Coeur d'Alene Lake and River Subbasin Assessment and Total Maximum Daily Loads

2013 Fernan Lake Addendum

(HUC 17010303)

State of Idaho
Department of Environmental Quality
October 2013

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Acknowledgments

This document was prepared by Kristin Larson of the Idaho Department of Environmental Quality (DEQ). It could not have been completed without the technical oversight of Bob Steed and help of Craig Nelson, both of DEQ's Coeur d'Alene Regional Office. The Fernan Lake Citizen Volunteer Monitoring Program (CVMP) has contributed much hard work and dedication to protecting water quality in the lake and provided invaluable data and knowledge of the watershed. Jim Szpara, DEQ State Office, provided invaluable GIS expertise in making the bathymetry map that was the basis for the load calculations in this total maximum daily load analysis. Erica Shiflet, DEQ State Office, provided outstanding technical editing expertise.

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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

µg/L micrograms per liter

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

AU assessment unit

BMP best management practice

C Celsius

CGP Construction General Permit

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

cfs cubic feet per second

CVMP Citizen Volunteer Monitoring Program

CWA Clean Water Act

DEQ Idaho Department of Environmental Quality

DO dissolved oxygen

EPA United States Environmental Protection Agency

F Fahrenheit

FLCRA Fernan Lake Conservation and Recreation Association

GIS geographic information systems

ha hectares

HRT hydraulic retention time

HUC hydrologic unit code

IDAPA refers to citations of Idaho administrative rules

kg kilograms

km kilometer

LA load allocation

lb pound

LC load capacity

LWQA Lake Water Quality Assessment Program

m meter

mg/L milligrams per liter

MS4 municipal separate storm sewer system

MSGP Multi-Sector General Permit

NB natural background

NPDES National Pollutant Discharge Elimination System

NTU nephelometric turbidity unit

SBA subbasin assessment

SWPPP stormwater pollution prevention plan

TKN total Kjeldahl nitrogen

TMDL total maximum daily load

TP total phosphorus

TSS total suspended solids

USC United States Code

WAG watershed advisory group

WLA wasteload allocation

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

This document addresses Fernan Lake within the Coeur d'Alene Lake subbasin (hydrologic unit code 17010303). The document is an addendum to the *Coeur D'Alene Lake and River (17010303) Sub-basin Assessment and Proposed Total Maximum Daily Loads* approved by the US Environmental Protection Agency in 2000. It updates the subbasin assessment (SBA) with information applicable to the Fernan Lake watershed and provides a TMDL analysis for the lake. The SBA describes the physical, biological, and cultural setting of the watershed; water quality status; pollutant sources; and recent pollution control actions relevant to Fernan Lake, located in Kootenai County in northern Idaho. The SBA is an important first step in developing a TMDL.

The TMDL analysis addresses §303(d)-listed water bodies—in this case, Fernan Lake. Fernan Lake is currently listed as impaired by excess nutrients/eutrophication, which results in the occurrence of blue-green algae blooms and the lake not meeting its recreational beneficial use. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition meeting water quality standards and full support of beneficial uses.

Subbasin at a Glance

Fernan Lake is located in Kootenai County near Coeur d'Alene, Idaho (Figure A). It is 54 hectares (ha) (381 acres) in size with 10.5 kilometers (6.5 miles) of shoreline and a maximum water depth of 8.2 meters (27 feet). Due to its close proximity to north Idaho's largest community of Coeur d'Alene, Fernan Lake is a popular residential and recreational-use lake for boating, fishing, swimming, and aesthetics.

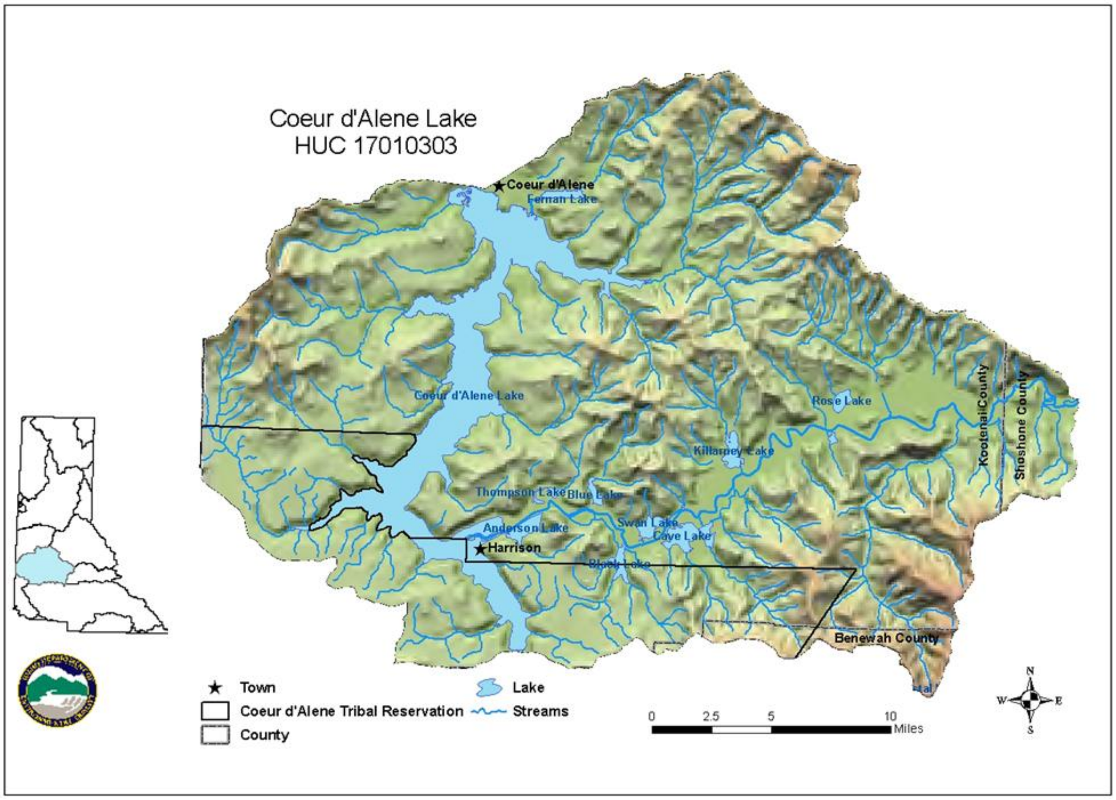


Figure A. Coeur d'Alene Lake subbasin (hydrologic unit code [HUC] 17010303).

The Fernan Lake watershed is 5,579 ha (13,786 acres); 3,118 ha (7,704 acres) (56%) are steep, forested mountains within the US Forest Service property boundaries. The watershed has 2,265 ha (5,596 acres) (41%) of privately owned land. State-owned lands account for 32 ha (80 acres) in the watershed. On the northwest end of the lake is Fernan Lake Village, comprised of approximately 71 homes and a mostly year-round population of 169 people.

Fernan Creek is the major perennial water input to Fernan Lake and is currently listed as fully supporting all beneficial uses. Fernan Creek receives perennial inflow from Stacel Creek and intermittent flow from Dry Gulch, State Creek, upper Fernan Creek, Jungle Gulch, Smith Gulch, and Rondo Gulch. Other sources of water input to the lake are other intermittent streams and ground water.

While snowpack in the upper watershed drives much of the stream hydrology into Fernan Lake, rain-on-snow events in the low to mid elevations of the watershed provide spikes in flow during November–February.

Key Findings

Fernan Lake blue-green algae blooms generally occur during late summer and fall. These blooms impair the lake's recreational beneficial use by significantly reducing water clarity and causing unsightly, thick, green algal mats along shorelines. In addition, some species identified in Fernan Lake may produce toxins that are capable of causing illness and death to animals and illness to humans. The toxins may also affect fish and other aquatic life.

Citizen Volunteer Monitoring Program (CVMP) data has been valuable in understanding physical and chemical conditions in Fernan Lake, conditions important to phosphorus availability and algal blooms. The data have shown that Fernan Lake is typically mixed enough to create relatively constant temperatures (i.e., isothermal conditions) during the summer months. The overall average shallow depth and frequent winds likely cause enough wave action to mix the lake and prevent stratification. While thermal stratification may occur for periods, the duration of stratification seems to be short-lived. This thermal mixing sustains aerobic conditions in the lower depths of the lakes. The absence of thermal stratification, shallow depth of Fernan Lake, and steep shoreline favoring less-abundant plant growth lends itself to the mesotrophic status of the lake, consistent with trophic status given to the lake by previous studies.

Discrepancies exist in previous literature regarding the bathymetry of Fernan Lake. In 2011, the Idaho Department of Environmental Quality (DEQ) collected new bathymetry data to create an updated map. This information was necessary for accurate phosphorus loading calculations and useful in calculating new morphometric information valuable in understanding the limnology of Fernan Lake. The new data reveals the lake has steep shorelines with a depth of 6.1–6.4 meters (20–21 feet) throughout much of the lake. The deepest part of the lake is 8.2 meters (27 feet) near the southern shoreline.

Available total phosphorus (TP) data show an annual period of elevated TP concentrations between August 15 and September 15, with a typical concentration of 31 micrograms per liter (μg/L). This equates to an existing TP load in Fernan Lake of 250 kilograms (kg) (550 pounds [lb]) at any time during the critical period.

After evaluating different data sources (using a DEQ nutrient data analysis of regionally similar lakes, TMDLs for Black Lake and a shallow mesotrophic lake in eastern Washington, and other sources), DEQ concluded that it was reasonable to establish a water quality target for Fernan Lake that would be within the range that represented other mesotrophic lakes with infrequent blue-green algae blooms. As such, the TP water quality target established for the Fernan Lake TMDL is 20 μg/L. With a target concentration of 20 μg/L, the load capacity of Fernan Lake is 160 kg (350 lb) at any time during the critical period of August 15–September 15.

The U.S. Census Bureau has delineated the Year 2010 Urbanized Area (UA) for the greater Coeur d'Alene vicinity, which is comprised of the densely-developed residential, commercial, and other non-residential land uses. This UA includes land draining into the western portion of Fernan Lake. Stormwater runoff from within a UA discharged into receiving waters through a Municipal Storm Sewer System (MS4) is regulated as a point source under the EPA. In addition, construction projects over one acre in size under the Construction Storm Water Permit is regulated as a point source under the EPA. The primary nonpoint source of pollution into Fernan Lake is Fernan Creek. Other nonpoint sources of nutrients are likely lawn/garden fertilizers and stormwater runoff from Fernan Lake Village, stormwater injection wells draining Fernan Lake Village and Fernan Hill Road, and septic effluent. Sources within the lake are internal cycling and submerged macrophytes on the east and west shores of the lake. TP load allocations and a required 35% reduction were assigned to both point and nonpoint sources in the watershed (Table B).

Table A. Total existing load, necessary reduction, and target loads for total phosphorus in Fernan Lake.

Existing TP Concentration[a] (µg/L)	Existing Load[a] (kg)	Necessary Reduction to Meet Target Concentration	Target Concentration[a] (µg/L)	Load at Target Concentration[a] (kg)
31	250	35%	20	160

[a] Concentrations and loads are during the critical time period between August 15 and September 15.

Table B. TP load allocations for Fernan Lake, by source. All load values are expressed with 2 significant figures.

Source	Existing Load (kg/yr)	Existing Load During Critical Period[a] (kg/yr)	Necessary Load Reduction from Existing Condition Percent	Necessary Load Reduction from Existing Condition (kg/yr)	Wasteload/ Load Allocation (kg/yr)	Wasteload/Load Allocation During Critical Period[a] (kg/yr)
Point Sources						
NPDES-regulated Stormwater from Urbanized Area	200	12	35%	70	130	7.8
Construction Storm Water under the CGP	10	0.6	35%	3.5	6.5	0.39
Nonpoint Sources						
Fernan Creek	2600	160	35%	910	1700	100
Fernan Lake Village lawns	300	18	35%	110	190	11
Stormwater Injection Wells	130	7.8	35%	46	84	5
Fernan Lake Road outside the Urbanized Area	160	9.6	35%	56	100	6
Septic Effluent	100	6	35%	35	65	3.9
Other	71	4.3	35%	25	46	2.8
Internal cycling	570	34	35%	200	370	22
Total	**4100**	**250**		**1500**	**2700**	**160**

[a] Loads are during the critical time period between August 15 and September 15. This is the load remaining after spring flows flush through Fernan Lake.

Introduction

This document addresses Fernan Lake within the Coeur d'Alene Lake subbasin (hydrologic unit code 17010303). Fernan Lake is on Idaho's current §303(d) list as not supporting its recreation beneficial use due to excessive nutrients and the occurrence of annual blue-green algae blooms on the lake (DEQ 2011). Blue-green algae are microscopic bacteria also known as cyanobacteria. Many species of blue-green algae occur naturally in surface waters, and blooms generally occur during late summer and fall. The physical appearance of blue-green algae blooms can be unsightly, often causing thick green mats along the shoreline. In addition, some species can produce toxins that may cause illness and death to animals and illness to humans (CDC 2008).

This addendum includes a subbasin assessment (SBA) update and a total maximum daily load (TMDL), which characterizes and documents pollutant loads to Fernan Lake. The first portion of this document, the SBA, includes 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). While this assessment is not a requirement of the TMDL, the Idaho Department of Environmental Quality (DEQ) performs the SBA to ensure impairment listings are up to date and accurate.

The SBA was then used to develop a TMDL for each pollutant of concern for Fernan Lake (Section 5). 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 (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 US Environmental Protection Agency (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 specific pollutants as "pollution." 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.

Regulatory Requirements

This document was prepared in compliance with federal and state regulatory requirements. The federal government, through EPA, assumed the dominant role in defining and directing water pollution control programs across the country. DEQ implements the CWA in Idaho, while EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The 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. 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.

Section 303 of the CWA requires states to adopt water quality standards and to review those standards every 3 years. EPA must approve states’ water quality standards. Additionally, states must monitor waters to identify those not meeting water quality standards. 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 and is included as the list of Category 5 waters in Idaho’s Integrated Report. For waters identified on this list, states and tribes must develop a TMDL for the pollutants, set at a level to achieve water quality standards. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating loads for several water bodies and/or pollutants within a given watershed.

1 Subbasin Assessment—Watershed Characterization

Fernan Lake is in the Coeur d’Alene Lake subbasin (hydrologic unit code 17010303) in northern Idaho. The lake is in the northern portion of the subbasin near the town of Coeur d’Alene, Idaho. This section presents physical, biological, and cultural characteristics specific to Fernan Lake. For additional information about the subbasin, see the *Coeur d’Alene Lake and River (17010303) Sub-basin Assessment and Proposed Total Maximum Daily Loads* (DEQ 1999a).

1.1 Physical and Biological Characteristics

Watershed characteristics relevant to pollutants impairing beneficial uses are assessed by describing physical and biological characteristics of the watershed, including a description of the climate, hydrology, and unique characteristics of the individual water bodies in the watershed. To evaluate the Fernan Lake watershed for sensitivity to activities that may impair beneficial uses, the geology, soil, vegetation, and assemblages of aquatic life are identified and described.

The terms “subbasin” and “watershed” are used throughout this section and the rest of the document to describe specific areas on the land. Subbasin refers to the land area that drains into the Spokane River (hydrologic unit code 17010303) (Figure 1). Subbasins are larger in area than watersheds, are defined consistently throughout the U.S. using 4th-field hydrologic codes, are identified in Idaho’s water quality standards, and contain many watersheds within them. DEQ uses subbasins for tracking and sorting Idaho’s waters. Watershed is used in this document to refer to the land area that drains into Fernan Lake and includes Fernan Lake. The Fernan Lake watershed is one of the many watersheds within the Coeur d’Alene subbasin.

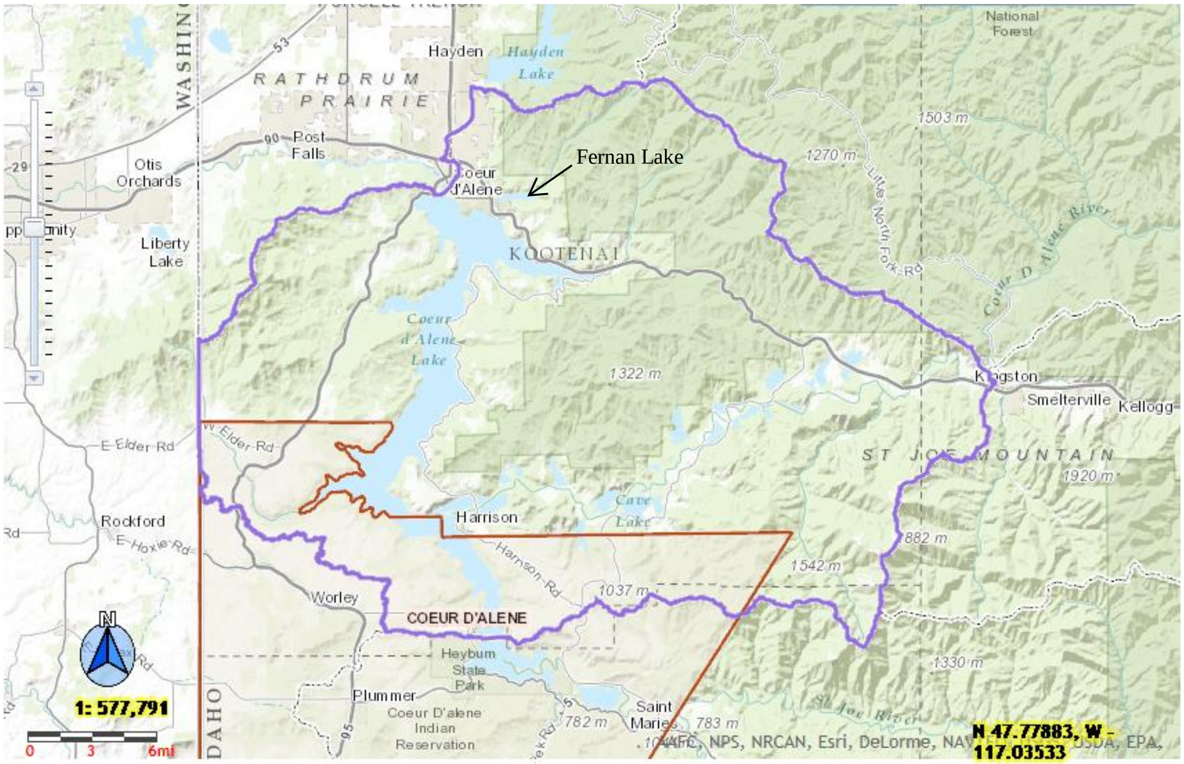


Figure 1. Coeur d'Alene Lake subbasin.

1.1.1 Climate

The climate in the region is characterized by relatively dry summers and cold, wet winters. Based on the US Weather Service's 50-year average, the average daytime temperatures in the summer range from 24–29 °C (75–85 °F) and in winter range from 3–9 °C (37–48 °F). Average annual precipitation in the area is 74 centimeters (29 inches) with average seasonal snowfall of 150 centimeters (59 inches).

1.1.2 Subbasin Characteristics

The Coeur d'Alene Lake subbasin is 1,683 square kilometers (km^2) (650 square miles) and includes the Coeur d'Alene Lake and Coeur d'Alene River and waters that drain directly into them (Figure 2). The Coeur d'Alene Lake subbasin is located primarily in Kootenai County of northern Idaho, with small portions in Benewah and Shoshone Counties. A portion of the subbasin is also within the boundaries of the Coeur d'Alene Reservation. It lies within the Northern Rocky Mountain physiographic region to the west of the Bitterroot Mountains.

Because the subbasin is predominantly in the elevation range of 900–1,400 meters (m) (3,000–4,500 feet), it is subject to winter "rain-on-snow" events. Such events create peaks in stream discharge that may exceed those observed during snowmelt in the spring months. In addition, the relative low elevation of the basin results in earlier maximum discharge during the period of snowmelt runoff.

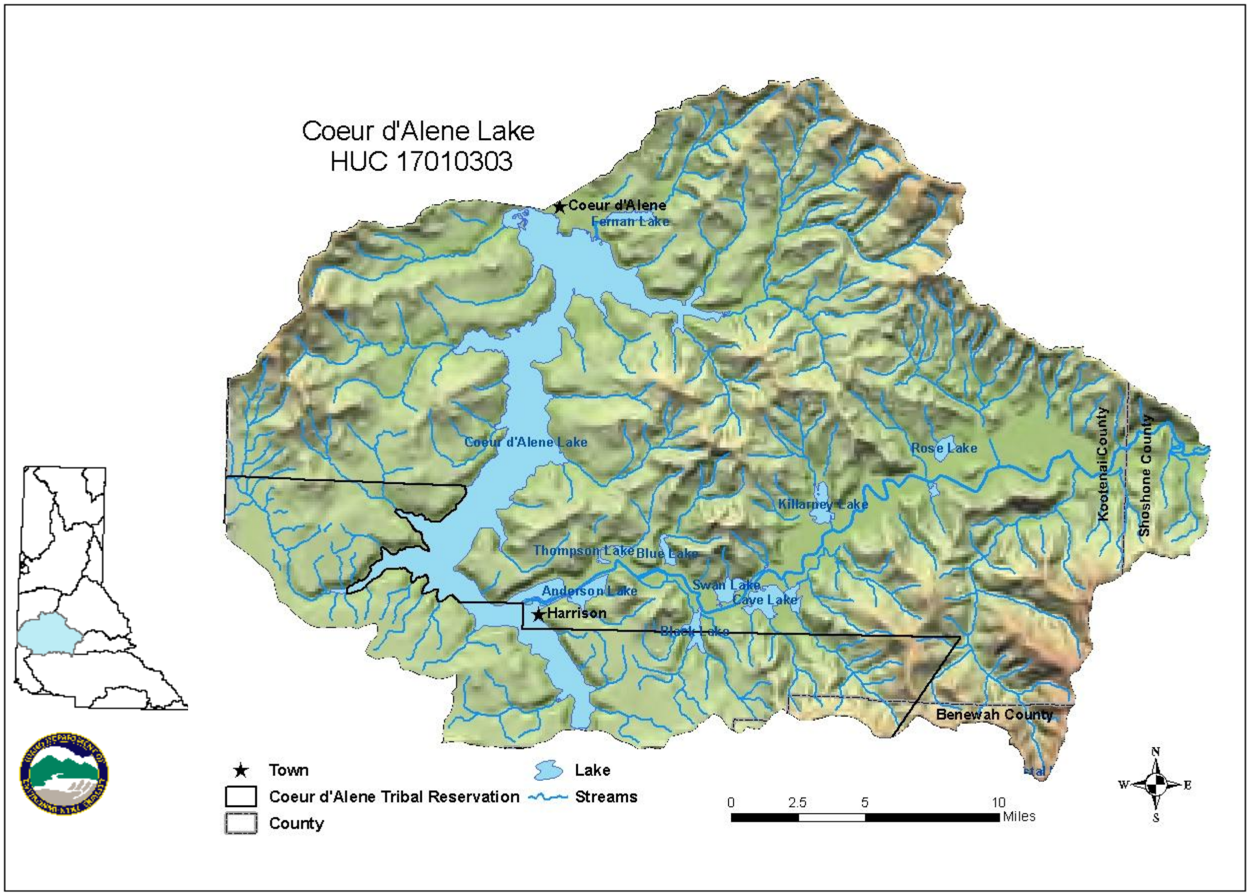


Figure 2. Waters of the Coeur d'Alene Lake subbasin (hydrologic unit code 17010303).

1.1.3 Watershed Characteristics

Fernan Lake (assessment unit ID17010303PN033_03) is located in Kootenai County in the northern portion of the subbasin. Fernan Creek is the major stream input to Fernan Lake. Fernan Creek receives perennial inflow from Stacel Creek and intermittent flow from Dry Gulch, State Creek, upper Fernan Creek, Jungle Gulch, Smith Gulch, and Rondo Gulch (Figure 3). There are no gage stations on Fernan Creek, so flow data are lacking, which affects the historical hydrography of this tributary. To the south of Fernan Creek is an intermittent channel that drains into Fernan Creek near the mouth. There are also intermittent channels that drain directly into Fernan Creek.

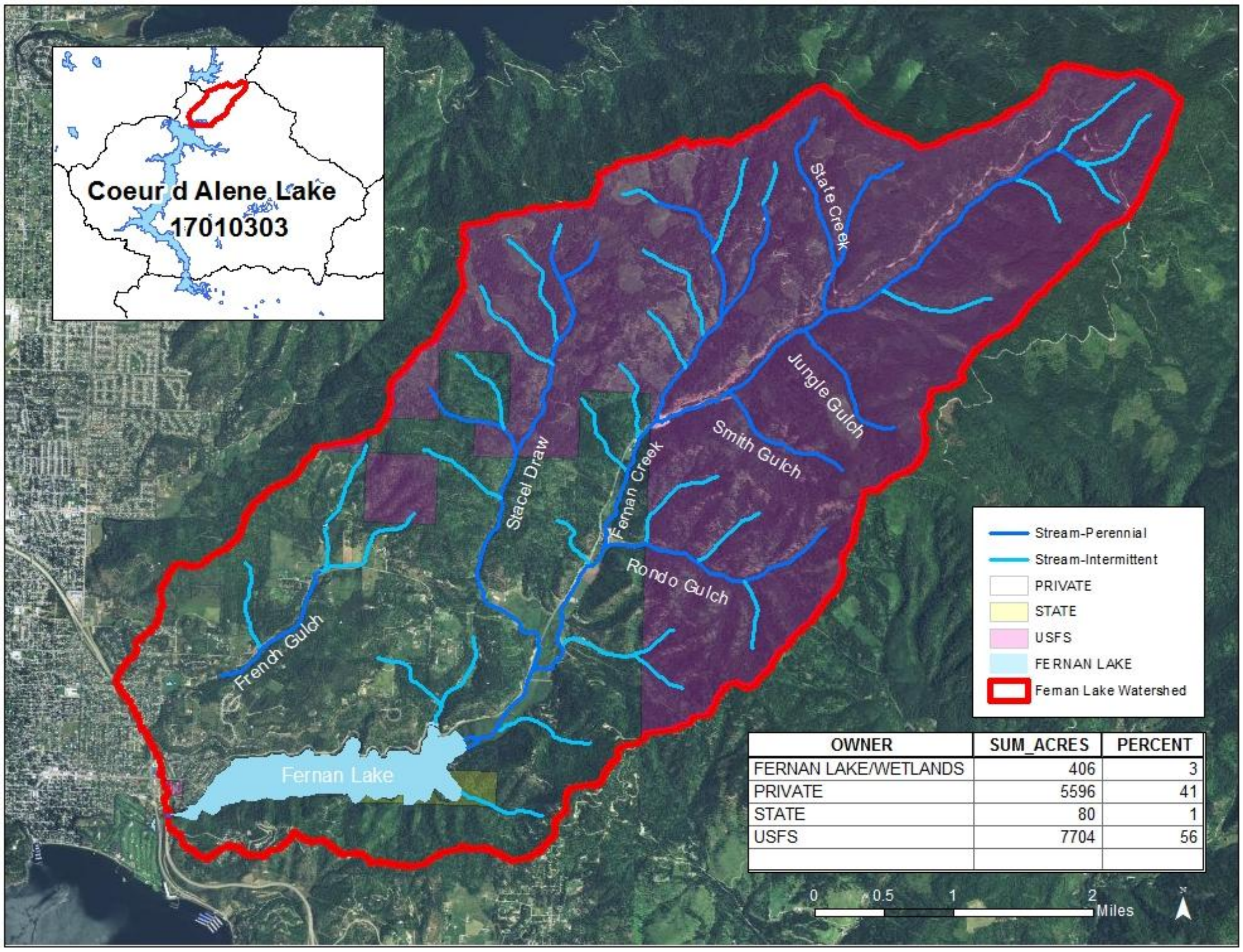


Figure 3. Fernan Lake watershed.

1.1.4 Geology and Soils

While it is close to the City of Coeur d'Alene, much of the Fernan Lake watershed is covered by steep, forested mountains with typical gradients of 40–60%. Much of the watershed consists of Intermediate Precambrian sediments of siltite, argillite, and quartzite of the Middle Proterozoic Prichard Formation (Figure 4). This formation is about 80% silt and clay, 10% muddy graded sand, 5% hummocky silt association, and 5% quarzitic or dolomitic silt-mud microlamina association (USGS 2012). The hillslopes above the northern shore of Fernan Lake are of Miocene basalt flow. The western edge of the watershed contains Pleistocene outwash fanglomerate flood and terrace gravels, including younger alluvial and older glacial-outwash and alluvial deposits.

Fernan Lake is one of several lakes formed in alluvial deposits of sand, gravel, cobbles, and boulders ringing the Rathdrum Prairie. As such, the lake contributes to the recharge to this sole-source aquifer.

The US Department of Agriculture has identified five different soil types surrounding Fernan Lake. The very deep, very poorly drained *Ramsdell* silt loam is on the north and east portion of the lake. The Fernan Lake Village area on the lake's northwest shore has the excessively drained *McGuire-Marble* series, which is volcanic ash/loess over glacial outwash. On the south side of the lake are three soil types: the moderately deep, well-drained *Huckleberry-Ardenvoir* soil—which is formed in loess and volcanic ash with material from metasedimentary origin—and the well-drained *McCrosket-Ardenvoir* and *McCrosket-Tekoa* series, both formed from metasedimentary bedrock overlain by loess.

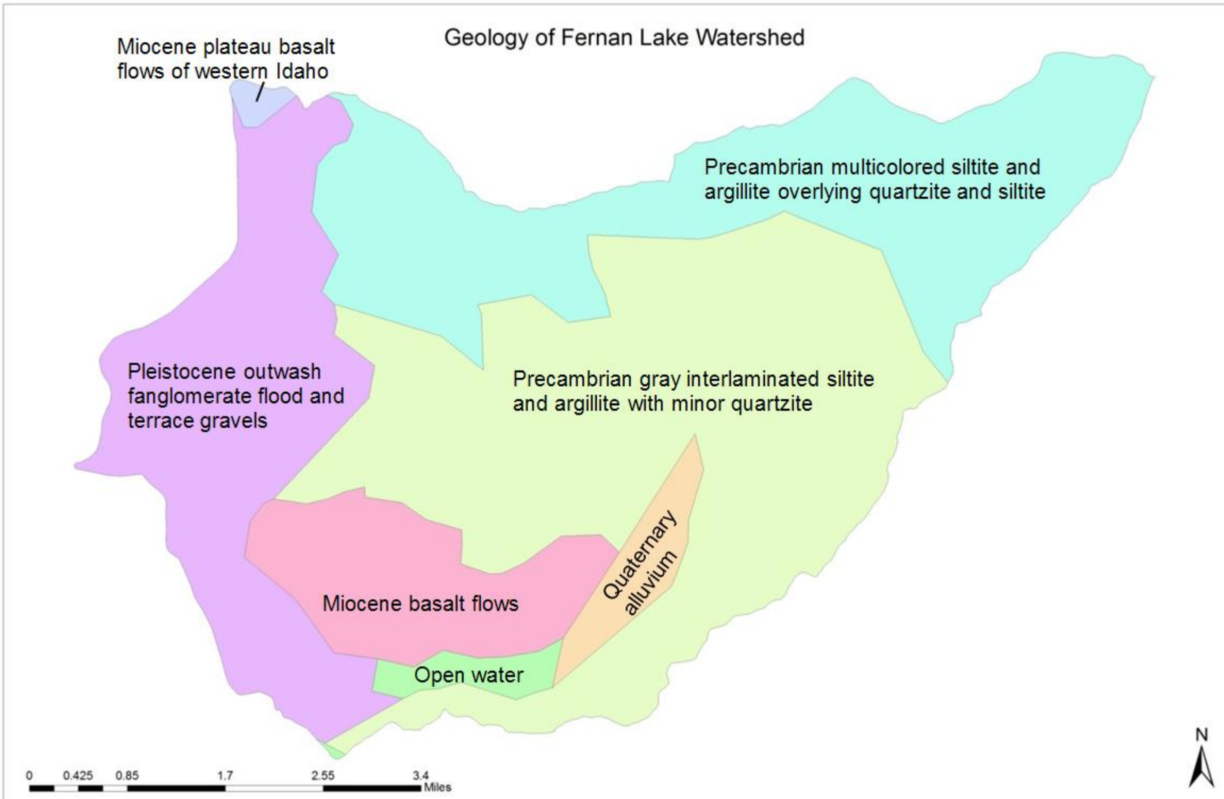


Figure 4. Geology of the Fernan Lake watershed.

1.1.5 Lake Characteristics

Fernan Lake is a narrow lake—approximately 3.5 km (2.2 miles) long and 0.56 km (0.35 miles) wide—extending east from the city of Coeur d'Alene. The watershed extends about 21 km (13 miles) to the northeast of the lake. Fernan Lake covers a surface area of 54 hectares (ha) (381 acres). Shoreline bottom gradients are very steep on all sides of the lake except at the northwest shore near Fernan Lake Village and the east shore at the Fernan Creek inlet. Fernan Creek is the main intermittent channel flowing into Fernan Lake. Several unnamed intermittent channels flow into Fernan Lake.

Due to the shallow depth of Fernan Lake, wave action caused by sufficient diurnal winds mixes the lake. While thermal stratification may occur, the duration of stratification is short-lived due to wind and wave action (See section 2.4 for analysis of temperature data).

Due to Fernan Lake Village, the Fernan Lake Road, and steep hillslopes adjacent to the southern end lake, much of the lake shoreline does not have riparian vegetation. However, well-established wetlands remain on the east side of the lake in the delta of Fernan Creek. A smaller wetland exists on the west end of the lake near the outlet.

1.1.5.1 Bathymetry

Bathymetry describes the elevation of the earth's surface beneath a water body. Falter (2001) explains in his previous study that discrepancies exist in historic Fernan Lake bathymetry data. In 2011, DEQ collected new bathymetry data to create an updated map (Figure 5). Using Spatial Analyst and 3D Analyst software, a new total lake volume was established of 7,894,510 m^3 (6,400 acre-feet).

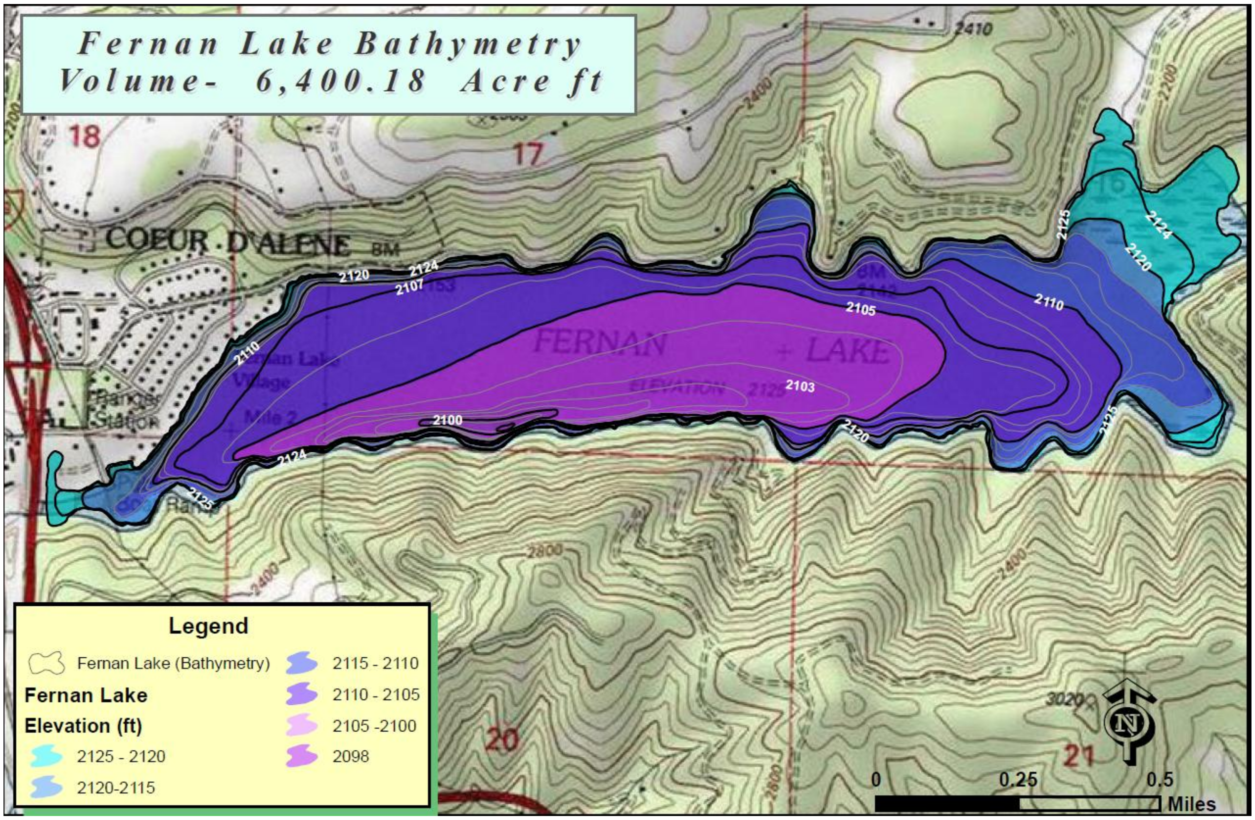


Figure 5. Bathymetry map of Fernan Lake (created by DEQ in 2012).

1.1.5.2 Morphometry

Morphometric (i.e., shape and dimension) characteristics of Fernan Lake have been determined from a number of sources (Mossier 1993; Milligan et al. 1983; and Falter 2001). While all agree the maximum depth of Fernan Lake is between 7.0–8.0 m (23–26 feet), Falter (2001) sites a discrepancy in mean depth across the sources. The new bathymetric data shows a mean depth of 5.1 m (16.8 feet) (Figure 5). The new bathymetry data verifies Falter's observation of the lake being mostly flat-bottomed at a depth of 6.1–6.4 m (20–21 feet), which is different from the old bathymetric map that indicated a gradual sloping of the lake from the shoreline. The new bathymetry data show a maximum depth of 8.2 m (27 feet) in a small area near the southern shore of the lake. An updated summary of morphometric characteristics is provided in Table 1.

Table 1. Morphometric characteristics of Fernan Lake.

Characteristic	Measurement
Elevation	649 meters (2,130 feet)
Area of watershed	49.7 square kilometers (19.2 square miles)
Lake volume	7,894,510 cubic meters (6,400 acre-feet)
Surface area	54 hectares (381 acres)
Mean depth (volume/surface area)	5.1 meter (16.8 feet)
Greatest depth	8.2 meter (27 feet)

1.1.5.3 Hydraulic Retention Time

Hydraulic retention time (HRT) is the ratio of the lake's volume to annual outflow of the lake. Falter (2001) estimated an HRT of 0.16 years using flow data collected by DEQ in 2000 and the old bathymetric map. He thought that a low HRT such as 0.16 would not support high algae production. Falter also thought that the previous mean 3-m depth was too shallow or the outflow estimate too high for the lake productivity that was observed. An assumed mean depth of 6 m was more appropriate and resulted in an HRT estimate of 0.41 years (Falter 2001).

DEQ calculated a new HRT of 0.32 years in Fernan Lake with the volume calculated from the new bathymetric data and flow data collected in Fernan Creek and French Gulch during 2008–2009 (DEQ 2010a). Flow was measured during base flow; low flow; along the ascending limb, peak, and descending limb of the hydrograph; and during rain-on-snow events. Flow from Fernan Creek was measured below the confluence with French Gulch, which is at the outlet of Fernan Lake. Outflow from the lake was determined by subtracting flow from French Gulch from the flow in Fernan Creek. Outflow estimates are provided in Table 2.

Table 2. Outflow estimates for Fernan Lake.

Flow Condition	Number of Days	Fernan Creek (below Fernan Lake) (cfs)	French Gulch (cfs)	Lake Outflow (cfs)	Lake Outflow (feet^3/year)
Rain-on-snow	7.0	69.2	8.4	60.7	37,000,000
Ascending limb	30	50.0	6.0	44.0	110,000,000
Peak flow	30	88.4	20.6	67.8	180,000,000
Descending limb	60	77.3	9.1	68.2	350,000,000
Low flow	60	34.2	0.0	34.2	180,000,000
Base flow	178	0.3	0.0	0.3	5,000,000
Total	**365**				**862,000,000**

Note: cubic feet per second (cfs)

1.1.6 Hydrology below Fernan Lake

Figure 6 illustrates the hydrology of Fernan Creek below the outlet of Fernan Lake. At the lake outlet, Fernan Creek is routed through a culvert under Interstate 90 (I-90), it then immediately meets with French Gulch. French Gulch drains a portion of western Coeur d'Alene.
Fernan Creek is then routed through another culvert that goes under a four-lane road (Coeur d'Alene Lake Drive) and then meets a small-sized pond with a dam at the downstream end. This

dam is used for flood control of Fernan Lake during seasonal high flows and it maintains Fernan Lake's elevation after run off. Figure 7 provides photographs of the dam during late fall when it is open and during early September when the flood gate is in place to control the elevation of Fernan Lake. The top of the dam is 1.7 m (5.6 feet) above the elevation of Coeur d'Alene Lake at summer pool.

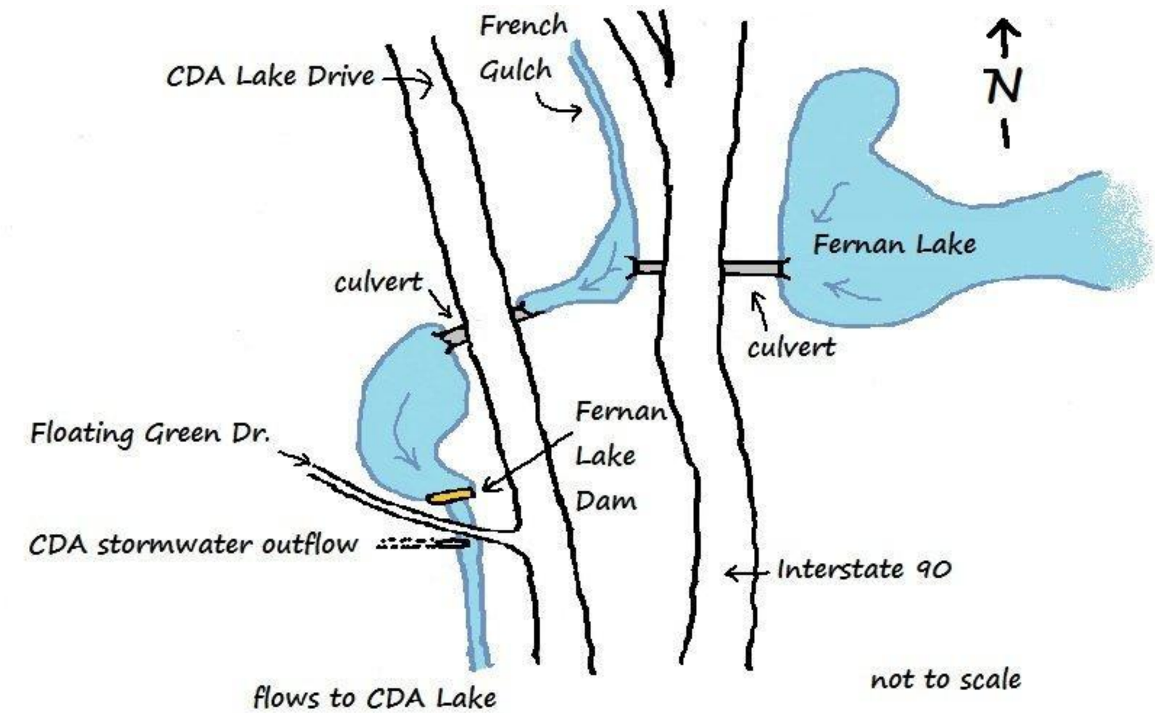


Figure 6. Hydrology of Fernan Creek below Fernan Lake.

Figure 7. Fernan Lake Dam when flood gates are open (left) and closed (right).

1.1.7 Fisheries and Aquatic Life

Due to easy access and its close proximity to the city of Coeur d'Alene, Fernan Lake is heavily frequented by anglers and is a typical put-and-take fishery. It is managed with simple regulations to provide a consumptive fishery oriented toward family fishing (IDFG 2007). As such, the fishery is composed of rainbow trout (*Oncorhynchus mykiss*), cutthroat trout (*Oncorhynchus clarkii*), smallmouth bass (*Micropterus dolomieu*), largemouth bass (*Micropterus salmoides),* crappie (*Pomoxis nigromaculatus*), perch (*Perca flavescens*), pumpkinseed *(Lepomis gibbosus*), bluegill (*Lepomis macrochirus*), northern pike (*Esox lucius*), channel catfish (*Ictalurus punctatus*), and bullhead catfish (*Ictalurus melas*). The lake is stocked annually with 3,000–5,000 channel catfish of catchable size; 19,000 triploid Kamloops rainbow trout of catchable size; and 5,000–7,000 westslope cutthroat trout fingerlings (IDFG 2011).

1.1.8 Vegetation

Timber cover on the drier, south-facing slopes of the watershed is dominated by ponderosa pine (*Pinus ponderosa*). North-facing slopes are dominated by Douglas-fir (*Pseudotsuga menziesii*). A complete list of trees, shrub, herb, and wetland species are described in detail in the *Draft Fernan Lake Watershed Management Plan* (Fernan Lake Watershed Technical Advisory Committee 2003). There are very limited defined riparian zones around Fernan Lake; rather, the Douglas-fir and ponderosa pine communities extend down to the waterline.

Based on the presence of hydrophytic vegetation, hydric soils, and positive indicators of wetland hydrology, seven areas are identified as wetlands around Fernan Lake and along Fernan Creek. These wetland areas and the hydrology feeding the wetlands are described in detail in the *Draft Fernan Lake Watershed Management Plan* (Fernan Lake Watershed Technical Advisory Committee 2003).

1.2 Cultural Characteristics

While much of the Fernan Lake watershed is undeveloped, the lake itself is on the eastern outskirts of the City of Coeur d’Alene. Therefore, it is a popular recreational destination for boating, fishing, and swimming.

The Fernan Lake watershed is 5,579 ha (13,786 acres) in size; 3,118 ha (7,704 acres) (56%) are steep, forested mountains within the US Forest Service property boundaries. The landownership in the watershed is 2,265 ha (5,596 acres) (41%) private and 32 ha (80 acres) (1%) state owned. Less than 3% of the watershed is wetlands or “surveyed water” (Figure 3).

Much of the northern hillsides adjacent to Fernan Lake are developed as residential property. Most of the northern shoreline of Fernan Lake is developed with very low-density cabins and homes, except for Fernan Lake Village, which occupies the northwest end of the lake. It is the only community in the watershed, with approximately 71 homes housing a year-round population of 169 people (US Census Bureau 2010). The southern hillsides adjacent to the lake are largely undeveloped due to difficulty in access and a hillside ordinance passed by the Coeur d’Alene City Council (City of Coeur d’Alene 2003). The southern shoreline is also largely undeveloped. From the mouth of Fernan Creek upstream for a few miles is floodplain property historically used for grazing and agricultural purposes.

The residents of Fernan Lake Village have a long history of community involvement in activities associated with the health of the lake. The Fernan Lake Conservation and Recreation Association (FLCRA) is a citizen group that has taken a proactive approach to addressing issues and concerns in the lake. FLCRA’s mission is to preserve the scenic and natural resource value of the

Fernan Lake watershed and enhance its beneficial uses, both public and private, utilizing sound conservational practices (Susan Andrews, FLCRA, pers. comm., 2012).

2 Subbasin Assessment—Water Quality Concerns and Status

Fernan Lake has a long history of blue-green algae blooms. Blooms generally occur during late summer and fall. The physical appearance of blue-green algae blooms can be unsightly, often causing thick green mats along shorelines. In addition, some species can produce toxins that may cause illness and death to animals and illness to humans (CDC 2008). These effects may impair beneficial uses such as agricultural water supply, drinking water supply, aesthetics, cold water aquatic life, and recreation.

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

Per section 303(d) of the Clean Water Act (CWA), 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. In Idaho, water bodies are divided into assessment units (AUs) for tracking and monitoring purposes.

2.1.1 About Assessment Units

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

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

2.1.2 Listed Waters

In *Idaho's 2010 Integrated Report*, Fernan Lake is listed as not supporting the recreational beneficial use due to nutrient/eutrophication and occurrence of annual blue-green algae blooms (Table 3) (DEQ 2011).

Table 3. §303(d)-listed segments in the Coeur d'Alene Lake subbasin.

Water Body	Assessment Unit Number	Pollutants	Listing Basis
Fernan Lake	ID17010303PN033_03	Nutrient/ Eutrophication Biological Indicators	Annual blue-green algae blooms

2.2 Applicable Water Quality Standards and Beneficial Uses

State water quality standards are established as the "yardstick" for the fishable and swimmable goal of the CWA. Water quality standards contain three key components: designated uses, water quality criteria (numeric and narrative), and an antidegradation policy. These components, as defined by IDAPA 58.01.02, are summarized below. Idaho adopts water quality standards to protect public health and welfare, enhance water quality, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

2.2.1 Beneficial Uses

Idaho water quality standards designate beneficial uses and set water quality goals for the waters of the state. Idaho water quality standards require that surface waters of the state be protected for *beneficial uses*, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses, as briefly described below. The *Water Body Assessment Guidance* (Grafe et al. 2002) provides a more detailed description of beneficial use identification for use assessment purposes.

Beneficial uses identified in the Idaho water quality standards include the following:

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

The recreation beneficial use of primary contact recreation and aquatic life are the beneficial uses that are addressed in this total maximum daily load analysis.

2.2.1.1 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" (40 CFR 131.3). The existing instream water uses and water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02 and .02.051.01). Existing uses include uses actually or historically occurring, whether or not the water 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 currently is not due to other factors such as dams blocking migration.

2.2.1.2 Designated Uses

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained" (40 CFR 131.3). Designated uses are simply uses officially recognized by the state. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher-quality use such as cold water aquatic life or salmonid spawning. Designated uses are specifically listed for water bodies in Idaho in the Idaho water quality standards (see IDAPA 58.01.02.010.24 and .02.109–160 in addition to citations for existing uses). Industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state.

Fernan Lake is designated in Idaho water quality standards for the cold water aquatic life, salmonid spawning, primary contact recreation, and domestic water supply beneficial uses (Table 4).

Table 4. Beneficial uses of §303(d)-listed streams.

Water Body/ Assessment Unit	Beneficial Uses[a]	Type of Use
Fernan Lake ID17010303PN033_03	Cold water aquatic life, salmonid spawning, primary contact recreation, domestic water supply	Designated

2.2.1.3 Presumed Uses

In Idaho, most water bodies do not yet have specific use designations in the water quality standards. 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 applies the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If an existing use, (e.g., salmonid spawning) also exists, then the additional numeric criteria for salmonid spawning would also apply (e.g., intergravel dissolved oxygen, temperature) because of the requirement to protect levels of water quality for existing uses.

2.2.2 Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients, and *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (IDAPA 58.01.02.250–251). Table 5 includes the most common numeric criteria used in TMDLs. Figure 8 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.

Idaho's water quality standards do not directly address blue-green algae (cyanobacteria) or the toxins that the organisms may produce. The standards do address conditions when algae blooms impair beneficial uses (i.e., recreation, cold water aquatic life, and aesthetics) with a narrative criteria for excess nutrients: "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses" (IDAPA 58.01.02.200.06). Narrative criteria also exist for floating, suspended, or submerged matter: "Surface waters of the state shall be free from floating, suspended, or submerged matter of any kind in concentrations causing nuisance or objectionable conditions or that may impair designated beneficial uses" (IDAPA 58.01.02.200.05). Regarding toxic substances, “surface waters of the state shall be free from toxic substances in concentrations that impair designated beneficial uses” (IDAPA 58.01.02.200.02). Determining narrative criteria exceedances is described in the *Water Body Assessment Guidance* (Grafe et al. 2002). Section 5 specifically addresses the DEQ narrative criteria evaluation policy.

DEQ’s procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.054. The procedure relies heavily upon biological parameters and is presented in detail in the *Water Body Assessment Guidance* (Grafe et al. 2002). This guidance requires using the most complete data available to make beneficial use support status determinations.

Table 5. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

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

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

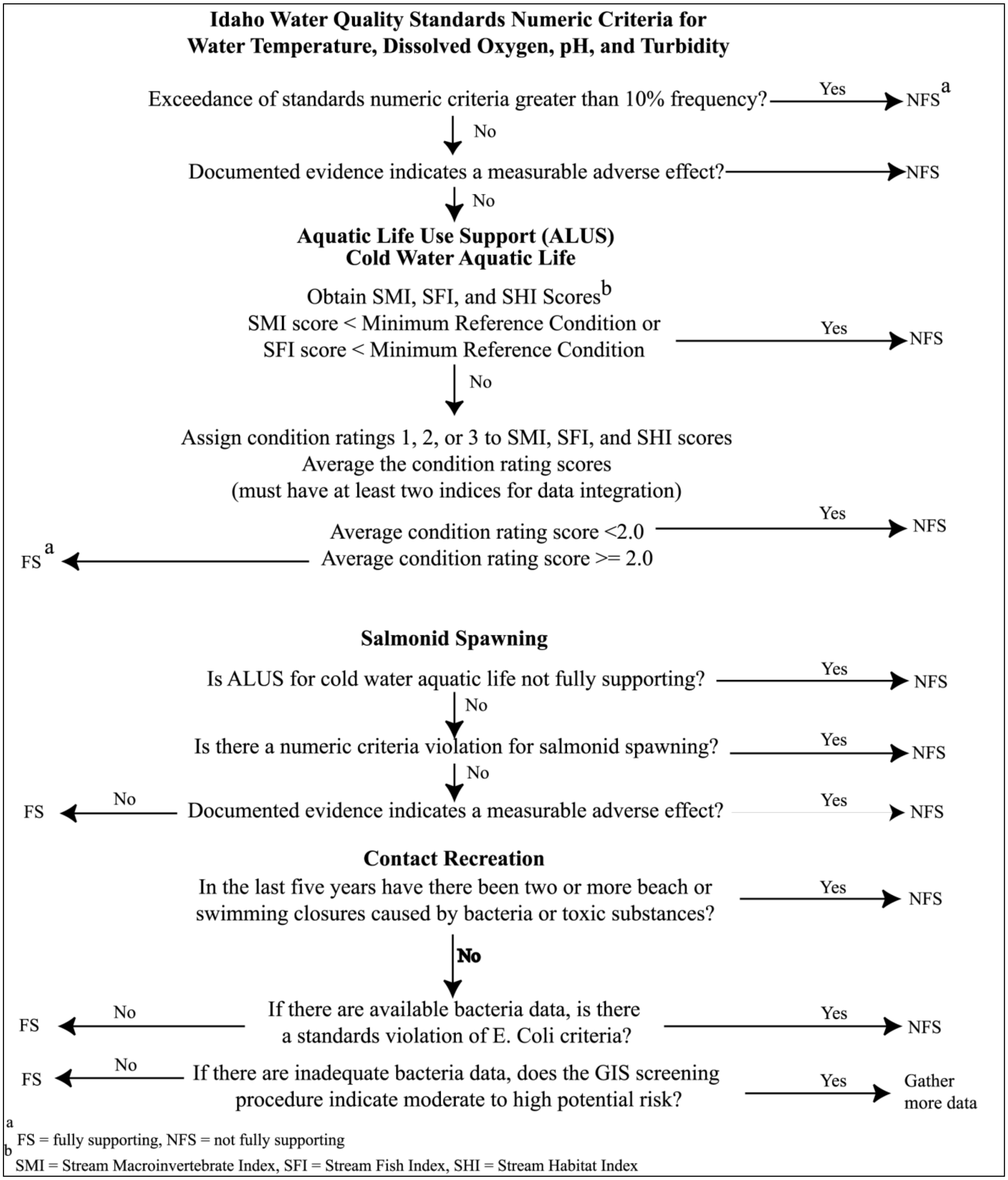


Figure 8. Steps and criteria for determining support status of beneficial uses in wadeable streams (Source: Grafe et al. 2002).

2.3 Pollutant/Beneficial Use Support Status Relationships

Most of the pollutants that impair beneficial uses in lakes are due to land/water disturbances caused by humans. The most common pollutants in northern Idaho lakes are dissolved oxygen, sediment, nutrients, and floating, suspended, or submerged matter (nuisance algae).

2.3.1 Dissolved Oxygen

Oxygen is necessary for the survival of most aquatic organisms and essential to stream or lake purification. Dissolved oxygen (DO) is the concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter (mg/L), parts per million, or percent of saturation. While air contains approximately 20.9% oxygen gas by volume, the proportion of oxygen dissolved in water is about 35%, because nitrogen is less soluble in water. Oxygen is considered to be moderately soluble in water. A complex set of physical conditions that include atmospheric and hydrostatic pressure, turbulence, temperature, and salinity affect the solubility.

DO levels of 6 mg/L and above are considered optimal for aquatic life. When DO levels fall below 6 mg/L, organisms are stressed, and if levels fall below 3 mg/L for a prolonged period, these organisms may die. Oxygen levels that remain below 1–2 mg/L for a few hours can result in large fish kills. DO levels below 1 mg/L are often referred to as hypoxic, while anoxic conditions refer to conditions with no measurable DO. Juvenile aquatic organisms are particularly susceptible to the effects of low DO due to their high metabolism and low mobility (they are unable to seek more oxygenated water).

DO reflects the health and balance of the aquatic ecosystem. Oxygen is produced during photosynthesis and consumed during plant and animal respiration and decomposition. Oxygen enters water through plant photosynthesis and directly from the atmosphere. Where water is more turbulent (e.g., riffles, cascades), the oxygen exchange is greater due to the greater surface area of water coming into contact with air. The process of oxygen entering water is called aeration.

Water bodies with significant aquatic plant communities can have significant DO fluctuations throughout the day. An oxygen sag will typically occur once photosynthesis stops at night and plant respiration/decomposition processes deplete DO concentrations in the water. Oxygen will start to increase again as photosynthesis resumes with daylight.

Temperature, flow, nutrient loading, and channel alteration all impact DO. Colder waters hold more DO than warmer waters. Oxygen is necessary to help decompose organic matter in the water and on the lakebed. Nutrient-enriched waters have a higher biochemical oxygen demand due to the amount of oxygen required for organic matter decomposition and other chemical reactions. This oxygen demand can result in lower lake DO levels.

2.3.2 Sediment

Both suspended (floating in the water column) and lakebed 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 exposures are detrimental. Elevated suspended sediment levels can interfere with feeding behavior (e.g., difficulty finding food due to visual impairment), damage gills, reduce growth rates, and in extreme cases 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 50–100 mg/L when maintained for 14–60 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, diminish DO through decomposition.

2.3.3 Nutrients

While nutrients are a natural component of the aquatic ecosystem, natural cycles can be disrupted by increased nutrient inputs from anthropogenic activities. Excess nutrients result in accelerated plant growth and can result in a eutrophic or enriched system.

The first step in identifying a water body's response to nutrient flux is to define which of the critical nutrients is limiting. A limiting nutrient is one that normally is in short supply relative to biological needs. The relative quantity affects the rate of aquatic biomass production. Either phosphorus or nitrogen may be the limiting factor for algal growth, although phosphorous is most commonly the limiting nutrient in Idaho waters. Ecologically speaking, a resource is considered limiting if the addition of that resource increases growth.

Total phosphorus (TP) is the measurement of all forms of phosphorus in a water sample, including inorganic and organic particulate and soluble forms. In freshwater systems, typically greater than 90% of the TP occurs in organic forms as cellular constituents in the biota or adsorbed (i.e., adhered) to particulate materials (Wetzel 1983). The remaining phosphorus is mainly soluble orthophosphate, a more biologically available form of phosphorus than TP that consequently leads to a more rapid growth of algae. In impaired systems, a larger percentage of the TP is orthophosphate. The relative amount of each form can provide information on the potential for algal growth within the system.

Nitrogen may be a limiting factor at times when a substantial depletion of nitrogen in sediments occurs due to uptake by rooted macrophyte beds. In systems dominated by blue-green algae, nitrogen is not a limiting nutrient since algae can fix nitrogen at the water/air interface. When water nitrogen concentrations are low, this ability gives them a competitive advantage over phytoplankton that cannot fix nitrogen.

Total nitrogen to TP ratios greater than seven are indicative of a phosphorus-limited system, while those ratios less than seven are indicative of a nitrogen-limited system. Only biologically available forms of the nutrients are used in the ratios because these are the forms used by the immediate aquatic community.

Nutrients primarily cycle between the water column and sediment through nutrient spiraling. Aquatic plants rapidly assimilate dissolved nutrients, particularly orthophosphate. If sufficient nutrients are available in sediments or the water column, aquatic plants will store an abundance of such nutrients in excess of the plants' actual needs, a chemical phenomenon known as luxury consumption. When a plant dies, the tissue decays in the water column and the nutrients stored within the plant biomass are either restored to the water column or the detritus becomes incorporated into the lakebed sediment. As a result of this process, nutrients (including orthophosphate) that are initially released into the water column in a dissolved form will eventually become incorporated into the lakebed sediment. Once these nutrients are incorporated into the lakebed sediment, they are available once again for uptake by yet another life cycle of rooted aquatic macrophytes and other aquatic plants. This cycle is known as nutrient spiraling and results in the availability of nutrients for later plant growth in higher concentrations downstream.

2.3.4 Sediment–Nutrient Relationship

The linkage between sediment and sediment-bound nutrients is important when dealing with nutrient enrichment problems in aquatic systems. Phosphorus adsorbs to soil through precipitation as calcium carbonate in calcareous soils or through phosphorus sorption by aluminum and iron-oxide minerals. HDR (2007) prepared a thorough literature review of fate and transport of phosphorus in soils, soil sorption isotherms, and fate and transport of phosphorus in ground water. Soil sorption modeling has proven soils have a finite capacity for sorption of phosphorus, with tremendous variability depending on soil type. Soils with a low percentage of calcium carbonate and/or clay particles have a lower affinity to adsorb phosphorus (HDR 2007). Regardless of the soil type, the primary form of phosphorus in soil and runoff is TP, not dissolved phosphorus because it is bound to soil.

Because phosphorus is primarily bound to particulate matter in aquatic systems, sediment can be a major source of phosphorus to rooted macrophytes and the water column. While most aquatic plants are able to absorb nutrients over the entire plant surface due to a thin cuticle (Denny 1980), bottom sediments serve as the primary nutrient source for most substratum attached macrophytes. The US Department of Agriculture (1999) determined that other than harvesting and chemical treatment, the best and most efficient method of controlling macrophyte growth is by reducing surface erosion and sedimentation.

Sediment acts as a nutrient sink under aerobic conditions. However, when conditions become anoxic, sediment releases phosphorous into the water column. Nitrogen can also be released, but the mechanism by which it happens is different. The exchange of nitrogen between sediment and the water column is primarily a microbial process controlled by the amount of oxygen in the sediment. When conditions become anaerobic, the oxygenation of ammonia (nitrification) ceases and an abundance of ammonia is produced. This results in a loss of nitrogen oxides to the atmosphere.

Sediment can play an integral role in reducing the frequency and duration of algae blooms in lakes and rivers. In many cases, phytoplankton biomass responds immediately when external sediment sources are reduced. In other cases, the response time is slower, often taking years. Nonetheless, the relationship is important and must be addressed in waters where phytoplankton is in excess.

2.3.5 Floating, Suspended, or Submerged Matter (Nuisance Algae)

Algae are an important part of the aquatic food chain. However, when elevated levels of algae impact beneficial uses, the algae are considered a nuisance aquatic growth. The excess growth of phytoplankton (algae is a type of phytoplankton), periphyton, and/or macrophytes can adversely affect aquatic life and recreational water uses. Algal blooms occur where adequate nutrients (nitrogen and/or phosphorus) are available to support growth. In addition to nutrient availability, flow rates, velocities, water temperatures, and penetration of sunlight in the water column all affect algae (and macrophyte) growth. Low-velocity conditions allow algal concentrations to increase because physical removal by scouring and abrasion does not readily occur. Increases in temperature and sunlight penetration also result in increased algal growth. When the aforementioned conditions are appropriate and nutrient concentrations exceed the quantities needed to support normal algal growth, excessive blooms may develop.

Water bodies with high nutrient concentrations that could potentially lead to a high level of algal growth are said to be eutrophic. The extent of the effect is dependent on both the type of algae present and the size, extent, and timing of the bloom. Nuisance algae blooms appear as extensive layers or algal mats on the surface of the water; they also often create objectionable odors and coloration in water used for domestic drinking water. In extreme cases, algal blooms can also impair recreational water uses due to toxicity.

Blue-green algae blooms appear in summer and fall and can be considered a nuisance in high concentrations. The physical appearance of blue-green algae blooms can be unsightly, often causing thick green mats along shorelines. In addition, some species can produce toxins (cyanotoxins) that may cause illness and death to animals or humans. The primary target organs for cyanotoxins are the liver and nervous system, but other health effects do occur.

In lakes, algae die and sink slowly through the water column, eventually collecting on the bottom sediments. The biochemical processes that occur as the algae decompose remove oxygen from the surrounding water. Because most of the decomposition occurs within the lower levels of the water column, a large algal bloom can substantially deplete DO concentrations near the lake bottom. Low DO in these areas can lead to decreased fish habitat since fish will not frequent areas with low DO. Both living and dead (decomposing) algae can also affect the pH of the water due to the release of various acid and base compounds during respiration and photosynthesis. Low DO levels caused by decomposing organic matter can also lead to changes in water chemistry and a release of sorbed phosphorus to the water column at the water/sediment interface.

Excess nutrient loading can be a water quality problem due to the direct relationship of high TP concentrations on excess algal growth within the water column, combined with the direct effect of the algal lifecycle on DO and pH within aquatic systems. Therefore, reducing TP inputs to the system can act as a mechanism for water quality improvements, particularly in surface-water systems dominated by blue-green algae. Phosphorus management within these systems can potentially result in improvements in nutrient (phosphorus), nuisance algae, DO, and pH levels.

2.4 Summary and Analysis of Existing Water Quality Data

An SBA analyzes and integrates 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.

Data are available to support development of the TP TMDL for Fernan Lake. Data used to support this TMDL analysis are derived from a series of historical reports and recent targeted water quality monitoring on Fernan Lake conducted by the Citizen's Volunteer Monitoring Program (CVMP).

2.4.1 Inflowing Stream Hydrology

Fernan Creek is the main tributary that flows into Fernan Lake. To the south of Fernan Creek is an unnamed intermittent channel that drains into Fernan Creek near the mouth. There are no gage stations on Fernan Creek, and as a result, insufficient flow data are available to display a long-term historical hydrograph of this tributary. However, from December 1999 to December 2000, DEQ conducted a water budget analysis of water flowing into and out of Fernan Lake. During those years, streamflow and stage height in Fernan Creek were monitored. Continuous stage data was regressed with flow to synthesize a stream hydrograph for the whole year (Figure 8). Typical of stream hydrographs in the Idaho Panhandle region, the highest streamflow on Fernan Creek is in the form of runoff from spring snowmelt and from rain-on-snow events occurring from November to February. Base flow on Fernan Creek is less than 1 cubic foot per second (cfs), because Fernan Creek goes subsurface in the localized lower depositional reaches. From these data, it was estimated that 79% of inflowing water to Fernan Lake is from Fernan Creek, 12% from other ungaged surface water, and 9% from precipitation (Falter 2001).

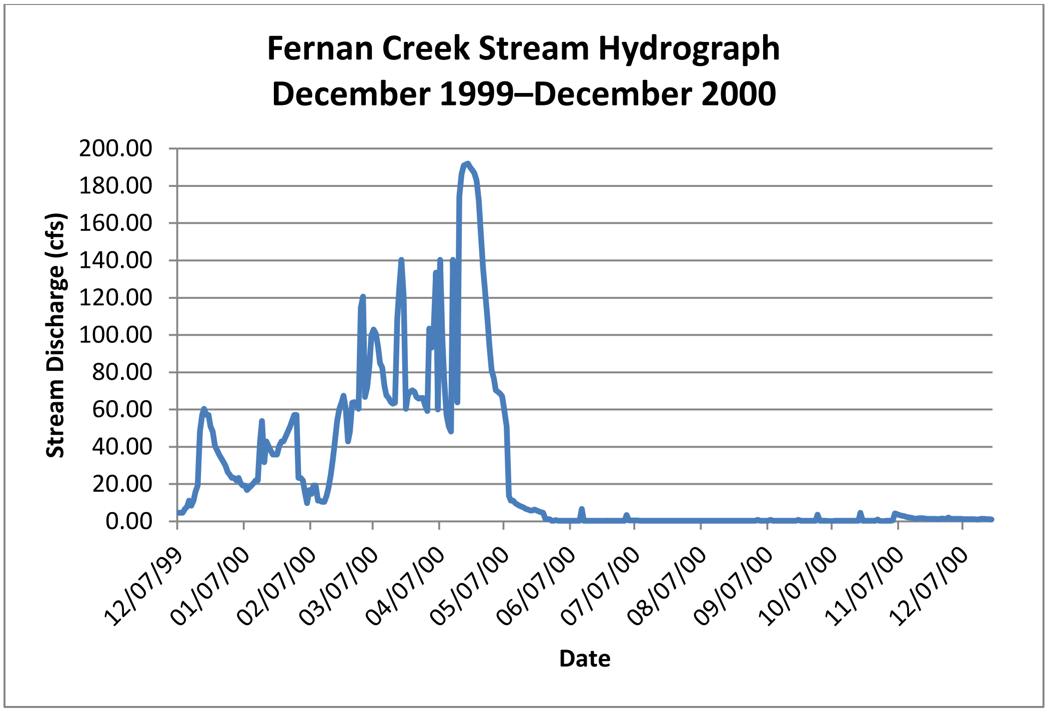


Figure 9. Stream hydrograph of Fernan Creek, December 1999–December 2000. Discharge measured in cubic feet per second (cfs).

2.4.2 Water Column Data

2.4.2.1 Temperature

The data for existing and available temperature measurements for Fernan Lake at the deep monitoring station are summarized in Table 6. Temperature profiles, depicting temperatures at different depths during a single monitoring event, are provided in Appendix A. The data were evaluated to better understand the frequency and duration of thermal stratification on Fernan Lake. Thermal stratification exists when a rapid temperature drop (at least 3 °C) occurs with depth such that two layers of different temperature water exist and mixing with overlying water is inhibited. As seen in Table 6, stratification was rarely observed in Fernan Lake; therefore, DEQ assumes that when thermal stratification occurs it is short lived. This stratification scenario is typical of shallow, north Idaho lakes where wind and waves mix lake water.

Table 6. Temperature data for Fernan Lake (from deep monitoring station).

Date	Data Source	Water Temperature (°C) at Depth								Thermal Condition
		0 m	1 m	2 m	3 m	4 m	5 m	6 m	7 m	
05/22/1990	LWQA[a]	—	15.5	15.0	14.0	13.7	13.4	13.2	—	Isothermal
06/26/1990	LWQA	—	22.7	22.6	21.5	18.0	15.4	14.8	14.6	Stratified
08/08/1990	LWQA	—	24.2	24.1	23.5	23.4	23.1	22.0	20.4	Isothermal
09/17/1990	LWQA	—	20.3	19.4	19.0	18.8	18.8	18.8	—	Isothermal
10/30/1990	LWQA	—	8.7	8.7	8.7	8.7	8.7	8.7	—	Isothermal
07/24/1991	LWQA	24.6	24.5	24.5	24.5	22.2	—	—	—	Isothermal
06/24/2003	Isaacson[b]	—	19.5	19.5	18.3	18.3	18.4	18.3	—	Isothermal
07/01/2003	Isaacson	22.1	22.0	21.8	21.3	21.0	20.1	19.5	19.5	Isothermal
07/21/2003	Isaacson	25.2	24.9	24.0	23.4	23.3	23.1	23.0	22.7	Isothermal
07/29/2003	Isaacson	26.1	25.1	23.9	23.8	23.8	23.7	23.7	23.7	Isothermal
08/07/2003	Isaacson	24.4	24.4	24.3	23.6	23.6	23.5	23.4	23.3	Isothermal
08/19/2003	Isaacson	24.1	24.0	23.4	23.4	22.7	22.7	22.7	22.7	Isothermal
08/27/2003	Isaacson	22.7	21.5	23.4	20.8	20.7	20.7	20.7	20.7	Isothermal
09/04/2003	Isaacson	22.1	21.7	21.2	20.6	20.6	20.6	20.6	20.5	Isothermal
09/15/2003	Isaacson	18.2	28.1	28.1	17.8	17.3	17.3	17.3	17.3	Isothermal
05/09/2005	CVMP[c]	15.5	15.5	15.3	15.2	14.6	14.1	12.5	12.3	Isothermal
06/06/2005	CVMP	17.5	17.3	17.2	17.0	16.9	16.9	16.9	16.9	Isothermal
05/11/2006	CVMP	14.0	13.9	13.4	13.2	13.1	13.0	13.0	12.8	Isothermal
04/16/2007	CVMP	10.0	10.0	10.0	10.0	10.0	9.3	9.1	9.0	Isothermal
05/14/2007	CVMP	17.0	16.3	16.0	15.0	14.7	14.6	14.2	13.2	Isothermal
07/16/2007	CVMP	25.5	25.3	24.7	24.5	24.4	23.8	22.2	22.0	Isothermal
09/18/2007	CVMP	18.0	18.0	18.0	17.8	17.6	17.6	17.6	17.6	Isothermal
05/30/2008	CVMP	17.1	16.8	16.6	16.6	14.7	11.8	11.8	11.8	Stratified
06/30/2008	CVMP	24.4	23.4	22.4	21.7	19.2	16.5	15.2	14.9	Stratified
08/28/2008	CVMP	19.2	19.1	19.0	18.0	17.8	17.8	17.8	17.8	Isothermal
09/08/2008	CVMP	19.3	18.9	18.3	18.0	17.9	17.8	17.7	17.7	Isothermal
09/09/2008	CVMP	17.7	17.7	17.7	17.8	17.8	17.8	17.8	17.8	Isothermal
09/30/2008	CVMP	16.9	16.3	16.2	15.6	15.5	15.5	15.3	15.3	Isothermal
10/21/2008	CVMP	10.3	10.4	10.4	10.4	10.4	10.4	10.4	10.4	Isothermal
01/28/2009	CVMP	0.6	2.1	2.3	2.4	2.6	3.1	3.7	4.4	Stratified
06/05/2010	CVMP	15.9	15.9	15.8	15.7	15.5	15.1	14.8	—	Isothermal
08/08/2011	CVMP	24.4	24.1	22.1	22.1	22.0	21.8	20.8	20.7	Isothermal
08/29/2011	CVMP	22.7	22.7	22.7	22.6	22.5	22.2	20.5	20.4	Isothermal
05/17/2012	CVMP	16.8	16.8	16.1	16.1	16.1	14.8	12.5	12.4	Stratified
07/05/2012	CVMP	22.9	20.9	19.5	19.2	18.0	16.5	16.0	16.0	Stratified
07/19/2012	CVMP	27.8	26.5	25.4	24.1	19.4	18.2	17.1	16.4	Stratified
07/20/2012	CVMP	25.2	25.2	25.2	24.9	19.4	17.4	16.6	16.5	Stratified
08/30/2012	CVMP	20.7	20.6	20.5	20.4	20.4	20.4	20.4	20.2	Isothermal

[a] LWQA = 1991 DEQ Lake Water Quality Assessment Program (Mossier 1993)
[b] Isaacson = subcontracted monitoring work done by Allen Isaacson (FLCRA 2003)
[c] CVMP = Citizen Volunteer Monitoring Program

2.4.2.2 *Dissolved Oxygen*

The data for existing and available DO measurements for Fernan Lake are summarized in Table 7. Certain concentrations of DO are necessary for aquatic organisms and are an indicator of water quality. Idaho's water quality criterion states that DO should exceed 6 mg/L at all times, except for the bottom 20% of a lake that is less than 35 m deep. The 6 mg/L criterion also does not apply to the hypolimnion (i.e., bottom, cold, unmixed layer) of a lake if the lake is stratified. Continuous monitoring is required when evaluating DO compliance with Idaho water quality standards, and since the Fernan Lake DO measurements are not continuous, the criterion is only used as a guideline. Data show several DO concentrations below 6 mg/L, but due to the criteria exceptions discussed above, none of those observations violate Idaho water quality standards criteria.

Table 7. Fernan Lake dissolved oxygen concentrations. Gray cells indicate dissolved oxygen concentrations below 6 mg/L observed in the bottom 20% of the lake. Black cells indicate dissolved oxygen concentrations below 6 mg/L observed in the hypolimnion of stratified lake conditions. Both conditions are exemptions under Idaho Water Quality Standards for DO.

Date	Location	Data Source	Dissolved Oxygen (mg/L) at Depth							
			0 m	1 m	2 m	3 m	4 m	5 m	6 m	7 m
05/22/1990	Deep	LWQA[a]	—	9.4	9.2	9.0	8.7	7.9	7.5	—
06/26/1990	Deep	LWQA	—	8.3	8.4	8.6	9.2	6.0	4.1	3.6
08/08/1990	Deep	LWQA	—	8.2	8.2	8.2	8.2	6.3	5.1	0.8
09/17/1990	Deep	LWQA	—	8.5	8.6	8.4	8.3	7.9	7.6	—
10/30/1990	Deep	LWQA	—	9.1	8.8	8.7	8.6	8.6	8.5	—
07/24/1991	Deep	LWQA	—	8.4	8.3	8.2	8.1	8.1	—	—
06/24/2003	Deep	Isaacson[b]	6.9	6.4	6.5	6.4	6.9	7.0	6.9	4.8
07/01/2003	Deep	Isaacson	6.8	6.8	6.9	6.8	7.0	6.5	5.2	5.1
07/21/2003	Deep	Isaacson	7.1	6.0	6.1	7.1	7.4	6.9	6.4	5.4
07/29/2003	Deep	Isaacson	7.9	6.4	7.1	7.2	7.3	7.3	7.1	5.6
08/07/2003	Deep	Isaacson	7.0	6.5	6.6	6.5	6.9	6.4	6.4	3.8
08/19/2003	Deep	Isaacson	7.5	7.2	7.2	7.4	7.7	7.1	7.4	6.9
08/27/2003	Deep	Isaacson	8.1	7.5	8.1	7.4	7.7	7.1	7.4	3.5
09/04/2003	Deep	Isaacson	8.7	7.7	8.1	7.7	7.1	6.9	7.0	3.7
09/15/2003	Deep	Isaacson	7.7	7.7	7.3	7.1	6.8	7.0	6.0	3.8
05/09/2005	Deep	CVMP[c]	—	7.9	7.5	7.5	7.7	7.6	4.2	3.8
06/06/2005	Deep	CVMP	7.0	7.0	6.4	6.6	6.7	6.6	6.5	6.8
05/11/2006	Deep	CVMP	9.6	9.3	9.5	9.3	8.9	9.2	9.0	9.0
04/16/2007	Deep	CVMP	7.5	7.5	7.4	7.4	7.3	7.4	7.4	7.3
05/14/2007	Deep	CVMP	9.0	8.7	8.7	8.6	8.4	8.4	8.2	6.6
07/16/2007	Deep	CVMP	7.7	7.6	7.3	7.1	7.0	6.1	2.6	1.8
09/18/2007	Deep	CVMP	7.0	6.6	6.7	6.7	6.7	6.8	6.4	6.3
05/30/2008	Deep	CVMP	10.1	10.0	10.1	10.3	9.7	5.8	5.8	5.8
06/30/2008	Deep	CVMP	9.6	9.2	9.2	9.4	10.1	7.4	3.6	3.1
08/28/2008	Deep	CVMP	10.6	10.6	10.3	9.9	9.9	9.6	9.6	8.6
09/08/2008	Deep	CVMP	10.8	10.9	10.9	10.3	9.9	9.6	9.6	9.6
09/09/2008	Deep	CVMP	9.5	9.1	9.6	9.6	9.6	9.6	9.6	9.6
09/30/2008	Deep	CVMP	9.5	9.4	9.5	9.5	9.5	9.5	9.2	8.8
10/21/2008	Deep	CVMP	8.2	8.2	8.2	8.1	8.1	8.1	8.0	7.1
01/28/2009	Deep	CVMP	14.0	12.2	11.3	10.5	9.5	7.8	4.0	2.4
06/05/2010	Deep	CVMP	9.7	9.7	9.7	9.7	9.7	9.3	8.4	—
08/08/2011	Inlet	CVMP	7.0	—	—	—	—	—	—	—
08/08/2011	Deep	CVMP	9.1	9.2	9.3	9.0	8.5	7.9	2.0	1.7
08/29/2011	Deep	CVMP	9.3	9.3	9.2	9.2	9.2	8.2	1.1	1.1
08/29/2011	Outlet	CVMP	8.9	9.1	8.6	8.0	2.0	—	—	—
05/17/2012	Inlet	CVMP	9.3	9.3	9.5	—	—	—	—	—

Date	Location	Data Source	Dissolved Oxygen (mg/L) at Depth							
			0 m	1 m	2 m	3 m	4 m	5 m	6 m	7 m
05/17/2012	Deep	CVMP	9.0	9.1	9.1	9.0	8.8	8.9	7.7	7.6
05/17/2012	Outlet	CVMP	9.1	9.3	9.2	9.2	8.2	—	—	—
07/05/2012	Inlet	CVMP	7.7	7.7	7.7	7.3	—	—	—	—
07/05/2012	Deep	CVMP	7.9	8.3	8	7.8	6.5	3.3	2.3	2.2
07/05/2012	Outlet	CVMP	8.0	8.3	8.2	4.6	4.0	2.8	—	—
07/19/2012	Deep	CVMP	8.3	8.3	8.5	8.5	8.3	9.9	0.4	0.1
07/20/2012	Deep	CVMP	7.71	7.21	7.6	7.55	8.62	2.5	0.04	0.04
08/31/2012	Deep	CVMP	8.0	7.9	7.9	7.8	7.8	7.8	7.7	3.9

[a] LWQA = 1991 DEQ Lake Water Quality Assessment Program (Mossier 1993)
[b] Isaacson = subcontracted monitoring work done by Allen Isaacson (FLCRA 2003)
[c] CVMP = Citizen Volunteer Monitoring Program

2.4.2.3 Water Transparency (Secchi Depth)

Water transparency is evaluated by measuring Secchi depth—the maximum depth at which a standardized black and white disk can be seen from the surface. Secchi depth is related to water turbidity and algae production. Mossier (1993) found that the water transparency of Fernan Lake was primarily affected by blue-green algae blooms. He reported a range in Secchi depths of 2.2–4.5 m in Fernan Lake. A historical record of Secchi depth data is presented in Table 8. The range in Secchi depth over the period of record is 1.1–7.5 m at the deepest part of the lake. In a typical year, Secchi depths appear to be greatest (indicating better water transparency) in the beginning of the summer (May through July) and smallest from the middle of summer until the end of summer (August through October) (Figure 10). Mean and median Secchi depths during the summer months are listed in Table 9. The data suggest a statistically insignificant negative trend in summer Secchi depths (Figure 11).

Table 8. Secchi depths of Fernan Lake over period of record.

Data Source	Location	Date	Depth (m)
LWQA[a]	Deep station	05/22/1990	7.5
LWQA	Deep station	06/26/1990	3.3
LWQA	Deep station	08/08/1990	2.6
LWQA	Deep station	09/17/1990	2.2
Isaacson[b]	Deep station	06/24/2003	4.3
Isaacson	Deep station	07/01/2003	3.7
Isaacson	Deep station	07/11/2003	3.4
Isaacson	Deep station	07/21/2003	3.7
Isaacson	Deep station	07/29/2003	3.7
Isaacson	Deep station	08/07/2003	2.3
Isaacson	Deep station	08/19/2003	2.0
Isaacson	Deep station	08/27/2003	1.6
Isaacson	Deep station	09/04/2003	1.4
Isaacson	Deep station	09/15/2003	1.1
LWQA	Deep station	05/22/2009	4.5
LWQA	Deep station	06/26/2009	3.3
LWQA	Deep station	08/08/2009	2.6
LWQA	Deep station	09/17/2009	2.2
CVMP[c]	Inlet	05/17/2012	1.5
CVMP	Deep station	05/17/2012	4.5
CVMP	Outlet	05/17/2012	4.5
CVMP	Inlet	07/05/2012	2.0
CVMP	Deep station	07/05/2012	1.7
CVMP	Outlet	07/05/2012	2.0
CVMP	Deep station	08/31/2012	3.0

[a] LWQA = 1991 DEQ Lake Water Quality Assessment program (Mossier 1993)
[b] Isaacson = subcontracted monitoring work done by Allen Isaacson (FLCRA 2003)
[c] CVMP = Citizen Volunteer Monitoring Program

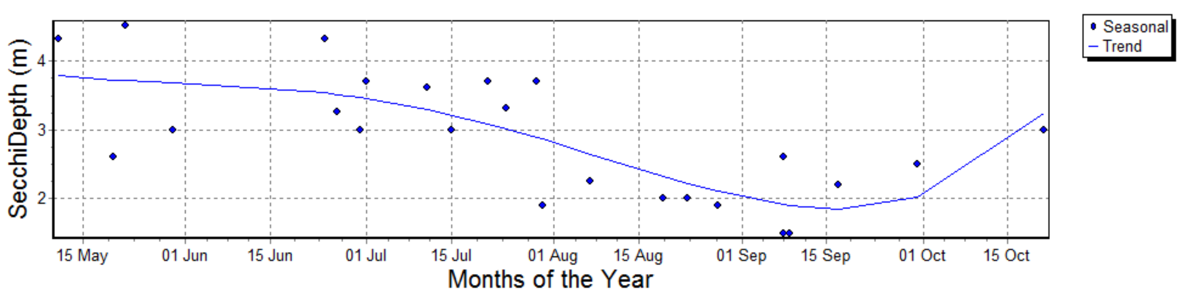


Figure 10. Annualized Secchi depth of Fernan Lake over period of record.

Table 9. Average Secchi depth in Fernan Lake during summer months.

Month	Secchi Depth (meters)	
	Mean	Median
May	5.5	4.5
June	3.6	3.3
July	3.2	3.7
August	2.4	2.5
September	1.7	1.8

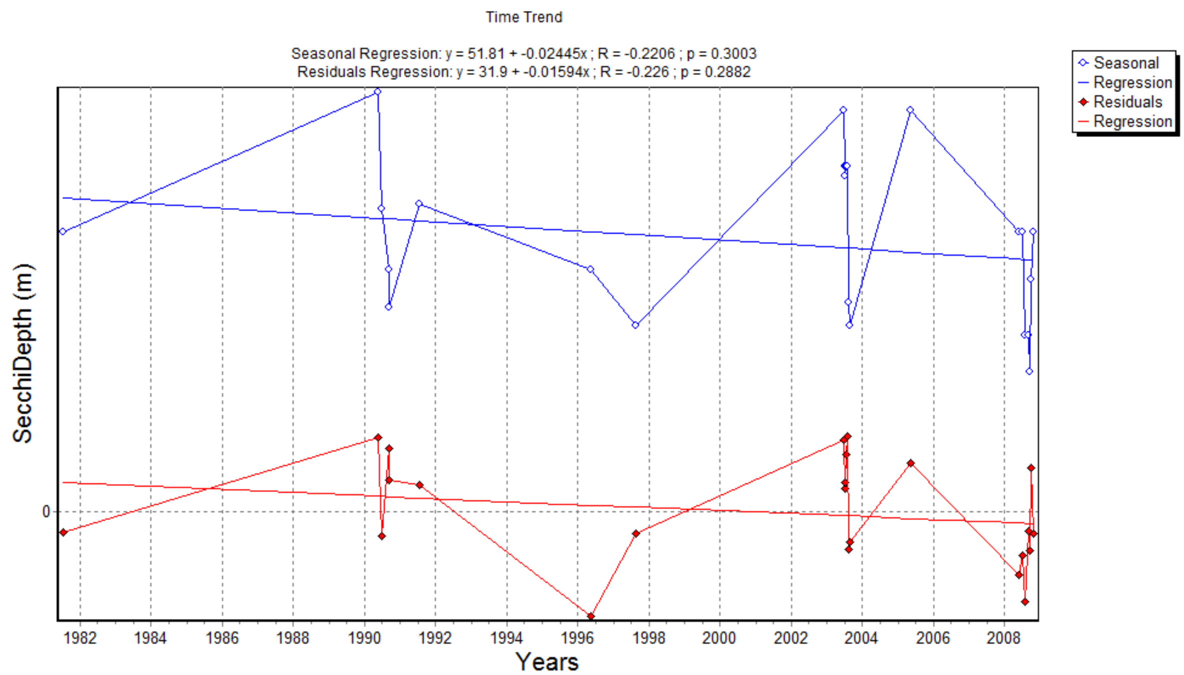


Figure 11. Trend in Secchi depth over period of record.

2.4.2.4 Nutrients and Chlorophyll

Nutrient and chlorophyll levels are measures of the cause and response of growth, or productivity, within a lake. Nutrients (TP in the case of Fernan Lake) are the food upon which algae grow. Chlorophyll is a measure of a pigment found in cyanobacteria and the chloroplasts of other algae and plants. Some algae growth is healthy in a lake, but excess phosphorus may lead to nuisance blooms. Chlorophyll has several chemical structures. As is typical for water quality science, the chlorophyll *a* molecule is the only structure measured or evaluated in this study. TP and chlorophyll *a* concentrations are determined from samples taken and evaluated by a laboratory.

TP and chlorophyll *a* samples were collected from the deepest location in Fernan Lake. Existing and available TP and chlorophyll *a* data since 1990 are shown in Table 10. Chlorophyll *a* samples, when taken, were collected at Secchi depth. TP samples were collected at Secchi depth and at 1 m from the bottom or as a composite depth-integrated sample. Due to such a small data set and the data gaps between years of monitoring, the following analysis is not conclusive.

To understand any seasonal patterns in TP concentrations, all existing data were annualized. Data indicate a period of elevated TP concentrations between August 15 and September 15 (Figure 12); no significant trend in TP concentrations is evident over the period of record (Figure 13). Further statistical analysis of TP data between August 15 and September 15 shows a normal distribution with an upper quartile concentration of 31 micrograms per liter (µg/L) (Figure 14). DEQ chose this value to represent the existing condition of Fernan Lake for the purposes of this TMDL; 75% of the samples collected between August 15 and September 15 were below 31 µg/L.

Chlorophyll *a* concentrations are graphed in Figure 15. High concentrations (>20 µg/L) of chlorophyll *a* were observed in August and September 2003 and July 2012. Figure 16 shows the trend in chlorophyll *a* concentrations over the period of record.

Table 10. Nutrient (total phosphorus) and chlorophyll *a* data collected on Fernan Lake.

Date	Data Source	Total Phosphorus (µg/L)			Chlorophyll *a* (µg/L)
		At Secchi Depth	Depth Integrated	1 meter off Bottom	At Secchi Depth
05/22/1990	LWQA[a]	16	—	18	—
06/26/1990	LWQA	17	—	25	—
08/08/1990	LWQA	13	—	26	—
09/17/1990	LWQA	22	—	30	—
10/30/1990	LWQA	21	—	—	—
06/24/2003	Isaacson[b]	—	16	—	3.0
07/21/2003	Isaacson	—	20	—	5.4
07/29/2003	Isaacson	—	21	—	6.1
08/07/2003	Isaacson	—	16	—	5.3
08/19/2003	Isaacson	—	22	—	7.2
08/27/2003	Isaacson	—	16	—	20.7
09/04/2003	Isaacson	—	27	—	30.3
09/15/2003	Isaacson	—	30	—	36.4
05/30/2008	CVMP[c]	19	—	22	10.6
06/30/2008	CVMP	20	—	32	7.8
07/30/2008	CVMP	18	—	38	3.3
08/28/2008	CVMP	23	—	36	9.6
09/30/2008	CVMP	20	—	19	3.1
10/21/2008	CVMP	15	—	22	4.9
01/28/2009	CVMP	8	—	—	—
05/17/2012	CVMP	14.9	—	43.3	1.7
07/05/2012	CVMP	26.4	—	27.5	21.1
08/31/2012	CVMP	23.1	—	—	10.5

[a] LWQA = 1991 DEQ Lake Water Quality Assessment Program (Mossier 1993)
[b] Isaacson = subcontracted monitoring work done by Allen Isaacson (FLCRA 2003)
[c] CVMP = Citizen Volunteer Monitoring Program

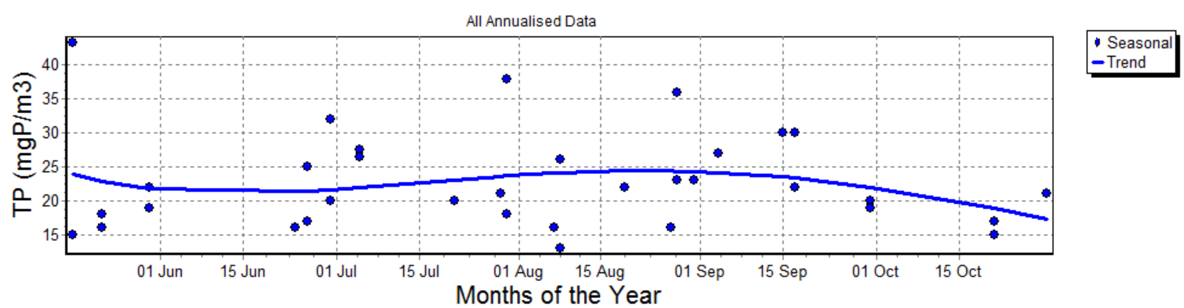


Figure 12. Annualized total phosphorus concentrations of Fernan Lake over period of record.

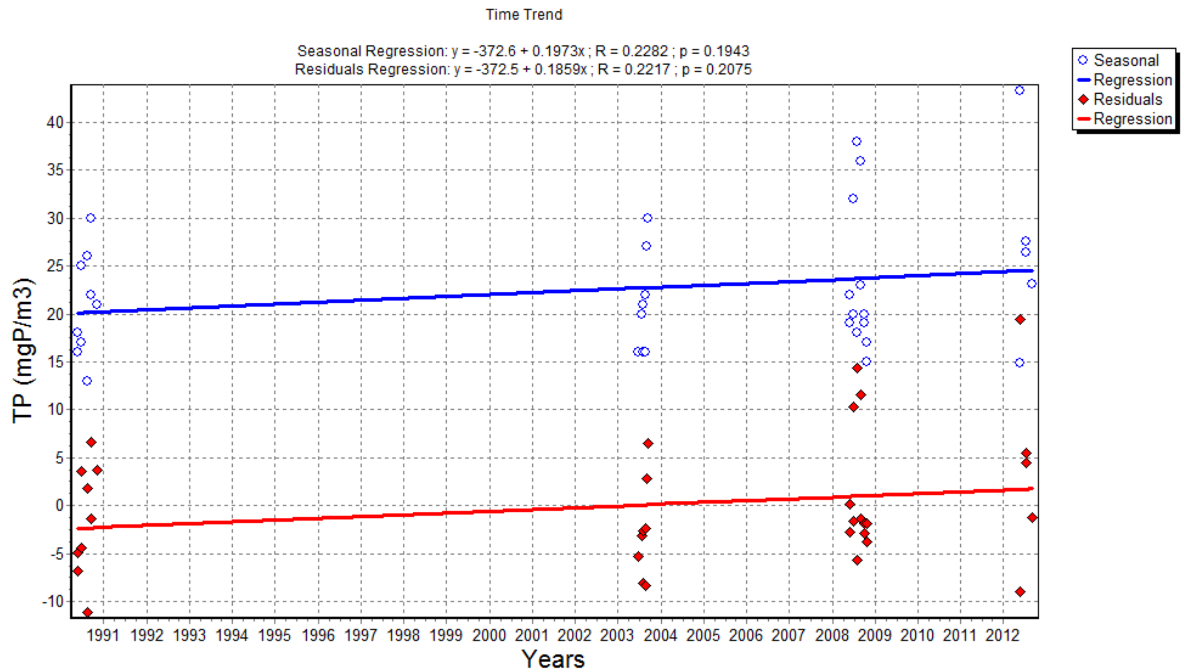


Figure 13. Trend in total phosphorus concentrations over period of record.

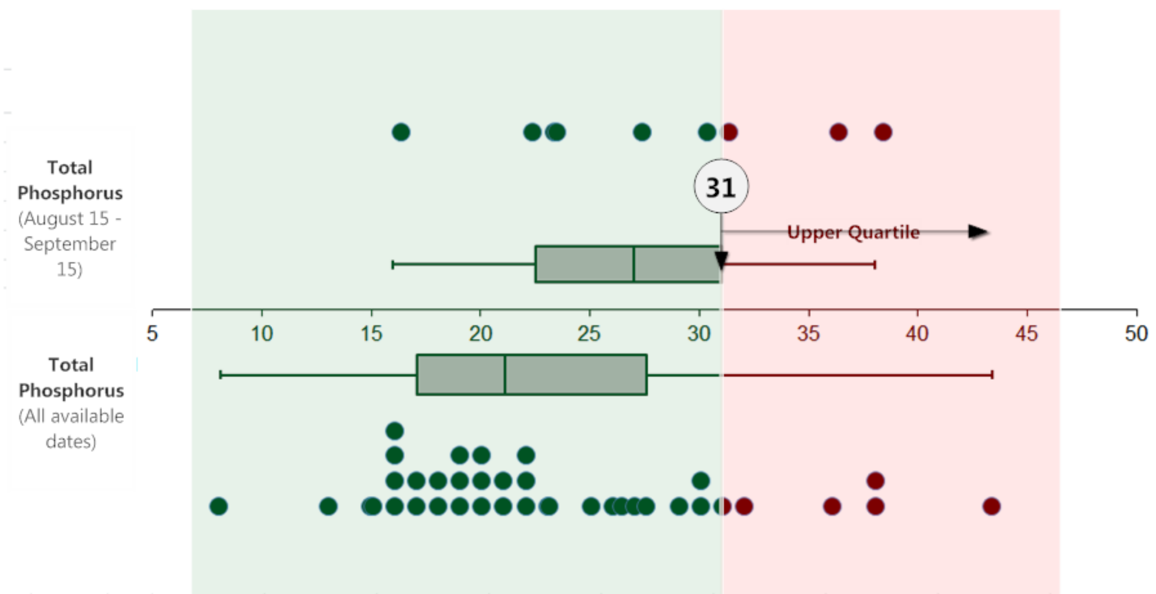


Figure 14. Distribution of total phosphorus concentrations (in micrograms per liter) showing upper quartile of record.

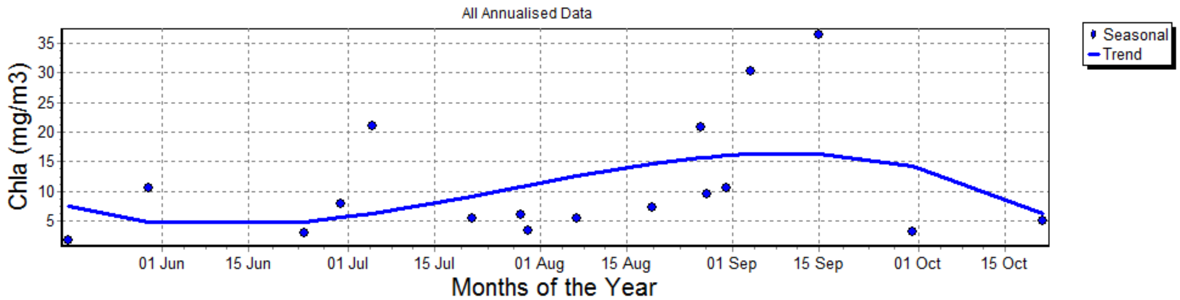


Figure 15. Annualized chlorophyll *a* concentrations of Fernan Lake over period of record.

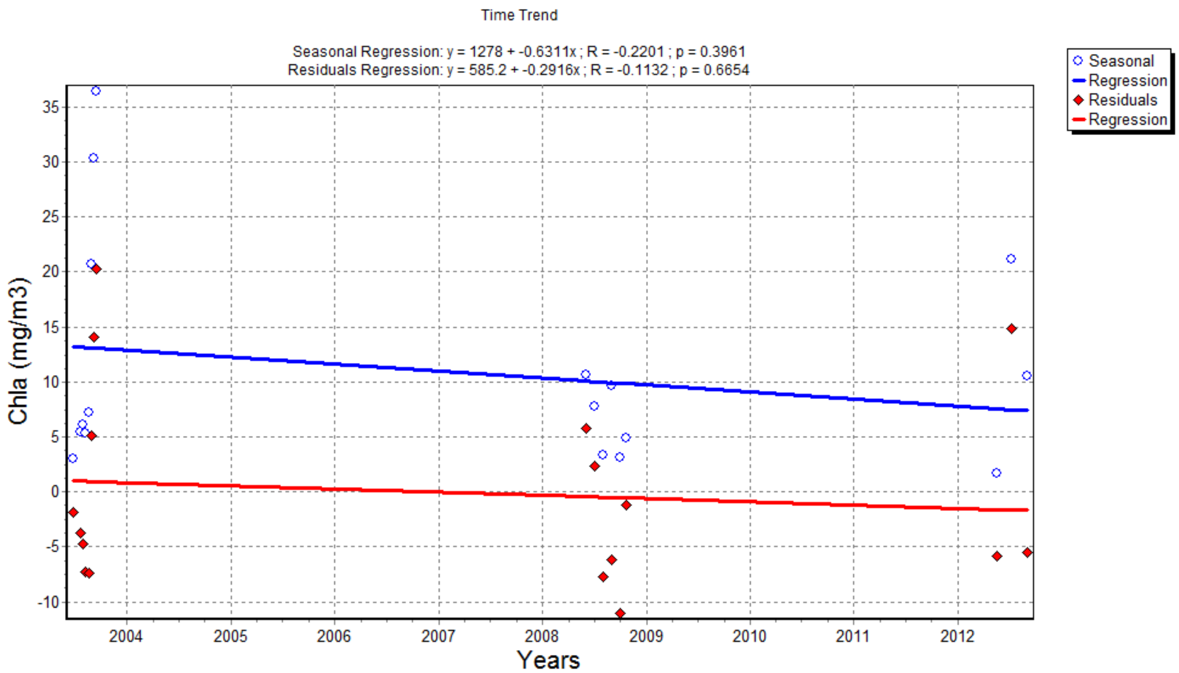


Figure 16. Trend in chlorophyll *a* concentrations over period of record.

2.4.3 Trophic Status of Fernan Lake

Trophic status describes the level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity. Mossier (1993) described the trophic status of Fernan Lake as mesotrophic to late mesotrophic. Falter (2001) examined historic data and conducted a series of assessments to conclude Fernan Lake is mesotrophic, but he cautioned that the shallow depth of Fernan Lake renders it susceptible to accelerated eutrophication.

Although new bathymetric data suggests a deeper mean depth than reported by Mossier (1993) and Milligan et al. (1983), the volume-to-surface area ratio is still low, which means the lake mixes from top to bottom throughout the summer. The isothermal conditions, shallow depth, and steep shoreline favoring less-abundant plant growth would lend to a trophic status in the mesotrophic range for Fernan Lake.

2.4.4 Biological and Other Data

No other recent data are available.

2.5 Data Gaps

While quality data were used to make this assessment, a continuous long-term data set was not available. As such, analysis of water quality trends and all the analyses based on Fernan Creek stream hydrology were not robust. It is important to collect several seasons of water quality and flow data from Fernan Creek to make and accurate evaluation of nutrient and sediment loading from the Creek. It is important to maintain a continuous water quality monitoring program in Fernan Lake using CVMP or other methods with appropriate data quality control.

3 Subbasin Assessment—Pollutant Source Inventory

This section includes an assessment of the known and suspected sources of phosphorus contributing to excess algae growth in Fernan Lake. Identified nutrient sources are categorized and quantified to the extent that reliable information is available. Sources of phosphorus may be point or nonpoint in nature.

3.1 Sources of Pollutants of Concern

Point sources—discrete end-of-pipe discharges—are typically regulated through the National Pollutant Discharge Elimination System (NPDES) program. In Idaho, this is administered by the EPA. Idaho Department of Environmental Quality writes water quality certifications on all NPDES permits. Point sources can be categorized as municipal, industrial, or stormwater discharges. Nonpoint sources are diffuse sources that typically cannot be identified as entering a water body at a single location. These sources are related to land activities that contribute phosphorus to surface waters as a result of runoff-producing storm events or ground water/surface water transfer. The following discussion describes what is known regarding point and nonpoint sources of TP contributing to the eutrophication of Fernan Lake.

3.1.1 Point Sources

Certain types of stormwater runoff are considered point source discharges for CWA purposes. Specifically, stormwater discharged from municipal separate storm sewer systems (MS4s) within U.S. Bureau of Census-delineated Urbanized Areas (UAs), stormwater discharges from certain types of industries (as defined in federal regulations at 40 CFR 122.26(b)(14)); and stormwater discharges from construction sites disturbing one or more acres must be permitted by the U.S. EPA. Regulated stormwater discharges within the Fernan Lake watershed include MS4 and construction site stormwater discharges. No regulated industrial stormwater discharges occur within the watershed.

The U.S. Census Bureau has delineated the Year 2010 Urbanized Area for the greater Coeur d'Alene vicinity, which is comprised of the densely-developed residential, commercial, and other non-residential land uses. Polluted stormwater runoff from this area may be transported through

MS4s into nearby waterbodies, or it may be transported directly into the waterbody. As mentioned above, urban stormwater discharged into receiving waters through an MS4 located within a UA is considered a regulated point source of pollutants under the federal CWA regulations; however, stormwater runoff discharging directly into the receiving water from residential areas (for example, from residential property directly adjacent to the lake) is considered a nonpoint source of pollutants.

The Coeur d'Alene UA includes land draining into the western portion of Fernan Lake (Figure 17). Fernan Lake Village is within the UA; However, Fernan Village does not own or operate an MS4; instead, stormwater from Fernan Lake Village is collected into a series of shallow injection wells. Therefore, stormwater from Fernan Lake Village is not considered a regulated point source, and is not required to manage stormwater under a NPDES permit. However, the MS4/drainage conveyance associated with Fernan Lake Road (and in particular, the portion of the Road located within the UA) is owned by Federal Highways Administration and operated by Eastside Highway District. In addition, the MS4/drainage conveyance associated with the Armstrong Park development is owned and operated by the City of Coeur d'Alene. Therefore, stormwater discharges from Fernan Lake Road and stormwater from the Armstrong Park development through this MS4 into Fernan Lake and its tributaries is considered a regulated point source discharge and therefore must be managed under a NPDES permit issued by EPA with water quality certification by the Idaho Department of Environmental Quality.

French Gulch drains the watershed to the north of Fernan Lake and joins Fernan Creek just below the outlet of Fernan Lake (see Figure 6). The MS4/drainage conveyance associated with the eastern Coeur d'Alene residential area and from I90 are owned and operated by the City of Coeur d'Alene and the Idaho Transportation Department, respectfully. Preliminary observations indicate under certain rainfall conditions, backwater from French Gulch flows into Fernan Lake. Preliminary data suggests this is very localized (just feet from the outlet culvert of Fernan Lake) and short-lived; however, because this condition exists, it is considered a point source and it must be managed under the NPDES MS4 permits issued to the City of Coeur d'Alene and Idaho Transportation Department.

Discharges from construction activities can be a significant source of pollutants including phosphorus. If a construction project disturbs more than 1 acre of land (or is part of a larger common development that will disturb more than 1 acre) and there is potential for stormwater discharge directly into a water body or indirectly through a municipal separate storm sewer, the operator is subject to regulations under the NPDES program (See 40 CFR 122.26(b) (14) (x) and (b) (15). Such activities must apply for NPDES coverage through the EPA's Construction General Permit.

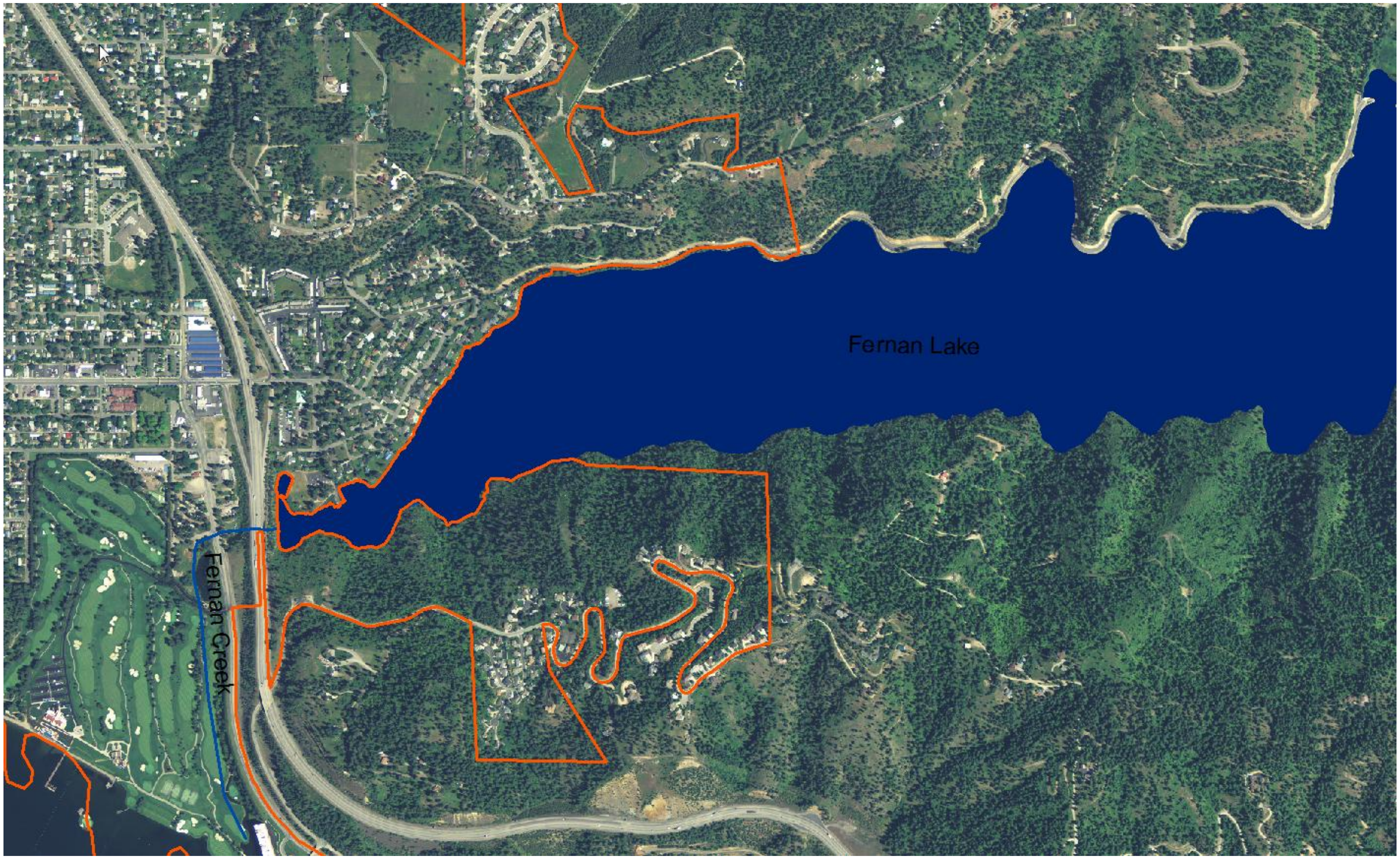


Figure 17. Map of the 2010 Census-Delineated Urbanized Area near Fernan Lake (area outlined in red).

3.1.2 Nonpoint Sources

Nonpoint TP sources are summarized below. The primary nonpoint source of pollution into Fernan Lake is the Fernan Creek watershed. Other sources of phosphorus are likely from the following sources: Fernan Lake Village lawns, stormwater injection wells from Fernan Lake Village and Fernan Hill Road, Fernan Lake Road outside the Urbanized Area, and septic effluent. Likely sources within the lake are internal cycling and submerged macrophytes on the east and west shores of the lake.

3.1.2.1 Fernan Creek Watershed

Approximately 80% of inflowing water to Fernan Lake is from Fernan Creek and its tributaries (Falter 2001). The Fernan Creek watershed is 3,980 ha (9,833 acres) in size: 2,810 ha (6,943 acres) (71%) on US Forest Service land, 1,142 ha (2,822 acres) (29%) in private ownership, and less than 1% wetlands (Figure 18).

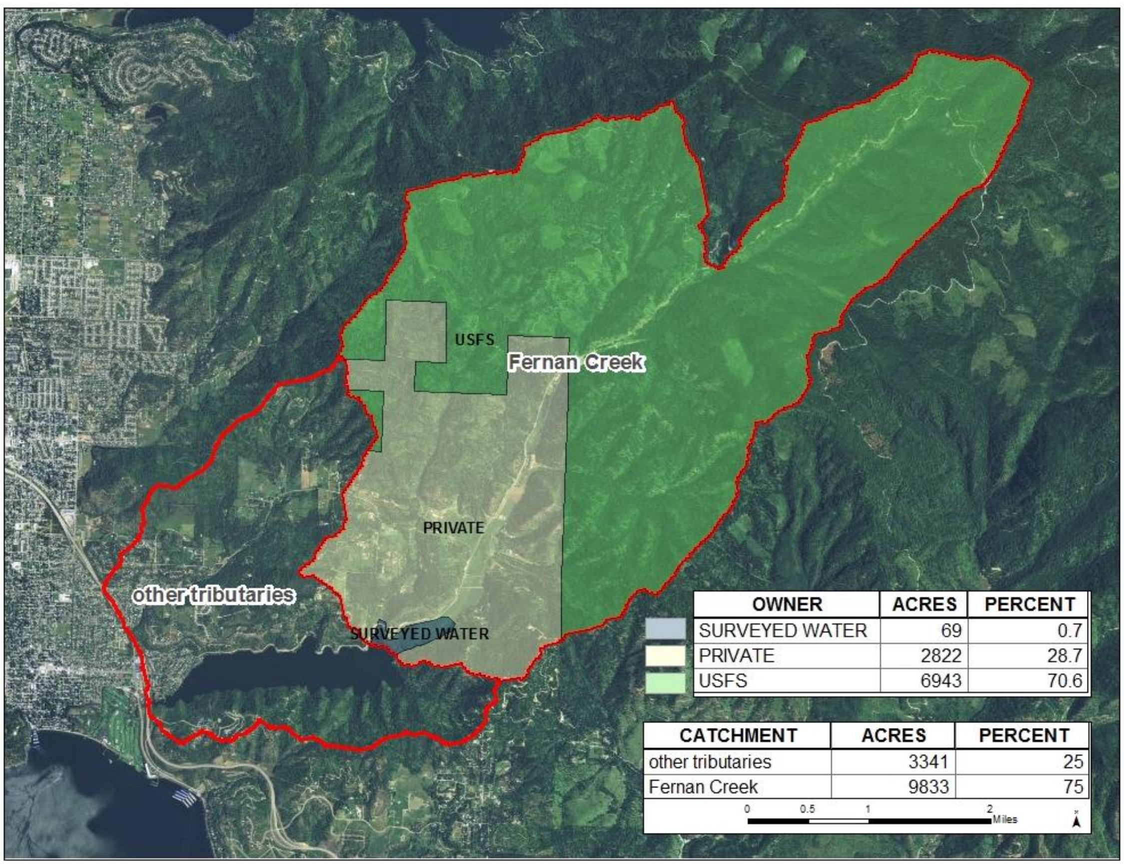


Figure 18. Fernan Creek watershed with landownership.

Sources of nutrients within the Fernan Creek watershed are described below:

- **US Forest Service property**—This property overlies the Middle Preterozoic Prichard geologic formation, which is parent material to highly erodible fine-grained silt and clay soils. As described in section 2.3, phosphorus adsorbs to soil; therefore, the primary transport mechanism of phosphorus is through transport of soil from runoff. Although much of the phosphorus load from the watershed is naturally occurring transport of phosphorus through runoff from forested areas, best management practice (BMP) implementation is critical on such erodible soils. Road and timber-harvest activities have the potential to increase the phosphorus load to Fernan Creek through runoff events. Road construction, poorly maintained roads, and timber harvest increase water yield and sedimentation in the watershed. The increase in water yield and sediment/phosphorus transport to the creek is directly related to the location and extent of timber harvest and road construction and maintenance activities.

- **Lower Fernan Creek Road Project**—Much disturbance has occurred to lower Fernan Creek, resulting in excessive erosion/sedimentation of the stream channel. In 2009, the Federal Highway Administration reconstructed Fernan Creek Road. However, in the process, they removed riparian vegetation and changed stream channel characteristics (Figure 19). In October 2009, the Federal Highway Administration attempted to restore the stream channel, which included a series of grade control structures made with boulders (Figure 20). The stream channel is in the process of revegetating (Figure 21). Excess material resulting from the road reconstruction project has been stockpiled near the Fernan Creek channel (Figure 22). Some erosion controls are in place on this stockpile. However, the creek is significantly eroding the toe of the stockpile, which is contributing to sedimentation/aggradation downstream and nutrients to Fernan Lake (Figure 23).


Figure 19. Fernan Creek before and after Federal Highway Administration road project. Pictures are from August 13, 2004 (left), and August 27, 2009 (right—photo courtesy of US Forest Service).


Figure 20. Restored stream channel with rock barbs (October 23, 2009).

Figure 21. Restored stream channel with new vegetation growth (May 1, 2012). Photos courtesy of US Forest Service.

Figure 22. Stockpiled material from road cutslope, Fernan Creek Road project—January 21, 2009.

Figure 23. Stockpiled material from road cutslope, Fernan Creek Road project—November 14, 2012.

- **Lower Fernan Creek Widening**—Just upstream of the Federal Highway Administration stream restoration project, Fernan Creek has overwidened, causing significant channel bank erosion (Figure 24). This widening contributes to downstream channel aggradation and nutrient loading to the lake.
- **Lower Fernan Creek Diminished Channel Capacity**—Within the depositional reaches of lower Fernan Creek, channel capacity for flow has diminished; therefore, the adjacent agricultural fields are flooding more frequently—and likely transporting fertilizer and topsoil-bound nutrients from the fields to Fernan Creek (personal communication, landowner) and eventually into Fernan Lake. In one reach, an agricultural field is perched above the floodplain with little channel capacity (Figure 25).

Figure 24. Overwidened eroding section of Fernan Creek, November 14, 2012.

Figure 25. Agricultural field perched above the floodplain with little channel capacity.

- **Fernan Rod and Gun Club**—The Fernan Rod and Gun Club is located on US Forest Service property. To adhere to strict safety rules, several berms have been created on the property immediately adjacent to Fernan Creek (Figure 26). Due to its close proximity to the berms, Fernan Creek may be eroding the toe of these berms, which may be contributing nutrients and excess sediment downstream.

Figure 26. Fernan Rod and Gun Club.

- **Stacel Creek**—During spring runoff, high-turbidity water has been observed from Stacel Creek into Fernan Creek. Land use in this subwatershed is primarily agriculture and forest practices.

3.1.2.2 Fernan Lake Village

Because Fernan Lake Village is adjacent to the lake, it is reasonable to assume phosphorus loading from lawn and garden activities and stormwater injection wells from Fernan Lake Village and Fernan Hill Road contributes phosphorus to the lake. Gradients of higher concentrations of water column algae have been observed in the lake, with the water often greener near Fernan Lake Village. In addition, Falter (2001) observed high organic sediments in Fernan Lake just off Fernan Lake Village, which may indicate a local nutrient source feeding a more abundant plant community.

The soils in Fernan Lake Village have a high sand and gravel percentage, low water holding capacity, high hydraulic conductivity, and minimal calcium carbonate (NRCS 2012). As such, the soils have a lower maximum phosphorus sorption capacity, and water applied in excess of the soil water holding capacity can move downward past the root zone into ground water and connected surface water. Furthermore, the repeated application of fertilizers and organic material to soils may saturate existing phosphorus-sorption capacity, rendering soils less capable of phosphorus retention.

3.1.2.2.1 Lawn and Garden

Green, healthy lawns need phosphorus, which they get through fertilization. Phosphorus concentration is the “P” of the N-P-K numbers on fertilizer packaging. Phosphorus is an essential nutrient for plant growth and plays an important role in photosynthesis and energy movement in plant tissues. Some of the phosphorus in a fertilizer application is used by the plant, but any excess leaches downward past the root zone, into the soils, and into ground water and connected surface water. Knowing the minimal amount of phosphorus to add when fertilizing is difficult and requires soil testing. Most fertilizer applicators over-apply phosphorus. It is likely that fertilizer over-application occurs in Fernan Lake Village, and phosphorous is being transported to Fernan Lake.

3.1.2.2.2 Fernan Village Stormwater Injection Wells

Stormwater is the water runoff that comes from roadways with curb and gutters, collection drains, and transport pipes. Stormwater can increase nutrient loading to surface waters. Geographic, physical, and climatic factors all play a part in the extent of pollutants that will make it to surface water through stormwater runoff. Stormwater from Fernan Lake Village and Fernan Hill Road is collected into a series of shallow injection wells installed in 1997 (Figure 27). Due to their close proximity to the lake, stormwater from these injection wells is assumed to have a hydrologic connection to Fernan Lake. Therefore these stormwater injection wells are likely a nonpoint source of phosphorus to the lake.

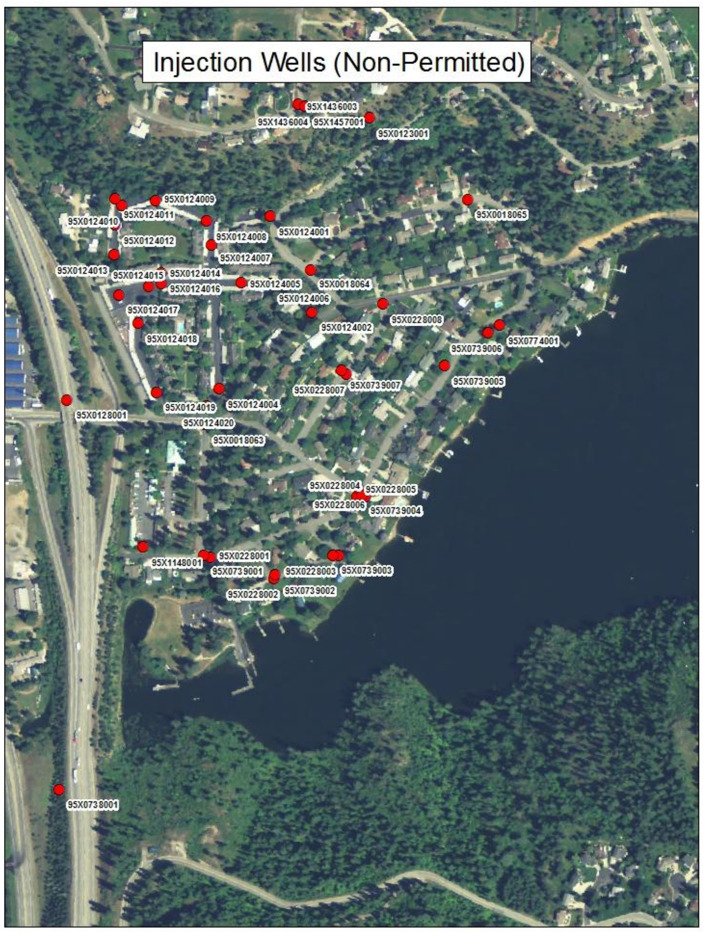


Figure 27. Location of shallow injection wells in the Fernan Lake Village area. Source of information: Idaho Department of Water Resources, 2013.

3.1.2.3 Fernan Lake Road (outside the City of Coeur d'Alene Urbanized Area boundary)

Fernan Lake Road is a heavily used 28.5-km (17.7-mile) road that parallels the northern shore of Fernan Lake before following Fernan Creek up to the Fernan Creek saddle in the Coeur d'Alene National Forest. A portion of this road falls within the UA and it is regulated under the EPA NPDES program; however, most of this road is not within the UA and pollutant loading from this section of the road is nonpoint in nature.

Falter (2001) identified the close proximity of the road to the lake as a reason why sediment and nutrient loadings to the lake from the road were substantial. In 2009, the Federal Highway Administration completed roadway construction that widened and stabilized the road and installed sediment and runoff control measures. These measures appear to be working properly. However, even properly functioning road BMPs will not totally sequester all nutrients; therefore, the following are factors that indicate that the road is likely a source of sediment/phosphorus to the lake:

- Stormwater routed through drainage ditches into relief culverts have been observed to discharge into Fernan Lake during prolonged precipitation events.
- Due to their proximity to the lake, the sediment and runoff control measures may not have enough retention time to sequester all nutrients from the road.
- Riparian vegetation between the road and Fernan Lake is minimal, leaving little buffer for sediment/phosphorus transport into the lake.
- Extremely large cutslopes of exposed/weathered bedrock may be a source of sediment/phosphorus during rain/runoff conditions.

3.1.2.4 Septic

In 1978, the city of Fernan Lake Village converted from septic systems to incorporation into the City of Coeur d'Alene's sewer/waste treatment system. Parcel maps from Kootenai County indicate residences that are on private septic systems within 91 m (300 feet) of the lakeshore. However, the Panhandle Health District estimates the load from these septic systems to Fernan Lake is probably no more than 5% of the total load (Fernan Lake Technical Advisory Committee 2003).

3.1.2.5 Internal Phosphorus Cycling Within the Lake

Neither detailed hydrologic studies nor specific modeling have been conducted to evaluate the internal dynamics of nutrient cycling within Fernan Lake. As with all lakes, internal sources of phosphorus include nutrient releases from lake sediments and decomposition of aquatic plants. Historical land-disturbing activities such as logging, construction, and agricultural activities in the watershed have introduced large amounts of phosphorus-containing sediments that accumulated at the bottom of the lake. Fernan Lake's infrequent stratification can result in reduced DO conditions near the bottom of the lake, which enhance phosphorus moving up into the water column. The steep northern and southern shorelines of Fernan Lake, with their rapid drop-off to the 6 m depth, preclude the excessive growth of aquatic plants like lily pads. Much of the water flows through Fernan Lake, which also suppresses excessive growth of aquatic plant species. Additional lake study and modeling, which is beyond the scope of this TMDL, may be warranted to better define the contributions of TP from internal lake dynamics. It is reasonable to conclude that internal cycling of TP is not a high percentage of the total TP load to Fernan Lake.

3.1.2.6 Other Nonpoint Sources

Other nonpoint sources are addressed together in this document, not because they are not important, but because of the lack of data to accurately quantify the load from these sources individually. These nonpoint sources include the following:

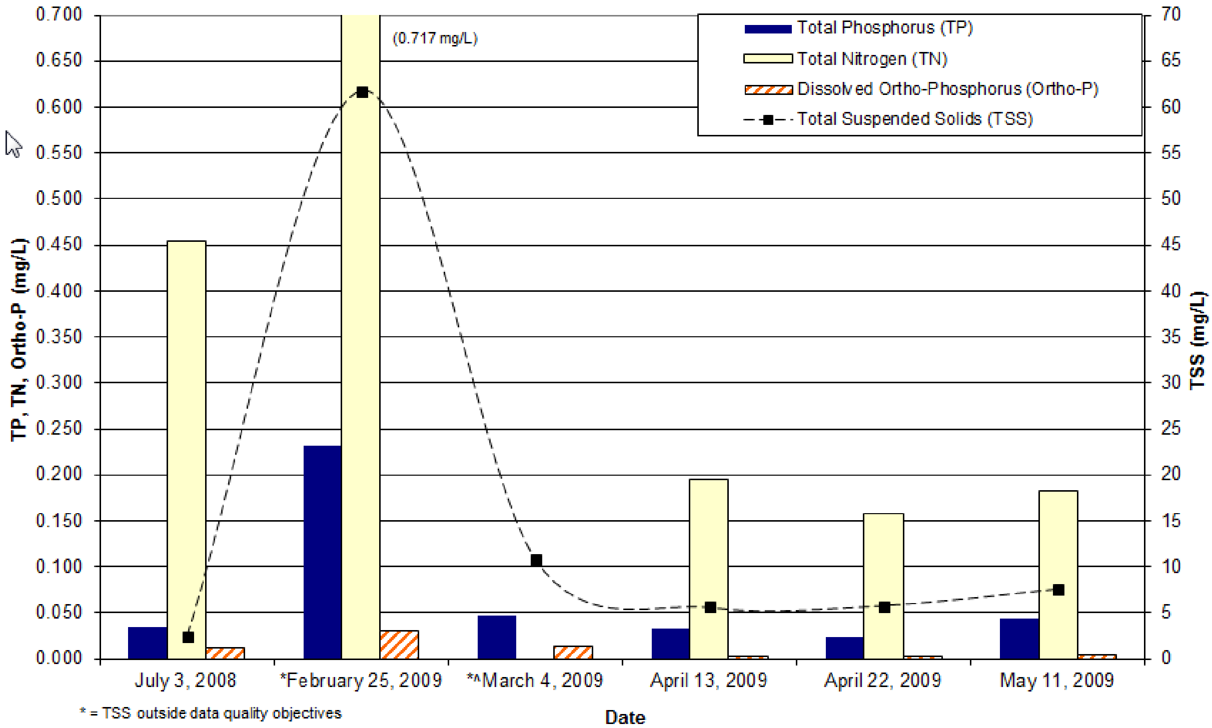
- Undeveloped property on the northern end of the lake
- Dispersed campgrounds on the southern end of the lake— these sites are only accessible by boat. Due to the lack of bathroom facilities at these heavily used sites, runoff from these sites likely produces a nutrient load to the lake.
- Submerged macrophyte growth in shallow areas on the eastern and western ends of the lake—Recent data collected on the southern end of Coeur d’Alene shows these areas have increased TP concentrations in the water column (Glen Rothrock, DEQ, pers. comm., 2012).
- While the dam below Fernan Lake is not a pollutant source, the management of the dam may have implications on wetland inundation and flushing flows in Fernan Lake and therefore on concentrations of TP in the lake.

3.1.3 Pollutant Transport

Most phosphorus loading to Fernan Lake is the result of nonpoint transport to the lake directly from the watershed either through runoff or movement through soils to ground water that discharges into the lake. The extent that phosphorus enters Fernan Lake from either of these pathways is dependent on soil characteristics.

The dominant soils adjacent to Fernan Lake have a high percentage of sand and gravel. They are classified as well-drained to excessively-drained, and they are rated “very limited” with regard to septic absorption field filtering capacity and seepage by the Natural Resources Conservation Service (NRCS 2012). The lack of calcium carbonate and low percentage of clay limits the soil’s ability to attenuate phosphorus, which supports this rating. Land use activities generating TP may have a percentage of phosphorus that percolates though the soil into ground water, which can discharge to Fernan Lake. However, phosphorus would be quickly bound to soil when it reaches the lake.

The primary pollutant transport pathway for phosphorus within the Fernan Lake watershed is sediment-bound phosphorus transported from rainfall/snowmelt runoff from Fernan Creek. A 2008–2009 DEQ study on 13 tributaries to Coeur d’Alene Lake during winter rain-on-snow events, spring runoff, and low-flow conditions showed the close correlation between TP concentrations and sediment. The highest suspended solids and nutrient concentrations were observed during early rain-on-snow events and spring runoff (DEQ 2010a) (Figure 28). The study calculated TP loading from the tributaries to Coeur d’Alene Lake by multiplying the TP concentration by the flow of the creek at the time of sample collection. The study concluded that TP loading was greatest during spring runoff (Figure 29).



^TN outside data quality objectives *TSS outside data quality objectives

Figure 28. Nutrient and suspended solids concentrations in Fernan Creek in 2008–2009. A rain-on-snow event occurred on February 25 (DEQ 2010a).

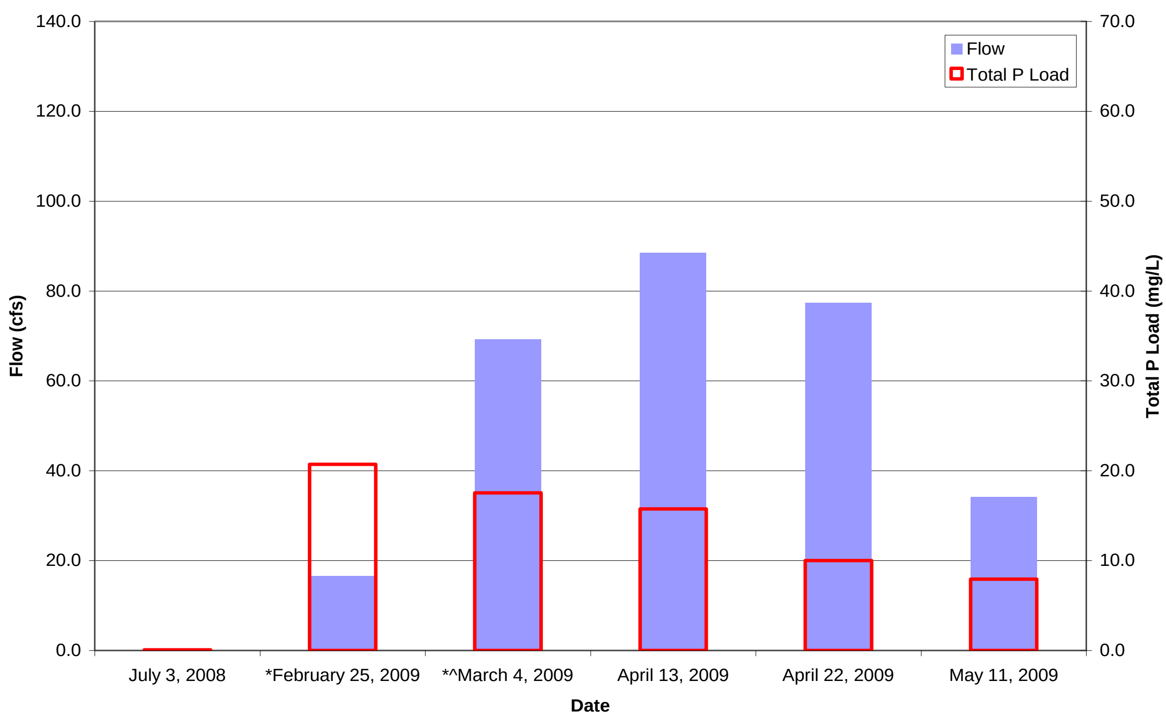


Figure 29. Total phosphorus loading from Fernan Creek in 2008–2009. A rain-on-snow event occurred on February 25 (DEQ 2010a).

Although higher concentrations of TP are a concern for loading to Fernan Lake, much of the higher flows pass through the lake, and colder temperatures are not conducive to aquatic plant growth during the winter and early spring months. However, the dissolved orthophosphorus to TP ratios during base-flow period in tributaries to Coeur d'Alene Lake were above that of reference streams in the region, suggesting bioavailable phosphorus may be a concern for beneficial uses for the streams and for loading to Coeur d'Alene Lake (DEQ 2010a). Results of this study also suggest higher concentrations of dissolved orthophosphorus from Fernan Creek at base flow to Fernan Lake is likely.

3.2 Data Gaps

Limited data were available for developing this TP TMDL for Fernan Lake. The following summarizes the various data gaps that limit the accuracy of accounting for all the variables associated with the point and nonpoint sources of phosphorus and their effect on the eutrophication of Fernan Lake**.** Where appropriate, these assumptions are identified and incorporated into the margin of safety, as discussed in section 5.

- No long-term water quality data exist immediately upstream of Fernan Lake to more accurately estimate phosphorus loading from the Fernan Creek watershed. It is important to characterize the pollutant sources in the Fernan Creek watershed to better allocate resources for TMDL implementation.
- No long-term water quality data exist for the unnamed tributaries that flow into Fernan Lake's northeast inlet. It is also important to understand the load from this creek into Fernan Lake.
- Additional data and modeling may improve understanding of TP contributions from internal lake dynamics.
- A ground water contribution of TP to the lake is likely, and additional studies are necessary to understand this contribution.
- No data have been collected to accurately characterize the nutrient load from storm drains, injection wells and lawn/garden fertilizers from Fernan Lake Village and Fernan Hill Road.
- No data have been collected to accurately characterize the nutrient load from Fernan Lake Road.
- While the dam below Fernan Lake is not a pollutant source, the management of the dam may have implications for TP concentrations in the lake. An evaluation of dam management and its effect on TP concentrations in the lake would be very valuable.
- French Gulch drains the watershed to the north of Fernan Lake and joins Fernan Creek just below the outlet of Fernan Lake (see Figure 6). More data needs to be collected to accurately characterize conditions when French Gulch backs up through the outlet of Fernan Lake and TP loading to the lake that results.

4 Subbasin Assessment—Summary of Past and Present Pollution Control Efforts

In 1978, the City of Fernan Lake Village converted from septic systems to incorporation into the City of Coeur d'Alene's sewer/waste treatment system. This project greatly reduced the amount of phosphorus delivered to Fernan Lake.

In 1996, the FLCRA was formed with a mission to preserve the scenic and natural resource value of the Fernan Lake watershed and enhance its beneficial uses, both public and private, utilizing sound conservational practices (Susan Andrews, FLCRA, pers. comm.). The group has worked with the City of Coeur d'Alene officials to pass city ordinances protecting the lake; participated in the DEQ-facilitated CVMP; contracted land use, geological, and water quality professionals to collect valuable data; put together a technical advisory committee to develop a Fernan Lake watershed plan; and educated the community on land use practices protective of the lake.

In March 2003, the Coeur d'Alene mayor and city council passed a hillside ordinance requirement for property annexed within the Fernan Lake watershed. The ordinance bans property development on slopes 35% or greater. It also requires the *Fernan Lake Management Plan* be considered in making land-use decisions within the Fernan Lake planning area (City of Coeur d'Alene 2003).

In 2009, the Federal Highway Administration widened and stabilized Fernan Lake Road and installed sediment and runoff control measures. This project was a vast improvement from the existing road, which was documented to be a large source of nutrients to Fernan Lake (Mossier 1993; Falter 2001).

5 Total Maximum Daily Load(s)

A TMDL prescribes an upper limit (i.e., load capacity) on discharge of a pollutant from all sources to ensure water quality standards are met. It further allocates this load capacity among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation, and nonpoint sources, each of which receives a load allocation. Natural background contributions, when present, are considered part of the load allocation but are often treated separately because they represent a part of the load not subject to control. Because of uncertainties about quantifying loads and the relation of specific loads to attaining water quality standards, the rules regarding TMDLs (40 CFR Part 130) require a margin of safety be included in the TMDL. Practically, the margin of safety and natural background are both reductions in the load capacity available for allocation to pollutant sources.

Load capacity can be summarized by the following equation:

$$LC = MOS + NB + LA + WLA = TMDL$$

Where:

LC = load capacity
MOS = margin of safety
NB = natural background

LA = load allocation
WLA = wasteload allocation

The equation is written in this order because it represents the logical order in which a load analysis is conducted. First, the load capacity is determined. Then the load capacity is broken down into its components. After the necessary margin of safety and natural background, if relevant, are quantified, the remainder is allocated among pollutant sources (i.e., the load allocation and wasteload allocation). When the breakdown and allocation are complete, the result is a TMDL, which must equal the load capacity.

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, determining critical conditions can be more complicated than it may initially appear.

Another step in a load analysis is quantifying current pollutant loads by source. This step allows for the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary for pollutant trading to occur. A load is fundamentally a quantity of pollutant discharged over some period of time and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for "other appropriate measures" to be used when necessary (40 CFR 130.2). These other measures must still be quantifiable and relate to water quality standards, but they allow flexibility to deal with pollutant loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1 Instream Water Quality Targets

The goal of the Fernan Lake TMDL is to restore "full support of designated beneficial uses" (Idaho Code 39-3611, 39-3615). The designated beneficial use targeted for restoration is the long-term maintenance of the primary contact recreation use. Fernan Lake's §303(d) listing is based on not meeting Idaho water quality standards narrative criteria and the presence of a number of recent potentially toxic blooms of blue-green algae where health advisories were placed on Fernan Lake. As such, DEQ and other federal and local agencies and stakeholders are establishing and implementing a TMDL for TP for Fernan Lake.

5.1.1 Target Selection

According to 40 CFR 130.7(c)(1), "TMDLs shall be established at levels necessary to attain and maintain the applicable narrative and numerical water quality standard." Since numeric nutrient criteria (absolute numeric values for TP) do not exist in the Idaho water quality standards, a critical step in developing the TMDL is identifying a numeric value to serve as the water quality target. A target level of 20 µg/L TP has been selected to represent the narrative criteria and reduce the number of blue-green algae blooms to a frequency occurring in unimpacted waters similar to Fernan Lake. Blue-green algae blooms happen naturally in unimpacted lakes, but not as frequently as they occur in Fernan Lake. The TMDL goal is to reduce the frequency of these blooms.

5.1.1.1 Rationale for Total Phosphorus Water Quality Target

A water quality target was established by reviewing conditions and existing TMDLs from neighboring lakes in Idaho and Washington. Available analyses included a DEQ nutrient data inventory of similar lakes in the region and TMDLs on two other comparable lakes in the region: Black Lake, also in the Coeur d'Alene Lake subbasin, and Newman Lake in eastern Washington.

5.1.1.1.1 DEQ Nutrient Data Inventory Summary

DEQ compiled baseline study data collected by DEQ and data collected by Citizen Volunteer Monitoring Program (CVMP) for Upper Priest, Spirit, and Upper Twin Lakes to compare TP ranges and trophic status. While DEQ acknowledges differences in limnology and trophic status between these three lakes and Fernan Lake, this data compilation was useful in demonstrating other practical ranges of TP concentrations for consideration when setting a lake-specific water quality target. Figure 31 displays the results of the DEQ data analysis of TP concentrations for the three lakes as well as Cocolalla, Lower Twin, and Hauser Lakes in Idaho.

Table 11 compares the EPA-recommended reference nutrient values—8.00 µg/L for TP—to the DEQ regional reference values for TP for the select group of lakes, ranging from 6 to 18 µg/L. This reference value is discussed in more detail in section 5.1.1.2.

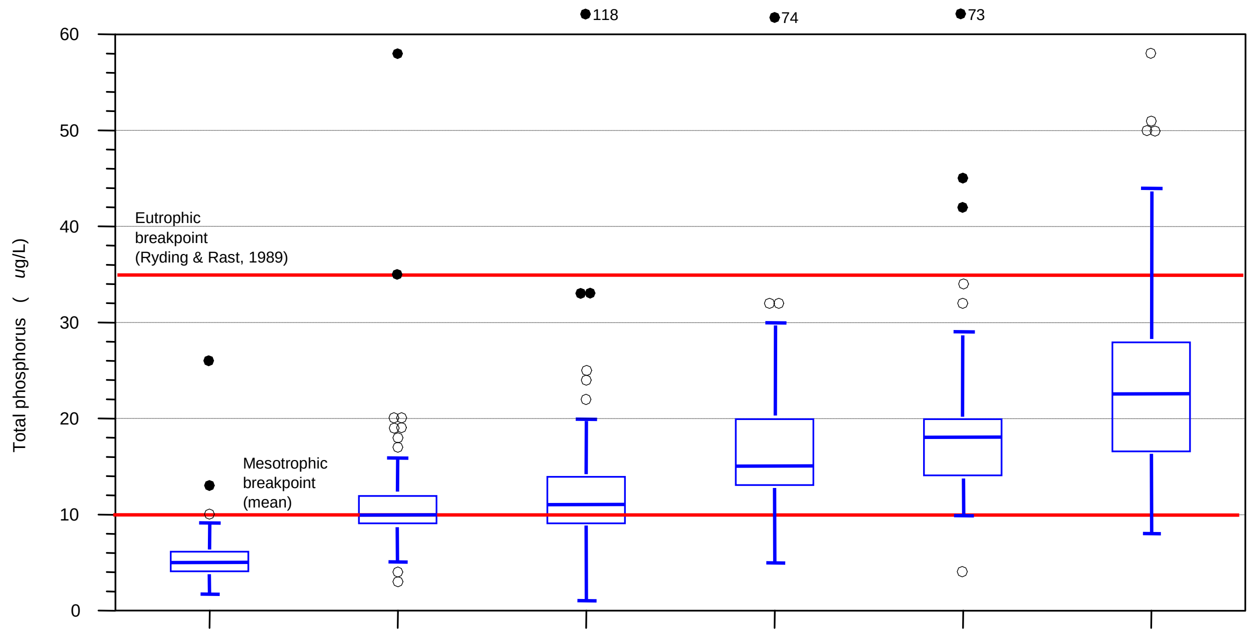


Figure 30. Northern Idaho sampling results among mid-size evaluated lakes from baseline studies and Citizen Volunteer Monitoring Program (CVMP) monitoring—mean total phosphorus in photic zone, April–October.

Table 11. Comparison of nutrient values with method detection limits.

Constituent	State of Idaho Aquatic Uses Criteria	EPA Recommended Nutrient Reference Value (µg/L)	Mean Seasonal, April–October (µg/L)			Method Detection Limit (µg/L)
			Upper Priest Lake	Spirit Lake	Upper Twin Lake	
Chlorophyll *a*	—	2.1[a] (Fluorometric method)	2.0[b] (1.9 median)	3.5[c] (2.5 median)	6.1[c] (5.6 median)	5 (Spectro. method)
Total phosphorus	Narrative criteria[d]	8.00[a] (summer)	6[b] (5 µg/L median)	12[c] (10 µg/L median)	18[c] (16 µg/L median)	10[e] (EPA 365.3)
Total Kjeldahl nitrogen (TKN)	Narrative criteria[d]	50[a]	115[b]	380[f]	260[g]	50

[a] EPA National Ecoregion Nutrient Guidance (EPA 2001). See section 5.1.1.2 for more information.
[b] DEQ baseline study, 1993–1995 (Rothrock and Mosier 1997)
[c] Citizen Volunteer Monitoring Program (CVMP) 1988–2002—oversight by DEQ
[d] Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses (IDAPA 58.01.02.200.06). Nutrients or other substances from anthropogenic causes shall not be present in concentrations which will produce objectionable algal

densities or nuisance aquatic vegetation, result in a dominance of nuisance species, or otherwise cause nuisance conditions.
[e] EPA Method 365.3 is the typical method used for TP analysis. Some laboratories have developed techniques that deliver a lower MDL that reliably meets or exceeds data quality objectives, but caution should be used when comparing data of unknown origins and varied laboratory techniques.
[f] Eastern Washington baseline study 1984 Soltero and Hall 1985)
[g] University of Idaho study 1985–1986 (Falter and Hallock1987)

5.1.1.1.2 Black Lake TMDL

Black Lake is located in Kootenai County, is one of several lateral lakes along the Coeur d'Alene River, and is similar to Fernan Lake. It is 346 acres in size with a maximum depth of 7.3 m. Black Lake has an HRT of 0.55 years. Like Fernan Lake, Black Lake may have periodic stratification June through August due to wind/wave action. A variety of data sources were used to develop a recommendation for the Black Lake TP water quality target, including EPA national ecoregion recommendations, DEQ nutrient data from regionally similar lakes, and a paleolimnology study conducted on Black Lake (DEQ et al. 2011). The TP water quality target recommended for the Black Lake TMDL is 20 µg/L. This TMDL was approved by EPA in 2012 (DEQ et al. 2011).

5.1.1.1.3 Newman Lake TMDL

Newman Lake—a shallow lake located 41.8 km (26 miles) northeast of Spokane, Washington—experienced frequent blue-green algae blooms in the late summer (WADOE 2007). Newman Lake is a mesotrophic-eutrophic lake with a volume of 26,146,829 m^3, a mean depth of 5.1 m (16 feet), and a maximum depth of 9 m (30 feet). Approximately 70% of the watershed has forestry as the dominant land use.

Unlike Fernan Lake, the primary source of phosphorus causing the algae blooms was from the lake sediments in late summer (WADOE 2007). To reduce this source, the whole lake was treated with alum in 1989 and a hypolimnetic oxygenator was installed in 1992. Despite these efforts, Newman Lake remained on Washington's §303(d) list of impaired waters due to phosphorus. As such, a TMDL was written and approved by EPA in 2007. The TMDL established a target TP concentration of 20 µg/L during June through August based on Washington Department of Ecology's recommended TP lake criteria for the Northern Rockies ecoregion.

5.1.1.2 Discussion of EPA National Ecoregion Nutrient Guidance

Between 1998 and 2003, EPA developed and finalized nutrient guidance to assist states and tribes in adopting nutrient standards. EPA's recommended reference values are statistically derived from a comparison within a population of rivers that are minimally impacted by human activities in the same ecoregion class. These values disregard the nexus between causal relationships of nutrient levels and adverse water conditions. EPA developed recommended reference values by distinguishing natural background from anthropogenic eutrophication in ecoregions around the country. EPA used standardized statistical methods of establishing guidance values designed to reflect reference conditions in each water body type (rivers and streams, lakes and reservoirs, wetlands) within each ecoregion. The lake reference values were developed by combining data for all lakes within each ecoregion, then applying a statistical evaluation resulting in a single number for each water quality constituent.

The guidance reference value was not appropriate for Fernan Lake for several reasons. One issue affecting the acceptability of the EPA ecoregion-based nutrient reference value is the level of spatial resolution and specificity. At Level III of this regional classification system, the continental United States contains 104 ecoregions. Idaho has 10 Level III ecoregions (see *http://www.epa.gov/wed/pages/ecoregions/id_eco.htm* for a map and descriptions of ecoregions). The Level III ecoregion containing Fernan Lake is Ecoregion 15, which encompasses the upper two-thirds of Idaho, plus a portion of western Montana.

The guidance reference value of greatest interest for Fernan Lake during the summer months is the TP concentration. Within Ecoregion 15, 25 data events represented TP during the summer months; at least 3 of those, and possibly more, are represented by concentrations of 0.00. Labs do not report zeros, and it is unclear what these zeros represent. They could represent missing samples or below detection lab results. These zeros were included in EPA's analysis and were used to calculate an ecoregion TP guidance value. As such, the EPA TP reference guidance value for these 25 events, and applicable to Fernan Lake, is 8.00 µg/L (EPA 2000). The reported value is likely to be less certain than depicted and probably only one significant figure. As a point of comparison, lake water samples from British Columbia lakes (within the same ecoregion) suggest a natural or reference level of TP between 6 and 15 µg/L (John Stockner, pers. comm., 2004).

5.1.2 Conclusions and Recommendations for Total Phosphorus Water Quality Target

Fernan Lake is a mesotrophic lake that would naturally have an intermediate level of productivity and should be commonly clear with some submerged aquatic plants and a medium level of nutrients. An appropriate water quality target should correlate with this mesotrophic status. DEQ used the data analysis presented in Figure 31 to define the range of 10–35 µg/L TP as representative of a mesotrophic lake in north Idaho. Lakes neighboring Fernan Lake with concentrations commonly lower than 20 µg/L (Spirit, Upper Priest, Lower Twin, and Upper Twin Lakes) typically do not have blue-green algae blooms. The Fernan Lake TMDL TP target is 20 µg/L. DEQ assumes that reductions in TP to meet this water quality target will reduce the rate of eutrophication and diminish the conditions that cause excess algal blooms in Fernan Lake. Meeting this target may also result in improved DO concentrations to levels that will support aquatic life, which should decrease release of TP from the sediments in the lake bottom.

The ultimate goal of a TMDL is to support beneficial uses, not solely to meet target criteria. Should reductions in pollutant loading result in achieving beneficial uses prior to meeting the recommended target, then it may be unnecessary to reduce loads further to meet the target (except to allow for a margin of safety). Similarly, if the target was to be met and beneficial uses not supported, the chosen target would be reexamined and possibly made more stringent. This assessment will be made during the 5-year review of the TMDL.

5.1.3 Monitoring Points

The Fernan Lake deep monitoring station should continue to be used as the primary monitoring location to evaluate future progress toward restoring and maintaining the primary contact recreation use. Currently, the CVMP is the primary entity to collect these data. For Fernan Lake, the target should be evaluated based on an average concentration of TP of one sample per month, July through September, within the isothermal or epilimnion portions of the water column. This progress measurement could also be compared to an annual average TP concentration, which should be used to demonstrate a statistical trend toward the 20 µg/L target. Showing progress of TP reductions over time by comparing the target to an annual average TP concentration is a practical approach for managing nonpoint sources and long-term recovery of uptake in Fernan Lake.

Monitoring should also occur at a minimum at the mouth of Fernan Creek. Given that it is the primary perennial tributary to Fernan Lake, it is important to understand the load of phosphorus going into the lake.

5.2 Load Capacity

The load capacity of Fernan Lake is defined by the amount of phosphorus a water body can have and still support its beneficial uses. The load capacity of Fernan Lake is expressed by the following equation:

$$LC = Concentration_{Target} \times Volume_{Fernan\ Lake}$$

With a target concentration of 20 µg/L and a volume of 7.9 million m^3, the load capacity of Fernan Lake is 160 kilograms (kg) (352 pounds lb) at any single time during the critical time period (between August 15 and September 15).

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" (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 subwatershed), but may be aggregated by type of source or land area. To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads.

Existing loads have been broken into two categories for this analysis: existing load and existing load during the critical time period. The *existing load* is the amount that each source of phosphorus generates and delivers to Fernan Lake. Due to the strong affinity of phosphorus for sediments, approximately 50% of TP from some sources is permanently lost to lake sediments when sediments remain aerobic (Falter 2001). Another 44% is estimated to pass through the lake during the low hydraulic retention (high discharge) time. Therefore, the *existing load during the critical time period* has been identified. This is the amount of phosphorus remaining in Fernan Lake during the critical time period (between August 15 and September 15) after sediment adsorption and flushing flows have occurred. Both types of existing loads are estimates made from available data. The critical time period has been described earlier to be that time period when TP concentrations are the highest and when blue-green algae blooms occur most frequently.

5.3.1 Existing Load during the Critical Time Period

The existing load to Fernan Lake during the critical time period is based on the average concentration of TP during the critical time period between August 15 and September 15. The existing load during the critical time period was calculated using the following equation:

$$LC = Concentration_{Avg.Existing} \times Volume_{Fernan\ Lake}$$

With an existing upper-quartile TP concentration of 31 µg/L and a volume of 7.9 million m^3, the existing load in Fernan Lake during the critical time period is 250 kg (551 lb) per year.

5.3.2 Existing Load

Once the existing load during the critical time period was determined, existing loads were determined for the known sources of phosphorus in the watershed. The primary point and nonpoint sources of pollution and their estimated TP loads to Fernan Lake are listed in Table 12. The method for determining the existing load for each source is described below.

Table 12. Estimated existing loads from phosphorus sources to Fernan Lake. Load values and percentages are expressed as 2 significant figures.

Source	Existing TP Load (kg/yr)	Existing TP Load during Critical Time Period[a] (kg/yr)	Percent of Total Load
Point Sources			
NPDES-regulated Stormwater from Urbanized Area	200	12	4.9
Construction Storm Water under the CGP	10	0.6	0.2
Nonpoint Sources			
Fernan Creek	2600	160	63
Fernan Lake Village lawns	300	18	6.9
Stormwater Injection Wells	130	7.8	3.1
Fernan Lake Road outside the Urbanized Area	160	9.6	3.8
Septic Effluent	100	6	2.4
Other	71	4.3	1.8
Internal cycling	570	34	14
Total	**4100**	**250**	**100**

[a] Concentrations and loads are during the critical time period between August 15 and September 15.

5.3.2.1 Fernan Creek Watershed

Fernan Creek is the largest source of TP to Fernan Lake, with an estimated contributing existing load of 2,600 kg (5,732 lb). Probable sources within the Fernan Creek watershed are described in section 3.1.2.1. Due to lack of sufficient data, allocations were not assigned to the individual sources; rather, one phosphorus load allocation was assigned to the entire Fernan Creek watershed.

The phosphorus load from Fernan Creek was estimated by adding up the concentration and discharge from different flow conditions in Fernan Creek. The flow conditions were rain-on-snow events; ascending limb, peak flow, and descending limb of the hydrograph; low flow; and base flow (Table 13). Discharge during each condition was taken from a hydrograph developed from the stage-flow regression using data collected by DEQ in 2000 (see Figure 9). No TP data exist for each flow condition in Fernan Creek above the lake. Using TP concentrations in Fernan Creek below the lake was not feasible due to the lag time in the lake of a sediment/phosphorus plume during rain-on-snow events. Therefore, TP concentrations were estimated using DEQ data collected in 2008–2009 from Wolf Lodge Creek. In addition to having a full data set, Wolf Lodge Creek was determined to be the best surrogate for Fernan Creek in this analysis for the following reasons:

1. The proportions of land use in both watersheds were comparable.
2. Wolf Lodge Creek is immediately adjacent to Fernan Creek—with the same aspect, elevation, and lithology.
3. Both watersheds have a wetland complex at the mouth.
4. Wolf Lodge Creek has a full data set for each of the flow conditions necessary for the analysis.

Table 13. Flows in Fernan Creek at the mouth (estimated from 2000 DEQ data) and total phosphorus concentrations (estimated from 2008–2009 DEQ data for Wolf Lodge Creek). Total Load values are express to 2 significant figures.

Flow Condition	Discharge			Total Phosphorus Concentration		Total Phosphorus Load	
	flow (cfs)	days/ year	m^3/ year	µg/L	kg/m^3	kg/ year	lb/ year
Rain-on-snow	60.00	7	1,027,562	69	0.000069	71	160
Ascending limb	140.00	60	20,551,235	60	0.000060	1200	2600
Peak flow	200.00	15	7,339,727	110	0.000110	810	1800
Descending limb	100.00	45	11,009,590	40	0.000040	440	970
Low flow	10.00	60	1,467,945	30	0.000030	44	97
Base flow	1.00	178	435,490	11	0.000011	4.8	11
		365			[1]Total	2600	5700

[1]**Total values are written to 2 significant figures**

Due to the strong affinity of phosphorus for sediments, approximately 50% of inflowing TP is permanently lost to lake sediments when sediments remain aerobic (Falter 2001). Another 44%

is estimated to pass through the lake during the low hydraulic retention (high discharge) time. Using this approximation, an existing load of 160 kg (352 lb) of TP is introduced from Fernan Creek to the Fernan Lake water column during the critical time period when blue-green algae blooms are present. This is 63% of the total existing load to the lake.

5.3.2.2 Fernan Lake Village

The location, geology, and soil physical/chemical characteristics in Fernan Lake Village make it reasonable to assume phosphorus loading from both lawn and other landscape activities and stormwater from Fernan Lake Village contribute to phosphorus loading to the lake. In addition, stormwater off Fernan Hill road is a source of phosphorus to the lake.

5.3.2.2.1 Fernan Village Lawns

In determining the amount of phosphorus that reaches Fernan Lake, unknowns like application rates, cumulative contributions, fertilizer phosphorus concentration, and soil phosphorus adsorption capacity drive the equations used to predict the phosphorus load to Fernan Lake. The following discussion exemplifies the potential for phosphorus loading to Fernan Lake from a single home site.

This example is for a hypothetical 13,067 ft^2 (0.3-acre) lakeside lot in Fernan Lake Village. The house, driveway, and patio cover 4,356 ft^2 (0.1 acres), leaving 8,712 ft^2 (0.2) acres to lawn and landscaping. DEQ visited a local hardware store that recommends a fertilizer that covers 4,000 square feet per 20-lb bag. The fertilizer's N-P-K numbers are 16-16-16. The fertilizer bag instructions recommend four applications per year. The following are assumptions from literature:

- Bluegrass plant uptake rate of 0.46 lb/10,000 $feet^2$/year (Mahler 2001)
- Soil bulk density of 120 lb/$feet^3$ (NRCS 2012)
- Phosphorus adsorption capacity of soil is 40 parts per million (Mehmood et. al. 2010; MDEQ 2005)
- Half of grass clippings are collected and half are mulched

With four applications per year, 28 lb of phosphorus would be added annually to the lawn and landscape of the hypothetical lot. Approximately 2 lb would be taken up by plants and removed as grass clippings. Another 6.5 lb would be adsorbed to soil below the root zone. The remaining 19 lb, hydrated by sprinklers, would be transported by ground water and potentially to Fernan Lake.

The estimated contributing phosphorus load from lawns and landscaping in Fernan Lake Village is difficult to estimate without significantly more information and understanding. Not everyone uses the form/rate of fertilizer used in this example, nor do they over-water their lawns. In addition, the further the distance a lot is from the lake, the less of a contribution they may be to the lake. Therefore, a total estimated load of 300 kg (661 lb) was assigned the TP load entering the lake from Fernan Village lawns. When factoring in a 50% loss of TP to adsorption on sediment and a 44% loss during high flow, an 18 kg (40 lb) load was figured for the critical time period between August 15 and September 15. This amounts to 6.9% of the total existing TP load.

5.3.2.2.2 Fernan Lake Village and Fernan Hill Road Stormwater Injection Wells

To determine the amount of runoff from Fernan Lake Village and Fernan Hill Road, the Modified Rational Method uses an empirical linear equation to calculate peak runoff rate and runoff volumes from a determined period with uniform rainfall intensity. The method was developed more than 100 years ago, but it is commonly used for drainage areas less than 20 acres (NJDEP 2004). The Modified Rational Method formula is:

$$Q = C \times i \times A$$

Where:

- Q = peak rate of runoff (cfs)
- C = runoff coefficient representing relationship between rainfall and runoff—a runoff coefficient for paved surfaces of 0.7 was determined from literature (NJDEP 2004)
- i = average intensity of rainfall for the time of concentration for a selected design storm—the average annual rainfall (inches/year) for Coeur d’Alene was determined from the National Oceanic and Atmospheric Administration, National Climatic Data Center
- A = drainage area in acres—the paved areas in Fernan Lake Village and Fernan Hill Road were digitized using ArcGIS then area was calculated

Once the peak rate of runoff of 0.03 cfs was determined, an estimated annual stormwater volume of 900,000 feet^3/year was calculated. To calculate a TP load, an average TP concentration was used from data collected in French Gulch from February to April 2009 (DEQ 2010a). French Gulch is a channelized ditch that drains much of the City of Coeur d’Alene stormwater. The average TP concentration from French Gulch is 106 µg/L. When using this formula to calculate the load from stormwater from Fernan Lake Village and Fernan Hill Road, this calculation did not include TP contributions from nonpaved or roofed surfaces, nor did it include runoff over frozen soils. Therefore, an estimated load of 130 kg (287 lb) was assigned to stormwater injection wells draining Fernan Lake Village and Fernan Hill Road. When factoring in a 50% loss of TP to adsorption on sediment and a 44% loss during high flow, an existing TP load of 7.8 kg (17 lb) from this source remains in the lake during the critical time period between August 15 and September 15. This source is 3.1% of the total existing load.

5.3.2.3 Fernan Lake Road (outside City of Coeur d’Alene UA)

Fernan Lake Road is a paved road that parallels the northern shore of Fernan Lake for approximately 3.2 km (2 miles). Sediment production off paved roads is limited to that which is transported in roadside ditches and relief culverts and through direct runoff from cut and fill slopes. DEQ conducted a literature search to better understand the sediment load from paved roads.

Clinton and Vose (2003) quantified total suspended solids (TSS) concentrations off four road surface types in the southern Appalachian Mountains. They determined TSS generated from paved surfaces was slightly above background. The paved road had property sediment control measures installed. The study results reflect the combined effects of road surface type, physical characteristics of the forest floor, soil stability and erodibility, and steepness of slope below the road surface. Reid and Dunne (1984) also indicate the road surface is the primary source of sediment from the road complex. They report sediment yield from a paved road is only 0.4% of that from a heavily used gravel surface road.

Clinton and Vose (2003) indicated sediment erosion control measures on paved roads were a factor in the low TSS concentrations observed in their study. Ketcheson and Megahan (1996) observed short travel distance of sediment from sheet and rill erosion from road fill slopes. In contrast, sediment concentrated and traveled much farther from berm drains and culverts.

Due to the close proximity of the road to the Fernan Lake shoreline, the sediment and runoff control measures may not have enough retention time to sequester all sediment and nutrients from the road. Furthermore, riparian vegetation between the road and Fernan Lake is limited, making the buffer capacity of this area minimal. Large cutbank slopes of erodible bedrock may also be a source of sediment/phosphorus to the lake. While the paved surface of Fernan Lake Road greatly reduces sediment transport to Fernan Lake, the cutbanks, ditches, and other features continue to contribute sediment and phosphorus to Fernan Lake. As such, it is reasonable to assume Fernan Lake Road is responsible for an existing load of 160 kg (353 lb) to the lake. When factoring in a 50% loss of TP to adsorption on sediment and a 44% loss during high flow, an existing TP load of 9.6 kg (21 lb) remains in the lake during the critical time period between August 15 and September 15, or 3.8% of the total existing load.

5.3.2.4 Septic Effluent

The Panhandle Health District estimates the load from these septic systems to Fernan Lake is probably less than 5% (Fernan Lake Technical Advisory Committee 2003). In this TMDL, TP from septic tanks was assigned 2.4% of the existing load or 100 kg (220 lb). After flushing high flows and sediment adsorption, an existing TP load of 6 kg (13 lb) remains in the lake during the critical time period.

5.3.2.5 Internal Cycling

While additional lake study and modeling may be warranted to better define the contributions of TP from internal lake dynamics, it is reasonable to conclude that internal cycling of TP is not a high percentage of loading to Fernan Lake.

To estimate internal cycling TP loading in Fernan Lake, DEQ reviewed internal cycling data from Upper Twin, Hauser, Lower Twin, and Cocolalla Lakes (DEQ 2000) (Table 14). These are mesotrophic lakes in the region with similar morphometric and limnologic characteristics.

Upper Twin Lake is located in Kootenai County and is most similar to Fernan Lake. Like Fernan Lake, Upper Twin Lake is a shallow, mesotrophic lake. It is 483 acres in size with a maximum depth of 5.0 m. Also like Fernan Lake, it may weakly stratify in August and September, but this stratification is quickly broken up by wind/wave action. TP from internal cycling in Upper Twin Lake is much lower than the other mesotrophic lakes considered in this comparison due to the lack of stratification in the lake. Due to the similar lake characteristics, it is reasonable to conclude that internal cycling in Fernan Lake is similar to Upper Twin Lake. However, algae blooms are infrequently reported on Upper Twin Lakes. Therefore, internal cycling in Fernan Lake was assigned 14% of the total existing load, or 570 kg (53 lb). Factoring flushing high flows and sediment adsorption, an existing TP load of 34 kg (75 lb) from this source is estimated to be in the lake during the critical time period between August 15 and September 15.

Table 14. Internal phosphorus loading of different mesotrophic lakes in north Idaho.

Lake	Stratification?	Internal Phosphorus Load (kg/yr)	Percentage of Total Load	Source
Upper Twin Lake	No	23	9.3	DEQ et al. (2011)
Hauser Lake	Yes	288	28.5	DEQ (2000)
Lower Twin Lake	Yes	101	18.2	DEQ (2000)
Cocolalla Lake	Yes	500	23	Rothrock (1995)

Other nonpoint sources have been grouped together not because of lack of importance, but due to the lack of data to accurately quantify the load from these sources. DEQ estimated the existing load from all other sources to be 71 kg (157 lb). When factoring in a 50% loss of TP to adsorption on sediment and a 44% loss during high flow, and existing TP load of 4.3 kg (9.5 lb) remains in the lake during the critical time period between August 15 and September 15. This equates to 1.8% of the total existing load.

5.3.2.6 Construction Storm Water under the Construction General Permit

Construction activities disturbing more than 1 acre of land (or activities part of a larger common development that will disturb more than 1 acre) with the potential for stormwater discharge into a water body or municipal storm sewer have been estimated to be 10 kg (2.2 lb) which is less than 1 % of the total existing load. When factoring high flushing flows and adsorption on sediment, 0.6 kg (1.3 lb) of the existing load remains during the critical time period between August 15 and September 15.

5.3.2.7 Stormwater from the Urbanized Area

A portion of the Fernan Lake watershed lies within the 2010-delineated Urbanized Area of the City of Coeur d'Alene that is regulated by the EPA's NPDES program This portion is illustrated in Figure 17. This includes part of Fernan Lake Road and the Armstrong Park subdivision. The estimated existing load is 4.94% of the total existing load or 200 kg (441 lb). When factoring in high flushing flows and adsorption on sediment, 12 kg (26 lb) of the existing load from this source remains during the critical time period.

5.4 Load Allocation

A TMDL allocates the load capacity among the various sources of the pollutant. The specification of load reductions in this TMDL are expressed as percentages with an equitable distribution of load reduction responsibility. Natural background levels are included in the target concentrations chosen for TP. The margin of safety for the Fernan Lake TP TMDL is implicit, which is summarized below in more detail. Therefore, the Fernan Lake TP TMDL is equal to the waste load allocation plus the load allocation, which is the sum of all sources of TP.

Existing loads and loads at the target concentration of 20 ug/L for Fernan Lake are listed in Table 15. The total load reduction for all sources is 35% to meet the target load capacity of 160 kg (350 lb) at any time during the critical time period (August 15–September 15). To determine the necessary load reduction of the individual nonpoint and point sources of TP, the excess phosphorus over the target load capacity was divided among the sources according to their percentage contributions (Table 16). Annual waste load allocation, load allocation, and reduction tables are the most appropriate representation of the information that exists. Total maximum daily loads are included in Appendix B.

Table 15. Total existing load, necessary reduction, and target loads for total phosphorus in Fernan Lake.

Existing TP Concentration[a] (µg/L)	Existing Load[a] (kg)	Necessary Reduction to Meet Target Concentration	Target Concentration[a] (µg/L)	Load at Target Concentration[a] (kg)
31	250	35%	20	160

[a] Concentrations and loads are during the critical time period between August 15 and September 15.

Table 16. TP load allocations for Fernan Lake, by source. All load values are expressed with 2 significant figures.

Source	Existing Load (kg/yr)	Existing Load During Critical Period[a] (kg/yr)	Necessary Load Reduction from Existing Condition Percent	Necessary Load Reduction from Existing Condition (kg/yr)	Wasteload/ Load Allocation (kg/yr)	Wasteload/Load Allocation During Critical Period[a] (kg/yr)
Point Sources						
NPDES-regulated Stormwater from Urbanized Area	200	12	35%	70	130	7.8
Construction Storm Water under the CGP	10	0.6	35%	3.5	6.5	0.39
Nonpoint Sources						
Fernan Creek	2600	160	35%	910	1700	100
Fernan Lake Village lawns	300	18	35%	110	190	11
Stormwater Injection Wells	130	7.8	35%	46	84	5
Fernan Lake Road outside the Urbanized Area	160	9.6	35%	56	100	6
Septic Effluent	100	6	35%	35	65	3.9
Other	71	4.3	35%	25	46	2.8
Internal cycling	570	34	35%	200	370	22
Total	**4100**	**250**		**1500**	**2700**	**160**

[a] Loads are during the critical time period between August 15 and September 15. This is the load remaining after spring flows flush through Fernan Lake.

5.4.1 Margin of Safety

To account for uncertainty associated with insufficient or unknown data and the relationship between pollutant loads and beneficial use impairment, a margin of safety is included in load analyses. There are several ways to implement a margin of safety. For Fernan Lake, conservative assumptions were used in the watershed loading calculations. These conservative assumptions, which convey an implicit margin of safety when estimating the load allocation, are summarized below:

- The TMDL is based on an upper quartile TP concentration observed during the period between August 15 and September 15, when TP concentrations are highest.
- The target concentration of 20 µg/L is conservative.
- Actual flow and TP data were used to calculate loads from a number of sources. Flows and TP concentrations from variable conditions (e.g., rain-on-snow, runoff) were overestimates, as they were measured at the peak of that particular condition.
- All load values were expressed in appropriate number of significant figures—conservative accounting for variability in the data. All “5”s rounded conservatively.

5.4.2 Seasonal Variation

Although much of the TP loading is during spring runoff, the critical period for nutrients affecting beneficial uses in Fernan Lake is the warmer months of summer and early fall. Nutrients promote aquatic vegetation growth, including algae, which usually is at its highest density in late summer—a time of high recreational use. The TMDL approach accounted for seasonal variation by choosing a target concentration for TP in Fernan Lake based on the upper quartile concentration for the time period between August 15 and September 15—the period of greatest concern for high densities of blue-green algae blooms.

5.4.3 Reasonable Assurance

EPA requires that TMDLs with a combination of point and nonpoint sources or with wasteload allocations dependent on nonpoint source controls provide reasonable assurance that the nonpoint source controls will be implemented and effective in achieving the load allocation (EPA 1991). Nonpoint source reductions listed in the Fernan Lake TMDL will be achieved through state authority within the Idaho Nonpoint Source Management Program. Section 319 of the federal CWA requires each state to submit to EPA a management plan for controlling pollution from nonpoint sources to waters of the state.

The plan must do the following:

- Identify programs to achieve implementation of BMPs
- Furnish a schedule containing annual milestones for utilization of program implementation methods
- Provide certification by the attorney general of the state that adequate authorities exist to execute the plan for BMP implementation
- Include a listing of available funding sources for these programs

The current *Idaho Nonpoint Source Management Plan* has been approved by EPA as meeting the intent of §319 of the CWA (DEQ 1999b).

As described in the *Idaho Nonpoint Source Management Plan* and set forth in Idaho rule, Idaho water quality standards require that if monitoring and surveillance

> indicate water quality standards are not met due to nonpoint source impacts, even with the use of current best management practices, the practices will be evaluated and modified as necessary by the appropriate agencies in accordance with the provisions of the Administrative Procedure Act. If necessary, injunctive or other judicial relief may be initiated against the operator of a nonpoint source activity in accordance with the [DEQ] Director's authorities provided in Section 39-108, Idaho Code. (IDAPA 58.01.02.350).

Idaho Code 39-3602 lists designated agencies responsible for reviewing and revising nonpoint source BMPs based on water quality monitoring data generated through the state's water quality monitoring program:

- Idaho Department of Lands for timber harvest activities, oil and gas exploration and development, and mining activities
- Idaho Soil and Water Conservation Commission for grazing and agricultural activities
- Idaho Transportation Department for public road construction
- Idaho State Department of Agriculture for aquaculture
- DEQ for all other activities

Existing authorities and programs for ensuring implementation of BMPs to control nonpoint sources of pollution in Idaho are as follows:

- Nonpoint Source §319 Grant Program
- State Agricultural Water Quality Program
- Wetlands Reserve Program
- Resource Conservation and Development
- Agricultural Pollution Abatement Plan
- Conservation Reserve Program
- Idaho Forest Practices Act
- Environmental Quality Improvement Program
- Stream Channel Protection Act
- §401 Water Quality Certification for Dredge and Fill

The Idaho water quality standards direct appointed advisory groups to recommend specific actions needed to control point and nonpoint sources affecting water quality limited water bodies. Upon EPA approval of this TMDL, the Fernan Lake Watershed Advisory Group (WAG), with assistance from appropriate local, state, tribal, and federal agencies, will begin formulating specific pollution control actions for achieving water quality targets listed in the Fernan Lake TMDL. The plan should be completed within 18 months of TMDL approval.

5.4.4 Natural Background

Background sources of TP are as follows:

- Natural runoff from undeveloped forested land within the Fernan Lake watershed
- Loading from areas in the lake with submerged macrophytes

- Internal cycling of phosphorus in Fernan Lake

5.4.5 Construction Stormwater and TMDL Wasteload Allocations

Stormwater runoff is water from rain or snowmelt that does not immediately infiltrate into the ground and flows over or through natural or man-made storage or conveyance systems. When undeveloped areas are converted to land uses with impervious surfaces—such as buildings, parking lots, and roads—the natural hydrology of the land is altered and can result in increased surface runoff rates, volumes, and pollutant loads. Certain types of stormwater runoff are considered point source discharges for Clean Water Act purposes, including stormwater that is associated with municipal separate storm sewer systems (MS4s), industrial stormwater covered under the Multi-Sector General Permit (MSGP), and construction stormwater covered under the Construction General Permit (CGP).

5.4.5.1 Municipal Separate Storm Sewer Systems

Polluted stormwater runoff is commonly transported through MS4s, from which it is often discharged untreated into local water bodies. An MS4, according to (40 CFR 122.26(b)(8)), is a conveyance or system of conveyances that meets the following criteria:

- Owned by a state, city, town, village, or other public entity that discharges to waters of the U.S.

Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.)

- Not a combined sewer
- Not part of a publicly owned treatment works (sewage treatment plant)

To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain an NPDES permit from EPA, implement a comprehensive municipal stormwater management program (SWMP), and use best management practices (BMPs) to control pollutants in stormwater discharges to the maximum extent practicable.

5.4.5.2 Industrial Stormwater Requirements

Stormwater runoff picks up industrial pollutants and typically discharges them into nearby water bodies directly or indirectly via storm sewer systems. When facility practices allow exposure of industrial materials to stormwater, runoff from industrial areas can contain toxic pollutants (e.g., heavy metals and organic chemicals) and other pollutants such as trash, debris, and oil and grease. This increased flow and pollutant load can impair water bodies, degrade biological habitats, pollute drinking water sources, and cause flooding and hydrologic changes, such as channel erosion, to the receiving water body.

Multi-Sector General Permit and Stormwater Pollution Prevention Plans

In Idaho, if an industrial facility discharges industrial stormwater into waters of the U.S., the facility must be permitted under EPA's most recent MSGP. To obtain an MSGP, the facility must prepare a stormwater pollution prevention plan (SWPPP) before submitting a notice of intent for permit coverage. The SWPPP must document the site description, design, and installation of control measures; describe monitoring procedures; and summarize potential pollutant sources. A copy of the SWPPP must be kept on site in a format that is accessible to workers and inspectors and be updated to reflect changes in site conditions, personnel, and stormwater infrastructure.

Industrial Facilities Discharging to Impaired Water Bodies

Any facility that discharges to an impaired water body must monitor all pollutants for which the water body is impaired and for which a standard analytical method exists (see 40 CFR Part 136).

Also, because different industrial activities have sector-specific types of material that may be exposed to stormwater, EPA grouped the different regulated industries into 29 sectors, based on their typical activities. Part 8 of EPA's MSGP details the stormwater management practices and monitoring that are required for the different industrial sectors. EPA anticipates issuing a new MSGP in December 2013. DEQ anticipates including specific requirements for impaired waters as a condition of the 401 certification. The new MSGP will detail the specific monitoring requirements.

TMDL Industrial Stormwater Requirements

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a wasteload allocation for industrial stormwater activities under the MSGP. However, most load analyses developed in the past have not identified sector-specific numeric wasteload allocations for industrial stormwater activities. Industrial stormwater activities are considered in compliance with provisions of the TMDL if operators obtain an MSGP under the NPDES program and implement the appropriate BMPs. Typically, operators must also follow specific requirements to be consistent with any local pollutant allocations. The next MSGP will have specific monitoring requirements that must be followed.

5.4.5.3 Construction Stormwater

The CWA requires operators of construction sites to obtain permit coverage to discharge stormwater to a water body or municipal storm sewer. In Idaho, EPA has issued a general permit for stormwater discharges from construction sites.

Construction General Permit and Stormwater Pollution Prevention Plans

If a construction project disturbs more than 1 acre of land (or is part of a larger common development that will disturb more than 1 acre), the operator is required to apply for a CGP from EPA after developing a site-specific SWPPP. The SWPPP must provide for the erosion, sediment, and pollution controls they intend to use; inspection of the controls periodically; and maintenance of BMPs throughout the life of the project. Operators are required to keep a current copy of their SWPPP on site or at an easily accessible location.

TMDL Construction Stormwater Requirements

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a gross wasteload allocation for anticipated construction stormwater activities. Most loads developed in the past did not have a numeric wasteload allocation for construction stormwater activities. Construction stormwater activities are considered in compliance with provisions of the

TMDL if operators obtain a CGP under the NPDES program and implement the appropriate BMPs. Typically, operators must also follow specific requirements to be consistent with any local pollutant allocations. The CGP has monitoring requirements that must be followed.

Postconstruction Stormwater Management

Many communities throughout Idaho are currently developing rules for postconstruction stormwater management. Sediment is usually the main pollutant of concern in construction site stormwater. DEQ's *Catalog of Stormwater Best Management Practices for Idaho Cities and Counties* (DEQ 2005) should be used to select the proper suite of BMPs for the specific site, soils, climate, and project phasing in order to sufficiently meet the standards and requirements of the CGP to protect water quality. Where local ordinances have more stringent and site-specific standards, those are applicable.

5.4.6 Remaining Available Load/Reserve for Growth

There was no available load to accommodate a reserve for growth.

5.5 Implementation Strategies

Meeting the TP load allocations requires implementation of various policies, programs, and projects aimed at improving water quality in Fernan Lake. Like the TMDL, the goal of the implementation plan will be to reduce nutrient loading to support beneficial uses. DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or if substantial progress is not being made toward achieving those goals. Conversely, should monitoring show beneficial uses are being supported prior to attaining TMDL targets, less restrictive load allocations will be considered.

Implementation strategies will concentrate on reducing nutrients. The implementation plan should better characterize the nutrient sources from the Fernan Creek watershed to better allocate resources for implementation. This requires a monitoring program to accurately quantify nutrients from the sources identified in this TMDL (and others if identified). Reducing pollutant loadings for nonpoint sources will most likely require a mix of policy changes, program initiatives, and BMP implementation.

5.5.1 Time Frame

Because pollutants in Fernan Lake come from nonpoint sources, pollution reduction efforts are on an opportunistic basis. Therefore, the time frame proposed for attaining beneficial uses in Fernan Lake is 20 years.

5.5.2 Approach

The implementation plan for Fernan Lake will explore opportunities to reduce TP pollution to Fernan Lake from US Forest Service property, Fernan Lake Village, and private property along Fernan Creek and other parts of the Fernan Lake watershed. It is important to characterize pollutant sources in the Fernan Creek watershed during the implementation phase of this TMDL and to evaluate the dam's effect on lake water quality

BMP implementation for other nonpoint sources to the lake will be addressed by designated management agencies. Grazing and agricultural aspects of the implementation plan will be written and developed by the Idaho Soil and Water Conservation Commission. Public road construction activities fall under the auspices of the Idaho Transportation Department. All other activities are under the purview of DEQ.

5.5.3 Responsible Parties

Implementing a plan to improve water quality in Fernan Lake will require the cooperation of many entities, including the following:

- Tribal government—Coeur d'Alene Tribe
- Federal government—Natural Resources Conservation Service, US Forest Service, Bureau of Land Management, Bureau of Indian Affairs
- State government—Departments of Environmental Quality, Lands, Transportation, Fish and Game, and Agriculture and the Idaho Soil and Water Conservation Commission
- County government—Kootenai County
- Local government—the City of Coeur d'Alene and Fernan Lake Village
- Quasi-government—Kootenai-Shoshone Soil and Water Conservation District
- Numerous private individuals

5.5.4 Monitoring Strategy

Funding sources will continue to be sought for the CVMP program, which collects valuable physical/chemical data on Fernan Lake. DEQ, the WAG, and/or designated management agencies will develop and implement any other monitoring plans, if needed, to measure changes to water quality once management actions are taken and BMPs are installed. If monitoring shows phosphorus reduction efforts are not being achieved, DEQ will determine whether load reduction targets, load allocations, and/or the implementation strategy should be revised.

On-going monitoring should include collection of nutrient and flow data from Fernan Creek to better understand the nutrient load into the lake from Fernan Creek. As stated in section 3.1.3, the highest loading of nutrients and nutrient-bound sediments is from early rain-on-snow events and on the ascending limb of the hydrograph. The monitoring program design should include these high-loading flow events.

5.6 Pollutant Trading

Pollutant trading (also known as water quality trading) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost-effective, local solutions to problems caused by pollutant discharges to surface waters. Pollutant trading is one of the tools available to meet reductions called for in a TMDL where point and nonpoint sources both exist in a watershed.

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

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

Pollutant trading is recognized in Idaho's water quality standards at IDAPA 58.01.02.055.06. DEQ allows for pollutant trading as a means to meet TMDLs, thus restoring water quality limited water bodies to compliance with water quality standards. DEQ's *Water Quality Pollutant Trading Guidance* sets forth the procedures to be followed for pollutant trading (DEQ 2010b).

5.6.1.1 Trading Components

The major components of pollutant trading are trading parties (buyers and sellers) and credits (the commodity being bought and sold). 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 by DEQ or its designated party.

Both point and nonpoint sources may create marketable credits, which are a reduction of a pollutant beyond a level set by a TMDL:

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

5.6.1.2 Watershed-Specific Environmental Protection

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

5.6.1.3 Trading Framework

For pollutant trading to be authorized, it must be specifically mentioned within a TMDL document. After adoption of an EPA-approved TMDL, DEQ, in concert with the WAG, must develop a pollutant trading framework document. The framework would mesh with the 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 (DEQ 2010b).

5.7 Public Participation

DEQ provides the WAG with all available information pertinent to the SBA/TMDL, such as monitoring data, water quality assessments, and relevant reports. The WAG was given the opportunity to actively participate in advising DEQ in the development of this addendum. The public will also have an opportunity to comment on this draft document. Following the public comment period, a distribution list will be provided in Appendix C, and a summary of public participation, comments, and DEQ's response to comments will be available in Appendix D

6 Conclusions

The goal of the Fernan Lake TMDL is to restore "full support of designated beneficial uses" (Idaho Code 39-3611, 39-3615). The designated beneficial use targeted for restoration is the long-term maintenance of the primary contact recreation use which has been impaired due to the presence of a number of recent potentially toxic blooms of blue-green algae where health advisories were placed on Fernan Lake. As such, DEQ and other federal and local agencies and stakeholders have established a TMDL for TP for Fernan Lake. This document was developed in compliance with federal and state regulatory requirements and with consultation with the Coeur d'Alene Lake Tributaries Watershed Advisory Group.

Data did not indicate that neither sediment or DO are impairing beneficial uses in Fernan Lake. However, TP is impairing the recreational beneficial use of Fernan Lake. TP load allocations were developed from nonpoint sources in the Fernan Lake watershed. Target loading analysis predicted that if the phosphorus load is reduced as recommended, the target phosphorus concentration of 20 μg/L TP in Fernan Lake shall be achieved. TMDL load allocations were assigned to both point and nonpoint sources in the watershed, which included the Fernan Creek watershed, Fernan Lake Village, stormwater injection wells, Fernan Lake Road (outside the Urbanized Area), septic effluent, NPDES-regulated stormwater, and construction storm water. Once this TMDL is approved, it is recommended that Fernan Lake be moved to Category 4a of Idaho's next Integrated Report (Table 17) indicating that a TMDL has been developed for nutrient impairment.

As time and resources allow, DEQ will continue to fund the CVMP program to collect valuable physical/chemical data on Fernan Lake. If monitoring shows phosphorus reduction efforts are not being achieved, DEQ will determine whether load reduction targets, load allocations, and/or implementation strategies should be revised.

Table 17. Summary of assessment outcomes.

Water Body	Pollutant	TMDL(s) Completed	Recommended Changes to the Next Integrated Report	Justification	TMDL Loads
Fernan Lake	Total phosphorus	Yes	Delist Nutrient/ Eutrophication Biological Indicators; Move to Category 4a	Nutrients impairing recreation beneficial use	35% reduction

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Glossary

§303(d)

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

Assessment Unit (AU)

A group of similar streams that have similar land use practices, ownership, or land management. However, stream order is the main basis for determining AUs. All the waters of the state are defined using AUs, and because AUs are a subset of water body identification numbers, they tie directly to the water quality standards so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape.

Beneficial Use

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

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.

Exceedance

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

Fully Supporting

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

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 Capacity (LC)	How much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, a margin of safety, and natural background contributions, it becomes a total maximum daily load.
Margin of Safety (MOS)	An implicit or explicit portion of a water body's load capacity set aside to allow for uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. The margin of safety 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 margin of safety is not allocated to any sources of pollution.
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 nonirrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.
Not Assessed (NA)	A concept and an assessment category describing water bodies that have been studied but are missing critical information needed to complete an assessment.
Not Fully Supporting	Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).
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 plants.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment that alter the functioning of natural processes and

produce undesirable environmental and health effects. Pollution includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.

Stream Order

Hierarchical ordering of streams based on the degree of branching. A 1st-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher-order streams result from the joining of two streams of the same order.

Total Maximum Daily Load (TMDL)

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

Wasteload Allocation (WLA)

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

Water Body

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

Water Quality Criteria

Levels of water quality expected to render a 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, aquatic habitat, or industrial processes.

Water Quality Standards

State-adopted and United States 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.

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Appendix A. Water Quality Data

Temperature, Dissolve Oxygen (DO), and Total Phosphorus (TP) Data

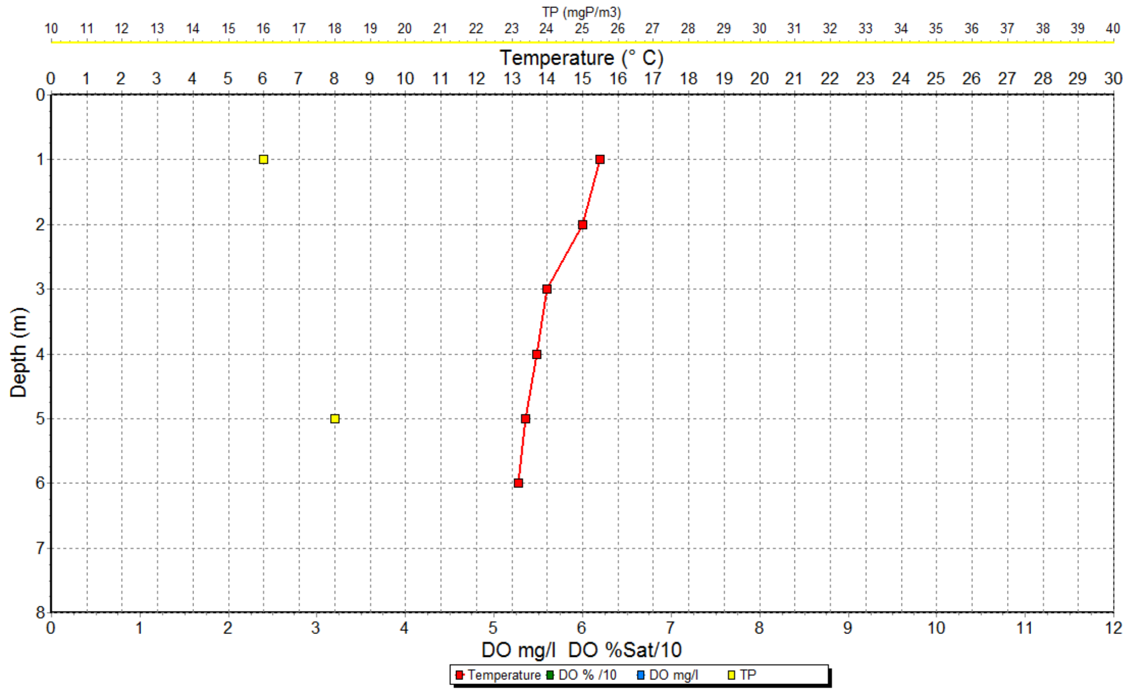

Figure A1. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—May 22, 1990.

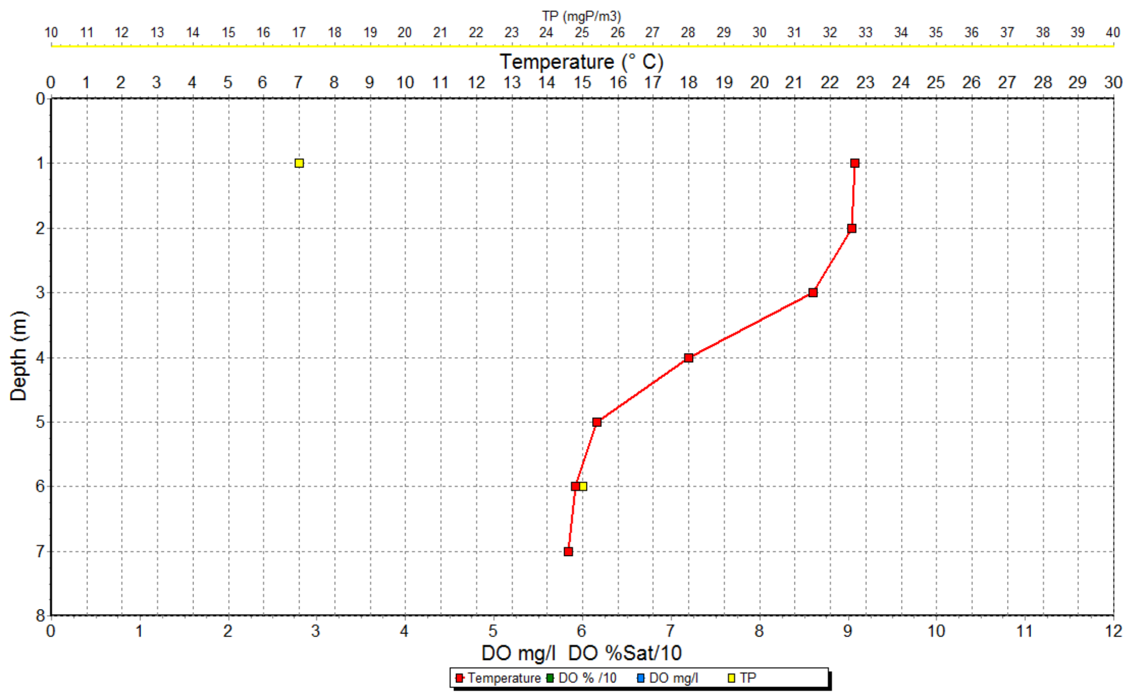

Figure A2. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—June 26 1990.

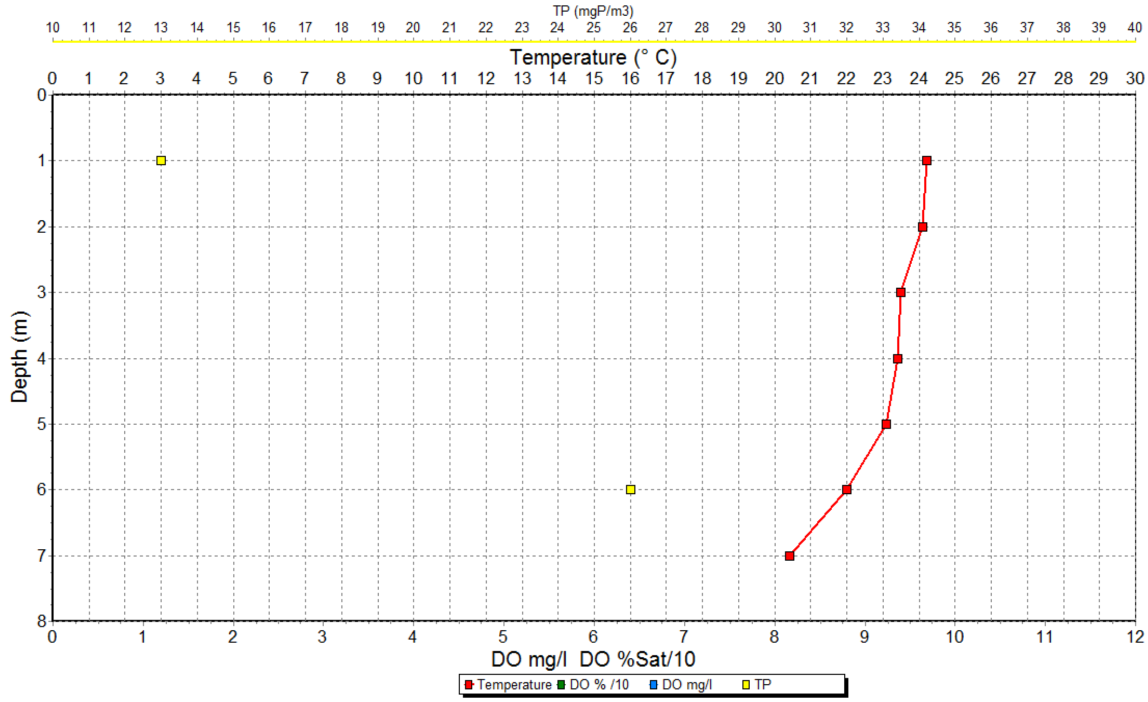

Figure A3. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—August 8, 1990.

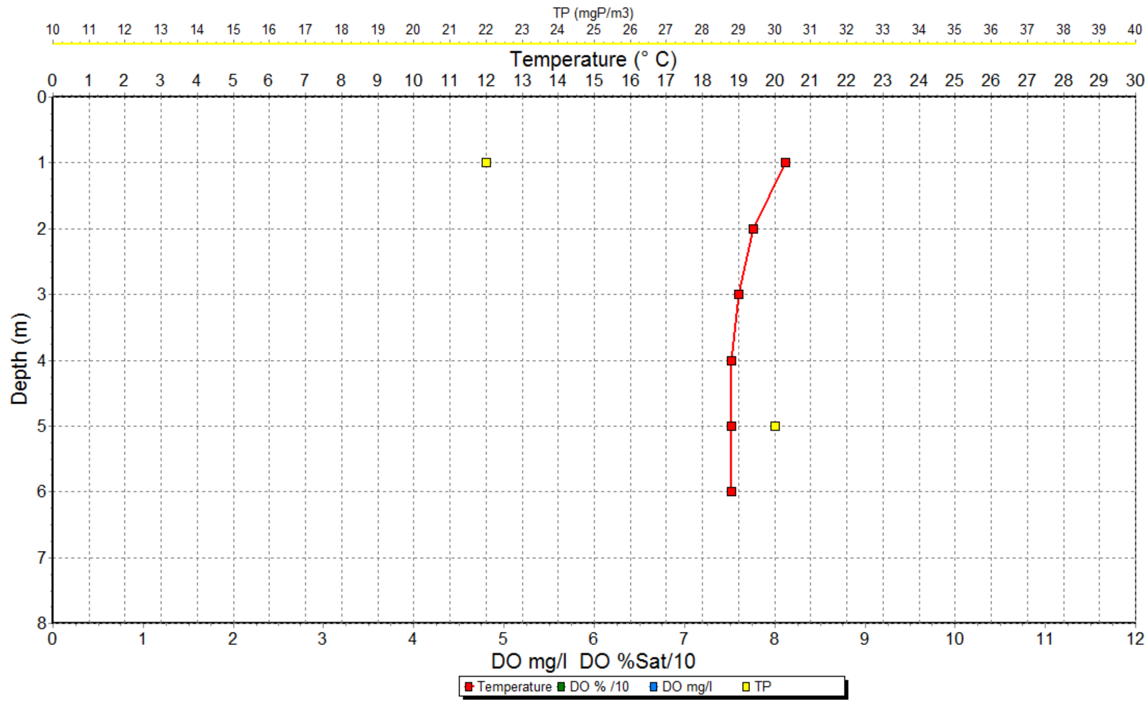

Figure A4. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—September 17, 1990.

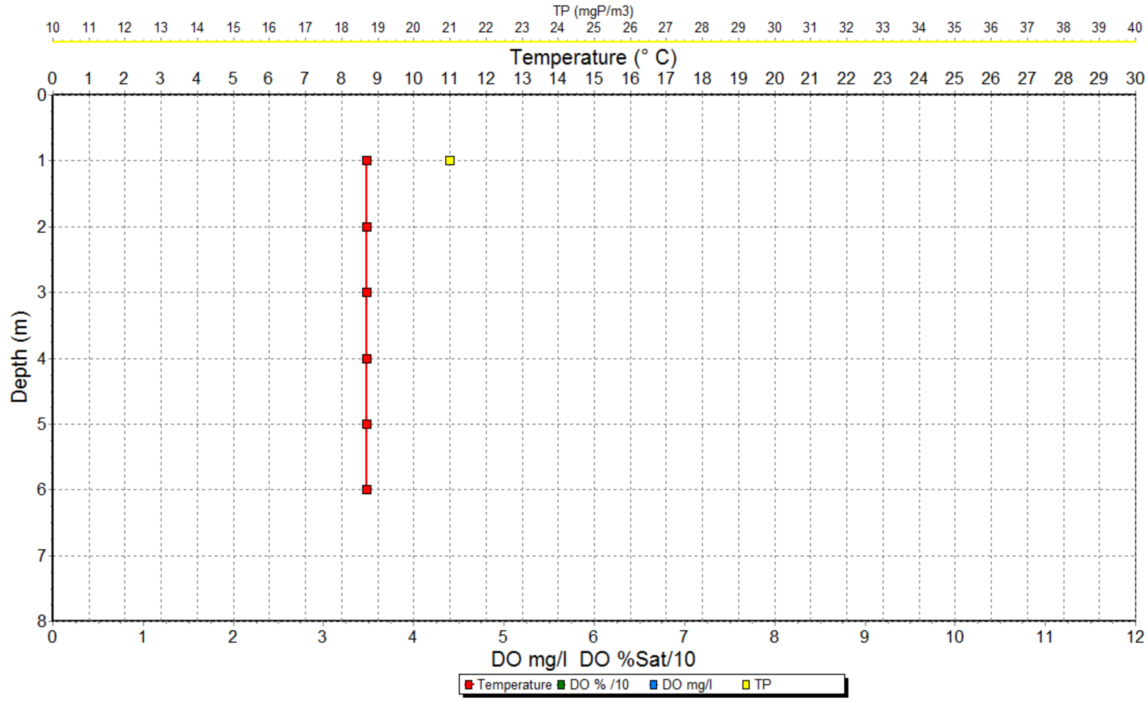

Figure A5. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—October 30, 1990.

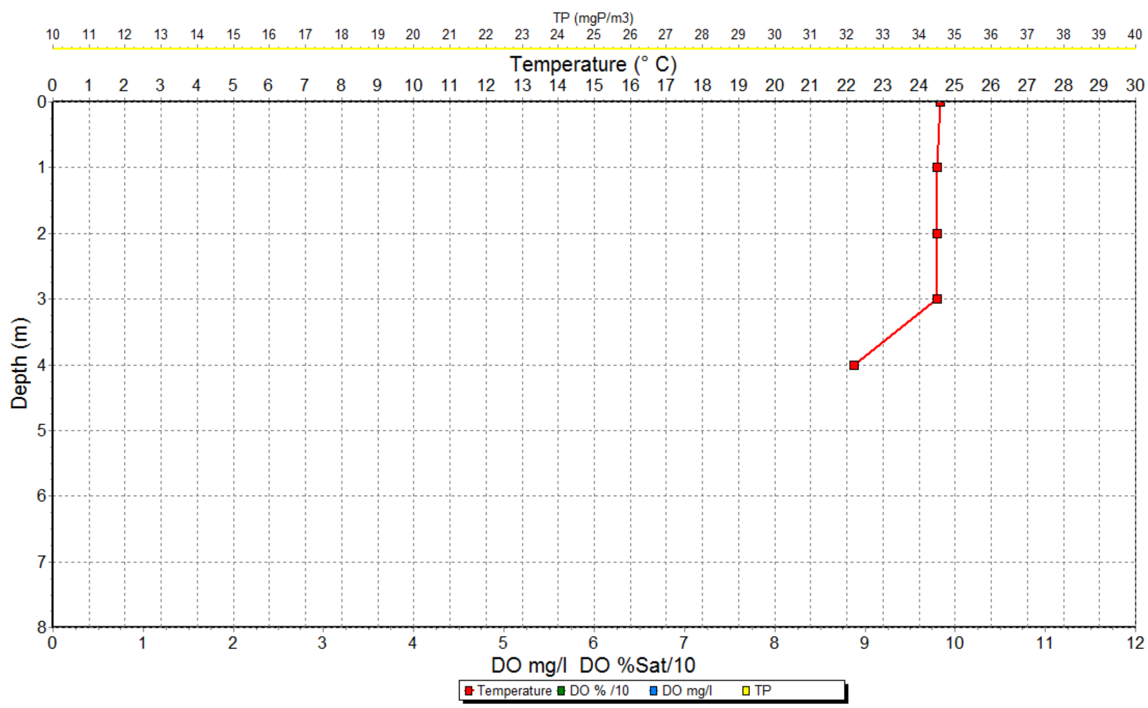

Figure A6. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—July 24, 1991.

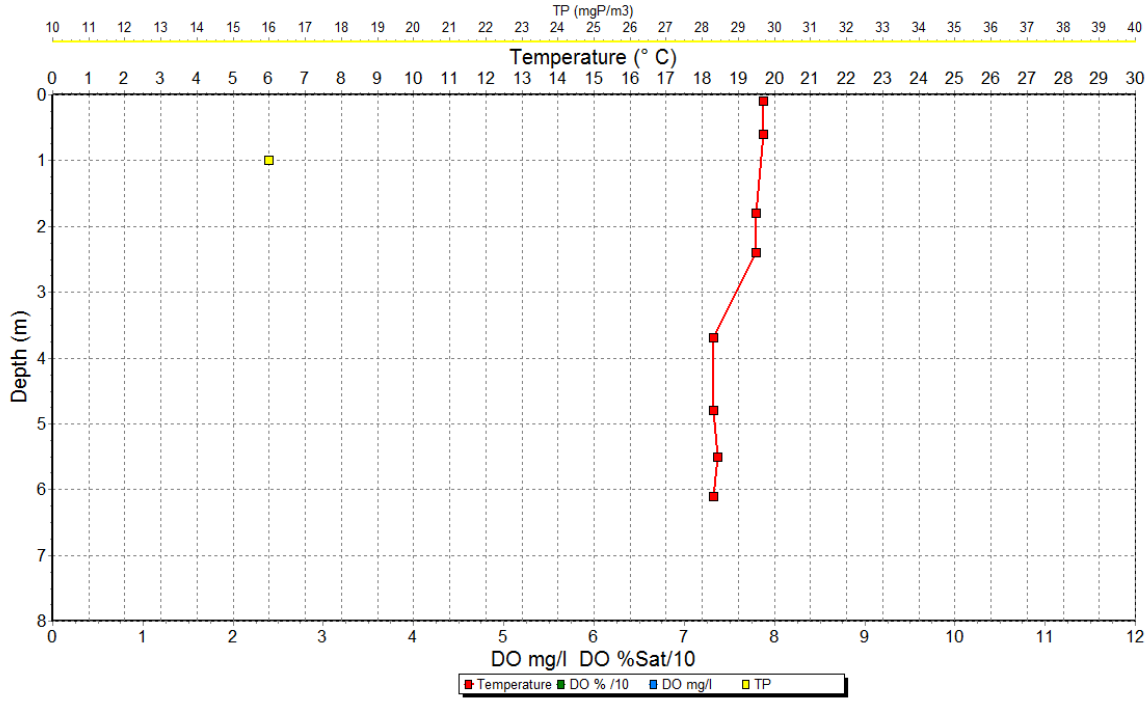

Figure A7. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—June 24, 2003.

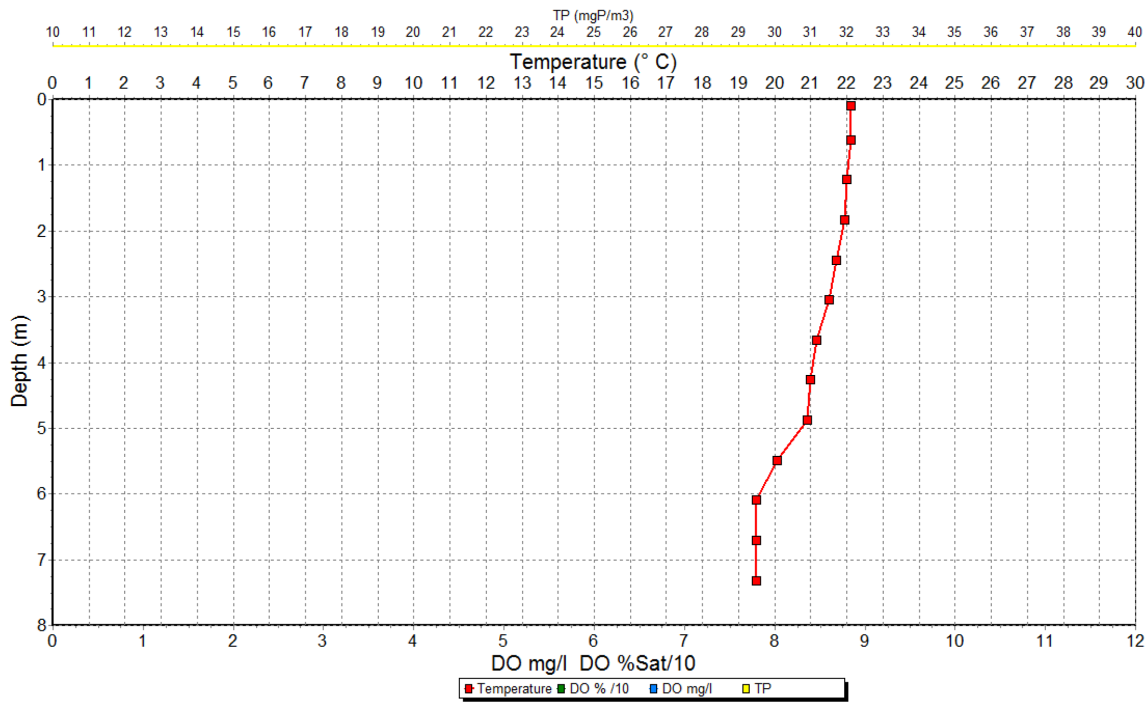

Figure A8. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—July 1, 2003.

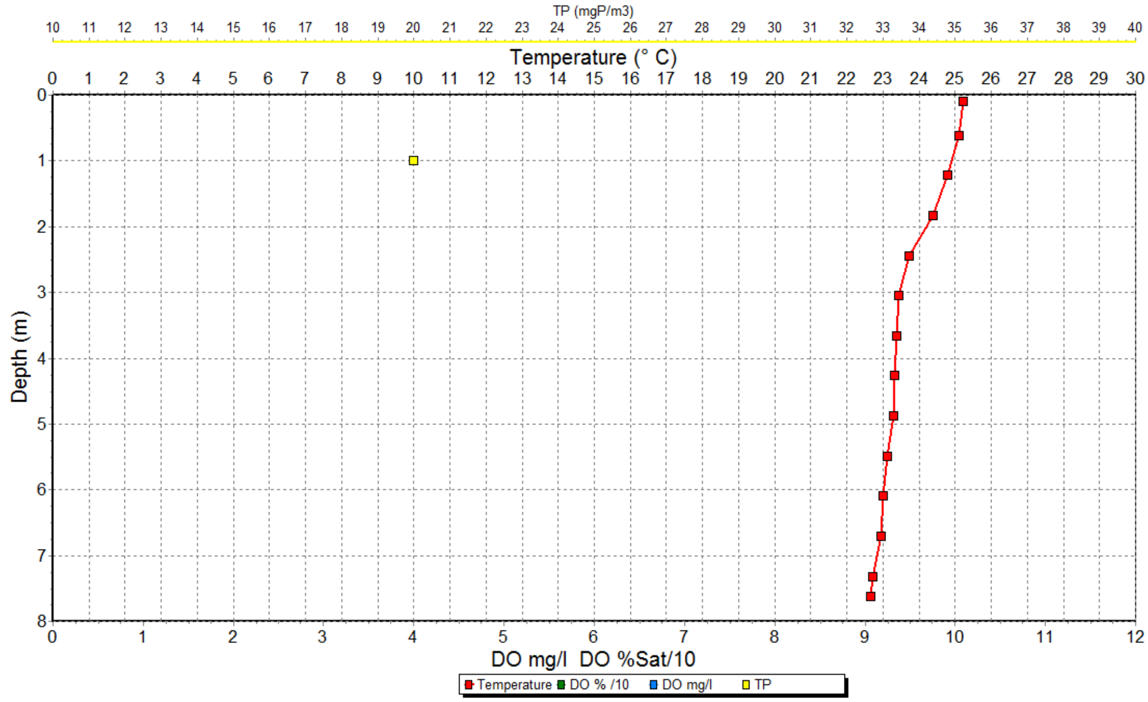

Figure A9. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—July 21, 2003.

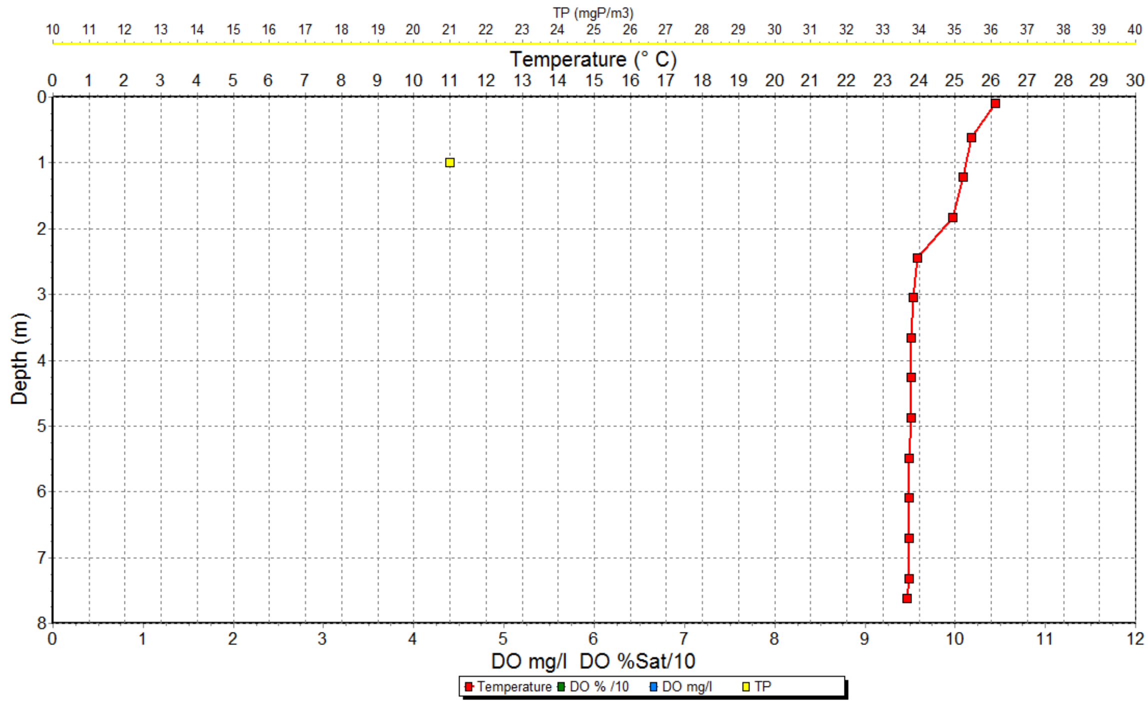

Figure A10. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—July 29, 2003.

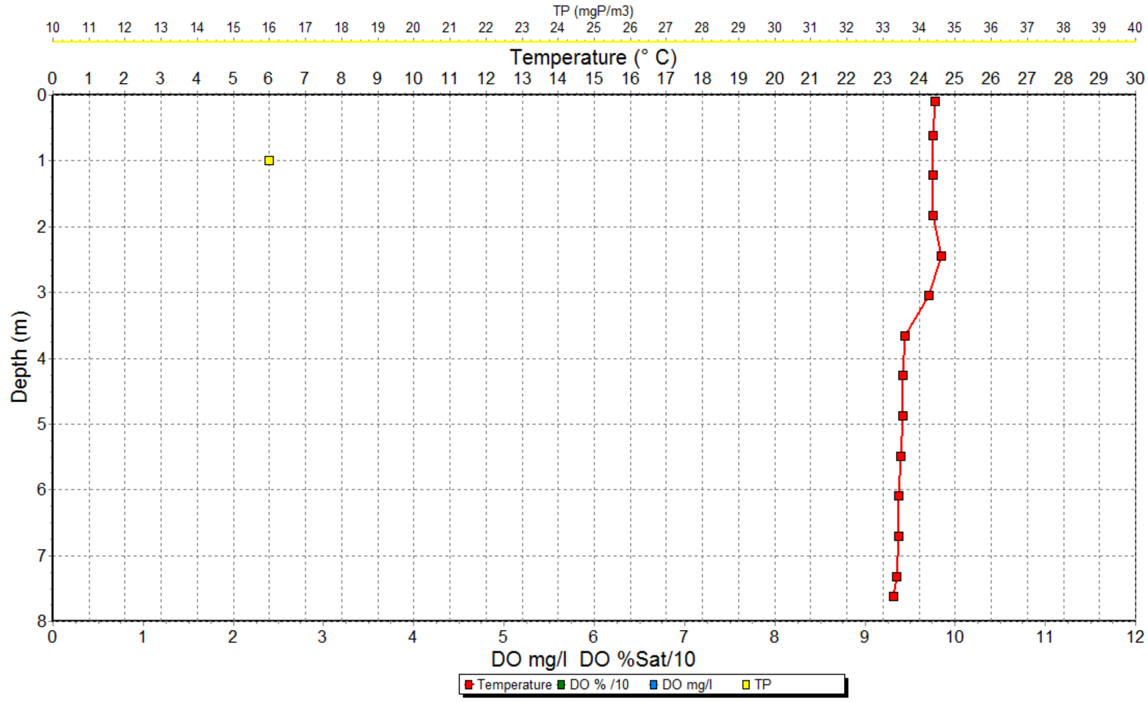

Figure A11. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—August 7, 2003.

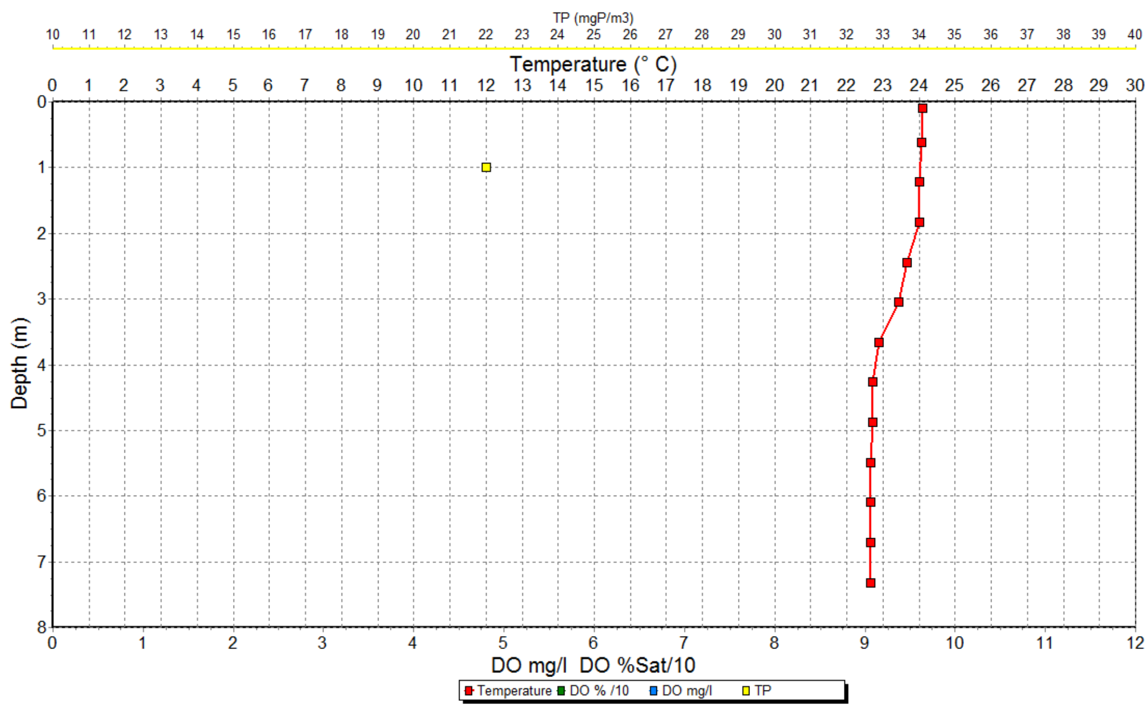

Figure A12. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—August 19, 2003.

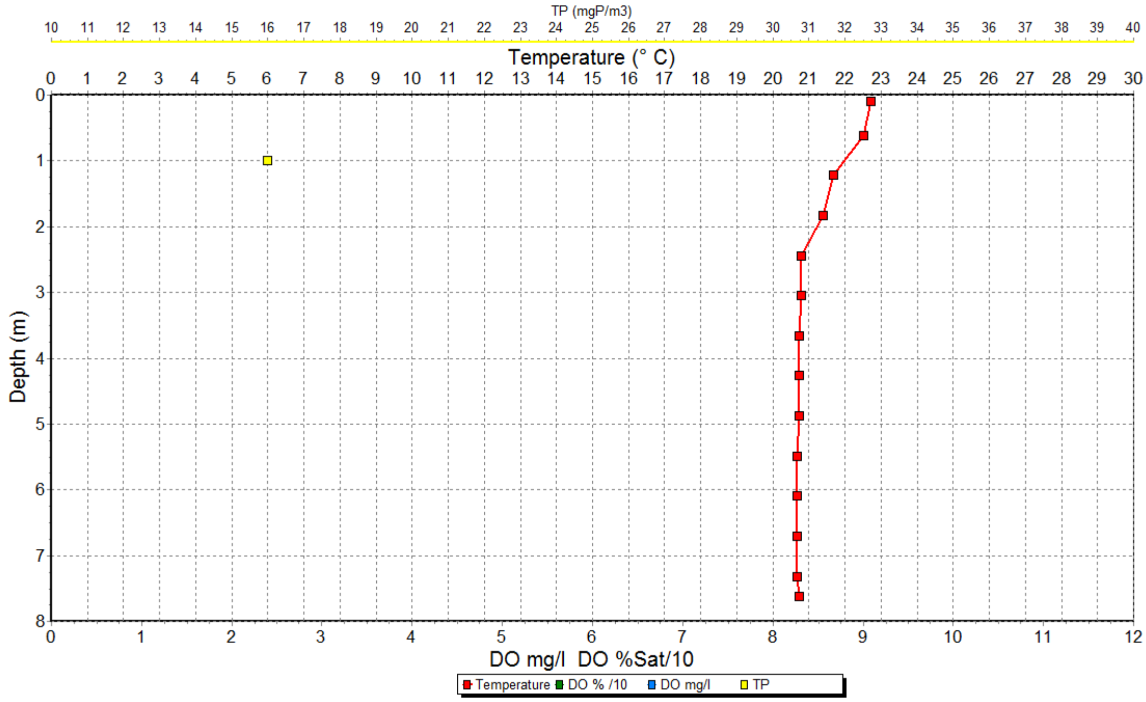

Figure A13. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—August 27, 2003.

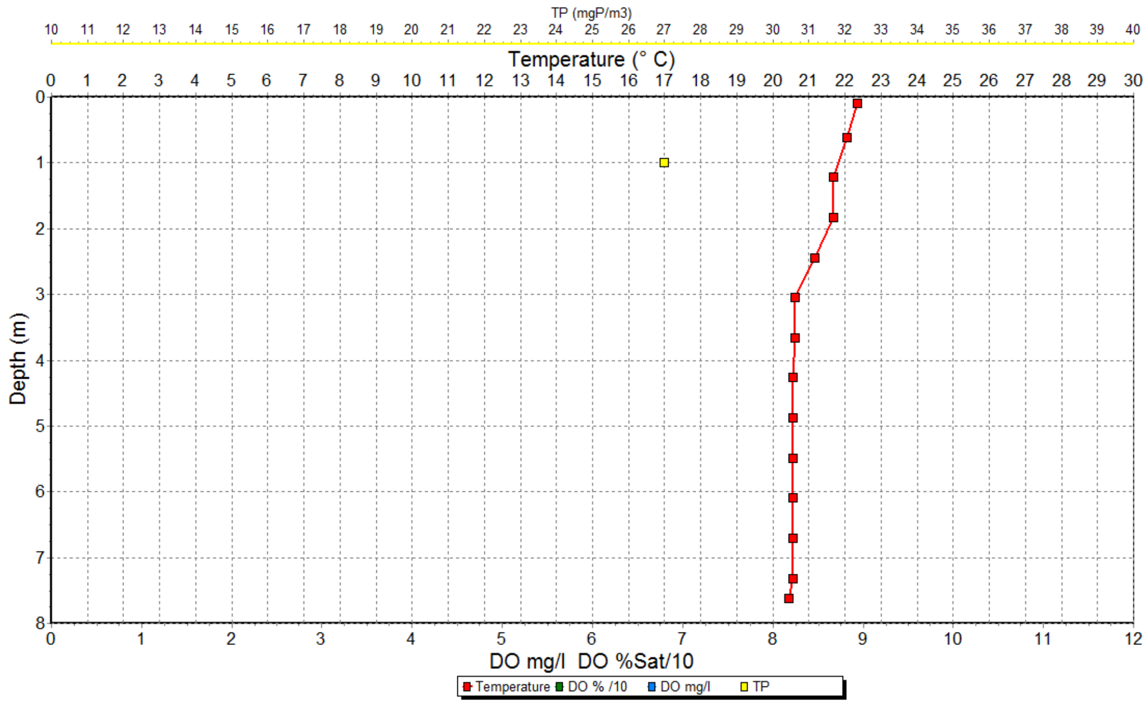

Figure A14. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—September 4, 2003.

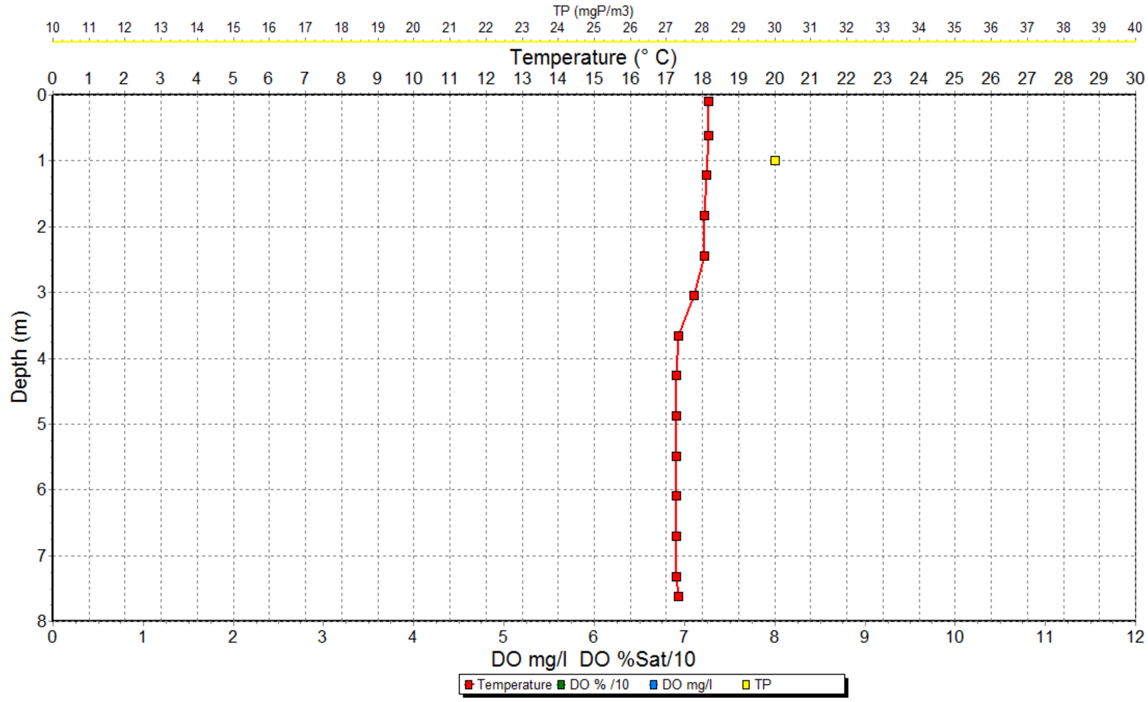

Figure A15. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—September 15, 2003.

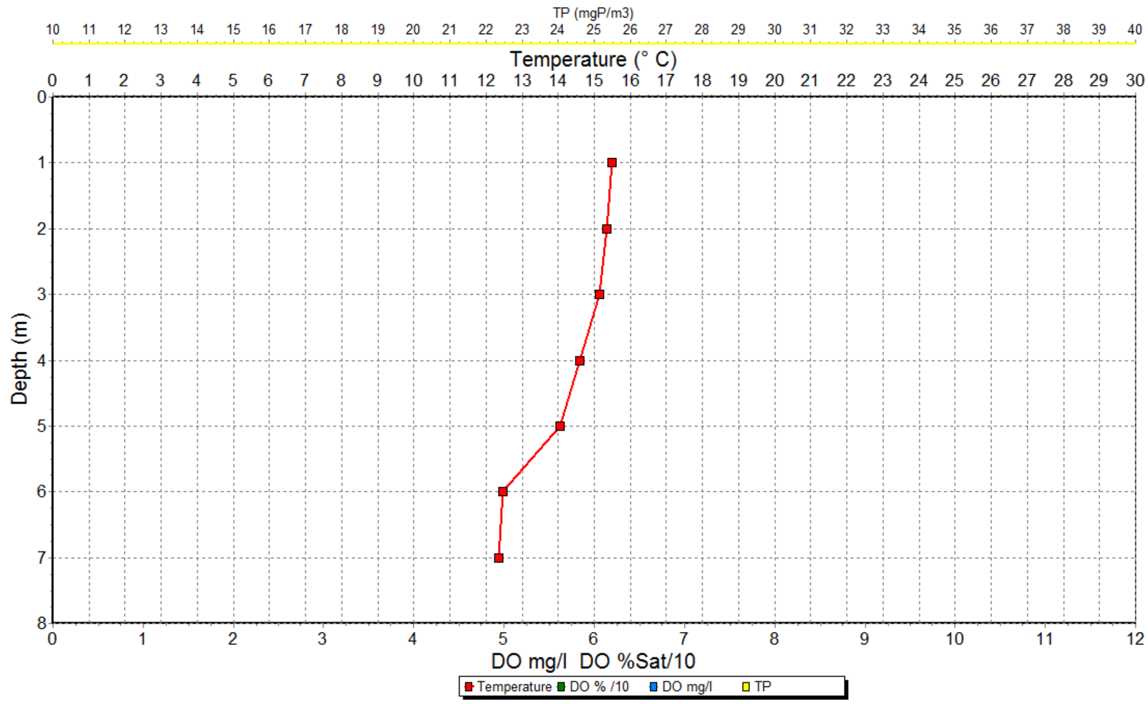

Figure A16. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—May 9, 2005.

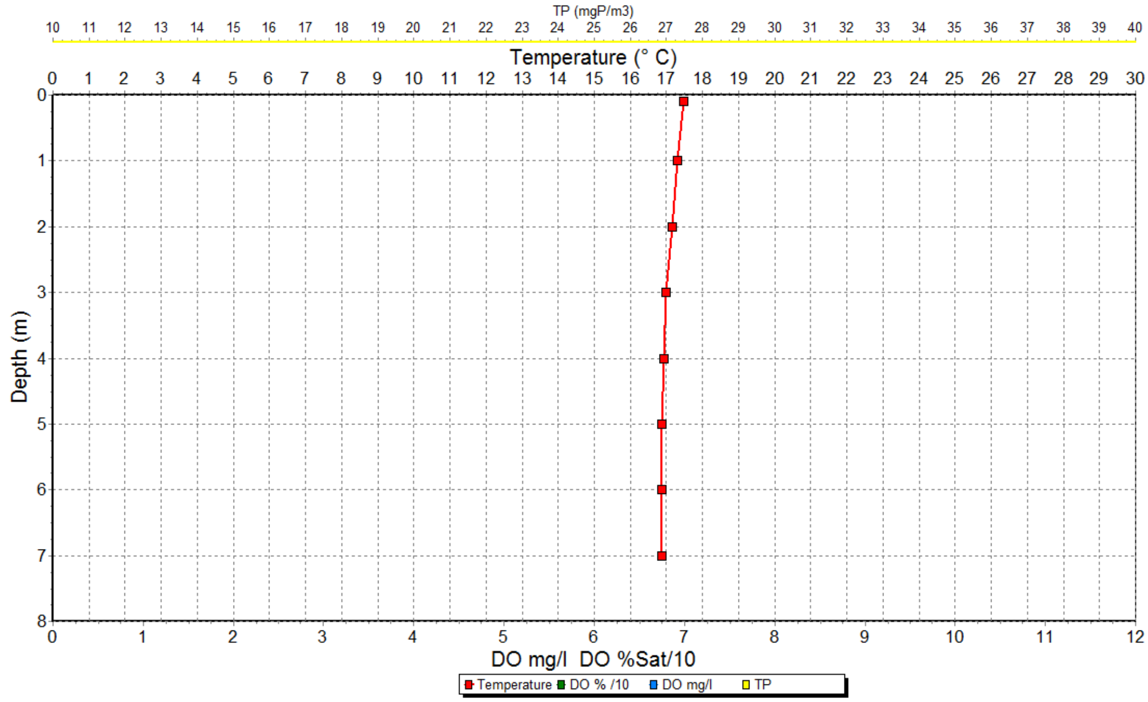

Figure A17. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—June 6, 2005.

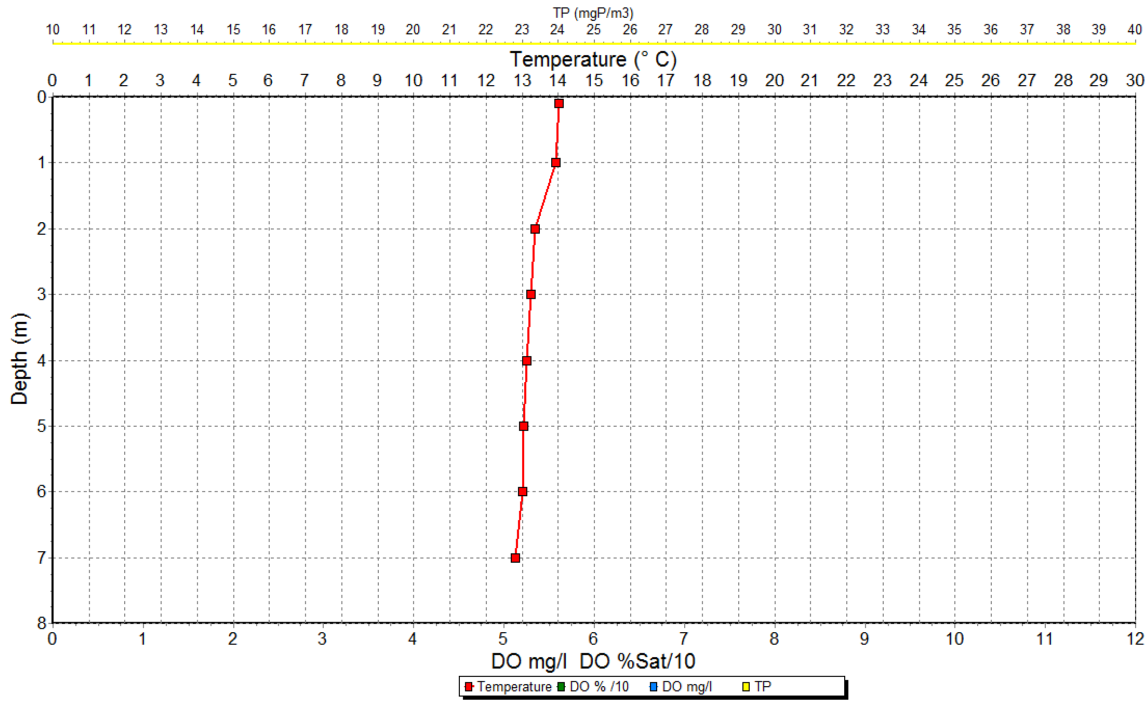

Figure A18. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—May 11, 2006.

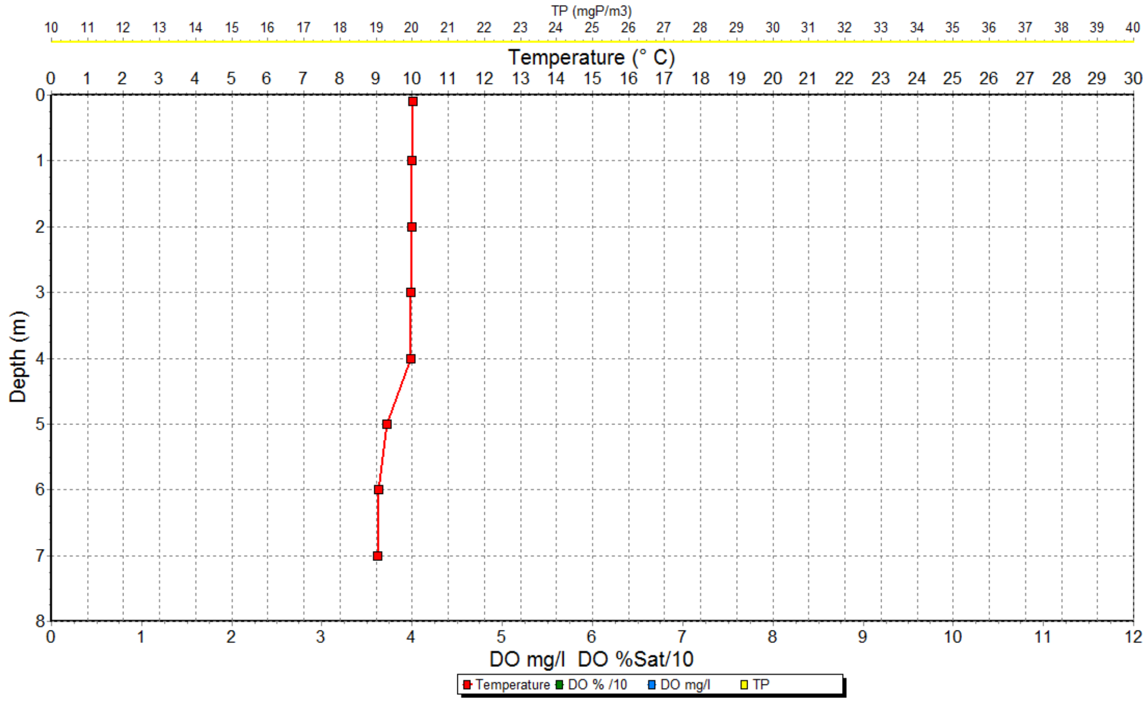

Figure A19. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—April 16, 2007.

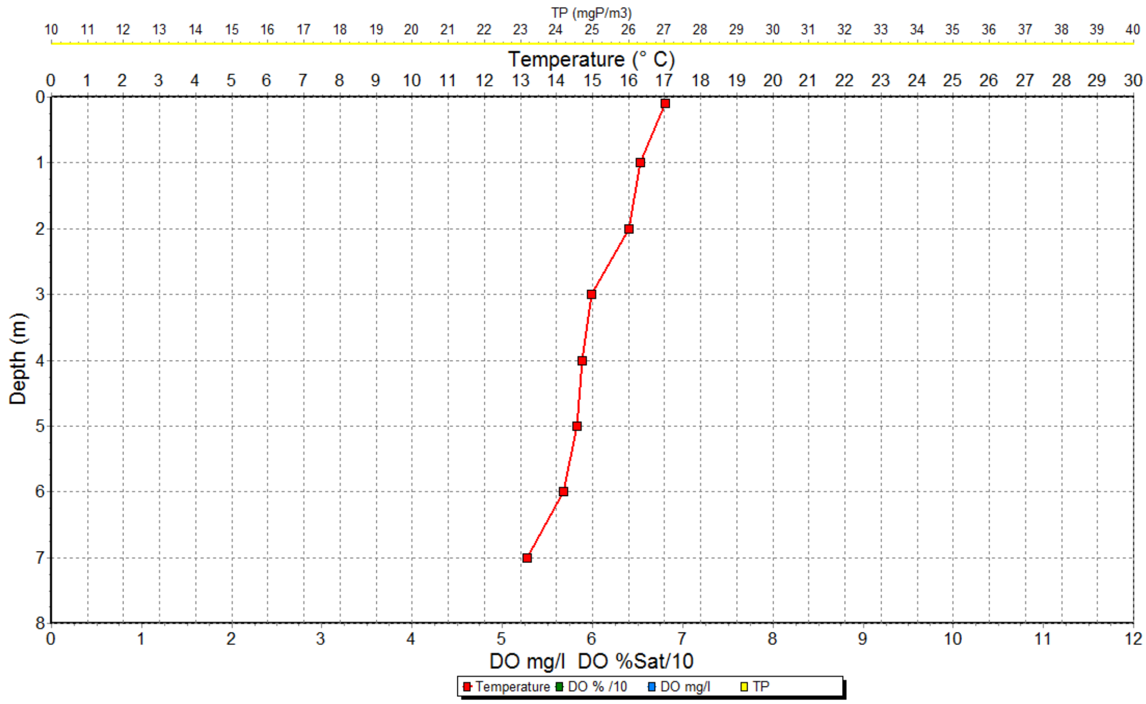

Figure A20. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—May 14, 2007.

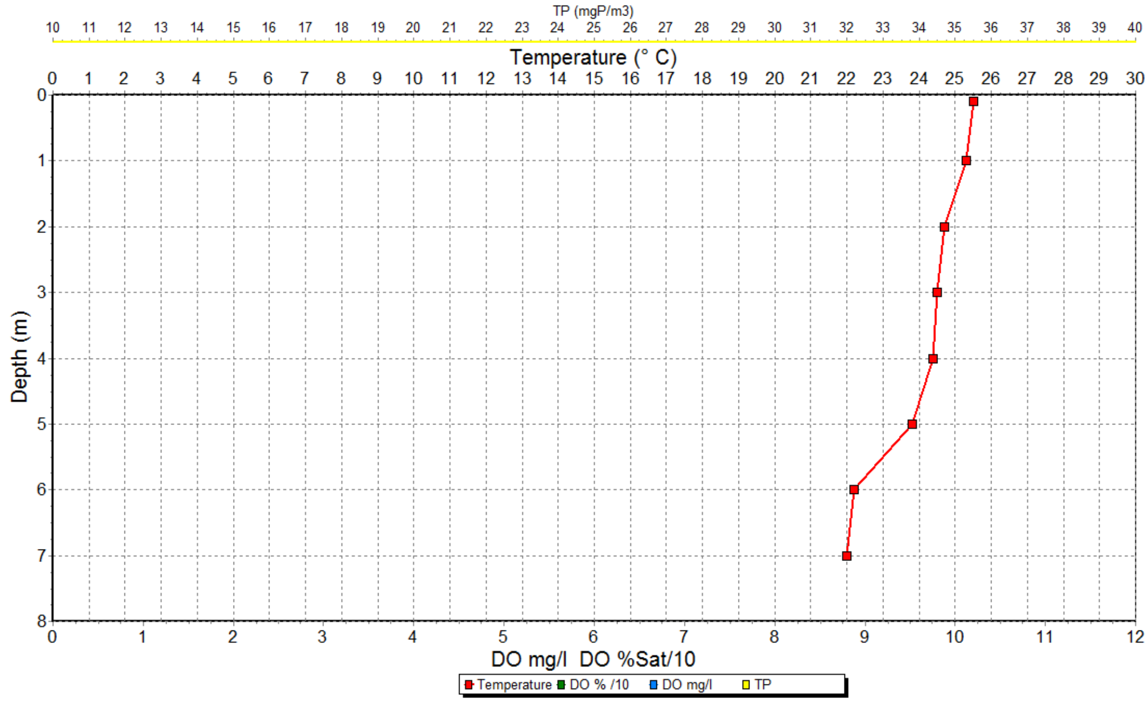

Figure A21. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—July 16, 2007.

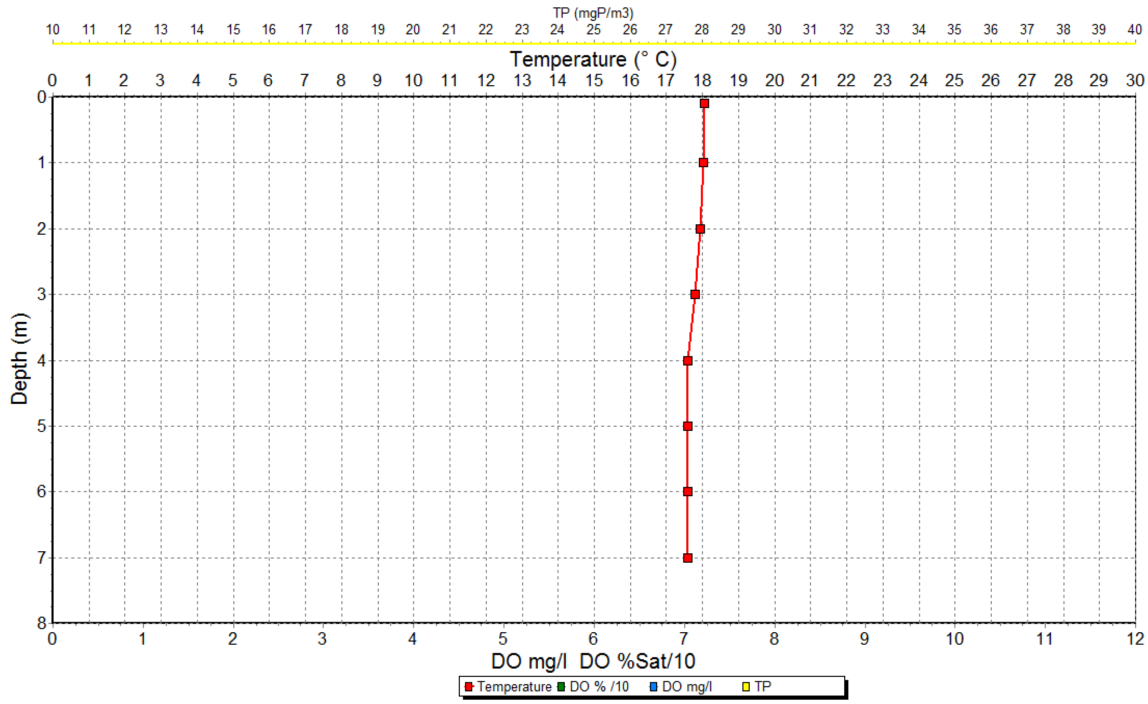

Figure A22. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—September 18, 2007.

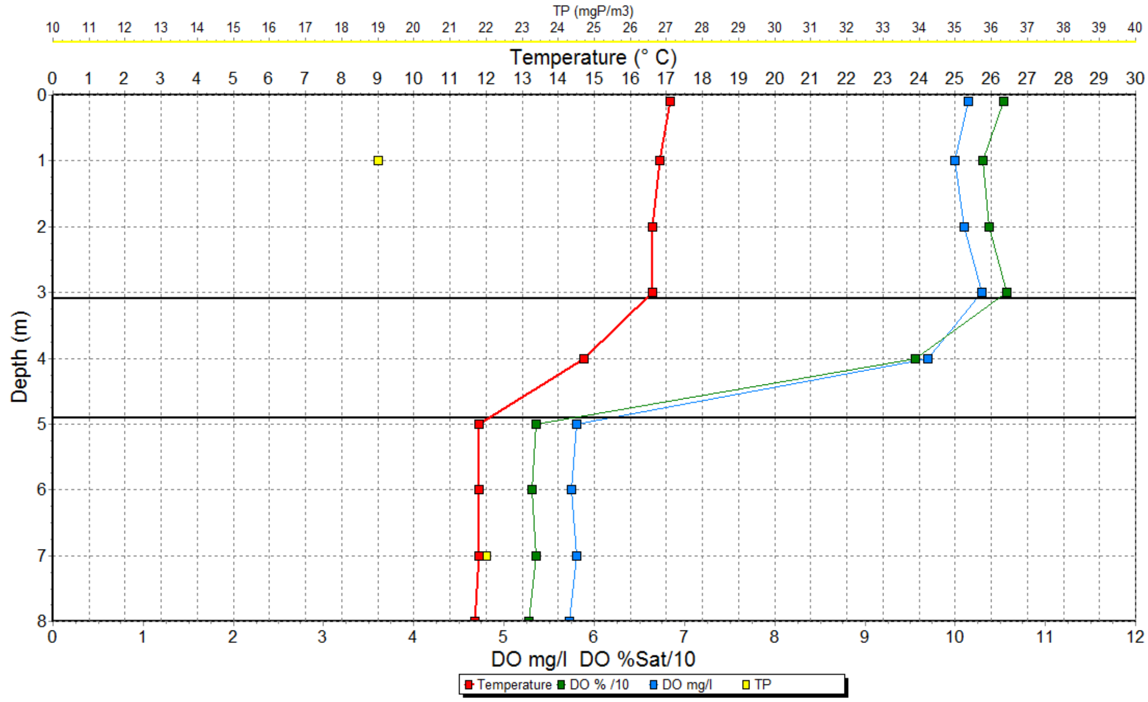

Figure A23. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—May 30, 2008.

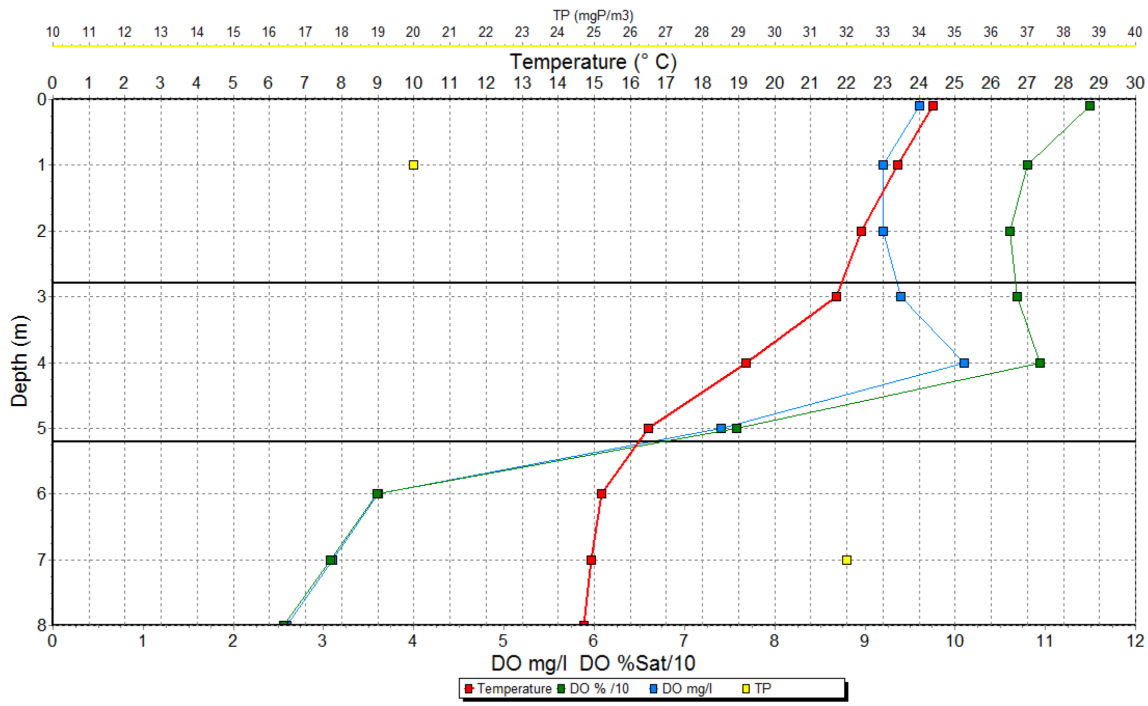

Figure A24. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—June 30, 2008.

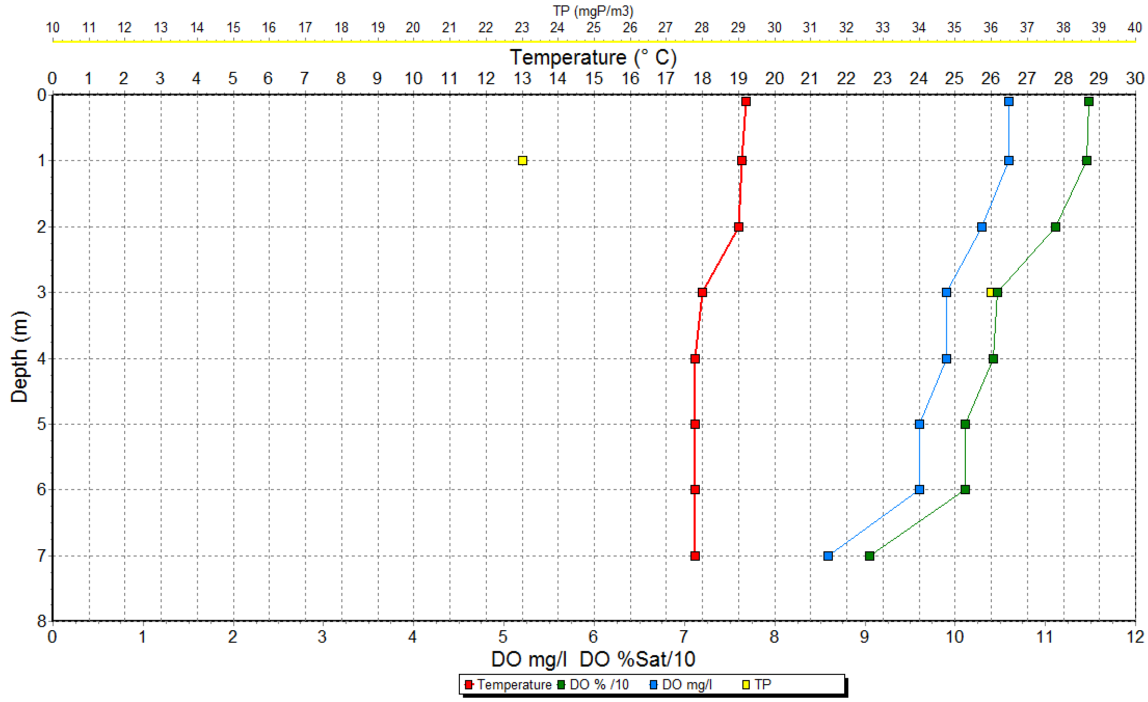

Figure A25. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—August 28, 2008.

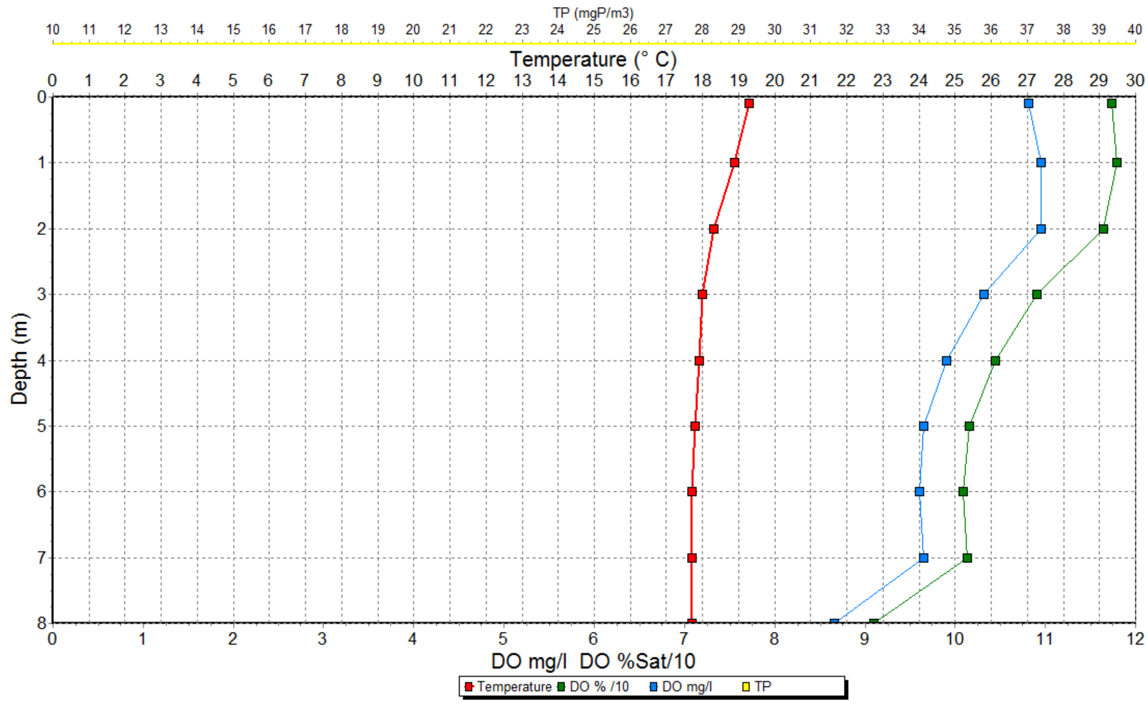

Figure A26. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—September 8, 2008.

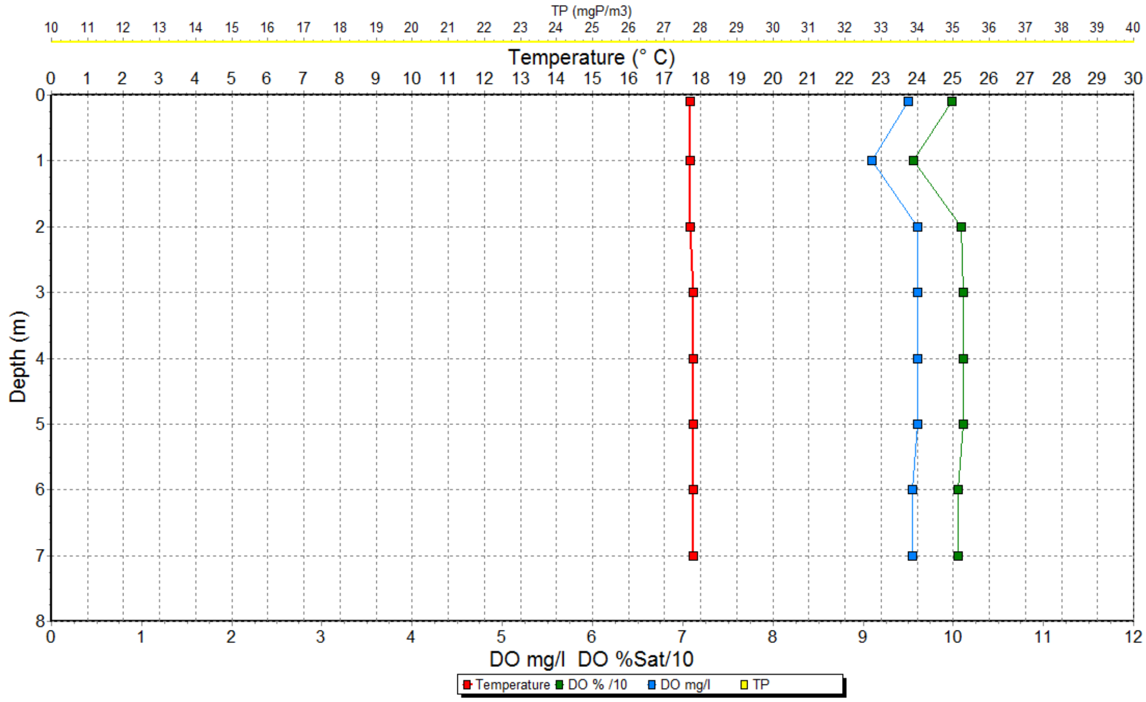

Figure A27. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—September 9, 2008.

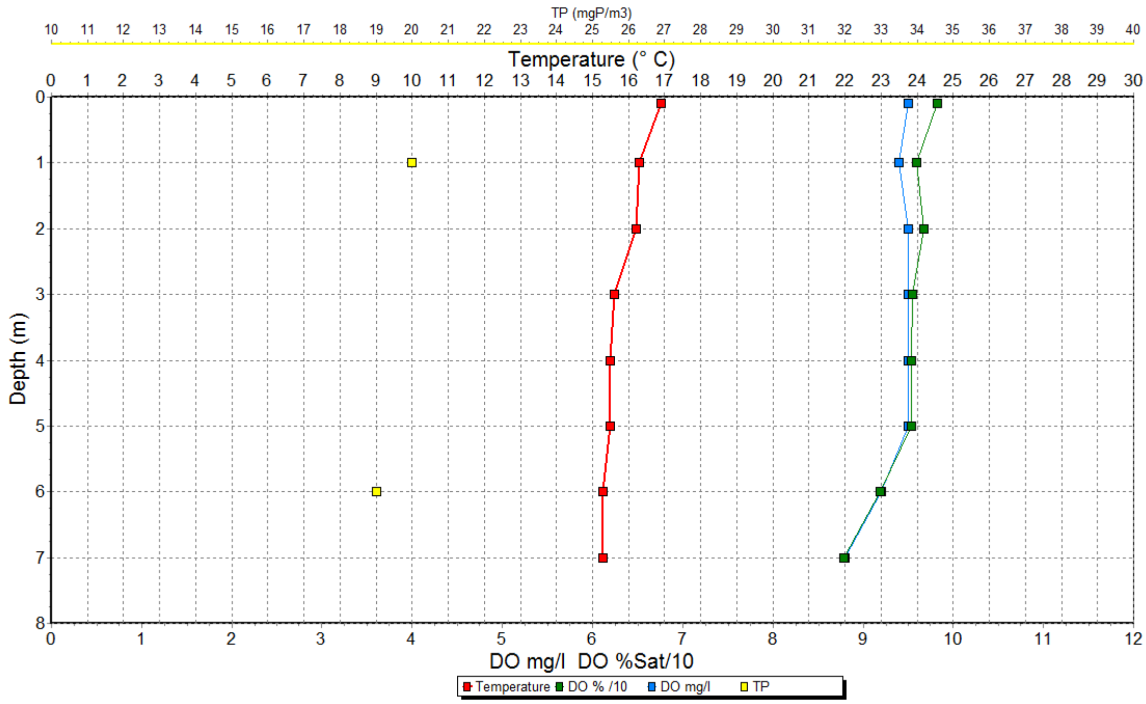

Figure A28. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—September 30, 2008.

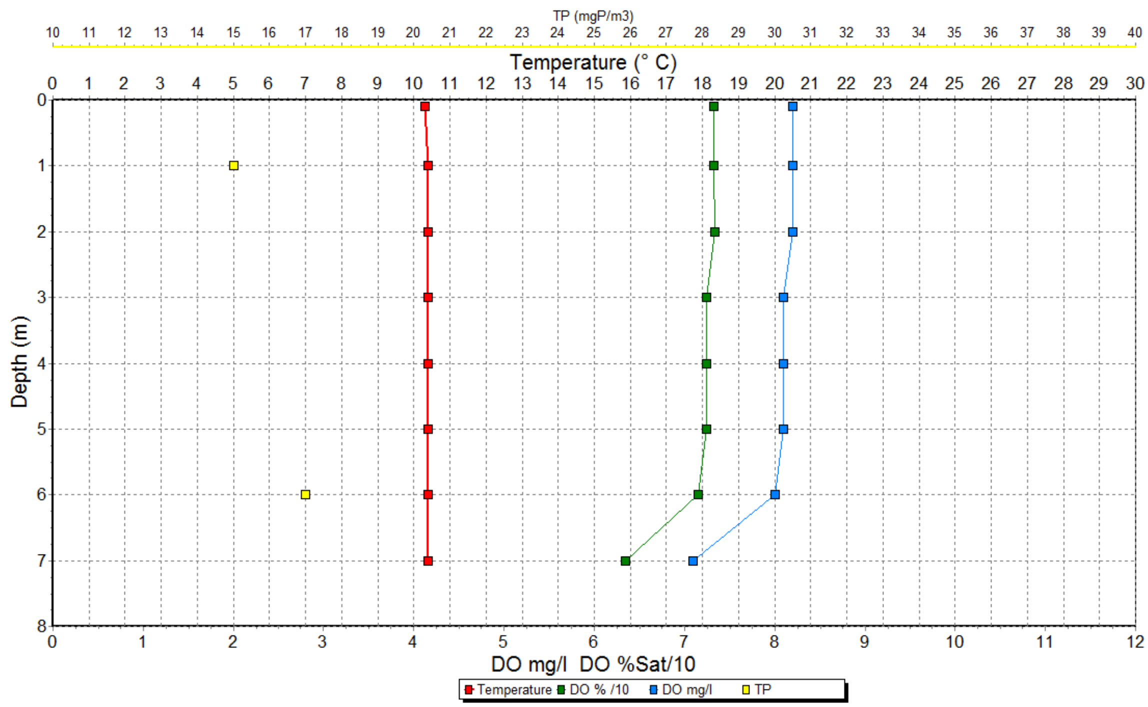

Figure A29. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—October 21, 2008.

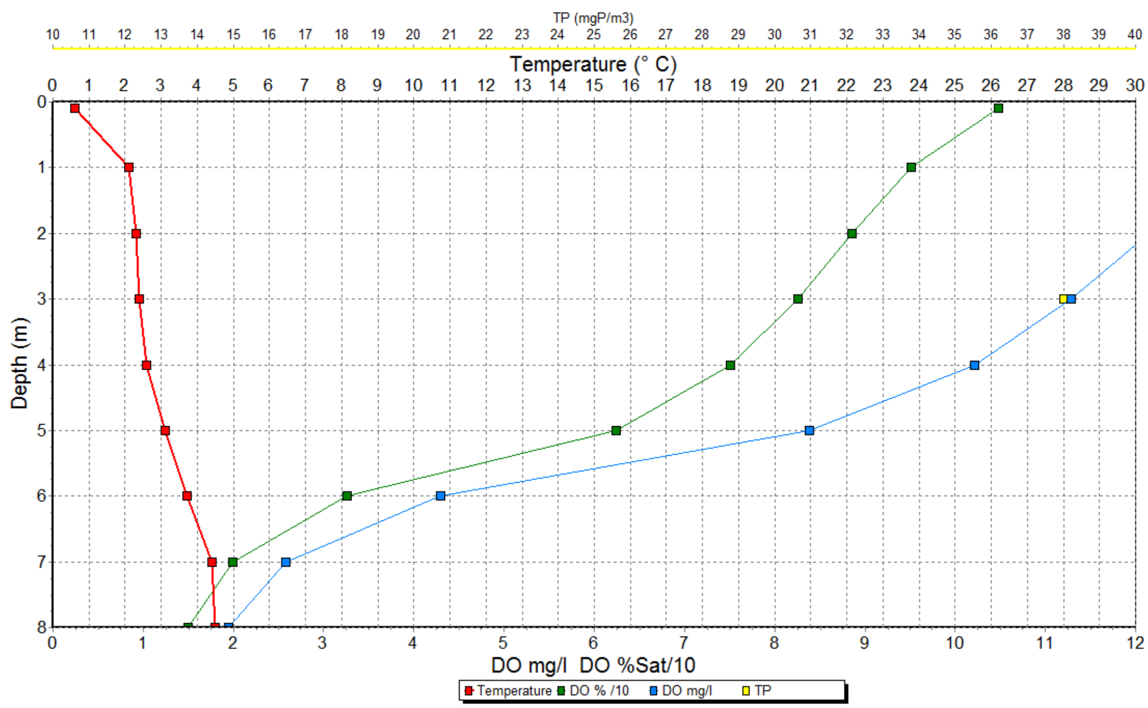

Figure A30. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—January 28, 2009.

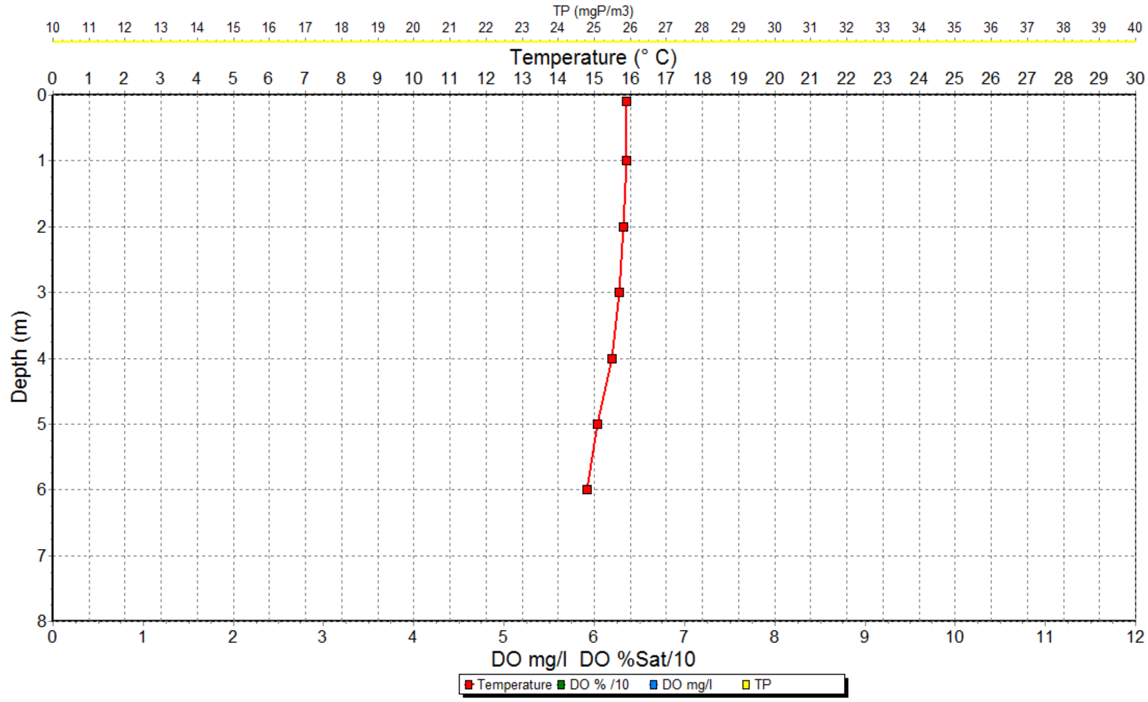

Figure A31. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—June 5, 2010.

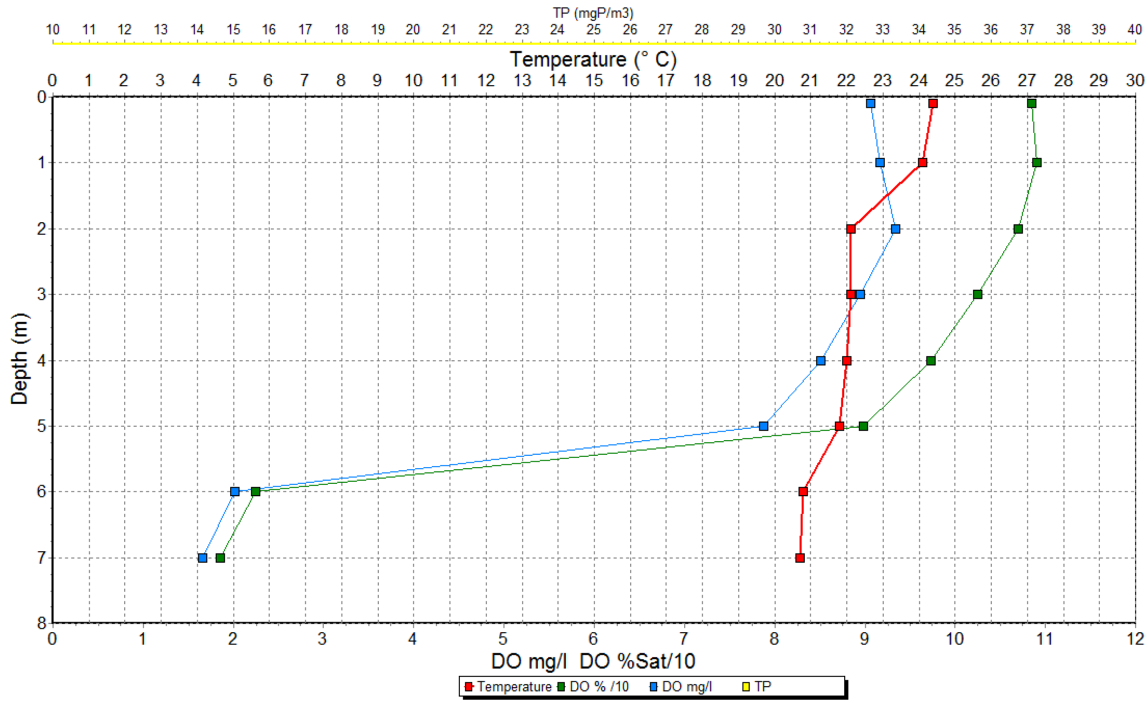

Figure A32. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—August 8, 2011.

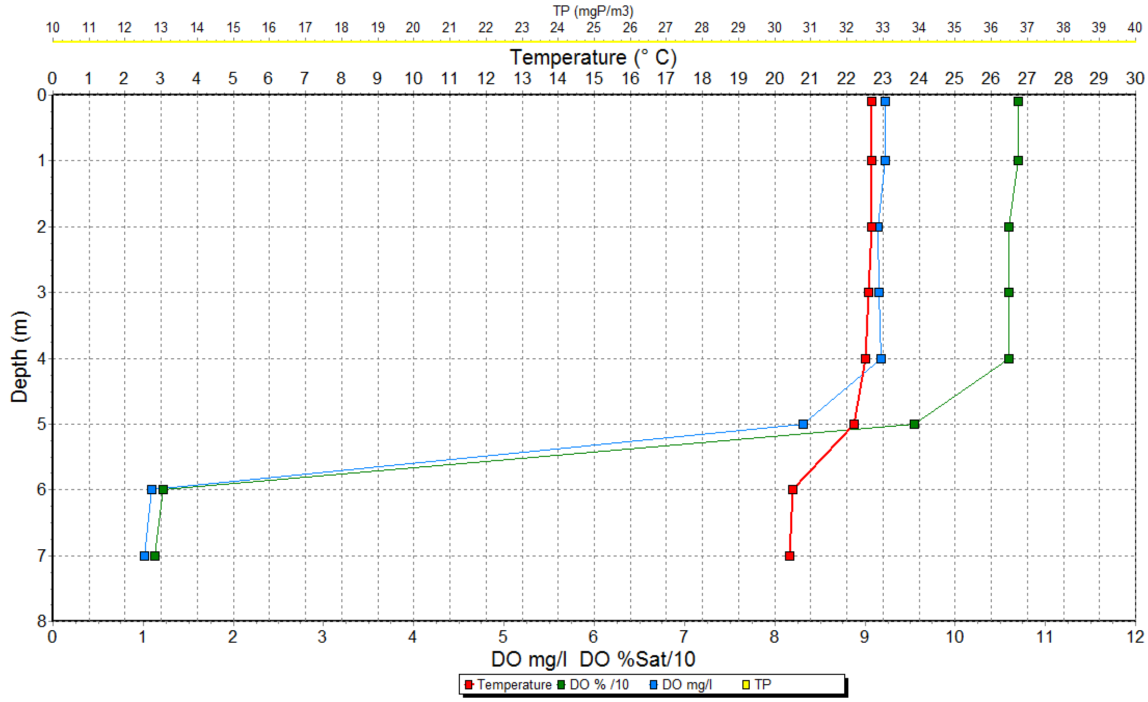

Figure A33. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—August 29, 2011.

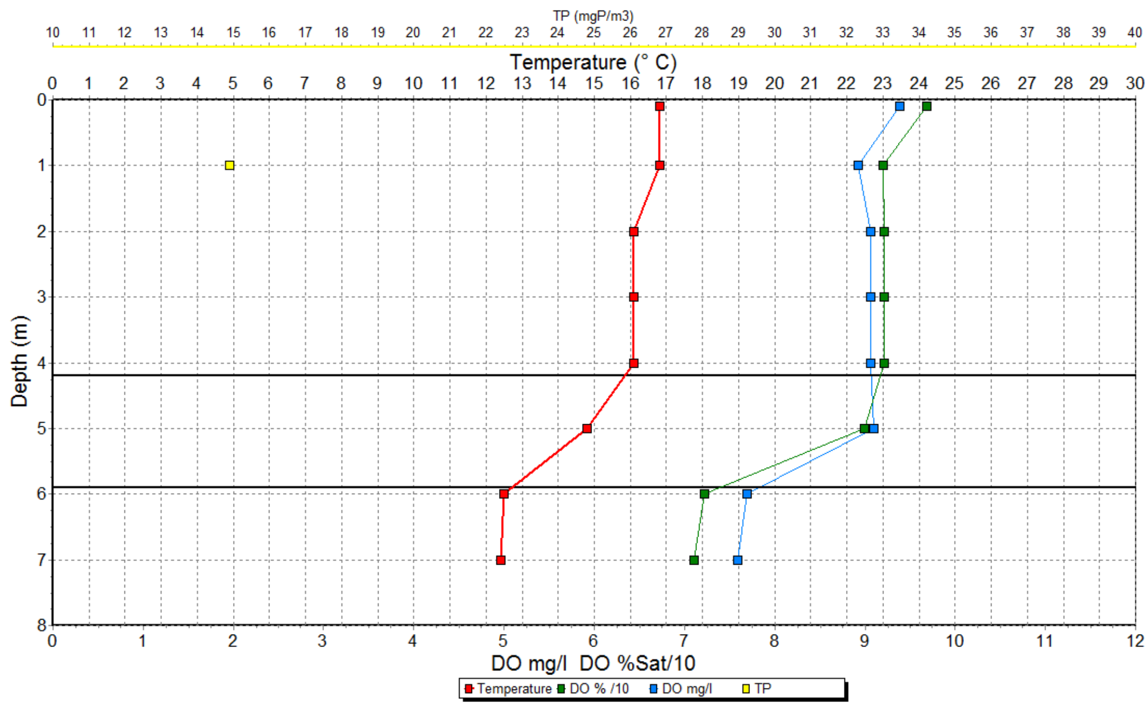

Figure A34. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—May 17, 2012.

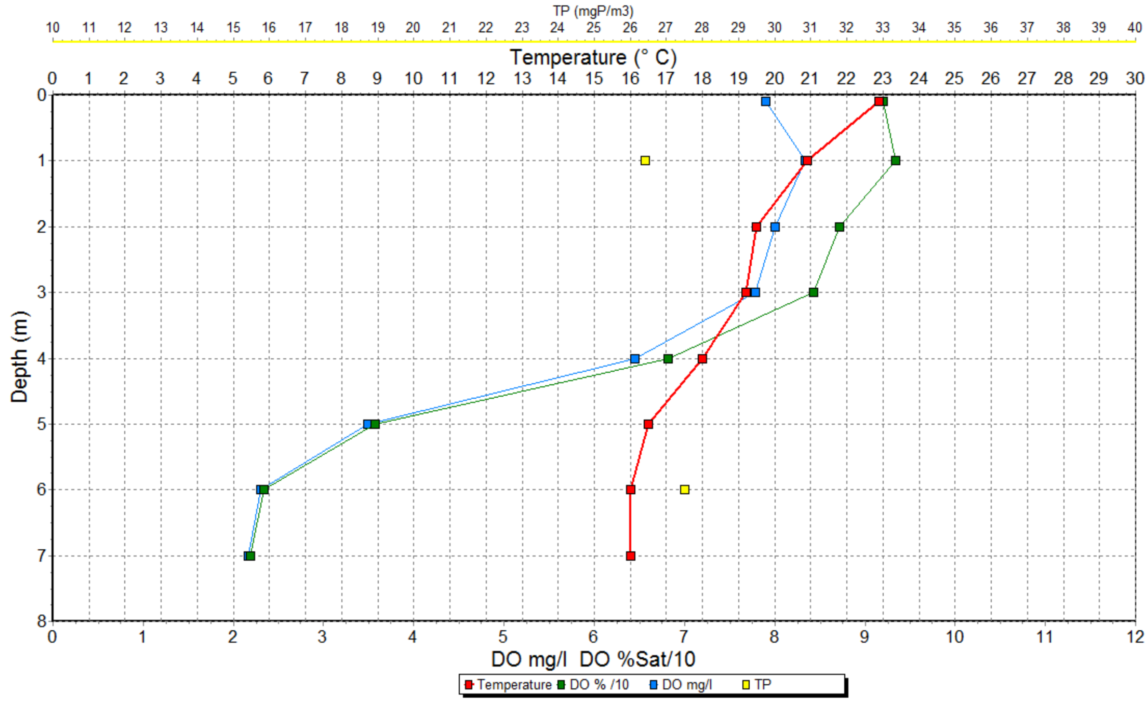

Figure A35. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—July 5, 2012.

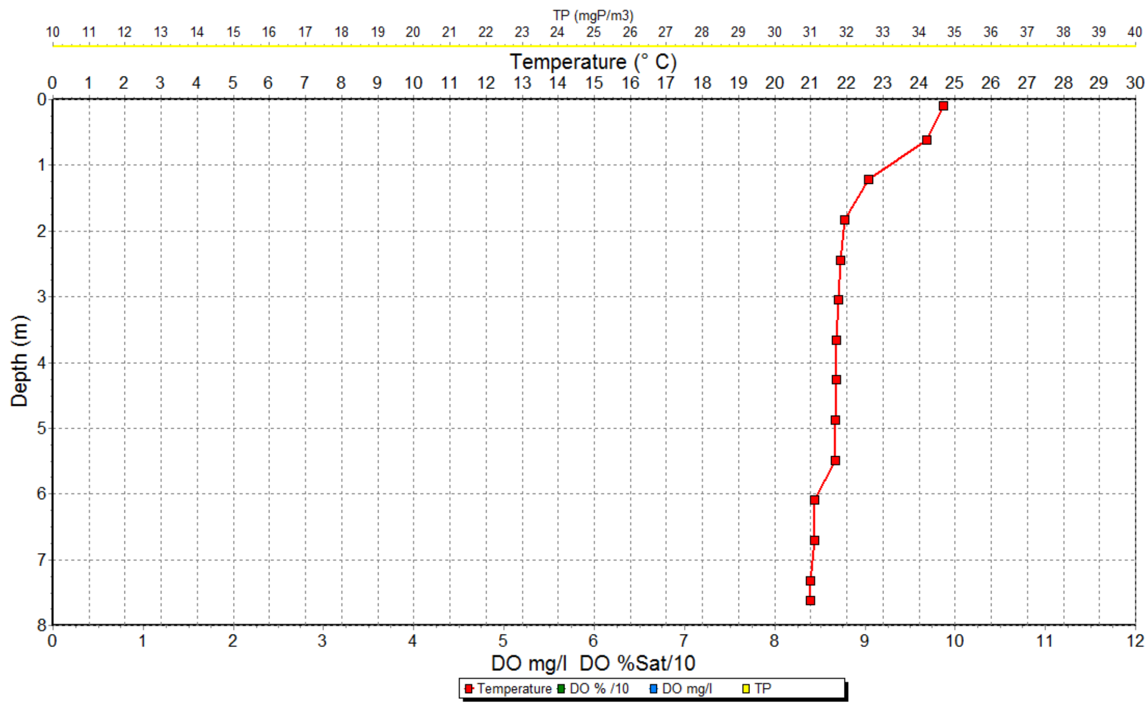

Figure A36. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—July 11, 2012.

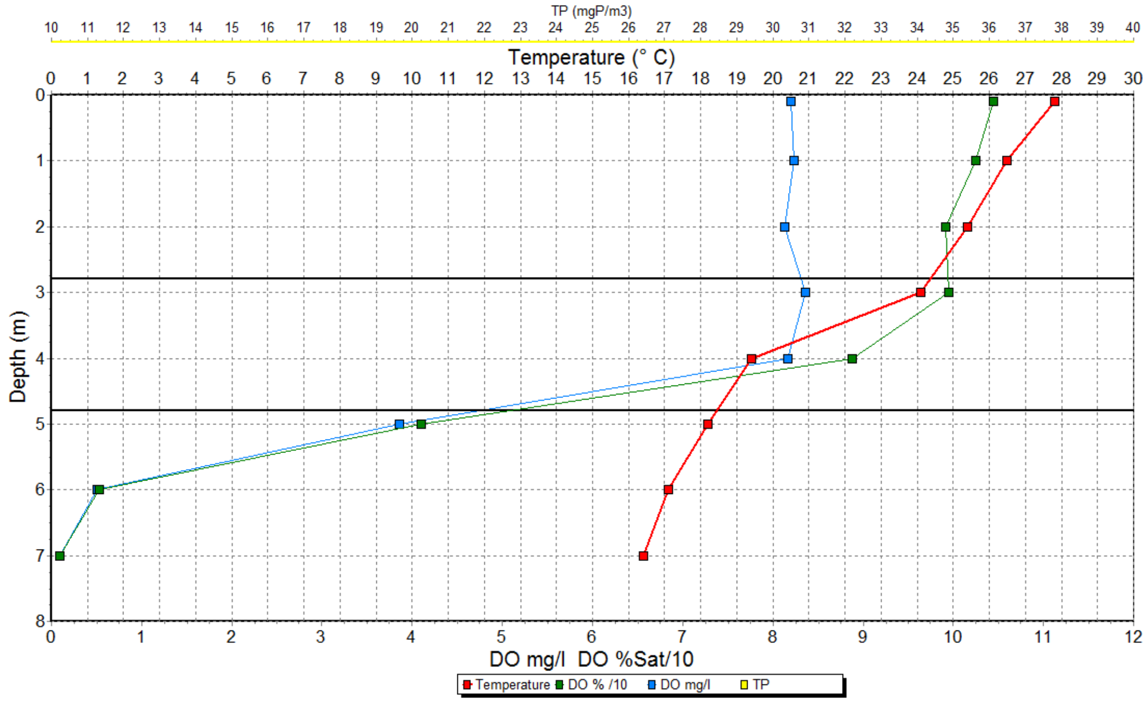

Figure A37. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—July 19, 2012.

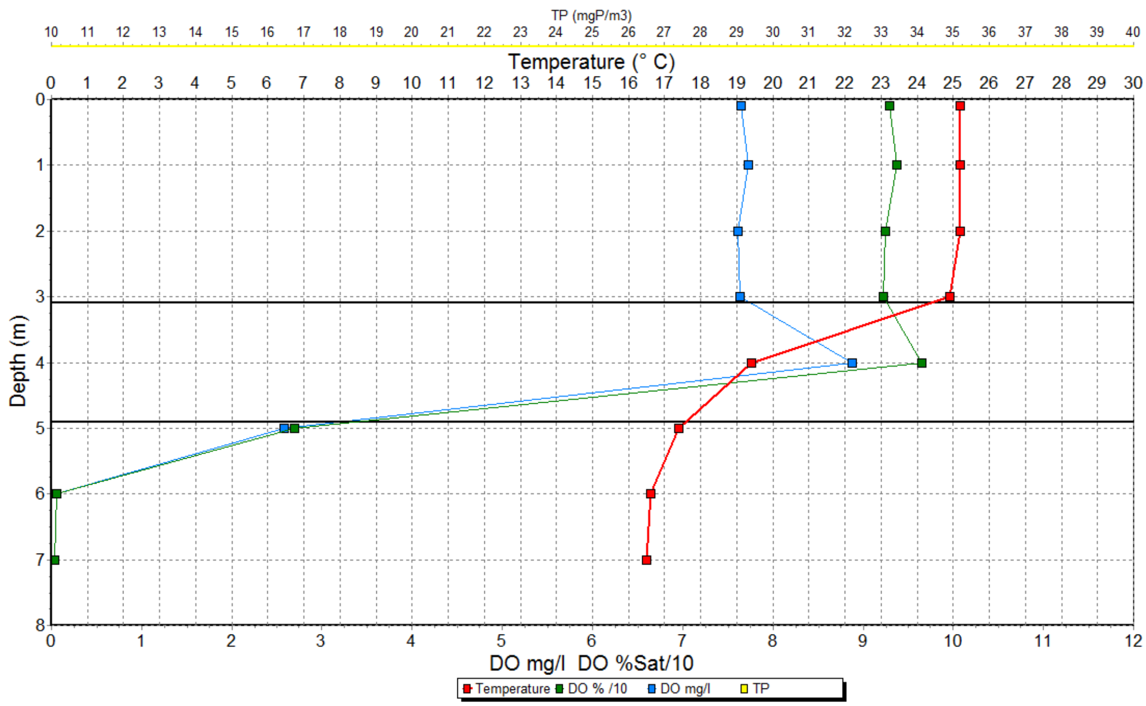

Figure A38. Temperature, dissolved oxygen (DO), and total phosphorus (TP) data—July 20, 2012.

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Appendix B. Daily Load Table

Table B1. Daily loads of nonpoint sources in the Fernan Lake watershed. All loads expressed to 2 significant figures.

Source	Existing Load (kg/day)	Existing Load During Critical Period [a] (kg/day)	Necessary Load Reduction from Existing Condition Percent	Necessary Load Reduction from Existing Condition (kg/day)	Wasteload/ Load Allocation (kg/day)	Wasteload/Load Allocation During Critical Period [a] (kg/day)
Point Sources						
NPDES-regulated Stormwater from Urbanized Area	0.55	0.033	35%	0.19	0.36	0.021
Construction Storm Water under the CGP	0.027	0.0016	35%	0.0096	0.018	0.0011
Nonpoint Sources						
Fernan Creek	7.1	0.44	35%	2.5	4.7	0.27
Fernan Lake Village lawns	0.82	0.049	35%	0.30	0.52	0.030
Stormwater Injection Wells	0.36	0.021	35%	0.13	0.23	0.014
Fernan Lake Road outside the Urbanized Area	0.44	0.026	35%	0.15	0.27	0.016
Septic Effluent	0.27	0.016	35%	0.096	0.18	0.011
Other	0.19	0.012	35%	0.068	0.13	0.0077
Internal cycling	1.6	0.093	35%	0.55	1.0	0.06
Total	11	0.68		4.1	7.4	0.44

[a] Concentrations and loads are during the critical time period between August 15 and September 15.

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Appendix C. Distribution List

The Fernan Lake TMDL will be distributed to the CDA Lake Tributaries WAG:

Bob Clark
Bob Flagor
Brett Bowers
Dan McCracken
David Fortier
David Gabrielsen
Dean Sutton
Denna Grangaard
Diane Partridge
Don Martin
Ekins, Jim
Glen Pettit
Gordon and Mary Sanders
Jamie Brunner
Janet and Steve Funk
Janet Torline
Larry Mundt
Laura Laumatia
Marie Pengilly
Mark Hoagan
Mike Stevenson
Miles Benker
Rebecca Stevens
Rusty Shephard
Sandra Raskell
Sandy Schlepp
Scott Fields
Steve Wilson
Susan Andrews
Tarita Harju
Tom Little
William Rust

Appendix D. Public Comments/Public Participation

A public comment period was run from September 11, 2013 to October 11, 2013 for the Fernan Lake TMDL. The following comments were submitted:

Ruen-Yeager & Associates, Inc. comments on the Fernan Lake TMDL. Submitted October 1st on behalf of East Side Highway District, Kootenai County:

Ruen-Yeager & Associates, Inc. comment: 3.1.2 – This section begins with a statement about the primary nonpoint source of pollution into Fernan Lake is the Fernan Creek Watershed. The next sentence immediately drills down to “other sources of phosphorus are . . . We could not find where it was substantiated that these other sources of phosphorus are a known fact? Particularly, Fernan Hill Road.

DEQ response: As stated in section 3.2 (Data Gaps), limited data were available for developing this TMDL for Fernan Lake, and to accurately characterize nutrient load from the sources identified in the TMDL. However, DEQ used analysis of existing data and our best professional judgment to determine likely nonpoint sources to Fernan Lake. Because we have no monitoring data to accurately identify many of the sources of phosphorus to Fernan Lake, we have updated the text in section 3.1.2 to state the sources identified in the TMDL are *likely* sources of total phosphorus to Fernan Lake.

Given the known locations of stormwater injection wells within Fernan Village, it was clear stormwater from Fernan Hill road drains to an injection well within the Village. Due to the close proximity of Fernan Village to Fernan Lake and the very porous geology underneath the Village, it was reasonable to assume there is a hydrologic connection between the injection wells in Fernan Village and Fernan Lake. Because there is no monitoring data to substantiate this assumption, we updated the language in 3.1.2.2.2 to state stormwater injection wells (including the one draining Fernan Hill Road) are *likely* a nonpoint source of phosphorus to the lake.

Ruen-Yeager & Associates, Inc. comment: 3.1.2.1 Bullet One, the third sentence mentions that much of the phosphorus load from the watershed is naturally occurring. Is this load quantified somewhere in the document? If not, could you please indicate what this naturally occurring load is?

DEQ Response: Fernan Lake is a mesotrophic lake that would naturally have an intermediate level of productivity; however, it has a high frequency of blue-green algae blooms. The goal of this TMDL is to reduce the frequency of blue-green algae blooms. The 20 ug/L water quality target for TP was selected from a range of total phosphorus concentrations observed in other lakes in the region that typically do not have blue-green algae blooms. While DEQ does not have the data to quantify the nutrient load from naturally occurring sources in the watershed, the 20 ug/L target includes naturally occurring total phosphorus plus additional loading that can be assimilated by the lake without the undo frequency of blue-green algae blooms.

Ruen-Yeager & Associates, Inc. comment: Figure 27, The East Side Highway District noted under Column FACILITYNA (sic) does not own, maintain, control, or in any way manage the first eight (8) listed items under Column FACILITYAD (sic).

DEQ Response: The data table presented in Figure 27 was obtained from a shapefile from Idaho Department of Water Resources showing the location of non-permitted injection wells. This shapefile was created in 2009. Upon preparing the response to this comment, it became known that Idaho Department of Water Resourced created a new shapefile in 2013. In the metadata of this shapefile, the information in question has been deleted. There are also many more injection wells identified in this shapefile in the vicinity of Fernan Lake Village. DEQ has replaced Figure 27 with a new figure created from the 2013 shapefile.

Ruen-Yeager & Associates, Inc. comment: 3.1.2.3 In the second paragraph, in the second sentence it is stated that, several factors indicate that the road (Fernan Creek Road) is still a source of sediment to the lake:

This appears to be a list of possibilities but there is no real indication that this is or is not occurring. These are assumptions but are stated as facts, please clarify.

DEQ Response: While DEQ has no quantifiable monitoring data to substantiate a load from Fernan Creek Road, we have observed during periods of prolonged precipitation stormwater discharge through relief culverts on Fernan Creek Road. Therefore, Fernan Lake Road is a source of sediment and phosphorus to Fernan Lake. The factors listed in section 3.1.2.3 further indicate that the road is likely a source of sediment and phosphorus to Fernan Lake. The text in section 3.1.2.3 has been changed to document these points.

Ruen-Yeager & Associates, Inc. comment: Please note that no system will sequester all phosphorus.

DEQ Response: This has been noted in the TMDL document.

Ruen-Yeager & Associates, Inc. comment: No discussion was found on the presence of retention systems that are now in place after the 2009 roadway reconstruction and the reduction in nutrient loading that has occurred from these systems.

DEQ Response: DEQ has no monitoring data to quantify a load reduction following roadway construction and the installation of stormwater and sediment reduction BMPs on Fernan Lake Road. However, it is typical to see a short-term increase in sediment and nutrient loading immediately following roadway construction and BMP installation, followed by a long-term reduction in sediment and nutrient loading.

Ruen-Yeager & Associates, Inc. comment: The riparian area is typically outside of the roadway right-of-way and is also typically not a road issue this statement seems out of place in this section on Fernan Lake Road.

DEQ Response: The riparian area is immediately adjacent to the road; and, when it is in proper functioning condition, it acts like a buffer for any runoff from the road system. It is appropriate to make this point in this section.

Ruen-Yeager & Associates, Inc. comment: This section notes a 2001 study by Falter indicating roadway sediment and nutrient loading as being substantial. Fernan Lake Road Roadway improvements were completed around 2009. It appears that the roadway improvements are not included or addresses only the previous study's conclusions.

DEQ Response: The text in section 3.1.2.3 has been changed to indicate roadway improvements and BMP installation are working properly. However, given the proximity of the road to the lake, the factors listed still indicate Fernan Lake Road is likely a source of sediment and phosphorus to the lake.

Ruen-Yeager & Associates, Inc. comment: Many of the steep slopes and cliffs are naturally occurring and have always existed. A component of this load should be considered background.

DEQ Response: The TMDL waste load allocation to Fernan Lake Road indicates a necessary 35 percent reduction in nutrient loading from the existing condition on the road. The remaining 65 percent includes background phosphorus from the steep side slopes and cutslopes of the road.

Ruen-Yeager & Associates, Inc. comment: 3.1.2.4 – It appears that by ignoring 5% of the total load by septic tanks the Plan misses and opportunity to address up to 15% of the stated objective of "Reducing Total Load by 35%.

DEQ Response: The 5 percent load from septic tanks has not been ignored; rather, it was assigned a 35% load reduction along with the other nonpoint sources of phosphorus to the lake.

Ruen-Yeager & Associates, Inc. comment: 3.1.2.6 – Bullet Two, Being familiar with the lake, property ownership, and camping possibilities, this comment seems inaccurate. There are bathroom public facilities on the lake.

DEQ Response: On the southern end of the lake there are remote camping sites that are only accessible by boat. There are no public restroom facilities at these sites.

Ruen-Yeager & Associates, Inc. comment: 5.3.2 This table should reference how the estimated existing Loads were determined.

DEQ Response: Section 5.3 explains in detail how the estimated existing loads were determined.

Ruen-Yeager & Associates, Inc. comment: 5.3.2.2 Last sentence of this paragraph. How is it known that Fernan Hill Road is a source of phosphorus to the Lake as stated?

DEQ Response: Because we have no monitoring data to quantify the load of phosphorus from Fernan Hill Road, we have stated in section 3.1.2 that it is *likely* a source of phosphorus to the Lake given the locations of the stormwater injection wells in Fernan Village and the porous geology under Fernan Village. We also state in section 3.2 that more monitoring data is needed to understand the loading from injection wells to Fernan Lake.

Ruen-Yeager & Associates, Inc. comment: 5.3.2.3 In the first paragraph, the second sentence seems unnecessary in this subheading as Fernan Lake Road is paved.

DEQ Response: Agree. The sentence was taken out.

Ruen-Yeager & Associates, Inc. comment: 5.3.2.7 the predominant storm water loading of the CDA UA is downstream of the Fernan Lake outlet as indicated in section 1.1.6. To assign all of this loading from the CDA UA to Fernan Lake indicates that the Fernan Lake Road portion within the CDA UA would be the only element with outfalls to Fernan Lake and would be the source of this loading, this is inaccurate.

DEQ Response: Only a portion of the 2010-delineated Coeur d'Alene UA was considered in the TMDL loading and load reduction analysis. That portion is the MS4/drainage conveyance associated with Fernan Lake Road (and in particular, the portion of the Road located within the UA) and the MS4/drainage conveyance associated with the Armstrong Park development. The text in this section was changed to make that more clear. This is also stated in section 3.1.1.

Comment From Claude Kimball:
We encourage DEQ's efforts at making Fernan Lake healthier not to mention more beautiful to look at.
We live above the lake and at times during the year, it looks like we are looking at a sewer.

While Fernan may never have blue water, efforts to keep the lake from becoming a marsh are most welcome.

I am wondering if there is any thinking that the homes closest to the lake should be required to connect to a sewage system. While it would appear that you have determined that the major pollutants of the lake are coming from upstream, how confident is DEQ that the septic systems surrounding the lake are not presenting a health hazard to those who enjoy the lake? There is a considerable amount of undeveloped land along the lake and I am wondering what impact the development of these lands would have on the lake if the homes are all allowed to be on septic systems?

DEQ Response:
The proposed plans primary focus is to reduce the frequency of blue-green algae blooms on the lake. The last two years' blooms have indeed been unsightly and we're sure it was not pleasant to look at from above.

As the TMDL states, most of the homes on the lake are connected to the City of Coeur d'Alene's wastewater treatment system. Fernan Village and Armstrong Park are connected to the City of Coeur d'Alene sewer system, as is Fernan Hill within the city limits. There is a low density of homes near the lake that are still on septic systems. The Panhandle Health District estimates septic loading the Fernan Lake as under 5 percent. DEQ is confident that Panhandle Health District evaluation of this load is accurate. However, just because this is a low percentage, doesn't mean it should be ignored. As we have seen with a number of other lakes, cleaning up septic loading to a lake can be challenging. We will look at all opportunities to decrease phosphorus to the lake, including septic tanks.

Fernan Lake and the residents that live around the lake are fortunate in that there is undeveloped land around the lake. Due to County Ordinances and property deeded to the City of Coeur d'Alene, much of the land on the southern end of the lake will not be developed. Should land be developed, the TMDL identifies septic tanks as a source of phosphorus to the lake, and it has given a load allocation to this source.

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