is provided on the Trestle Creek watershed, which is utilized as a reference watershed to support modeling of the water quality impaired watersheds addressed in this SBA report. Trestle Creek is not identified as impaired from excessive sediment in Idaho's 2002 Integrated Report. The following information was summarized from the U.S. Forest Service (USFS) *Trestle Creek Watershed Improvement Environmental Assessment* (USFS 1995)

Trestle Creek is an important bull trout stream and has been studied extensively. Trestle Creek epitomizes a number of high gradient forested watersheds on the northeast side of Pend Oreille Lake. Trestle Creek is a linear watershed that drops 3,300 feet from the divide across from Quartz Creek (Lightning Creek watershed) to Pend Oreille Lake. The entire watershed is in the Kaniksu National Forest; however, there are numerous private in-holdings along Trestle Creek at lower reaches. The watershed is accessed by USFS roads #275 and #1082.

The portion of Cabinet Mountains where Trestle Creek is located has a rounded smooth topography due to scouring by the continental ice sheet movement in the past. These smooth mountain side slopes have some areas of weak to moderately incised draws. Areas of talus and avalanche chutes are also found. A few alpine glaciers were once present at higher elevations, as evidenced by the cirque basins on northerly aspects.

The watershed landscape is dominated by glacial scour and glacial deposition areas. In the scour areas, soil tends to range from rock outcrops and predominantly shallow soil to areas of deep soil. Deposition areas have deep to very deep soil. The glacial till materials that make up the subsoil and substratum layers of the soil are weakly weathered with a high component of fragmented rock. The surface soil consists of volcanic ash 6 inches to 18 inches thick, mostly originating from Mt. Mazama in Oregon about 6,700 years ago. The underlying bedrock geology consists of hard, metasedimentary rocks of the pre-Cambrian (Belt Series). Some till layers can be very dense and, if close enough to the ash soil layer, may restrict the flow of water.

The drainage pattern of Trestle Creek is pinnate with palmate patterns in the headwaters of many tributaries. This pattern is typical of steep mountain terrain susceptible to rapid flood response. Areas of high drainage density are associated with high flood peaks, high sediment production, and steep hill slopes.

Annual precipitation ranges from 59 inches per year at Lunch Peak, at the head of Trestle Creek, to 42 inches per year near the mouth. Annual precipitation is thought to be higher along the southeast side of the valley because of the higher elevation and because of lake effects.

The lower portions of Trestle Creek were homesteaded at the turn of the century and involved clearing of the riparian corridor of large trees and some irrigation ditch development. Portions of the watershed also burned in the 1910 fire, and the stream bottom began to head cut and become entrenched as a result. This down cut in the lower 2 miles of Trestle Creek is still evident today. Also, during this time period, 21 mining claims were patented on the ridges approximately 1 or 2 miles above Trestle Creek. Their effects are considered insignificant. Between 1910 and 1940 logging continued in the privately-owned

lower riparian sections of the drainage, and the USFS logged mid slope areas that had not been burned in 1910. This resulted in increased spring flows, reduced late season base flows, and more bedload being moved out of the tributaries and into the main Trestle Creek. After 1940 logging progressed into the upper half of the drainage. Large trees were removed from the riparian areas and slash was left to accumulate into debris dams. The stream tended to braid around these debris dams in fairly steep terrain. Due to stream bank cutting in these braided sections, bedload deposition in lower portions increased. These braids and debris dams persist today, although only larger pieces of slash remain, slightly increasing stream stability. Trestle Creek contains some of the highest quality bull trout habitat remaining in the Pend Oreille Subbasin (Corsi, *et al*, 1998).

1.3 Cultural Characteristics

The five watersheds addressed in this report comprise 121,927 acres, or approximately 190 square miles of the Pend Oreille Subbasin. The following subsections provide brief summaries of various cultural characteristics, including land use/landcover, land ownership, population, history, and economics.

Land Use and Land Management

Table 1-7 summarizes the land use/land cover and the acreages and percentages of each category by watershed. The land use/land cover data are derived from USGS 1992 National Land Cover Dataset (USGS 2006) data but were modified in the Sand Creek watershed to more accurately reflect local recent changes in land use. Each watershed was classified based on the following land use categories: barren land, forest, grassland permanent, grassland agricultural, shrubland, urban/developed land, and water/wetlands. Using GIS, each watershed was also segregated into different land management entities which are summarized in Table 1-8. The land use/landcover data are displayed in Figures 1-4 and 1-5, and land management within each watershed is displayed in Figures 1-6 and 1-7.

Upper Pack River Watershed

The Upper Pack River watershed from its headwaters downstream to Caribou Creek is categorized as a step-pool system that drains approximately 48,466 acres. Fifty-three percent of the watershed is forest, with 21 percent classified as shrubland and 17 percent as barren land (Table 1-7 and Figure 1-4). The remaining acreage is classified as grassland (8%) with urban or developed land being less than 1 percent of the watershed. Eighty-four percent of the watershed is managed by the USFS, with 15 percent in private ownership. Less than 1 percent of the watershed is managed by the Bureau of Land Management (BLM) and the State of Idaho. There are approximately 173 miles of unpaved road within the Upper Pack River watershed.

Table 1-7. Pend Oreille Lake Tributaries - Land Use Distribution

Watershed	Land Use	Acres	Percent of Total
Gold Creek	Barren Land	13	0.2
	Forest	6,445	83.2
	Grassland Agriculture	1,058	13.7
	Shrubland	150	1.9
	Urban or Developed Land	72	0.9
	Water/Wetlands	10	0.1
Gold Creek Total		7,748	100.0
North Gold Creek	Barren Land	4	0.0
	Forest	10,418	99.0
	Grassland Permanent	28	0.3
	Shrubland	61	0.6
	Urban or Developed Land	6	0.1
	Water/Wetlands	1	0.0
North Gold Creek Total		10,518	100.0
Rapid Lightning Creek	Barren Land	324	1.0
	Forest	29,563	95.4
	Grassland Agriculture	487	1.6
	Shrubland	557	1.8
	Urban or Developed Land	38	0.1
	Water/Wetlands	17	0.1
Rapid Lightning Creek Total		30,986	100.0
Sand Creek	Barren Land	105	0.4
	Forest	16,089	66.5
	Grassland Agriculture	3,124	12.9
	Grassland Permanent	2,172	9.0
	Shrubland	767	3.2
	Urban or Developed Land	1,862	7.7
	Water/Wetlands	91	0.4
Sand Creek Total		24,210	100.0
Upper Pack River	Barren Land	8,287	17.1
	Forest	25,578	52.8
	Grassland Permanent	4,061	8.4
	Shrubland	10,302	21.3
	Urban or Developed Land	94	0.2
	Water/Wetlands	145	0.3
Upper Pack River Total		48,467	100.0
Grand Total		121,929	100.0

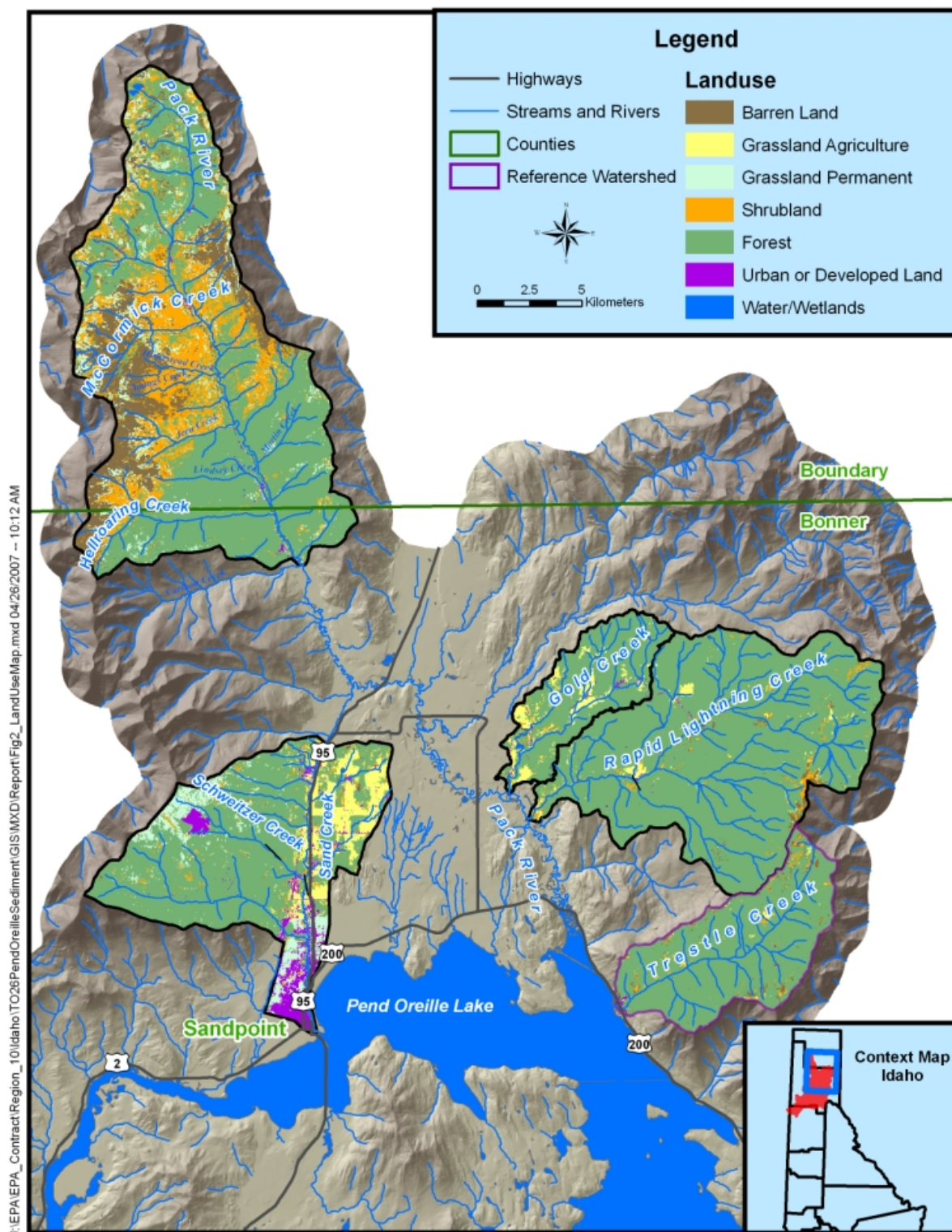


Figure 1-4. Land Use for Upper Pack River, Gold Creek, Rapid Lightning Creek, Sand Creek, and Trestle Creek Watersheds

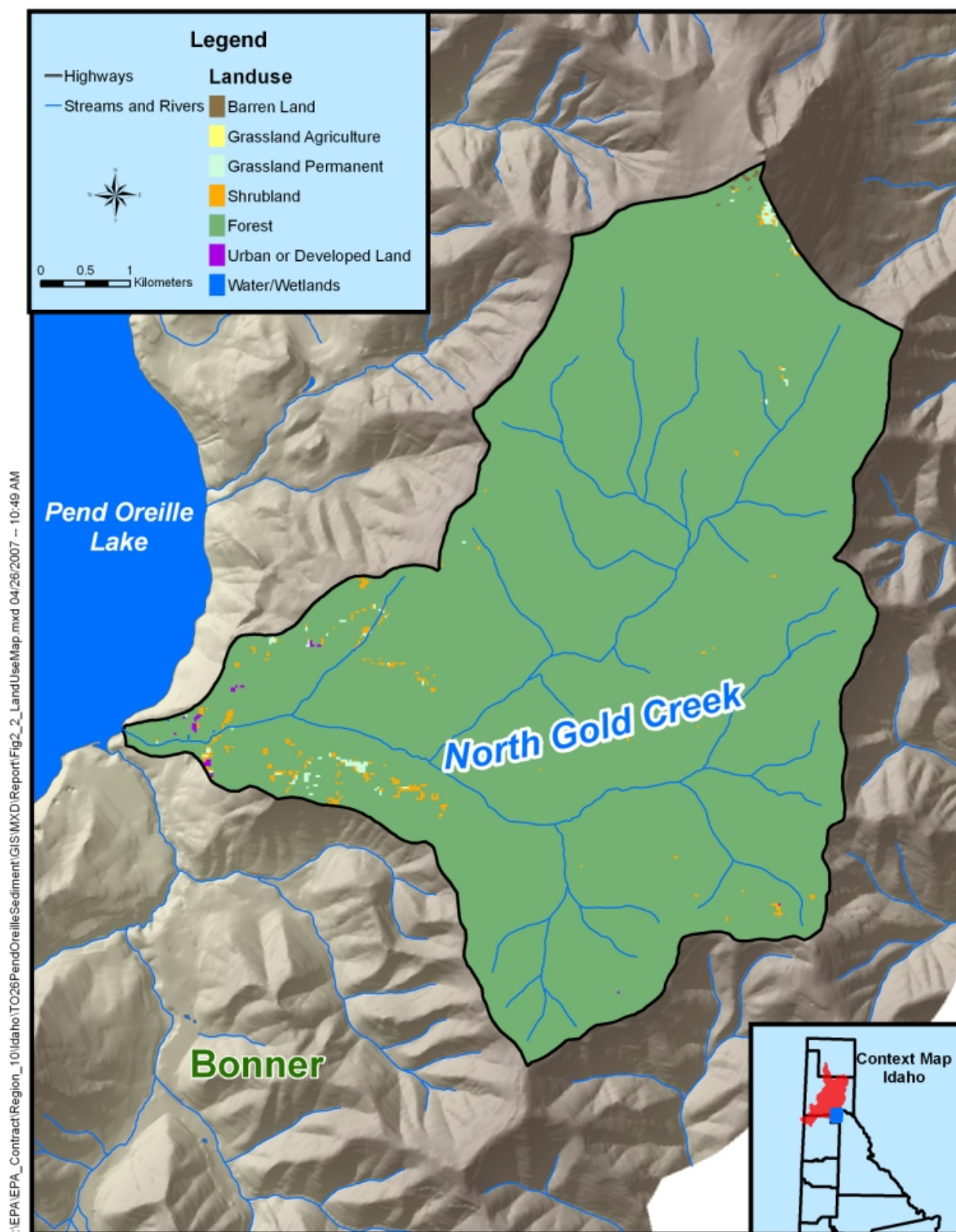


Figure 1-5. Land Use for North Gold Creek Watershed

Sand Creek Watershed

The Sand Creek watershed, a tributary on the east side of Pend Oreille Lake, drains 24,209 acres. The land use/land cover is composed of forestry (67%), agriculture grasslands (13%), permanent grasslands (9%), urban or developed land (8%), and small areas of shrubland and barren land (Table 1-7 and Figure 1-4). The riparian corridor of Sand Creek through Sandpoint, Idaho is heavily urbanized. Land ownership in the watershed is primarily private land (67%), with the remainder of the watershed held by the City of Sandpoint (18%), BLM (8%), state (3%), and USFS (4%). The watershed continues to experience growth in land development, including the Schweitzer Creek subwatershed. Classification of agriculture lands was aggregated into two general categories – agriculture grasslands and permanent grasslands. Agriculture grasslands are typically tilled and utilized to support agriculture activities. Permanent grasslands, which include ski slopes, natural grassland areas and unimproved pasturelands, are grasslands that are not typically altered or tilled to support agriculture activities. There are approximately 103 miles of unpaved road and 69 miles of paved road within the Sand Creek watershed.

Gold Creek Watershed

The Gold Creek watershed is the smallest assessed watershed, and drains approximately 7,747 acres of land. Similar to the other assessed watersheds, the Gold Creek watershed is dominated by forested area (83%). Agricultural activities occur in the watershed with 14 percent classified as agriculture grassland. Less than 1 percent of this watershed is composed of urban or developed lands (Table 1-7 and Figure 1-4). This watershed is mainly held in private land ownership (88%) (Table 1-8) with the remaining land being held by the USFS (11%) and state forest land (1%). Some land conversion from forest to residential is occurring in the watershed. There are approximately 29 miles of unpaved road within the Gold Creek watershed.

Rapid Lightning Creek Watershed

The Rapid Lightning Creek watershed is the largest of all the assessed watersheds, with a drainage area of 30,985 acres. This watershed is dominated by forests (95%) (Table 1-7 and Figure 1-4). The remaining acreage of the watershed is classified as shrubland (2%) with agriculture grassland, barren land, and urban or developed land totaling less than 3 percent of the watershed. Sixty percent of the Rapid Lightning Creek watershed is in private ownership, 32 percent is USFS-managed, 7 percent is state-managed forest, and less than 1 percent is managed by BLM (Table 1-8). There are approximately 148 miles of unpaved road within the watershed.

North Gold Creek

The North Gold Creek watershed area is approximately 10,498 acres. Ninety-nine percent of this watershed is forest (Table 1-7 and Figure 1-5) and 99 percent of the North Gold Creek watershed is managed by the USFS, with the remaining 1 percent distributed among the Department of Defense and private owners (Table 1-8). There are approximately 37 miles of unpaved road within the watershed.

Table 1-8. Pend Oreille Lake Tributaries - Land Management Distribution

Watershed	Land Manager	Land Use	Acres	Percent (by watershed)
Gold Creek	PRIVATE	Barren Land	13	0.16
		Forest	5,538	71.48
		Grassland Agriculture	1,051	13.57
		Shrubland	145	1.87
		Urban or Developed Land	72	0.93
		Water/Wetlands	10	0.14
	PRIVATE Total		6,829	88.15
	STATE	Forest	43	0.55
	STATE Total		43	0.55
	USFS	Barren Land	0	0.00
		Forest	864	11.16
		Grassland Agriculture	6	0.08
		Shrubland	4	0.06
	USFS Total		874	11.29
Gold Creek Total			7,746	100.00
North Gold Creek	MIL	Forest	3	0.03
		Water/Wetlands	0	0.00
	MIL Total		3	0.03
	PRIVATE	Forest	18	0.17
	PRIVATE Total		18	0.17
	USFS	Barren Land	4	0.04
		Forest	10,397	98.84
		Grassland Permanent	28	0.27
		Shrubland	61	0.58
		Urban or Developed Land	6	0.06
		Water/Wetlands	1	0.01
	USFS Total		10,497	99.80
North Gold Creek Total			10,518	100.00
Rapid Lightning Creek	BLM	Forest	121	0.39
	BLM Total		121	0.39
	PRIVATE	Barren Land	90	0.29
		Forest	17,781	57.39
		Grassland Agriculture	384	1.24
		Shrubland	246	0.79
		Urban or Developed Land	37	0.12
		Water/Wetlands	11	0.04
	PRIVATE Total		18,549	59.87
	STATE	Barren Land	28	0.09
		Forest	2,195	7.09
		Grassland Agriculture	10	0.03
		Shrubland	17	0.05

Watershed	Land Manager	Land Use	Acres	Percent (by watershed)
		Urban or Developed Land	0	0.00
		Water/Wetlands	0	0.00
	STATE Total		2,250	7.26
	USFS	Barren Land	206	0.66
		Forest	9,465	30.55
		Grassland Agriculture	94	0.30
		Shrubland	294	0.95
		Urban or Developed Land	0	0.00
		Water/Wetlands	5	0.02
	USFS Total		10,064	32.48
Rapid Lightning Creek Total			30,984	100.00
Sand Creek	BLM	Barren Land	6	0.02
		Forest	1,860	7.68
		Grassland Agriculture	8	0.03
		Grassland Permanent	93	0.38
		Shrubland	31	0.13
	BLM Total		1,998	8.25
	City of Sandpoint	Barren Land	15	0.06
		Forest	3,834	15.84
		Grassland Agriculture	6	0.02
		Grassland Permanent	68	0.28
		Shrubland	61	0.25
		Urban or Developed Land	12	0.05
		Water/Wetlands	5	0.02
	City of Sandpoint Total		4,001	16.52
	PRIVATE	Barren Land	82	0.34
		Forest	8,889	36.72
		Grassland Agriculture	3,110	12.85
		Grassland Permanent	1,917	7.92
		Shrubland	645	2.67
		Urban or Developed Land	1,795	7.42
		Water/Wetlands	84	0.35
	PRIVATE Total		16,522	68.25
	STATE	Barren Land	1	0.00
		Forest	588	2.43
		Grassland Permanent	90	0.37
		Shrubland	24	0.10
		Urban or Developed Land	54	0.22
		Water/Wetlands	2	0.01
	STATE Total		759	3.13

Watershed	Land Manager	Land Use	Acres	Percent (by watershed)
	USFS	Barren Land	2	0.01
		Forest	919	3.79
		Grassland Permanent	4	0.02
		Shrubland	6	0.02
	USFS Total		931	3.84
Sand Creek Total			24,211	100.00
Upper Pack River	BLM	Forest	198	0.41
		Grassland Permanent	2	0.00
		Shrubland	3	0.01
	BLM Total		203	0.42
	PRIVATE	Barren Land	604	1.25
		Forest	5,671	11.70
		Grassland Permanent	345	0.71
		Shrubland	626	1.29
		Urban or Developed Land	37	0.08
		Water/Wetlands	56	0.11
	PRIVATE Total		7,339	15.14
	STATE	Barren Land	215	0.44
		Forest	53	0.11
		Grassland Permanent	47	0.10
		Shrubland	11	0.02
	STATE Total		326	0.67
	USFS	Barren Land	7,467	15.41
		Forest	19,655	40.55
		Grassland Permanent	3,668	7.57
		Shrubland	9,662	19.94
		Urban or Developed Land	57	0.12
		Water/Wetlands	89	0.18
	USFS Total		40,598	83.76
Upper Pack River Total			48,466	100.00
Grand Total			121,925	

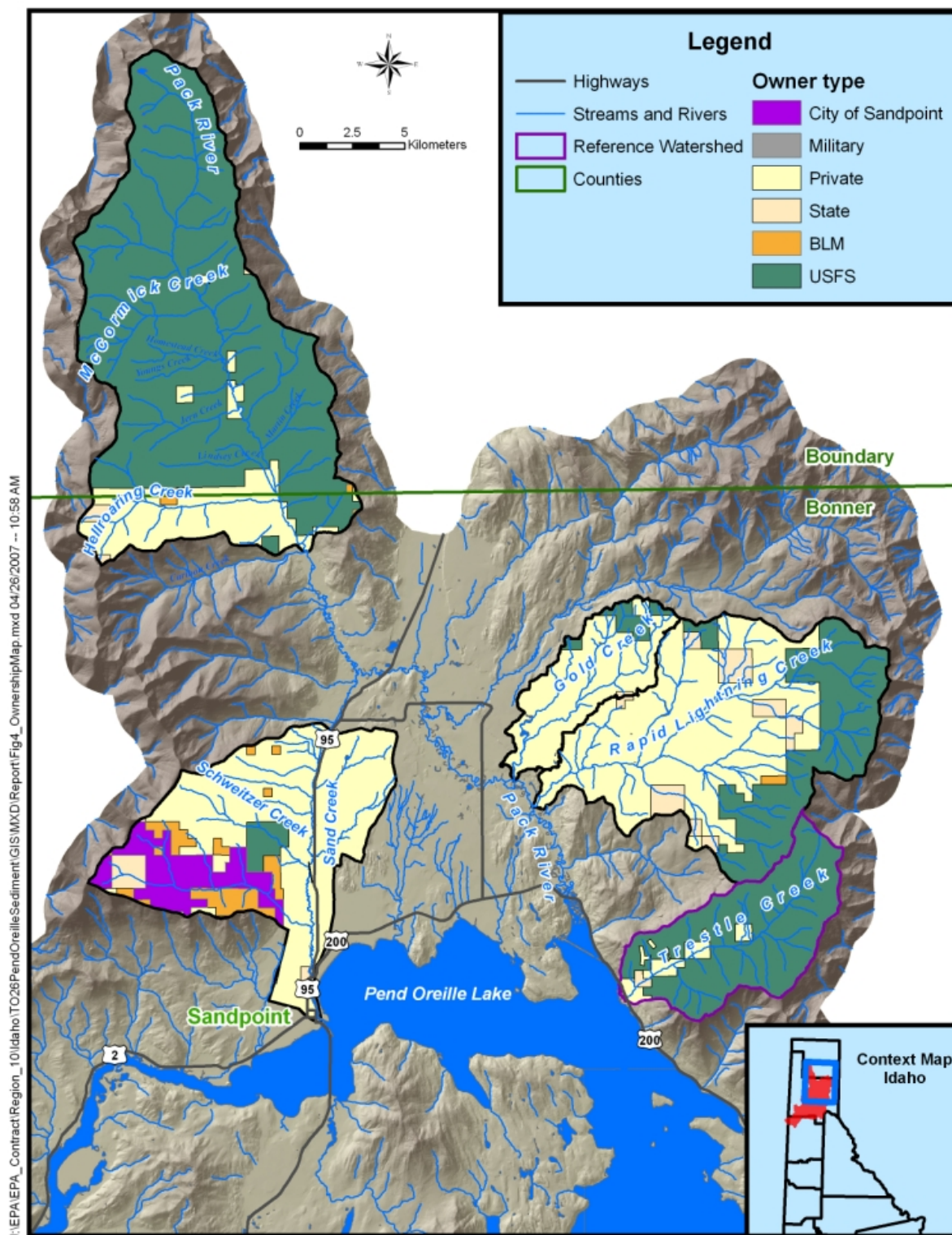


Figure 1-6. Land Management for Upper Pack River, Gold Creek, Rapid Lightning Creek, Sand Creek, and Trestle Creek Watersheds

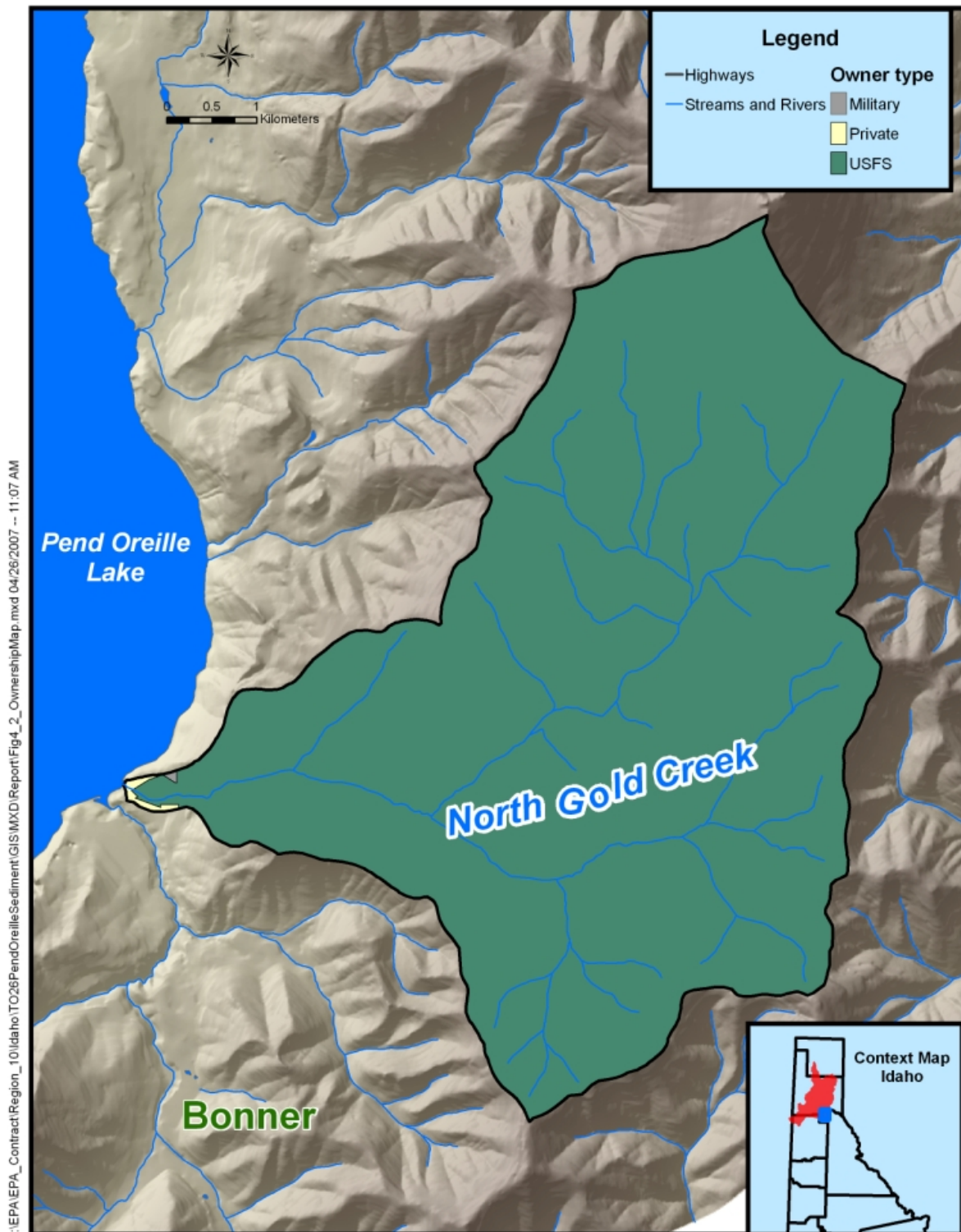


Figure 1-7. Land Management for North Gold Creek Watershed

Trestle Creek

The Trestle Creek watershed has a drainage area of 12,574 acres. Table 1-9 summarizes the land use/land cover distribution of the watershed which is dominated by forested area (94%). The remaining acreage of the watershed is classified as shrubland and barren land totaling 4 percent with permanent grassland, and urban or developed land totaling less than two percent of the watershed. (See Figure 1-4 for graphic display of land use/land cover of Trestle Creek watershed). Ninety percent of the Trestle Creek watershed is managed by the USFS, 9 percent is privately-owned, and less than 1 percent is state-managed forest (Table 1-10).

Table 1-9. Land Use Distribution for Trestle Creek Watershed

Basin	Land Use	Acres	Percent Of Total
Trestle Creek	Barren Land	323	2.57
	Forest	11,769	93.59
	Grassland Permanent	129	1.03
	Shrubland	299	2.38
	Urban or Developed Land	40	0.32
	Water/Wetlands	15	0.12
		12,574	100.00

Table 1-10. Land Management Distribution for Trestle Creek Watershed

Watershed	Land Managers	Land Use	Acres	Percent (by watershed)
Trestle Creek	PRIVATE	Barren Land	23	0.18
		Forest	979	7.79
		Grassland Permanent	19	0.15
		Shrubland	28	0.22
		Urban or Developed Land	39	0.31
		Water/Wetlands	15	0.12
	PRIVATE Total		1,103	8.77
	STATE	Barren Land	10	0.08
		Forest	98	0.78
		Grassland Permanent	0	0.00
		Shrubland	11	0.09
	STATE Total		119	0.95
	USFS	Barren Land	290	2.31
		Forest	10,691	85.03
		Grassland Permanent	110	0.87
		Shrubland	260	2.07
		Urban or Developed Land	1	0.01
		Water/Wetlands	0	0.00
	USFS Total		11,352	90.29
Trestle Creek Total			12,574	100.00

Cultural Features and Population

Most of the Upper Pack River watershed is within Boundary County, Idaho. The 2000 U.S. Census population of Boundary County was 9,871 but an update conducted in 2006 estimated the population at 10,831 with very few of these residents living in the Upper Pack River watershed (U.S. Census Bureau 2007a). Gold Creek, Rapid Lightning Creek, Sand Creek, North Gold Creek, and Trestle Creek are all located in Bonner County, Idaho. The 2000 U.S. Census Bureau estimate for Bonner County population was 36,835 but a 2006 estimate of the population was 41,275 (U.S. Census Bureau 2007b). Sandpoint is the Bonner County seat with a population of 6,835 (U.S. Census Bureau 2000), which represents the largest urban area within the watersheds of concern. Urban growth is expected to continue in Sand Creek, Schweitzer Creek and the Pack River watersheds.

History and Economics

The Pend Oreille Subbasin was glacially formed during the ice age and the east side of the lake was in the path of the ancient Missoula Flood. Pend Oreille Lake is a leading recreational fishery destination and because of the lake's characteristic as one of the deepest lakes in the world, it is still used to test large-scale submarine prototypes. The Pend Oreille Subbasin supports a diversity of recreational opportunities, including skiing in the Schweitzer Ski Basin, golfing, camping, boating, and hunting. In addition to recreation, other key industries include forestry and textiles. There are national forests and the Pack River Flats Wildlife Management Area within Boundary and Bonner Counties. Pend Oreille Lake, the City of Sandpoint, and many recreational attractions throughout the Pend Oreille Subbasin make these watersheds a prime location for continued growth and development (PRWC 2006). The drinking water for the City of Sandpoint is withdrawn from Little Sand Creek, a tributary to Sand Creek.

2. Subbasin Assessment – Water Quality Concerns and Status

This section contains an assessment of water quality concerns and status for 11 assessment units in the Pend Oreille Subbasin currently identified as impaired in Idaho's 2002 Integrated Report. These 11 assessment units are identified in Category 5 of Idaho's 2002 Integrated Report as being water quality limited as a result of excess sediment or an unknown pollutant resulting in nonsupport of the cold water aquatic life use.

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

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

About Assessment Units

Assessment units (AUs) now define all the waters of the state of Idaho. These units and the methodology used to assign them can be found in the *Water Body Assessment Guidance* second edition, WBAGII (Grafe *et al.* 2002).

AUs are groups or segments of streams that have similar land use practices, ownership, or land management. Stream order, however, is the main basis for determining AUs—although ownership and land use can change significantly over time, the AU generally remains the same.

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

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

The boundaries from the 1998 §303(d) listed segments have been transferred to the new AU framework, using an approach quite similar to how DEQ has been writing SBAs and TMDLs. All AUs contained in the listed segment were carried forward to the 2002 listings in Section 5 of the Integrated Report. AUs not wholly contained within a previously listed segment, but partially contained (even minimally), were also included on the 303(d) list.

This was necessary to maintain the integrity of the 1998 §303(d) list and to maintain continuity with the TMDL program. These new AUs will lead to better assessment of water quality listing and de-listing. When assessing new data that indicate full support, only the AU that the monitoring data represents will be removed (de-listed) from the impaired waters list.

Listed Waters

Table 2-1 shows the pollutants of concern and the boundaries of each sediment impaired AU addressed in the *Pend Oreille Tributaries Sediment TMDLs* document. Not all the water bodies will require a TMDL, as will be discussed later. However, a thorough investigation, using the available data, was performed before this conclusion was made. This investigation, along with a presentation of the evidence of non-compliance with standards is contained in the following sections.

Table 2-1. Water Quality Impaired Assessment Units - Pend Oreille Subbasin

Watershed Name	Water Body Name	Assessment Unit	Impairment Boundaries	Pollutant of Concern
Upper Pack River	Upper Pack River	ID17010214PN041_02	Upper Pack River – source to Lindsey Creek. First and 2 nd order portions of Pack River, West Branch Pack River, Zuni Creek, Martin Creek, Homestead Creek, Lindsey Creek, Pearson Creek, Youngs Creek, Thor Creek, Beehive Creek, and Slide Creek.	Cause Unknown*
		ID17010214PN041_03	Mainstem Upper Pack River, source to Lindsey Creek.	Cause Unknown*
	McCormick Creek	ID17010214PN042_02	McCormick Creek – Source to Pack River. First and 2 nd order portions of McCormick Creek.	Cause Unknown*
	Hellroaring Creek	ID17010214PN044_02	Hellroaring Creek – source to Pack River. First and 2 nd order portions of Hellroaring Creek.	Cause Unknown
Sand Creek	Sand Creek	ID17010214PN049_02	First and 2 nd order portions, source to Schweitzer Creek.	Cause Unknown*
		ID17010214PN049_03	Sand Creek – Source to Schweitzer Creek. Third order portion of Sand Creek.	Cause Unknown*
	Schweitzer Creek	ID17010214PN052_02	Schweitzer Creek – source to Sand Creek. First and 2 nd order portions of Schweitzer Creek.	Sediment
Gold Creek	Gold Creek	ID17010214PN034_02	Gold Creek – Source to Pack River. First and 2 nd order portions of Gold Creek.	Cause Unknown*
Rapid Lightning Creek	Rapid Lightning Creek	ID17010214PN033_03	Rapid Lightning Creek – Trapper Creek to Pack River. Third order portion of Rapid Lightning Creek.	Cause Unknown*
North Gold Creek	North Gold Creek	ID17010214PN025_02	North Gold Creek – Source to Pend Oreille Lake. First and 2 nd order portions of North Gold Creek and Branch North Gold Creek.	Sediment
		ID17010214PN025_03	North Gold Creek – Branch North Gold Creek to Pend Oreille Lake. Third order portion of North Gold Creek.	Sediment

*Sediment was determined to be the suspected cause of impairment during the Subbasin Assessment process.

A stressor identification analysis was completed in September 2006 for those AUs where the pollutant of concern is listed as an unknown cause in Table 2-1, which includes Rapid Lightning Creek, Gold Creek, Upper Pack River, McCormick Creek, Hellroaring Creek, and Sand Creek (TerraGraphics 2006). The stressor identification reports verify the nonsupport of a beneficial use and specify, when possible, a specific pollutant(s) contributing to the water quality impairment.

2.2 Applicable Water Quality Standards

Beneficial Uses

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

Existing Uses

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

Designated Uses

Designated uses under the CWA are “...those uses specified in water quality standards for each water body or segment, whether or not they are being attained.” Designated uses are simply uses officially recognized by the State. In Idaho these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to support 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 58.01.02.003.27 and .02.109-.02.160 in addition to citations for existing uses).

Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. These undesignated uses 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 exists (e.g., salmonid spawning), because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would also apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water aquatic life is not found to be an existing use, a 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 2-2 summarizes the beneficial uses of the water bodies addressed in this SBA report.

Table 2-2. Pend Oreille Subbasin Beneficial Uses of Select Sediment Impaired Water Bodies

Water Body	Uses*	Type of Use
Upper Pack River	CWAL, SS, PCR, DWS	Designated
Sand Creek	CWAL, PCR, DWS	Presumed
Schweitzer Creek	CWAL, PCR,	Presumed
Gold Creek	CWAL, PCR, SS	Presumed
Rapid Lightning Creek	CWAL, PCR	Presumed
North Gold Creek	CWAL, SS, PCR	Existing
Trestle Creek	CWAL, SS, SCR, SRW	Designated

* CWAL – cold water aquatic life, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, AWS – agricultural water supply, DWS – domestic water supply, SRW – special resource water

**Salmonid spawning was added as a beneficial use August 14, 2007 based on Idaho Department of Fish and Game fisheries data (see page 50).

Criteria to Support Beneficial Uses

Surface waters in Idaho are protected by a set of rules called the “Water Quality Standards and Wastewater Treatment Requirements,” which are part of the Administrative Rules of the Department of Health and Welfare, Volume 16, Title 01, Chapter 02. These rules protect “beneficial uses” of the surface waters of the state. Sediment can have direct effects on beneficial uses for salmonid spawning, cold and warm water aquatic life, and domestic, agricultural, and industrial water supplies (IDEQ 2003). The beneficial uses that will be addressed by these TMDLs are as follows (IDAPA 58.01.02, Section 100):

Aquatic Life

- Cold water biota: waters suitable or intended to be made suitable for protection and maintenance of viable communities of aquatic organisms and populations of significant aquatic species which have optimal growing temperatures below 18°C.
- Salmonid spawning: waters that provide or could provide a habitat for active self-propagating populations of salmonid fishes.

Beneficial uses are typically protected by a set of numeric and narrative criteria. Idaho’s water quality standard for sediment is narrative, “*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). Narrative criteria fall under the category of general criteria, which apply to all surface waters regardless of use classification. A narrative

standard for sediment is necessary and desirable as it accommodates the vast range of sediment conditions that exist in nature (IDEQ 2003).

With no fixed numeric criterion, a major challenge to preparing a TMDL for sediment is development of a numeric target that can be used to derive a load capacity. The target is a site-specific interpretation of the narrative sediment criterion based on an assessment of how sediment in a particular water body impairs beneficial use. The sediment targets are surrogate measures for beneficial use support. As such, they supplement a load or concentration goal used in a TMDL, providing a bridge over the uncertainty in the connection between sediment loading and support of beneficial uses (IDEQ 2003).

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.053. The procedure relies heavily upon biological parameters and is presented in detail in the WBAGII (Grafe, *et al.* 2002). This guidance requires the use of the most complete data available to make beneficial use support status determinations.

Figure 2-1 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.

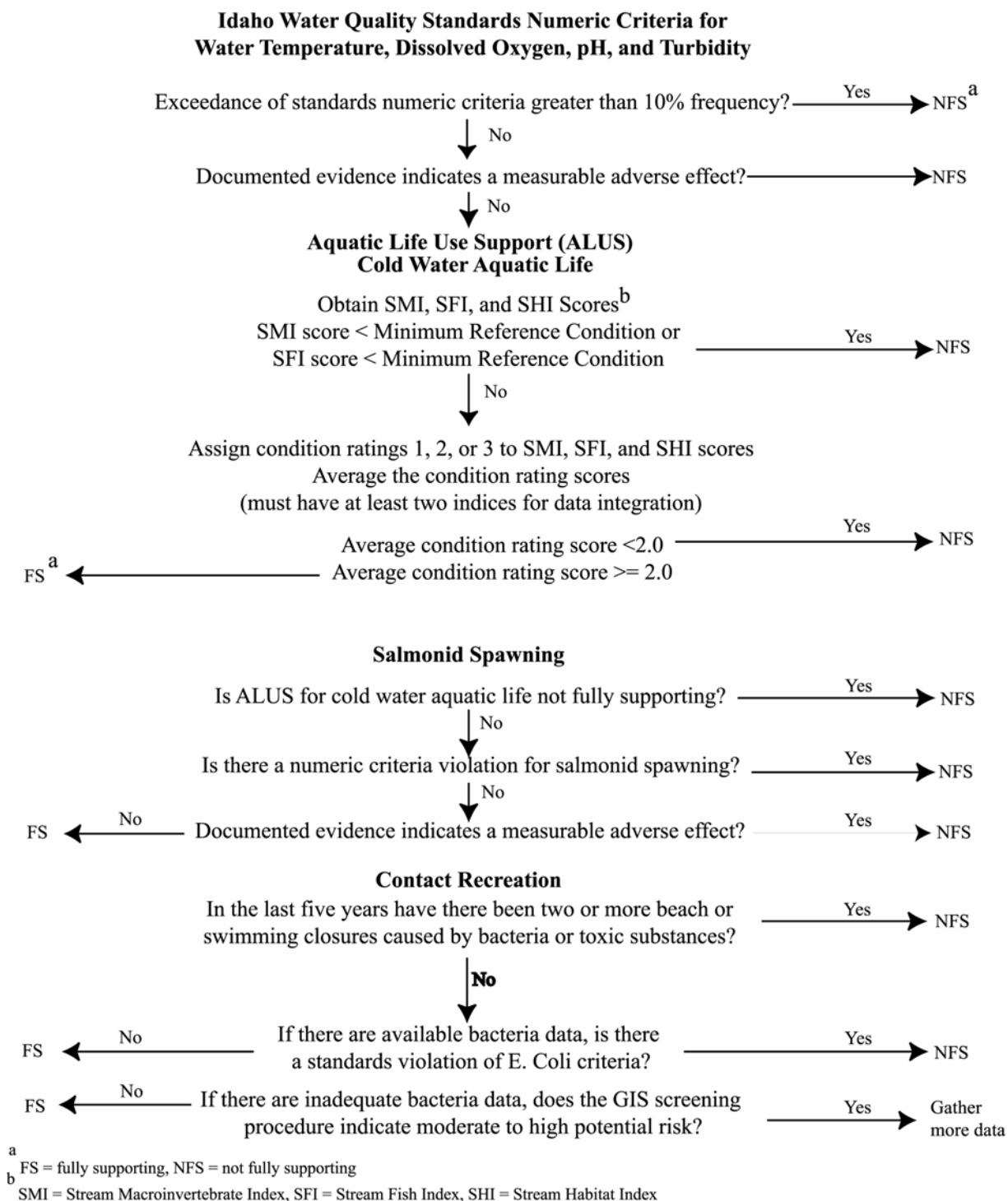


**Figure 2-1. Determination Steps and Criteria for Determining Support Status of
Beneficial Uses in Wadeable Streams: Water Body Assessment Guidance,
Second Edition (Grafe, *et al.* 2002)**

2.3 Pollutant/Beneficial Use Support Status Relationships

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

Sediment

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

Newcombe and Jensen (1996) reported the effects of suspended sediment on fish, summarizing 80 published reports on streams and estuaries. For rainbow trout, physiological stress, which includes reduced feeding rate, is evident at suspended sediment concentrations of 50 to 100 milligrams per liter (mg/L) when those concentrations are maintained for 14 to 60 days. Similar effects are observed for other species, although the data sets are less reliable. Adverse effects on habitat, especially spawning and rearing habitat presumably from sediment deposition, were noted at similar concentrations of suspended sediment.

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

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

Settleable solids are defined as the volume (ml) or weight (mg) of material that settles out of a liter of water in 1 hour (Franson, *et al.* 1998). Settleable solids may consist of large silt, sand, and organic matter. Total suspended solids (TSS) are defined as the material collected by filtration through a 0.45 micrometer (μm) filter. Settleable solids and TSS both contain nutrients essential for aquatic plant growth. Settleable solids are not as nutrient rich as the smaller suspended solids, but they do affect river depth and substrate nutrient availability for macrophytes. In low flow situations, settleable solids can accumulate on a stream bottom, thus decreasing water depth. This increases the area of substrate exposed to light, facilitating additional macrophyte growth.

2.4 Summary and Analysis of Existing Water Quality Data

Two main sources of water quality data were used in this SBA and TMDL: DEQ monitoring (BURP) data and IDL CWE Analyses. In addition, existing historical EPA STORET data were summarized.

Flow Characteristics

There are no USGS gages currently recording flow measurements in the Pend Oreille Subbasin. However, five gage stations that have historical discharge data for limited time periods are listed in Table 2-3 (see Figure 2-3 for gage locations).

Table 2-3. Select USGS Stations in the Pend Oreille Subbasin

Station ID	Station Name	Parameters	Time Period
12392300	Pack River near Colburn, Idaho	Daily discharge, monthly and annual means, peak streamflow	1958-1982
12392390	Pack River at Rapid Lightning Creek near Colburn, Idaho	Daily discharge, monthly and annual means, peak streamflow	1988-1993
12392400	Rapid Lightning Creek near Samuels, Idaho	Daily discharge, monthly and annual means, peak streamflow	1963-1968
12392450	Rapid Lightning Creek near Colburn, Idaho	Daily discharge, monthly and annual means, peak streamflow	1988-1990
12392660	Sand Creek near Sandpoint, Idaho	Daily discharge, monthly and annual means, peak streamflow	1988-1993

Monthly average flows for the period of record for the five USGS gages with historical data are presented in Figure 2-2. The highest monthly average flows occur between April and June (Spring), which is indicative of a snowmelt runoff dominated pattern. Several major peak flow events have occurred in the Pend Oreille Subbasin over the past century. Some of the known large flood events in the Pend Oreille Subbasin occurred in 1894, 1948, 1956, 1969, 1974, and 1997. Among the limited available gaging data, one of the highest documented flow events was recorded in 1974 for the Pack River near Colburn, Idaho gage station (12392300), with a peak flow of 6,880 cubic feet per second (cfs). Another high peak flow event (4,370 cfs) at that location was recorded in 1969 (TerraGraphics 2006).

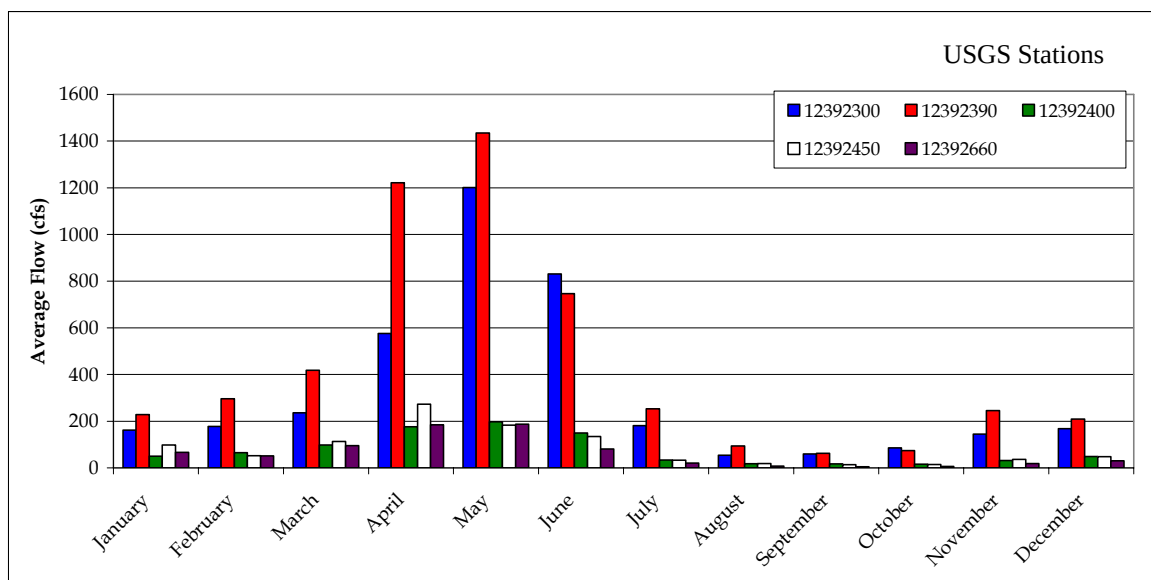


Figure 2-2. Monthly Average Flows for Select Pend Oreille Lake Tributaries

Water Column Data

Total solids, total suspended solids, total dissolved solids, and turbidity measurements collected between 1974 and 1979 reside in the EPA STORET database but the age of this data renders it inconsequential for this assessment. Overall there are very limited water chemistry data from the Pend Oreille Lake tributaries. A few water chemistry measurements were collected by volunteer monitors in 2000 and 2001. As summarized in the stressor identification reports completed in September 2006, a small number of samples were collected in August 2006 for temperature, pH, dissolved oxygen, conductivity, total nitrogen and total phosphorus. This water quality data, collected in August 2006 for the Upper Pack River, McCormick Creek, Hellroaring Creek, and Rapid Lightning Creek was summarized in the *Pend Oreille Subbasin Stressor Identification Reports* (TerraGraphics 2006).

In addition to the paucity of water column data, there are a number of other factors that impede the ability of typical monitoring and assessment approaches to characterize causes, loads and sources of sediment in the Pend Oreille Lake tributaries. Due to the geology, land use practices in these watersheds, and the characteristics of the sediment suspected of causing the beneficial use impairment, a typical suspended sediment modeling approach would not be an appropriate method for assessing the sediment budget. Typically grain sizes associated with erosion in the Pend Oreille Subbasin are too large to travel (or be measured) as suspended sediment. Fine and coarse sediments become lodged between the rocks and boulders that comprise the bottom of most of the waterways in these watersheds and do not move much during normal or low flows. The movement of sediment normally occurs during the larger flow events, which are hard to predict and the hardest time to measure sediment bedload.

Biological and Other Data

Idaho DEQ BURP surveys were completed annually in 1994-1998 on the majority of the streams included in this TMDL assessment, with the exception of AU ID17010214PN049_02 (Sand Creek – source to Schweitzer Creek). An additional survey was completed in 2003 for the Upper Pack River (ID17010214PN041_02). Data sets collected by BURP surveys include habitat, macroinvertebrates, and fisheries information. The locations of the BURP sites in each AU are shown in Figures 2-3 and 2-4. Table 2-4 includes a summary of the habitat data.

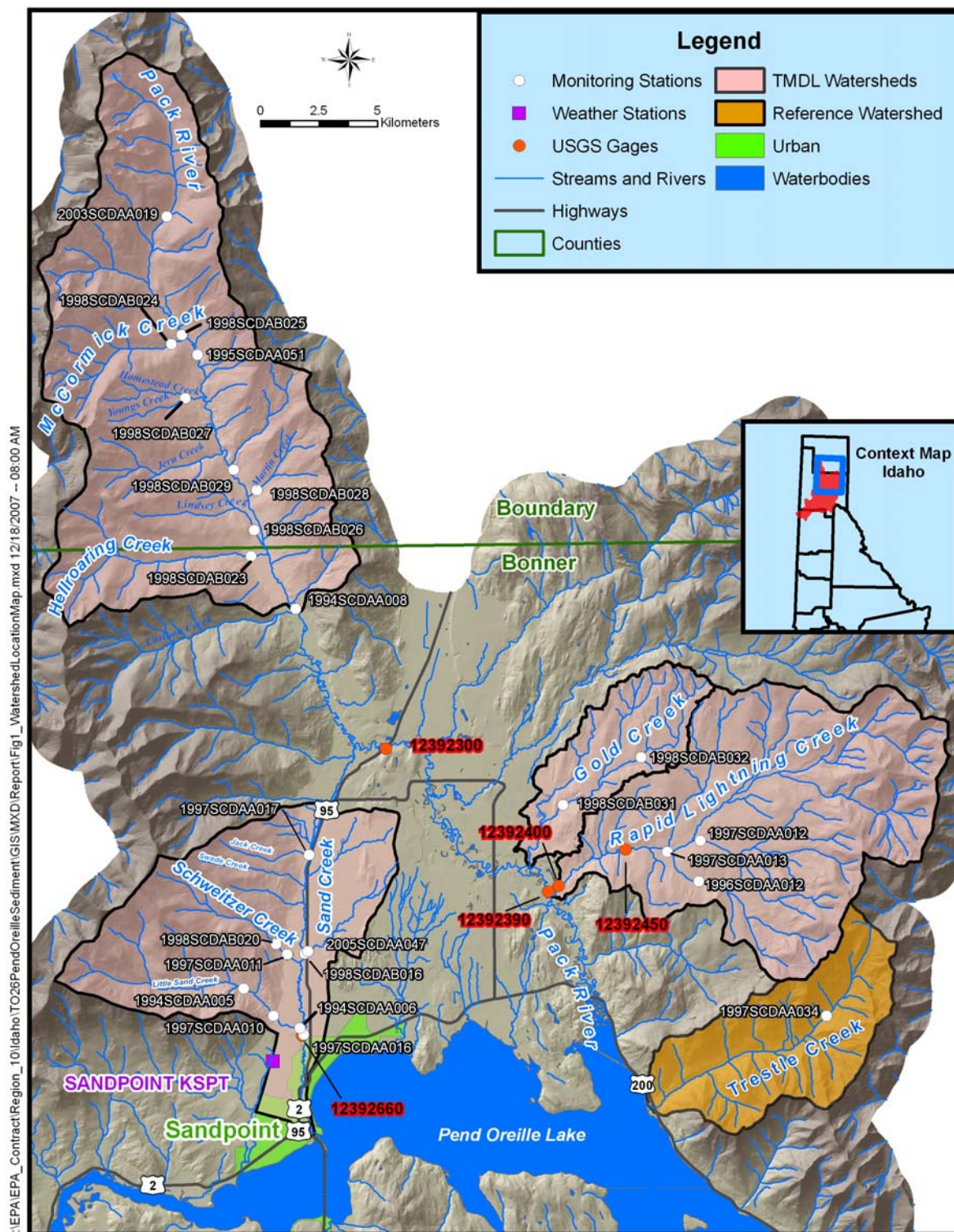


Figure 2-3. BURP Stations in Upper Pack River, Gold Creek, Rapid Lightning Creek, Sand Creek, and Trestle Creek Watersheds

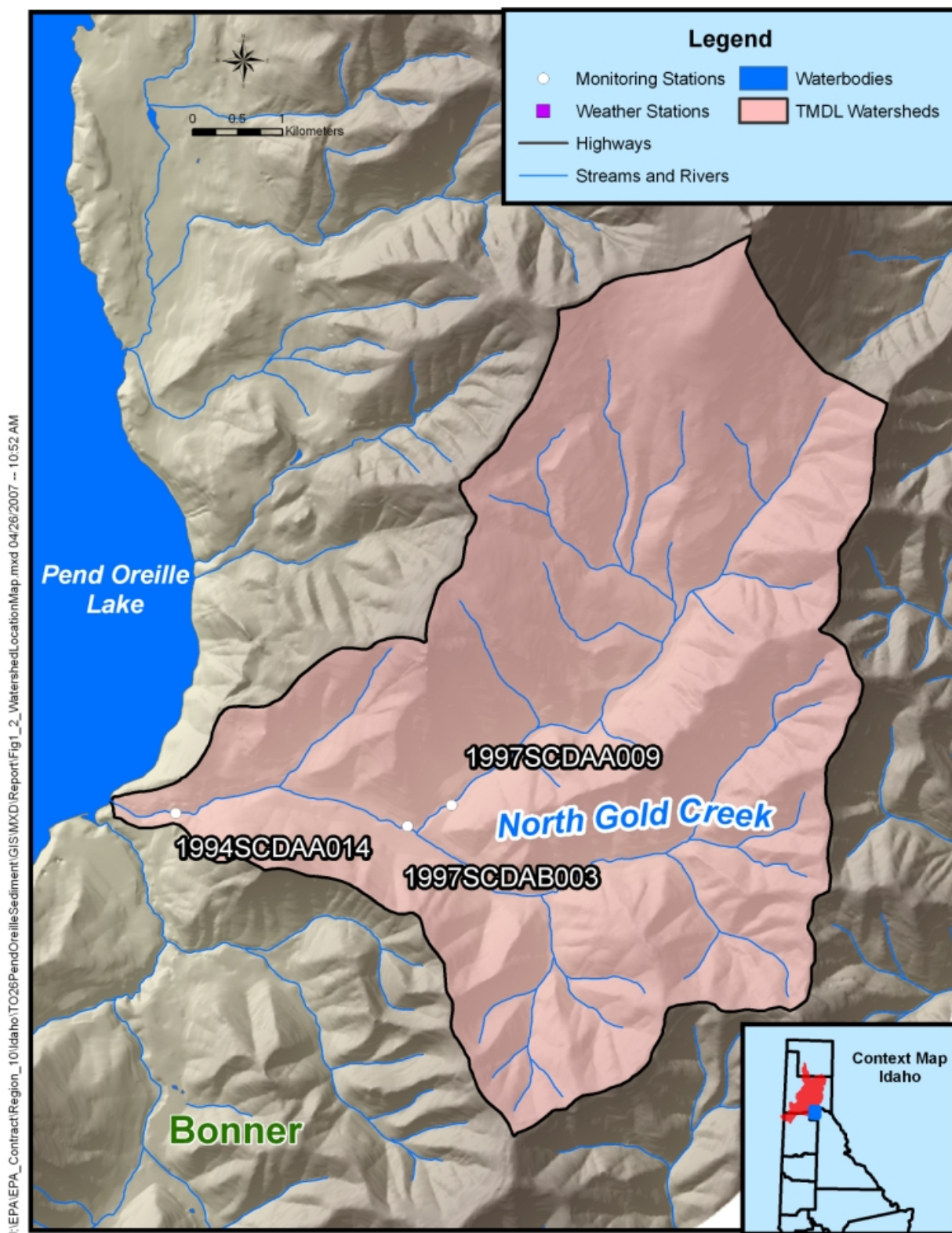


Figure 2-4. BURP Stations in North Gold Creek Watershed

Table 2-4. Index Scores for Pend Oreille Lake Watersheds

Watershed Name	Assessment Unit	Water Body Name	BURP ID	Stream Macroinvertebrate Index (SMI)	Stream Fish Index (SFI)	Stream Habitat Index (SHI)
Upper Pack River	ID17010214PN041_02	Martin Creek	1998SCDAB028	10.296	30	69
		Pack River	2003SCDAA019	68.984	NA	78
		Youngs Creek	1998SCDAB027	61.736	81.624	83
	ID17010214PN041_03	Pack River	1995SCDAA051	47.27	68.946	46
		Pack River (Lower)	1998SCDAB029	57.446	69.874	61
		Pack River (Upper)	1998SCDAB025	51.378	NA	64
	ID17010214PN042_02	McCormick Creek	1998SCDAB024	40.768	24.192	79
Lower Upper Pack River	ID17010214PN044_02	Hellroaring Creek	1998SCDAB023	45.315	51.861	70
Sand Creek	ID17010214PN049_02	Sand Creek	1998SCDAB016	29.387	63.807	42
	ID17010214PN049_03	Sand Creek (Upper)	1997SCDAA017	40.228	NA	51
	ID17010214PN052_02	Schweitzer Creek	1997SCDAA011	57.739	NA	72
		Schweitzer Creek	1998SCDAB020	50.323	66.602	76
		Schweitzer Creek (Lower)	1995SCDAA057	49.266	81.058	12
Gold Creek	ID17010214PN034_02	Gold Creek (Lower)	1998SCDAB031	66.293	60.014	63
		Gold Creek (Upper)	1998SCDAB032	49.817	NA	41
Rapid Lightning Creek	ID17010214PN033_03	Rapid Lightning Creek	1997SCDAA013	47.75	NA	60
North Gold Creek	ID17010214PN025_02	North Gold Creek (North Branch)	1997SCDAA009	74.977	NA	82
		North Gold Creek (Upper)	1997SCDAB003	59.914	NA	81
	ID17010214PN025_03	Lower Fish Creek	1994SCDAA003	66.862	NA	52
		North Gold Creek	1994SCDAA014	49.759	50.42	43
		Flume Creek	1997SCDAA012	41.86	NA	61

Biological data are available for those streams assessed by BURP crews, with index scores presented in Table 2-5. The first index is the Stream Macroinvertebrate Index (SMI). By recording the abundance of macroinvertebrates known to live only in specific temperature conditions, the index is used as a direct biological measure of cold water aquatic life (Grafe *et al.* 2002). A detailed description of this index can be found in Jessup and Gerritsen (2000). A high score (three) on the index indicates a healthy assemblage of species close to reference condition streams in the state.

Table 2-5. Index Scoring Criteria

Condition Category	SMI (Northern Mountains)	SFI (Forest)	SHI (Northern Rockies)	Condition Rating
Above 25 th percentile of reference condition	≥65	≥81	≥66	3
10 th to 25 th percentile of reference condition	57-64	67-80	58-65	2
Minimum to 10 th percentile of reference condition	39-56	34-66	<58	1
Below minimum of reference condition	<39	<34	NA	Minimum threshold

Note: NA indicates not available; SHI does not have a minimum threshold condition rating.

The second index is the Stream Fish Index (SFI). This index is also considered a direct biological measure of cold water aquatic life and is used to determine how close the stream is to achieving the Clean Water Act “fishable” goal. The details of the development of this index can be found in Mebane (2002). Mebane developed this index based on least impacted and stressed sites. Fish counts are taken in each watershed and the index relates data found to known index, or reference sites.

The last index considered when determining beneficial use support is the Stream Habitat Index (SHI). Details of this index can be found in Fore and Bollman (2000). The habitat index considers ten habitat metrics such as: instream cover, substrate composition, bank and canopy cover and zone of influence. SHI is not considered to be a direct biological measure; therefore it is recommended that it always be used in conjunction with at least one other index. This is due to significant variability in physical habitat measures (Grafe *et al.* 2002). Metrics tailored to forested areas were used for the SHI. Each index uses a scale of one to three. The values resulting from each index are averaged to determine the support status of each water body as described in DEQ’s Water Body Assessment Guidance, Second Edition (Grafe *et al.* 2002). A score of three indicates the stream is most likely to fully support beneficial uses. Average values of two or greater indicate a water body that is in full support of its beneficial uses, however, the condition significantly varies from reference conditions and assessors can examine additional information, if available, to determine support status of the water body. Scores of less than two indicate that a water body is not supporting its beneficial uses. Scores from at least two indices are required to make a support status determination. If either the macroinvertebrate or fish score is zero, the water body is considered to not fully support beneficial uses.

According to the watershed index scores, biological functions were generally more degraded in the tributaries draining into the Pack River than the mainstem segment. Lindsey Creek was not assessed because it was dry at the time of the survey. Index scores for the Sand

Creek waterbodies were generally below the criteria, indicating these waterbodies were impaired. Downstream segments of the Gold Creek and North Gold Creek watersheds appear to be more degraded than the upstream segments.

Idaho Department of Fish and Game (IDFG) conducted bull trout redd counts between October 11 and October 26 from 1983 to 2001 for selected waterbodies within the Pend Oreille Subbasin (IDFG 2004). Table 2-6 summarizes the results for the Pack River, Gold Creek and North Gold River. A flat trend was generally observed for the period evaluated. The number of redd counts observed in the Pack River varies substantially; this could be due in part to unstable habitat conditions. However, redds counted in the Pend Oreille Subbasin indicate the drainage area bull trout population is relatively abundant when compared to other parts of northern Idaho (IDFG 2004).

Table 2-6. Summary of Bull Trout Redd Survey Results for Selected Waterbodies within the Pend Oreille Subbasin

Sample Year	Water Body Name		
	Pack River	Gold Creek	North Gold Creek
1983	34	131	16
1984	37	124	37
1985	49	11	52
1986	25	78	8
1987	14	62	36
1988	NA	111	24
1989	NA	122	37
1990	NA	84	35
1991	NA	104	41
1992	65	93	41
1993	21	120	32
1994	22	164	27
1995	0	95	31
1996	6	100	39
1997	4	76	19
1998	17	120	22
1999	0	147	16
2000	8	168	19
2001	28	127	16

Status of Beneficial Uses

To assist planners responsible for writing TMDLs for Idaho streams, DEQ has explored measurements of sediment that may assist in setting targets and in gauging progress toward meeting water quality standards. The ultimate measure of sediment water quality standard attainment, and the only measure recognized in Idaho's water quality rules, is instream beneficial use support (IDEQ 2003). Sediment-caused impairment can take many forms and be measured in a variety of ways. Some of the key assessment tools utilized by DEQ to assess the status of cold water aquatic life use or salmonid spawning include DEQ's Water Body Assessment Guidance (WBAG), stressor identification reports, and CWE assessment reports. Each of these tools have been employed to the degree possible to validate the

support or nonsupport of beneficial uses for the Upper Pack River watershed including the mainstem river (17010214PN041_02 and 03), McCormick Creek (17010214PN042_02), and Hellroaring Creek (17010214PN044_02); Sand Creek (17010214PN049_02 and 03) and Schweitzer Creek (17010214PN052_02); Gold Creek (ID17010214PN034_02); Rapid Lightning Creek (ID17010214PN033_03), and North Gold Creek (ID17010214PN025_02 and 03).

Having analyzed BURP data in accordance with WBAG II protocols, DEQ's assessment of the data resulted in the placement of these water bodies in Category 5 of the 2002 Integrated Report due to biological impairment. BURP data are used to determine beneficial use support status, but WBAG II analysis does not identify the cause of impairment. This results in identification of biological impairment without a specific pollutant recognized.

Subsequently the IDL completed CWE assessment reports in 2003 for some of the watersheds addressed in this report (McCormick Creek, Hellroaring Creek, Trestle Creek, Upper Rapid Lightning Creek and Gold Creek). Therefore as part of the Subbasin Assessment process DEQ, with the support of an EPA Region 10 contractor, completed a Stressor Identification report for the following water bodies addressed in the *Pend Oreille Tributaries Sediment TMDLs* report: Upper Pack River watershed including the mainstem river (17010214PN041_02 and 03), McCormick Creek (17010214PN042_02), and Hellroaring Creek (17010214PN044_02); Sand Creek (17010214PN049_02 and 03); Gold Creek (ID17010214PN034_02); and Rapid Lightning Creek (ID17010214PN033_03). Stressor identification reports summarize a formal and rigorous process that:

- Identifies stressors causing biological impairment in aquatic ecosystems, and
- Provides a structure for organizing the scientific evidence support the conclusions (EPA 2000).

The Stressor Identification process is triggered by biological assessment data indicating that a biological impairment has occurred (EPA 2000). The Stressor Identification process evaluates pollutants and watershed characteristics that are most likely causing the biological impairment. In the *Pend Oreille Subbasin Stressor Identification* summary report prepared by TerraGraphics, Environmental Engineering, Inc. in September 2006, seven potential stressors were identified. The potential stressors included:

- Low nutrients resulting in low fish and macroinvertebrate abundance;
- Increased flood frequency and maximum stream flows with a concomitant decrease in base flows;
- Increased sediment delivery and percent fines;
- Reduction in riparian cover, shift in riparian plant species, lower quality shade;
- Increased metal concentrations;
- Increased nutrients; and
- Ineffective sampling or inappropriate reference stream reaches for comparison.

A summary of the data collected and conclusions from the stressor identification results are provided in the *Pend Oreille Subbasin Stressor Identification* summary report which can be obtained through DEQ. The key conclusions from the *Pend Oreille Subbasin Stressor*

Identification summary report for each assessment unit as they pertain to validating the need for sediment TMDLs are provided below.

Upper Pack River (ID17010214PN041_02)

Excessive sediment loading in the stream bed was confirmed as the key stressor and, therefore, development of a sediment TMDL to restore the cold water aquatic life use for the lower portion of Upper Pack River watershed is necessary (TerraGraphics 2006).

McCormick Creek (ID17010214PN042_02)

Given the data collected through the stressor identification assessment and available BURP data, the large cobble substrate and low percent fines found does not support the premise that sediment delivery is a significant contributing factor to the poor SMI scores. While additional data would prove useful in the refinement of candidate causes of impairment, it was determined that the most likely causes for the poor macroinvertebrate and fish index scores was sampling/assessment problems not excessive sediment loading. Therefore, development of a TMDL for sediment is not recommended for McCormick Creek (TerraGraphics 2006).

Hellroaring Creek (ID17010214PN044_02)

Based on the analysis of existing biological, chemical, habitat and watershed conditions, the stressor identification analysis determined that excessive sediment (significant proportion of fine sediment) was a key cause of the low SMI and SFI scores. As a result, sediment was verified as the cause of impairment. Therefore, it is necessary for sediment TMDLs to be developed to restore the cold water aquatic life use for the lower Upper Pack River and Hellroaring Creek watersheds (TerraGraphics 2006).

Gold Creek (ID17010214PN034_02)

It was determined that the likely cause of impairment was the high percentage of sediment fines in the stream bed, particularly in upper Gold Creek. While other stressors were identified, it is recommend that a sediment TMDL be developed to restore the cold water aquatic life use for the watershed (TerraGraphics 2006).

Rapid Lightning Creek (ID17010214PN033_03)

Based on the analysis of existing biological, chemical, habitat, and watershed conditions, it was determined that excessive fine sediment is the likely stressor of the macroinvertebrate community in Rapid Lightning Creek. However, it was recommended that the need for TMDL development would be based on comparing modeled results of sediment loading in Rapid Lightning Creek to a reference watershed condition (TerraGraphics 2006).

Sand Creek (ID17010214PN049_03)

It was determined that excessive fine sediment was the most likely stressor, but the assessment was not able to discern if the sediment loads were the result of natural background loads or anthropogenic activities. Despite limited data, it was recommended that the need for TMDL development would be based on comparing modeled results of sediment loading in Sand Creek to a reference watershed condition (TerraGraphics 2006).

Conclusions

Initially TMDLs for sediment or an unknown pollutant were considered necessary for 11 AU in the Pend Oreille Subbasin based on limited BURP data. Additional chemical, biological and physical data provided through the *Pend Oreille Subbasin Stressor Identification* verified which waterbodies are considered impaired by sediment. Critical periods causing impairment are likely to be associated with sediment delivery during high flows (i.e., April through June) caused in part, by snowmelt or rain-on-snow events.

Specific conclusions verifying excessive sediment as a cause of beneficial use impairment for each watershed were presented in the *Pend Oreille Subbasin Stressor Identification Reports* prepared in September 2006. Synopses of the conclusions from this report are summarized below in Table 2-7 which validate the need for sediment TMDLs and future implementation to achieve sediment load reductions. A stressor identification analysis was not completed for North Gold Creek watershed. For TMDL calculation purposes, modeling of the McCormick Creek and Hellroaring Creek watersheds would be combined with the Upper Pack River watershed to aggregate sediment loading estimates and pollutant load allocations.

Table 2-7. Verification of Beneficial Use Impairment Caused by Excessive Sediments¹

Water Body	Conclusions	TMDL Recommendation
Upper Pack River	Excessive sediment was identified as the most probable stressor.	Develop sediment TMDL for Upper Pack River.
McCormick Creek	Low nutrients and sampling/assessment problems were identified as the most likely causes for poor macroinvertebrate and fish scores not excessive sediment loading.	A TMDL is not recommended for McCormick Creek since it is likely not impaired as a result of sediment loading. However, sediment loads for McCormick Creek will be accounted for through the Upper Pack River sediment TMDL.
Hellroaring Creek	The likely causes of impairment are from increased sediment delivery, low nutrients and, to a lesser extent, stream temperature.	Develop sediment TMDL for Hellroaring Creek.
Gold Creek	Impairment was caused by excessive sediment fines and thermal modification.	Develop sediment TMDL for Gold Creek.
North Gold Creek	Stressor identification analysis was not performed	Develop sediment TMDL for North Gold Creek.
Rapid Lightning Creek	Excessive coarse to fine grain sediment within the stream may be the primary stressor however insufficient data were available to determine the need for a sediment TMDL.	It was recommended that the watershed be modeled to determine if the amount of sediment being delivered to the system is significantly higher than background levels.
Sand Creek and Schweitzer Creek ²	High percent fines were a likely stressor but with existing data it was difficult to determine if this was a natural condition or human induced.	Develop sediment TMDL based on modeled results to allow comparison of natural load to current load.

¹ Source: Pend Oreille Subbasin Stressor Identification Reports, September 28, 2006, TerraGraphics Environmental Engineering, Inc.

² Jack Creek, Swede Creek, and Little Sand Creek were not assessed in the Stressor Identification Reports completed in September 2006 but these tributaries are included in the TMDL for the Sand Creek watershed.

2.5 Data Gaps

Limited data are available to determine if McCormick Creek watershed is impaired by excessive sediment loads. Specifically, McCormick Creek is very different from streams commonly found in Idaho; therefore, fish and macroinvertebrate scores derived using the BURP protocol are very difficult to interpret, and comparison with reference streams is not appropriate. In addition, low specific conductivity was observed in this water body, making electrofishing an ineffective way to collect fish community data. Preliminary assessment of this watershed based on limited water column data indicate that low nutrient levels may be the cause of the impairment in addition to elevated water temperature. Additional water quality data for various nutrient parameters collected from this water body could help confirm and identify the sources of the impairment.

Additional instream sediment measurements from these watersheds could also help evaluate the extent of the sediment impairment and enable better calibration of the assessment model. Similarly, additional fisheries information from these watersheds, in particularly Sand Creek and Rapid Lightning Creek, could also help evaluate the extent of the impairment and allow better evaluation of the effectiveness of a future TMDL implementation plan. BURP data for Sand Creek from the source to Schweitzer Creek (AU 17010214PN049_02) would be useful to confirm its beneficial use status and would provide information for the modeling approach.

Rapid Lightning Creek lacks sufficient instream metals data from both Flume and Rapid Lightning Creeks to determine if metals loadings are an issue. For the Sand Creek watershed, the collection of additional temperature and nutrient data should be considered since insufficient data are available to determine whether these parameters are contributing to the impairment.

CWE road scores are also not available for many assessment waterbodies. Completing these evaluations for the AUs included in this TMDL could reduce uncertainty regarding the TMDL assessments and allow better evaluation of the effectiveness of Best Management Practices (BMP), which in turn provide a better tool for adaptive management. Fire data for the period 1970 to present would also be useful.

3. Subbasin Assessment–Pollutant Source Inventory

This section discusses known and suspected sources of sediment – the pollutant of concern in this *Pend Oreille Tributaries Sediment TMDLs* report. This includes information on both point and nonpoint sources of sediment. In addition, this section summarizes the data gaps related to sources of pollution and includes a list of suggested research and monitoring activities.

3.1 Sources of Pollutants of Concern

Permitted point source discharges are not considered sources of sediment loading in the Pend Oreille Subbasin. Nonpoint sources are considered to be the major source of sediment loading to the tributaries and streams in the Pend Oreille Subbasin. Generally, nonpoint sources of sediment within the Pend Oreille Subbasin are well understood and are directly related to the land use activity and land cover type within each watershed. Mass wasting associated with natural processes/events or accelerated by anthropogenic activities can be a source of sediment loading, but in the recent past has not been a major contributor to most watersheds except for the Upper Pack River watershed. Depending on a wide array of event-specific characteristics, other landscape scale events such as forest fires and tree harvesting practices may contribute minor to significant sediment loadings to the watersheds.

Summary of Point Sources

There are no known point sources, municipal separate storm sewer systems, or Superfund sites within the portion of the Pend Oreille Subbasin addressed in this report. However, there is a general construction permit that is applicable to areas greater than 1 acre occurring within the Subbasin.

Summary of Nonpoint Sources

Sediment occurs naturally as a geologic process. Streams function to move sediment from source areas of high gradient and friable soil material through intermediate elevations and gradients to depositional reaches where sediment is incorporated into the floodplain or transported to larger waters. Land management practices have the potential to accelerate erosion or to alter depositional processes. This is when sediment is recognized as a pollutant impacting the beneficial uses of a water body. When sediment is present in excess of a stream's ability to transport it, it is considered a pollutant. Excessive sediment loads interfere with natural processes that aquatic life depends on, and can result in increased instability of natural stream channels further accelerating erosion. Both fine sediment, and excessive bedload (or larger sediment) can be a pollutant.

Land conditions resulting from silvicultural practices and roads in the area are the primary non-natural, nonpoint sources of sedimentation. Timber harvest and associated road construction can intercept water flows and alter peak flows, as well as provide trigger points for mass wasting events. These altered flows and sediment delivery mechanisms influence stream function.

Altering the dimension, pattern and profile of stream channels changes the transport and deposition of sediment as well as the morphology of streams and rivers which can influence water quality parameters. For instance, the widening of a channel can contribute to higher temperatures in the stream. To address one aspect of sediment pollution without regard to others on a watershed scale has little potential to successfully reducing sediment or improving water quality or fisheries on a meaningful scale. Initiating an increase in erosion or change in flow pattern can have grave consequences over many years. Many of the processes creating excessive amounts of sediment were initiated before these relationships were understood. Today, a number of land management practices are perpetuating the problems of the past and are contributing to an increasing deficit of water quality and fisheries values.

For the Pend Oreille Subbasin, there are several land management activities recognized as general sources of sediment loading: 1) urban or developed land, 2) shrubland, 3) forest land, 4) grassland/herbaceous/pasture/hay, 5) forest fires, 6) tree harvesting, 7) mass wasting, 8) roadways, 9) and stream channel alteration. All these activities or events are identified in the *Lake Pend Oreille Key Watershed Bull Trout Problem Assessment* report as factors that impact and degrade bull trout habitat (Corsi et al. 1998). A brief summary of each of these various sources in relation to the Pend Oreille Subbasin is provided below.

Urban or Developed Land

Conversion of forested land to urban or developed land increases road densities, impervious surface areas, and construction activities. These activities generally result in reduction of natural vegetation, and if occurring in the stream riparian area, also reduce shade and the recruitment of large organic debris. Vegetation is frequently cleared from stream banks, resulting in reduced stream bank stability. Land development may also restrict a channel's natural flow pattern resulting in an increased stream flow and acceleration of stream bank erosion. The combined effects from these activities are likely to result in an increase in runoff and erosion rate, which subsequently leads to an increase in sediment loading.

Given the small amount of urban or developed land, loading from this land use activity is considered a relatively insignificant source of sediment in the Upper Pack River, Gold Creek, Rapid Lightning Creek, and North Gold Creek watersheds. The urban areas within the Sand Creek watershed are contributing sediment loading to Sand Creek, particularly the land development activities within the riparian corridor. As shown in Table 1-7 and Figure 1-4, 7.7 percent of the Sand Creek watershed is composed of urban or developed land.

Forested Land and Shrubland

All watersheds in the Pend Oreille Subbasin are dominated by forest land and shrubland. Forest land and shrubland are indicative of natural conditions and, therefore, sediment loading rates for these land use categories are defined as background loadings. According to USFS, the erosion rate and sediment yield rate for shrubland and forested land is very similar (see Appendix A for more details). While sediment delivery from these land use categories may result from natural processes such as overland runoff, sheet erosion, and soil erosion along stream banks, it is considered to be in equilibrium with the natural sediment loading capacity of the tributaries and streams within each watershed. As such, undisturbed forest land and shrubland are recognized as background sources of sediment loading in each watershed. Barren areas consisting of rock and lacking vegetation occur within the

watersheds; however, erosion and sediment transport from these areas are assumed to be negligible.

Grassland

Land management activities associated with grassland, herbaceous, pasture, hayland, and ski slopes such as plowing, irrigation, and grazing, could decrease macrospore system and organic matter content and increase runoff, erosion, and sediment loading (Pack River Watershed Council 2006). Two general categories of grassland areas were summarized for the area – Grassland Permanent and Grassland Agriculture. Grassland Permanent pertains to relatively undisturbed grassy areas such as upland meadows. This type of grassland occurs in the Sand Creek watershed, the Upper Pack River watershed, and the North Gold Creek watershed. Grassland Agriculture refers to grassland periodically disturbed by human activities and thus, the erosion rate is higher than for undisturbed Grassland Permanent. Grassland Agriculture occurs in Sand Creek watershed, Rapid Lightning Creek watershed, and Gold Creek watershed. Sediment loadings from these land management activities are insignificant in Gold Creek, Rapid Lightning Creek, and North Gold Creek watersheds, but are a recognized source in the Upper Pack River and Sand Creek watersheds.

Some of the grasslands (agriculture) are utilized for livestock grazing. Livestock operations and access to riparian corridors can in some cases generate sediment loading to streams. Livestock operations include cow-calf or beef enterprises, generally less than 100 cows. Some of the large timber companies lease out their cutover timberlands for livestock grazing. Some of the federal- and state-managed lands are also leased out for livestock grazing. Cattle grazing is primarily seasonal, beginning in the spring and ending in the fall (PRWC 2006). The average size of individual farms and ranches in the area is about 300 acres. There are approximately 180 small animal feeding operations, all with less than 300 animals and 652 small farms in the Pend Oreille Subbasin (NRCS 2006).

Forest Fires

Forest fires often decreases vegetation, bank stability, increase stream velocities, and alter stream channel geomorphology. This can increase runoff and sediment loading to the waterbodies. Sediment loading resulting from forest fires are expected to be minor for most watersheds in this report since the most recent fire occurred almost 40 years ago. Burned forestlands in the Pend Oreille Subbasin generally become revegetated within several years after a fire event (see Appendix A for more details). Multiple forest fires have occurred in these watersheds during 1952, 1960, 1967, and 2000 (see Figure 3-1).

Tree Harvesting

Similar to burned forests, harvested forest lands in the Pend Oreille Subbasin also become revegetated within a few years from the harvest event (see Appendix A for more details). Harvesting could lead to increase stream flows, especially during peak flows, which may lead to increase stream bank erosion. Harvested lands often experience an increase in runoff and mass wasting potential, therefore resulting in additional sediment loading to the waterbodies. Sediment loading due to timber harvesting is expected to be relatively minor for most watersheds since most harvesting occurred prior to 1997. Figure 3-1 displays historic forest fires and tree harvesting areas within the study area. Sediment loading from

this source is expected to have the highest impact to the Upper Pack River Watershed and the North Gold Creek Watershed since harvest activities occurred relatively recently.

Mass Wasting

Mass wasting is a natural process that can occur in watersheds of the Pend Oreille Subbasin. Frequently in landslide-prone areas, human activities can increase both the occurrence of landslides and the potential for these mass wasting events to deliver excessive sediment to streams. Undisturbed watersheds have demonstrated a certain capacity to assimilate mass movement of material; however, there is also a threshold where the system can no longer process increased amounts of material delivered to the stream, and the stream channel structure is altered, frequently causing impairment to beneficial uses.

According to the available CWE results for select watersheds in the Subbasin, mass wasting could be a significant source of sediment loading in the Upper Pack River (IDL 2003a, 2003 b, 2003c). Loading from mass wasting in Gold Creek and Rapid Lightning Creek watersheds are expected to be negligible and no mass wasting information is available for the North Gold Creek and Sand Creek watersheds. However, the steep slopes and soil characteristics of the Schweitzer Creek watershed create conditions that are prone to mass wasting.

Roadways

The roadway networks in the Upper Pack River, Rapid Lightning Creek, North Gold Creek, and Gold Creek watersheds are primarily associated with forestry activities. Roads built to facilitate timber harvest and other activities can be significant sources of sediment. A road system in forested lands includes the road surface along with water runoff management structures such as rolling dips and cross culverts; down gradient fillslopes and up gradient cutslopes; drainage ditches; and stream crossings. Road systems produce sediment mass and a percentage of that mass can be delivered to basin streams.



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Sediment production from a road surface will vary according to such factors as inherent erodibility and runoff producing capacity of the soil and running surface, degree of gravel capping, road gradient and road segment length, sufficiency and maintenance of water runoff management structures, and road use. Road surface erosion may be accelerated by rut formation when vehicles travel the road during the wet, spongy conditions of spring thaw and peak runoff. Sediment production from the road surface and other parts of the road system does not equate to sediment yield to a stream. The ratio of production to yield often depends on the sediment exit point in proximity to a stream locale, including the area of intervening forest floor which serves to function as a sediment trap settling area (Ketcheson and Megahan 1996).

Sediment production also comes from fillslopes and cutslopes. Fillslopes and cutslopes can contribute sediment to drainage ditches through soil creep, sheet wash, rilling, and slumping. A cutslope can also intercept the shallow subsurface flow of forested floors, and this groundwater will surface and weep at the cutslope, at times accelerating erosion and slumping.

In some isolated instances, private residential road density is increasing as land is converted from timber to rural home sites. When these private roads are inventoried, it is clear that many of them do not meet the standards of Idaho Forest Practices Act (FPA) roads. They are often not capped with gravel; they tend to become heavily rutted and thus frequently graded, which produces loose soil; and they do not have sufficient water runoff management structures when built on steep slopes. Homes along stream courses are often desired by homeowners, and thus, overall, there is a high potential of sediment delivery from residential private roads to streams.

Road density in a watershed is a known indicator of fisheries habitat quality. In particular, with increased road density, bull trout populations tend to decline due to the additional sediment delivery and potential alternations to ground water base flow. Stream crossings can alter stream channel stability and accelerate flow, causing added sources of sediment. Detailed analysis of road densities, stream crossings, and road impacts on streams throughout the watersheds in the Pend Oreille Subbasin were conducted as part of the modeling approach used to develop the sediment TMDLs in this report. Data on road delineation and road surface (paved or unpaved) for each watershed were compiled by DEQ from a variety of sources including BLM, USFS, Bonner County, City of Sandpoint, USFS, and private land owners. When the type of road surface was unknown, it assumed that the road was unpaved. Table 3-1 summarizes the paved and unpaved roads within each watershed.

Table 3-1. Paved and Unpaved Roads within Each Watershed

		Length (Miles)	
Watershed	Land Managers	Not Paved	Paved
Gold Creek	Bonner County	8	0
	PRIVATE	20	0
	USFS	1	0
Gold Creek Total		29	0
North Gold Creek	PRIVATE	0	0
	USFS	37	0
North Gold Creek Total		38*	0
Rapid Lightning Creek	BLM	0	0
	Bonner County	10	1
	PRIVATE	81	0
	STATE	18	0
	USFS	40	0
Rapid Lightning Creek Total		148*	1
Sand Creek	BLM	4	0
	Bonner County	11	14
	City of Sandpoint	16	26
	ITD	0	9
	PRIVATE	66	18
	STATE	6	2
Sand Creek Total		103	69
Upper Pack River	BLM	1	0
	Bonner County	3	0
	PRIVATE	40	0
	USFS	129	0
Upper Pack River Total		173	0
Grand Total		491	70

* Total value varies from sum of individual values due to rounding error.

Channel Stability

In-stream bank erosion can be a significant source of sediment. Any of the land uses or land management activities described above that encroach on the riparian corridor of tributaries and streams can have a significant effect on stream channel stability and geomorphology, which can become a chronic source of sediment loading. From recorded field observations and results of the stream bank erosion survey, it is known that stream bank erosion can be a significant direct sediment contributor to basin streams. Direct impacts to channel stability can negatively impact all biological functions within a water body.

The following excerpts from the CWEs prepared in 2003 for Hellroaring Creek, Gold Creek, and McCormick Creek provide a limited evaluation of channel stability for a few select tributaries in the Pend Oreille Subbasin (IDL 2003d, 2003e, and 2003f).

- Five similar reaches in Gold Creek were evaluated in September 1998 when stream flow was relatively low. The third and fifth reaches scored in the high range, and the

others scored in the moderate range. The channel stability score is 60.5. The overall channel stability rating is high.

- Four similar reaches in the forested portion of Hellroaring Creek were evaluated in August 1998 when stream flow was relatively low. All of the reaches have a moderate Channel Stability Index. The overall channel stability rating is moderate.
- Three similar reaches in the forested portion of McCormick Creek were evaluated in August 1998 when stream flow was relatively low. All three reaches scored in the moderate range. The overall channel stability rating is moderate.

It is extremely difficult to partition current stream bank erosion rates to related factors such as: 1) naturally occurring (background); 2) remnants of effects from historic fires followed by increased flows; 3) remnant effects of historic timber harvesting in the riparian zone and construction of a transportation network; 4) excess stream energy of peak flows related to hydrologic openings from timber harvesting; 5) channel straightening and conversion of wetlands and wet meadows for agriculture purposes; 6) excess current sediment loads which lead to a decrease in stream depth; and 7) the effect of floodplain encroaching roads, as the roads can interfere with the stream's natural tendency to seek a steady state gradient, and at high discharge periods may cause the stream to erode stream banks and the stream bed. For these reasons, sediment loading from stream bank erosion was not quantified in the TMDL calculations presented in Section 5 of this report.

Pollutant Transport

Delivery of large material through the system is episodic during the winter and spring months when high flows and/or rain on snow events occur. Where the road network in a watershed encroaches on the riparian areas, chronic delivery of sediment occurs. Watershed gradient and soil characteristics of the subbasin combined with roadways and forest harvesting that can increase the potential for mass wasting, are also transport mechanisms within a watershed. Anthropogenic increases in mass wasting are evident in other similar watersheds and are a significant source of sediment through both stream alteration and direct delivery to the stream.

Pollutant Source Assessment Conclusions

The following excerpt from the *Pack River Stream Channel Assessment* report prepared by Golder Associates, Inc. in 2003 provides a synopsis of the various anthropogenic activities in the Pend Oreille Lake watersheds that contribute sediment loading to streams.

In addition to the Pack River watershed's predisposition to naturally high sediment yields, erosion has likely increased as a result of a wide range of human activities that mobilize and supply sediment. It is apparent in some instances that these impacts have caused impaired channel types that do not correspond to the natural geologic setting, hydrologic regime, and sediment load. Moreover, some of the areas of the Pack River channel are now geomorphic stream types that are less efficient at transporting flood flows and sediment than the desired stream type. Sediment inputs from road building throughout the upper watershed, coupled with the loss of vegetation due to timber harvest and fire, likely exacerbate the amount of natural sediment into the drainage to a high degree. Megahan and Kidd, 1972 emphasized the problems from road construction, and in particular, mass failures associated with roads in watersheds on a highly erosive granitic batholith. Sediment on a batholith also originates from road-cut slopes, where

exposed granite weathers quickly. Megahan and Kidd, 1972 emphasized that roads constitute one of the primary sources of stream sediments on the granitic batholith. They reported sediment production rates from roads on a batholith 770 percent higher than rates in similar nearby watersheds that remain undisturbed. Of that increase, 30 percent was due to surface erosion from roads, and 70 percent was due to mass soil failures. Megahan and Kidd, 1972 also indicated that once logging ceased, sedimentation continued where roads had been cut through the soft, weathered granitic rocks. They also pointed out the need to treat surfaces of abandoned roads because the soft granite weathered easily without treatment and produced sediment for many years.

The individual or cumulative effects of the different land management activities and anthropogenic alterations to stream channels coalesce to deliver sediment loads to Pend Oreille Lake tributaries and streams that in some cases are excessive.

3.2 Data Gaps

The following is a summary of the data needs for nonpoint sources of sediment.

Nonpoint Sources

Long-term sampling of sediment loads will be cost prohibitive; consequently model results will continue to be recognized as viable data that can provide acceptable loading estimates of nonpoint sources of sediment in each watershed. Given the limited amount of data on forest, agriculture, and urban BMPs utilized in the Upper Pack River, Gold Creek, Rapid Lightning Creek, Sand Creek, and North Gold Creek watersheds, the modeling approach assumed no sediment BMPs were in place. Evaluating the effectiveness of BMPs aimed at reducing sediment loads over time will be crucial to a successful TMDL implementation plan.

Additional information on forest harvesting (date and scale) from privately managed lands would improve modeling of sediment loading estimates in Upper Pack River, Gold Creek, Rapid Lightning Creek, Sand Creek watersheds. A mass wasting study for the North Gold Creek watershed could also provide a better understanding of the effects of recent harvest activities on sediment loading to the watershed. Storm water monitoring, especially for the Sand Creek watershed, could enable better identification of the sediment sources from urban development and possible refinement of sediment run-off coefficients for urban land use. Streambank erosion data are lacking and could be an important sediment source in the Pend Oreille Lake tributaries particularly in the Upper Pack River.

4. Subbasin Assessment – Summary of Past and Present Pollution Control Efforts

The following section provides a general overview of activities and regulatory and voluntary methods aimed at managing sediment loading within the study area. The FPA governs the harvest and reforestation of all timberlands in Idaho. These rules are, in part, requirements for BMPs designed to abate erosion and retard sediment delivery to streams. The IDL has implemented the Act's rules and regulations aggressively over the past 15 years. Currently, the majority of the forested lands in the Pend Oreille Subbasin are managed by the state or federal government. This large state and federal ownership helps ensure that the rules and regulations of the FPA are implemented. All harvests managed by the USFS must meet the federal Inland Native Fish Strategy (INFISH) guidelines. These guidelines prescribe 300-foot wide buffers for streams with fish uses. Current and proposed timber sales within the Subbasin include road projects aimed at improving water quality. Road projects include road obliteration, resurfacing, slope stabilization, stream crossings, and drainage improvements.

Much of the remaining information presented in Chapter 4 is derived from the *Pack River Watershed Management Plan and TMDL Implementation Plan* prepared by the Bonner Soil and Water Conservation District, Pack River Technical Advisory Committee, and the Pack River Watershed Council in July 2006.

Idaho Code §39-3601 specifies certain entities as designated agencies for various land use activities. These include the IDL for timber harvest and mining activities, the Idaho Soil Conservation Commission (ISCC) for grazing and agricultural activities through local conservation districts, the Idaho Transportation Department (ITD) for public road construction, and the DEQ for all other activities. Designated agencies take the lead in identifying and selecting proven management practices that can be used to reduce nonpoint source pollution and facilitate implementation for their respective activities.

4.1 Forestry - Idaho Department of Lands

The FPA is state policy and is legislatively mandated. A Forest Practices Advisory Committee composed of various interest groups was established with the specific responsibility to review and improve forestry BMPs so forest practices will be conducted using the latest economically sound information and practices to protect water quality. The Committee conducts research into forest practice questions and gathers information from various sources, effectively providing a feedback loop for continuous improvement of forest practices. Many of the activities to improve water quality now being implemented in the Pend Oreille Subbasin are the direct result of improved practices and BMPs put in place by the FPA. The FPA was codified during the mid-1970s to comply with Section 208 of the federal CWA. The FPA established mandatory rules and regulations leading to BMPs to be used during forest practices to protect surface water quality. Espinosa, *et al.* (1997) described estimated sediment delivery in amounts greater than USFS management plan goals from the 1950s through the 1970s, and noted that the awareness of watershed and habitat degradation problems helped initiate a moderation of timber and road construction impacts in the early 1980s. On-site audits of FPA compliance were conducted in 1978, 1984, 1988, 1992, 1996, 2000, and 2004. Because of these audits, BMPs were revised to promote better

water quality protection. Under the FPA, the forest industry and the State of Idaho developed and are implementing a CWE process for forest lands in Idaho. The goal of this method is to systematically examine forested watersheds and identify on-the-ground cases where forest management may be contributing to water quality problems as defined by the CWA and state standards.

When problems are identified, the process leads directly to corrective management prescriptions where the problem is occurring. In 1991, the CWE analysis process was added to the IDL tool chest. This process includes assessments of erosion hazards, canopy closure, stream temperature, hydrology, sediment delivery, channel stability, beneficial uses, and nutrients. The CWE process provides a broad scale watershed assessment that determines if water quality problems exist and what should be done to mitigate those problems. This process can be initiated by the IDL, by a watershed advisory group, or by DEQ at any time it appears beneficial and when funding is available. CWE assessments have been completed on the Upper Pack River, Sand Creek, Gold Creek, and Rapid Lightning Creek. CWE reports define corrective management actions where on-the-ground conditions have been documented. These actions include BMPs based on FPA guidelines to ensure that forestry activities are not impairing water quality conditions. DEQ works closely with the FPA Committee, IDL, and private industry to ensure sediment BMPs are implemented, and will continue to do so.

Idaho's water pollution administrative rules governing nonpoint source activities (IDAPA 58.01.02.001.350) recognize BMPs as the most appropriate method to handle nonpoint sources, and section .03.a. recognizes the FPA as administered by the IDL as an approved BMP for silviculture and forestry. The IDL is the designated agency in Idaho for administering the Idaho FPA on state, private, and federal forestlands. In addition to the regular FPA inspection program conducted by the IDL, the Forest Practices Water Quality Management Plan calls for statewide audits of the application effectiveness of forest practices rules.

The IDL performs a variety of pollution control efforts in the Pend Oreille Subbasin. These efforts include enforcement of FPA rules, FPA education, Stewardship Forestry Assistance, Stewardship Cost-Share Programs, general forestry education, management of State endowment lands, and administration and enforcement of the Minerals Act. The FPA requires forest landowner compliance with forestry BMPs. On-site inspections include review of road construction and maintenance, stream crossing construction, stream protection zone encroachment by equipment, and road/skidtrail locations. Stewardship Forestry Assistance includes on-site visits with landowners to provide education, information, and technical training on forestry and stream-side BMPs. The State administers the Stewardship Program that includes assistance to landowners through cost sharing forestry, riparian, and agroforestry practices. The IDL also supports the Logger Education and Professionalism Program and Pro-Logger Program by providing workshops and training in the areas of logging BMP and FPA rules. Topics presented in 2003 included "Installing Culverts to Meet Fish Passage Guidelines." Stream crossing structures are engineered to meet 50-year peak flows. Roads are inventoried and inspected on a periodic basis. Pollution (sediment and temperature) management problems are identified and repaired as soon as weather conditions and funding permit. From the time of the initial 1998 §303(d) list until now (2007), the IDL, in conjunction with cooperating large industrial forest landowners, has undertaken a number

of capital improvement projects expressly to reduce potential sediment generation from existing forest roads.

4.2 Agriculture - Idaho Soil Conservation Commission

The ISCC is the designated management agency in Idaho for managing agricultural nonpoint source pollution. Although the ISCC does not have regulatory or licensing authority over water quality or pollution control, the mission of the ISCC is to provide support to Idaho's Soil and Water Conservation Districts for wise use and improvement of natural resources. The ISCC works with the Bonner Soil Conservation District and the Boundary Soil Conservation District, the Idaho Association of Soil Conservation Districts, and the Natural Resources Conservation Service (NRCS) in a *conservation partnership* to reach common goals and successfully deliver conservation programs that support water quality management.

The effects of agricultural practices on water quality vary depending on the management practices and location of particular operations in relation to surface and groundwater. The conservation partnership assists landowners in implementing BMPs that minimize negative impacts to water quality. The partnership is committed to targeting watersheds listed as water quality limited, and program delivery efforts prioritize projects occurring in degraded watersheds.

Given that less than 1 percent of the Pend Oreille Subbasin is considered cropland, BMPs for sediment management and soil conservation are effectively targeted to any potential problem conditions. Approximately 9 percent of the Subbasin is Pasture/Hay land (NRCS 2006). Minimal livestock grazing does occur within the basin. Current watershed improvement projects include fencing and hardening of livestock stream crossings, riparian vegetation restoration, and bank stabilization. In 1979 the original Agricultural Pollution Plan (AgPlan) was developed in response to Section 208 of the CWA and represents the agricultural portion of the State Water Quality Management Plan. Subsequently the AgPlan was revised in 1983 and 1991. The most current AgPlan, *Idaho Agriculture Pollution Abatement Plan, 2003*, sets goals and provides guidance for management of all nonpoint source-related activities throughout the state. Proposed and currently implemented pollution control efforts will help restore water quality. Field observations note that implemented projects have been generally effective in the basin. Further development and implementation of pollution control efforts will help to achieve water quality standards within a reasonable time.

4.3 Idaho Transportation Department

The ITD is designated as a lead agency responsible for TMDL implementation actions related to public roadways. ITD coordinates these efforts with local roadway jurisdictions such as highway districts, counties, and municipalities.

ITD's principal operations are dominated by the need to maintain and improve the state highway system; however, ITD also provides local transportation agencies with planning support and contract administration services for federally funded activities associated with local roads. The effects of state and local roadway infrastructure on environmental quality is primarily dictated by past roadway corridor development. For the most part, highway corridors are well established and will continue to influence environmental baseline conditions, particularly with respect to stream morphology and hydrology in lower stream

reaches. Maintenance activities and roadway improvement projects on existing routes, however, do pose some risk of additional adverse impact to these highly altered systems, mainly from short-term construction related sediment discharge.

In some cases, adverse environmental impacts resulting from previous construction of transportation systems near water bodies may be correctable through beneficial stream channel and floodway alterations and/or reclamation actions. These may include but are not limited to the use of biological and physical stabilization techniques, as well as realignment and subsequent removal of original roadway fill material.

4.4 Idaho Department of Environmental Quality

With the responsibility for lead agency coordination, the DEQ will provide forums for the exchange of scientific information between lead agencies and other interested parties throughout the implementation of a TMDL Implementation Plan. The designated management agencies are responsible under Idaho Code §39-3601 for complying with the provisions and agreements set forth within an implementation plan. While the DEQ is responsible for overseeing the development of an implementation plan and monitoring progress over time, the success of the TMDL implementation plan is directly dependent on the commitment and involvement of lead agencies and stakeholders within the watershed and their ability to implement the necessary changes outlined in a plan to restore beneficial uses.

4.5 Other Participants

As described above, the lead agencies under a TMDL Implementation Plan are DEQ, IDL, ITD, and ISCC, with involvement from the NRCS and the Bonner Soil and Water Conservation District. Federal agencies working in cooperation with IDL on forestry issues include the USFS and BLM. The Bonner County road department will work in cooperation with ITD to address water quality impacts from county roads within the watershed. The DEQ recognizes that involvement from the IDFG as well as the Bonner County Planning Department and the WAG may have significant impacts on designated beneficial uses in the Pack River watershed and will make a genuine effort to include them in all aspects of TMDL implementation and planning. TMDL implementation will also be coordinated with all aspects associated with the implementation of the Bull Trout Conservation Plan prepared by Governor Philip E. Batt in 1996 (Batt 1996).

5. Total Maximum Daily Load(s)

A TMDL prescribes an upper limit load capacity on discharge of a pollutant from all sources to ensure 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 considered individually 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 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 that 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 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 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.

Chapter 5 is organized to present and summarize the TMDL calculations and allocations for sediment impaired assessment units associated with Gold Creek, North Gold Creek, Sand Creek, Schweitzer Creek, and the Upper Pack River. Since the TMDLs are established based on land use categories and land management responsibilities, the sediment TMDL required for Hellroaring Creek is incorporated within the TMDL calculations for the Upper Pack River. Likewise while a specific TMDL for McCormick Creek was deemed unnecessary as

an outcome of the stressor identification reports, pollutant load reductions for McCormick Creek are nonetheless included in the TMDL calculations for Upper Pack River since the entire Upper Pack River watershed was modeled as one watershed.

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.

5.1 In-stream Water Quality Targets

The sediment TMDLs in this report address water-quality limited water bodies in the Pend Oreille Subbasin. The goal of a TMDL is to restore the water quality impairment to "full support of designated beneficial uses" (Idaho Code 39.3611.3615). Specifically in the case of sediment TMDLs, sedimentation must be reduced to a level where full support of the beneficial uses is demonstrated using the current assessment method accepted by DEQ at the time the water body is reassessed.

Loading capacities for these sediment TMDLs will be represented in terms of mass per unit of time (tons/ year and lbs/day). The interim goals will be set based on conditions in a reference watershed supporting native fish populations, more specifically, bull trout populations. Bull trout populations serve as excellent indicators of water quality conditions because bull trout are highly sensitive to environmental disturbances at all life stages and long-term population persistence is dependent upon five habitat characteristics; 1) cover, 2) channel stability, 3) substrate composition, 4) water temperature, and 5) availability of migratory corridors (Rieman and McIntyre 1993). As such, the impact of sediment loading on bull trout populations provides a viable measure regarding nonsupport of the narrative water quality standard for cold water aquatic life use.

The final goal will be achieved when biomonitoring demonstrates full support of the cold water aquatic life use and salmonid spawning beneficial use in relation to sediment loading. Sources contributing sediment can be reduced, but a substantial period (perhaps up to 30 years) may be required before beneficial use recovery is achieved.

Design Conditions

Modeled sources of sediment to water bodies within the Pend Oreille Subbasin are all nonpoint sources. Each TMDL addresses the nonpoint sediment yield of each watershed based on land use. Sediment from nonpoint sources is loaded episodically during high discharge events. High discharge events typically occur between November and May at intervals of several years. Critical conditions typically coincide with these large sediment delivery events. The typical minimum return period of the storm events that cause major sediment yield events is 10 to 15 years.

Target Selection

The sediment load capacity at which full support of beneficial uses is exhibited has been set at various levels in TMDLs developed by the DEQ. These have ranged from setting an interim load capacity at the background level for some watersheds in the Coeur d'Alene Lake Subbasin and the Pend Oreille Subbasin to more than 200 percent above background in some areas of the state.

Since numeric sediment criteria do not exist in the Idaho water quality standards for the Pend Oreille Subbasin, a critical step in development of sediment TMDLs is formulation of a rationale for creating a numeric translator for narrative criteria to serve as the water quality target. To determine the most appropriate target, each subbasin must be evaluated on an individual basis. Although it is well understood that streams have the ability to process sediment levels above natural background levels, it is not well understood to what level this is possible before impairment occurs. As a result, the use of a reference watershed was chosen as the method to derive a water quality target or numeric translator.

A reference (condition) stream was chosen to determine the appropriate sediment target to be used. A reference watershed, a watershed known to support a healthy population of bull trout was selected using local knowledge, data, and input from the Pend Oreille Tributary Working Group. Trestle Creek, a tributary to Pend Oreille Lake, was selected as the reference stream for the development of sediment TMDLs for these watersheds in the Pend Oreille Subbasin. Trestle Creek was chosen as a reference watershed because it supports some of the highest numbers of bull trout redds in the Lake Pend Oreille system (Corsi, *et al.* 1998), the stream is exhibiting passing WBAGII scores, and because the stream is considered undisturbed or "least impacted." Table 5-1 provides select land use characteristics in the Trestle Creek Watershed that demonstrate the undisturbed or "least impacted" conditions.

Table 5-1. Trestle Creek - Reference Watershed Characteristics

	Trestle Creek
Watershed Type	Reference Watershed
Watershed (acres)	12,574
Designated Beneficial Uses	CWAL, SS, SRW, SCR
Land Use Types	% Land Use (acres)
Forest*	94.0% (11,769)
Recent Harvested Forest (1997-2006)	0.6% (75)
Recent Burned Forest (1997-2006)	0.0% (0)
Pastureland-Permanent	1.0% (129)
Shrubland*	2.4% (299)
Urban or Developed Land	0.32% (40)
Barren	2.6% (323)
Water/Wetlands	0.12% (15)
	Number of Mass Wasting Events
Natural Slides*	0
Anthropogenic Slides	4

* Loads from naturally occurring land use types are not allocated for reductions.

The robust native fish community in Trestle Creek and the undisturbed characteristics (coniferous forest) of the watershed provide an acceptable representation of minimally impacted conditions to which impaired water bodies can be compared. To convert the

qualitative and quantitative characteristics (WBAGII scores) of a reference condition watershed into a numeric translator, a method was developed to estimate a percentage above the natural background load of sediment in the Trestle Creek Watershed. This would establish the load capacity or water quality target for similar watersheds not supporting their cold water aquatic life or salmonid spawning uses.

The sediment yield target was derived from the current condition of Trestle Creek by modeling the watershed using the same method and input variables as those used for each impaired water body. Using the modeling approach summarized in Appendix A, sediment yield coefficients were applied to each appropriate land use/land cover category in Trestle Creek and multiplied by the associated acreage. Based on literature values which are provided in Appendix A, it appeared that a sediment yield coefficient of about 0.02 to 0.03 tons/acre/year was on the conservative side of an average for coniferous forestland. A value of 0.0234 tons/acre/year used in previous DEQ TMDL studies was calculated using the WATSED program. Because this value fell within the acceptable range of values, it was chosen as the sediment yield coefficient for calculating the Pend Oreille Tributaries Sediment TMDLs.

A sediment yield value representative of minimally impacted conditions was determined by multiplying the acreage of the watershed by the natural background sediment coefficient. The percentage above natural background was then derived by subtracting natural background conditions from current conditions, dividing by natural background conditions and then multiplying by 100.

$$\text{Percent Above Background (Water Quality Target)} = \frac{\text{Current Estimated Load (t/a/yr)} - \text{NB (t/a/yr)}}{\text{NB}} \times 100$$

The current sediment yield condition (percentage above natural background) of Trestle Creek was then analyzed to determine the most appropriate sediment yield target for the sediment impaired water bodies in the Pend Oreille Subbasin. Once the sediment yield target was defined, all other impaired water bodies within the Pend Oreille Subbasin were analyzed to determine watershed-specific current conditions, load allocations, and load reductions based on target conditions in Trestle Creek.

Through this method, a target of 42 percent above the natural background load was defined. Using this reference watershed approach, it is then assumed that if the sediment-impaired streams in the Pend Oreille Subbasin achieve a sediment yield condition similar to Trestle Creek (42 percent above background), it is anticipated that they ultimately will meet the target necessary to remove sediment as a pollutant source causing nonsupport of beneficial uses.

According to the method outlined above, the 42 percent above background target appears to be reasonable and protective of the beneficial uses of the watersheds in the Pend Oreille Subbasin. Therefore, the target load capacity for the sediment TMDLs in this report is set at 42 percent above natural background conditions.

Sediment Model Development

A method, specific to the Pend Oreille Subbasin, was developed to estimate the sediment load to select streams within this Subbasin. The method was developed to quantify the State

of Idaho's narrative sediment water quality standard. The method accounts for all land use types separately. By estimating the existing contributing sediment load by land use types, implementation strategies may be developed to manage sediment loads on a more site-specific basis. All attempts to model sediment load were intended to provide a relative rather than exact sediment yield.

Six different types of modeling or estimation techniques were used to quantify the sediment load to the streams in the Pend Oreille Subbasin, depending on the source of the eroded sediment.

- Sediment yield coefficients, derived from the literature and previous studies, were used to estimate the sediment load from forestland, harvested forestland, burned forestland, shrubland, and urban areas.
- Revised Universal Soil Loss Equation Version 2 (RUSLE 2) estimated erosion from agricultural and permanent pastureland.
- WEPP Roads calculated erosion from roads, paved and unpaved, at stream crossings.
- The McGreer Relationship approximated erosion from roads, other than at stream crossings.
- The Cumulative Watershed Effects reports provided data to estimate the sediment load due to mass wasting (landslides) events.
- Application of best professional judgment was used to estimate stream erosion due to narrowing of the stream channel near roadways (road encroachment).

The results of these models and methods were then synthesized using Excel spreadsheets, one for each watershed, and the existing sediment contribution from each source of sediment was estimated. The natural background sediment load was estimated, and the sediment load capacity of each watershed was approximated. Appendix A contains a detailed description of the modeling methodology and input data used to develop the load capacity and TMDL calculations.

Monitoring Points

The existing DEQ BURP network will be utilized for long-term evaluation of compliance for watersheds exceeding the sediment target. While specific targets for sediment reduction are set as guidelines, beneficial use support status will be determined using the current assessment method accepted by DEQ at the time the water body is assessed. Monitoring will be completed using BURP protocols and other available information to assess support status of beneficial uses. While specific reaches of each water body are impaired by sediment, sediment yield reductions will be required from the entire watershed to ultimately achieve full support status. As a result future monitoring at the water body specific BURP stations listed in Table 5-2 will be critical to understanding movement toward beneficial use support on a long-term basis. The location of each BURP station in Table 5-2 is shown in Section 2, Figure 2-3.

Table 5-2. BURP Monitoring Stations for Long-term Evaluation of Beneficial Use Support

Watershed Name	Assessment Unit	Water Body Name	BURP ID
Gold Creek	ID17010214PN034_02	Gold Creek	1998SCDAB031
North Gold Creek	ID17010214PN025_02 ID17010214PN025_03	North Gold Creek	1994SCDAA014
Sand Creek	ID17010214PN049_02 ID17010214PN049_03	Sand Creek	1998SCDAB016
	ID17010214PN052_02	Schweitzer Creek	1997SCDAA011
Upper Pack River	ID17010214PN041_02	Pack River	2003SCDAA019
	ID17010214PN041_03	Pack River	1998SCDAB029
		Pack River	1994SCDAA008*

* DEQ will determine if the wadable stream or large river protocol is appropriate for beneficial use assessment at this station location.

5.2 Load Capacity

The load capacity of a TMDL designed to address sediment-caused water quality impairment is complicated by the fact that the state's water quality standard is a narrative standard rather than a quantitative standard. In these Pend Oreille Subbasin watersheds, the sediment-impairing beneficial uses is large bedload material in some places, however, most of the sediment-causing impairment is fine sediment. Adequate quantitative measurements of the effect of excess sediment have not been developed. Given this difficulty, an exact sediment load capacity for each TMDL is difficult to ascertain. Attempts to model sediment yield within the each watershed are designed to achieve relative rather than exact sediment estimates.

The natural background sediment rate is the sediment yield within a watershed prior to anthropogenic influences. The natural background sediment load was calculated by multiplying the area of each watershed by the natural background coefficient (0.0234 tons/acre/year), based on forested conditions. The natural background sediment yield coefficient applied within the Pend Oreille Subbasin assumes that each watershed was entirely vegetated by coniferous forest. Table 5-3 summarizes the load capacity of each water body. This calculation establishes the estimated allowable target load or the water quality target for each watershed. In the case of Rapid Lightning Creek, the load capacity is higher than the estimated existing sediment load and therefore a TMDL is not required. (See Appendix A for more detail.)

Table 5-3. Load Capacity Summary

Watershed	Load Type	Watershed Area (acres)	Estimated Existing Load (tons/year)	Natural Background Load (tons/year)	Load Capacity at 42% above Background ¹ (tons/year)
Gold Creek	Sediment	7,747	390	181	257
North Gold Creek	Sediment	10,519	762	246	349
Rapid Lightning Creek	Sediment	30,985	1,014 ²	717	1,018
Sand Creek	Sediment	24,209	2,039	562	798
Upper Pack River	Sediment	48,467	2,309	970	1,377

¹Load capacity=natural background x 1.42

²No TMDL is required since Existing Sediment Load is approximately equal to Load Capacity.

Seasonality and Critical Conditions Affecting Sediment Load Capacity

Sediment from nonpoint sources is not delivered to streams seasonally. It is delivered episodically, primarily during high discharge events. These critical events typically occur during November through May; however, such events may not occur for several years. The return time is usually about 10 to 15 years.

Critical conditions are part of the analysis of load capacity. The beneficial uses are impaired due to chronic sediment conditions, further substantiating the need for these TMDLs to address annual sediment loads. The concept of critical conditions is difficult to reconcile with the impact caused by sediment. The critical condition concept assumes that under certain conditions, chronic pollution problems can become acute pollution problems. Therefore, it is important to ensure that acute conditions do not occur. The proposed sediment reductions in the TMDL will reduce the chronic sediment load and will also reduce the likelihood that an acute sediment loading condition will exist. It is in this way that critical conditions are accounted for in the TMDL.

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 must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a watershed), 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.

There are no wasteload allocations for National Pollution Discharge Elimination System (NPDES)-permitted point sources of sediment in the Pend Oreille Subbasin. All sources of sediment to surface waters within the Pend Oreille Subbasin are nonpoint sources. Using the modeling method summarized in Appendix A, natural background loading estimates were derived for each watershed. Then human-caused nonpoint source loading estimates were derived in the same manner. The sediment yield from forestland, burned forestland, harvested forestland, shrubland, urban areas and unpaved and paved roads were estimated using sediment yield coefficients which are listed in Appendix A. The model coefficients used for forestland assume that Forest BMPs and practices in compliance with the Idaho

Forest Practices Act or better are in place for harvest and forest road construction and maintenance. The sediment yields from grassland areas (permanent and agriculture) were estimated using the RUSLE2 erosion model. It was assumed there was no erosion from barren (rock) areas and water.

The sediment yield from roads at stream crossings were estimated using the Water Erosion Prediction Project (WEPP) Roads erosion model, and the sediment yield from other roads were estimated using the McGreer relationship and the CWE scores (if available) for the roads in each watershed. In all cases the sediment yield rates for paved roads were considered to be 50 percent less than the rate used for unpaved roads. The sediment delivered to the streams from mass wasting events was estimated from the CWE Assessment reports (if available), and a unit erosion rate was estimated to predict erosion of streambanks caused by road crossings. Appendix A describes these processes in detail and provides graphic representation of spatial data analysis conducted to calculate land use/land cover loading estimates by watershed. Estimated existing sediment loads expressed as annual averages for all nonpoint sources for Gold Creek, North Gold Creek, Rapid Lightning Creek, Sand Creek, Schweitzer Creek, and the Upper Pack River are summarized by land use/land cover type in Table 5-4.

Table 5-4. Estimated Annual Average Existing Sediment Loads for Each Watershed by Land Type

Land Type	EXISTING SEDIMENT LOAD ¹ (tons/year)				
	Gold Creek	North Gold Creek	Rapid Lightning Creek	Sand Creek	Upper Pack River
Forest ²	151	210	690	376	584
Forest - Harvested	0	435	4	0	398
Forest - Burned	0	0	0	0	0
Grassland-Agriculture	170	0	78	406	0
Grassland-Permanent	0	3	0	261	386
Shrubland ²	3	1	13	18	241
Urban	18	2	9	465	23
Unpaved Roads	31	72	108	347	255
Paved Roads	0	0	0	73	0
Mass Wasting-Natural ²	0	0	0	0	34
Mass Wasting-Anthropogenic	0	0	0	0	296
Road Encroachment	17	39	112	93	92
Total Existing Load	390	762	1,014	2,039	2,309

¹ Existing Sediment Load = Natural Background Load + Human-caused Nonpoint Sources Load

² Sediment sources defined as natural.

5.4 Load Allocation

The pollutant load allocation is the load capacity minus a margin of safety and natural background. A pollutant load allocation is composed of the wasteload allocation of point sources and the load allocation for nonpoint sources. Since there are no sediment contributions from NPDES-permitted point sources, the wasteload allocation for all the TMDLs in this document is zero. These sediment TMDLs establish load allocations for nonpoint sources only.

Load allocations and reductions were modeled for each watershed and are summarized in Table 5-5. The allocations and percent reduction goals are based on the modeled estimate of nonpoint source sediment contribution and the watershed-specific reduction necessary to maintain loads below the load capacity, which was set at 42 percent above natural background conditions. (See Appendix A for a more detailed description of the derivation of the load allocations and reductions and a description of the conversion from average annual sediment loads (tons/year) to maximum daily sediment loads (lbs/day).)

Load allocations and percent reduction goals were also calculated for each type of land owner and are summarized in Tables 5-6 through 5-9. Further discussion on steps taken to allocate sediment load between landowners or resource managers along with a detailed breakdown of modeled land use type contribution can be found in Appendix A. The load reduction required for each land owner/resource manager is based on the difference between the estimated existing sediment contribution from each land use within each ownership category and the load capacity of the watershed at 42 percent above natural background. The background load is not treated as part of the load capacity and is not allocated as part of the TMDL..

The Pack River Watershed Council is an active group working in the Pack River watershed to reduce pollutant loads. Their involvement will help to achieve goals outlined in the TMDL. DEQ will also continue to be involved with public and agency groups working to reduce sediment loads within the Pack River watershed. In Tables 5-6 through 5-9 varying time frames (15-30 years) for meeting the pollutant load allocations have been listed. For certain land management categories where sediment load reduction requirements are small (≤ 5 tons per year) a shorter time frame of 15 to 20 years may be achievable. Land managers should support the premise that pollutant load reductions may be achieved sooner where implementation strategies are targeted in areas where annual average sediment load reductions are 5 tons per year or less.

Table 5-5. Summary of Pollutant Load Reductions Required by Watershed

Watershed	Watershed Area (acres)	a	Estimated Existing Load (lbs/day)	b	Load Capacity at 42% above Background (lbs/day)	(a-b)	Required Sediment Load Reduction (lbs/day)	(a-b)/a x 100
		Estimated Existing Load (tons/year)		Load Capacity at 42% above Background (tons/year)		Required Sediment Load Reduction (tons/year)		Percent Load Reduction Required
Gold Creek	7,747	390	6,797	257	4,476	133	2,321	34%
North Gold Creek	10,519	762	13,285	349	6,093	412*	7,192	54%
Sand Creek	24,209	2,039	35,566	798	13,915	1,241	21,650	61%
Upper Pack River	48,467	2,309	40,275	1,364	23,787	945	17,989	41%
Rapid Lightning Creek	30,985	1,014	17,684	1,018	17,757	0**	0**	0%**

*Value varies from difference between column "a" and column "b" due to rounding error.

** Sediment determined not to be a pollutant of concern based on model.

Table 5-6. Sediment Load Allocations and Load Reductions Required for Land Managers in Gold Creek Watershed

Land Managers	Area (acres)	Existing Load (tons/year)	Existing Load (pounds/day)	Required Sediment Load Reduction (tons/year)	Required Sediment Load Reduction (pounds/day)	Time Frame for Meeting Allocations
Private	6,829	352	6,136	124	2,158	30 Years
County (Roads)	0***	10	166	5	94	15 Years
USFS	875	27	477	4	69	15 Years
Total	7,747*	390**	6796**	133	2,321	

*The State also owns 43 acres in this watershed, but it was not included because they have no required sediment load reduction.

**The State has an existing sediment load of 1 tons/year (17 lbs/day) and a required sediment load reduction of 0 tons/year (0 lbs/day), but it was not included because the required sediment load reduction is 0 tons/year.

*** Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table 5-7. Sediment Load Allocations and Load Reductions Required for Land Managers in North Gold Creek Watershed

Land Managers	Area (acres)	Existing Load (tons/year)	Existing Load (pounds/day)	Required Sediment Load Reduction (tons/year)	Required Sediment Load Reduction (pounds/day)	Time Frame For Meeting Allocations
Private	18	2	35	1	20	15 Years
USFS	10,498	760	13,248	411	7,171	30 Years
Total	10,516*	762	13,284**	412	7,191	

*The Military also owns 3 acres in this watershed, but it was not included because they have no required sediment load reduction.

**Total value varies from sum of individual values due to rounding error.

Table 5-8. Sediment Load Allocations and Load Reductions Required for Land Managers in Sand Creek Watershed

Land Managers	Area (acres)	Existing Load (tons/year)	Existing Load (pounds/day)	Required Sediment Load Reduction (tons/year)	Required Sediment Load Reduction (pounds/day)	Time Frame For Meeting Allocations
Private	16,523	1,648	28,738	1,075	18,752	30 Years
City of Sandpoint	4,000	164	2,852	55	953	30 Years
County Roads	0***	59	1,037	45	783	30 Years
State - IDL	758	53	916	29	503	30 Years
State – ITD Roads	0***	29	506	22	382	30 Years
BLM	1,997	65	1,128	15	269	30 Years
Total	24,209*	2,039**	35,563**	1,241	21,649**	

*The USFS also owns 931 acres in this watershed, but it was not included because their sediment load reduction is less than 0.5 tons/year.

**The USFS has an existing sediment load of 22 tons/year (386 lbs/day) and a required sediment load reduction of less than 0.5 tons/year (7 lbs/day), but it was not included because the required sediment load reduction is less than 0.5 tons/year. The total value varies from the sum of individual values due to rounding error.

*** Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table 5-9. Sediment Load Allocations and Load Reductions Required for Land Managers in the Upper Rack River Watershed

Land Managers	Area (acres)	Existing Load (tons/year)	Existing Load (pounds/day)	Required Sediment Load Reduction (tons/year)	Required Sediment Load Reduction (pounds/day)	Time Frame For Meeting Allocations
Private	7,339	336	5,858	118	2,055	30 Years
County Roads	0**	15	258	9	162	30 Years
State	327	6	104	3	51	15 Years
USFS	40,598	1,946	33,942	814	14,203	30 Years
BLM	203	6	109	1	17	15 Years
Total	48,467	2,309	40,272*	945	16,487*	

*Total value varies from sum of individual values due to rounding error.

** Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Margin of Safety

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs include a margin of safety. The margin of safety is a conservative measure incorporated into the TMDL equation that accounts for the uncertainty associated with calculating the allowable sediment loading to ensure beneficial uses are attained. EPA guidance allows for use of implicit or explicit expressions of the margin of safety, or both. When conservative assumptions are used in development of the TMDL, or conservative factors are used in the calculations, the margin of safety is implicit. When a specific percentage of the TMDL is set aside to account for uncertainty, then the margin of safety is considered explicit.

Because the measure of sediment entering a stream throughout an entire watershed is a difficult and inexact science, assigning an arbitrary explicit margin of safety would add more error to the analysis. Therefore, the margin of safety for these sediment TMDLs in the Lake Pend Oreille Subbasin is implicit. The margin of safety is derived from conservative assumptions and estimates made in the model construction and application, which results in conservatively high estimates of sediment yield to surface water. Conservative estimates were made in the development of all land use type sediment yield coefficients. The conservative assumptions utilized in the modeling combine to provide an implicit margin of safety that over predicts sediment yield estimates to streams. A summary of the various assumptions that support an implicit margin of safety are provided in Table 5-10. Given the conservative assumptions used in the modeling approach, no additional explicit margin of safety is necessary as part of the TMDL calculations.

Table 5-10. Conservative Assumptions

	CONSERVATIVE ASSUMPTIONS
1	The McGreer relationship, comparing CWE Road Score and road erosion, was developed for roads on a Kaniksu granitic terrain, while it is being applied to a Belt terrain in this study. This overestimates the sediment yield from the roads.
2	Roads, further away than 200 feet from a stream, will have a delivery ratio of 10%.
3	Roads within 200 feet of a stream will have a delivery ratio of 80%.
4	Roads within 200 feet of a stream crossing will have a delivery ratio of 100%, an 8% grade to the stream, and have an insloped bare ditch.
5	Riparian areas have the same erosion rate as forested land. The actual erosion rate is lower because in riparian areas the topography will be flatter and have more grasses that will reduce erosion significantly
6	If the date of the landslide is not know it will be assumed to have occurred 10 years ago and the average annual sediment contribution will be divided by 10 years. In reality, the anthropogenic slides could have occurred 150 years ago. Also, erosion will occur at a much higher rate directly after the event, and as time goes on the rate will decrease. Assuming a straightline erosion rate is conservative.
7	The initial assumption for the sediment yield rate from forested land is 0.0234 tons per acre per year. This was developed for the Belt Supergroup so it is a conservative assumption for this terrain.
8	Assume delivery ratio from forest land to the streams is 100%.
9	Assume erosion from urban area is 0.25 tons per acre per year
10	The natural background sediment yield was based on the assumption that the land cover of each watershed is 100 percent forested.
11	Normally accelerated rates of erosion typically do not persist for more than several after revegetation, assigning an above background sediment yield coefficient to harvested forestland is a conservative estimate after several years.
12	Normally accelerated rates of erosion typically do not persist for more than several after revegetation, assigning an above background sediment yield coefficient to historic burns is a conservative estimate after several years.
13	It is assumed that streambank erosion occurs across the full width of a stream channel upstream and downstream of every road crossing
14	It is assumed that all erosion from grassland is delivered directly to a stream.
15	Simulation period of 30 years for WEPP Roads yielded an erosion rate from roads that was higher than average.
16	The Trestle Creek watershed is considered fully supportive of beneficial uses, so the Target % Above Background level was set by trial and error until the allowable sediment load was equal to the existing sediment load.

Seasonal Variation

Sediment from nonpoint sources is loaded episodically, primarily during high discharge events. These critical events coincide with the critical conditions that occur during November through May, generally during the rising limb of the annual hydrograph. Because of the episodic nature of sediment loading and the limitations modeling such events due to the number and uncertainty of factors involved in their occurrence, almost all models estimating sediment load predict average annual loads, which essentially averages high sediment load events with the periods of low sediment delivery (normally during the falling limb of the seasonal hydrograph) to arrive at an average annual sediment load. To estimate the total maximum daily sediment load, a method was developed to convert the average annual load to the total maximum daily load. It was assumed that the proportion of the maximum daily sediment load to the average annual sediment load is identical to the proportion of maximum daily flow to the average annual flow. Using this relationship, the average annual sediment load can be converted to the total maximum daily sediment load, which would occur at the end of May according to the daily flow hydrograph. Thus the seasonal variation in sediment loading is estimated by using the known seasonal variation in water flow. Appendix A discusses this process in more detail.

Reasonable Assurance

Given the large percentage of land in Upper Pack River, Trestle Creek, and North Gold Creek watersheds and other portions of the Pend Oreille Subbasin under USFS management, a high priority has been placed on forest management to improve bull trout habitat which should ensure implementation actions to reduce sediment loading. Sediment loads from private lands can be targeted through incentives provided to private land owners by the Bonner Soil and Water Conservation District and NRCS or grant programs administered by the IDEQ. The management committee formed by the Avista FERC Settlement Agreement has identified several tributaries in the Pend Oreille Subbasin as a priority bull trout restoration area, which should translate to the availability of significant management funds for watershed restoration projects.

Background

The background sediment loads for Gold Creek, North Gold Creek, Sand Creek, and the Upper Pack River are listed in Table 5-11 below. Natural background sediment yield was calculated by multiplying the watershed acreage by the sediment yield coefficient for forested land, and by adding the material contributed to surface waters from a naturally-occurring slide. The background load is not treated as part of the load capacity and is not allocated as part of the TMDL. Any unknown unallocated point sources would be included in the background portion of the load allocation.

Table 5-11. Background Sediment Load

Stream	Natural Background (tons/year)
Gold Creek	181
North Gold Creek	246
Sand Creek	562
Upper Pack River	970

Load Reserve

No part of the load allocation in these sediment TMDLs is held for additional future loading. There is no remaining available load for allocation. All future watershed management activities should be targeted to decrease sediment loads within each watershed.

Construction Storm Water and TMDL Wasteload Allocations

Construction Storm Water

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

The Construction General Permit

If a construction project disturbs more than 1 acre of land (or is part of larger common development that will disturb more than 1 acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan (SWPPP).

Storm Water Pollution Prevention Plan

To obtain the Construction General Permit (CGP) operators must develop a site-specific SWPPP. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically and maintain appropriate BMPs through the life of the project.

Construction Storm Water Requirements

When a stream is identified as impaired and has a TMDL developed, DEQ will incorporate a gross wasteload allocation for anticipated construction storm water activities. Since there are no construction outfalls, the wasteload allocation for sediment and other pollutants is zero. Typically, there are specific requirements that must be followed 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 BMPs from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is one source of information to meet the standards and requirements of the GCP. Local ordinances may have more stringent and site specific standards that are applicable. Permit applicants should contact the Coeur d'Alene Regional Office of DEQ for recommendations of construction BMPs that will be in compliance with the applicable TMDLs.

5.5 Implementation Strategies

DEQ and a designated management agency (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 designed 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 suspected sources of impairment and develop management actions appropriate to deal with these issues. Data gaps exist in the Pend Oreille Subbasin sediment model and are not expected to be filled in the near future. However, DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or significant progress is not being made toward achieving the goals.

Time Frame

For these sediment TMDLs at the watershed scale, 30 years has been allotted for meeting load allocations. For certain land management categories where sediment load reduction requirements are small (≤ 5 tons per year) a shorter time frame of 15 to 20 years may be achievable. This timeframe should permit one or two large channel forming events to occur in the stream, which should be needed to remove the excess fine sediment from the stream bottoms.

Approach

TMDLs will be implemented through continuation of ongoing nonpoint source management activities in the Pend Oreille Subbasin. In partnership with the WAG, DMAs and other appropriate managers are expected to:

- Develop BMPs for forestry, road maintenance, agriculture, urban storm water runoff, and bank stabilization to achieve load allocations.
- Adhere to existing sediment TMDL allocations and implementation plans (e.g., Clark Fork/ Pend Oreille Subbasin Assessment and TMDLs, 2001, 2004 Lake Pend Oreille Nearshore TMDL Implementation Plan) for other relevant assessment units that will advance sediment load reductions required by the TMDLs in this report.
- Refine selection and responsibility for the implementation of BMPS in areas currently classified as grasslands (permanent or agricultural) that have been converted or will be to developed land (urban).
- Give reasonable assurance that management measures will meet load allocations through both quantitative and qualitative analyses of management measures.
- Adhere to measurable milestones for progress.
- Implement an effective public education and outreach strategy to improve knowledge of those in the watersheds on how to advance sediment management strategies.
- Develop a timeline for 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 wasteload allocations are being met, and whether or not water quality standards are being met.

The designated management agencies will recommend specific control actions and will then submit the implementation plan to DEQ. The 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 designated management agencies, the public, the Pack River Watershed Council, the WAG, and other organizations, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical.

Monitoring Strategy

In-stream monitoring of the beneficial uses (cold water and salmonid spawning) support status during and after implementation of sediment abatement projects will establish the final sediment load reduction required by the TMDL. Data quality objectives that support evaluation of BMPs will be defined by DEQ and reviewed with the WAG. Monitoring will be conducted using the DEQ-approved monitoring procedure at the time of sampling. Identical measurements will be made in appropriate reference streams where beneficial uses are supported.

5.6 Conclusions

Based on the results from the modeling of a reference watershed (Trestle Creek), a sediment load capacity target of 42 percent above natural background conditions was set for Gold Creek, North Gold Creek, Rapid Lightning Creek, Sand Creek, Schweitzer Creek, and the Upper Pack River. The natural background sediment load was developed by classifying the land use type as forestland, determining the associated acreage from a geographical information system (GIS) analysis, and multiplying the designated acreage by a sediment yield coefficient specific to forestland. Modeling attempts by DEQ Coeur d'Alene regional office on the Kootenai/Moyie Rivers, St. Joe River, and the Lower Clark Fork River have generated a similar sediment yield target, and have been found to be protective of beneficial uses while allowing for an acceptable margin of safety.

All sediment loads allocated within the Pend Oreille Subbasin are allocated to nonpoint sources. No allocation is allotted for point sources of sediment. Sediment load allocations were allocated to resource managers and landowners based on the amount of sediment load from their land and the modeled land use types within the watershed. This report provides the required outcomes necessary to meet the federal regulations and guidance for TMDLs. The outcomes are summarized in Table 5-12. Since the TMDLs are established based on land use categories and land management responsibilities, the sediment TMDL required for Hellroaring Creek is incorporated within the TMDL calculations for the Upper Pack River. Likewise while a specific TMDL for McCormick Creek was deemed unnecessary as an outcome of the stressor identification reports, pollutant load reductions for McCormick Creek are nonetheless included in the sediment TMDL calculations for Upper Pack River since the entire Upper Pack River watershed was model as one watershed. Any reductions in sediment loading from the McCormick Creek watershed will further advance the sediment load reductions set by the TMDL for Upper Pack River. While only the mainstem of Sand Creek and Schweitzer Creek were validated as impaired, thus warranting TMDLs, additional TMDLs were established for other assessment units in the Sand Creek watershed including Sand Creek (ID17010214NP048_03 and _03a), Jack Creek (ID17010214NP050_02), Swede Creek (ID17010214NP051_02), and Little Sand Creek (ID17010214NP053_02). Sediment reductions in these assessment units will advance the success of achieving the sediment load allocations established for the Sand Creek watershed.

Based on the modeling results and the demonstration that the existing sediment load for Rapid Lightning Creek is below the load capacity, a sediment TMDL is not necessary for this assessment unit. However, Rapid Lightning Creek must still adhere to the sediment allocation established for the watershed in accordance with the Pack River sediment TMDL set forth in the 2001 DEQ *Clark Fork/Pend Oreille Subbasin Assessment and TMDLs* (IDEQ 2001).

Table 5-12. Sediment TMDL Outcomes

Water Body Name	Assessment Unit	Pollutant	TMDL(s) Complete	Recommended Changes to Integrated Report	Justification
Upper Pack River	ID17010214PN041_02 ID17010214PN041_03	Sediment	Yes	Move to Section 4a*	TMDL Completed
McCormick Creek	ID17010214PN042_02	Sediment	No	Remove unknown as pollutant	Stressor ID report verified that sediment was not the cause of nonsupport of CWAL
Hellroaring Creek	ID17010214PN044_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Sand Creek	ID17010214PN049_02 ID17010214PN049_03 ID17010214PN048_03 ID17010214PN048_03a	Sediment	Yes	Move to Section 4a*	TMDL Completed
Jack Creek	ID17010214PN050_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Swede Creek	ID17010214PN051_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Schweitzer Creek	ID17010214PN052_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Little Sand Creek	ID17010214PN053_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
Gold Creek	ID17010214PN034_02	Sediment	Yes	Move to Section 4a*	TMDL Completed
North Gold Creek	ID17010214PN025_02 ID17010214PN025_03	Sediment	Yes	Move to Section 4a*	TMDL Completed

* Section 4a of the Integrated Report is "Impaired Waters with a Completed TMDL."

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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.

Adfluvial

Describes fish whose life history involves seasonal migration from lakes to streams for spawning.

Algae

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

Alluvium

Unconsolidated recent stream deposition.

Aquatic

Occurring, growing, or living in water.

Aquifer

An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.

Assemblage (aquatic)

An association of interacting populations of organisms in a given water body; for example, a fish assemblage or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).

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.

Batholith

A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.

Bedload

Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.

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.

Biological Integrity

1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).

Biota

The animal and plant life of a given region.

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.

Community

A group of interacting organisms living together in a given place.

Conductivity

The ability of an aqueous solution to carry electric current, expressed in micro (μ) mhos/centimeter at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.

Cretaceous

The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.

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.
Ecology	The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.
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.
Ecosystem	The interacting system of a biological community and its non-living (abiotic) environmental surroundings.
Effluent	A discharge of untreated, partially treated, or treated wastewater into a receiving water body.
Endangered Species	Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.
Environment	The complete range of external conditions, physical and biological, that affect a particular organism or community.
Erosion	The wearing away of areas of the earth's surface by water, wind, ice, and other forces.
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 <i>Water Quality Standards and Wastewater Treatment Requirements</i> (IDAPA 58.01.02).

Feedback Loop	In the context of watershed management planning, a feedback loop is a process that provides for tracking progress toward goals and revising actions according to that progress.
Flow	See <i>Discharge</i> .
Fluvial	In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.
Focal	Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.
Geographical Information Systems (GIS)	A georeferenced database.
Gradient	The slope of the land, water, or streambed surface.
Ground Water	Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.
Growth Rate	A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population.
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.

Hydrology

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

Impervious

Describes a surface, such as pavement, that water cannot penetrate.

Intergravel Dissolved Oxygen

The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.

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.

Key Watershed

A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations.

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.

Loam

Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.

Macroinvertebrate

An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500 µm 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 uncertainty about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.

Mass Wasting

A general term for the down slope movement of soil and rock material under the direct influence of gravity.

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.

Milligrams per Liter (mg/L)

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

Million Gallons per Day (MGD)

A unit of measure for the rate of discharge of water, often used to measure flow at wastewater treatment plants. One MGD is equal to 1.547 cubic feet per second.

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 Assessed (NA)

A concept and an assessment category describing water bodies that have been studied, but are missing critical information needed to complete an assessment.

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.

Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.
Parameter	A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.
pH	The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.
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.
Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Protocol	A series of formal steps for conducting a test or survey.
Qualitative	Descriptive of kind, type, or direction.

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.
Resident	A term that describes fish that do not migrate.
Riffle	A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.
Riparian	Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.
River	A large, natural, or human-modified stream that flows in a defined course or channel or in a series of diverging and converging channels.
Runoff	The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.

Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.
Settleable Solids	The volume of material that settles out of one liter of water in one hour.
Species	1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
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.
Storm Water Runoff	Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.
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 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 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.

Total Dissolved Solids

Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS)

The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 microns or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Tributary

A stream feeding into a larger stream or lake.

Turbidity

A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

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 Pollution

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

Water Quality

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

Water Quality Criteria

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

Water Quality Limited

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

Water Quality Limited Segment (WQLS)

Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed."

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 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.

Water Body Identification Number (WBID)

A number that uniquely identifies a water body in Idaho and ties in to the Idaho water quality standards and GIS information.

Wetland

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

Appendix A. Understanding the Sediment Models

INTRODUCTION

In the panhandle region of Idaho, sediment is the pollutant of concern in many of the water quality limited streams. The lithology, or terrain of the region, governs the type of sediment. Two major types of terrain dominate in northern Idaho. These are the meta-sedimentary Belt Supergroup and granitics present either in the Kaniksu batholith or in smaller intrusions such as the Round Top Pluton and the Gem Stocks. In some locations, Columbia River Basalt formations are important, but these tend to be to the south and west; primarily on the Coeur d'Alene Tribal Reservation. Granitics mainly weather to sandy materials, but also weather to pebbles or larger-sized particles. Pebbles and larger particles with significant amounts of sand remain in the higher gradient stream bedload. The Belt terrain produces silt size particles, pebbles, and larger particles. Silt particles are transported to low gradient reaches, while the larger particles comprise the majority of the higher gradient stream bedload. Basalts erode to silt and particles similar in size to the Belt terrain. Large basalt particles are less resistant and erode into smaller particles.

A method, specific to the Pend Oreille Subbasin, was developed to estimate the sediment load to select streams within this Subbasin. The method was developed to quantify the State of Idaho's narrative sediment water quality standard. The method accounts for all land use types separately. By estimating the existing contributing sediment load by land use types, implementation strategies may be developed to manage sediment loads on a more site-specific basis. All attempts to model sediment load were intended to provide a relative rather than exact sediment yield.

MODELING METHODS

Six different types of modeling or estimation techniques were used to quantify the sediment load to the streams in the Pend Oreille Subbasin, depending on the source of the eroded sediment.

- Sediment yield coefficients, derived from the literature and previous studies, were used to estimate the sediment load from forestland, harvested forestland, burned forestland, shrubland, and urban areas.
- Revised Universal Soil Loss Equation Version 2 (RUSLE 2) estimated erosion from agricultural and permanent pastureland.
- WEPP Roads calculated erosion from roads, paved and unpaved, at stream crossings.
- The McGreer Relationship approximated erosion from roads, other than at stream crossings.
- The Cumulative Watershed Effects reports provided data to estimate the sediment load due to mass wasting (landslides) events.
- Application of best professional judgment was used to estimate stream erosion due to narrowing of the stream channel near roadways (road encroachment).

Results of these models and methods were then synthesized using Excel spreadsheets, one for each watershed, and the existing sediment contribution from each source of sediment was

estimated. The natural background sediment load was estimated, and the sediment load capacity of each watershed was approximated. The loading capacity calculations were based on the modeling results of a reference watershed, and the percent increase in sediment load above background levels that watershed could accept before the sediment would start to impair the beneficial uses of the stream. This target percentage above background was then used in each of the other watersheds to determine their load capacities. (A detailed description of how the target percentage was derived is found later in this chapter.) If the existing sediment load was greater than the load capacity of the watershed, then the amount that the existing sediment load needed to be reduced (sediment load reduction) was estimated for the watershed. A portion of the total sediment load reduction was then allocated to each land manager or owner (load allocation) for each sediment source within each watershed based on percent ownership within the individual watershed.

Sediment loading is a long-term process, and most calculations are performed on an average annual basis. To meet EPA requirements, a process was developed that converts the average annual sediment load to a total maximum daily load (TMDL). Each spreadsheet consists of between 35 and 40 worksheets to perform these analyses and summarize the data. (These spreadsheets are available electronically through DEQ.

EXISTING SEDIMENT LOAD

Sediment Yield Rates

The sediment loads from forestland, harvested forestland, burned forestland, shrubland, urban areas, and paved and unpaved roads were estimated using sediment yield coefficients applied to areas derived from Geographical Information System (GIS) data. Sediment yield coefficients estimate the sediment load delivered to streams from different land use/landcover types within each watershed. Values for sediment yield coefficients were obtained from literature, EPA-approved TMDLs, group discussions, and professional experience. These various sources provided a wide range in sediment yield coefficient values, and final values chosen for use in the model were based on best professional experience and judgment provided by DEQ and approved by the Pend Oreille Tributary Working Group. Due to the uncertainty in the coefficient values and the variability of the land being modeled, this method provides a relative, rather than exact, estimate of sediment yield within the basin. Table A-1 summarizes the sediment yield coefficients obtained from the literature.

Table A-1. Sediment Yield Coefficients

Location	Site Treatment	Sediment Yield (tons/acre/year)	Reference
Georgia Piedmont	Natural Harvest Roads	0.002 1.8 1.6	Hewlett 1979
North Carolina	Roller-Chop and Burn Shear Stumps, Windrow Slash Shear Stumps, Windrow Slash, Herbicide	1.8 1.8 4.5	Pye and Vitousek 1985
Southeast U.S.	Natural Harvest with Roads Burn Chop Chop and Burn Windrow Slash Disk	0.0 to 0.2 0.05 to 0.23 0.02 to 0.32 0.02 to 0.11 0.07 to 0.18 0.09 to 0.11 1.13 to 4.5	Burger 1983
Hubbard Brook Experimental Forest, NH	Natural Harvest and Herbicide	0.011 0.05	Hornbeck, <i>et al.</i> 1987
Fernow Experimental Forest, WV	Natural Harvest Natural Clearcut with unplanned road and no BMPs Clearcut with unplanned road with BMPs (1st year) Clearcut with unplanned road with BMPs (after 5 years)	0.05 0.02 0.0027 to 0.011 1.34 0.043 0.012 to 0.02	Aubertin and Patric 1972 and 1974 Patric 1980 and Kochenderfer, <i>et al.</i> 1987 Kochenderfer and Hornbeck 1999
Cherokee County, TX	Natural Harvest, Chop, and Burn Harvest, Shear, Windrow, and Burn	0.008 0.006 0.36	Blackburn, <i>et al.</i> 1986 Blackburn and Wood 1990
Gulf Coastal Mississippi	Natural Harvest, Chop, and Burn Harvest, Shear, and Windrow Harvest, Shear, and Windrow and Plow Beds	0.1 3.35 3.35 4.5	Beasley 1979
South Carolina	Natural Clearcut	0.01 0.07	Van Lear, <i>et al.</i> 1985
Sumter National Forest, SC	Low-Intensity Burn High-Intensity Burn	0.06 2.6	Robichaud and Waldrop 1994
Fraser Experimental Forest, CO	Natural Roads and Harvest (Fool Creek) Roads and Harvest (Deadhorse Creek)	0.018 0.005 0.014	Leaf 1974 Leaf 1974 Stottlemeyer 1987

Location	Site Treatment	Sediment Yield (tons/acre/year)	Reference
H.J. Andrews Experimental Forest, OR	Natural Clearcut	0.014 0.09	Sollins, <i>et al.</i> 1980
Ouachita Mountains, AR	Natural Harvest, Roller-Chop, and Burn Harvest, Selection Cut	0.005 0.09 0.018	Miller, <i>et al.</i> 1988
Silver Creek, ID	Clearcut with Buffer - 1st Year Clearcut with Buffer - 2nd Year	5.8 1.8	Clayton and Kennedy 1985
Beaver Creek, AZ	Natural Clearcut	0.009 to 0.09 0.14	Ward and Baker 1984 Heede and King 1990
Casper Creek, CA	Selective Clearcut	6.1	Krammes and Burns 1973
Drew County, AR	Natural Selection Cut Clearcut	0.002 0.005 0.12	Beasley and Granillo 1988
Clark County, AR	Natural Clearcut - Chemical Prep Clearcut - Mechanical Prep	0.03 0.11 0.24	Beasley, <i>et al.</i> 1986
Quebec, Canada	Natural	0.0067 to 0.034	Naiman 1982
Hawkes Bay, New Zealand	Natural During Harvest including road building 1st Year after Harvest 2nd Year after Harvest 3rd Year after Harvest 4th Year after Harvest 5th Year after Harvest 6th Year after Harvest	0.015 0.17 0.92 0.065 0.078 0.139 0.045 0.19	Fahey and Marden 2006
Colorado Front Range	Immediately after Forest Fire Four Years after Forest Fire	1000*Natural Erosion Rate 10*Natural Erosion Rate	Morris and Moses 1987
San Jacinto Mountains, CA	One Year after Forest Fire	18* Natural Erosion Rate	Wohlgemuth, <i>et al.</i> 2002
	Prescribed Burns Wildfires	0.4 to 2.6 9 to 49	Robichaud 2000
Northern Cascade Mountains	For 3 Years after Wildfires	0.1 to 0.8	Radek 1996
Eastern Oregon	First Year after Wildfire Second Year after Wildfire Fourth Year after Wildfire	9 to 22 About 0.09 to 2.2 0	Robichaud and Brown 1999
Ponderosa Pine Forest	Low Severity Fire after 3 years Moderate Severity Fire after 7 years High Severity Fire after 14 years	Erosion Rate Returned to Normal Erosion Rate Returned to Normal Erosion Rate	DeBano and Krammes 1996

Location	Site Treatment	Sediment Yield (tons/acre/year)	Reference
		Returned to Normal	
Salmon River, ID	Normal After Fire	0.36 2.5	Lundeen 1971
	Normal After Fire	0.67 1.9	Potts 1985

The land use/land cover data used to support the modeling is the 1992 National Land Cover Dataset provided by USGS (USGS 2006). At the time that the project began, this was the most current land use/land cover data set available. While a 2005 land use/land cover data set is now available through USGS, these data were not available until after the project began and after much of the analyses were performed. The Pend Oreille Tributary Working Group was made aware of this new set of data, but because the land use has remained relatively constant over the years and because of the delay it would cause in the project completion if the new data were utilized, it was decided to move forward and complete the TMDLs using the 1992 GIS dataset. The GIS data subdivided the watershed's land use and land manager categories. There were many different land use categories, so to make the modeling process more reasonable, these land use sub-categories were grouped into Forestland, Shrubland, Permanent Grassland, Agricultural Grassland, Urban, Barren, and Water. Roads were later added using data from DEQ, which were then supplemented with data from Bonner and Kootenai Counties. It was assumed that barren areas were rock and that erosion from these sites was negligible. Also, it was assumed that there would be no erosion from areas designated as "Water." Figures A-1 through A-4 depict roads and land use for each watershed. Figure A-5 displays the roads and land use for Trestle Creek, the reference watershed.

The land manager categories included Private, City of Sandpoint, County, State-IDL (Idaho Department of Land), State-ITD (Idaho Transportation Department), U.S. Forest Service (USFS), U.S. Bureau of Land Management (BLM), and Military. All land within each watershed was assigned a land use and land manager category. GIS data that depicted forest harvest history and forest fire history were also obtained from the USFS (See Figure 3-1 in Chapter 3 of the *Pend Oreille Tributaries Sediment TMDLs*).

After reviewing the literature, it appeared that a sediment yield coefficient of about 0.02 to 0.03 tons/acre/year was on the conservative side of an average for coniferous forestland. A value of 0.0234 tons/acre/year used in previous DEQ TMDL studies was calculated using the WATSED program. Because this value fell within the acceptable range of values, it was chosen as the sediment yield coefficient for calculating the Pend Oreille Tributaries Sediment TMDLs.

After reviewing the literature sources shown Table A-1, it is apparent that accelerated rates of erosion typically do not persist for more than about 4 years after a fire or harvest event because the forestland quickly revegetates. The model assumes that an accelerated erosion rate occurs for 10 years after a fire or harvest. The model coefficients used for forestland assume that Forest BMPs and practices in compliance with the Idaho Forest Practices Act or

better are in place for harvest and forest road construction and maintenance. Areas burned or harvested prior to 1997 were assigned the natural background coefficient. This is not to say the forest returned to natural conditions, but only that the erosion rate is the same as for a natural forest.

The erosion from harvested areas is greatest when the forest is first harvested and decreases over time as vegetation is reestablished. The same is true of burned areas. To simplify the modeling of burned and forested areas where the sediment yield rate vary continuously over this 10-year period, constant sediment yield rates were assigned to three distinct periods – fires and harvests that occurred between 2004 and 2006, fires and harvests that occurred between 2001 and 2003, and fires and harvests that occurred between 1997 and 2000. For harvested forest lands, the same sediment delivery coefficient was used regardless of whether the harvested area was on sloped or upland areas. This should be acknowledge as a conservative approach since the sediment delivery coefficient is based on the premise that all sediment generated from forest areas has the potential for delivery to a stream, whereas in an upland harvest area it is reasonable to assume that some of the sediment may be captured by riparian areas.

To the extent data were available, the effects of forest harvest practices on sediment yield rates were also considered. Using GIS, 21 different national forest harvest practices as catalogued by USFS were queried for application in the Idaho Panhandle National Forest to determine the extent of their use in the watersheds addressed in the Pend Oreille Tributaries Sediment TMDLs. Only the nine specific activities listed below were identified in conjunction with the harvesting periods for which data were available.

- Shelterwood cut (4131)
- Shelterwood cut (4133)
- Group selection cut (4152)
- Liberation cut (4211)
- Commercial thinning (4220)
- Sanitation (salvage) (4230)
- Sanitation cut (4232)
- Special cut (4240)
- Precommercial thinning – individual or selected trees (4521)

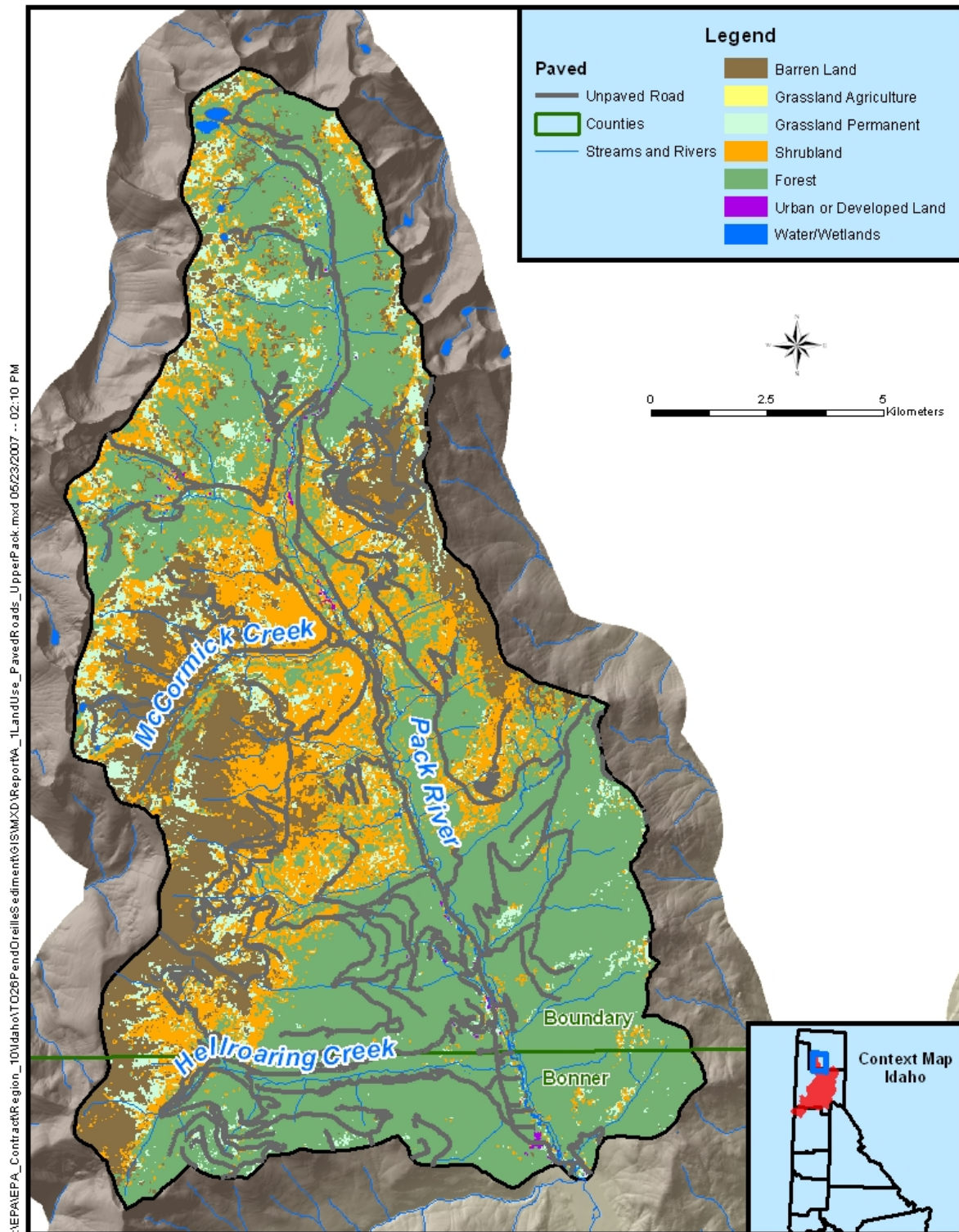


Figure A-1. Roads and Land Use for Upper Pack River Watershed

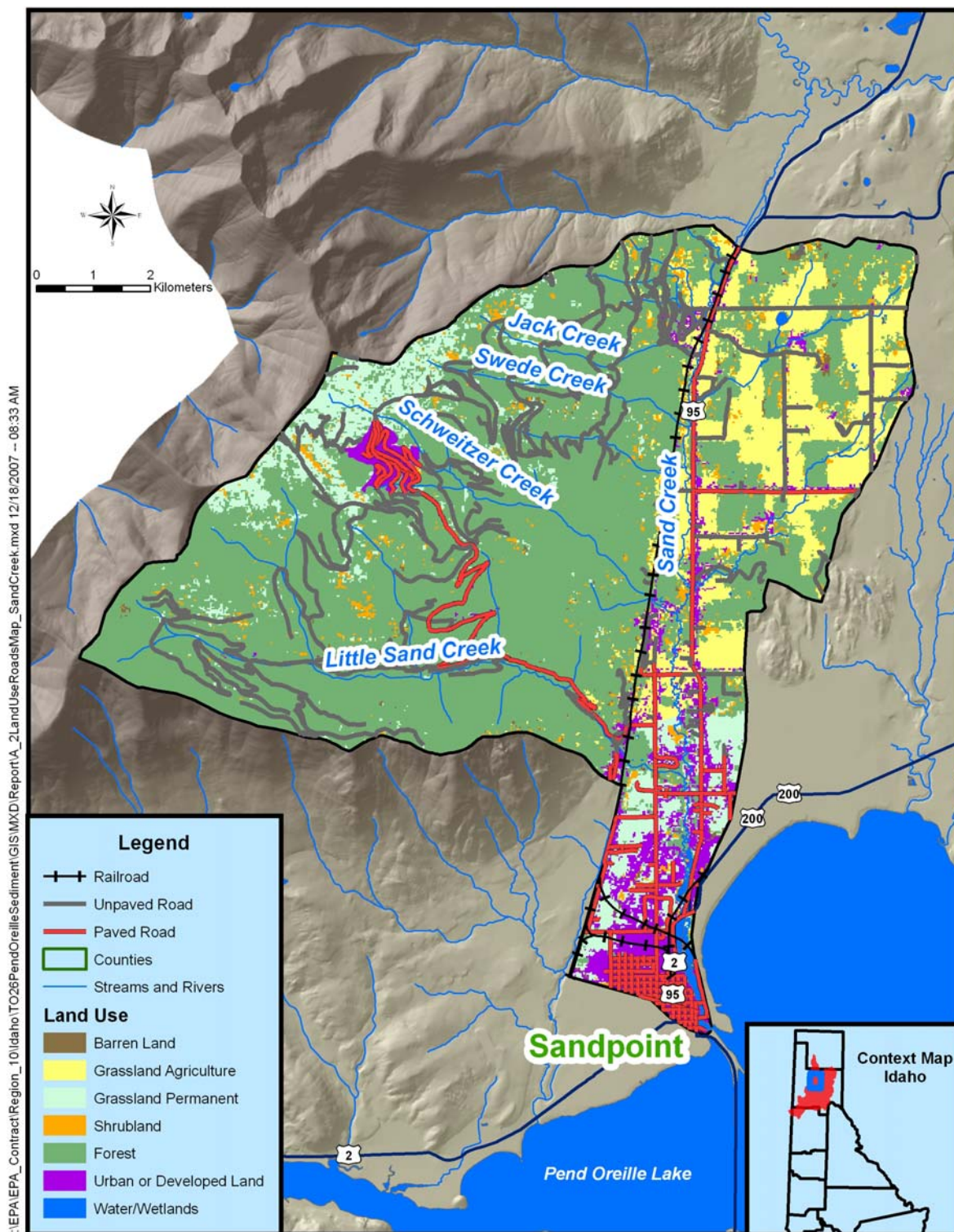


Figure A-2. Roads and Land Use for Sand Creek Watershed

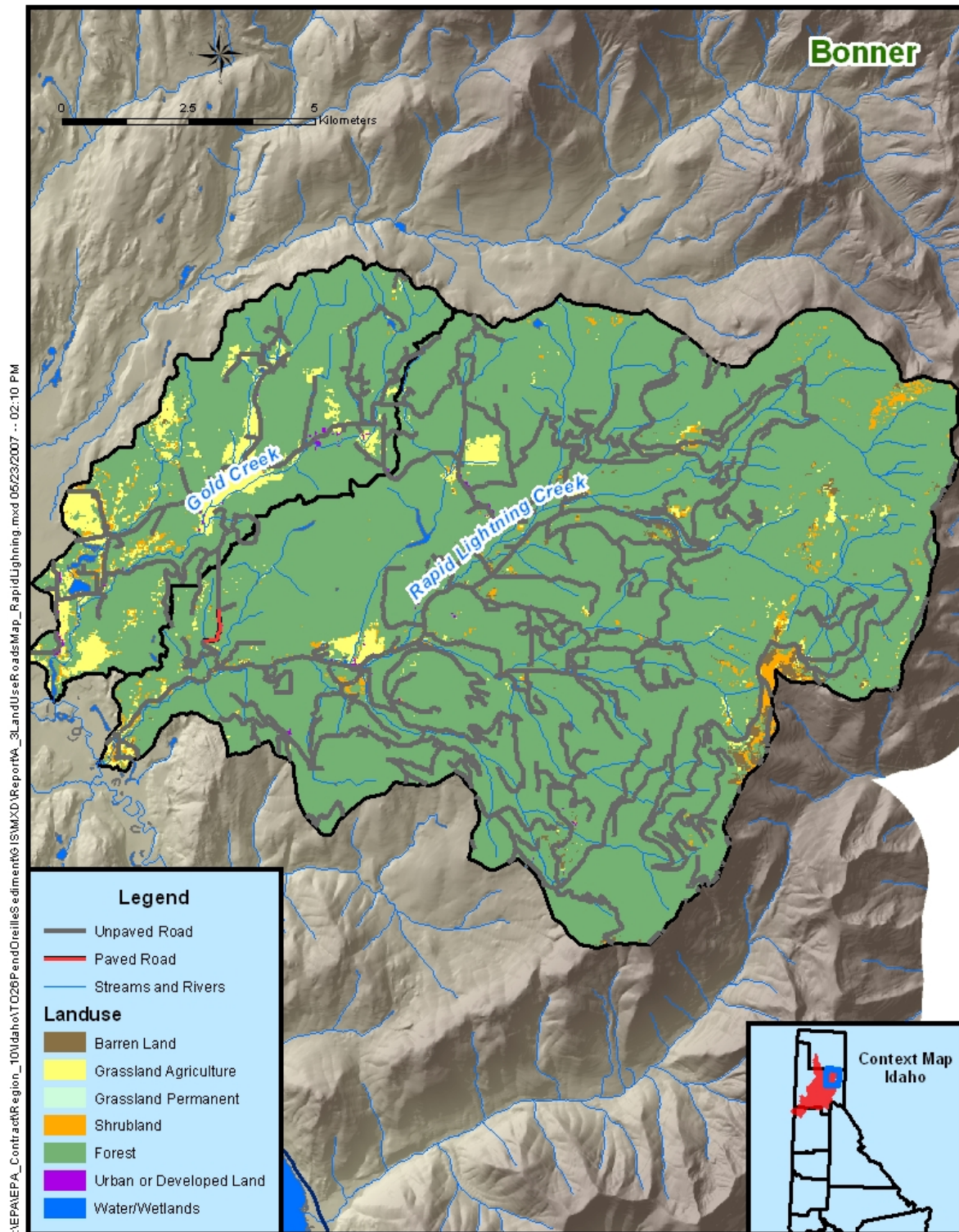


Figure A-3. Roads and Land Use for Gold Creek and Rapid Lightning Creek Watersheds

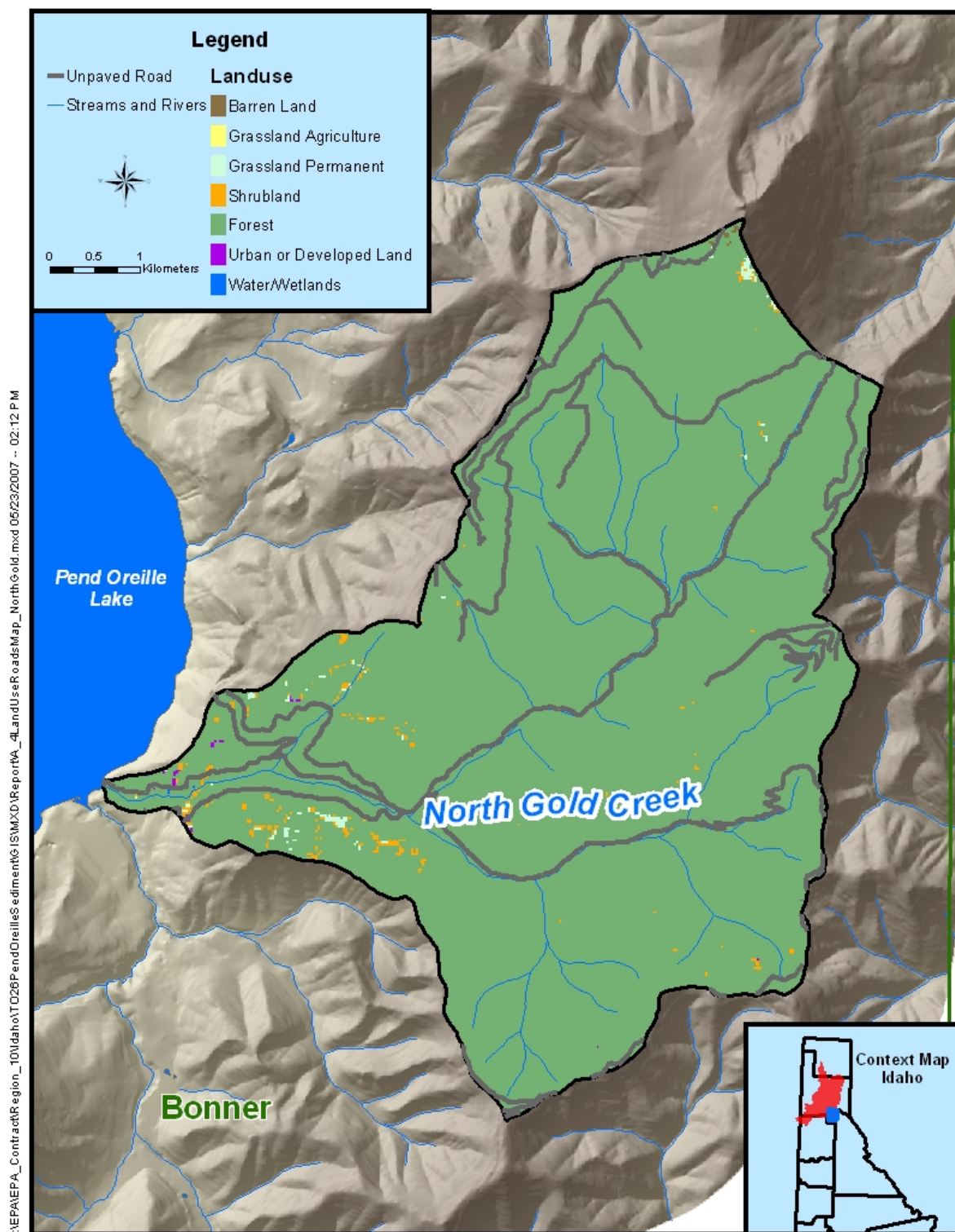


Figure A-4. Roads and Land Use for North Gold Creek Watershed

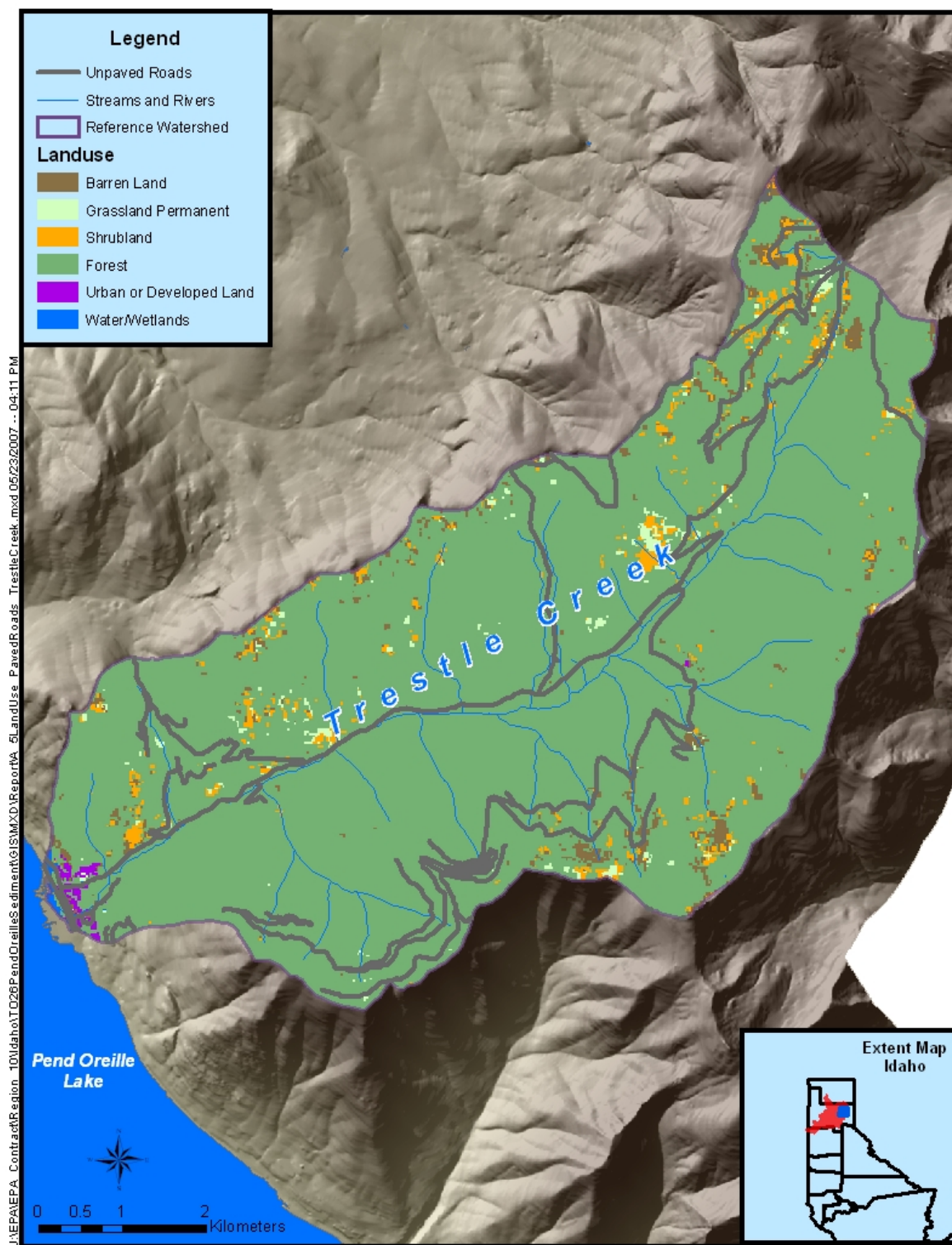


Figure A-5. Roads and Land Use for Reference Watershed - Trestle Creek Watershed

Sediment yield from urban areas is difficult to estimate. The value used in this study was developed from best professional judgment accounting for relevance with other land use types and was used in the development of sediment TMDLs for the Lower Clark Fork River (IDEQ 2007). Based on the literature sources in Table A-1 and best professional judgment, the sediment yield rate from shrubland is the same as from forestland.

All sediment yield coefficients are expressed as tons per acre per year (t/a/y) and are applied to the acreage of each land use and manager developed from the GIS coverage. Table A-2 shows the sediment yield rates for each type of land use.

Table A-2. Sediment Yield Rates from Nonpoint Sources

Land Type	Sediment Yield Rate (tons/acre/year)					
	Trestle Creek	Gold Creek	North Gold Creek	Rapid Lightning Creek	Sand Creek	Upper Pack River
Forest	0.0234	0.0234	0.0234	0.0234	0.0234	0.0234
Forest - Harvested (2004-2006)	1	1	1	1	1	1
Forest - Harvested (2001-2003)	0.1	0.1	0.1	0.1	0.1	0.1
Forest - Harvested (1997-2000)	0.05	0.05	0.05	0.05	0.05	0.05
Forest - Burned (2004-2006)	10	10	10	10	10	10
Forest - Burned (2004-2006)	1	1	1	1	1	1
Forest - Burned (2004-2006)	0.1	0.1	0.1	0.1	0.1	0.1
Grassland-Agriculture	-	0.16	-	0.16	0.13	-
Grassland-Permanent	0.31	-	0.11	-	0.12	0.095
Shrubland	0.0234	0.0234	0.0234	0.0234	0.0234	0.0234
Urban	0.25	0.25	0.25	0.25	0.25	0.25
Unpaved Roads @ Stream Crossings	0.94	0.94	2.80	0.94	7.74	2.80
Unpaved Roads W/In 200' of Stream but not at Stream Crossings	0.65	0.69	0.78	0.53	0.78	0.78
Unpaved Roads Greater than 200' from of Stream	0.08	0.09	0.10	0.05	0.10	0.10
Paved Roads @ Stream Crossings	0.47	0.47	1.40	0.47	3.87	1.40
Paved Roads W/In 200' of Stream but not at Stream Crossings	0.33	0.35	0.39	0.27	0.39	0.39
Paved Roads Greater than 200' from of Stream	0.04	0.05	0.05	0.03	0.05	0.05
Mass Wasting (tons/year)	5	0	0	0	0	296
Road Encroachment	4.54	4.54	4.54	4.54	4.54	4.54

RUSLE 2

RUSLE 2 was used to predict erosion from grassland within the basin. Grassland was divided into two uses – agricultural grassland and permanent grassland. Agricultural grassland was assumed to be disturbed every 10 years by plowing the ground and then re-seeding it. This also includes non-traditional agricultural grassland such as rural residential. The inclusion of rural residential grassland with agricultural grassland was an appropriate conservative assumption to apply since it is likely that over a 10-year period this grassland could reasonably be expected to be disturbed, thus generating more sediment load than

permanent grassland. Permanent grassland includes grass areas that remain relatively undisturbed, such as upland meadows.

RUSLE 2 does not take into account stream bank erosion, gully erosion, or scour erosion. Erosion rates were developed based on the soil, the characteristics of the agriculture, and the slope. Contour maps overlain with the land use maps are used to define the slope of the agricultural land, which is an important parameter in RUSLE 2. Detailed data on specific land management and soil conservation practices (*e.g.*, buffer strips, terraces) within each watershed were not available, so they were not input into RUSLE 2. As a result, it is assumed that runoff and the sediment it carries from grassland areas (agricultural or permanent) flows directly into the stream. As a corollary principle, it is assumed that once TMDL implementation is initiated, if it is found that soil erosion conservation practices have been in place, a credit for sediment load reductions achieved by existing BMPs can be incorporated into RUSLE 2 and quantified.

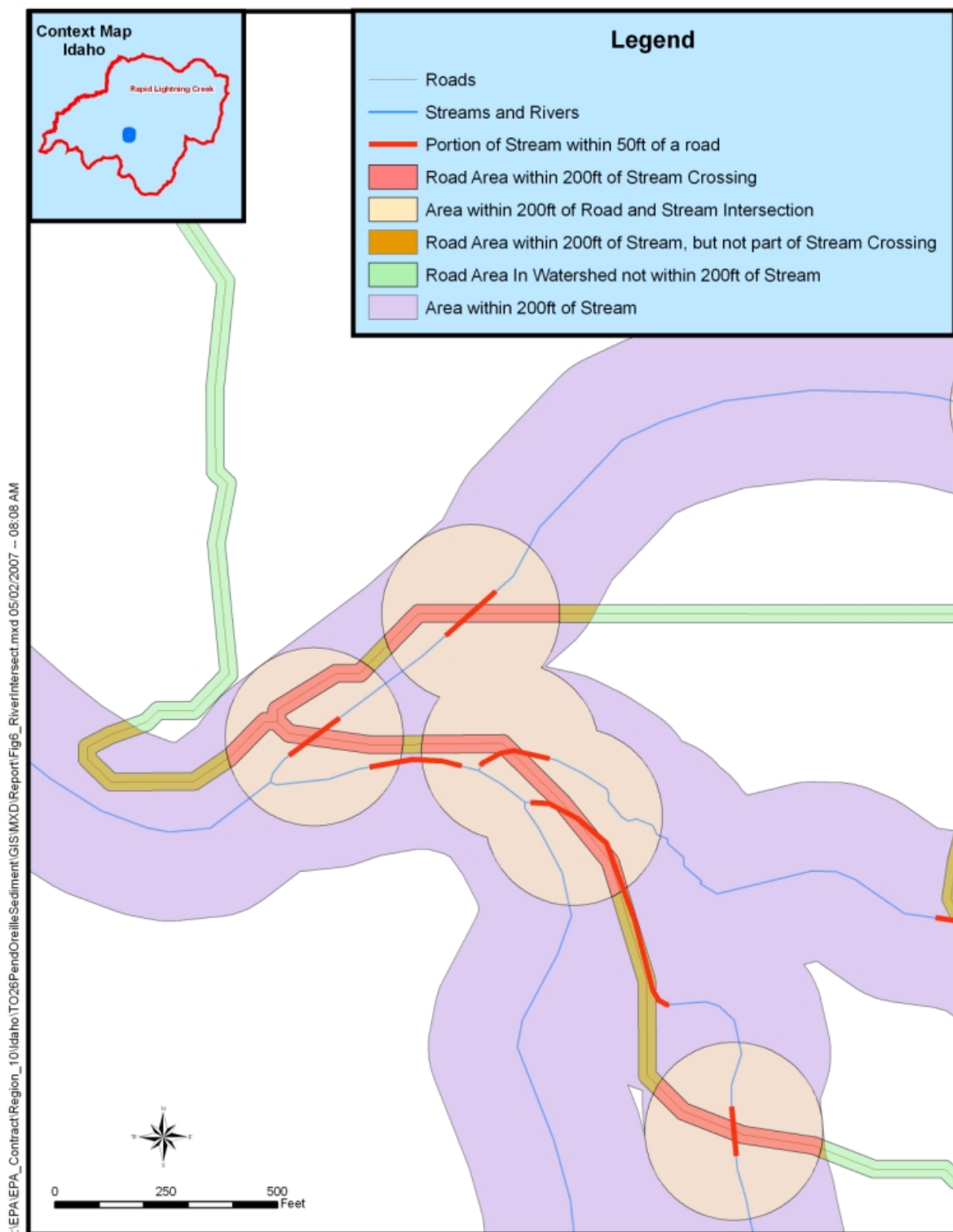
One of the inputs to the RUSLE 2 model is the length of the flow path through the grassland. In general, flat areas have longer flow lengths before encountering a stream, and steep areas have shorter flow lengths; therefore, it is assumed that the flow length for grassland areas with slopes less than 3 percent are 1,000 feet, the flow length for areas with slopes between 3 percent and 20 percent are 500 feet, and the flow lengths for areas with slopes greater than 20 percent are 300 feet. The DEQ electronic project file contains the input data and output for the RUSLE 2 model.

WEPP Roads

Roads were divided into three different sections – roads at stream crossings, roads within 200 feet of a stream but not within 200 feet of a stream crossing, and roads farther than 200 feet from a stream. Figure A-6 displays the different road sections evaluated to estimate sediment loading from paved and unpaved roads within each watershed.

The WEPP Roads computer model was used to estimate erosion from roads within 200 feet of a stream crossing. It was assumed that erosion from the road occurs within 200 feet of the stream on each side of the stream, and that the entire eroded amount enters the stream (delivery rate = 100 percent). It was assumed that unpaved roads consisted of native material, and the soil type, obtained from the soil maps, was matched to the soil textures provided in the model. Climate information for Sandpoint, Idaho was provided by the program and used in the model. The typical road section was based on field observations. The road width was assumed to be 40 feet, including the fill slope. The road slope toward the stream was assumed to be 8 percent. All roads were assumed to have “low” traffic volume except for Sand Creek, which assumed a “high” traffic volume. The simulation period was 30 years, which should provide a reasonable period of rainfall data. The DEQ electronic project file contains the input data and output for the WEPP Roads model.

The WEPP Roads program was used to calculate erosion from unpaved roads. The erosion rate used for paved roads at stream crossings was half the rate for unpaved roads at stream crossings. This rate was chosen using best professional judgment after a comprehensive review of the literature.



McGreer Relationship

Road scores, developed with the CWE protocol, were used to estimate erosion from unpaved roads within 200 feet of a stream but not at stream crossings and unpaved roads farther than 200 feet from a stream (IDL 2000). A relationship (the McGreer Relationship) was developed for roads on a Kaniksu granitic terrain in the LaClerc Creek watershed to estimate erosion based on the road's CWE score (McGreer 1998). Its application to roads on a Belt terrain conservatively estimates (overestimates) sediment yields from these systems. Road erosion rates were estimated using the relationship between the CWE road score and the sediment yield per mile of road (Figure A-7).

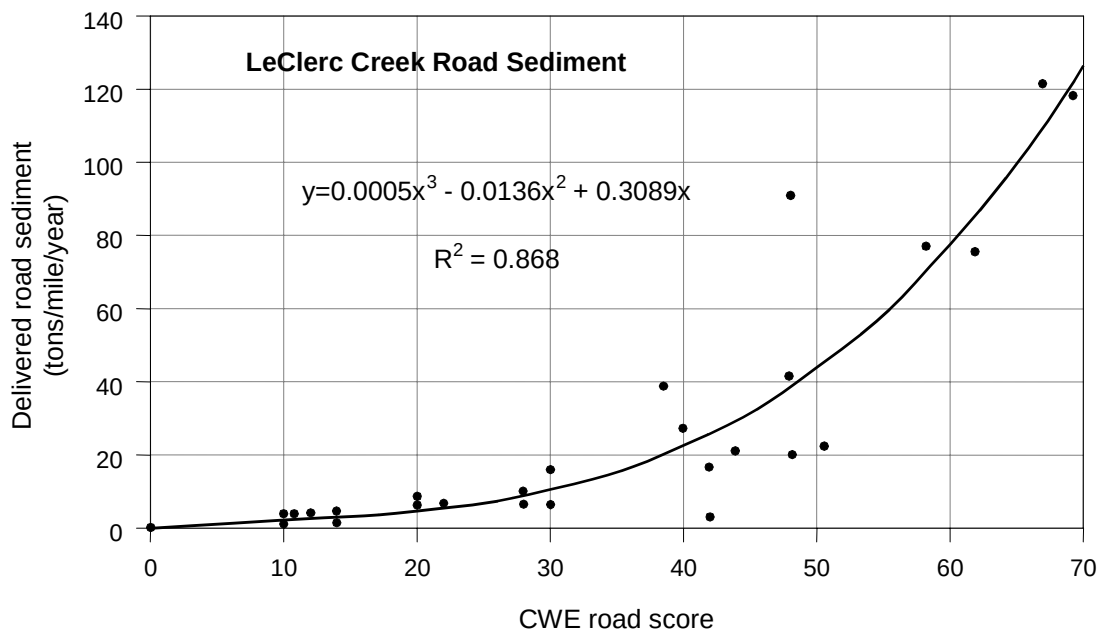


Figure A-7. Sediment Export from Roads Based on CWE Scores

It was assumed that unpaved roads within 200 feet of a stream but not within 200 feet of a stream crossing have a delivery percentage of 80 percent, or in other words, 80 percent of the eroded sediment is delivered to a stream. This is a conservative estimate of actual delivery. Unpaved roads at a distance farther than 200 feet from a stream have a delivery percentage of 10 percent.

There are CWE assessment reports for Gold and Rapid Lightning Creeks, but only a portion of the roads in the watersheds were evaluated to derive the road score. It was assumed that the CWE road score was appropriate for all roads in these two watersheds. North Gold Creek, Sand Creek, and the Upper Pack River did not have CWE assessment reports performed, and in these cases, the average road score for the state (20) was used.

The McGreer Relationship was used to calculate erosion from unpaved roads. The DEQ electronic project file contains the input data and output for these calculations. The erosion rate used for paved roads at stream crossings was half the rate for unpaved roads at stream crossings. This rate was chosen using best professional judgment after a comprehensive review of the literature.

CWE Data – Mass Wasting

The sediment yield from mass wasting events (landslides) was estimated from the IDL CWE assessment report data. Mass wasting events were classified into Anthropogenic (manmade) or Natural. If the failure type was listed as “cut” or “fill,” the slide was assumed to be an anthropogenic slide. From maps in the CWE assessment report, most of the anthropogenic mass wasting events appeared to be associated with roads.

If the failure type was classified as “other,” the slide was assumed to be a naturally occurring slide. Naturally occurring mass wasting events were allocated to natural background conditions and did not require a load reduction. Anthropogenic slides were allocated to land owners and managers or to road ownership.

The CWE assessment report provided data on the volume and delivery ratio of each mass wasting event that occurred in the watersheds studied in the CWE process. Gold Creek and Rapid Lightning Creek did not have any mass wasting events. Watersheds that did not have CWE data (Sand Creek and North Gold Creek) were assumed to have no mass wasting events. This does not mean that mass wasting did not occur, but that there were no data available to estimate mass wasting.

For the Upper Pack River, there were CWE data for several watersheds (McCormick, Homestead-Youngs, Hellroaring, Martin, Lindsey, and Jeru Creeks). For mass wasting events in these drainages, the volume of sediment delivered to the streams was estimated by multiplying the volume of the event by the delivery ratio. It was assumed that the entire volume of sediment would be delivered to the streams over a 10-year period, so the average annual sediment yield for each mass wasting event was calculated by dividing the total volume delivered by 10 years. Because the anthropogenic events seemed to be associated with roads, the average annual sediment yield for the mass wasting events was divided by the length of roads in the associated watersheds to get an estimate of sediment yield per mile of road in the watersheds. This unit sediment delivery for mass wasting events was then multiplied by the entire length of roads in the Upper Pack River. The DEQ electronic project file contains the input data and output for these calculations.

Stream Erosion

Roads cause stream sedimentation by an additional mechanism. The presence of roads in the floodplain of a stream often interferes with the stream’s natural tendency to meander and seek a steady state gradient. During high discharge periods, the constrained stream often erodes at the roadbed or, if the bed is armored, erodes at the opposite bank of its bed. The erosion resulting from a road-imposed gradient change results in stream sedimentation. The bulk of this erosion is assumed to occur during large discharge events, which occur on a 10- to 15-year return period (McClelland, *et al.* 1997). For each event, stream erosion is assumed to occur across the entire channel width and 3 feet up the bank on each side to a depth of one-quarter inch for the distance that the channel is within 50 feet of the road. This volume is divided by 10 years to get the average annual sediment yield rate due to road encroachment.

Streambank erosion also occurs from other causes, such as livestock accessing the stream, which can be a significant source of sediment in a watershed. Unfortunately, there is a lack of data on where streambank erosion is occurring and how much sediment is entering the

stream from these locations; therefore, the model does not account for streambank erosion other than near roads.

Existing Sediment Load

The existing sediment load to the streams in each watershed is determined by summing all the possible sources of sediment discussed above. Table 5-4 of the *Pend Oreille Tributaries Sediment TMDLs* provides a summary of the existing sediment load in each watershed and from each sediment source, and Tables 5-6 through 5-9 of that report summarize the existing sediment load from each land manager.

TARGET SELECTION

Although it is well understood that streams have the ability to process sediment levels above natural background levels, it is not well understood to what level this is possible before impairment occurs. Sediment load targets have been set at various levels to support TMDL development throughout northern Idaho. To determine the most appropriate target, each subbasin must be evaluated on an individual basis.

A reference (condition) stream was chosen to determine the appropriate sediment target to be used. A reference watershed, (watersheds generally supporting beneficial uses, or those assumed to be biologically functioning), was selected using local knowledge and input from the Pend Oreille Tributary Working Group. Trestle Creek, a tributary to Pend Oreille Lake, was selected as the reference stream for the development of sediment TMDLs in the Pend Oreille Subbasin for a variety of characteristics that demonstrate the stream is minimally impacted and is currently at a level supporting a robust native fish population. These characteristics, which are summarized in the *Lake Pend Oreille Key Watershed Bull Trout Problem Assessment*, (Corsi, *et al.* 1998) include:

- Trestle Creek is one of two streams in the Pend Oreille Subbasin with relatively consistent bull trout redd counts from 1983 to 1997.
- Trestle Creek supports one of the highest number of bull trout redds in the Pend Oreille Lake system.
- Of all the Pend Oreille Lake tributaries, Trestle Creek supports a bull trout population with the highest probability of persistence (95%) over the next 100 years.

Additionally, based on the Water Body Assessment Guidelines, Version 2, Trestle Creek demonstrates passing scores that further indicate the watershed displays a minimally impacted condition. Bull trout are highly sensitive to environmental disturbances at all life stages, and long-term population persistence is dependent upon five habitat characteristics: 1) cover, 2) channel stability, 3) substrate composition, 4) water temperature, and 5) availability of migratory corridors (Rieman and McIntyre 1993). Thus, given that Trestle Creek supports a robust bull trout population (as well as westslope cutthroat trout) it further suggests that habitat conditions in this stream provide a viable reference condition that can be effectively used to establish a water quality target for other Pend Oreille Lake tributaries not supporting cold water aquatic life use.

A method was developed to estimate the percentage that the existing sediment load was above the natural background sediment load in the Trestle Creek watershed. This would

establish the load capacity or water quality target for similar watersheds not supporting their cold water aquatic life or salmonid spawning uses.

The sediment yield target was derived from the current condition of Trestle Creek by modeling the watershed using the same method and input variables as those used for each impaired water body. Sediment yield coefficients were applied to each appropriate land use/land cover category in Trestle Creek and multiplied by the associated acreage. A sediment load value reflecting the minimally impacted condition of Trestle Creek was determined by multiplying the acreage of the watershed by the natural background sediment coefficient. The percentage above natural background was then derived by subtracting natural background conditions from current conditions, dividing by natural background conditions and then multiplying by 100.

Trestle Creek was identified as a reference watershed based on many characteristics and professionals working within the subbasin and was modeled independently and found to be supporting sensitive species at a current modeled sediment yield of 42 percent. Although 42 percent is the desired TMDL target, support status will be determined through continued monitoring and assessment conducted by the DEQ. Using this reference watershed approach, it is then assumed that if the sediment-impaired streams in the Pend Oreille Subbasin achieve a sediment yield condition similar to Trestle Creek, it is anticipated they ultimately will support their beneficial uses.

Rapid Lightning Creek was modeled using this method in addition to Gold Creek, North Gold Creek, Sand Creek, and the Upper Pack River. In the modeling effort for Rapid Lightning Creek, it was found that the existing sediment load of 1,014 tons/year was below its load capacity (1,018 tons/year); therefore, it was concluded that a sediment TMDL was not necessary for Rapid Lightning Creek. Other factors, such as increased temperatures, may be impacting aquatic communities within Rapid Lightning Creek as discussed in the stressor identification report. Even though Rapid Lightning Creek modeling demonstrated that current sediment loads are below the 42 percent above background level by only 4 tons/year, sediment may still be contributing slightly to the impairment of the stream.

Sediment yield rates for Trestle Creek are provided in Table A-2. The DEQ electronic project file contains the input data and output for the sediment load and load capacity calculations for Trestle Creek.

LOAD ALLOCATION

Sediment load reduction allocations were assigned to land owners and managers based on modeled land use types located within areas of ownership. The load reduction required for each land owner/manger was based on the difference between the existing sediment contribution and the sediment load capacity at 42 percent above natural background conditions. Steps were taken to allocate load reductions based on land use contributions to the excess sediment and the percent of the land use owned by each land owner. Sediment load contributions from forest (natural background), shrubland, and naturally occurring mass wasting events were not allocated as reductions.

After the existing sediment load was estimated, the next step was to approximate the natural background sediment load. The natural background sediment load is the amount of sediment that would enter the stream assuming the entire watershed was coniferous forest. Each

watershed was assumed to be covered in forest, except for barren area and water, and would have an erosion rate equal to 0.0234 tons/acre/year. Table 5-5 of the *Pend Oreille Tributaries Sediment TMDLs* summarizes these results, and the DEQ electronic project file contains the natural background load calculations for each watershed.

The load capacity was then estimated. The load capacity is the natural background sediment load multiplied by the allowable target percentage (42%) increase in sediment load above natural background. The target percentage increase was determined from Trestle Creek, the reference watershed discussed previously. Table 5-5 of the *Pend Oreille Tributaries Sediment TMDLs* summarizes these results, and the DEQ electronic project file contains the load capacity calculations for each watershed.

The next step was to determine the sediment load difference between the existing sediment load and the load capacity. If the existing sediment load was greater than the load capacity, then the required sediment load needed to be reduced by the difference to meet the target. This reduction was allocated based on the load contributed from different sediment sources and based on the land ownership. If the existing sediment load was less than the load capacity, then the modeled watershed was considered to be below the sediment TMDL target, and no sediment load reduction is required; however, it is possible that beneficial uses may still be impaired by other pollutants. This situation occurs in Rapid Lightning Creek.

The load reduction for each sediment source was then calculated. First, the sediment load from each sediment source/land use was calculated. Then, the percent of the sediment load attributed to each sediment source was computed. Finally, the sediment reduction allocation was determined by multiplying the percent of the sediment load attributed to each sediment source by the total load difference. This is the sediment reduction required from each sediment source.

Next, the sediment load reduction allocation per land use type was estimated. The anthropogenic existing sediment load from each type of land use was summed, not including Forestland, Shrubland, or natural mass wasting events. Each type of land use's percent contribution to the total existing anthropogenic sediment load was determined. The sediment load reduction allocation per type of land use is calculated by multiplying the total required sediment load reduction by the percent contribution of the anthropogenic sediment load contribution for each type of land use. The DEQ electronic project file contains the sediment load reduction allocation per land use type calculations for each watershed. The load reduction allocations for each watershed by land use/landcover category are summarized in Tables A-3 through A-6.

The reader should note that the areas associated with unpaved roads, paved roads, stream sections affected by road encroachment, and mass wasting locations are represented as zero in Tables A-3 through A-23 to avoid double counting the acreage associated with these sediment sources. Because the areas associated with these sediment sources are relatively small in comparison to the land use types (*i.e.*, Forestland, Shrubland, Grassland, *etc.*), their individual areas were not removed from the overall watershed acreage. If the area from these sediment sources was also included in the tables, the area would be accounted for twice, and the total acreage would not equal the actual total acreage for the watershed. Therefore, the amount of area that each of these eight sediment sources (there are three types of paved and unpaved roads each) derived from each of the 13 types of land uses were not included in the

tables below. Because the areas are small, it has little or no affect on the validity of the model. This assumption adds slightly to the margin of safety.

Table A-3. Load Allocations per Land Use for Gold Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Percent of Load	Sediment Load Reduction (tons/year)
Grassland-Agriculture	1,058	169	72	96
Urban	72	18	8	10
Unpaved Roads - Road Crossing	0**	9	4	5
Unpaved Roads - Within 200'	0**	12	5	7
Unpaved Roads - Exceeding 200'	0**	10	4	6
Road Encroachment	0**	17	7	10
Total	1,129*	235	100	133*

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-4. Load Allocations per Land Use for North Gold Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Percent of Load	Sediment Load Reduction (tons/year)
Forest - Harvested (04-06)	356	356	65	267
Forest - Harvested (01-03)	491	49	9	37
Forest - Harvested (97-00)	597	30	5	22
Grassland-Permanent	28	3	1	2
Urban	6	2	0	1
Unpaved Roads - Road Crossing	0**	31	6	23
Unpaved Roads - Within 200'	0**	27	5	21
Unpaved Roads - Exceeding 200'	0**	13	2	10
Road Encroachment	0**	39	7	29
Total	1,479*	550	100	412

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-5. Load Allocations per Land Use for Sand Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Percent of Load	Sediment Load Reduction (tons/year)
Grassland-Agriculture	3,124	406	25	306
Grassland-Permanent	2,172	261	16	197
Urban	1,862	465	28	351
Unpaved Roads - Road Crossing	0**	252	15	190
Unpaved Roads - Within 200'	0**	28	2	21
Unpaved Roads - Exceeding 200'	0**	67	4	51
Paved Roads - Road Crossing	0**	53	3	40
Paved Roads - Within 200'	0**	5	0	4
Paved Roads - Exceeding 200'	0**	15	1	11
Road Encroachment	0**	93	6	70
Total	7,157*	1,645	100	1,241

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-6. Load Allocations per Land Use for Upper Pack River

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Percent of Load	Sediment Load Reduction (tons/year)
Forest - Harvested (04-06)	387	387	27	252
Forest - Harvested (97-00)	215	11	1	7
Grassland-Permanent	4,061	386	27	252
Urban	94	24	2	15
Unpaved Roads - Road Crossing	0**	138	10	90
Unpaved Roads - Within 200'	0**	45	3	29
Unpaved Roads - Exceeding 200'	0**	72	5	47
Anthropogenic Mass Wasting	0	296	20	193
Road Encroachment	0**	92	6	60
Total	4,757	1,450*	100*	945

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

The sediment load reduction was then allocated to each land manager for each type of land use. The total existing anthropogenic sediment load for each type of land use is determined by summing the existing sediment load from each type of land manager and land use in the watershed. Each type of land manager's percent contribution to the total existing anthropogenic sediment load for each land use type was determined. The sediment load reduction allocation for each land manager for each type of land use was calculated by

multiplying the total required sediment load reduction for each land use by the percent contribution of the anthropogenic sediment load contribution for each owner and for each type of land use. The total sediment load reduction for each land manager is the sum of sediment load reductions for each land manager for each type of land use. Tables A-7 through A-9 show the landowner load reduction allocations for Gold Creek. Tables A-10 and A-11 provide the landowner load reduction allocations for North Gold Creek. Tables A-12 through A-18 contain the landowner load reduction allocations for Sand Creek. Tables A-19 through A-23 show the landowner load reduction allocations for the Upper Pack River. The DEQ electronic project file contains the sediment load allocations for each land owner/manager per land use type calculations for each watershed.

Table A-7. Sediment Load Reduction from Private Landowners in Gold Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Agriculture	1,052	168	2,934	95	1,658
Urban	72	18	313	10	177
Unpaved Roads - Road Crossing	0**	7	115	4	65
Unpaved Roads - Within 200'	0**	9	150	5	85
Unpaved Roads - Exceeding 200'	0**	7	114	4	64
Road Encroachment	0**	11	191	6	108
Total	1,123*	219*	3,817	124	2,158*

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-8. Sediment Load Reduction from County in Gold Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Unpaved Roads - Road Crossing	0**	2	32	1	18
Unpaved Roads - Within 200'	0**	2	39	1	22
Unpaved Roads - Exceeding 200'	0**	3	51	2	29
Road Encroachment	0**	2	44	1	25
Total	0	10*	166	5	94

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-9. Sediment Load Reduction from USFS in Gold Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Agriculture	6	1	17	1	10
Unpaved Roads - Road Crossing	0**	1	12	0	7
Unpaved Roads - Within 200'	0**	1	21	1	12
Unpaved Roads - Exceeding 200'	0**	0	6	0	4
Road Encroachment	0**	4	66	2	37
Total	6	7	122	4	69*

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-10. Sediment Load Reduction from Private Landowners in North Gold Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Unpaved Roads - Road Crossing	0**	1	15	1	11
Unpaved Roads - Within 200'	0**	0	4	0	3
Road Encroachment	0**	0	7	0	5
Total	0	1	27*	1	20*

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-11. Sediment Load Reduction from USFS in North Gold Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Forest - Harvested (04-06)	356	356	6,210	267	4,654
Forest - Harvested (01-03)	491	49	857	37	642
Forest - Harvested (97-00)	597	30	520	22	390
Grassland-Permanent	28	3	55	2	41
Urban	6	2	27	1	20
Unpaved Roads - Road Crossing	0**	30	524	23	393
Unpaved Roads - Within 200'	0**	27	474	20	355
Unpaved Roads - Exceeding 200'	0**	13	233	10	174
Road Encroachment	0**	38	670	29	502
Total	1,479*	549*	9,570	411	7,171

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-12. Sediment Load Reduction from Private Landowners in Sand Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Agriculture	3,110	404	7,050	305	5,321
Grassland-Permanent	1,917	230	4,012	174	3,028
Urban	1,796	449	7,828	339	5,908
Unpaved Roads - Road Crossing	0**	197	3,442	149	2,598
Unpaved Roads - Within 200'	0**	17	299	13	226
Unpaved Roads - Exceeding 200'	0**	49	851	37	642
Paved Roads - Road Crossing	0**	15	256	11	194
Paved Roads - Within 200'	0**	1	11	0	8
Paved Roads - Exceeding 200'	0**	4	70	3	53
Road Encroachment	0**	59	1028	44	776
Total	6,823	1,425	24,847	1,075	18,752*

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-13. Sediment Load Reduction from City of Sandpoint in Sand Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Agriculture	6	1	13	1	10
Grassland-Permanent	68	8	142	6	107
Urban	12	3	53	2	40
Unpaved Roads - Road Crossing	0**	33	580	25	438
Unpaved Roads - Within 200'	0**	8	137	6	103
Unpaved Roads - Exceeding 200'	0**	7	115	5	86
Paved Roads - Road Crossing	0**	4	76	3	57
Paved Roads - Within 200'	0**	0	5	0	4
Paved Roads - Exceeding 200'	0**	6	102	4	77
Road Encroachment	0**	2	41	2	31
Total	86	72	1,263*	55*	953

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-14. Sediment Load Reduction from County in Sand Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Unpaved Roads - Road Crossing	0**	10	175	8	132
Unpaved Roads - Within 200'	0**	2	36	2	27
Unpaved Roads - Exceeding 200'	0**	7	130	6	98
Paved Roads - Road Crossing	0**	24	425	18	321
Paved Roads - Within 200'	0**	1	13	1	10
Paved Roads - Exceeding 200'	0**	3	53	2	40
Road Encroachment	0**	12	205	9	155
Total	0	59	1,037	45*	783

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-15. Sediment Load Reduction from State (IDL) in Sand Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Permanent	90	11	188	8	142
Urban	54	14	235	10	178
Unpaved Roads - Road Crossing	0**	6	108	5	81
Unpaved Roads - Within 200'	0**	1	14	1	10
Unpaved Roads - Exceeding 200'	0**	2	43	2	33
Paved Roads - Road Crossing	0**	2	28	1	21
Paved Roads - Exceeding 200'	0**	0	8	0	6
Road Encroachment	0**	2	41	2	31
Total	144	38	667*	29	503*

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-16. Sediment Load Reduction from State (ITD) in Sand Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Paved Roads - Road Crossing	0**	8	138	6	104
Paved Roads - Within 200'	0**	3	58	3	44
Paved Roads - Exceeding 200'	0**	2	29	1	22
Road Encroachment	0**	16	282	12	213
Total	0	29	506*	22	382*

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-17. Sediment Load Reduction from USFS in Sand Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Permanent	4	1	9	0	7
Total	4	1	9	0	7

Table A-18. Sediment Load Reduction from BLM in Sand Creek

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Agriculture	8	1	18	1	14
Grassland-Permanent	93	11	194	8	146
Unpaved Roads - Road Crossing	0**	5	88	4	66
Unpaved Roads - Within 200'	0**	0	2	0	1
Unpaved Roads - Exceeding 200'	0**	2	34	1	26
Paved Roads - Exceeding 200'	0**	0	1	0	1
Road Encroachment	0**	1	19	1	14
Total	101	20	356	15	269*

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-19. Sediment Load Reduction from Private Landowners in Upper Pack River

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Permanent	345	33	572	21	373
Urban	37	9	161	6	105
Unpaved Roads - Road Crossing	0*	28	484	18	315
Unpaved Roads - Within 200'	0*	9	159	6	103
Unpaved Roads - Exceeding 200'	0*	17	295	11	193
Anthropogenic Mass Wasting	0	69	1,199	45	781
Road Encroachment	0*	16	283	11	185
Total	382	181	3,153	118	2,055

*Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-20. Sediment Load Reduction from County in Upper Pack River

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Unpaved Roads - Road Crossing	0**	3	52	2	34
Unpaved Roads - Within 200'	0**	1	26	1	17
Unpaved Roads - Exceeding 200'	0**	1	20	1	13
Anthropogenic Mass Wasting	0	5	90	3	58
Road Encroachment	0**	3	61	2	40
Total	0	14*	248*	9	162

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-21. Sediment Load Reduction from State (IDL) in Upper Pack River

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Permanent	47	4	78	3	51
Total	47	4	78	3	51

Table A-22. Sediment Load Reduction from USFS in Upper Pack River

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Forest - Harvested (04-06)	387	387	6,754	252	4,403
Forest - Harvested (97-00)	215	11	187	7	122
Grassland-Permanent	3,668	348	6,076	227	3,961
Urban	57	14	249	9	162
Unpaved Roads - Road Crossing	0**	108	1,875	70	1,222
Unpaved Roads - Within 200'	0**	34	597	22	389
Unpaved Roads - Exceeding 200'	0**	53	930	35	606
Anthropogenic Mass Wasting	0	221	3,859	144	2,516
Road Encroachment	0**	72	1,258	47	820
Total	4,327	1,249*	21,786*	814*	14,203*

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

Table A-23. Sediment Load Reduction from BLM in Upper Pack River

Land Type	Area Associated With Anthropogenic Sediment Load (acres)	Anthropogenic Sediment Load (tons/year)	Anthropogenic Sediment Load (pounds/day)	Sediment Load Reduction (tons/year)	Sediment Load Reduction (pounds/day)
Grassland-Permanent	2	0	3	0	2
Unpaved Roads - Exceeding 200'	0**	0	5	0	3
Anthropogenic Mass Wasting	0	1	18	1	12
Total	2	1	25*	1	17

*Total value varies from sum of individual values due to rounding error.

**Note: While roads are present, the acreage for roads is not provided because the area (acreage) is insignificant when compared to the overall area of the watershed.

UNIT CONVERSION

The methods described above determined the average annual sediment load in tons per year. It is also of interest to estimate the total maximum daily load of sediment. It was assumed that the sediment load is proportional to the stream flow, and the total maximum daily sediment load would occur at the same time as the maximum daily flow. It was further assumed that the ratio of the total maximum daily sediment load to the average annual sediment load is the same as the ratio of the maximum average daily flow volume to the average annual flow volume. The total maximum daily sediment load was estimated from the average annual sediment load by multiplying the ratio of the maximum average daily flow to the average annual flow by the average annual sediment load. The equation is shown below.

$$TMDL = \frac{MaximumDailyFlowVolume}{AverageAnnualFlowVolume} * AverageAnnualSed.Load$$

Because there is a lack of long term and reliable flow records for the Pack River and its tributaries, the Priest River was chosen to determine the ratio of maximum daily flow volume to average annual flow volume. It was assumed that the proportion of daily flow volume to average annual flow volume on the Pack River is the same as that on the Priest River. Flow data were obtained from the U.S. Geological Survey (USGS) Gage #12395000 on the Priest River near Priest River, Idaho. There were daily mean flow values for each day of the year for 56 years of records from October 1949 through September 2005. The DEQ electronic project file contains the analysis used to determine the conversion of average annual sediment load to total maximum sediment load.

ASSUMPTIONS

Because of the lack of data and the approximations needed to model any actual physical process, numerous assumptions were made, and are listed below.

1. Road prism width on forest haul roads is 40 feet, including ditch width and road fill width.
2. The “barren” land type is assumed to be rock in both pristine and existing conditions and, therefore, has no erosion.
3. Shrubland has the same erosion rate and sediment yield rate as forested land.
4. Riparian areas have the same erosion rate as forested land.
5. There have been no significant fires since 1967 and the area burned in 1967 has revegetated sufficiently so the erosion rate is the same as in pristine conditions.
6. If CWE data list Failure Type as “Cut Slope” or “Fill Slope,” then it is an anthropogenic landslide, and if the CWE data list Failure Type as “Other,” then it is a natural slide.
7. If the date of the landslide is not known it is assumed to have occurred 10 years previous, and the average annual sediment contribution is divided by 10 years.
8. Constructed forest haul roads remain in place even after timber is harvested.
9. Zero to 2 years after forest harvest, soil is disturbed and contains about 20 percent to 40 percent shrubs.
10. Three to 6 years after forest harvest, soil is undisturbed and contains about 50 percent shrubs/small trees.
11. Seven to 10 years after forest harvest, soil is undisturbed and contains 80 percent forest.
12. The initial assumption for the sediment yield rate from forested land is 0.0234 tons per acre per year. This was developed for the Belt Supergroup so it is a conservative assumption for this terrain. A literature search was performed and this value is within the normal range for sediment yield rate from forestland in the northwest.
13. The effect of road encroachment goes 50 feet upstream and downstream from road crossings, and removes a quarter inch of sediment from the stream cross-section once every 10 years.
14. The dimensions of the creeks in the watersheds used in the analysis are the assumed average dimensions for all creeks in the watershed, not just the mainstem.
15. Soil density is 100 pounds per cubic foot
16. The soil types, Boulder creek-Moss Variant-Lumberjack Variant and Andic Cryochrepts-Rock Outcrop-Marblecreek family, defined by STATSGO were not listed in RUSLE 2, so the Generic Loamy Sand soil type was used, which should best approximate the soil type.
17. In watersheds that had some CWE assessments performed on smaller sub-basins (*i.e.*, Upper Pack River), the sediment yield was estimated per mile of road in the CWE sub-basins and then this unit rate was applied to the entire watershed based on the length of roads in the watershed. Because the mass wasting events seemed to always be associated with roads, a sediment load per unit length of road was used to estimate sediment yield from mass wasting.
18. There are no other sources of streambank erosion except for road encroachment.

19. Erosion from forest roads farther away than 200 feet from a stream will be estimated by the McGreer Relationship and will have a delivery ratio of 10 percent.
20. Erosion from forest roads within 200 feet of a stream but not within 200 feet of a stream crossing will be estimated by the McGreer Relationship and will have a delivery ratio of 80 percent.
21. Forest roads within 200 feet of a stream crossing will be estimated using the WEPP Roads program and will drain into the stream with a 100 percent delivery ratio. The roads are assumed to have an 8 percent grade to the stream with a bare, insloped ditch. Soil type used in the model is based on soil type in the watershed.
22. Areas designated as Water have no erosion from them.
23. Accelerated rates of erosion typically do not persist for more than several years after forest fires because of revegetation, assigning an above background sediment yield coefficient to historic burns is a conservative estimate after several years.
24. The CWE assessment report only determines the road score for some of the roads in the watershed. It is assumed that the average score applies to all roads in the watershed.
25. Some of the watersheds did not have CWE assessment reports and, in these cases, the average road score for the state was used.

MARGIN OF SAFETY (MOS)

An implicit MOS is incorporated into the model design. Numerous conservative estimates were made in the model construction, which causes it to develop conservatively high estimates of sediment yield to surface water. Conservative estimates were made in the development of all land use type sediment yield coefficients. Table 5-10 in Chapter 5 of the *Pend Oreille Tributaries Sediment TMDLs* summarizes the conservative assumptions that when combined provide an implicit MOS that over-predicts sediment yield estimates to streams.

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Appendix B. Unit Conversion Chart

Table B-1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft ²) Square Miles (mi ²)	Hectares (ha) Square Meters (m ²) Square Kilometers (km ²)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft ² = 0.09 m ² 1 m ² = 10.76 ft ² 1 mi ² = 2.59 km ² 1 km ² = 0.39 mi ²	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft ² = 0.28 m ² 3 m ² = 32.29 ft ² 3 mi ² = 7.77 km ² 3 km ² = 1.16 mi ²
Volume	Gallons (gal) Cubic Feet (ft ³)	Liters (L) Cubic Meters (m ³)	1 gal = 3.78 L 1 L = 0.26 gal 1 ft ³ = 0.03 m ³ 1 m ³ = 35.32 ft ³	3 gal = 11.35 L 3 L = 0.79 gal 3 ft ³ = 0.09 m ³ 3 m ³ = 105.94 ft ³
Flow Rate	Cubic Feet per Second (cfs) ^a	Cubic Meters per Second (m ³ /sec)	1 cfs = 0.03 m ³ /sec 1 m ³ /sec = 35.31cfs	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 C. Data Sources

Table C-1. Data Sources for Pend Oreille Lake Tributaries Sediment TMDLs

Description	Source ^a	Data Format
Stream flow	USGS	Tables of USGS historic daily flows for gages in the Pend Oreille River Basin.
Climate data	National Weather Service (downloaded from INSIDE Idaho webpage)	Tables of daily precipitation, snowfall, and temperature data for 2 stations (Sandpoint KSPT and Bayview Model Basin) in the project basin
Land cover	USGS	National Land Cover Dataset - Landsat 7 raster dataset circa. 1992. Original dataset was clipped and shifted to match 2004 aerial photography. Land use value was aggregated based on IDEQ and WAG recommendations. Urban delineations –near ski resort-were also modified per IDEQ and WAG guidance.
Geology	IDWR	Shapefiles of major lithological units and surficial geology
Soils	NRCS	Geodatabase of STATSGO soil classification.
Surface elevation	USGS	7.5-minute Digital Elevation Model (DEM) grids
Stream reaches, segments, and lakes	USGS	National Hydrography Dataset (NHD) shapefiles
Forest	Idaho Department of Lands	Shapefile with National Forest Boundaries for Idaho
Fire	IPNF	A fire history coverage from 1870 to 1970 for the Idaho Panhandle National Forests
Land ownership	U.S. Bureau of Land Management (downloaded from INSIDE Idaho)	Land Status for Idaho, GCDB-based surface management land status (sometimes known as "ownership") and Public Land Survey System (PLSS) information for Idaho. Modified to reflect city of Sandpoint owned lands per IDEQ guidance.
Landslides	IPNF	Estimated sediment volumes - Spreadsheet with estimated cubic yards
Roads	IPNF	Shapefile of Sandpoint Ranger District Roads.
	ITD	Shapefile with roads from the official State Highway System.
	IDEQ	Road coverage (214) obtained from IDEQ. Modified to include portions of Bonner and Kootenai county roads.
Timber harvesting	IPNF	Access database with information on harvest, site preparation, planting, and other on-the-ground activities that have occurred or are planned to occur on a stand or activity unit, linked to coverage of stands. Contains activities up to 2004 for USFS lands only.
Historic Water Quality Data	U.S. EPA	Table with TSS and turbidity data from the 70's and 80's (from STORET database)
Streambank stability	Pack River Stream Channel Assessment Report (Golder Associates, 2003)	The report includes geomorphic classification, riparian inventory, and fish habitat for 6 main reaches in the Pack River
Percent fine sediment	IDEQ	Table with data for BURP sites within project subbasins
Bank stability	IDEQ	Table with bank stability percent for BURP sites within project subbasins
Pool riffle ratio	IDEQ	Table with pool riffle ratio for BURP sites within project subbasins
Cumulative Watershed Effects (CWE)	IDL	CWE assessment results for Gold Creek, Hellroaring Creek, Upper/Lower Rapid Lighting Creek, Sand Creek, and McCormick Creek; may include landslide information
Other Documents	Idaho Soil Conservation Commission	Idaho Agricultural Pollution Abatement Plan

Description	Source ^a	Data Format
	IDEQ	Relevant Subbasin Assessment reports and TMDLs, 2002 Integrated Report, WQS, TMDL and sediment guidance documents
	IDEQ	Draft Pack River Watershed Management Plan, February 2005
	IDEQ	Pack River Watershed Management Plan and TMDL Implementation Plan, July 2006
	Idaho Department of Fish and Game	Regional Fisheries Management Investigations
	Lake Pend Oreille Watershed Advisory Group	Lake Pend Oreille Key Watershed Bull Trout Problem Assessment
	Clark Fork Settlement Agreement	Appendices including protection, mitigation, and enhancement measures
	USFS	NEPA Documents for the Sandpoint Ranger District
Stressor Identification Report	TerraGraphics Environmental Engineering, Inc.	Stressor Identification Reports for Upper Pack River, McCormick Creek, Hellroaring Creek, Gold Creek, Rapid Lightning Creek, Sand Creek; September 28, 2006.

^a Sources: NRCS: Natural Resource Conservation Service, NWS: National Weather Service, USGS: United States Geological Survey, IDL: Idaho Department of Lands, IPNF: USDA Forest Service - Idaho Panhandle National Forests, USFS: United States Forest Service, ITD: Idaho Transportation Department

Appendix D. Distribution List

Pend Oreille River WAG participants:

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 participants (those, which are not on the WAG):

Channing Swan, Stimson Lumber Company
Charlie Holderman, Kootenai Tribe
Ted Runley, City of Priest River
Jessica Erickson, Pack River Watershed Coalition
Kate Wilson, Lakes Commission
Donna DeFrancesco, Golder

Appendix E. Public Comments

Document Section	Commenter	Comments	Response	Page
1 <i>Subbasin Assessment – Watershed Characterization</i>	Panhandle BAG	It appears that the sediment TMDL developed for Sand Creek did not include its lower reach. The Assessment Unit descriptions (from the 2002 Integrated Report) state that the 2 AUs included in the sediment TMDL for Sand Creek extend from its source to its confluence with Schweitzer Creek. See Table ES-1, p. ES-4. According to the map (figure ES-1, on p. ES-2) Schweitzer Creek enters Sand Creek several miles upstream from its mouth. Therefore, there are several stream miles within and above the inundated section that are not, but should be included in the TMDL for sediment. The water quality and beneficial uses in this section of the creek and downstream would definitely benefit from reducing the sediment loading.	The TMDL is written for the entire length of Sand Creek	5-6