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State of Washington

Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load

2010-2016 Implementation Report

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2010-2016 Implementation Report

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Executive Summary

The Spokane River begins at the outlet of Lake Coeur d'Alene in Idaho and flows west through the City of Spokane, Washington (Figure ES-1). The river continues northwest through Lake Spokane, then west-northwest toward its confluence with the Columbia River. Lake Spokane is created by Avista Corporation's Long Lake Dam.

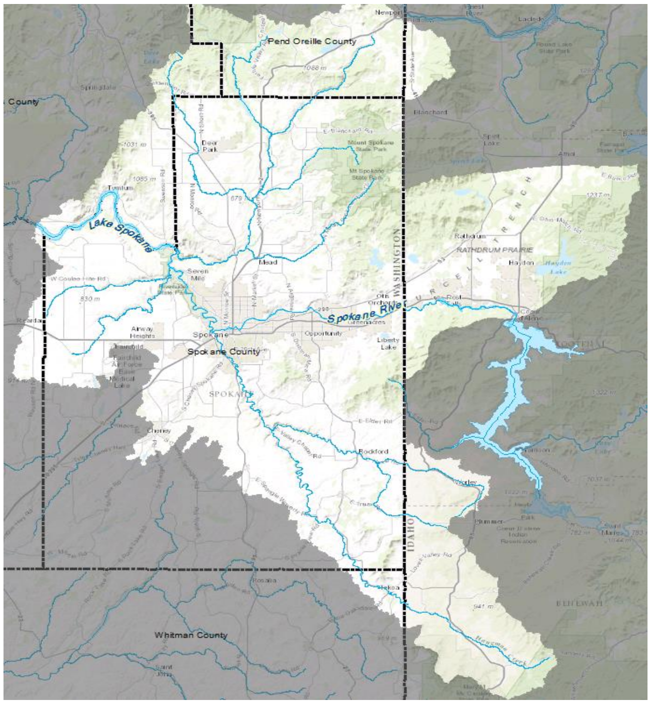

Figure ES-1. The Spokane River watershed

Low dissolved oxygen levels are common in the deeper parts of Lake Spokane (also referred to as Long Lake), and algae blooms have plagued the lake for decades. Scientific studies on the lake dating back to the 1970s indicated the lake contained too much phosphorus. These studies prompted the City of Spokane to take steps to reduce phosphorus and other nutrients discharged from their wastewater treatment plant. Despite some water quality improvement resulting from those efforts, Lake Spokane still does not meet Washington State water quality standards for dissolved oxygen.

In 2010, the Environmental Protection Agency approved the Washington State Department of Ecology's (Ecology) Spokane River and Lake Spokane Dissolved Oxygen Water Quality Improvement Plan. This plan is also called a total maximum daily load or TMDL. The TMDL includes requirements for the following nutrient sources within Washington State:

- Point sources such as municipal wastewater treatment plants or industrial facilities that discharge treated water into the river. There are five point source dischargers in Washington on the Spokane River. There are three point source dischargers to the Spokane River in Idaho. These Idaho dischargers did not receive allocations in the TMDL, but must meet required reductions as part of a compliance schedule in their discharge permits.

- Nonpoint source pollution that enters our waters from everyday activities such as over-application of fertilizer, poor management of livestock and pet waste, bare stream banks that erode, and failing septic systems. Most of the nonpoint source pollution comes from the tributaries (Hangman Creek, Deep Creek, and the Little Spokane River) and the area around Lake Spokane.

- Avista received a portion of the responsibility because Long Lake Dam created the conditions that led to the dissolved oxygen problem.

Since 2000 several groups have completed over 300 projects to reduce nonpoint source pollution. The majority of the projects are in the Hangman Creek watershed and over a quarter are in the Little Spokane drainage. The types of projects completed include connecting homes with septic systems to a sewer; improving forest roads to reduce erosion; installing livestock best management practices such as covered manure facilities, fencing off waterways, etc.; converting to direct seeding or minimum till; planting riparian (stream bank) areas with trees and shrubs; and using various methods to protect streambanks from eroding. Almost half of the nonpoint source reduction projects planted riparian areas and nearly a quarter of the projects converted conventional farming techniques to direct seed. Between 2010 and 2014, almost 19 miles of stream were planted and 13.6 square miles of farm fields converted to direct seeding or mulch till. Switching to direct seed methods saved an estimated 52,000 tons of soil. During 2015 and 2016, 86 additional acres of riparian area were planted with native trees and shrubs; 7,000 willow whips were planted within a 10-mile stretch of Hangman Creek; farmers applied nutrient management best management practices to over 24,000 acres; and 115 on-site septic systems were replaced or repaired.

Point source dischargers must significantly reduce the amount of nutrients from their facilities, and they are taking a variety of measures to get there. Between 2010 and 2014, facilities applied best management practices to optimize the treatment process. For example, they installed equipment or applied chemicals to enhance the treatment process, or reduced the amount of water used in their process. During 2015 and 2016, the dischargers researched new technology to reduce phosphorus and other nutrients from their discharges or began preliminary actions to initiate upgrades to tertiary treatment.

The cities of Spokane and Spokane Valley, along with Spokane County, are working to redirect runoff so it can infiltrate into the ground. In addition, the City of Spokane is burying large underground vaults that can store excess combined sewage and stormwater until it can be treated at the wastewater treatment facility, rather than overflow to the Spokane River or Hangman Creek. The City of Spokane Valley and Spokane County removed their last stormwater outfalls to the Spokane River. The Washington State Department of Transportation is also an active partner in reducing stormwater from the highways by performing maintenance and working with adjacent landowners to eliminate pollution sources entering the ditches and drains.

Multiple groups are collecting monitoring data from Lake Coeur d’Alene to Long Lake Dam. Some of the observations from the data are:

- Summer total phosphorus concentrations in the river are trending downward at the Idaho-Washington state line, Greene Street, Riverside State Park, and the riverine assessment point below Nine Mile Dam. Total phosphorus concentrations have not yet met the TMDL target at the riverine assessment point, but progress has been made toward the goal.

- The two deepest and furthest downstream Lake Spokane monitoring sites continue to have the lowest dissolved oxygen levels. Years with higher flows, such as 2011, help keep dissolved oxygen levels in the bottom layer higher. Mean summer total phosphorus concentrations in the upper layer of the lake decline in a downstream direction, so concentrations are higher at Nine Mile and are lower by Long Lake Dam. With the exception of 2015, blue-green algae blooms occur less frequently, and typically do not last as long. In 2015 the weather was hot and dry with an earlier than normal runoff season.

- Total phosphorus concentrations at the mouth of Hangman Creek appear to be decreasing during the summer (July through October) season, although the allocation is still not met. This indicates that either efforts to install BMPs are helping during low flows or recent summer periods are experiencing lower flows. The March through May and June seasons experience higher levels of runoff and erosion resulting in higher total phosphorus concentrations.

- The mouth of the Little Spokane River shows a similar pattern to Hangman Creek. The July through October total phosphorus concentrations are declining, although not meeting the allocation. As with Hangman Creek, BMPs and lower summer flows during drier summers may be the reason for the decline. The March through May and June total phosphorus concentrations show some improvement but are elevated due to runoff and storm events.

- Groundwater total phosphorus data from Spokane County wells in the Spokane Valley Rathdrum Prairie Aquifer suggest there is an overall downward pattern in concentrations. However, 15 or more wells out of 49 sampled in 2015 and 2016 have concentrations higher than the allocations assigned in the TMDL (0.0076 – 0.0081 mg/L).

One pound of phosphorus can grow 700 pounds of algae.

- Knud-Hansen, 1994

All of the activities to address point and nonpoint sources appear to have the desired effect of lowering nutrient levels in the river, lake, and groundwater. Groups should persist in taking steps outlined in existing compliance schedules and plans so that nutrient levels continue to decline toward TMDL targets in the remaining four plus years of implementation. At this time, Ecology does not detect any necessary alterations in implementation activities.

Recommendations for the next several years focus on monitoring efforts and include:

- Sampling for phosphorus and other nutrients during springtime high flows. Understanding where high nutrient concentrations come from in the spring can pinpoint where implementation efforts should occur.

- Monitoring groundwater along densely populated Lake Spokane shorelines, such as the Nine Mile community.

In the coming years, Ecology will continue to track nonpoint implementation activities. Dischargers will be finalizing engineering reports, plans, and specifications for new tertiary treatment and beginning construction. Timelines for installing treatment technology vary slightly among the dischargers, but the target to meet the final water quality-based effluent limits is 2021. Ecology anticipates beginning a 10-Year Assessment no earlier than 2021 to determine if the TMDL allocations are being met. Ecology is working with a monitoring workgroup to define goals, objectives, and steps to take toward the 10-Year Assessment.

The 10-Year Assessment will determine compliance with the TMDL. This biennial report is intended to capture conditions and provide general observations of monthly data. Comparisons made in this report are only considered estimates and will be superseded by conclusions from tributary TMDLs, special studies, or the 10-Year Assessment.

Introduction

The 6,640 square-mile Spokane River watershed begins at the outlet of Lake Coeur d'Alene in Idaho and flows west through the City of Spokane, Washington (Figure 1). The river continues northwest through Lake Spokane, then west-northwest toward its confluence with the Columbia River. Downstream of Lake Spokane the northern portion of the river flows through the reservation of the Spokane Tribe of Indians.

Lake Spokane, created by Avista Corporation's (Avista) Long Lake Dam, does not meet Washington State water quality standards for dissolved oxygen. In 2010, the Environmental Protection Agency approved the Washington State Department of Ecology's (Ecology) plan to improve the lake's water quality: The Spokane River and Lake Spokane Dissolved Oxygen Total Maximum Daily Load (TMDL) (Moore and Ross, 2010). To achieve compliance with the dissolved oxygen standard, the TMDL requires significant reductions in phosphorus loads.

One of Ecology's commitments in the TMDL is to write a report every two years (the biennial report) to document progress toward meeting the TMDL allocations. This document contains information about activities to reduce nutrients from 2010 through 2016. The original report documented activities between 2010 and 2014. Implementation information from 2015 and 2016 was added to the original report, so that all the information is located in one document. The 2015-2016 updates may be located separately below the text originally written for the 2010-2014 report, or a section's entire language may have been updated. Information prior to 2010 is included in the report to provide historical context. You may consider this document as a report card on the commitments described in the TMDL, the activities taking place to reduce phosphorus, and the progress made toward achieving water quality standards.

Background

Algae blooms and low dissolved oxygen levels in the lower depths of Lake Spokane (Long Lake) have existed for decades. Patmont et al. (1987) described water quality problems that occurred in the lake during the 1930s, 1960s, and beyond. During the 1970s, Eastern Washington University and others completed multiple studies on the lake. These studies indicated that removing phosphorus, particularly from the City of Spokane's wastewater treatment plant, would help improve the lake's water quality (Patmont et al., 1987). In December 1977, the City of Spokane completed an upgrade to their wastewater treatment plant to remove 85 percent of the phosphorus coming into the plant (Patmont et al., 1987). As a result, the lake's minimum dissolved oxygen concentrations in the summer of 1978 showed significant improvement (Cusimano, 2004).

Despite the improvement, algae blooms continued to occur and more point source dischargers began operating. This prompted a group of Lake Spokane homeowners to file a lawsuit. The lawsuit launched decades of study, modeling, phosphorus management planning (1989 Spokane River Phosphorus Management Plan, 1992 Total Phosphorus TMDL, 2010 Spokane River and Lake Spokane Dissolved Oxygen TMDL), and improvement actions.

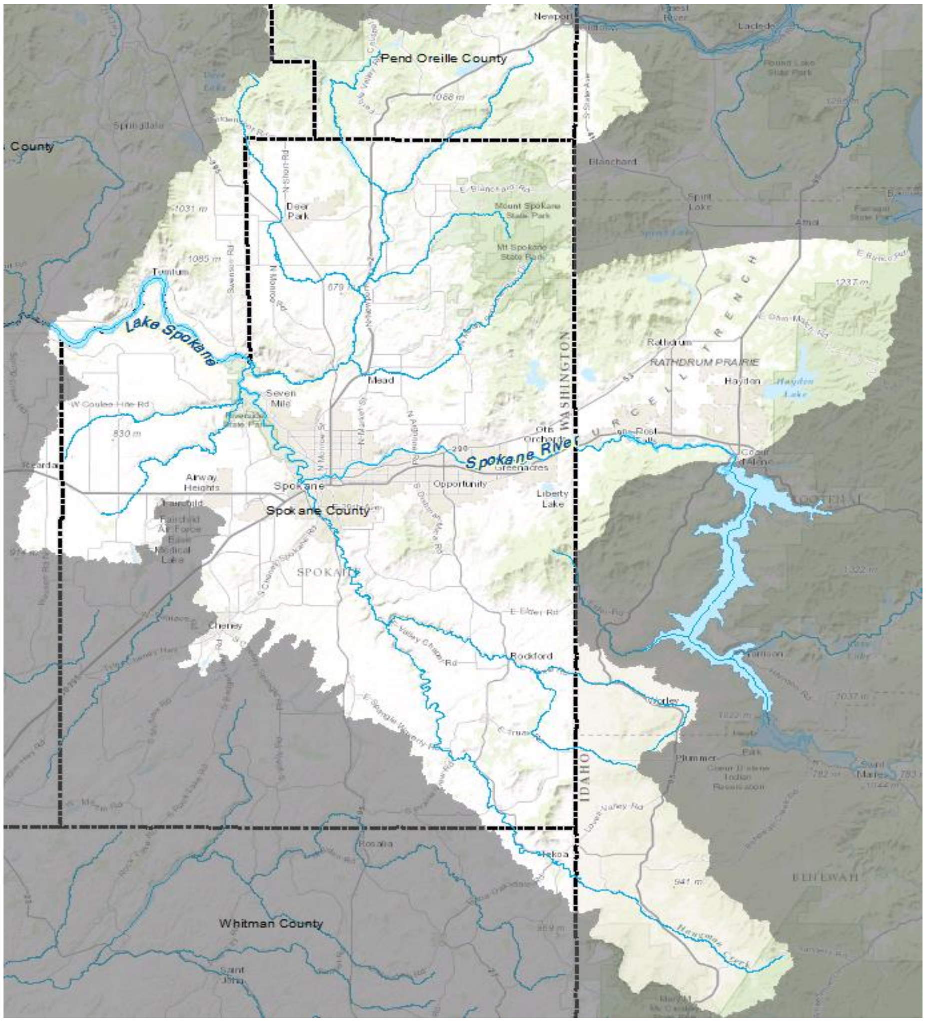

Figure 1. The Spokane River watershed covered by the dissolved oxygen TMDL

Figure 2 shows an improving trend in minimum volume-weighted dissolved oxygen levels in the hypolimnion, or the deepest parts of the lake from 1972 through 2016, despite significant population growth in the study area. Several actions described in the following pages likely contributed to the recent improvement shown in the graph, such as banning phosphorus in detergents and fertilizer, applying chemical enhanced primary treatment, optimizing manufacturing processes, and operation of a new wastewater treatment plant. The graph shows we are on the correct path toward improving dissolved oxygen in the Spokane River and Lake Spokane, but we need to ensure activities continue in order to achieve water quality standards.

Within the next five years, entities discharging to the river in Washington will complete the installation of additional equipment to significantly lower nutrients in their discharges. Ecology also expects practices that reduce nutrients from nonpoint sources will be more widespread by 2020. In addition, dischargers in Idaho are expected to complete upgrades to lower nutrients from their facilities in the next seven years. We anticipate these steps will achieve the allocations in the TMDL and improve Lake Spokane's dissolved oxygen levels.

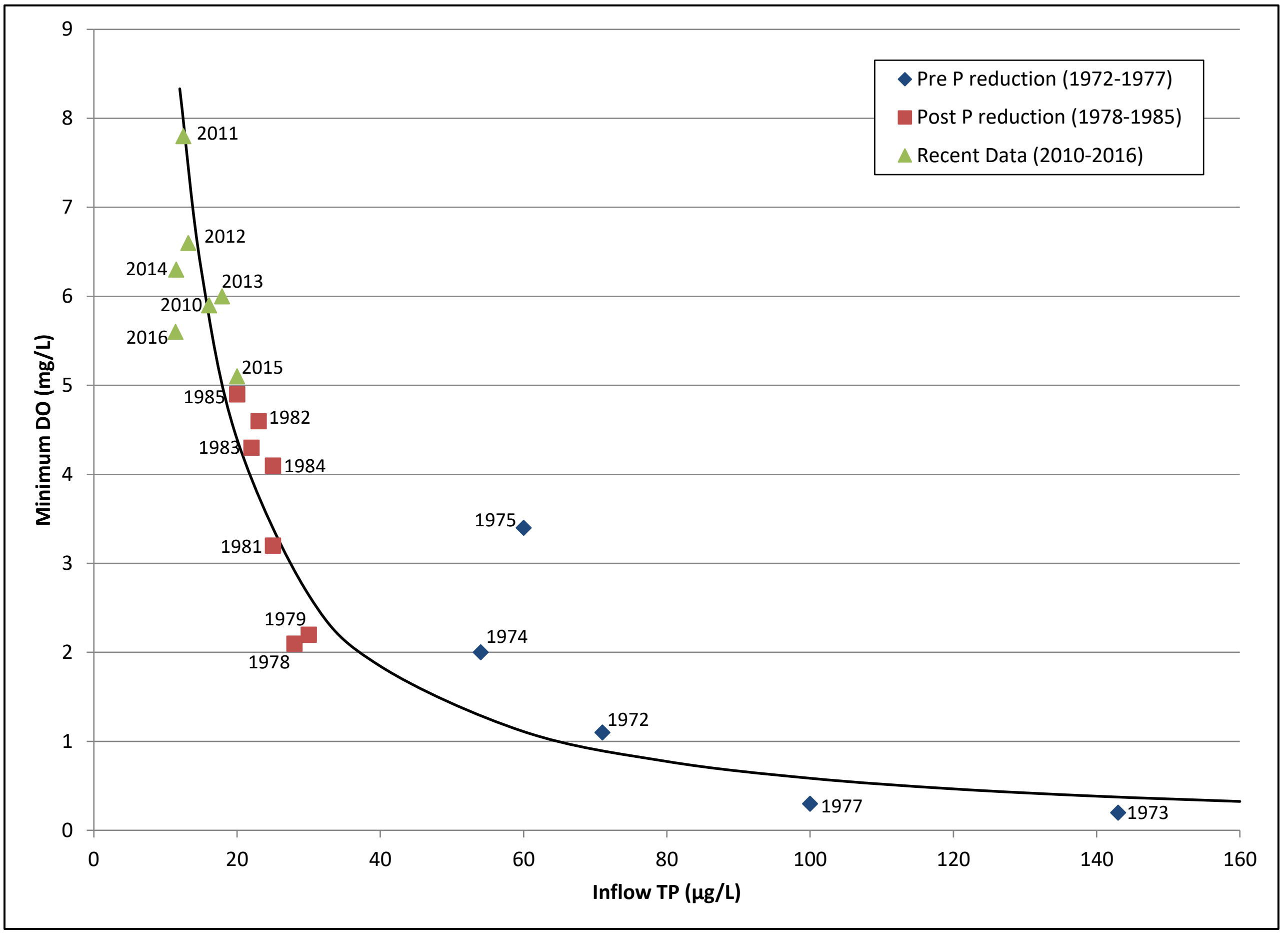

Figure 2. June-October volume weighted mean inflow TP concentration related to minimum volume weighted hypolimnetic DO concentrations before and after advanced wastewater treatment* (Avista, 2017)

**Concentrations from 1972 through 1985 from observed loading at Nine Mile Dam (Patmont et al., 1987). Mean inflow TP Concentrations from 2010-2016 were taken as Volume-Weighted Mean TP Concentrations at Station LL5, in lieu of loading data from Nine Mile Dam.*

Goals from the TMDL

The goal of the TMDL is to achieve the dissolved oxygen water quality standard in Lake Spokane. Achieving the allocations established in the TMDL for point sources and non-point sources, Avista's responsibility, and the assumptions for Idaho should result in the lake attaining the water quality standard.

For the Washington State point sources (municipal wastewater treatment plants and industrial dischargers), the seasonal (March through October) wasteload allocations are based on meeting a maximum monthly average total phosphorus concentration of 50 µg/L (micrograms per liter or parts per billion) within ten years (Moore and Ross, 2010). Ecology used discharge volume estimates to convert the nutrient concentrations into pounds per day (Table 1). Spokane County's new Regional Water Reclamation Facility (SCRWRF) was required to meet a seasonal average total phosphorus concentration of 42 µg/L at the time the facility began operating.

Idaho point sources to the Spokane River are included in the TMDL because federal law requires upstream states to comply with water quality standards of downstream states. Modeling for the TMDL showed that nutrients from the three Idaho dischargers affect dissolved oxygen levels in Lake Spokane. Ecology does not have authority to require reductions in Idaho, but we worked with the Environmental Protection Agency (EPA) who is responsible for issuing permits in Idaho. The permits contain conditions that ensure compliance with Washington water quality standards. So the TMDL assumed that Idaho wastewater treatment plants and stormwater combined would achieve the following nutrient reductions:

- 7.2 lb/day phosphorus
- 497 lb/day CBOD
- 94.4 lb/day ammonia

Table 1. Wasteload allocations for Washington State point sources (Moore and Ross, 2010)

Point Source Discharge	2027 Projected Flow Rates (MGD) [1]	NH3-N		TP		$CBOD_5$ [2]	
		mg/L	lb/day (WLA)	mg/L	lb/day (WLA)	mg/L	lb/day (WLA)
Liberty Lake	1.5	variable[3]	variable[3]	0.036	0.45	3.6	45.1
Kaiser[4]	15.4	0.07	9.0	0.025	3.21	3.6	462.7
Inland Empire Paper Company	4.1	0.71	24.29	0.036	1.23	3.6	123.2
City of Spokane	50.8	variable[3]	variable[3]	0.042	17.81	4.2	1780.6
Spokane County (new plant)	8	variable[3]	variable[3]	0.042	2.80	4.2	280.4
Stormwater[5]	2.36	0.05	0.98	0.310	6.1	3.0	59.1
CSO	0.12	1.0	1.0	0.95	0.95	30.0	30.0

Notes:

1- Actual, not projected flows, will determine compliance with wasteload allocations in NPDES permits.

2- NPDES permit limits will use $CBOD_5$ (as shown) rather than $CBOD_{ult}$ (as modeled).

3- Ammonia wasteload allocations vary depending on the season based on the following effluent concentrations (loading limits use these concentrations and the design flow):

Liberty Lake:
March-May, October: 0.71 mg/L
June-September: 0.18 mg/L

City of Spokane and Spokane County:
March-May, October: 0.83 mg/L
June-September: 0.21 mg/L

4- Wasteload allocations for Kaiser are lower than other dischargers due to non-contact groundwater, which is low in nutrients and comprises a significant portion of the facility's discharge.

5- Stormwater wasteload allocation is for Washington sources only and is based on average existing flows, not 2027 projected flows.

The TMDL assigned load allocations to nonpoint sources of pollution. The three tributaries (Hangman Creek, Deep Creek, and the Little Spokane River) and the area surrounding Lake Spokane are the primary sources of nonpoint pollution to the river and lake. For nonpoint sources, the allocations were calculated using a critical, low-flow condition (Table 2). As with the point sources, the nonpoint allocations apply from March through October. In Hangman and Deep Creeks, the allocations vary by season and translate to the following reductions:

- 20 %: March – May
- 40 %: June
- 50 %: July – October

In the Little Spokane River, the allocation represents a 36 percent decrease in phosphorus during the entire March through October critical season.

Table 2. Tributary and groundwater TMDL allocations (Moore and Ross 2010)

Water Body and Season	2001 Flow (cfs)	Total Phosphorus		Ammonia (NH3-N)		CBOD	
		Allocation Concentration (mg/L) [1]	2001 Load Allocation (lb/day)	Allocation Concentration (mg/L)	2001 Load Allocation (lb/day)	Allocation Concentration (mg/L)	2001 Load Allocation (lb/day)
Hangman Creek							
March– May Average	229	0.113	140.2	0.034	42.1	3.3	4102.1
June	31	0.044	7.5	0.012	2.1	2.8	479.0
July – October Average	9	0.030	1.4	0.009	0.4	2.3	107.9
Coulee Creek							
March– May Average	30	0.113	18.2	0.034	5.5	3.3	533.7
June	8	0.044	1.8	0.012	0.5	2.8	116.5
July – October Average	2	0.030	0.4	0.009	0.1	2.3	28.6
Little Spokane River							
March – May Average	565	0.034	102.5	0.035	106.2	2.1	6409.3
June	426	0.023	53.9	0.005	11.5	2.1	4828.2
July – October Average	364	0.016	32.2	0.006	11.0	1.5	2867.8
Groundwater – Upstream of Lake Spokane							
March – May Average	1946	0.0081	87	N/A	N/A	N/A	N/A
June	1583	0.0078	66	N/A	N/A	N/A	N/A
July – October Average	1165	0.0076	48	N/A	N/A	N/A	N/A
Groundwater / Surface Water Runoff – Lake Spokane Watershed							
March – May Average	588[2]	0.025	79	N/A	N/A	N/A	N/A
June	225[2]	0.025	30	N/A	N/A	N/A	N/A
July – October Average	180[2]	0.025	24	N/A	N/A	N/A	N/A

Notes:

1- Allocation concentrations are based on critical low flow conditions.
2- Reservoir correction flows in the water quality model. Flows are both positive and negative. The listed value is the average of positive inflows to the reservoir.

In the TMDL, Avista received a "responsibility" because they are not responsible for discharging nutrients, but their Long Lake Dam created the lake and conditions that contribute to the reservoir's impairment. Avista's task is to increase dissolved oxygen in the deeper parts of Lake Spokane from July 1 through October 31. The level of dissolved oxygen improvement required depends on the location and depth of the lake, as well as time of the year, but the required increase ranges from 0.1 to 1.0 mg/L.

In addition to allocations, the TMDL laid out a schedule containing milestones to indicate progress toward achieving the allocations. The schedule divided the milestones based on the number of years following approval of the TMDL.

Within first five years of implementation (2015):

- NPDES permittees will:
    - Achieve interim performance-based limits in NPDES permits.
    - Complete a best management plan.
    - Start, continue, or complete target pursuit actions.
- Avista will develop a Dissolved Oxygen Water Quality Attainment Plan within two years following EPA approval of the TMDL, or 2012.
- Non-discharger groups will work to reduce nutrients from nonpoint sources.
- Ecology and others will monitor and assess nutrient levels.
- Ecology will develop dissolved oxygen/phosphorus TMDLs for the Little Spokane River and Hangman Creek.

Ten years after approval of the TMDL (2020):

- NPDES permittees in Washington will operate newly-installed technology to meet their allocations. If necessary, they may start, continue, or complete target pursuit actions.
- Avista will assess performance of the activities identified in their water quality attainment plan to improve dissolved oxygen.
- The riverine assessment point downstream of Nine Mile Dam, that also considers input from the Little Spokane River, will achieve a total phosphorus concentration of 10 μg/L.

Fifteen years after approval of the TMDL (2025):

- Between 11 and 26 percent of total suspended solids in Hangman Creek and the Little Spokane River tributaries will be reduced. To meet this goal, landowners in these tributary watersheds will need to apply 75 to 100 percent of the necessary best management practices.

A discussion of adjustments to these timelines and how we have performed in relation to these goals and timeline is presented in the Progress Report section.

Tributary TMDLs

The Spokane River and Lake Spokane TMDL established load allocations at the mouths of the three tributaries: Hangman Creek, Deep Creek, and the Little Spokane River. As a result, Ecology must develop water quality improvement plans (also called Total Maximum Daily Loads or TMDLs) in order to divide the nutrient allocations from the dissolved oxygen TMDL at the tributary mouths among the various nutrient sources located upstream. For Deep Creek, more study is needed to understand the nutrient contributions since little water quality data are available, but Ecology has initiated TMDLs on Hangman Creek and the Little Spokane River. Although there are some small point source discharges on these tributaries (mostly on Hangman Creek), the TMDL acknowledges the nutrients come mainly from nonpoint sources of pollution.

Following is a description of where Ecology is in the process to develop nutrient TMDLs on Hangman Creek and the Little Spokane River. In addition, general information is provided on what is being done to implement TMDLs for other water quality parameters. Additional information on implementation activities is discussed in the nonpoint source section of this document.

Hangman Creek / Latah Creek

2010-2014

The Environmental Protection Agency (EPA) approved the Hangman Creek TMDL for fecal coliform bacteria, temperature, and turbidity impairments in September 2009. An implementation plan followed in May 2011. Several implementation projects by the Spokane Conservation District, The Lands Council, the City of Spokane, the Coeur d'Alene Tribe, and the Washington Department of Transportation to reduce pollution from nonpoint sources have been completed or are underway. Many of these projects will also reduce nutrients that contribute to dissolved oxygen and pH impairments.

The dissolved oxygen and pH TMDL is currently on hold while Ecology works on water quality standards policy issues related to stagnant and intermittent flow conditions, which are in part a natural phenomenon in the watershed. The goal of the policy work is to better align the water quality standards with the modeled natural conditions to reflect conditions present prior to human influence in the watershed. This effort has been further complicated by litigation filed in 2014 that challenges EPA's approval of provisions to incorporate natural conditions in the application of water quality criteria.

2015-2016 Update

During 2015 and 2016 Ecology continued to work on potential pathways to reconcile the disparity between the numeric water quality criteria and the naturally attainable water quality condition in Hangman Creek watershed. Ecology also consulted with EPA regarding potential outcomes of the litigation and how it could affect the completion of this and other TMDLs. During this same timeframe, Ecology focused efforts on assessing nonpoint sources in the watershed and implementation of best management practices to address these sources. TMDL development resources were focused on completing the Little Spokane dissolved oxygen and pH TMDL.

In 2017, Ecology will launch a study which will provide additional data regarding nutrient and sediment loading throughout the watershed. The goals of this data and modeling analysis are to help prioritize areas for implementation. This study has two primary objectives to meet these goals:

1. Study and model the reach where the Tekoa Wastewater Treatment Plant discharges to develop water quality based effluent limits protective of dissolved and pH water quality standards in Hangman Creek.
2. Assess the Hangman Creek watershed's contribution of pollutants affecting dissolved oxygen in the Spokane River. A watershed-wide total phosphorus and sediment study will determine where reductions need to occur within the watershed to achieve the desired results at the mouth of Hangman Creek during the spring runoff season. Additionally, a surface and groundwater study in the lower reaches of the basin will show where reductions are needed during the summer low-flow season.

Data collected during this study will also be useful for a future dissolved oxygen and pH TMDL in the watershed.

Little Spokane River

2010-2014
EPA approved a TMDL for fecal coliform bacteria, temperature, and turbidity impairments on the Little Spokane River and its tributaries in April 2012. Implementation partners, such as the Spokane and Pend Oreille County conservation districts, continue to implement best management practices for agriculture and septic systems in the watershed. The Lands Council is also working on riparian restoration projects. These implementation activities also address dissolved oxygen and pH impairments in the watershed. An implementation plan for bacteria, temperature, and turbidity will be developed in conjunction with the implementation plan for the future dissolved oxygen and pH TMDL.

2015-2016 Update
The Little Spokane River dissolved oxygen and pH TMDL is in development and is expected to be completed in late 2018. During 2015 and 2016, Ecology conducted a year-long study that focused on quantifying nutrient loading from various parts of the watershed during different seasons of the year. This effort also had a focus on assessing conditions in tributary streams. Ecology began analyzing the data collected during this study and earlier studies for TMDL development.

Ecology will use QUAL2K and River Metabolism Analyzer (RMA) modeling to set allocations to address dissolved oxygen and pH impairments throughout the Little Spokane Watershed. The TMDL will also contain a watershed loading analysis to determine where total phosphorus loading reductions should be prioritized to achieve the allocation set by the Spokane River DO TMDL at the mouth of the Little Spokane River. Once the TMDL is completed Ecology will work with the local community and interested parties to develop an implementation plan for this and the previous TMDL.

Regional Activities

Banning the use of detergents and fertilizers with phosphorus began as a local effort to improve the water quality of Liberty Lake, but since that time diverse groups united together to expand the bans beyond Liberty Lake and the Spokane watershed.

Laundry and Dishwasher Detergent Phosphorus Bans

Liberty Lake Sewer and Water District (LLSWD) led the way regionally and nationally with banning phosphorus in laundry detergents in 1989. Spokane County and the City of Spokane joined LLSWD and others to support a statewide ban that passed the Washington State legislature in 1995, which was one year later than a nationwide ban adopted in 1994.

LLSWD became the first utility to ban phosphorus dishwasher detergents in 2005. A number of point source dischargers, non-profits, and environmental groups were instrumental in convincing the Washington State Legislature to adopt a phosphorus detergent ban in Spokane County three years later in July 2008. In July 2010, 16 years after the statewide ban on phosphorus laundry detergents, the Washington State Legislature extended the ban statewide on automatic dishwasher detergents containing phosphorus. In January 2014, Proctor and Gamble announced a plan to eliminate all phosphates from its laundry detergent worldwide within the next two years. Proctor and Gamble products represent one quarter of the global detergent market.

The detergent bans are important to municipal wastewater treatment plants because they reduce the amount of phosphorus entering their facilities, so there is less phosphorus to remove. The Liberty Lake Sewer and Water District detected a 16.84 percent decrease in the amount of phosphorus coming into their plant after the statewide ban (Adams, 2014). The ban appears to have also reduced the amount of phosphorus that enters the Spokane County Regional Water Reclamation Facility (SCRWRF) by about 20 percent below its influent design concentration of 7.2 milligrams per liter (mg/L). For homeowners on septic systems, these detergent bans helps to reduce the amount of phosphorus that may leach from drain fields and enter ground water.

Phosphorus Fertilizer Ban

In 2005, the LLSWD took steps to ban the use of fertilizer containing phosphorus within their boundaries. About three years later several community groups and governments from the Spokane area began working to establish a statewide ban on lawn fertilizers containing phosphorus: the Washington Lakes Protection Association (WALPA), Environmental Priorities Coalition, Scotts Miracle-Gro, Fred Meyer, LLSWD, Lake Whatcom, Avista, Inland Empire Paper, The Lands Council, Spokane Riverkeeper, and the City of Spokane. In the fall of 2010, The Lands Council proposed a phosphorus fertilizer ban as an environmental community priority for the 2011 Washington State legislative session (WALPA 2015).

In 2011 with the support of local stakeholders, the Washington State Legislature passed Engrossed Substitute House Bill (ESHB) 1489, which prohibits the application of fertilizers containing phosphorus to “land, including residential property, commercial property, and publicly owned land, which is planted in closely mowed, managed grass.” (ESHB 1489, 2011). That year, Governor Gregoire signed the bill into law but it did not become effective until

January 1, 2013. The law only allows the application of fertilizers containing phosphorus under the following conditions:

- Establishing new grass.
- Repairing damaged grass during the growing season.
- Growing grass as part of a sod farm.
- Applying the fertilizer on pasture.
- Soil test results show a phosphorus deficiency.

The ban on phosphorus fertilizers decreases the amount of phosphorus that can leach into groundwater, or wash into rivers, lakes, or storm drains during rainstorms. This ban is particularly effective for homeowners with lawns along creeks, rivers, and lakes.

Nonpoint Source Activities

Nonpoint sources of phosphorus are generally those that flow over or through the ground before entering surface water. Because the pollutants do not enter water through pipes, the sources of the pollutants are difficult to locate. Chances are most people contribute to nonpoint source pollution while maintaining yards, washing cars, keeping pets or livestock, growing gardens or agricultural crops, or recreating near the water.

We can reduce the amount of nutrients we contribute by keeping lawn clippings, manure, and livestock out of surface water; and allowing water from property to soak into the ground rather than flowing onto streets or over the ground into ditches. To reduce nutrients from nonpoint sources, people need to apply best management practices (BMPs) such as composting lawn clippings instead of dumping them in the water; decreasing the amount of fertilizer on lawns, gardens, or crops; washing cars over lawns; keeping pet and livestock waste out of water; maintaining trees and shrubs along streams; etc.

To gather information on nonpoint sources of phosphorus in the Spokane watershed in both Idaho and Washington, Spokane County commissioned a study that began in 2009. The study led to the completion of the Spokane River Watershed Nonpoint Source Phosphorus Reduction Plan (NPS Plan) in December 2011 (GeoEngineers et. al, 2011). The plan characterized the watersheds in both states, quantified nonpoint source loading by land use, prioritized BMPs people can adopt, and identified BMPs for each watershed. The NPS Plan helps guide where to target implementation activities.

More than ten groups are working to reduce nonpoint pollution in the Spokane basin. Among the groups are conservation districts; environmental non-profits; tribes; local, state and federal agencies; and private corporations. Some of the point source dischargers have taken steps to reduce their nonpoint source contributions along with reducing nutrients in their discharges. Working to reduce nonpoint pollution sources is challenging, because the tools to compel people to change their practices are different from permitted activities. Typically the availability of incentives and cost-share programs help landowners decide to make needed improvements.

Since 2000, landowners and the groups described in the following pages have completed over 300 projects to decrease the amount of phosphorus in the basin's waters. As of 2014, over half of the projects were located in the Hangman Creek watershed, 57 projects were within the Little Spokane River watershed, and 26 projects were located in the Spokane River and Lake Spokane watersheds. The nonpoint source reduction projects between 2010 and 2014 have addressed phosphorus in several different ways:

- 81 projects planted riparian areas (stream banks) with native trees and shrubs which helps reduce stream bank erosion. Approximately 19 miles of stream were planted.
- 50 projects applied BMPs to agricultural land. The majority of the BMPs were to convert from conventional tillage to mulch-till or direct seed. About 13.6 square miles are no longer conventionally tilled, saving an estimated 52,000 tons of soil.

- 29 projects installed fencing to keep livestock away from over a mile of surface water. Fencing livestock away from streams keeps manure, urine, and sediment out of the water.
- 15 projects reduced stormwater by directing runoff to areas where it can soak into the ground.
- 9 projects were installed to stabilize eroding shorelines.

The majority of nonpoint source reduction projects during 2015 and 2016 were in the Hangman Creek watershed. The following list is of some of the practices applied to reduce nutrients from nonpoint sources during 2015 and 2016:

- 86 acres of riparian area planted with native trees and shrubs.
- Almost 24,300 acres of nutrient management applied to agricultural crops.
- Over one mile of fencing installed outside of the riparian buffer to restrict livestock access to surface water.
- Three beaver dam analog structures placed in a tributary to Hangman Creek.
- 115 on-site septic system replacements or repairs.
- 144 acres of forest management or health practices applied.
- 16 pieces of direct seed equipment purchased with low interest loans.
- 7000 willow whips planted within two separate five mile stretches of Hangman Creek.
- $7.7 million awarded within the greater Spokane watersheds over the next five years for conservation tillage, precision agriculture, riparian buffers or easements, and forest health improvements.

An estimate of the amount of phosphorus removed by these projects is difficult to determine due to complex environmental interactions. To give you an idea of the complexity, the amount of phosphorus and other nutrients in a stream depends on how it entered surface water (from runoff, infiltration, or leaching), the season, whether the nutrient is dissolved or in particulate form, the amount and timing of rainfall, vegetated cover, amount of aquatic biota, and soils (Carpenter et al. 1998). In addition, despite groups' best efforts, some projects do not achieve the desired results. For example, high flows can wipe out planted areas that did not have time to become established, and plants can die.

As indicated above, activities to control nonpoint source pollution occur all over the landscape, from forests to farms and our own backyard. In addition to applying best management practices, groups are working to inform people on how to reduce their nutrient contribution, or bringing the issue to local and state governments' attention so they can take action. The following pages first describe basin-wide nonpoint source reduction activities, followed by watershed-specific activities.

Basin-wide Activities

Spokane County

Since 1983, Spokane County has prioritized hooking up septic systems located over the aquifer to the sewer system. Between 1984 and 2001, the County connected 20,100 homes and businesses to the sewer (HDR, 2015). In 2001, under an updated Comprehensive Wastewater Management Plan (CWMP), the County created the Septic Tank Elimination Program (STEP) with the goal to hook up all developed parcels in the STEP areas to the sewer by 2012. As of 2017, the County has about 600 more connections to complete, which will bring the total number of new sanitary sewer connections to approximately 42,000 since 1984. Spokane County's 2014 CWMP and 2017 Six-Year Capital Improvement Program now focuses on extending sewer service to unsewered areas within the County's Urban Growth Area. In 2016, the County installed trunk sewer to serve an industrial area in the north-east portion of the City of Spokane Valley. Additional trunk sewer will be installed in that area in 2017 to allow for septic tank elimination. The County is also designing sewer to be installed in north Spokane around the intersection of US Highway 2 and Mt Spokane Park Drive. Installation of this sewer will begin in 2018 and serve an area currently using septic systems for wastewater disposal.

Requirements in the Shoreline Master Programs (SMP) are anticipated to help control nutrients from nonpoint sources of phosphorus. In SMPs, counties must plan for development while providing protections for shorelines so they are able to resist erosive forces of water as well as retain vegetation to filter and take up nutrients. Spokane County's comprehensive update to their SMP became effective in January 2013. An amendment to the SMP in 2014 included regulations for on-site septic systems within the 200-foot shoreline area.

City of Spokane

The City of Spokane also participated in the STEP, eliminating several thousand septic tanks. The City's objective was to intercept and connect all feasible remaining on-site wastewater systems in the City's sanitary sewer service area and over the aquifer sensitive area. (A few septic tanks are not feasible to connect because of excessive distance from the nearest sewer, adverse topography, and/or rock excavation.) The City estimated that approximately 800,000 gallons of on-site septic system effluent a day would be intercepted and prevented from draining over the aquifer.

In the fall of 2015, the City restored a section of Garden Springs Creek in Finch Arboretum. To improve fish passage, restore a natural flow regime, and reduce sediment, a small dam was removed and a small section of the channel was reconstructed. Shrubs and trees were also planted to create native riparian buffer.

The City installed five pet waste stations with baggies at High Bridge Dog Park. City crews empty the dumpster weekly.

Forest Roads

Washington's forest practice rules (WAC 222) require large forest landowners to bring all of their roads into compliance with current state forest practice standards by October 31, 2016. They were required to submit Road Maintenance and Abandonment Plans (RMAPs) for accomplishing this by July 2006. RMAP work was designed to tackle the worst problems first (those most likely to cause harm to streams, fish habitat, or public safety) and was metered out in a generally "even flow" fashion during the ten year implementation period.

Each RMAP covers:

- Removing and/or replacing stream crossings that block fish passage.
- Preventing or limiting sediment delivery from the road network to streams.
- Repairing, maintaining or closing roads that run adjacent to streams.
- Minimizing interception of groundwater or surface water by roads.
- Correcting drainage or other possible problems in unstable or potentially unstable areas that could damage public resources or threaten public safety.

Landowners filed annual RMAP progress reports with the Department of Natural Resources. Most large forest landowners have now completed their RMAPs but will continue to maintain their roads and repair and replace crossings as necessary to meet the requirements of the forest practices rules.

Small forest landowners (those who harvest on average less than two million board feet of timber per year) are required to bring their forest roads up to forest practice standards at the time they harvest their lands.

Inland Empire Paper Company

Inland Empire Paper Company (IEP) owns and manages approximately 100,000 acres of forestland in the Spokane River watershed, in both Washington and Idaho. IEP's forestry practices have always exceeded each state's Best Management Practices (BMPs), particularly with respect to water quality issues, forest road construction and maintenance, and reforestation. These modern forestry practices reduce or eliminate sediments and the associated nutrients delivered into water bodies. Some examples of these activities, practices, or projects include:

- IEP completed its Road Maintenance and Abandonment Plan (RMAP) projects at the end of 2015. Since 2001, IEP has spent well over $500,000 in reducing sediment delivery from forest roads, and improving fish passage on stream crossings. These projects included replacement of undersized culverts with bridges, streambank stabilization, abandonment of stream-adjacent parallel roads, gravelling roads, and outslope road-grading.

- IEP has been instrumental in cooperating and coordinating with neighboring landowners to remove cattle from the riparian areas of Fish Creek. (Fish Creek is in the Idaho portion of the Spokane River watershed. Fish Creek begins on the east side of Mt. Spokane and flows into Twin Lakes, north of Rathdrum, Idaho.) Sediment delivery from this non-IEP cattle operation was greatly reduced by fencing cattle away from streamside areas, stabilizing streambanks with rock and log structures, and planting vegetation on unstable slopes.

- Since 2001, IEP has managed forest recreation on its timberlands. Unmanaged recreation tends to damage roads during wet weather, contributing to road instability and sedimentation. IEP manages recreation with a comprehensive permit system that utilizes gate closures and forest patrols to control access. It has the added benefit of providing a platform for educating the public about water quality issues.

Since 1952, IEP has been a leader in reforestation techniques. Exposed soil on recently harvested areas or burned areas could potentially deliver sediment to adjacent streams. However, by leaving forested buffers along streams, planting or re-seeding promptly after harvest, and leaving soil layers undisturbed, sediment from the uplands has been eliminated.

Spokane Conservation District (SCD)

The SCD has several departments that work in concert to protect natural resources. The SCD's Water Resources Department completed 31 projects between 2010 and 2014 within Spokane County (Table 3) that will help reduce the amount of phosphorus entering Lake Spokane. Collectively, the projects included planting over 12,000 native trees and shrubs in about 15 miles of riparian area, fencing over a mile of stream, installing eight waste storage facilities and heavy use areas, etc. Nine of the 31 projects installed BMPs to prevent pollution from livestock operations. The Water Resources Department also provided technical assistance during several site visits.

The SCD's Production Agriculture Department also works to reduce phosphorus through promoting direct seeding practices. Direct seeding is a farming practice where farmers plant the next crop into the existing stubble from a previous crop. This practice reduces the amount of soil that is lost from wind and water erosion. This improves water quality because there is less sediment and associated nutrients entering surface water. The SCD established a direct seed equipment loan program so that farmers can apply for low-interest loans to purchase farm equipment needed to transition to direct seeding. The SCD has been able to work with other conservation districts to extend the program beyond Spokane County. In 2012 and 2013, the SCD distributed about $3.9 million throughout the program's entire area, with approximately $1.2 million spent in Spokane County. The SCD estimates the equipment is used on 26,000 acres within Spokane County, and primarily in the Hangman Creek watershed.

Several different types of equipment are necessary for direct seeding. For example, equipment to manage the amount of remaining residue or stubble is important so that the drills are able to penetrate through the residue into the underlying soil. Ecology categorized the list of equipment purchased throughout Eastern Washington using the conservation district's loan program. From this information, Ecology determined that farmers used the $3.9 million loaned out to purchase 54 pieces of farm equipment for direct seeding. The high cost of this farm equipment makes loan programs such as the SCD's necessary to expand the amount of farmland under direct seed. Increasing direct seed acreage results in water quality improvement.

The SCD provides environmental education as an important element of their communication strategy for non-point source pollution, whether it is for children or adults. The SCD has partnered with the Franklin Conservation District to bring the following programs to Spokane-area schools:

- Wheat Week
- Water on Wheels
- Trout in the Classroom
- West Valley Outdoor Learning Center's Fourth Grade Field Day
- Floods, Flowers, and Feathers
- WaterFest
- Kids in the Hills
- Earth Day Events

Each program offers hands-on, interactive demonstrations and activities, while teaching the children about the importance of our natural resources, particularly soil and water. Each lesson is offered free of charge to K-12 schools in our area. These fun lessons are available to other groups, such as home-school groups and civil organizations like the Boy & Girl Scouts of America.

The SCD brings its message outside of the classroom and provides citizens with current and pertinent information in a variety of ways, including a biannual newsletter and other publications, a website, and participation in the following public events:

- Spokane County Interstate Fair
- Ag Expo
- Southeast County Fair
- Water Festival
- Farm Forum
- The Secrets of Soil
- Spokane Youth Environmental Conference.

Table 4 shows the number of students and adults SCD's educational activities have reached between 2012 and 2015.

Table 3. Spokane Conservation District 2010-2014 BMP projects

Project Name	Type	Watershed	Waterbody	Date	Budget	# of plants	Description
Riparian Fencing Project	Riparian fencing		Spokane River/Mt. Spokane	2012	$8,000		800' riparian fencing in foothills of Mt. Spokane
Livestock BMP Project	Livestock BMPS		Spokane River/Mt. Spokane	2012			Implement roof/runoff system and heavy use area/drainage
Livestock BMP Project	Livestock BMPS		Spokane River/Mt. Spokane	2012			Install roof/runoff system, heavy use area, and waste storage facility
Livestock BMP Project	Livestock BMPS		Spokane River/Hangman	2012	$6,000		Installed heavy use area
Willow Warrior Project	Riparian planting	Hangman	Hangman Creek	2008 - 2014	$1000/yr	5000-6000/yr	Riparian planting of willow whips each year
Hangman Watershed Producers AWEP	Ag BMPs	Hangman	Entire Watershed	2010 - 2012	$1,200,0 00		Specialized EQIP program for watershed ag producers; many BMPs
Rock Creek Streambank Stabilization	Streambank stabilization	Hangman	Rock Creek	2010			Installed soil lifts along 450' of stream
Hangman Creek Streambank Stabilization	Streambank stabilization	Hangman	Hangman	2011	$60,000		Sloped streambanks along 1600' of the creek
Livestock BMP Project	Livestock BMPs	Hangman	Trib to Rock Creek	2012			Installed off-channel watering facility
Livestock BMP Project	Livestock improvement	Hangman	California Creek	2012	$8,000		Installed a high-use area, roof runoff structure, and waste storage facility
Sediment Basins	Ag BMP	Hangman	Upland	2012	$4,000		Installed 2 sediment basins
Livestock BMP Project	Livestock improvement	Hangman	Hangman Creek	2012	$16,459		Implemented a high use area, roof runoff structure, and 3 waste storage facilities
Livestock BMP Project	Livestock BMPs	Hangman	Hangman	2014	$20,000		Installed waste storage facility
Livestock BMP Project	Livestock BMPs	Little Spokane	Wethey Creek	2010	$50,000		Riparian fencing and off-channel watering on 300' of creek

Project Name	Type	Watershed	Waterbody	Date	Budget	# of plants	Description
Livestock BMP Project	Livestock BMPS	Little Spokane	Little Spokane River	2012			Implement a waste storage facility and heavy use area
Livestock BMP Project	Livestock BMPS	Little Spokane	Bear Cr.	2012			Install sub-surface drainage, heavy use area, waste storage facility, and riparian fencing (800')
Eloika Lake Weed Management Project	Aquatic weed mgt	Little Spokane	Eloika Lake	2012			Weed maintenance on 60 acres of Eurasian milfoil
Livestock Improvement Project	Livestock BMPS	Little Spokane	Little Spokane River	2012			Install sub-surface drainage, heavy use area, waste storage facility, and riparian fencing (400')
Eloika Lake Weed Management Project	Aquatic weed mgt	Little Spokane	Eloika Lake	2013	$35,000		Weed maintenance of Eurasian milfoil
Fish Barrier Removal Project	Fish barrier	Little Spokane	Otter Creek	2013	$80,000	600	Remove culverts and replace with free standing bridge, and replant riparian area
Fish Barrier Removal Project	Fish barrier	Little Spokane	Deadman Creek	2013	$80,000	700	Remove culverts and replace with free standing bridge, and replant riparian area
Lake Spokane Shoreline Project	Shoreline naturalization	Lower Spokane	Lake Spokane	2012	$20,000	250	Remove bulkhead, stabilize and naturalize the shoreline (approx 200')
Fish Barrier Removal Project	Fish barrier	Lower Spokane	Coulee Creek	2012	$80,000	300	FFFPP - remove old culverts and replace with free-standing bridge, and replant riparian area
Livestock BMP Project	Livestock BMPS	Lower Spokane	Deep Creek tributary	2013	$60,000	400	Installed heavy use area, sub-surface drainage, waste storage facility, 1/2 mi. of riparian fencing, off creek watering facility, and pasture management
Riparian planting	Riparian planting	Lower Spokane	Lake Spokane	2013	$200	120	Shoreline planting - next to bulkhead removal project
Barker Road Riparian Project	Riparian planting	Middle Spokane	Spokane River	2012	$400	12	Planted 12 ball and burlap pines for remediation of bridge work
Riparian protection	Riparian	Spokane	Spokane River	2014	$40,000		Installed riparian fencing and cleaned up access

2015-2016 Update
The SCD continued their On-Site Septic System Program, which was initiated in the summer of 2014. In 2015 and 2016, SCD completed 66 sewer system connections. Most of those connections were made in the City of Spokane Valley over the aquifer. SCD completed 14 repair or replacement projects as well. Since the beginning of the on-site septic system program, the SCD has completed 115 projects.

SCD has been working to restore riparian areas throughout the greater Spokane watershed:

- In the Little Spokane Watershed, SCD worked to realign a portion of Bear Creek into its original channel. The realignment increased the stream length by 700 feet. Over 2,500 trees and shrubs were planted within the new four-acre riparian area and 1,500 feet of fencing was installed to protect the plantings from livestock.
- In Hangman Creek, SCD once again led the Willow Warriors program. Over the biennium this program planted 7000 willow whips within two separate five-mile reaches. SCD also assisted the Town of Spangle with planting about 800 plants along a two-acre portion of Spangle Creek.
- Along the mainstem Spokane River at the Idaho-Washington state line, SCD helped develop and improve river access by installing fencing, and improving the parking area and ramp to the water to reduce erosion. SCD also planted over 900 trees and shrubs in a three and a half acre riparian area.

Additionally, SCD completed projects to improve fish habitat and protect water quality from livestock and farming operations. As part of the SCD's fish habitat restoration work, they improved about six and half acres of riparian habitat by planting 4,000 trees and shrubs. SCD installed several livestock best management practices. They built one aerated waste storage facility, one dairy lagoon, one heavy use area where livestock drink water or feed, and installed 3,900 feet of riparian fencing. In 2015 and 2016, SCD helped farmers purchase 12 additional direct seed drills or related items, two sprayers, and two auto-steer or GPS devices. This brings the total up to 70 pieces of direct seed related equipment put to use in the greater Spokane watershed (Figure 3).

SCD initiated two programs which will help to protect water quality for many years. The first program is the Voluntary Stewardship Program (VSP) for Spokane County. The SCD is working with a local working group to develop a plan to address Spokane County's critical areas that intersect with agricultural land uses. This plan will ensure that agriculture remains viable while protecting critical areas. The second program is the Greater Spokane Regional Conservation Partnership Program (RCPP). This is a multi-state endeavor involving 21 partners. The goal of the program is to install various agricultural BMPs to improve water quality in the Spokane Basin. The goals of the 2016 to 2021 program include:

- 120,100 acres of conservation tillage.
- 20,000 acres of precision agriculture.
- 750 acres of streamside buffers.
- 400 acres of conservation easements.
- 8,750 acres of forest stand improvements.

To achieve these goals, the US Natural Resources Conservation Service has dedicated $7.7 million of their programs' funding, which is matched, dollar-for-dollar, by the program partners.

Table 4. Spokane Conservation District's educational contacts between 2012 & 2015

	Number of Students and Adults Contacted		
Year	**2012-2013**	**2013-2014**	**2015-2016**
Classroom Lessons	5335	4055	3700
Special Events	1684	1066	1280

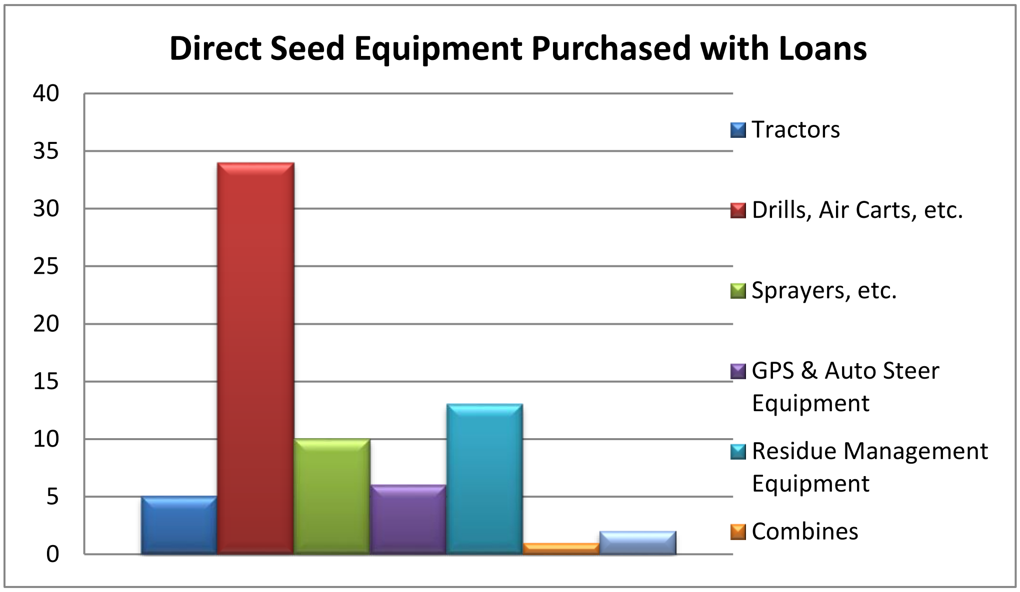

Figure 3. Direct seed equipment purchased throughout Eastern Washington using Spokane CD loans

Spokane River Forum

The Spokane River Forum (SRF) keeps the public connected with the activities underway to meet the TMDL targets, as well as all the other issues affecting the Spokane River and Lake Spokane. The SRF continues to house all TMDL-related information, as well as distribute meeting information to advisory group members and the public (see http://spokaneriver.net). Another service the SRF provides is organizing public meetings to learn about and discuss activities to improve the water quality of the Spokane River. Additionally, several times a month the SRF distributes the Spokane River eNews to more than 2,700 people.

The SRF is an advocate for public access to the river, so they maintain and promote a Spokane River Water Trail web site and organize several kayak and canoe excursions on the river. Getting people on the Spokane River helps increase awareness about the river's water quality and the TMDL. When people are on the water, the SRF is able to educate people about BMPs they can use to reduce their phosphorus and nutrient inputs.

Along with seven other partners, the SRF helped launch an environment-friendly certification program, called EnviroStars. Local businesses that use practices to keep pollutants out of storm drains and the sewer can gain certification as an EnviroStar. People are able to tell if the products or services they purchase are environmentally friendly by EnviroStar signs displayed by the businesses.

Washington State Department of Ecology (Ecology)

Most implementation work performed by Ecology involves performing assessments; providing technical assistance to show people what compliance with water quality standards looks like; conducting education and outreach to children and adults; providing financial assistance for wastewater treatment upgrades and BMPs to improve water quality; and only when necessary, enforce water quality laws.

Ecology has continued tracking implementation activities performed by partners to implement the TMDL. The information is in a database and will be used to help identify where work has been done and needs to be done, what BMPs were installed, and help plan future effectiveness monitoring projects.

Watershed-Specific Activities

Upper Spokane Watershed (HUC 17010305) and Middle Spokane Watershed (WRIA 57)

Kootenai Environmental Alliance (KEA)

In the Upper Spokane watershed, KEA is Lake Coeur d'Alene's Waterkeeper and their mission is to ensure the lake is swimmable, fishable and drinkable. They have several educational programs going on to help students understand the different things that impact the quality of the lake. In spring 2017, they hosted a Youth Water Summit for five different high schools in the area. The students researched and presented their findings and ideas during this summit where they were judged by professionals and peers. They also host a Fifth Grade Water Festival. This event is a field trip for five different schools where they rotate through five different educational stations all centered around the Lake Coeur d’Alene watershed and water quality. In June 2017, KEA plans to host some storm drain stenciling events to help mark areas that drain to the lake that are currently unmarked. They will be taking boat tours this summer to look for illegal shoreline disturbances as well as educate attendees about shoreline erosion and restoration. KEA also hopes to monitor the water in the lake during their boat tours on a regular basis.

The Lands Council (TLC)

Between 2010 and 2014, TLC and Gonzaga students worked together to enhance riparian areas of the Spokane River along Gonzaga University’s campus in the Middle Spokane watershed.

Hangman Creek Watershed (WRIA 56)

Coeur d'Alene Tribe (Tribe)

The Tribe worked with Avista Corporation to purchase approximately 650 acres along Hangman Creek to redirect the creek into old abandoned stream channels and create wetlands. The Tribe is also working on restoration projects along Sheep Creek, which is a tributary to Hangman Creek. For example, on one reach the Tribe installed structures that encourage beaver enhancement, but also help with flow control.

The Tribe also collaborated with the Idaho Department of Transportation on the Highway 95 widening project to revise designs for culverts, etc. so that reconnecting Hangman Creek to its floodplain would be possible at some future point.

The Tribe and the Spokane Conservation District partnered to host breakfasts to educate farmers about the benefits of direct seeding. They had good attendance, so they will continue the breakfasts in the future. The Tribe has a farm primarily in the Hangman Creek watershed that is approximately 5000 acres. A goal is to convert some of the farm to direct seeding.

Inland Northwest Land Conservancy (INLC)

The INLC works to secure conservation easements designed to perpetually protect the land by limiting certain uses. Three easements exist in the Hangman Watershed. The INLC relies on other groups in cooperation with the landowner to complete restoration or rehabilitation projects within the easements. Within the Hangman Creek watershed, the INLC performed assessment and monitoring work, planted native riparian vegetation, conducted education outreach to landowners, and worked to secure future grants and easements.

Natural Resources Conservation Service (NRCS)

The NRCS, Spokane Conservation District, and Ecology partnered on the Agricultural Watershed Enhancement Program (AWEP). NRCS spent $757,000 in three years for the program. AWEP funding was only available within the Hangman Creek watershed, but in both Washington and Idaho. This funding helped farmers convert 3000 acres of conventionally tilled land into direct seed, and over 2700 acres into mulch till. (Mulch till is using a harrow or roller in addition to direct seeding.) The funding was also used for installing grassed waterways and fencing. AWEP was not the only program to help pay for transitioning to direct seed. The Environmental Quality Incentives Program (EQIP) paid to convert approximately 3700 acres to direct seed.

In the Hangman Creek watershed a total of over 8,693 acres (approximately 13.6 square miles) were converted to direct seed between 2010 and 2014. Research indicates that the erosion from these conservation practices is about 1 ton per acre annually, compared to 7 tons per acre annually from conventional tillage. This equates to over 52,000 tons of soil retained in the converted direct seed fields.

NRCS also has programs for nutrient and pesticide management. The nutrient management program includes soil testing, development of a nutrient budget, and precision application.

Overall, there have not been reductions in fertilizer use, but there is more strategic use of fertilizer, affecting where it is applied.

2016 Update
The NRCS gained 23 contracts among all the Spokane River and tributary watersheds in 2016. In the Hangman watershed, the practices were primarily forestry and chemical use related. NRCS helped thin one acre of forest to improve forest health, and planted 49 acres as part of forest management in the watershed. Over 20,400 acres of agricultural cropland had nutrient management practices applied such as precision application of nutrients, use of enhanced efficiency fertilizer, or crop tissue testing. Pest management practices were applied to over 3,700 acres. Finally, NRCS contracted to use residue management and mulch till on 91 acres in the watershed. Using the same six ton per acre estimate for soil conservation on no till and mulch till ground, this 91-acre site potentially saved 546 tons of soil.

The Lands Council (TLC)

The Lands Council (TLC), with help from hundreds of volunteers, interns, and County Correctional work crews, has achieved significant work in the Hangman Creek watershed. In WRIA 56, TLC restored riparian areas on 15 individual sites: six on California Creek, three on Rock Creek, one on Marshall Creek, one on Spring Creek, and four on Hangman Creek. In 2015 TLC added two more sites to its restoration work in WRIA 56 on Hangman Creek.

In addition to riparian restoration, TLC also provides assistance to landowners in order to alleviate problems caused by beavers so that wetlands created by beavers are maintained. On California Creek, TLC staff assisted landowners in wrapping trees to deter beaver from felling, which resulted in the creation of a series of beaver dams and wetlands. The TLC's goal is to maintain beaver habitat by reducing landowner conflict, which will reduce phosphorous as well. Beaver ponds have been shown to reduce annual discharge of total phosphorus by up to 21 percent (Correll, Jordan, and Weller, 2000). In areas where landowners want to encourage beaver activity, TLC also builds analogue beaver dams: a series of posts hammered across a perpendicular cross section of a creek with branches woven through it. A handful of these devices were installed on California Creek 2016. The analogue dams collect other debris that comes downstream which begins to pond water. These devices are therefore often used by nearby beavers to build larger dam complexes.

TLC is committed to public education through targeted outreach activities. They have circulated 350 water quality educational brochures, completed 30 surveys on water quality knowledge, and connected with 150 landowners including 42 who were willing to implement riparian restoration activities on their properties or farms in WRIA 56. TLC developed an entire program to bring environmental science-based field trips and corresponding classroom lessons to many Spokane-area high schools, including Freeman High School. In 2017 and 2018, TLC is meeting with nine municipalities in WRIA 56 to explain policies in Eastern Washington's Low Impact Development (LID) Manual, and to share information on available funding for implementing LID projects which will help reduce nonpoint source pollution.

Washington State Department of Ecology (Ecology)

Phosphorus tends to bond to soil, so Ecology is interested in understanding tillage practices in the Hangman watershed. Ecology staff looked at more than 400 farm fields and covered 600 road miles looking at erosion in conventionally tilled and direct seeded farmland. Research shows that direct seed can reduce soil erosion up to 95 percent, which is consistent with what Ecology staff observed. In conventionally-tilled ground, they noticed water-formed channels, soil deposited at the base of slopes, and sediment entering streams. Water erosion was most evident on long and steep north-facing slopes with little crop residue cover.

During livestock operation assessments, Ecology looks for sites that have conditions revealed by scientific literature to cause water quality problems, such as stream banks that have little to no vegetation and are eroding. To conduct the assessments, staff stay on public property adjacent to streams and look for signs of pollution.

As a result of the tillage and livestock operation assessments, Ecology referred approximately nine nonpoint source agricultural operations to the Spokane or Pine Creek conservation districts for technical and financial assistance. The conservation districts then work with the landowners to help them adjust their practices to protect water quality. In turn, Ecology strives to help local conservation districts acquire funding so they can help farmers apply BMPs to improve water quality.

2015-2016 Update
During 2015 Ecology staff assessed approximately 34 livestock operations for water quality protections. As follow-up to the assessments, staff focused on nine sites where concerns were previously noted and we had already contacted the landowners or operators. We also followed up on three livestock complaints and four tillage complaints. Over the biennium, we sent 12 letters referring livestock owners to local conservation districts for technical and financial assistance.

Washington State Department of Transportation (WSDOT)

To improve safety at the Cheney-Spokane and Highway 195 intersection, WSDOT installed a new highway interchange in the summer of 2013. At this location the highway and interchange are located within the Hangman Creek floodplain, and the steep vertical banks of Hangman Creek typically slough into the creek during high flows. To protect the interchange from Hangman Creek's erosive capabilities, WSDOT also completed 1,000 feet of stream bank protection in 2013. The project included burying large rocks outside of the ordinary high water line, sloping the banks to a 3:1 slope using wrapped soil lifts, and planting a mixture of potted plants every six inches. Plant whips were installed in the fabric lifts and container plants were planted between the lifts. The banks were also seeded with native grasses. WSDOT plans to irrigate the plantings for three years to ensure the plants get established. The project required removing 17,000 cubic yards of soil, used 7,500 cubic yards of rock, and cost over $600,000.

Little Spokane River Watershed (WRIA 55)

Natural Resources Conservation Service (NRCS)

As described earlier, NRCS had 23 new contracts in 2016. In the Little Spokane watershed, those contracts resulted in 20 acres of tree planting for forest management, and 74 acres of thinning timber to improve forest health. On agricultural cropland, farmers contracted with NRCS to apply nutrient and pest management on 864 acres.

The Lands Council (TLC)

The Lands Council (TLC), with help from volunteers and interns, has achieved significant work in Little Spokane River watershed. In 2015 TLC worked to restore two sites in WRIA 55 on Deadman Creek.

In addition to riparian restoration, TLC also provides assistance to landowners in order to alleviate problems caused by beavers so that wetlands created by beavers are maintained. TLC staff and volunteers assisted landowners in wrapping thousands of trees to deter beavers from felling in certain areas, and have installed pond-leveling devices to minimize unwanted flooding at two sites in WRIA 55.

TLC has developed an entire program to bring environmental science-based field trips and corresponding classroom lessons to many Spokane-area high schools. High schools participating in this program include Post Falls High School, The Community School, Bancroft School, On Track Academy, Mead Alternative High School, St. George's School, and Lewis & Clark High School.

Washington State Department of Ecology (Ecology)

Ecology staff received and followed up on seven complaints about livestock operations or livestock related stormwater runoff during the 2015 to 2016 timeframe. We also investigated two tillage complaints, and one construction stormwater complaint in the watershed.

Lower Spokane (WRIA 54)

Natural Resources Conservation Service (NRCS)

Of the 23 contracts the NRCS initiated in 2016, nutrient management practices were applied to approximately 3,000 acres in the Lower Spokane watershed, which includes the Deep Creek watershed. The contracts also called for installing 259 acres of a cover crop.

Stevens County Conservation District (Stevens CD)

In 2012, the Stevens CD initiated an active educational program involving one of Lakeside High School's science classes. The program's goal was to increase students' awareness of natural resources and explain how they can influence Lake Spokane's water quality. Stevens CD staff and invited speakers from agencies, organizations working to improve water quality, and conservation groups gave weekly presentations to the class from February through May 2012. Groups of students then designed a topic-specific presentation and activity based on what they learned, which they presented to the sixth grade students.

At the beginning of the 2012-2013 school year, the Stevens CD and Northeast Tri-County Health District (NETCHD) gave presentations to high school science and seventh grade classes about watersheds and water quality. The focused high school science education program, described previously, began again at the end of January 2013 and continued through May. The Stevens CD surveyed the high school students at the end of the year. The responses indicated the students learned new information that they shared with their family members. The CD also gained insight on how to improve the program in the future.

The educational program included outreach to adults as well. The Stevens CD wrote ten water quality-related articles that appeared in several local newspapers. The Stevens Public Utility District (PUD) adapted one article and mailed it to their customers who are located along much of Lake Spokane. In addition, Stevens CD staff made presentations at Lake Spokane Association meetings and hosted two meetings about septic tank maintenance and the NETCHD's repair and replacement loan program.

Outreach was not the only activity the Stevens CD worked on in 2012. The District also performed a water quality monitoring study to determine if septic systems are influencing the water quality of Lake Spokane. The Stevens CD monitored optical brighteners which are compounds added to laundry detergent. If the study shows brighteners are in Lake Spokane, then effluent from septic systems may be reaching the lake. April through October 2012, and May through June 2013, the Stevens CD sampled 20 near-shore sites (16 on the Stevens County side and 4 on the Spokane County side). The District also monitored fecal coliform bacteria, Secchi depths, water temperature, dissolved oxygen, pH, and specific conductance. The study showed that optical brighteners do not appear to be getting into the lake from septic systems. These results may be due to:

- Dilution from ground water or lake flows.
- The groundwater and surface water interface is not clearly defined.
- Several people using detergents without optical brighteners.
- The sandy soil may be better at filtering drain field effluent than thought.

Some sites found to have one or more high fecal coliform levels had waterfowl in the area prior to sampling.

The Stevens CD also works in the Chamokane Creek watershed, which enters the Spokane River just downstream of Long Lake Dam. The District completed some stream bank stabilization work along Chamokane Creek and produced a water quality-focused newsletter that was sent to approximately 907 watershed residents.

In the coming years, the Stevens CD will be working on a composting education program and identifying solutions. The idea is to identify an easily accessible location where people can drop off livestock manure, yard debris, and other organic material. This action would move potential sources of nutrients to an appropriate location and prevent nutrient sources from stockpiling up.

2015-2016 Update
During the Stevens County BMP Implementation project, Stevens CD conducted a shoreline assessment on over 10 miles of Lake Spokane shoreline. Letters were then sent to over 300 landowners encouraging them to eliminate "lawn-to-lake" environments and consider establishing vegetative buffers. As a result of this effort, 13 landowners received technical assistance from the Stevens CD. The District worked with Avista to plant over 13,000 trees on 70 acres of shoreline resulting in annual load reductions of 6,419 pounds of nitrogen, 2,469 pounds of phosphorus, and 26 tons of sediment per year.

Stevens CD continued working with the Nine Mile School District and science teacher Teri Sardinia at Lakeside High School. Over 400 Lakeside sophomore science students attended three different natural resources field days. Natural resource professionals continued to provide guest lectures and serve as mentors for student science projects that were submitted to local symposiums.

In the summer of 2015, the Stevens CD received funding so the USGS could expand their groundwater study along the northern shore of Lake Spokane.

The Lands Council (TLC)

The Lands Council (TLC), with help from volunteers, interns, and County Correctional work crews, has achieved significant work in the Lower Spokane River watershed. In WRIA 54, TLC planted native riparian trees and other plants on two sites on Coulee Creek and two on Deep Creek. One of the sites on Deep Creek is also used to harvest coyote willow whips. In total, 1.2 miles of stream have been restored. In addition, TLC has an ongoing partnership with the Stevens County Conservation District wherein TLC staff teaches Lakeside High School students about water quality and natural resources.

Washington State Department of Ecology (Ecology)

In the summer of 2014, the United States Geological Survey (USGS) and Ecology partnered on a study of groundwater and aquatic vegetation along Lake Spokane's shoreline below the Suncrest community. This study will determine if nutrients from on-site septic systems are leaching into groundwater and impacting the lake. If they are, another study will be needed to evaluate how many nutrients enter the lake. The hope is that funding will become available for additional groundwater studies along other sections of the lake's densely populated shorelines.

2015-2016 Update
The Lake Spokane groundwater and aquatic vegetation study was completed in 2015. Please see the Monitoring and Data Observation sections for more information about this study and a new groundwater study at the mouth of Deep Creek. (As mentioned above, the Stevens CD is working with the USGS to continue the groundwater study along Lake Spokane.)

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Permit Holder Activities

Stormwater

Prior to the 2010 to 2014 timeframe covered by this report, local and state governments were busy reducing the amount of stormwater entering the river. In 2008, Spokane County and the cities of Spokane and Spokane Valley published a regional stormwater manual to establish standards for stormwater design and management to protect water quality, natural drainage systems and down-gradient properties as urban development occurs. Also in 2008, Spokane County built two stormwater facilities (Browne Mountain, and Price and Wall) designed to capture, filter, and infiltrate stormwater.

The actions to address stormwater nutrient pollution listed in the dissolved oxygen TMDL include:

- Inventory stormwater outfalls to determine which outfalls have the greatest impact.
- Develop a quality assurance project plan (QAPP) and monitor stormwater for phosphorus, ammonia, carbonaceous biochemical oxygen demand (CBOD).
- Ecology recommends the City of Spokane install a flow gauge in the Cochrane combined sewer overflow (CSO) basin.
- Develop and present education programs to developers, businesses, and residents.
- Compare monitoring results to TMDL allocations for the Spokane River, Hangman Creek, and the Little Spokane River. If allocations are exceeded, install BMPs.

The state and local governments covered under the stormwater permit issued by Ecology are the Washington State Department of Transportation, City of Spokane, City of Spokane Valley, and Spokane County. The City of Spokane is working to reduce its discharges to the Spokane River and Hangman Creek, and the City of Spokane Valley and Spokane County worked to eliminate their stormwater discharges. For example, Spokane County completed their Liberty Lake Outfall Elimination Project in 2014.

Eastern Washington Phase II Municipal Stormwater Permit

Ecology issued the City of Spokane, City of Spokane Valley, and Spokane County each a permit under the Eastern Washington Phase II Municipal Stormwater Permit. However, they each have slightly different requirements to address the dissolved oxygen TMDL based on their unique circumstances. These stormwater requirements first became effective on August 1, 2014, nearly four years after EPA approved the TMDL. This delay to issue permits occurred because the TMDL was approved after Ecology issued the stormwater permits. Ecology expects to reissue the permit to these municipalities in 2019.

City of Spokane

The City of Spokane completed an Integrated Clean Water Plan, which includes preliminary phosphorus, ammonia, and CBOD monitoring data in stormwater. The Plan proposes major stormwater management facilities for the Cochran Basin, which encompasses about half of the City's stormwater system (see more information below). The City has also holistically integrated its infrastructure upgrades with the stormwater system. Each time a street construction project is designed, practices to reduce stormwater are prioritized. A few examples can be seen along Lincoln Street between 29^{th} and 8^{th} Avenue, High Drive, Broadway, Kendall Yards Olmstead Green, and Crestline.

City of Spokane Valley

The City of Spokane Valley finalized their 2014-2019 Stormwater Capital Improvement Plan in May 2013. The plan provides a framework for designing and constructing projects to reduce stormwater based on identified needs, problem areas, or permit requirements. To view the plan visit: http://www.spokanevalley.org/filestorage/6862/6927/8180/8361/2014-2019_Stormwater_Capital_Improvement_Plan_(Summary_Report).pdf

2015-2016 Update

The City of Spokane Valley's stormwater system consists of nearly 15,000 structures, 3,600 facilities, and more than 31 miles of pipe and culverts. The City established stormwater ordinances and codes, and adopted stormwater regulations which are located in the Spokane Valley Municipal Code (SVMC) Chapter 22.150. The City also adopted the Spokane Regional Stormwater Manual and City of Spokane Valley Street Standards and Plans which provide the design and construction standards for projects.

In 2015, the City of Spokane Valley completed construction on two facilities that reduced the amount of stormwater, or the effect it had on water quality. In the spring of 2015, a new decant facility began operations, which allows water to be separated from debris that is sucked up from street storm drains by vactor trucks. The more significant achievement occurred in August 2015 when the City of Spokane Valley eliminated their last stormwater outfall to the Spokane River. The outfall was located on the Sullivan Road southbound bridge, but was removed while work to improve the bridge was underway. Stormwater from the new bridge is now directed to infiltration areas.

Each year the City of Spokane Valley performs a variety of education and outreach activities targeted at children and adults. According to the City's annual reports, they use "classroom education, trainings, brochures, billboards, websites, "Storm Drain Dan" costume and activity books, poster boards, short sketches, citizen inquiries, construction projects, games, photos and community events" to deliver water quality improvement messages (City of Spokane Valley Public Works Department Stormwater Utility, 2017). In 2015, City staff participated in eight outreach events and six events in 2016.

During the biennium, Stormwater Utility staff inspected more than 2,850 drywells, catch basins, and spills. Maintenance activities included gathering 2.6 million pounds of debris during street sweeping, cleaning 1,000 structures, and caring for over 11 acres of grass. The City also installed 63 new stormwater structures and responded to over 117 street flooding calls.

For more information on the City of Spokane Valley's stormwater efforts, visit: http://www.spokanevalley.org/stormwater.

Spokane County

In 2014, Spokane County's plan to replace approximately a mile of concrete stormwater channel on Country Homes Boulevard was set in motion. Where there was once concrete is now an elaborate system of bio-infiltration swales, rain gardens, and a subsurface pipe designed to treat stormwater and reduce pollutants. Spokane County will construct a decant facility that separates waste collected by street sweepers and vactor trucks which clean out storm drains. Wastes from the decant facility are then disposed of appropriately. The County's decant facility will be similar to the City of Spokane's completed decant facility. These facilities help improve water quality by properly treating and disposing material, nutrients, and other pollutants that would otherwise be flushed into the storm drain system and into the river.

2015-2016 Update

In 2015-2016, Spokane County's Stormwater Utility constructed a number of capital improvement projects with grant assistance from Ecology, including Country Homes – Wall to Division; Market – Parksmith to Farwell; Hawthorne – Waikiki to State Route 395; and Hawthorne – State Route 395 to State Route 2. All new construction on private and public projects implement appropriate construction and post construction BMPs designed in accordance with the Spokane Regional Stormwater Manual (an Ecology approved manual). Additionally, Spokane County has a robust public education and outreach program with K-12 and adult components. Finally, Spokane County facilities all have operation and maintenance plans to ensure water quality is protected. More about Spokane County's stormwater reduction efforts can be viewed at: http://www.spokanecounty.org/918/Stormwater-Utility. More information about Spokane County's work to reduce non-point source pollution due to stormwater can be found in the NPDES annual reports at: http://www.spokanecounty.org/971/Water-Quality-NPDES-UIC.

Liberty Lake Sewer and Water District (LLSWD)

Although not required by a permit, the LLSWD takes an active role in reducing pollutants from stormwater. Under RCW 57.08.005(10), the LLSWD has the authority to provide for the reduction, minimization, or elimination of pollutants, including those contained in stormwater. The LLSWD conducted a stormwater management study in 1985, and later developed a stormwater management plan in 1998. The LLSWD established stormwater control and treatment requirements for development on private and public lands within the district boundaries. These requirements state that owners of those properties shall comply with planning and construction on their property. In accordance with the LLSWD's Stormwater Resolution 26-13, a stormwater permit application form shall be completed by the owner, accompanied by an engineered stormwater management plan as well as an erosion and sediment control plan.

Other Activities

In 2013, Ecology published the *Eastern Washington Low Impact Development Guidance Manual*. The manual was a collaborative product of Spokane County, Ecology, the Washington Stormwater Center, Washington State University, and the Eastern Washington Phase II Municipal Stormwater Permittees. The purpose of the manual is to provide stormwater managers, site designers, and design reviewers with a common understanding of low impact development (LID) goals, objectives, design of individual practices, and flow reduction and water quality treatment that are applicable to eastern Washington.

Washington State Department of Transportation (WSDOT)

WSDOT has its own NPDES Municipal Stormwater Permit. The permit became effective on April 5, 2014, and will expire in 2019. As required by WSDOT's March 2012 permit, WSDOT performed discharge inventories within their right-of-way inside the NPDES Phase II coverage areas of the Spokane River dissolved oxygen and Hangman Creek multi-parameter TMDLs. The work occurred in 2012 through 2013, and included inventorying and mapping outfalls to surface waters, looking for illicit discharges to the system, and identification of potential nutrient sources.

In the Spokane River watershed, WSDOT surveyed Interstate 90 and highways 2, 195, 395, and 291 between the urban growth area boundary and the City of Spokane or City of Spokane Valley limits. Crews did not locate any possible illicit discharges but identified two sites in 2013 as potential nutrient sources. Further evaluation of the sites showed that increased nutrient loading was not an issue. WSDOT will be surveying newly reconstructed sections of highway within the Phase II area for any new discharge points.

In the Hangman Creek watershed, WSDOT inventoried highways 27, 274, 278, and 904. Crews identified several areas along the highways that could discharge to surface water. Closer examination of these discharge areas showed that ten discharges were due to agricultural operations, and approximately 61 sites would improve after WSDOT's highway maintenance. Where necessary, WSDOT is working with landowners adjacent to the discharges to eliminate pollutant sources. WSDOT also reported maintenance concerns or potential pollution sources outside their jurisdiction to either the relevant city or Ecology.

Point Source Dischargers

By October 2011, the City of Spokane, LLSWD, Kaiser Aluminum (Kaiser), and Inland Empire Paper Company (IEP) received National Pollutant Discharge Elimination System (NPDES) permits from Ecology. All of these permittees have compliance schedules to meet TMDL targets for phosphorus, ammonia, and carbonaceous biochemical oxygen demand (CBOD) by 2021. Spokane River dischargers began researching technologies they could employ to achieve the reductions called for in the TMDL and their permits.

Ecology issued the first NPDES permit for Spokane County's new Regional Water Reclamation Facility (SCRWRF) at the end of November 2011. The County did not receive a compliance schedule to meet TMDL allocations because their facility was new, and they were required to meet water quality standards at the time the plant began operating.

In Idaho, the Environmental Protection Agency (EPA) issues the NPDES permits, and the Idaho Department of Environmental Quality certifies that the permits will achieve Idaho water quality standards. On September 30, 2014, the Environmental Protection Agency issued NPDES permits to the dischargers in Idaho (the City of Coeur d'Alene, Hayden Area Regional Sewer Board, and City of Post Falls). The permits became effective as of December 1, 2014. As in Washington, the Idaho dischargers received a compliance schedule to achieve limits for phosphorus, ammonia, and carbonaceous biochemical oxygen demand, but the timeline is slightly different than in Washington. The target date for Idaho dischargers is November 30, 2024; three years after Washington.

Following are details about Washington and Idaho dischargers and their efforts to reduce nutrients in their effluent.

Washington Dischargers

Inland Empire Paper Company (WA-0000825)

Since 2001, Inland Empire Paper Company (IEP) has embarked on a modernization program that resulted in improvements to nearly every process within its facility using state-of-the art equipment. This significant investment into the phased modernization effort raised IEP's status to one of the most modern newsprint facilities in the world. Following is a summary of IEP's specific achievements that have resulted in improvements to the efficiency of its water treatment system and reduced nutrient levels in its discharge (Figure 4 and Appendix C):

1. Paper Machine #5 (2001) - IEP installed a modern energy and water-efficient paper machine that remains the newest of its kind in North America. The machine utilizes heat recovery and water reuse to minimize energy use and water consumption.

2. Water Conservation Projects (2004 to present) - In 2004, IEP initiated an aggressive water conservation program. Numerous projects have been implemented, including: re-use of process water in various mill processes, re-use of water from the recycling of old newsprint, installation of water control devices on pump seals, and optimization of water-intensive

processes. Reducing the volumetric loading to the effluent treatment system increased the residence time within the system, which resulted in greater treatment potential for removing biochemical oxygen demand (BOD_5), total phosphorus (TP), and ammonia (NH_3).

a. Conustrenner (2004) – The conustrenner is a compact, highly efficient, self-cleaning fractionation filter. Approximately 1-1.4 million gallons per day (MGD) of primary treated water is diverted to the conustrenner for reclamation and reuse in the pulp mill processes, greatly reducing freshwater needs and volumetric loading to the water treatment system.

b. Pump Seals (2005 to 2007) – Flow limiting devices were installed on mechanical seal water lines for numerous pumps around the mill. These devices greatly reduced freshwater consumption to the process streams, resulting in a substantial decrease in the volumetric loading to the water treatment system.

c. Retention Aid Carrier Water (2012) - IEP switched from using fresh water to reclaimed process water for its retention aid carrier water. This modification reduced treated effluent flow by approximately 100 gallons/minute.

d. Disk Filter Shower Water (2014) – IEP's #1 Disk Filter showers were changed from fresh water to reclaimed process water. This modification reduced treated effluent flow by approximately 200 gallons/minute.

e. PM5 Vacuum Roll Seal (2015) – IEP installed a new style of lubrication seal on a paper machine vacuum roll that reduced fresh water consumption and discharge by 10 million gallons/year.

3. MBBR #1 (2006) - IEP installed a 2.0 million gallon per day Moving Bed Biofilm Reactor (MBBR) for enhanced BOD_5 removal. This system is currently achieving in excess of 50 percent BOD_5 removal and has improved the efficiency of the overall water treatment system.

4. MBBR's #2 and #3 (2009) - IEP further improved the efficiency of its secondary water treatment system with the installation of two additional MBBR systems, providing IEP with the maximum amount of effective secondary treatment possible.

5. Surge control (2009) – IEP converted its existing 75-foot diameter clarifier to a surge control system to equalize hydraulic flow and BOD_5 loadings to its secondary treatment system. This allows more uniform loading conditions to the water treatment system, thereby reducing variability in the final effluent and providing process stability.

6. #5 Thermo-Mechanical Pulping (TMP) Refiner Effluent Treatment (2010) – with installation of the new #5 TMP system, IEP improved the treatment of this high BOD_5 effluent stream by sending this effluent to a Dissolved Air Floatation (DAF) system. The average TSS reduction across the DAF is over 90 percent and the average BOD_5 reduction is approximately 45 percent.

7. Elimination of Starch (2010) - IEP eliminated the use of cationic starch in the paper making process that was a large contributor of BOD_5 and phosphorous loading to the water treatment system.

8. Chip segregation (2011) – IEP receives waste wood chips from local sawmills as a raw material supply for its paper making process. Chip species are separated and used only on grades where they are most effective, resulting in improved energy efficiency and bleaching. Reducing the bleaching needs of any specific paper type results in less BOD_5 and TP load to the water system and subsequently lower final discharge concentrations of TP, NH_3 and BOD_5.

9. Nutrient Optimization (2012 to present) – IEP's wood-based materials are deficient in nutrients such as phosphorus and nitrogen, so IEP actually adds these nutrients to its water treatment system for the health of the microorganisms that are responsible for BOD_5 removal. IEP has been operating at lower nutrient targets in an effort to optimize the water treatment system operations for BOD_5, TP and NH3.

10. Stock Blending (2013) – Pulp mill modifications were implemented to allow for pulp-specific blending. Targeting specific pulps has improved the bleaching efficiency and reduced the amount of dissolved material (BOD_5, TP) created during the reaction.

11. Phosphoric Acid (2016) – IEP's secondary treatment system is deficient in nutrients, including phosphorus, and therefore must add nutrients for the health of the secondary biological system for efficient and effective removal of BOD_5. In 2016 IEP changed its form of phosphorus feed from agricultural grade Ammonium Ortho-polyphosphate to phosphoric acid (P acid). Phosphoric acid provides complete and readily available phosphorus as a nutrient to the secondary treatment system for more efficient use and enhanced control of residual phosphorus. Ammonium Ortho-polyphosphate contains phosphorus forms that are not bioavailable which contribute to elevated levels of total phosphorus in the effluent that are difficult to remove.

12. Speece Cone (2016) - a Speece cone system was installed immediately downstream of IEP's effluent pumps to oxygenate 100 percent of the water that leaves the effluent pump house, including all flows to the primary clarifier, reclaimed effluent wastewater, and all water directed to surge tanks used on-site for surge control. The Speece cone super oxygenates the water that passes through by creating an intense bubble swarm at the inlet of the cone. The geometry of the cone and the buoyant force of the bubbles do not allow any the bubbles to exit, thereby ensuring complete dissolution. An onsite oxygen generator is used to provide a nearly pure oxygen source from ambient air.

    The system was installed in a proactive effort to increase BOD_5 removal in the primary clarifier and to offset any septic conditions that may develop in the primary clarifier due to IEP's ongoing effort to reduce wastewater discharge flows.

13. Urea (2017) – IEP's secondary treatment system is deficient in nitrogen, as the mill's raw material sources are naturally lacking this nutrient. Nitrogen must be added for the health of the microbiological system and for the effective assimilation of BOD_5, which is another regulated parameter under IEP's NPDES permit. In 2017, IEP changed its form of nitrogen feed from Aqua Ammonia to Urea, since Aqua Ammonia has the potential to impact forthcoming permit limitations for ammonia. Urea Ammonium Nitrate (UAN) solution contains a higher concentration of nitrogen compared to Aqua Ammonia. UAN also contains a mixture of nitrogen sources that are slow-, medium-, and fast-release, that may allow for a better nutrient balance throughout the entire wastewater treatment system.

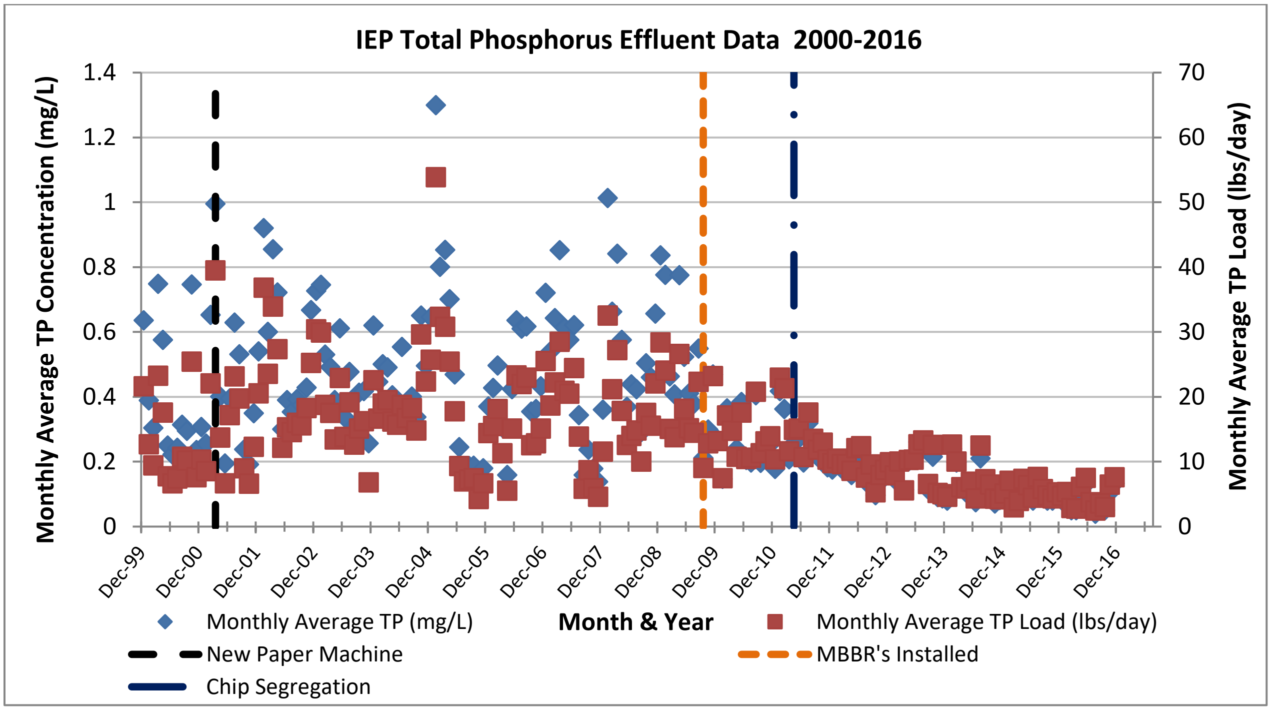


Figure 4. IEP's total phosphorus reductions from applying best management practices in the plant

Kaiser Aluminum (WA-0000892)

Kaiser's monitoring data shows that they are close to meeting the TMDL targets (Leber 2014). In 2012, daily total phosphorus concentrations were below 6 lb/day with the exception of February. In 2013, the daily total phosphorus levels were below 4 lb/day, and a majority of the time they were lower than 3 lb/day. Kaiser's final water quality-based effluent limit for total phosphorus is 3.21 lb/day. Kaiser's average ammonia and carbonaceous biochemical oxygen demand (CBOD) levels are also below the final water quality based effluent limit. To see a presentation of the data, see: http://www.spokaneriver.net/wp-content/uploads/2014/03/Leber.Annual-meeting-DO-TMDL-2014.pdf.

Kaiser's 2012 and 2013 Seasonal average loads for total phosphorus, carbonaceous oxygen demand, and ammonia are below the final seasonal limits per July 1, 2014 Annual Status Report (Table 5).

Table 5. Kaiser seasonal performance compared to final effluent limits for each parameter

Seasonal (March 1 – October 31) Performance Comparison (lb/day)			
Parameter	2012 Seasonal Average	2013 Seasonal Average	Final Seasonal Limitation
Total Phosphorus	2.34	1.47	3.21
Carbonaceous Biological Oxygen Demand	237	239	462.7
Ammonia	3.2	2.9	9.0

The BMPs that Kaiser put into place that have resulted in reductions in phosphorus in their discharge include:

- Replacement of phosphoric acid with sulfuric acid in the industrial wastewater treatment system.
- Discontinued use of phosphate detergents when the company ceased production of coated coil.

The current BMP used by Kaiser is the reduction of discharge flows, which reduced the amount of non-contact cooling water used in the facility. Some equipment was converted to air cooled rather than water cooled. Kaiser estimates this BMP reduced peak seasonal water demand by 10 to 15 percent.

In the future, Kaiser will research BMPs related to their use of water treatment chemicals.

In March 2014, Kaiser requested Ecology modify their NPDES permit by allowing a delay in the engineering design report and installation of the technology upgrade. Kaiser would like additional time to explore integrating plans for PCB groundwater treatment with upgrades to the sewage treatment facility. Ecology agreed and modified the permit. The permit modification requires technology selection notification by July 1, 2016, an engineering report for treatment technology by January 1, 2017, and installation and operation of phosphorus treatment technology by January 1, 2019. The permit modification was finalized on November 18, 2014.

2015-2016 Update

Kaiser's monitoring data during the period shows that they consistently achieved the TMDL final limitations in 2015 and 2016 (Figure 5). Kaiser's 2015 and 2016 seasonal average loads (March 1 – October 31) for total phosphorus, carbonaceous oxygen demand, and ammonia are presented below along with the TMDL final limitations (Figure 5 and Table 6).

The current BMP used by Kaiser is the reduction of discharge flows, which reduced the amount of non-contact cooling water used in the facility. During 2016, a motor/generator set that converted alternating current (AC) to direct current (DC) for a cold mill drive motor was replaced with a rectifier that is more energy efficient for making the conversion. The rectifier does not require cooling water. Kaiser estimates this BMP reduced peak summer water demand by 400,000 gallons per day.

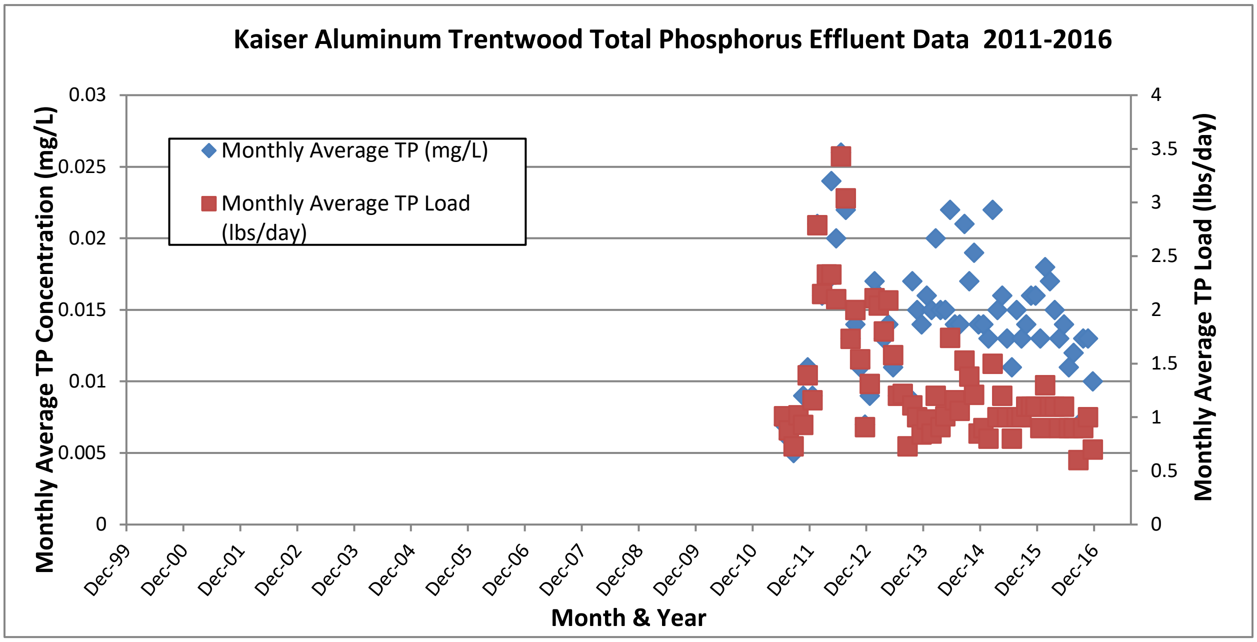


Figure 5. 2011-2016 Kaiser Aluminum total phosphorus effluent data

Table 6. Kaiser seasonal performance compared to final effluent limits for each parameter

Seasonal (March 1 – October 31) Performance Comparison (lb/day)				
Parameter	2014 Seasonal Average	2015 Seasonal Average	2016 Seasonal Average	Final Seasonal Limitations
Total Phosphorus	1.2	1.5	1.7	3.21
Carbonaceous Biological Oxygen Demand	123	192	206	462.7
Ammonia	1.5	1.5	1.7	9.0

Liberty Lake Sewer and Water District (WA-0045144)

In an effort to improve the water quality of Liberty Lake, the LLSWD constructed a wastewater collection and treatment facility in 1973 that replaced existing on-site septic systems. The treatment facility was completed in August 1982. The LLSWD completed minor modifications to the facility by replacing the aerobic digester blowers in 1998 and replacing the chlorination system with an ultraviolet disinfection system in 2002.

LLSWD was one of the first dischargers in the region to upgrade their facility to achieve enhanced phosphorous removal from its discharge to the river (Phase 1 upgrades) in anticipation of more restrictive limitations resulting from the TMDL waste load allocations. To achieve this removal, in 2006 the LLSWD converted their facility from an extended aeration process to a biological nutrient removal treatment process. This reduced the phosphorous discharge from 20-25 pounds per day before the upgrade to 3-4 pounds per day after the upgrade was complete. The result of the Phase I upgrades was removal of 91 percent of the phosphorous that enters the plant. Effluent data in Appendix C show the reductions in phosphorus, ammonia, and CBOD resulting from the addition of biological nutrient removal to the treatment process. Figure 6 shows the total phosphorus reduction in the plants' effluent through 2016.

The construction for Phase 2 of the facility upgrades is now underway and anticipated to be on-line by March 2018. These upgrades include advanced tertiary treatment through chemical addition and membrane filtration. This additional treatment will further reduce phosphorous discharge to less than ½ pound per day. This will equate to better than 99 percent removal of phosphorous entering the plant.

The cost for Phase I ($12.5M) and Phase II ($22.7M) upgrades total $35.2 million over a 10 year period (2006-2016). The District's 4,000 customers will see a 385 percent increase in sewer rates as a result of these two upgrades. Operation costs between the Phase I and Phase II upgrades have doubled from $500,000 to $1.0M annually.

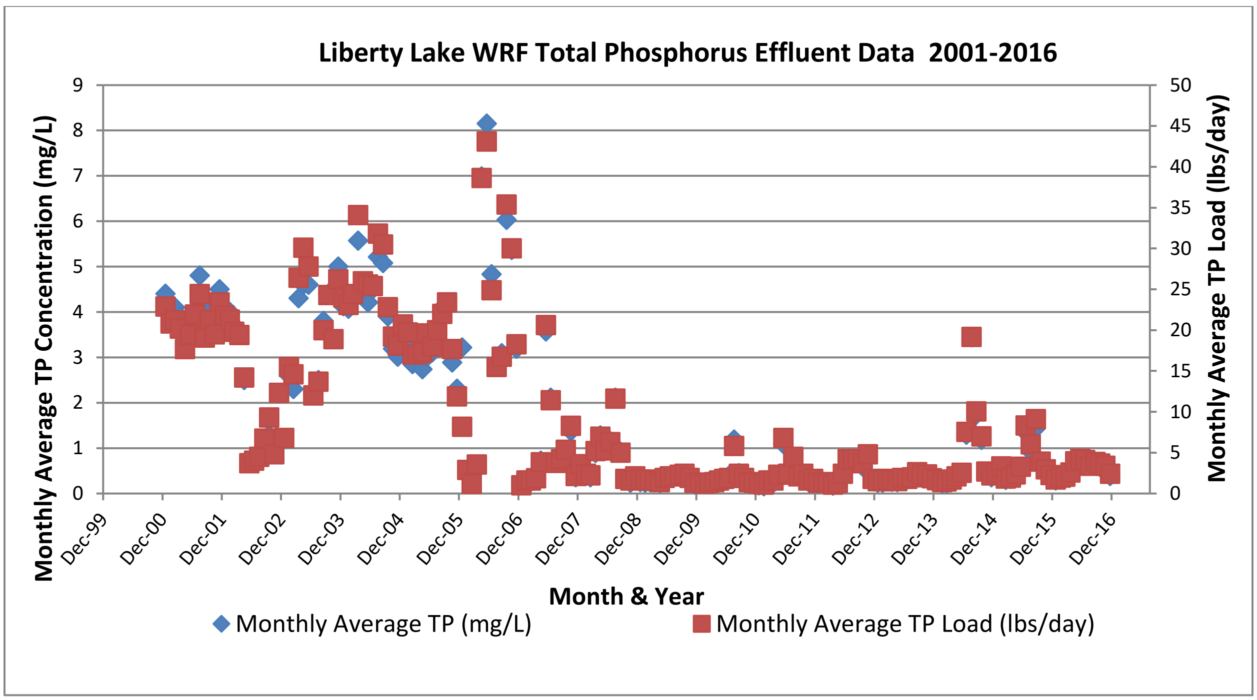


Figure 6. Liberty Lake Sewer and Water District total phosphorus effluent data

In addition to the upgrades to the treatment facility, the LLSWD has installed reclaimed water mains in various locations in preparation for future water reuse projects. For example, they installed a new undercrossing of I-90 to allow LLSWD to supply reclaimed water to areas south of the freeway. In early 2014, the LLSWD Commissioners passed a resolution requiring new development to install "purple" pipe wherever it was expected to be beneficial. Recently the

District has partnered with the City of Liberty Lake for reclaimed water line road crossings for eventual use at the City's Trailhead Golf Course.

LLSWD is a leader in the charge to reduce phosphorus in detergents and fertilizers:

- In December 1989, LLSWD passed Resolution 40-89 banning phosphorus in laundry detergent. A nationwide ban followed in 1993, while the state of Washington lagged a year behind with its ban in 1994. Twenty years later, in January 2014, Proctor and Gamble announced a plan to eliminate all phosphates from its laundry detergent worldwide within the next two years. Proctor and Gamble products represent one quarter of the global detergent market.
- In July 2005, LLSWD passed Resolution 23-05 banning phosphorus in automatic dishwasher detergent. Bans in Spokane, Whatcom and Clark counties followed in 2008. Proctor and Gamble (makers of Cascade) silently and without "Green" marketing removed phosphorus from its detergent formulations in 2009. In Washington, a statewide ban took effect in 2010. There are now 16 states with bans against automatic dishwasher detergent containing phosphorous. All major detergent companies have now removed phosphorus from their formulations. Following the detergent ban in Spokane County, the LLSWD has seen reductions of approximately 16 percent in Total Phosphorus in the influent to our reclamation facility (Figure 7).

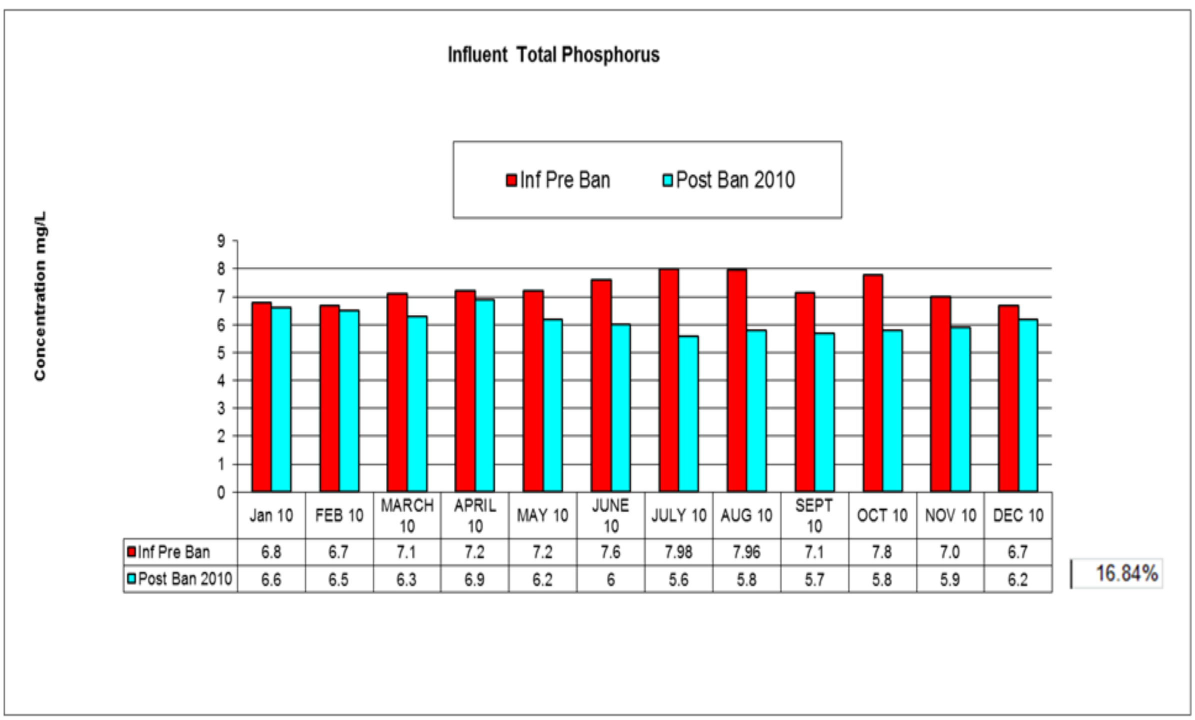


Figure 7. 2010 total phosphorus concentrations entering the Liberty Lake Sewer & Water District treatment facility

- In November 2005, the LLSWD passed Resolution 46-05 banning phosphorus in lawn fertilizer within the watershed of Liberty Lake. In June 2009, LLSWD amended the resolution (Resolution 18-09) banning phosphorus in lawn fertilizer district-wide. Two years later in 2011, Washington State passed "Clean Fertilizers, Healthier Lakes and Rivers" legislation (ESHB 1489) into law. Washington was the eighth state to pass fertilizer legislation. Now there are 11 states with bans against lawn fertilizer containing phosphorous. In response to these laws, companies that make fertilizers have reformulated their products.

- From 2005 to 2015, the LLSWD has partnered with Greenstone Homes to offer free bags of phosphorus-free fertilizer. Figure 8 shows that in 2011, out of the 850 vouchers distributed, LLSWD patrons claimed 303 bags of fertilizer. The program was discontinued in 2015 due to low participation in the program. Since the adoption of ESHB 1489 in 2011 participation in the program has declined.

The LLSWD has protective measures in place to reduce and prevent nonpoint source pollution (i.e. stormwater). They are maintained and strengthened when possible, including diversion/treatment of runoff, reduction of excessive lawn fertilization, community cleanup programs, promotion of smart/low impact development, and prevention of disruption of the watershed. Protection and prevention strategies are promoted in watershed studies, demonstration projects, environmental education programs, workshops, and newsletter/news article dissemination of information that explains the relationship between watersheds, water bodies, water quality, and human impacts to these resources. For example, since 1992 LLSWD performs an annual Beach and Leaf pickup within their boundary. Residents removed nearly 13,000 bags in 2013, which is the most removed since 2003 (Figure 9). This equates to 585 pounds of phosphorus removed from the watershed.

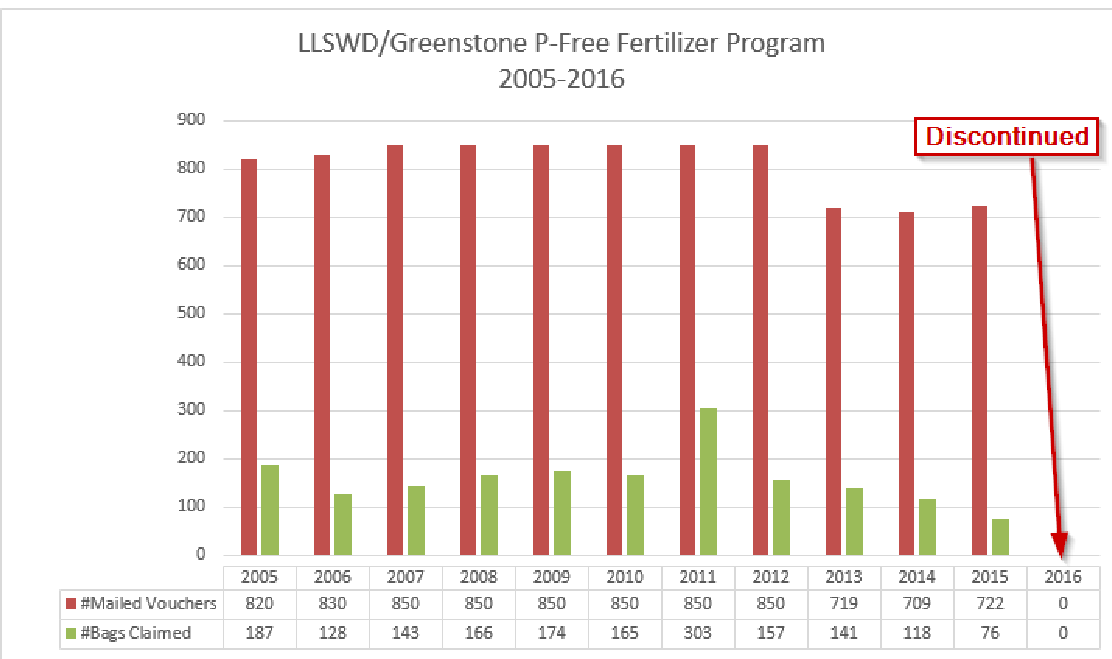


Figure 8. Liberty Lake Sewer & Water District phosphorus free fertilizer vouchers distributed and claimed

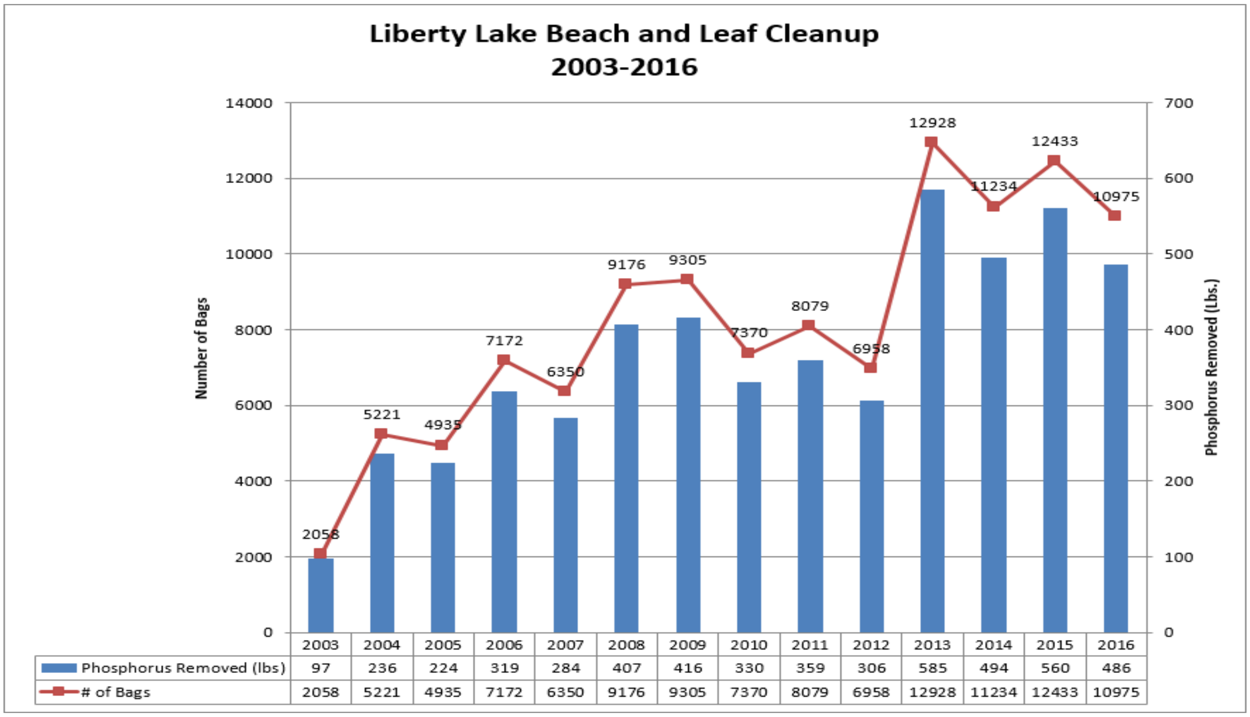


Figure 9. Bags of leaves removed during Liberty Lake Sewer & Water District's annual Beach and Leaf Pickup event

Spokane Riverside Park Water Reclamation Facility (RPWRF) (WA-002447-3)

The RPWRF is the Spokane community's oldest and largest water reclamation facility. The facility treats about 34 million gallons of wastewater a day and discharges secondary effluent to the Spokane River. The City of Spokane has a combined sewer system, where runoff from about one third of the city enters the sanitary sewer pipes. The RPWRF can handle peak hydraulic flows of up to 150 million gallons a day (mgd) during storm events, and can treat up to 100 mgd for the duration of most storms. RPWRF provides preliminary treatment, chemically enhanced primary treatment (CEPT), advanced secondary treatment, and disinfection. CEPT and advanced secondary treatment provide enhanced phosphorus removal.

Phosphorus treatment known as CEPT was tested beginning in June 2011 and is now standard operation. With CEPT, the City adds aluminum sulfate (alum) and anionic polymer ahead of the primary clarifiers to aid in solids and phosphorus removal (previously, alum was only used in the advanced secondary process for phosphorus removal). The use of CEPT has allowed the City to increase its treatment capacity while reducing phosphorus in its effluent (Figure 10). The technology increased total phosphorus removal in primary treatment from 30 percent to 70 to 80 percent, and reduced alum dosing by 30 percent. Initially, CEPT was implemented as a short-term pilot project, but with its success in reducing phosphorus levels, the City will continue to use CEPT as a treatment component year-round at RPWRF.

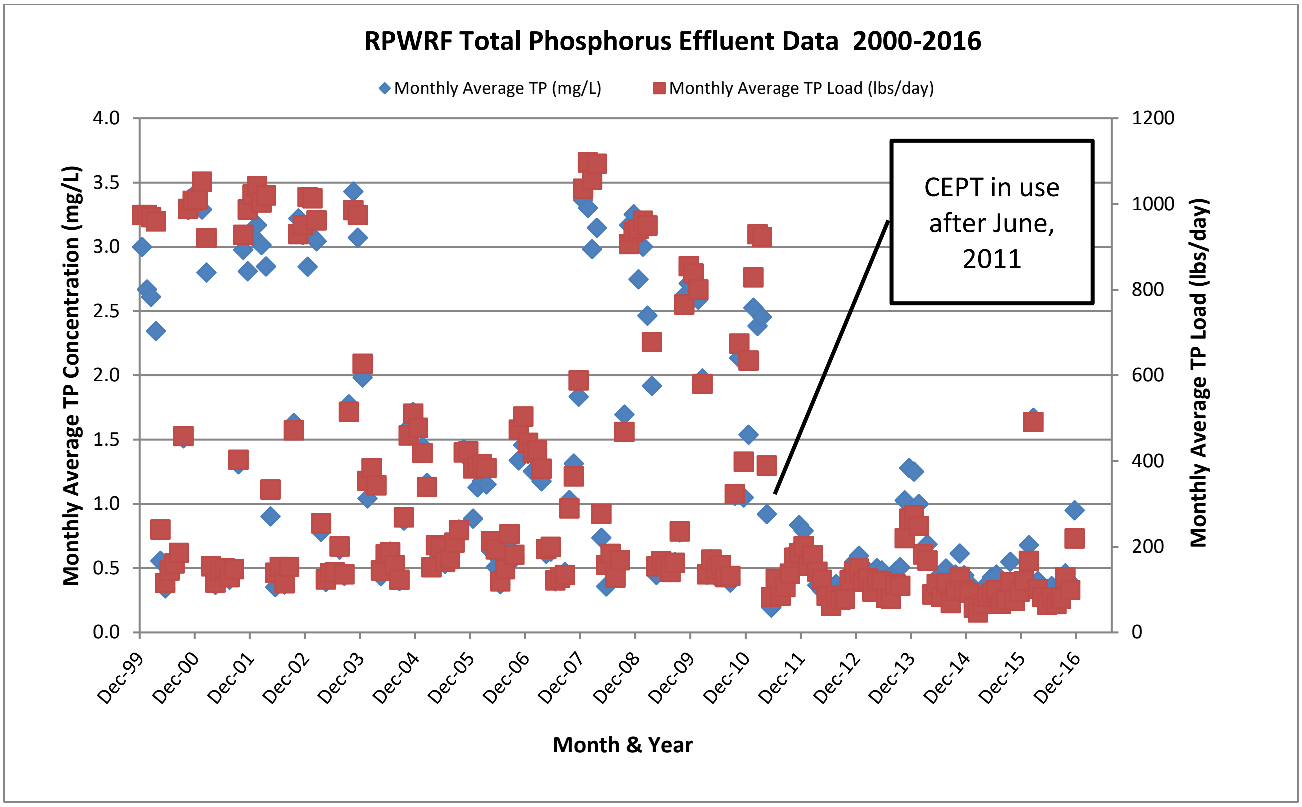


Figure 10. RPWRF total phosphorus effluent data 2000-2016

Planning and design work is under way to add additional treatment at the plant. This tertiary treatment level is often referred to as the Next Level of Treatment (NLT). Membrane technology will be used to further reduce pollutants like heavy metals, PCBs, phosphorus, and CBOD; and to improve the quality of the water released to the River. The NLT Engineering Report and Facility Plan Amendment Number 3 can be found at https://my.spokanecity.org/publicworks/wastewater/treatment-plant.

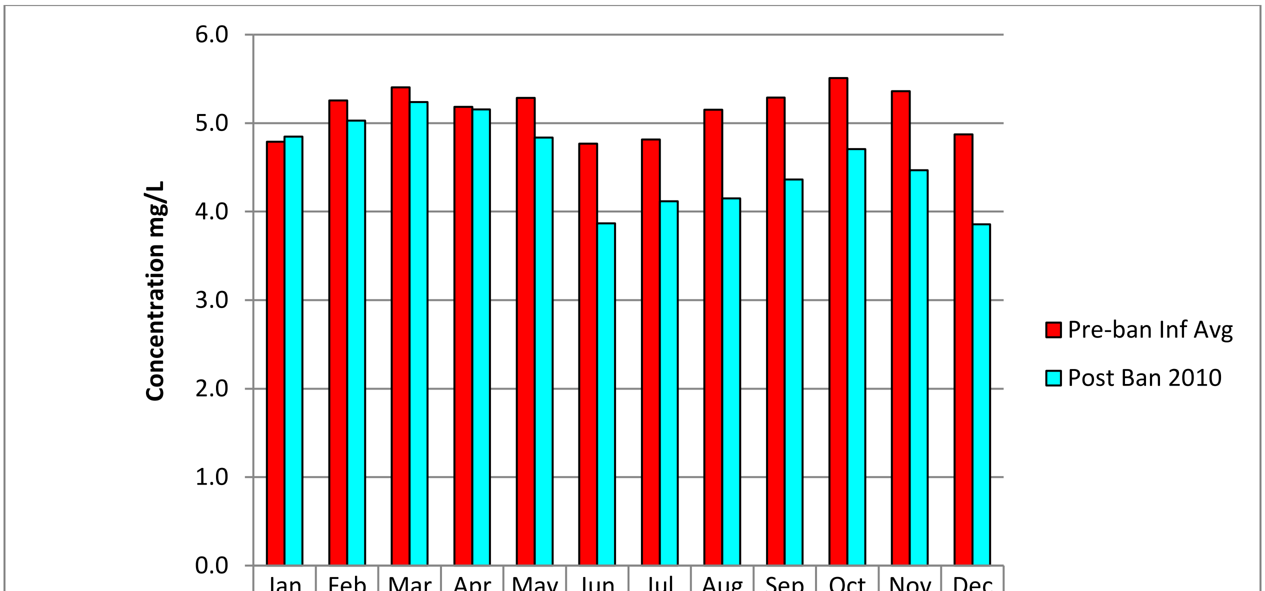
The City was approved in 2015 to use a General Contractor/Construction Manager (GC/CM) process to construct NLT. This allows the city to hire a company to serve as "GC/CM" early in the process to assist with design, participate in Value Engineering, and ensure constructability. A joint venture of MWH Constructors / Slayden Group / B&E Electric was awarded the contract for GC/CM in fall 2015.

Additional pilot testing was conducted in 2015 and 2016 between two membrane systems. The first was an immersed vacuum system manufactured by General Electric, Inc. The second was a pressurized canister system manufactured by Pall Corporation. Both technologies showed promise towards being able to meet RPWRF's allocation for total phosphorus in the Spokane River. The Pall membrane system was ultimately selected in summer 2016 for use in the final design of NLT for RPWRF.

Construction of a third digester at RPWRF began in 2014 and completion is anticipated in 2017. This secondary digester is a silo-type and will allow for additional capacity and redundancy.

Construction of a fifth primary clarifier was started in 2016 along with groundbreaking for a new chemical storage facility. The additional clarifier will allow for increased plant capacity for future flows. It will also allow for additional flow diversion/equalization when the NLT membranes are operational. The chemical storage facility will allow for additional alum and polymer storage that will be required for NLT.

The City of Spokane participated in regional efforts to reduce phosphorus loading from laundry detergent, automatic dishwasher detergent, and fertilizer. Spokane County implemented a ban on dishwasher detergent with phosphorus in July 2008. Figure 11 depicts the effects of the dishwasher phosphorus ban on RPWRF influent concentrations, comparing average concentrations before the ban (2006-2007) to after the ban in 2010. Annual average phosphorus influent concentrations were 11.4 percent lower in 2010 compared to the pre-ban average from 2006 and 2007. In 2011, the influent's average annual phosphorus concentration showed even more reduction (17.5 percent lower compared to pre-ban), likely due to more residents using low phosphorus products. Since 2011, influent phosphorus concentrations have since leveled off to a 19.4 ± 3.2 percent reduction for the 2012-2016 period.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pre-ban Inf Avg	4.8	5.3	5.4	5.2	5.3	4.8	4.8	5.1	5.3	5.5	5.4	4.9
Post Ban 2010	4.8	5.0	5.2	5.2	4.8	3.9	4.1	4.2	4.4	4.7	4.5	3.9

Figure 11. Phosphorus influent pre- and post- dishwasher detergent ban

The Spokane County Regional Water Reclamation Facility (SCRWRF) came online in November 2011, taking some of the flow that originally went to RPWRF and potentially some of the higher phosphorus concentrations because flows are sanitary sewage only. Because the City of Spokane has a combined sewer system, phosphorus concentrations in the wet months can be attributed to stormwater runoff as well as sanitary sewage. CSO and stormwater flows contain lower concentrations of phosphorus than sanitary sewer flows, about an average of 2 mg/L and 1 mg/L, respectively, based on recent sampling. August is typically the driest month of the year, so phosphorus concentrations can be primarily attributed to sanitary flows that month. Influent samples showed average phosphorus concentrations to be 18 percent lower in the month of August 2010-2016 compared to 2006-2007.

Combined Sewer System
The City's NPDES permit also includes conditions for their combined sewer overflows (CSOs). A CSO occurs when a combination of storm water and sewage exceeds the capacity of the sewer system and the excess flows into the Spokane River. The TMDL called for the following actions to reduce phosphorus from the CSOs:

- Monitor total phosphorus discharged from CSOs.
- CSO Reduction Program (Long Term Control Plan per EPA's Nine Minimum Controls).

Ecology approved the City's plan to control CSOs in accordance with Chapter 173-245 WAC. (See the City's 2013 Combined Sewer Overflow (CSO) Plan Amendment for more information: https://my.spokanecity.org/publicworks/wastewater/cso). The City's NPDES Permit allows one overflow per outfall per year on a 20-year moving average for each of its remaining 22 CSO outfalls and requires that any overflows meet water quality standards. The permit requires that the City must meet this performance standard by Dec. 31 , 2017. An additional five CSO storage facilities were built in 2015 and three more were constructed during 2016. This brings the total CSO tanks to 14 as of December, 2016. Construction of several smaller vaults, a number of weir modifications and a reduction in CSO outfalls to 20 have also taken place. CSO control facilities are continuing to be constructed through 2017. The City has real-time information on the CSOs and monthly and annual reports are available online at the web address included above.

Integrated Clean Water Plan
The City developed an Integrated Clean Water Plan, which is a plan that addresses CSOs, stormwater, and wastewater treatment plant upgrades simultaneously. The purpose of the plan is to achieve a cleaner river faster through prioritization of projects based on their positive environmental impact to the river, using cost-effective and innovative approaches, and holistic integration with other infrastructure projects. More information and a copy of the plan can be found at https://my.spokanecity.org/publicworks/wastewater/integrated-plan.

Spokane County Regional Water Reclamation Facility (SCRWRF) (WA-0093317)

The SCRWRF was required to meet water quality standards when it became operational in December 2011. Data from the facility shows that from March through October of 2015, the average amount of total phosphorus coming into the plant was 355 lb/day, and the average total phosphorus content of the effluent leaving the plant was 3.01 lb/day. In March through October 2016, the average amount of total phosphorus coming into the plant was 346 lb/day, and the average total phosphorus content of the effluent leaving the plant was 1.76 lb/day. The average amount leaving the plant in 2015 and 2016 was well below the seasonal limit of 3.34 lb/day and translates to more than a 99 percent reduction (Figure 12). In 2015 and 2016, ammonia levels in the facility's effluent were below the various seasonal limits, and carbonaceous biochemical oxygen demand (CBOD) was lower than the seasonal permit limits and typically below the lab detection limit of 2.0 mg/L (Appendix C). The County has been able to achieve these low nutrient levels using chemically enhanced primary treatment (CEPT) in combination with ultrafiltration membranes in a membrane bioreactor (MBR).

Before SCRWRF was operational, all the wastewater went to the City of Spokane's RPWRF for treatment. (The County owns 10 million gallons per day [MGD] of capacity at the City's plant.) In January 2017, the SCRWRF treated about 8.2 MGD, and the County sent approximately 2.3 MGD to the City's plant (about 1.9 MGD from North Spokane and 0.4 MGD from the Valley). Because SCRWRF is able to remove more phosphorus from wastewater than the City's RPWRF, the amount of phosphorus entering the river has decreased. The SCRWRF's phosphorus removal is about an order of magnitude (10 times) better than if it were treated at Spokane's RPWRF. Therefore, since December 2011, an estimated additional 30 pounds per day of phosphorus has been removed from the river during the critical season.

Spokane County also participated in regional efforts to reduce phosphorus loading from laundry detergent, automatic dishwasher detergent, and fertilizer. The state legislature implemented a ban on automatic dishwasher detergent with phosphorus in Spokane County in July 2008. These bans appear to have reduced the amount of phosphorus that enters the SCRWRF by about 20 percent below its influent design concentration of 7.2 mg/L.

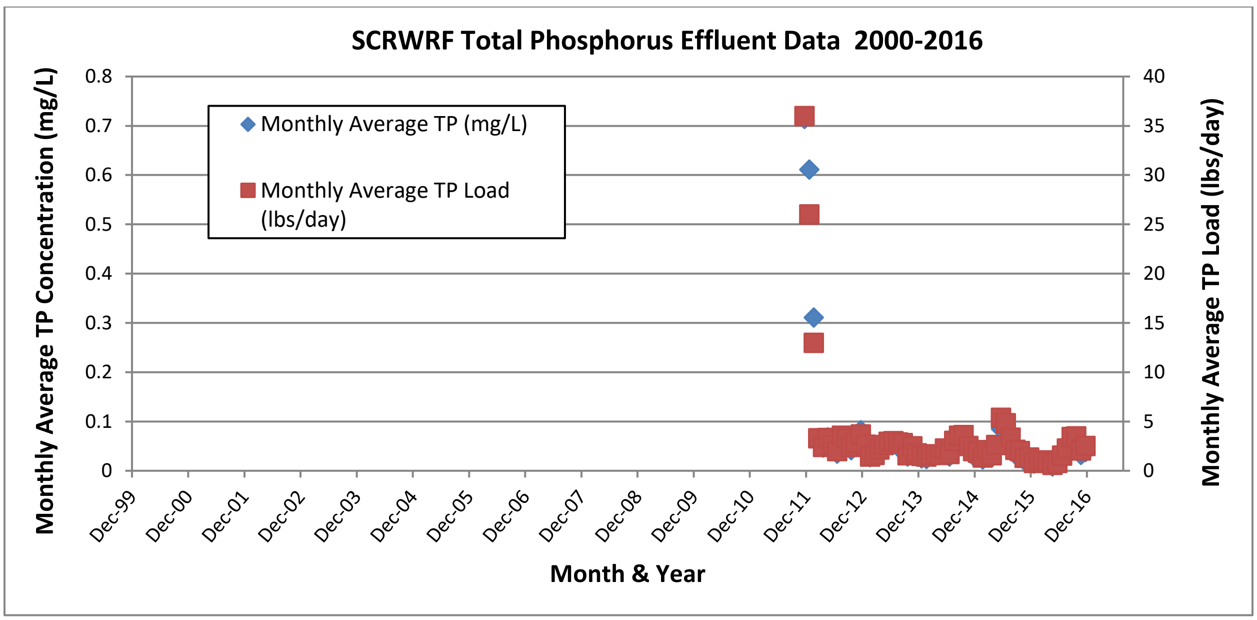


Figure 12. Spokane County Regional Water Reclamation Facility total phosphorus effluent data

Idaho Dischargers

City of Coeur d'Alene

Currently, the City of Coeur d'Alene is constructing upgrades in phases to achieve tertiary treatment (Keil 2014). The City completed pilot tests of treatment technology and believes they will be able to meet the permit limits after the plant is operational. They are currently testing various membrane filtration systems, which should be complete in two years. Figure 13 shows the total phosphorus concentrations in the City plant's effluent since 2000.

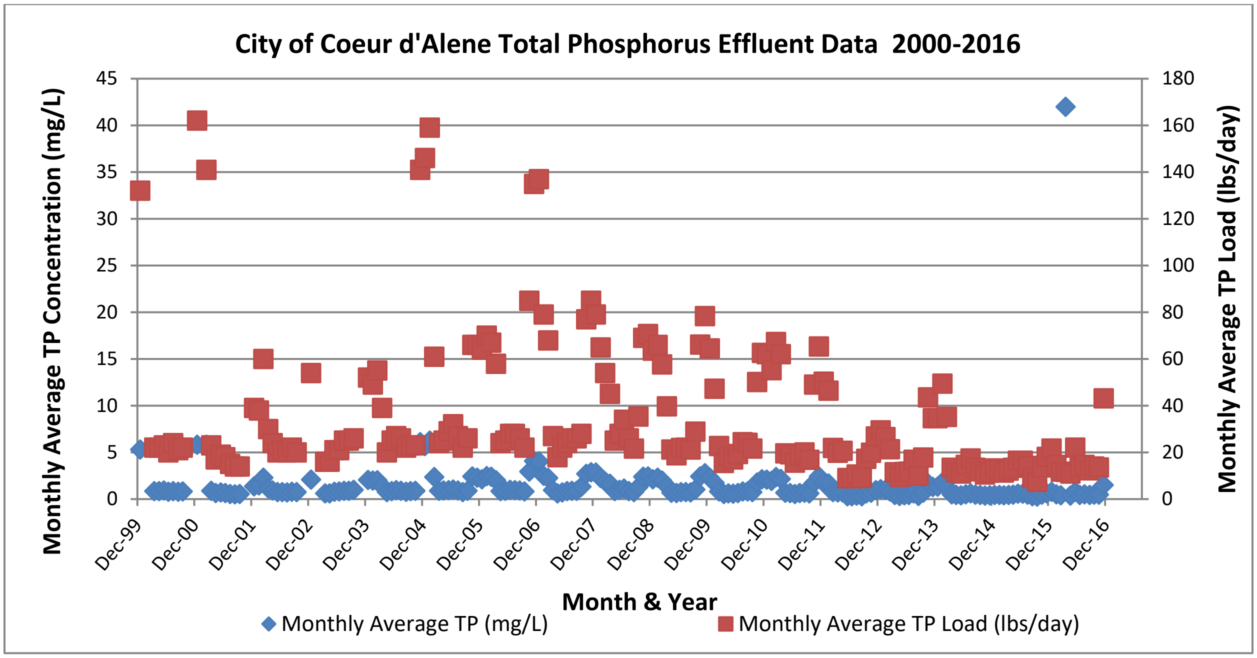


Figure 13. City of Coeur d'Alene total phosphorus effluent data

City of Post Falls

Status up to 2014

The Water Reclamation Facility operated by the City of Post Falls has been removing phosphorus via biological treatment since about 1996, in advance of a requirement to do so. The extended aeration system coupled with biological selector cells has historically removed phosphorus at levels above expected performance of a biological system.

In 1999 removal of phosphorus was included in a new NPDES permit. Since that time, other upgrades have been made to improve plant performance. For example, in 2005 and 2006 the oxidation ditches at the Water Reclamation Facility were upgraded to provide more consistent treatment. Figure 14 illustrates the total phosphorus concentrations discharged in the facility's effluent.

In 2010 a new oxidation ditch was added to the Water Reclamation Facility which provides full nitrification/denitrification treatment and improves the reliability of nutrient removal processes. Although the existing extended aeration system had historically removed almost all ammonia-nitrogen, this upgrade enabled the removal of nitrate and the recovery of alkalinity lost through ammonia removal.

The City of Post Falls has included expected treatment requirements for its new NPDES permit in its 2013 Water Reclamation Master Plan. Elements of this plan, including flow equalization, are currently in design and on-schedule. The master plan includes tertiary treatment of effluent.

2015-2016 Update
Flow equalization was added to the City's treatment system in 2016. This system mitigates daily flow variations and allows for economical sizing of downstream treatment systems. The City of Post Falls is currently pilot testing tertiary treatment technology, as outlined in the NPDES Permit Compliance Schedule.

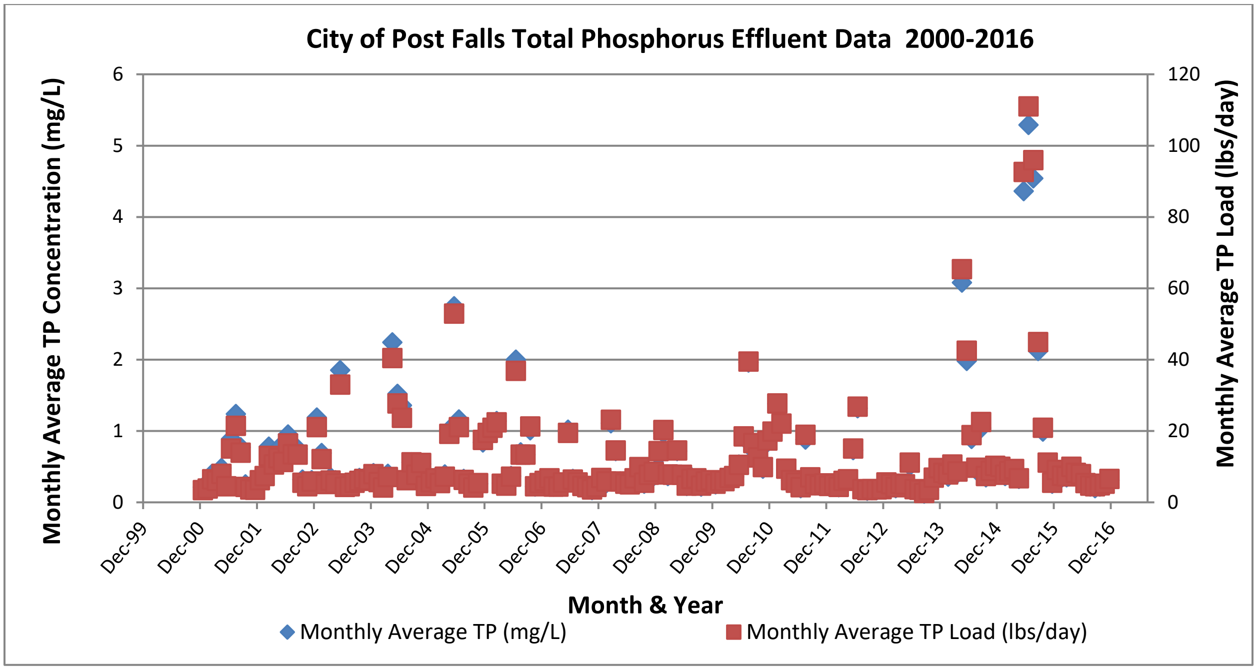


Figure 14. City of Post Falls total phosphorus effluent data

Hayden Area Regional Sewer Board

The Hayden Area Regional Sewer Board's (HARSB) installed flow equalization and biological nutrient removal treatment systems. Plant effluent total phosphorous has dropped from 2 – 4 mg/l to 0.2 – 0.5 mg/l (Figure 15). Plans are being developed to design and install tertiary treatment by 2023 to meet a 0.05 mg/l total phosphorous seasonal average. In addition, HARSB continues to avoid discharging to the Spokane River when flows are less than 2,000 cubic feet per second at Post Falls dam.

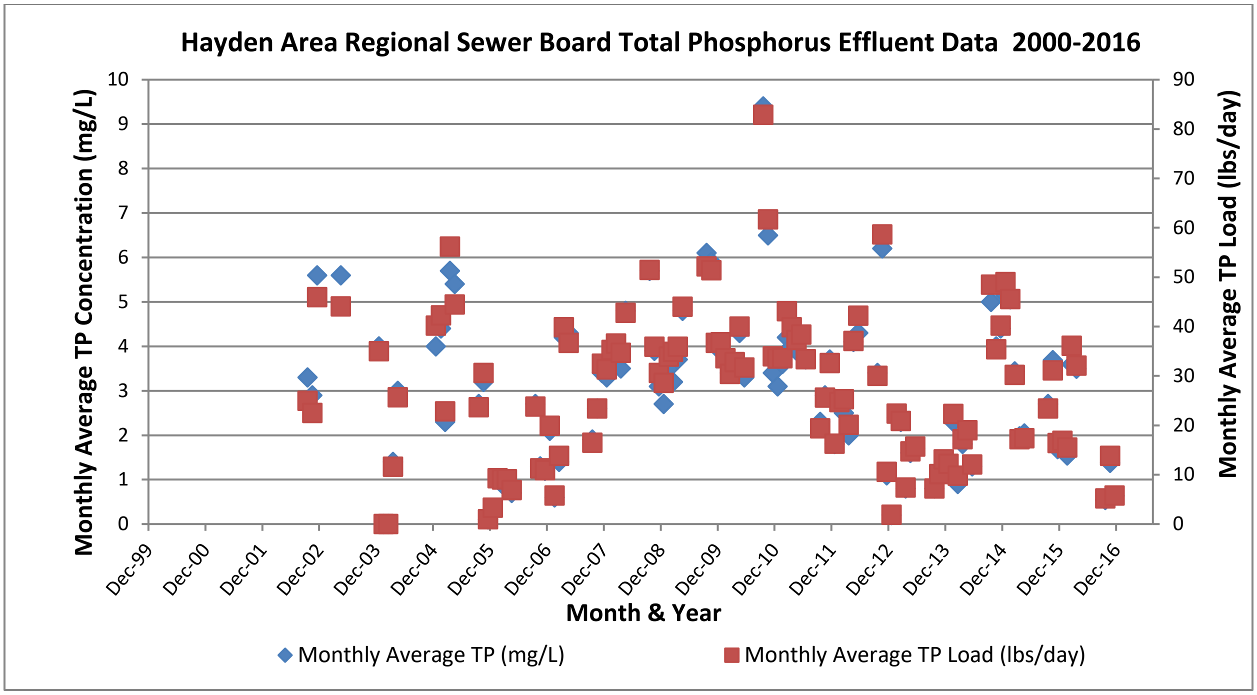


Figure 15. Hayden Area Regional Sewer Board total phosphorus effluent data

Avista's Dissolved Oxygen Responsibility

Avista Corporation (Avista) owns and operates the Spokane River Hydroelectric Project (Project), which consists of five dams on the Spokane River, including Long Lake Hydroelectric Development (HED), which creates Lake Spokane. In June 2009, the Federal Energy Regulatory Commission (FERC) relicensed Avista's Spokane River Project for another 50 years. To relicense the project, Ecology issued a 401 Water Quality Certification, which FERC incorporated into Avista's license. Avista received certification from Ecology in 2009 that includes a schedule to comply with water quality standards.

Avista does not discharge nutrients into either the Spokane River or Lake Spokane. However, the impoundment creating Lake Spokane increases the residence time for water flowing down the Spokane River, and thereby influences the ability of nutrients contained in those waters to reduce dissolved oxygen (DO) levels. As such, Avista received a proportional level of responsibility for improving DO levels in Lake Spokane as identified in the DO TMDL. Therefore, per the schedule to comply with water quality standards in the FERC license, Avista was required to develop a water quality attainment plan for dissolved oxygen. Avista's Lake Spokane Dissolved Oxygen Water Quality Attainment Plan (Avista and Golder, 2012) addresses improving its proportional level of responsibility as determined in the DO TMDL. (To view plan, see: https://www.myavista.com/-/media/myavista/content-documents/our-environment/river-documents/water-quality/2012-0308.pdf?la=en

They completed a five-year report of the company's activities, which can be read at: https://www.myavista.com/-/media/myavista/content-documents/our-environment/river-documents/water-quality/ls_do_wqap_5year_report_3-24-17.pdf?la=en. The report includes water quality data from Avista's six monitoring sites and an update on the activities Avista is undertaking to improve dissolved oxygen in the lake. The activities range from educational brochures and events to riparian plantings, land purchases, and carp studies.

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Monitoring

One of the purposes of the biennial reports is to track the performance in meeting the primary goals of the TMDL. According to the TMDL (Moore and Ross, 2010), the monitoring data should be compiled and qualified to assess the data and determine the effectiveness of the TMDL target pursuit actions. So, this monitoring section is intended to record the water quality conditions that occur over time; identify any new information gained from monitoring data gaps; and provide observations of the collected data over time. The biennial reports could identify data gaps, recommend additional monitoring, and indicate if conditions are improving.

Evaluating compliance with the TMDL requirements is beyond the scope of the biennial reports. Compliance will be determined during the 10-Year Assessment. One of the primary reasons why the biennial reports should not solely be used to determine compliance with the TMDL is that the majority of the data used is collected monthly. Monthly grab samples may not be representative of conditions, particularly during higher flows. For TMDL compliance decisions we need more data, such as bimonthly and perhaps from more locations, so we have a high confidence level in the conclusions.

Many entities monitor water quality in Lake Coeur d'Alene, the Spokane River, tributaries to the Spokane River, Lake Spokane, and groundwater. These entities include:

- Idaho Department of Environmental Quality (IDEQ)
- Coeur d'Alene Tribe
- City of Coeur d'Alene
- United States Geological Survey
- Hayden Area Regional Sewer Board (HARSB)
- City of Post Falls
- Ecology
- Liberty Lake Sewer and Water District (LLSWD)
- Kaiser Aluminum
- Inland Empire Paper
- Spokane County
- City of Spokane
- Avista
- Spokane Riverkeeper

Figure 16 shows the sampling locations within the Spokane River Basin. Descriptions of the monitoring activities are described in the following pages according to where in the watershed they are performed: Lake Coeur d'Alene, the Spokane River, its tributaries, Lake Spokane, or groundwater.

Lake Coeur d'Alene

The Idaho Department of Environmental Quality (IDEQ) and the Coeur d'Alene Tribe (Tribe) routinely monitor Lake Coeur d'Alene and surrounding watersheds for nutrients as part of implementing the Coeur d'Alene Lake Management Plan (Idaho Department of Environmental Quality and Coeur d'Alene Tribe, 2009). IDEQ and the Tribe monitor a total of 11 sites, seven to eight times each year. Timing of the sample collection depends on when specific lake conditions of interest occur (Coeur d'Alene Tribe and IDEQ, 2012). The goal of the plan is to keep nutrients low and dissolved oxygen levels up so that the heavy metals in the lake's bottom sediments remain there. Among the many parameters IDEQ and the Tribe sample for are dissolved oxygen, nutrients (including phosphorus), chlorophyll, cyanobacteria, and phytoplankton.

Spokane River

Idaho

The United States Geological Survey (USGS) sampled the Spokane River at two stream gage locations in Idaho from water year (Oct. 1-Sept. 30) 2009 through 2013:

- Downstream of the outlet of Lake Coeur d'Alene (gage # 12417610) at Coeur d'Alene (Latitude 47°40'55", Longitude 116°47'51", NAD83) Flow data collected at this site began in August 2009 and ended in July 2014. The USGS continued to take water quality samples until October 2016. The USGS relocated this stream gage downstream below Blackwell Island near Coeur d'Alene. The new gage number is 12417650.

- Near Post Falls (gage # 12419000) (Latitude 47°42'11", Longitude 116°58'40", NAD83) This is a long-term flow measurement gage. The USGS last collected water quality samples from this site in July 2014.

The USGS's purpose for collecting water quality samples at these locations was to determine concentrations, assess transport, and examine long-term trends of cadmium, zinc, lead, nitrogen, and phosphorus in the Coeur d'Alene basin (Clark and Mebane 2014).

Washington

From 2010-2016, Ecology's Environmental Assessment Program (Ecology) monitored water quality monthly at several sites on the Spokane River beginning at the Lake Coeur d'Alene outlet and continuing down the river to below Nine Mile Dam (Table 7).

Between 2010 and 2014 Ecology sampled the river at ten locations, but only three locations during 2015 and 2016 (bolded in Table 7). Appendix A contains the data for conductivity, pH, dissolved oxygen and temperature and the laboratory results for fecal coliform bacteria, ammonia nitrogen, nitrate and nitrite nitrogen, soluble reactive phosphorus, total suspended solids, total phosphorus, total persulfate nitrogen, and turbidity.

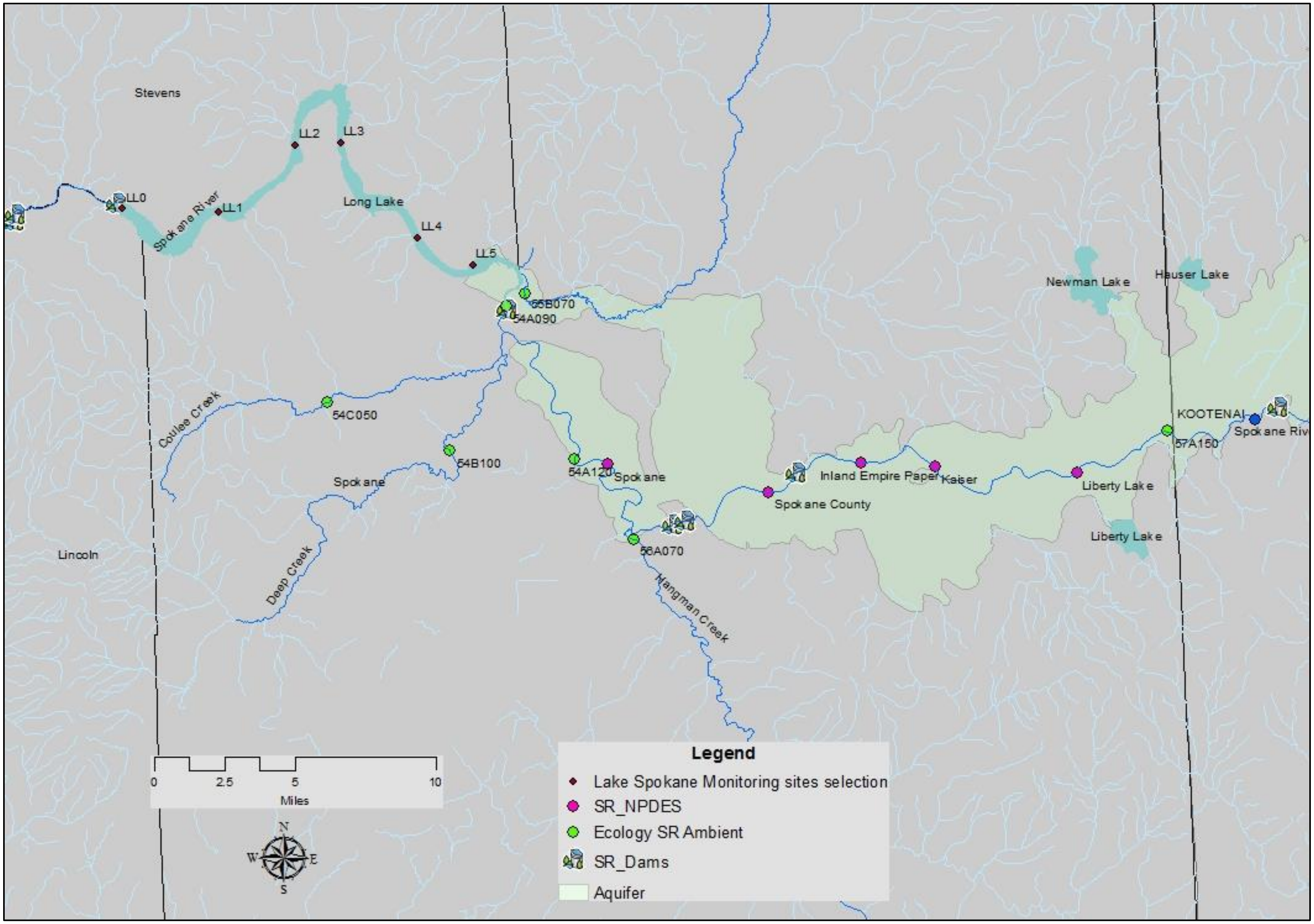

Figure 16. Spokane River basin monitoring locations

Table 7. WA Department of Ecology monitoring locations on the Spokane River*

http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html			
River Location	**Station #**	**River Mile^**	**Water Year****
Spokane River @ Lake Coeur d'Alene	57A240	111.7	2007-2010
Spokane River near Post Falls	57A190	110.7	2007
Spokane River @ Stateline Bridge	57A150	96.35	1991-2016
Spokane River @ Sullivan Road	57A146	87.7	2009-2010
Spokane River @ Plante's Ferry Park	57A140	84.2	2008-2010
Spokane River below Monroe Street	57A125	73.1	2007-2008
Spokane River @ Sandifur Bridge	57A123	72.6	2009-2010
Spokane River @ Fort Wright Bridge	54A130	69.8	2009-2010
Spokane River @ Riverside State Park	54A120	66	1972-2016
Spokane River @ Nine Mile Bridge	54A090	58	2000, 2007-2010, 2013-2016
Spokane River @ Long Lake	54A070	33.3	2007-2010

*Bolded sites represent locations monitored between 2015 and 2016.
^ River miles are counted beginning at the mouth and increasing upstream.
**Water year begins October 1st and continues through September 30th.

Entities discharging to the river in Washington sample their effluent for nutrients and other constituents before it is released into the river as part of their permit requirements. Spokane County's permit for their Regional Water Reclamation Facility required them to monitor the Spokane River for nutrients above and below their facility's outfall during the second and fourth year of their permit. The City of Spokane monitored two of their combined sewer overflows (CSOs) and two stormwater outfalls from 2012-2014 for development of their Clean Water Integrated Plan (CH2M Hill, 2014) (Table 8). The City samples effluent from these pipes for total phosphorus, nitrate-nitrite, ammonia, total suspended solids, carbonaceous biochemical oxygen demand, and biochemical oxygen demand. As part of the Eastern Washington Phase II Municipal Stormwater Permit (effective August 1, 2014), the City was required to develop a plan to monitor stormwater in the Cochran Basin for DO-TMDL parameters. A quality assurance project plan (QAPP) was developed and approved by Ecology and monitoring began in 2016. Results of the sampling are also included in Appendix A.

Tributaries

Ecology established long-term monitoring sites near the mouths of the two major tributaries to the Spokane River: Hangman Creek and the Little Spokane River (Table 9). Deep Creek, and its tributary, Coulee Creek, flow intermittently; typically only flowing in the spring. Beginning in October 2013, Ecology placed ambient monitoring sites on Deep and Coulee creeks, but this monitoring was temporary so it ended in September 2015. Data from these stations are included in Appendix A. Ecology initiated a groundwater study at the mouth of Deep Creek in 2016 which is discussed below.

Table 8. City of Spokane stormwater and combined sewer overflow monitoring sites.

	Identification # / Basin	General Location	Dates sampled
Combined Sewer Overflow	6	0.25 miles upstream of the City's Riverside State Park Water Reclamation Facility	2013-2014
	34	Trent Bridge (from South Hill)	2013
Stormwater	Cochran Basin	north side of Spokane (5,300 acres)	2012-2014, 2016
	Washington Basin	north of Washington St Bridge (450 acres)	2013

Table 9. WA Department of Ecology Spokane River tributary monitoring locations*

http://www.ecy.wa.gov/programs/eap/fw_riv/rv_main.html			
Tributary Location	**Station #**	**River Mile**	**Water Year****
Little Spokane River near mouth	55B070	1.1	1994-2016
Hangman Creek @ mouth	56A070	0.6	1995-2016
Deep Creek at Garfield Road bridge	54B100	5.9	2015
Coulee Creek at N Brooks Road	54C050	7.6	2015

*Bolded sites represent locations monitored between 2010 and 2016.
**Water year begins October 1st and continues through September 30th.

Lake Spokane

Ecology published a data report on their May 2010 to October 2011 Lake Spokane nutrient monitoring effort (Ross 2013). The report is a compilation of all Ecology's data from five monitoring stations on Lake Spokane, a site at the mouth of the Little Spokane River, and a lower Spokane River site. The monitoring effort achieved the data quality objectives for the study. The report can be viewed at: https://fortress.wa.gov/ecy/publications/publications/1303029.pdf.

In accordance with its Dissolved Oxygen Water Quality Attainment Plan (DO WQAP), Avista has been completing monitoring at six lake stations, LL0 through LL5, during May through October since 2012. Monitoring at prescribed depths throughout the water column at each station includes both in-situ sampling of water temperature, dissolved oxygen (DO), pH, conductivity, and water clarity as well as sample analyses for nitrate plus nitrite, total persulfate nitrogen (TN), soluble reactive phosphorus (SRP), total phosphorus (TP), chlorophyll-a, phytoplankton and zooplankton. The monitoring and sampling are conducted in accordance with the Quality Assurance Project Plan for Lake Spokane Baseline Nutrient Monitoring (TetraTech 2014).

Figure 17 shows the locations of the six monitoring stations within Lake Spokane. Station LL0 is located at a depth of 157-164 feet and is the farthest downstream in the reservoir. Station LL1 is located across from the Lake Spokane Campground and Boat Launch at a depth of about 111 feet. Station LL2 is down-reservoir from Tumtum and Sunset Bay at a depth of about 85 feet. Station LL3 is just up-reservoir from Willow Bay at a depth of about 62-65 feet. Station LL4 is across from Suncrest Park and boat launch at a depth of about 29 feet. Station LL5 is the farthest up-reservoir, slightly up-reservoir from the Nine Mile Recreation Area on the north side of the river, at a depth of about 19 feet.

Longitudinally, Lake Spokane can be divided into three zones representing varying physical characteristics of the lake (Figure 17). The upper portion of the reservoir is considered to be the riverine zone and has the shallowest depths and fastest velocities, characteristics similar to a large river. Station LL5 is within this riverine zone. Stations LL3 and LL4 are located within the transition zone of the reservoir, where the reservoir is changing from a riverine environment to a more lacustrine (lake) environment. Within the transition zone, depths are greater than in the riverine zone but the littoral areas (shallow areas where sunlight can reach the bottom) are still similar to that seen in the riverine zone. Stations LL0, LL1, and LL2 are located in the lacustrine zone of the reservoir, where there is both littoral and deep water environments. Water depths in the lacustrine zone are much deeper than the rest of the reservoir.

The vertical structure of Lake Spokane is set up by thermal stratification, largely determined by its inflow rates and temperature, change in storage, climate, and location of the Long Lake Dam powerhouse intake. Within Lake Spokane's lacustrine zone, thermal stratification creates three layers (the epilimnion, metalimnion, and hypolimnion) that are generally present between late spring and early fall. The epilimnion is the uppermost layer, and the warmest due to solar radiation. The metalimnion contains the thermocline and is the transition layer between the epilimnion and the hypolimnion. The hypolimnion is the deepest layer and is present throughout the lacustrine zone.

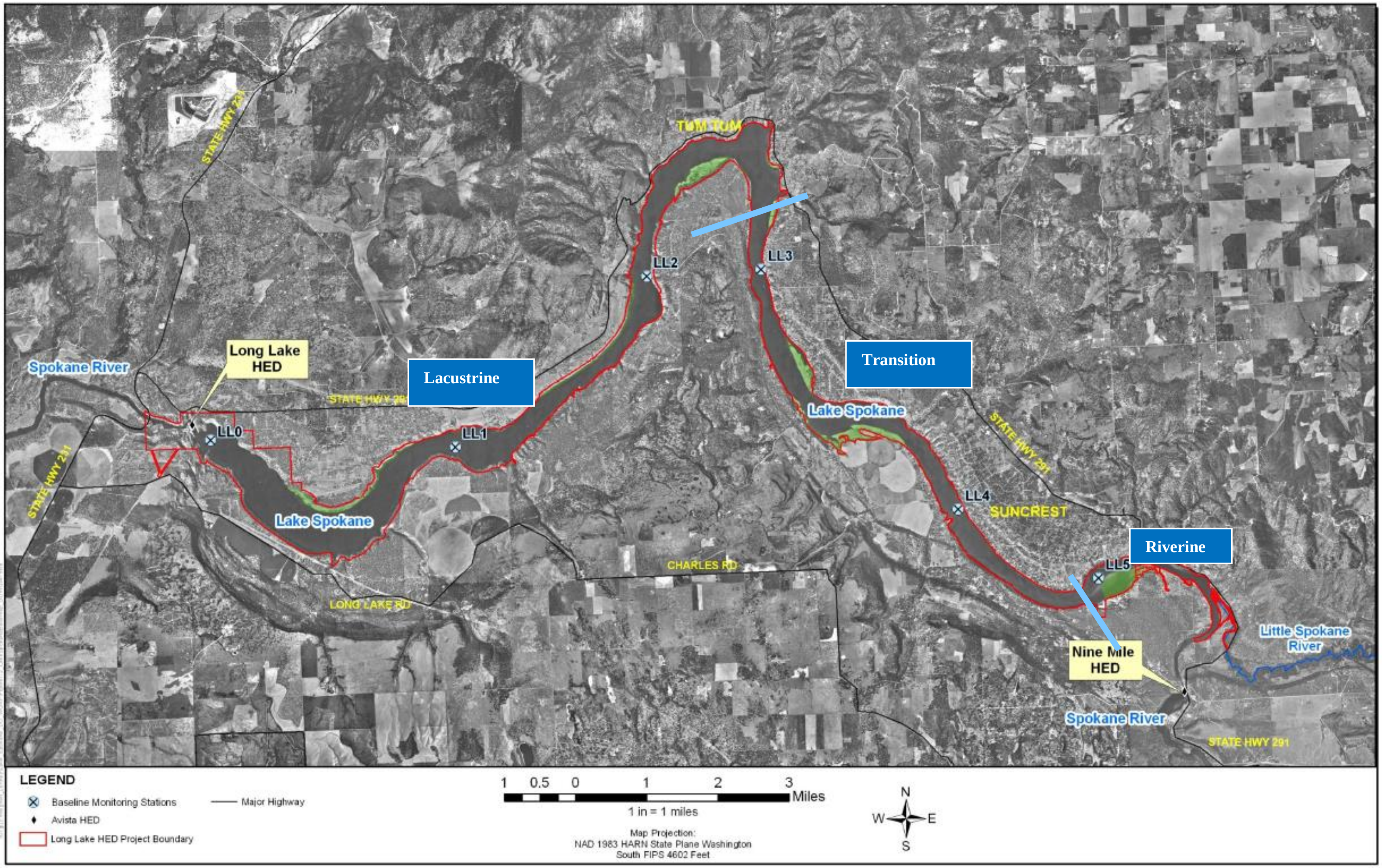

Figure 17. Lake Spokane morphometric zones and monitoring stations

Groundwater

Spokane County
Both the Spokane County Environmental Services' Water Resources and City of Spokane staff monitor groundwater wells for nitrate and total phosphorus. Spokane County staff monitor the Spokane Valley Rathdrum Prairie Aquifer via 45 to 49 wells scattered throughout the County. More information about the monitoring effort, including data, can be found at https://www.spokanecounty.org/1285/Groundwater-Monitoring.

The City of Spokane monitors seven drinking water wells (Electric, Parkwater, Nevada, Grace, Hoffman, Central, and Ray Street). All of these wells are sampled once a year toward the end of July with the exception of Ray Street, which is monitored quarterly. The City of Spokane produces yearly drinking water reports which can be found at: https://my.spokanecity.org/publicworks/environmental/documents/.

Lake Spokane
In the summer of 2014 and spring of 2015, the United States Geological Survey (USGS) conducted an initial study to determine if nutrients from septic systems in the Suncrest area were getting into groundwater and making their way into Lake Spokane. In the summer of 2014, the USGS collected samples of aquatic plants rooted near the shoreline and tested them for a nitrogen isotope that indicates presence of septic tank nutrients. In spring 2015, the USGS took groundwater samples from shallow piezometers or wells at 30 locations near the Suncrest shoreline on Lake Spokane. The samples were analyzed for nitrate plus nitrite, ammonia, and soluble reactive phosphorus. The USGS completed a report of the study, "Preliminary characterization of nitrogen and phosphorus in groundwater discharging to Lake Spokane, northeastern Washington, using stable nitrogen isotopes" (Gendaszek et al. 2016), which is available online at https://pubs.er.usgs.gov/publication/ofr20161029.

Deep Creek
In summer 2016, Ecology began monitoring groundwater at the mouth of Deep Creek. Ecology installed two piezometers (small shallow wells) in the dry creek bed and one along the shoreline of the Spokane River just downstream of the confluence with Deep Creek (red dots in Figure 18). The wells are sampled quarterly for nutrients, chloride, and alkalinity. If Deep Creek is flowing, Ecology also collects surface water samples for nutrient analysis, as illustrated by the blue dot in Figure 18. Work to determine groundwater flow and nutrient loading will occur in the summer of 2017.

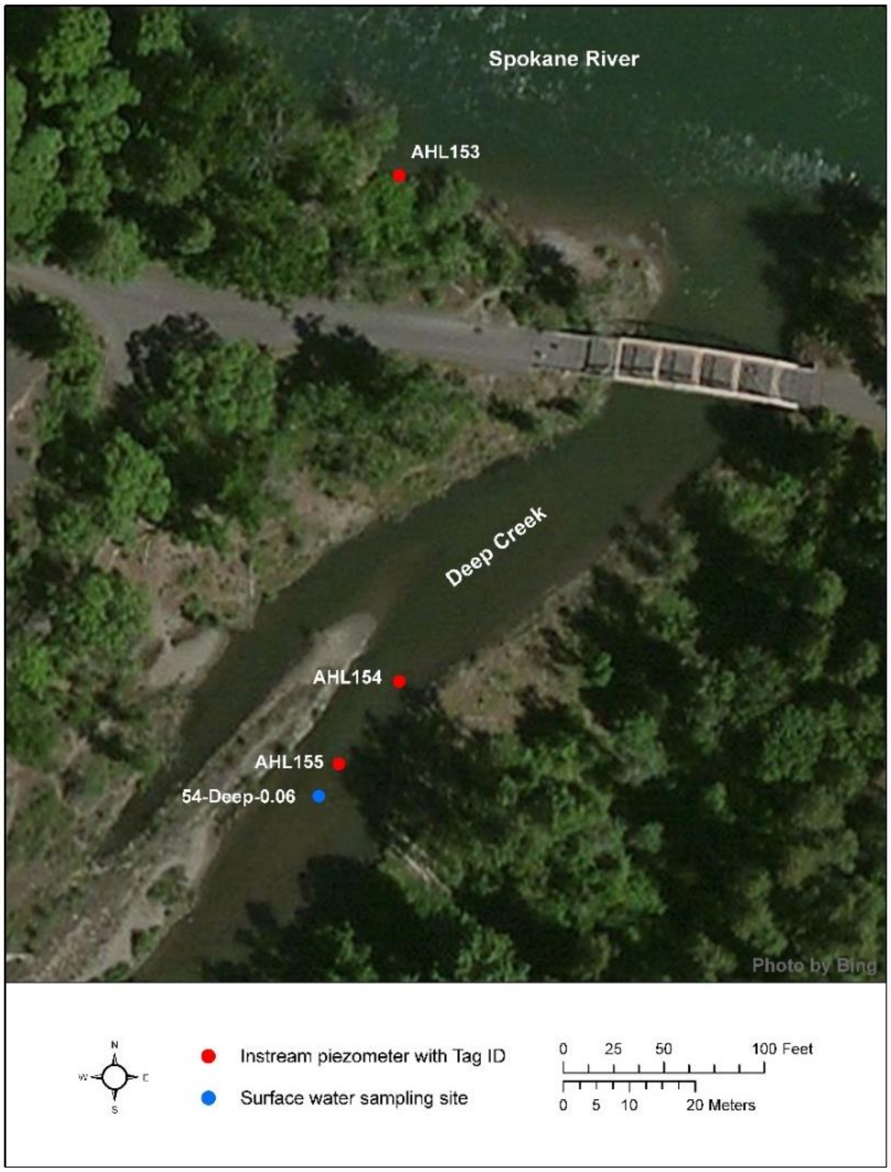

Figure 18. Deep Creek 2016-2017 monitoring locations

Data Observations

Lake Coeur d'Alene

In 2009, the Coeur d'Alene Tribe and Idaho Department of Environmental Quality (IDEQ) completed the Coeur d'Alene Lake Management Plan. The goal of the plan is reduce nutrients so that dissolved oxygen levels in the lake remain high to prevent metals in the bottom sediments from being released into the lake. The plan lists several 'trigger criteria' intended to signify if lake health and water quality is declining and additional actions are required.

In Lake Coeur d'Alene, total phosphorus, soluble reactive phosphorus, and total nitrogen levels are variable, but the highest concentrations occur in spring during run-off, then decline through the rest of the year (Cooper 2014).

The IDEQ and Coeur d'Alene Tribe completed a report summarizing the status of and trends in Lake Coeur d'Alene (Idaho Department of Environmental Quality and Coeur d'Alene Tribe, 2016). According to the report,

> "Dissolved oxygen levels during the summer stratified season have slowly declined from their 1990's levels in the northern lake, while chlorophyll *a* and phosphorus levels have increased. The southern regions of the lake remain in a higher productivity state. The northern lake's trophic indicators appear to be trending away from the preferred oligotrophic state, though additional data and analysis is needed to more completely quantify these emerging trends and assess their potential impacts."

IDEQ and the Tribe determined that total phosphorus concentrations in the south part of the lake between 2008 and 2014 were routinely higher than the Lake Management Plan's trigger criteria of 8 μg/L (0.008 mg/L) annual geometric mean. In the northern part of the lake, the trigger criteria were occasionally surpassed. Statistical evaluation of the data revealed that total phosphorus concentrations in 2003 through 2014 were significantly higher than during 1991 through 1992. So, the southern end of Lake Coeur d'Alene has less dissolved oxygen than the northern section of the lake. However, nutrient levels in the northern section of the lake may be getting higher which may result in lower dissolved oxygen. IDEQ and the Tribe identified that dissolved oxygen levels in the lake's southern region are usually lower than the trigger criteria, whereas in the northern areas of the lake, dissolved oxygen levels only occasionally fall below the criteria.

Spokane River

Idaho

The United States Geological Survey (USGS) used the LOADEST model to determine loads and flow-weighted concentrations as a way to reduce bias from "variation in the sampling frequency and timing of sampling over the stream hydrograph." (Clark and Mebane 2014). The river flow during water year 2010 was less than the average, while most of water years 2011 and 2012 were greater than the historic 25-year average. Water years 2009 and 2013 had flows right around the historic mean or average.

The average flow-weighted total phosphorus concentration for all five years at the outlet of Coeur d'Alene was 0.008 mg/L, and near Post Falls the average concentration was 0.009 mg/L. The authors attributed the 0.001 mg/L increase in total phosphorus between the sites to the wastewater treatment plants' discharge. The water year 2009 to 2013 average total phosphorus loading from Lake Coeur d'Alene into the Spokane River was 52.9 tons/year.

The average total nitrogen concentration at the Lake Coeur d'Alene outlet was 0.095 mg/L and near Post Falls, average total nitrogen increased by 0.035 mg/L to 0.130 mg/L. The average total nitrogen load from Lake Coeur d'Alene to the Spokane River was 628 tons/year.

Since 2004, Spokane River total phosphorus concentrations collected by Ecology at the Washington-Idaho state line have typically been below 0.010 mg/L (Figures 19 and 20). Total phosphorus concentrations show little seasonal variation and have an annual average around 0.008 mg/L. Average monthly total phosphorus concentrations from October 2003 through January 2017 have also been below or near 0.010 mg/L

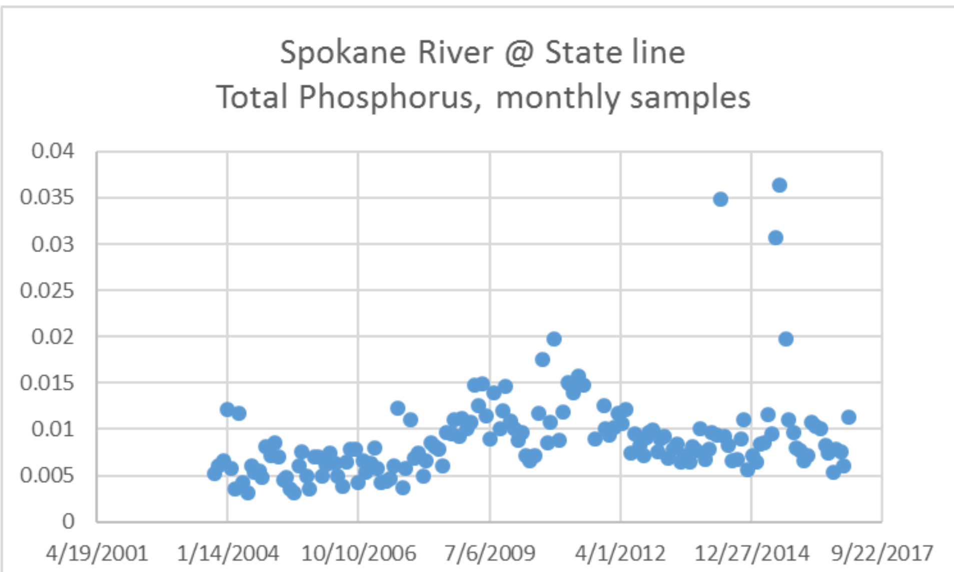

Figure 19. Monthly total phosphorus concentrations at WA-ID state line

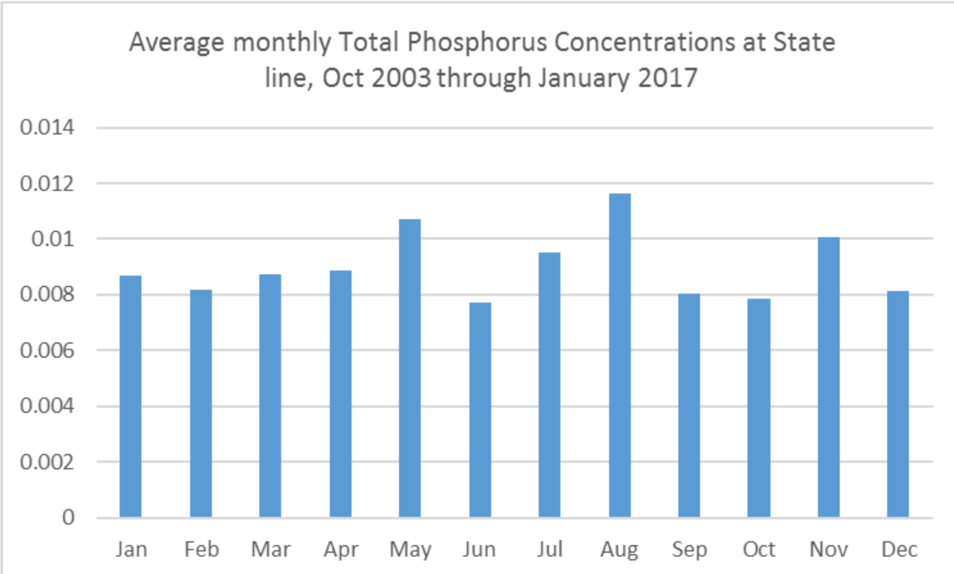

Figure 20. Average monthly total phosphorus concentrations at WA-ID state line

The Fact Sheets for NPDES permits issued September 30, 2014 to Coeur d'Alene, Hayden Area Regional Sewer Board, and Post Falls, provided an in-river total phosphorus concentration target at State line of 0.010 mg/L (EPA, 2013). The Fact Sheet estimated that with final permit limits in place by 2024, the Spokane River at State line would have a median (the 'middle' number of a list of numbers) February through October total phosphorus concentration of 0.0091 mg/L, and that it would be below 0.010 mg/L 55 percent of the time. Between October 2003 and January 2017, the February through October total phosphorus concentration at the Washington-Idaho state line was below 0.010 mg/L in 71 percent of the samples. The highest total phosphorus concentration at the state line is 0.0364 mg/L which occurred August 2015, but in May 2014 and July 2015, concentrations were also above 0.03 mg/L. Figure 19 shows that the majority of the samples have a total phosphorus concentration of 0.015 mg/L or less.

Washington

Ecology collected Spokane River samples in 2012 and 2013 in the vicinity of Millwood, WA, as a part of a groundwater-surface water interaction study related to the Inland Empire Paper Company (IEP) NPDES permit (Tarbutton and Sinclair, 2016). The study involved three surface water sample sites with a total of 50 river samples collected (maximum of 22 samples collected per site). Two sample sites were upstream of the IEP outfall and one was downstream. The median total phosphorus concentration of all river samples was 0.0082 mg/L and the average was 0.0085 mg/L. Several total phosphorus samples were below the reporting limit (0.005 mg/L). The eight total phosphorus samples collected from Argonne Bridge downstream of IEP also had a median concentration of 0.0082 mg/L and an average concentration of 0.0092 mg/L.

Figure 21 shows the variation in flow in relation to total and soluble reactive phosphorus concentrations in the Spokane River at Riverside State Park. The flow data represent the median of monthly average flows between1990 and 2014 from the US Geological Survey (USGS), while the phosphorus data are the median of monthly observations from Ecology's 2004 to 2013 monitoring results. These are typical patterns observed since 2004 to 2013. The main sources of phosphorus to the Spokane River at the Riverside monitoring station are point sources such as the City's Riverside Park Water Reclamation Facility (RPWRF), which provide a fairly constant phosphorus load to the river. As flow increases in the spring (March through May), phosphorus concentrations decline significantly likely due to dilution. When the lowest flows occur in late summer (August and September), total phosphorus concentrations increase from their May low (10 ug/L or 0.010 mg/L) to about 25 ug/L (0.025 mg/L) in August.

These seasonal phosphorus patterns changed in recent years (2012-2014) (Figure 22). Over the past few summer periods, river phosphorus concentrations have remained low. Total phosphorus concentrations observed in 2014 at Ecology's Riverside State Park monitoring location during the most critical months for both algal growth and dissolved oxygen concentrations (June through September) ranged between 8.2 µg/L in June and 16 µg/L in August (0.0082 – 0.016 mg/L).

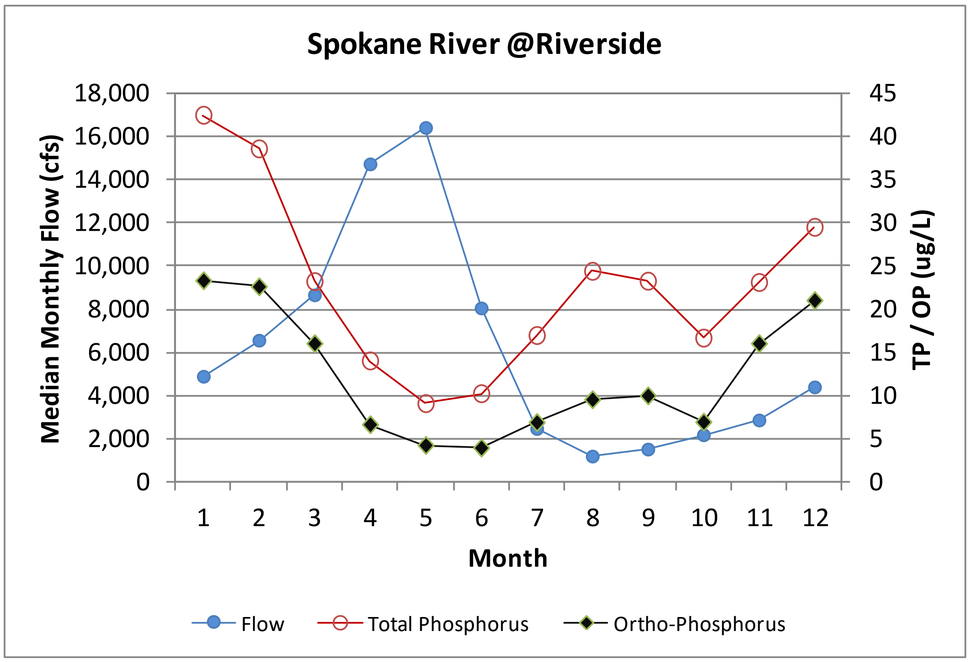

Figure 21. Typical seasonal variation in 1990-2014 flows and 2004-2013 phosphorus concentrations observed at Ecology's Spokane River at Riverside State Park monitoring location.

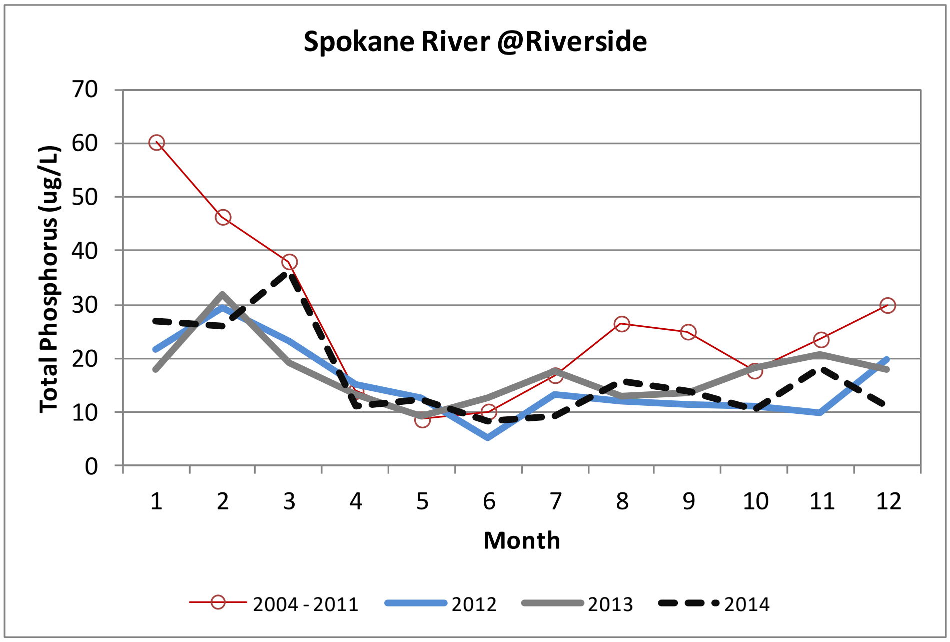

Figure 22. Median 2004-2011 total phosphorus concentrations in relation to 2012 and 2013 concentrations at Ecology's Riverside monitoring location.

Looking at long-term patterns in total phosphorus (Figure 23) and soluble reactive phosphorus (Figure 24) it is apparent that activities implemented to control phosphorus since 2012, particularly at the City of Spokane's Riverside Park Water Reclamation Facility (RPWRF), have acted to reduce total phosphorus concentrations.

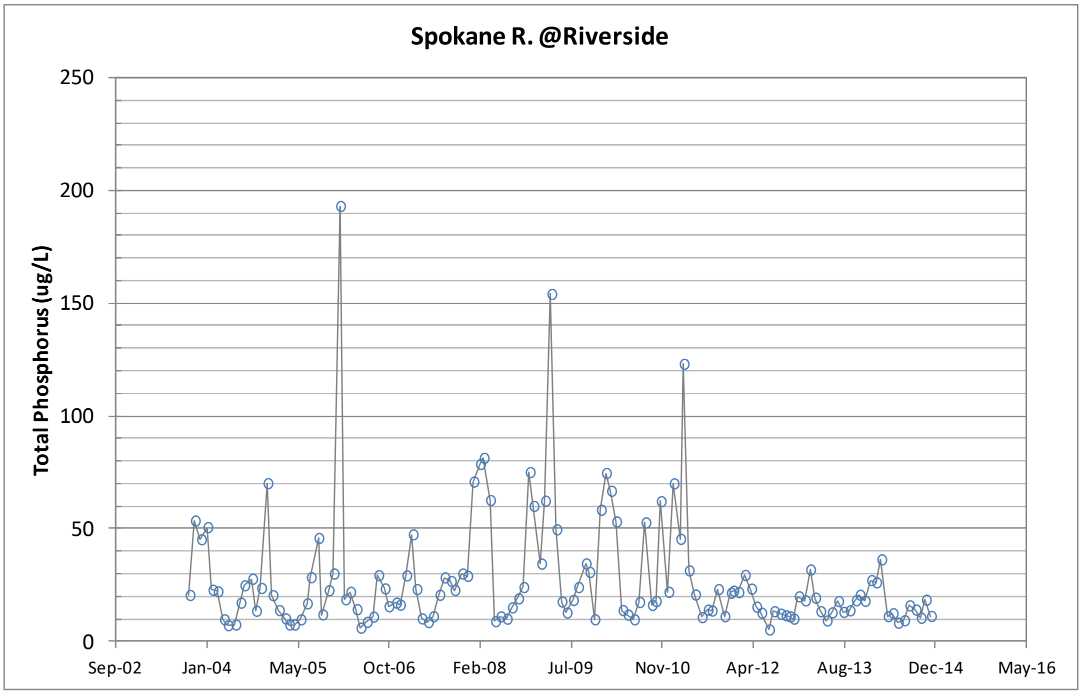

Figure 23. Variation in monthly total phosphorus concentrations at the Riverside monitoring location

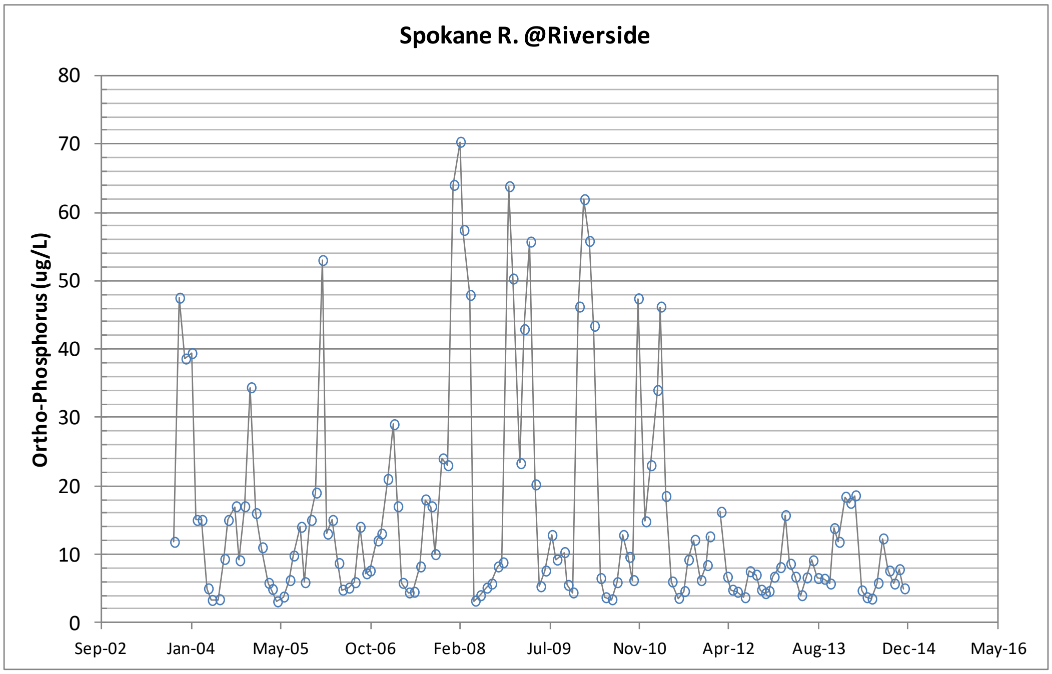

Figure 24. Variation in monthly soluble reactive phosphorus concentrations at the Riverside monitoring location

The last series of figures (Figures 25 and 26) display monthly phosphorus variation since the 1970s to the most recently reported data. For most months, phosphorus concentrations observed over the past three years are at historic low concentrations.

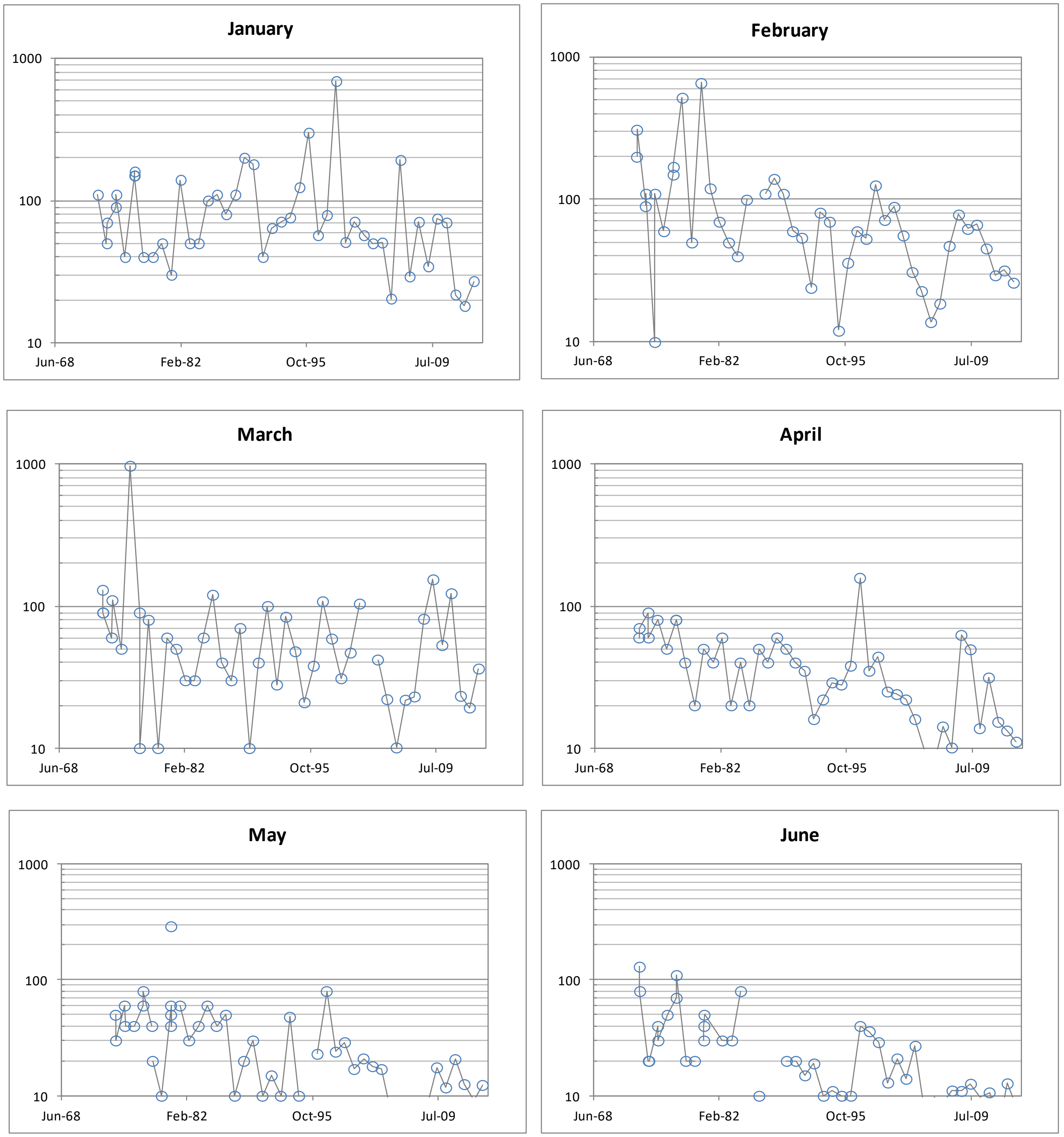

Figure 25. Variation in Spokane River total phosphorus concentrations (µg/L) (vertical axes), January to June, Riverside State Park monitoring location Figure 19.

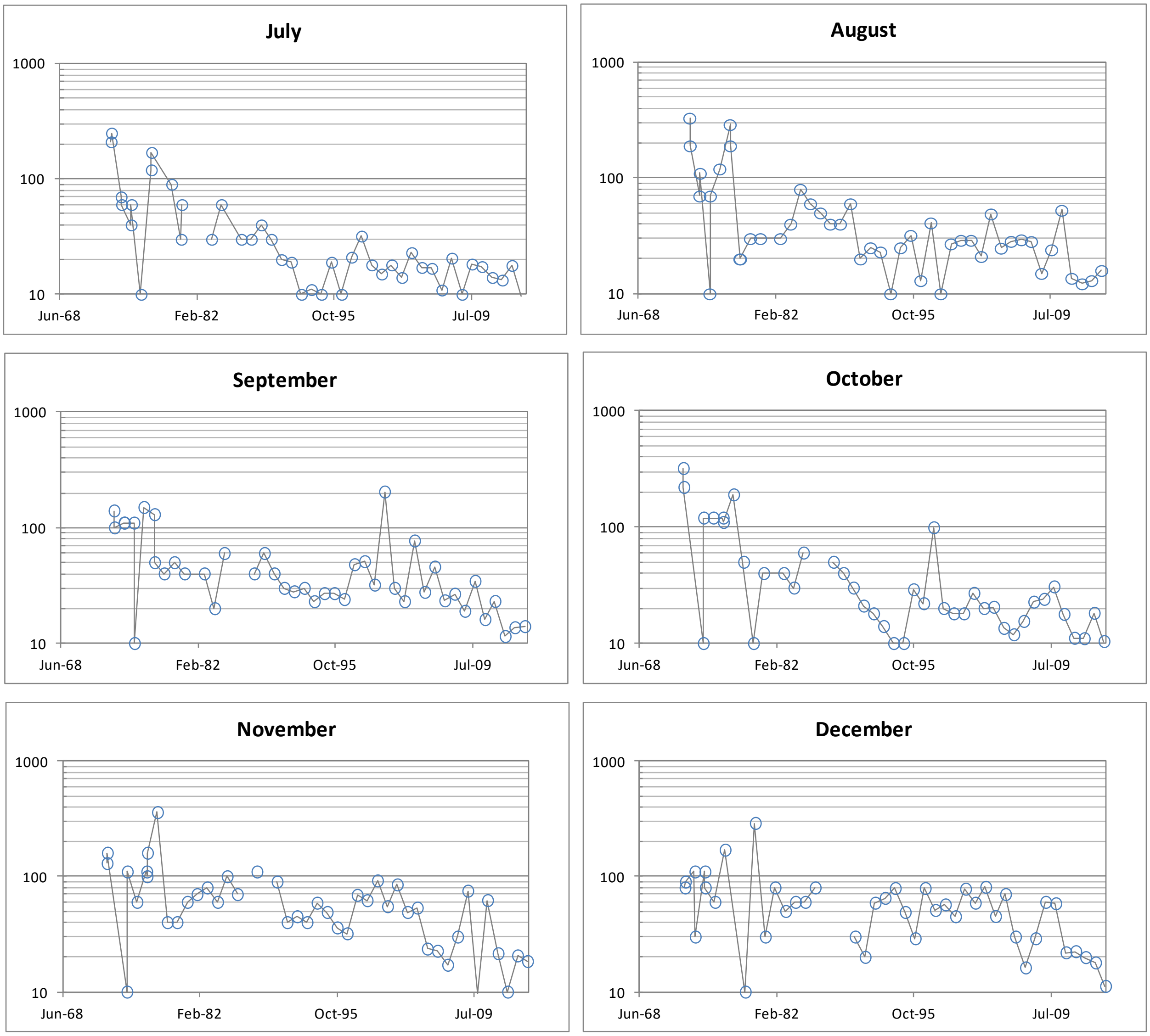

Figure 26. Variation in Spokane River total phosphorus concentrations (µg/L) (vertical axes), July to December, Riverside State Park monitoring

From 1991 to 2011 the effluent discharged to the Spokane River from the City of Spokane's RPWRF was relatively steady at about 37 million gallons per day (MGD). In 2012, the discharge level declined 26 percent to 27 MGD due to diverting flow to the newly on-line Spokane County Regional Water Reclamation Facility or SWRWRF (Figure 27). In addition to diverting flow, the City implemented chemically enhanced primary treatment (CEPT) in June 2011 to reduce phosphorus levels in the effluent. Prior to CEPT, effluent total phosphorus concentrations were 0.490 mg/L. Following implementation, concentrations declined by 29 percent to 0.350 mg/L (Figure 28). Not a huge drop but together with the decrease in discharge volume (from the diversion of influent to the SCRWRF) the RPWRF is putting less phosphorus into the river.

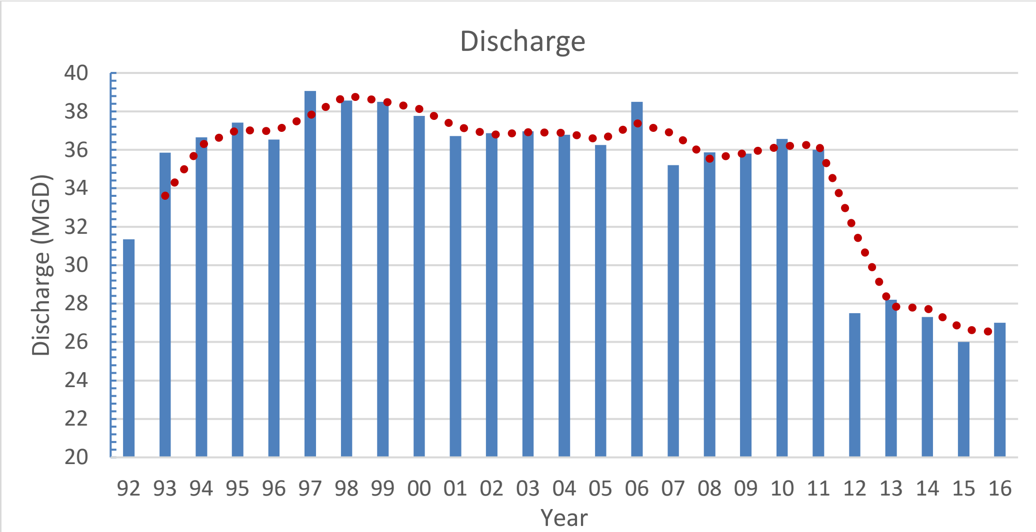

Figure 27. City of Spokane treatment plant July-September effluent discharge in million gallons per day.

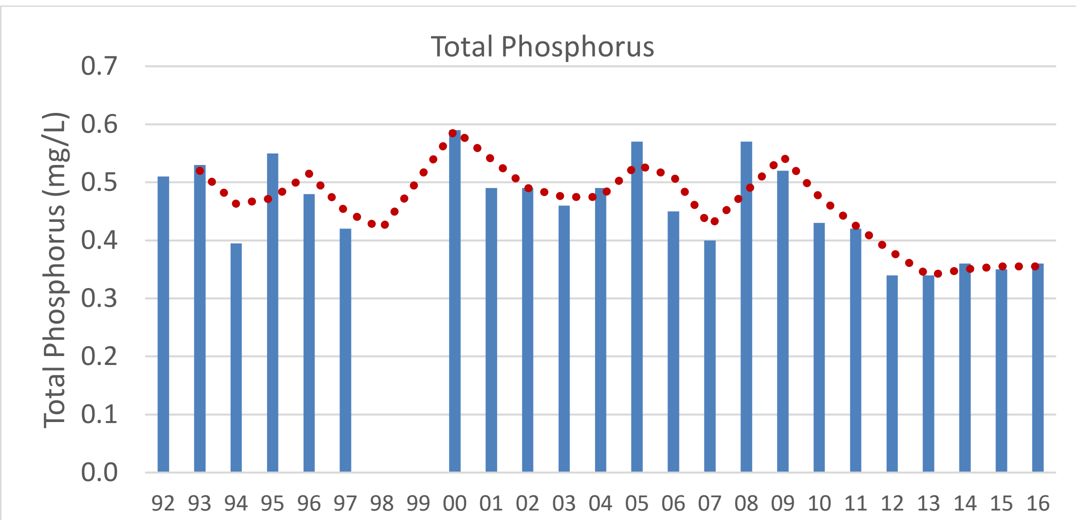

Figure 28. Concentration of Total phosphorus discharged July-September from the City of Spokane treatment plant.

As indicated earlier, SCRWRF is partly responsible for the improving conditions at Riverside State Park. In addition to receiving diverted wastewater from the City of Spokane, the facility has achieved a reduction in total phosphorus effluent concentrations since operations were initiated in 2011. The SCRWRF's total phosphorus levels were initially 0.07 mg/L and are currently about 0.02 mg/L (Figure 29).

In contrast, as mentioned earlier, the City of Spokane's effluent phosphorus is currently around 0.35 mg/L, or 17.5 times greater than the SCRWRF effluent. Effectively, the City reduced its phosphorus load to the Spokane River by 29 percent just by sending some influent that is now in the County's service area to the SCRWRF. At the most optimal treatment methods the City uses, this wastewater diversion amounts to about 27.5 pounds per day (lb/day). (The City currently discharges 79.8 lb/day to the river, July-September). The significant benefit from the SCRWRF is that it reduces this discharge load from 27.5 lb/day to 1.5 lb/day, which is a 94 percent reduction. Together these plants have decreased the wastewater phosphorus load during July through September by about 46 percent since 2012.

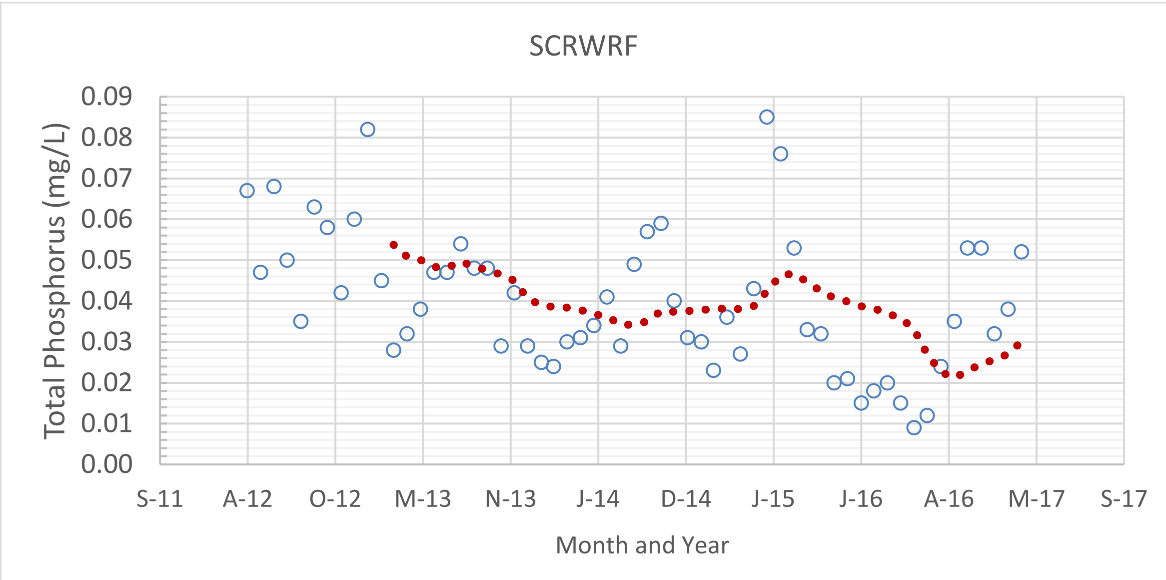

Figure 29. Total phosphorus concentrations in SCRWRF's effluent

The results of the decreased phosphorus load from the City's RPWRF and County's SCRWRF is that typical total phosphorus concentrations during July through September at Ecology's Riverside State Park ambient site are around 15 ug/L (0.015 mg/L) (Figure 30). Prior total phosphorus concentrations were typically around 30 ug/L (0.030 mg/L), which is a 42 percent decrease from prior concentrations.

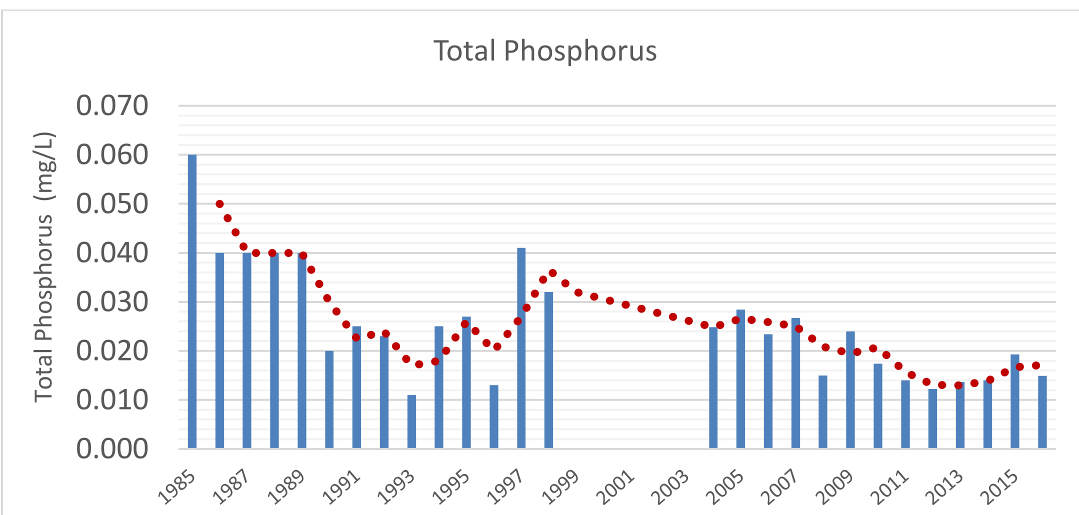

Figure 30. July-September total phosphorus concentrations at Riverside State Park

To evaluate trends in total phosphorus concentrations at Riverside State Park, Figures 31 and 32 show total phosphorus and soluble reactive phosphorus concentrations (blue circles), 1988-2016. A two-month moving average is shown by the red dotted line in these figures. A calculated trend line using a least squares regression (shown in pink) provides a rough guide of the overall annual average trend. Based on the least square line, typical annual average total phosphorus concentrations are currently around 20 ug/L (0.02 mg/L) but typically less than that. (Soluble reactive phosphorus comprises about 45 percent of the total phosphorus concentration at Riverside State Park.)

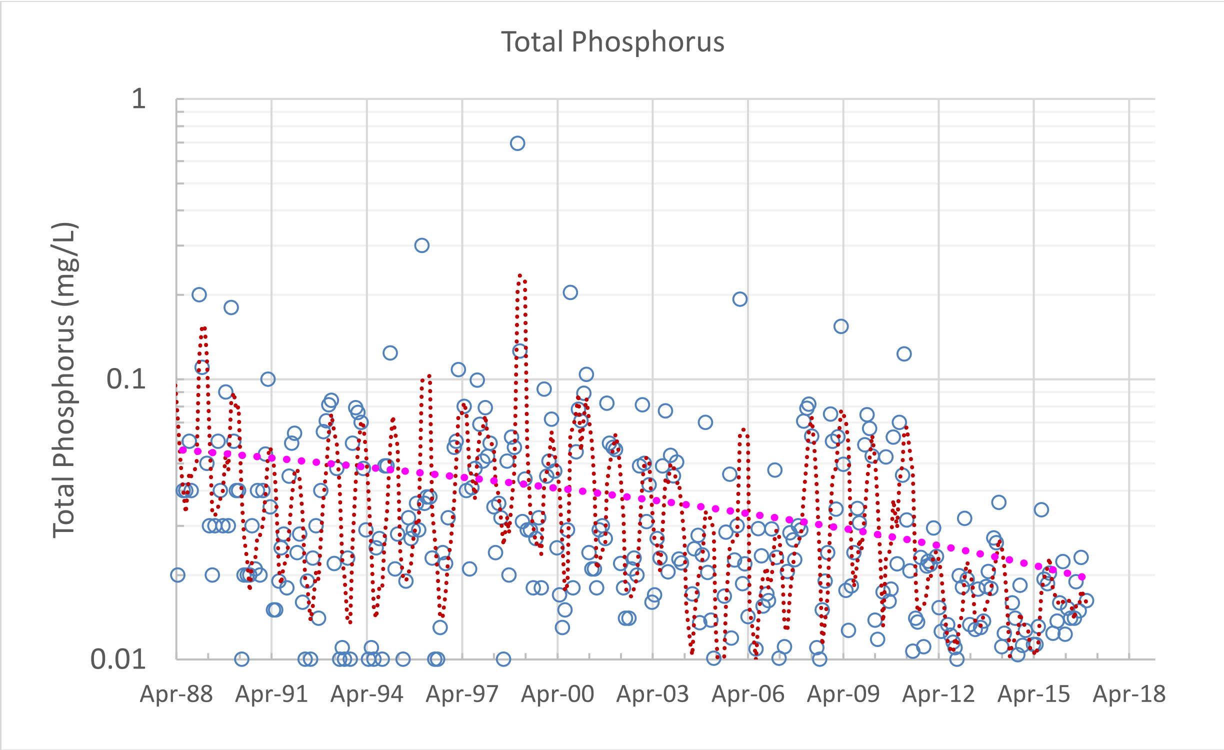

Figure 31. Long term total phosphorus concentrations at Riverside State Park

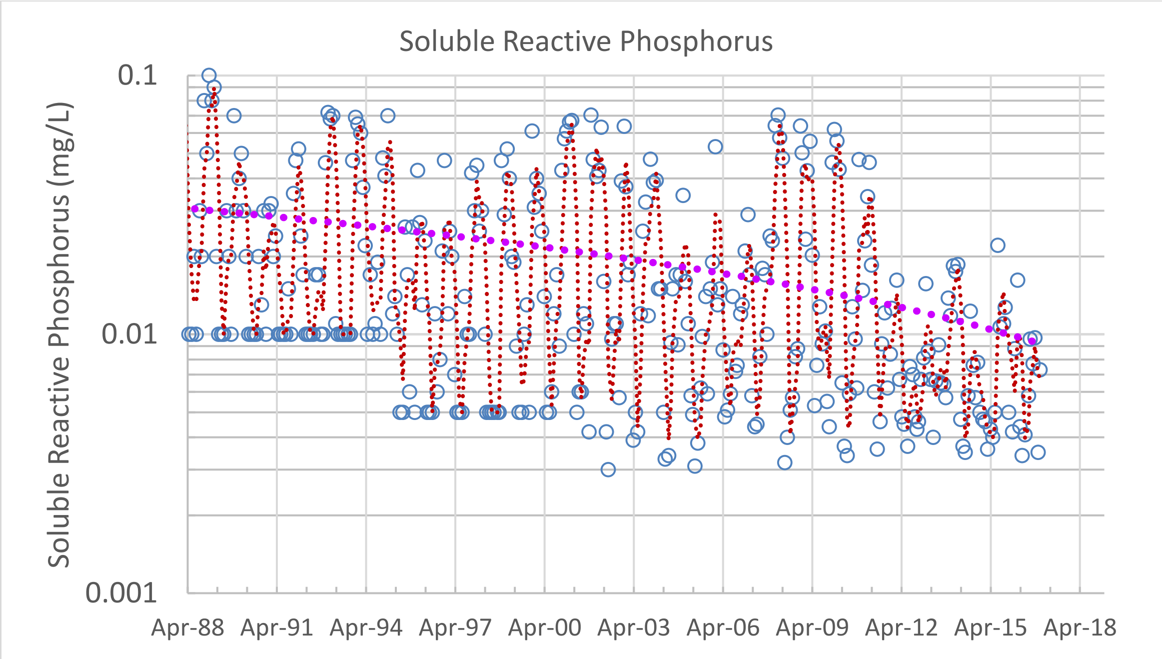

Figure 32. Long term soluble reactive phosphorus concentrations at Riverside State Park

Other results from the RPWRF and SCRWRF are revealed when looking beyond the annual average to the monthly average total phosphorus data at Riverside State Park. Since 2012, total phosphorus concentrations appear to be less variable and have smaller peaks in the November to March timeframe (Figure 33). The April through September concentrations are more stable than during 1988 to 2010.

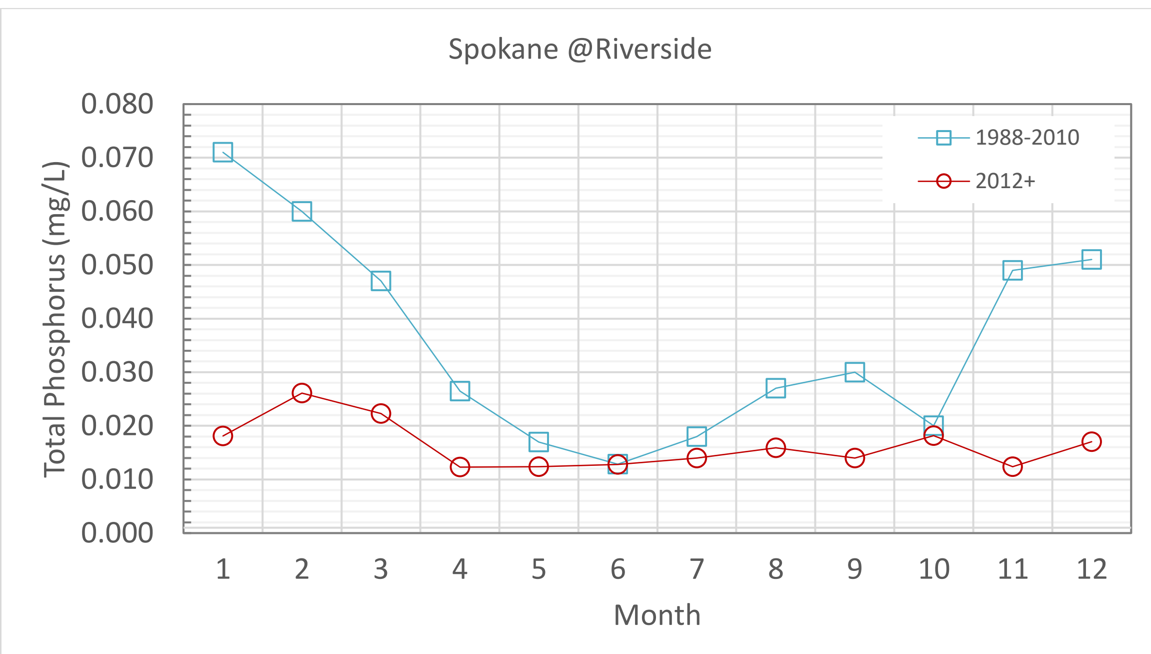

Figure 33. Monthly average total phosphorus concentrations at Riverside State Park

Tributaries

Hangman Creek
The TMDL assigned varying seasonal allocations for Hangman Creek, which are March-May, June, and July-October. The long-term data indicate that the March to May timeframe is when phosphorus levels are highest at the mouth of Hangman Creek (Figure 34 and 35). Hangman Creek concentration data indicate high turbidity during February, April, and December 2012, as well as February, March, and April 2013. Fecal coliform bacteria was extremely high (estimated 1500 cfu/100 mL) compared to the water quality criteria of 100 cfu/100 mL during the December 2012 sampling event. Nitrates were also elevated in February and December 2012 and January through March 2013. The pH levels regularly exceeded state water quality criteria, and exceeded nine pH units in May of 2013. Overall, the pattern in results from 2010-2016 suggests generally decreasing phosphorus concentrations (Figure 35). (Note that the March through May season was extended to a February through May season in Figure 35.)

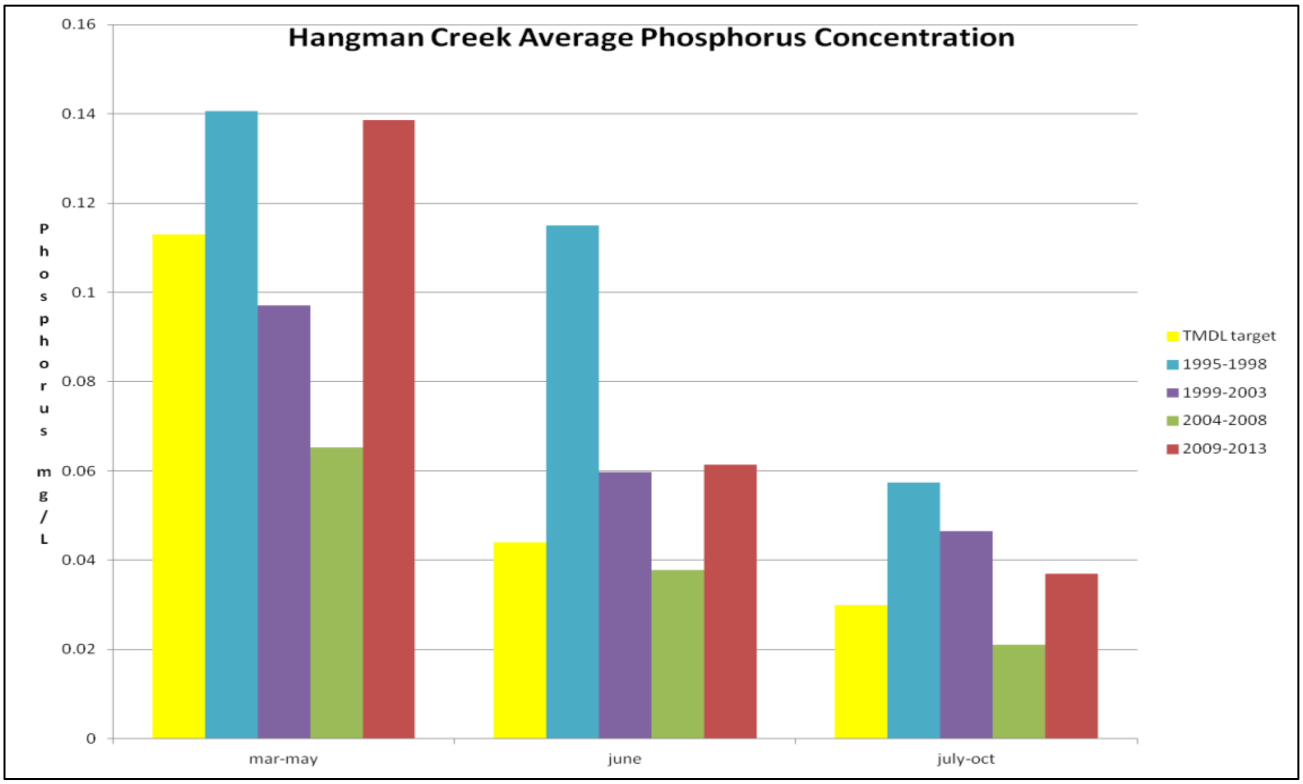

Figure 34. Hangman Creek historic (1995-2013) average phosphorus concentrations

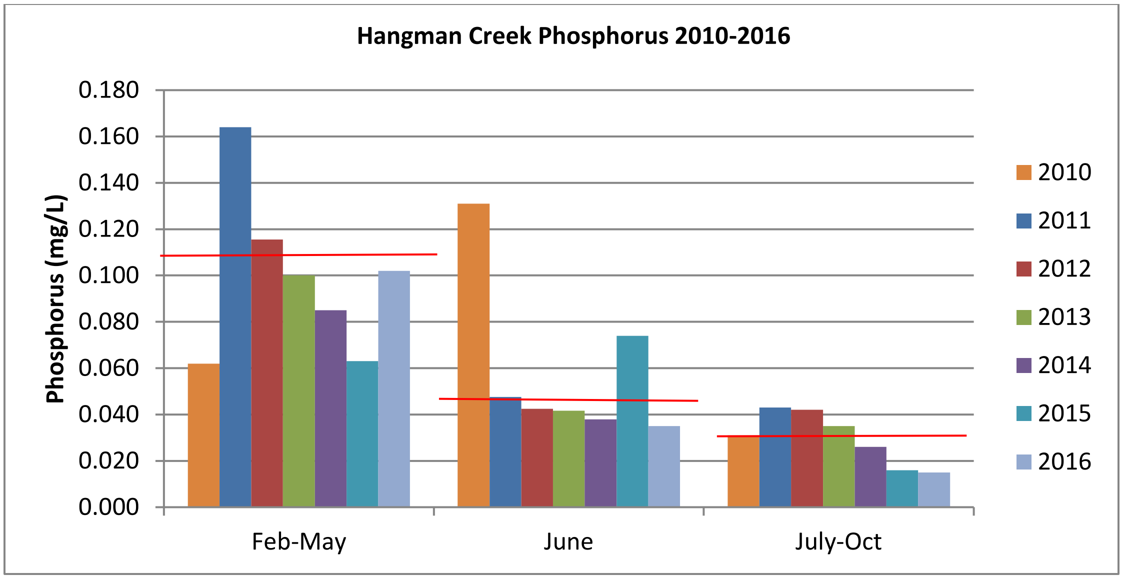

Figure 35. Hangman Creek current phosphorus concentrations since 2010.

2015-2016

Figure 35 illustrates the seasonal phosphorus concentrations in Hangman Creek from 2010 through 2016. In the figure, the TMDL allocations for concentration are indicated by the red lines through each season. Except for June of 2015, the concentration allocated in the TMDL appears have been met since 2014. Ecology staff captured the June 2015 exceedance because their scheduled monthly sampling happened to occur right after a major storm event. This storm event may suggest that drier weather patterns contributed to the lower phosphorus concentrations.

Figures 36 through 38 illustrate long-term seasonal (Feb-May, June, and July-Oct) phosphorus concentrations and average seasonal flows for 1995-2016. They show the correlation between increased flow and increased phosphorus concentrations. Figure 39 indicates the February through May seasonal peak flow against the average flow. More frequent monitoring than once per month is required to capture the variability during the data collection phase of the 10-Year Assessment, particularly when sampling February through May.

One factor which may impact the water quality of Hangman Creek, and particularly that of a few of its tributaries was that a devastating wildfire occurred in late summer 2016. A majority of the Rock Creek basin burned, including riparian vegetation and livestock exclusion fencing. The water quality effects of this fire have yet to be determined.

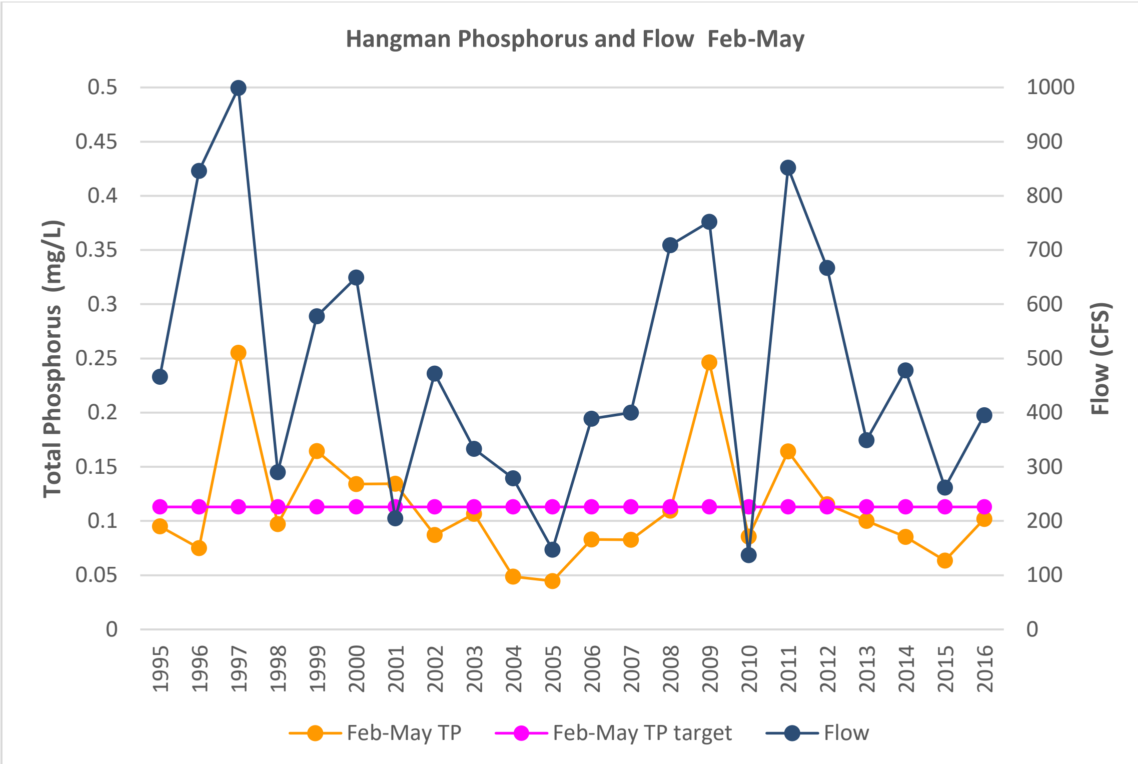

Figure 36. Hangman Creek February-May total phosphorus (left axis) and flow (right axis).

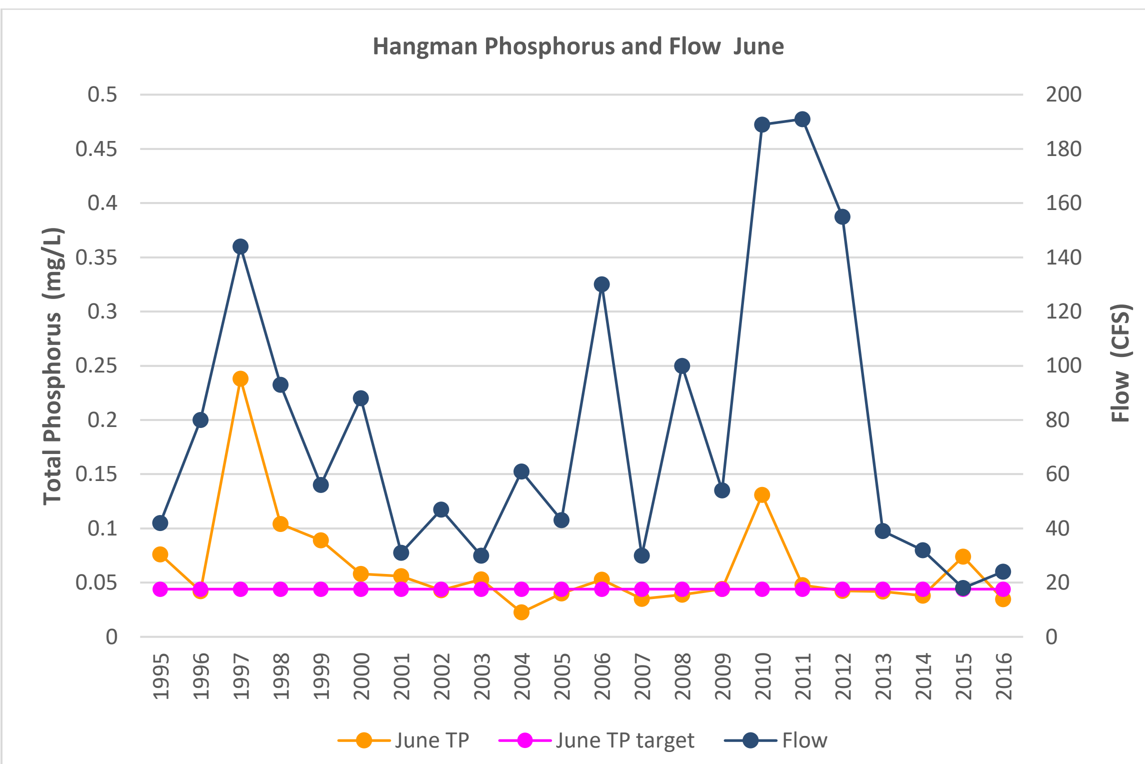

Figure 37. Hangman Creek June total phosphorus and flow

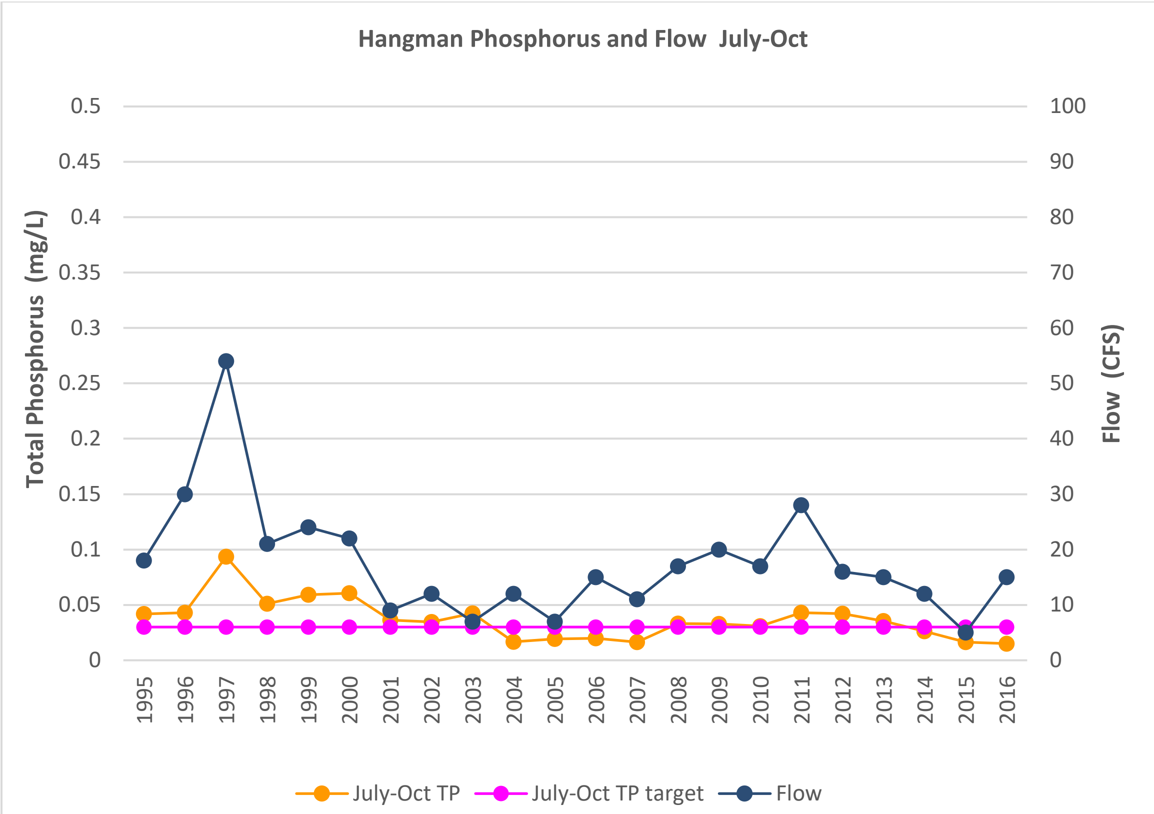

Figure 38. Hangman Creek July-October total phosphorus and flow

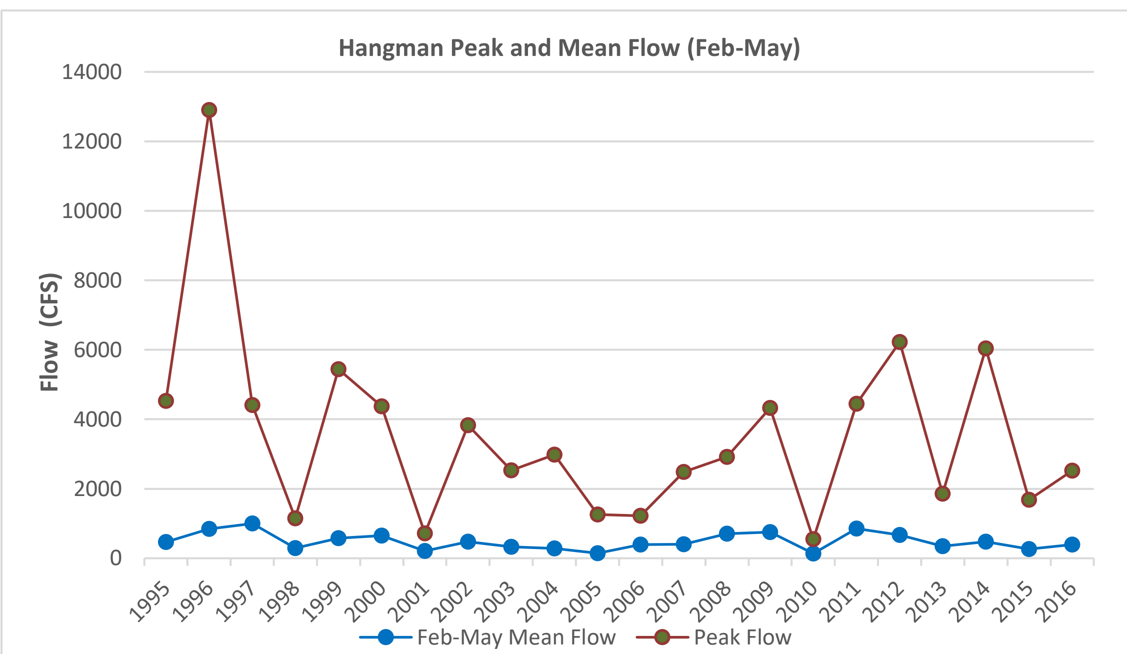

Figure 39. Hangman Creek February-May peak and average flow

Impact of Hangman Creek Discharge on Lower Spokane Water Quality

Hangman Creek's highly turbid discharge to the lower Spokane River in spring and its potential to adversely impact both the river and Lake Spokane is an on-going concern. To examine this further, Ecology staff analyzed routine water quality data for both ambient monitoring sites on Hangman Creek at the mouth, and the Spokane River at Riverside State Park. Monthly monitoring data collected since 1988 at the two locations identified times when both Hangman Creek and the downstream Spokane River monitoring location had indicators of degraded water quality (i.e. elevated suspended solids, nutrient concentrations, bacteria etc.) We noted times when Hangman Creek had diminished water quality but the Spokane River did not.

Data show that in order for a particular Hangman Creek-based storm event to have a noticeable effect on Spokane River water quality, the tributary flow on average needed to comprise about 10 percent or more of the total downstream Spokane River flow. Over the 28-year record of monthly observations considered (1988 to 2016), 23 storm events were identified when Hangman Creek's flow approached and or exceeded 10 percent of total Spokane River flow. When these events are considered together, the median total phosphorus concentrations in Hangman Creek were 282 ug/L with a range of 99 to 1740 ug/L. In comparison, for the same events, total phosphorus concentrations in the Spokane River had a median of 80 ug/L and a range of 32-693 ug/L.

A closer examination of the daily rather than monthly data provided insight as to how often these storm events occurred and when. Based on daily average flows observed at the United States Geological Survey (USGS) stations on the Spokane River (above Hangman - 12422500) and the mouth of Hangman Creek (12425000) since 1988, there have been 124 events when Hangman Creek daily average flows represented at least 8 percent of the total Spokane River flow. Of these 124 events, 93 percent occurred between December and March; the majority occurring between January and March. There are almost no instances when Hangman Creek flows were greater than 10 percent during the critical summer months. The reason for this is the differing times that peak flows occur in Hangman Creek in comparison to the Spokane River.

Figure 40 uses 2008 data to show the typical annual pattern in the timing of the flows of the Spokane River in relation to Hangman Creek and the Little Spokane River. The daily average flows in Hangman Creek had a number of runoff peaks occurring between February and April. Despite a few peaks in April, Hangman Creek's daily average flows were declining while flows in the Spokane River were increasing.

Flows in the Spokane River tend to peak in May which are associated with the transit of snow-melt occurring within the greater Lake Coeur d'Alene drainage area and entering the Spokane River. This runoff tends to have low total phosphorus concentrations around 0.009 mg/L (9 ug/L) at the Washington-Idaho Stateline and typically increases to 0.013 mg/L (13 ug/L) by the Riverside State Park ambient monitoring station. This annual pulse of relatively lower phosphorus water has the effect of flushing Lake Spokane prior to the summer algae growing period and, in the process, due to timing and its sheer volume, helps minimize potential impacts from Hangman Creek on Lake Spokane. However, it is important to note this flow pulse does not entirely remove the suspended sediment, adsorbed phosphorus and organic matter introduced to the reservoir from Hangman Creek.

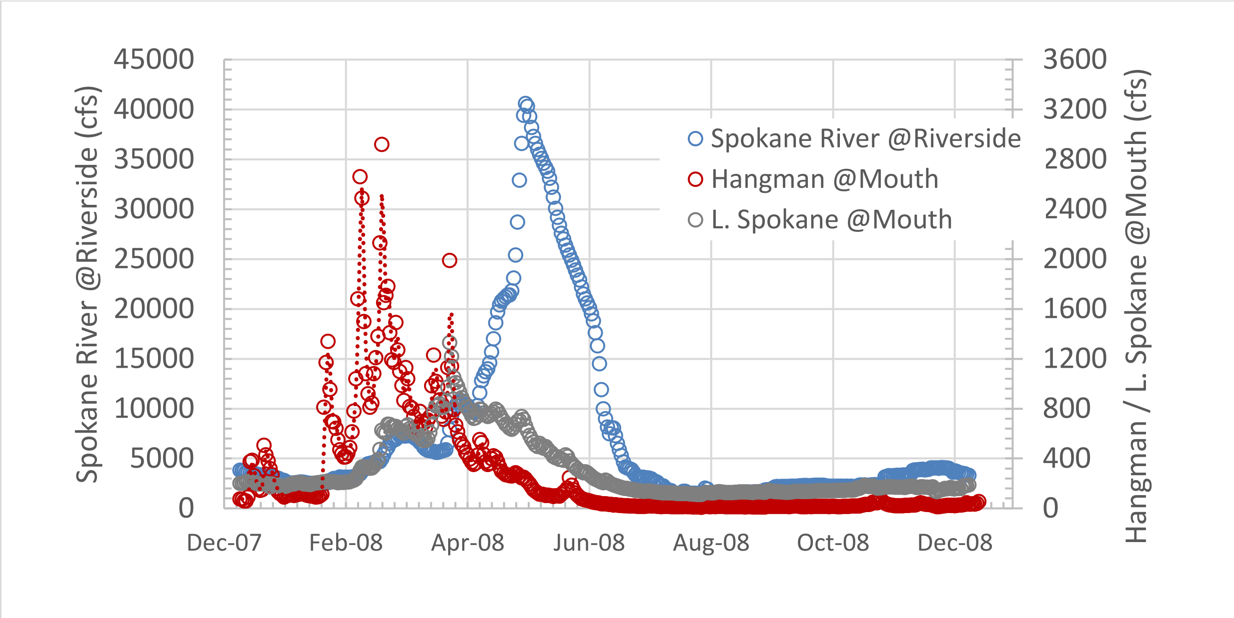

Figure 40. Typical annual pattern of daily average flows for Hangman Creek, the Little Spokane River (both right scale), and Spokane River (left scale) as illustrated by 2008 data

Phosphorus levels in Hangman remain elevated throughout the year from a peak of around 130 ug/L in March, coincident with the maximum flows, declining to around 25 ug/L during the summer months. Fortunately, flows are quite low during the summer and are, therefore, heavily diluted once entering the Spokane River, reducing their impact on the reservoir.

In the Little Spokane River, peak flows typically occur in April. As discussed earlier, peak flows in the Spokane River normally occur in May due in part to a considerably larger watershed. This timing is important since both the Little Spokane River and Hangman Creek usually have elevated phosphorus and nitrogen concentrations which tend to increase with the magnitude of flow.

Little Spokane River

Similar to Hangman Creek, the TMDL established allocations depending on the season and are divided into March-May, June, and July-October. The long-term phosphorus data indicates that the March to May timeframe is when phosphorus levels are highest at the mouth of the Little Spokane River (Figures 41 and 42). The data suggest that phosphorus concentrations are higher during high flow years. The patterns of inter-annual variation are similar to Hangman Creek, suggesting generally decreasing phosphorus concentrations.

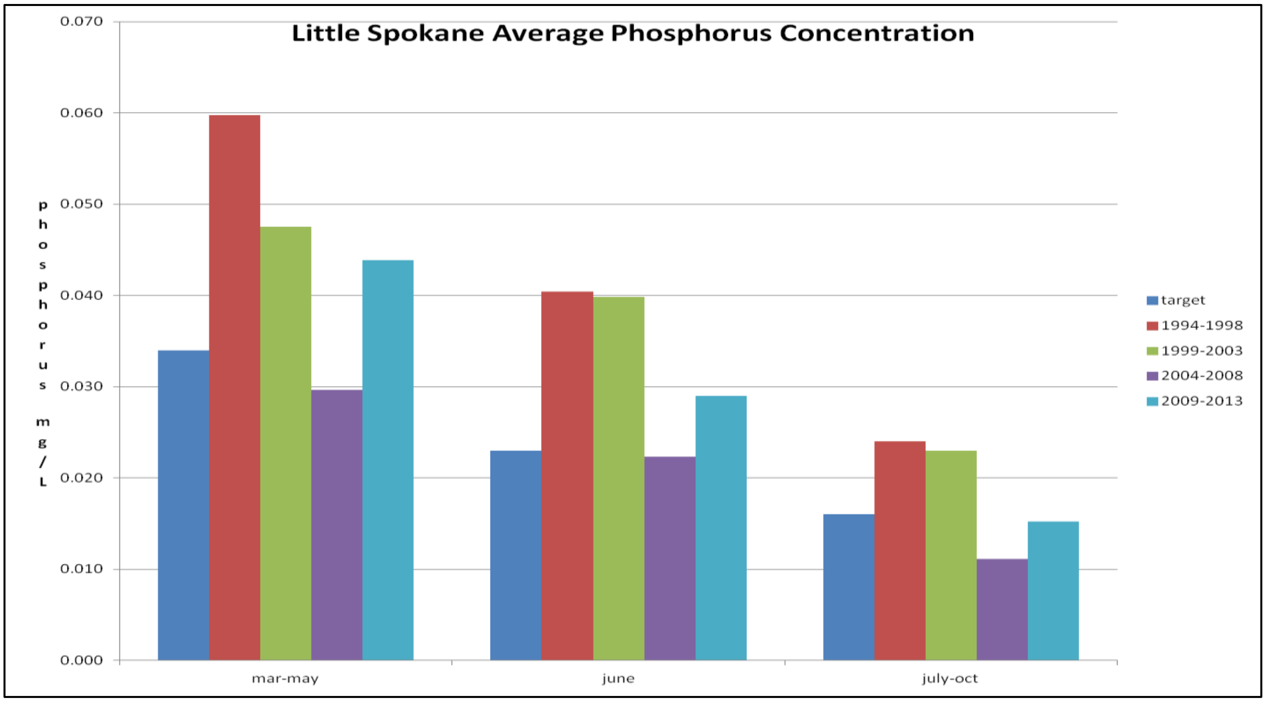

Figure 41. Little Spokane River historic (1994-2013) average phosphorus concentrations

2015-2016

Figure 42 illustrates the 2010-2016 seasonal average phosphorus concentrations for the Little Spokane River, again with a red line indicating the TMDL target concentrations. As with Hangman Creek, the June 2015 sampling caught the effects of a major storm. The impact was much more dramatic in the Little Spokane watershed than in the neighboring Spokane or Hangman watersheds, likely due to increased precipitation resulting from the watershed being in line with the storm's path. Except for February-May 2016 and June 2015, the TMDL allocations have been met the past three years. Although Figures 43-45 are missing the June 2015 storm event, they illustrate the correlation between flow and phosphorus concentration. Figure 46 shows the February through May seasonal peak and average flows. The figure shows that the magnitude of difference between peak and mean flow in Little Spokane watershed is much less than in the Hangman watershed. This is likely a result of the large amount of steady groundwater inflow (about 250 cfs) from the Spokane Valley/Rathdrum Prairie Aquifer and a different geologic setting that has a more prolonged spring melt period than the Hangman watershed.

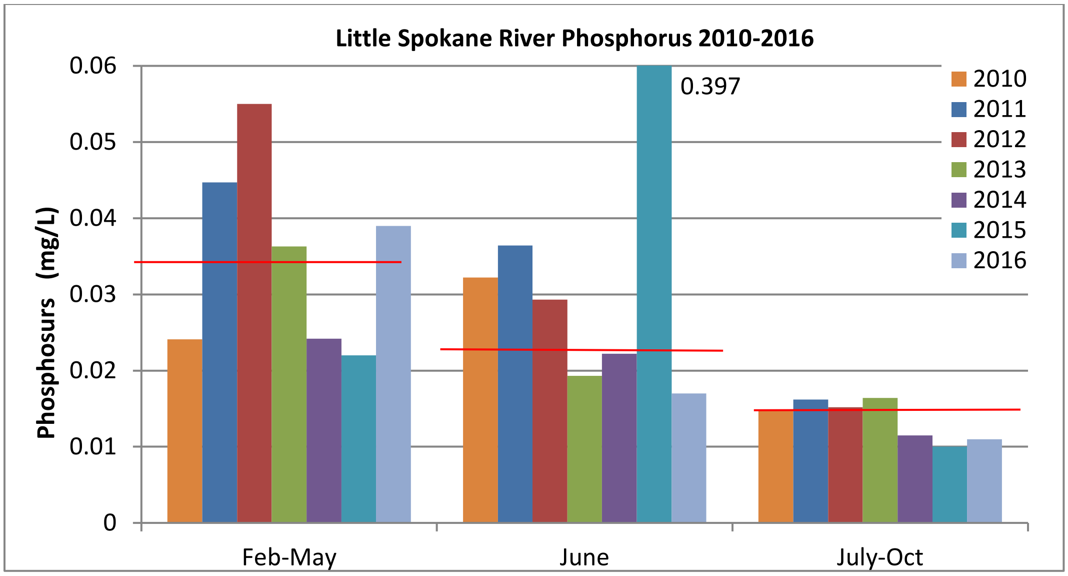

Figure 42. Little Spokane River current phosphorus concentrations

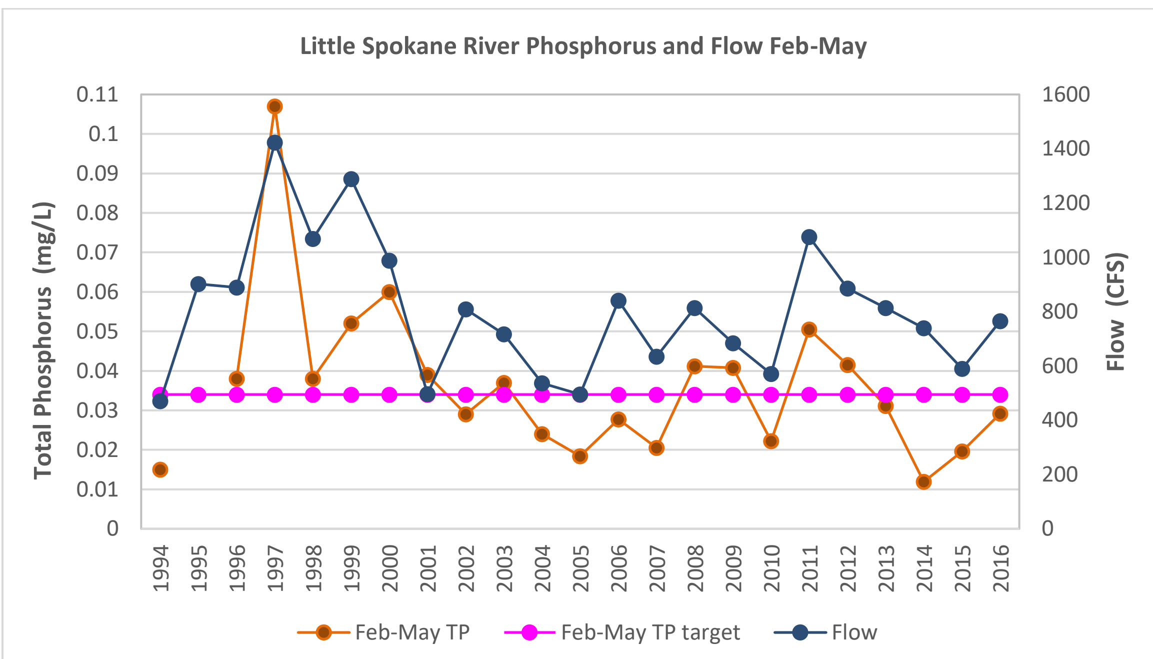

Figure 43. Little Spokane River February-May total phosphorus and flow

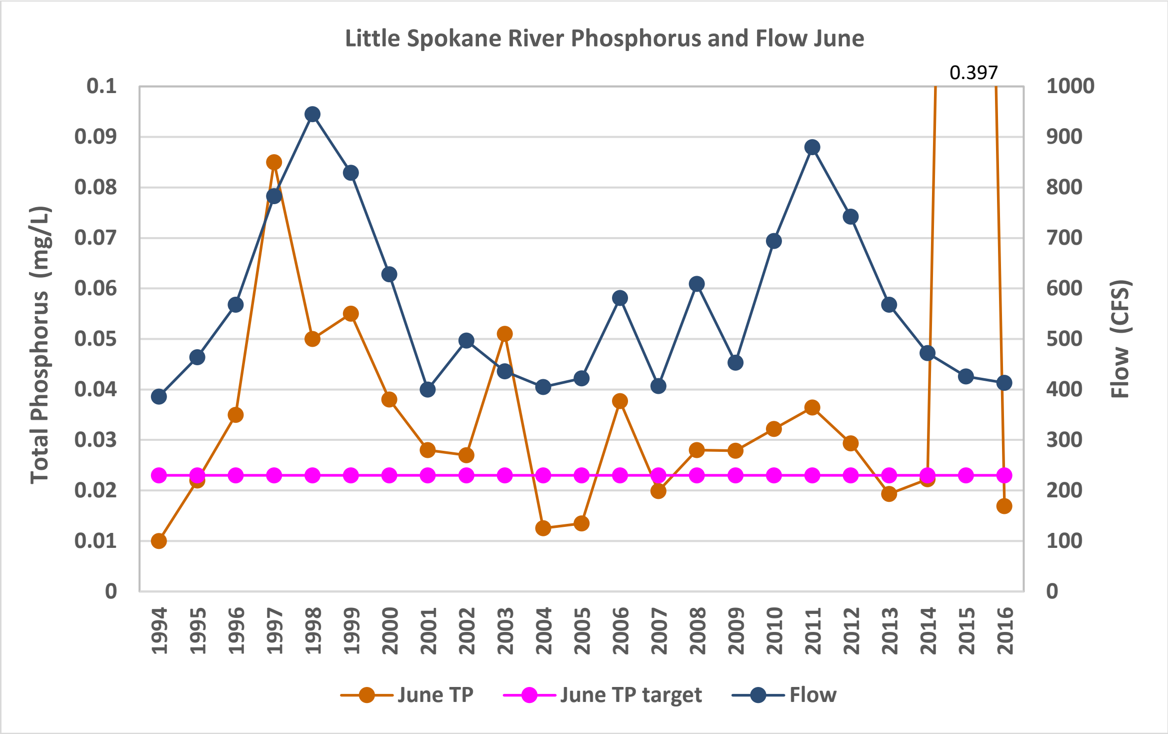

Figure 44. Little Spokane River June total phosphorus and flow

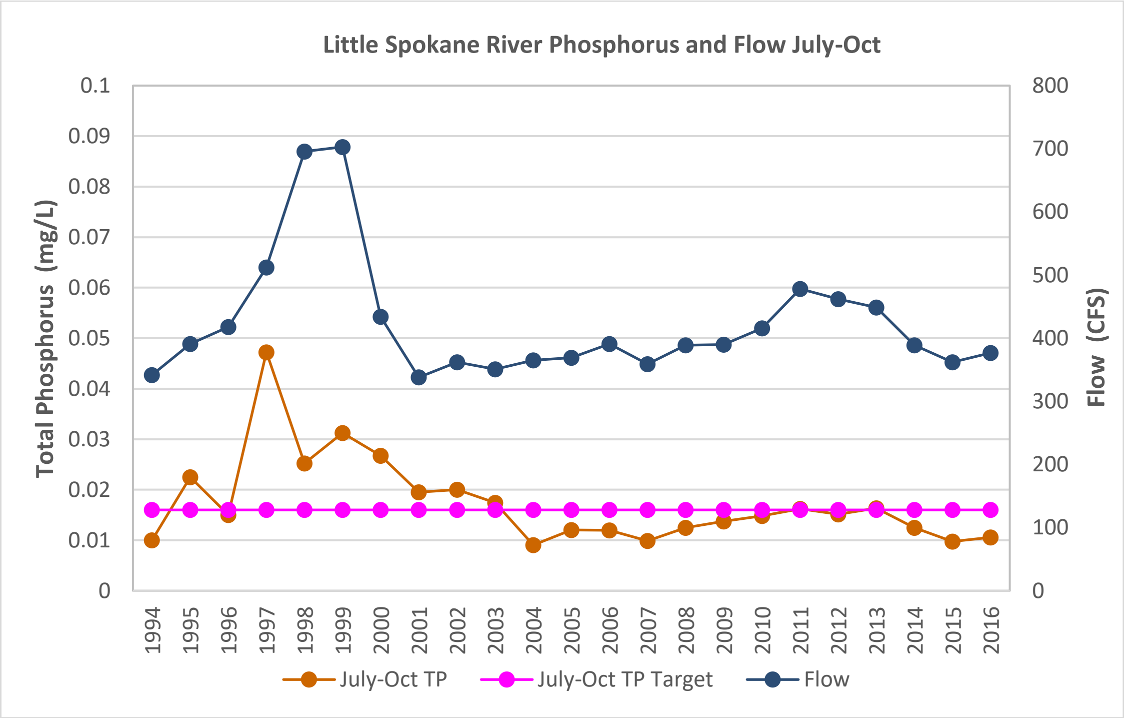

Figure 45. Little Spokane River July-October total phosphorus and flow

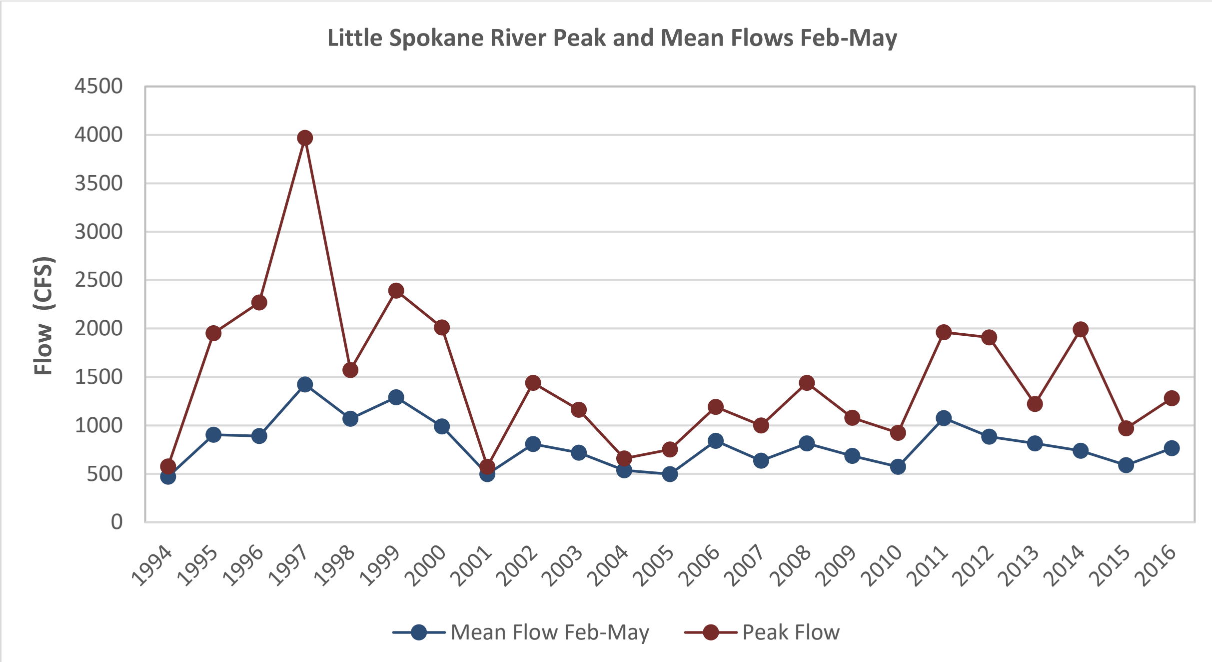

Figure 46. Little Spokane River February-May peak and average flow

Coulee & Deep Creeks

Ecology's new sampling locations on Deep and Coulee Creeks will provide data to help update this 'boundary condition' in the TMDL model. When the Spokane River model was constructed, Ecology made an assumption that the water from Deep and Coulee Creeks was similar to that from Hangman Creek. Preliminary data from sampling the Deep and Coulee Creek basin stations indicate this assumption was incorrect. The surface water concentrations appear to be lower than Hangman Creek in the spring, and higher during other times of the year. However, these surface water flows dry up several miles upstream from the confluence with the Spokane River, so it is unknown what nutrient concentrations enter the system.

2015-2016

Ecology's Environmental Assessment Program (EAP) collected samples from Deep Creek about five miles from the confluence with the Spokane River since the location had perennial flow. Samples were collected from October 2013 to 2014 and again in April 2015 (see data in Appendix A). Soluble reactive phosphorus at this location ranged from 0.007 to 0.060 mg/L, and averaged 0.021 mg/L. Soluble reactive phosphorus concentrations during May through August 2014 were less than 0.01 mg/L. Total phosphorus ranged from 0.056 to 0.011 mg/L, and averaged 0.023 mg/L. All of the total phosphorus samples exceeded 0.010 mg/L. However, data from three out of the 14 samples are suspect since the total phosphorus concentrations were less than the soluble reactive phosphorus concentrations.

Coulee Creek flows into Deep Creek about one mile from the confluence with the Spokane River. The site sampled by EAP is located about seven miles upstream from the confluence with Deep Creek because it had perennial flow. EAP visited the site 17 times between October 2013 and June 2015, but only 12 samples were collected due to ice or little to no flow (Appendix A). Soluble reactive phosphorus ranged from 0.085 to 0.021 mg/L and averaged 0.053 mg/L. Total phosphorus concentrations ranged from 0.088 to 0.032 mg/L, with an average of 0.057 mg/L. Coulee Creek had higher phosphorus concentrations than Deep Creek during the sample period. As with Deep Creek, three samples are suspect since the soluble reactive phosphorus concentrations came back higher than the total phosphorus concentrations.

As described earlier, EAP began a groundwater sampling effort in 2016 at the mouth of Deep Creek. Preliminary groundwater information is presented below. However, because Deep Creek was flowing during some sample events, EAP took three surface water grab samples. Total phosphorus in these samples ranged from 0.083 to 0.062 mg/L from September 2016 to January 2017 (Appendix A). It is unknown if the higher phosphorus concentrations observed during this period typically occur at the mouth of Deep Creek.

Spokane River longitudinal data assessment

In August and September 2000, Ecology conducted sampling along the Spokane River from the Washington-Idaho state line to downstream of Nine Mile Dam to determine phosphorus concentration in the river as part of the Dissolved Oxygen TMDL investigation (Cusimano, 2004). More recent data, collected at several of the same locations, in August and September 2013 through 2016 indicate there has been a decrease in TP concentrations (Figure 47). The data used in Figure 47 are presented in Table 10, which provides the measured values, averages, and percent reductions since 2000. All four sites shown in Table 10 had at least a 40 percent reduction in the average August and September total phosphorus concentration between 2000 and 2013-2014.

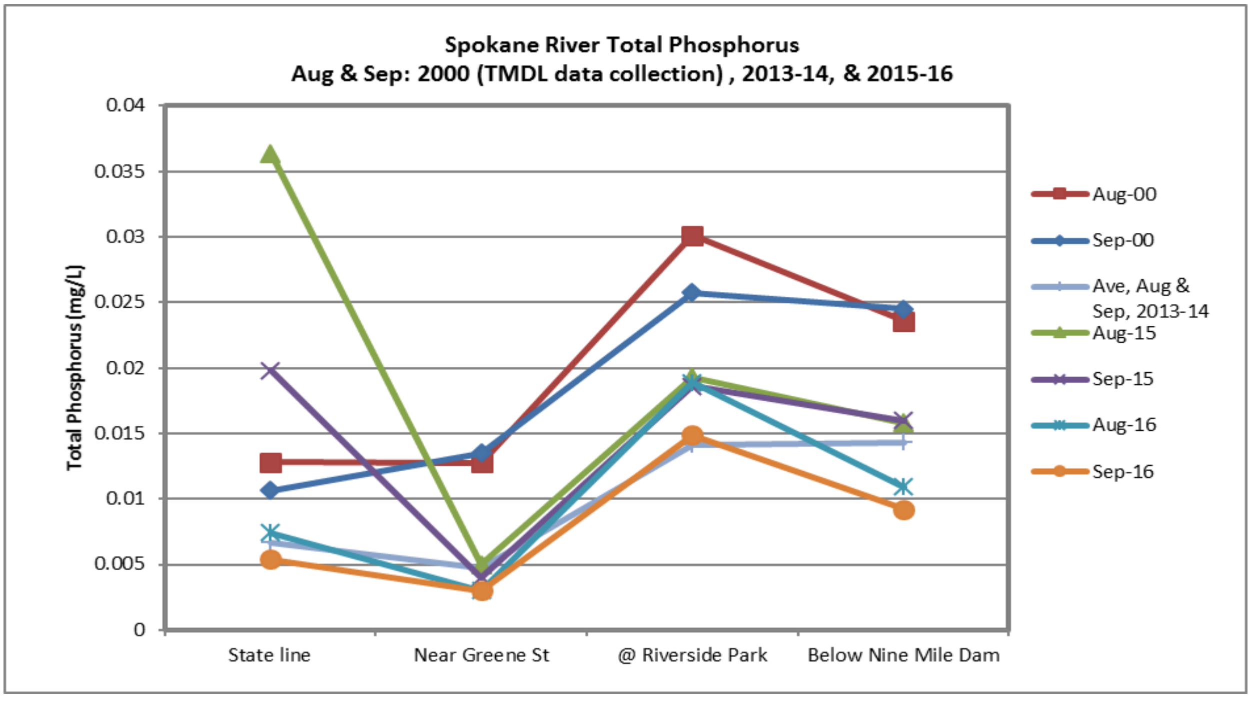

Figure 47. Spokane River total phosphorus concentrations from August and September data collected in 2000 and 2013-16.

Table 10. Spokane River total phosphorus concentrations (mg/L)*

Sample Site	Stateline	Greene Street	@ Riverside State Park	Below Nine Mile Dam
Aug 2000	0.013	0.013	0.030	0.024
Sep 2000	0.011	0.014	0.026	0.025
Average (2000)	0.012	0.013	0.028	0.024
Aug 2013	0.007	0.004	0.013	No sample
Sep 2013	0.006	0.004	0.014	0.014
Aug 2014	0.007	0.005	0.016	0.015
Sep 2014	0.007	0.006	0.014	0.014
Average (2013-14)	0.007	0.005	0.014	0.014
Aug 2015	0.0364	0.005	0.0193	0.0158
Sep 2015	0.0198	0.004	0.0186	0.016
Aug 2016	0.0074	0.003	0.0189	0.0109
Sep 2016	0.0054	0.003	0.0149	0.0092
Average (2015-16)	0.01725	.00375	0.0179	0.0129
% change (of average), 2000 to 2013-14	-43%	-64%	-49%	-40%
% change (of average), 2000 to 2015-16	43%	-71%	-36%	-46%
% change (of average), 2013-14 to 2015-16	157%	-21%	27%	-9%

* All data were collected by Ecology, except 2013-16 data at Greene Street which were collected by Spokane County. Samples collected in 2000 are averages of two grab samples per day collected over two consecutive days.

Comparing 2013-2014 with 2015-2016 in Table 10 indicates increases in phosphorus at some locations and decreases at others. Of note, relatively high phosphorus concentrations measured at the Washington-Idaho state line in 2015 were not seen at the Greene Street site downstream. The higher total phosphorus concentrations observed in August and September 2015 are likely the result of the Post Falls wastewater treatment plant having occurrences of effluent phosphorus above interim permit limits.

Figures 48 through 51 are the monthly median loading rates observed each month during 2012 to 2016. Loads are presented in pounds per day (lb/d). The loading rates are characteristic of each month and are not monthly totals. A log-scale is used to show the differences at the lower scales.

For comparative purposes, Figure 49 and 51 present the loads normalized by drainage area, (somewhat of a 'yield'). In these figures, the load is divided by the drainage area so that the tributaries were on an equal footing to the Spokane River. By normalizing drainage area we can more easily detect if a particular monitoring location has a disproportionately higher sediment or total phosphorus load per area per time. Because the load is the multiplication of flow and concentration, if a comparison was made just based on non-normalized loads then the Spokane would far exceed the tributaries due to its higher flows even though it may have very low concentrations.

Figures 48 and 49 show that Hangman Creek carries a large sediment load during peak runoff (February-March) but its magnitude declines rapidly with declining flows. In comparison (and surprisingly), the Little Spokane River typically carries an overall higher sediment load due to its more sustained flows. The flow is sustained by groundwater from the aquifer entering the Little Spokane River near the mouth. In the Little Spokane River, total suspended solids levels appear to be related to flow magnitude.

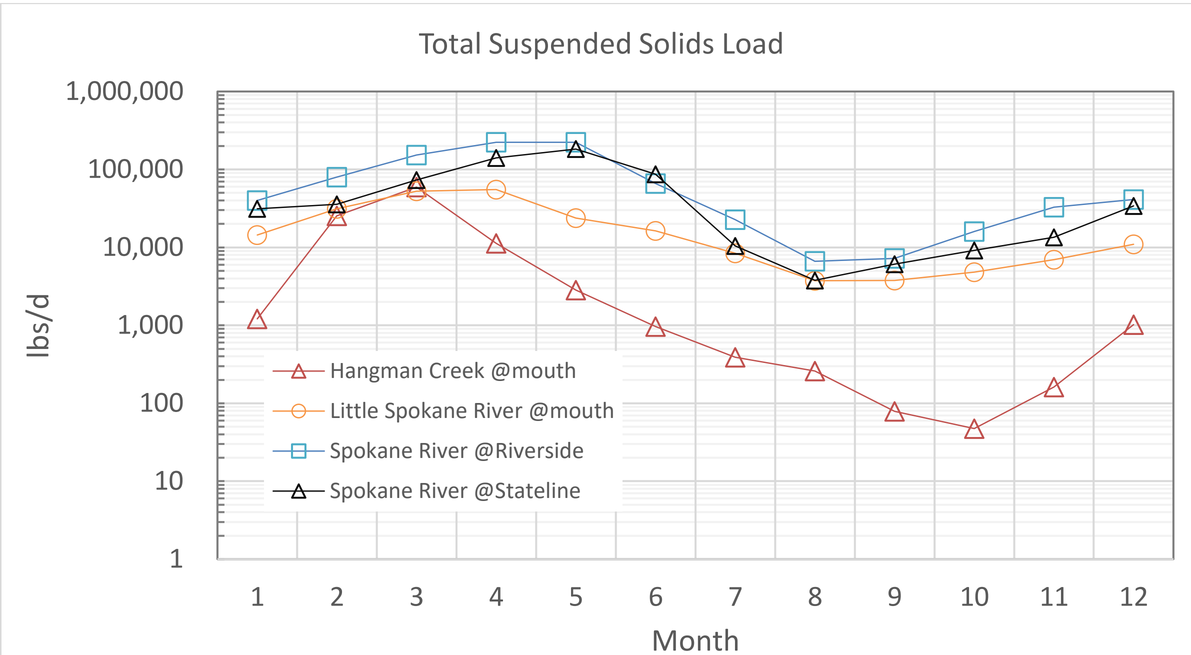

Figure 48. 2012-2016 median monthly total suspended solids loads in the Spokane River and Tributaries

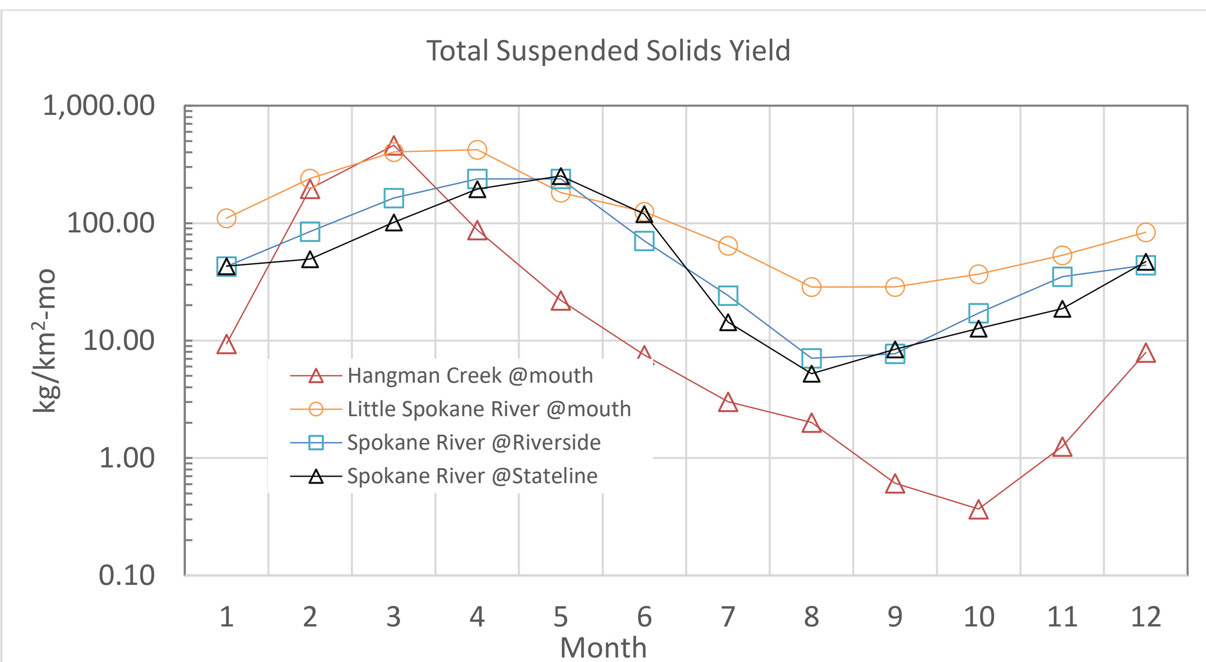

Figure 49. 2012-2016 median monthly total suspended solids yields per watershed

Median monthly total phosphorus loading for 2012 through 2016 is shown in Figures 50 and 51. Peak total phosphorus yields occur in the Hangman Creek watershed during February and March. This is also the peak annual runoff period and the total phosphorus observed is likely adsorbed to sediment particles. This indicates that surface runoff and land-based sources are the principal pathways that nonpoint generated phosphorus enters the Spokane River and tributaries.

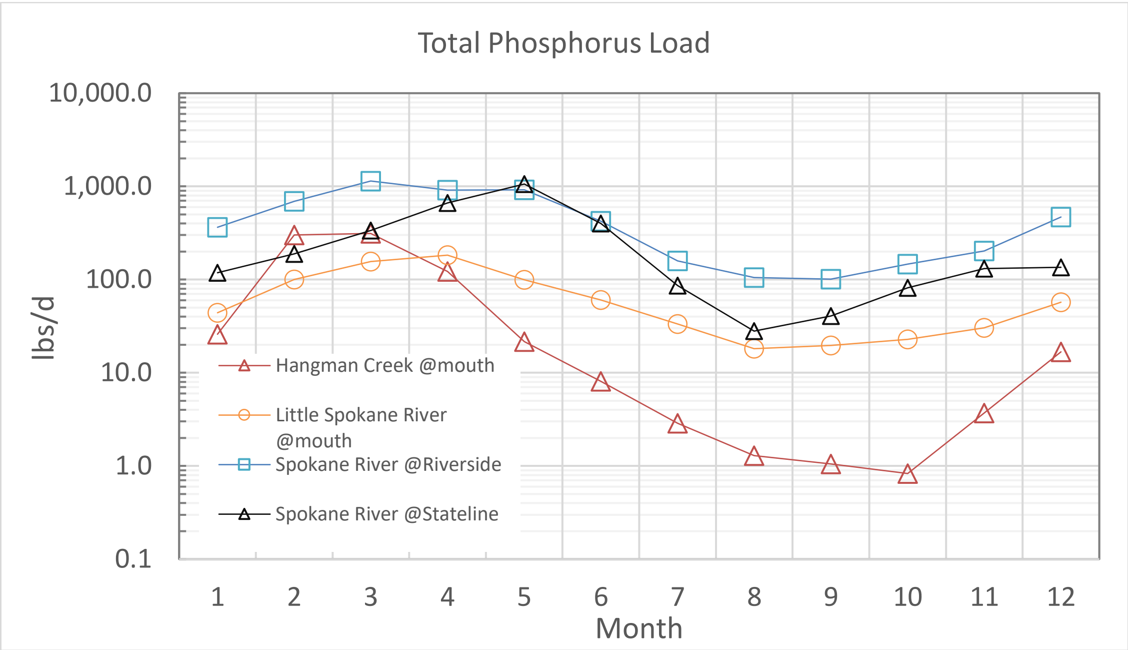

Figure 50. 2012-2016 median monthly total phosphorus loading in the Spokane River and tributaries

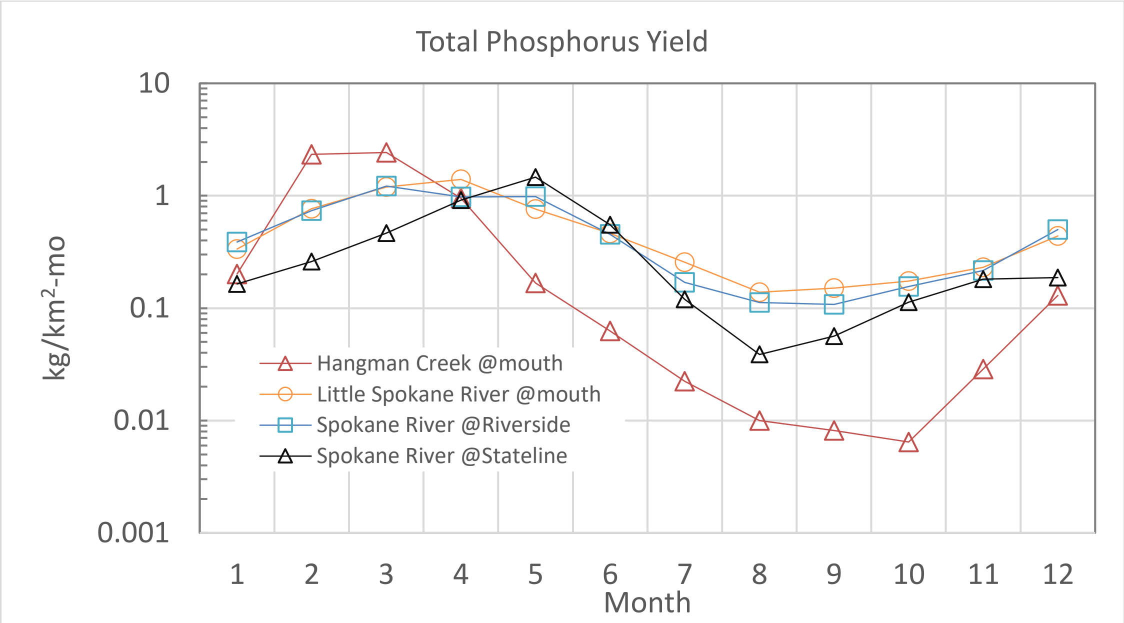

Figure 51. 2012-2016 median monthly total phosphorus yield by watershed

In the Little Spokane River, a majority, or about 74 percent, of the total phosphorus is soluble reactive phosphorus (Figure 52), which is not adsorbed to sediment particles. During the summer period, phosphorus concentrations in the Little Spokane River often decline to levels below those now observed in the main Spokane River. This indicates, at least for phosphorus, this tributary does not pose a significant source to the Lake Spokane reservoir during this critical time. (Phosphorus does not tend to be mobile in groundwater which is a major source of flow during the summer for the Little Spokane River.)

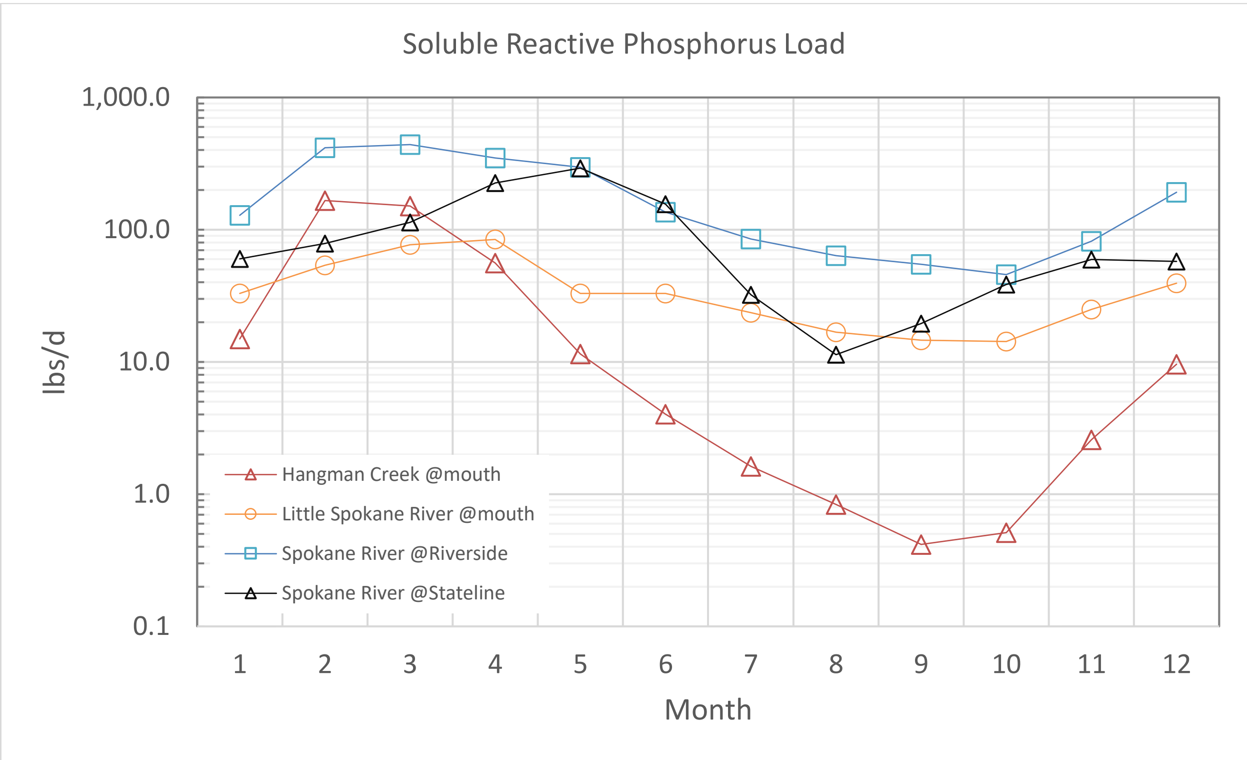

Figure 52. 2012-2016 median monthly soluble reactive phosphorus loading in the Spokane River and tributaries

Looking at longer trends, Figures 53 through 55 present median annual loads for two periods 1988-2011 and 2012-2016. Most of the monitoring locations have reductions in total suspended solids loading for the more recent period (2012 to 2016) when compared to the 1988-2011 period. For most of the monitoring locations the reduction is around 30 percent. However, Hangman Creek has a reduction of about 40 percent, which holds true when factoring in differences in flows. Part of the reason for the decrease may be related to a lower frequency and intensity of storm events rather than results of best management practice implementation. To better understand the reason for the reduction, a more careful look at the flow data is required.

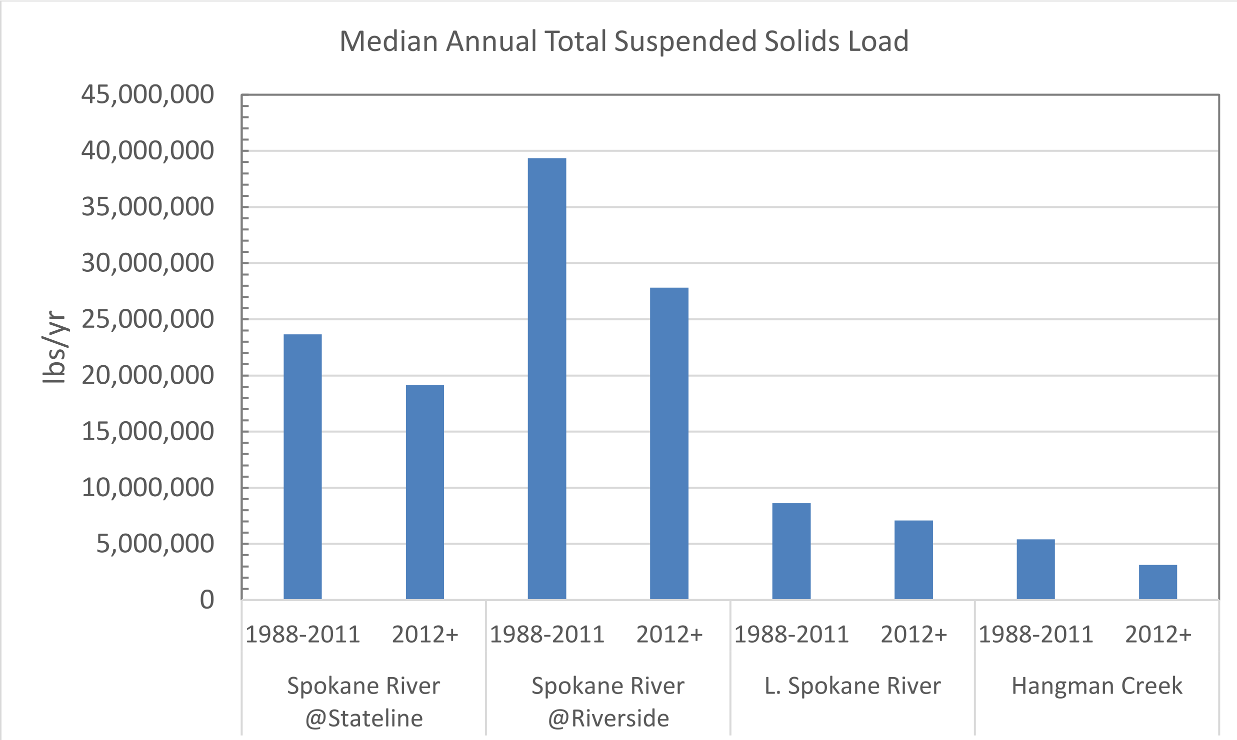

Figure 53. Comparison of recent and historic median annual total suspended solids loads in the Spokane River and tributaries

As with the suspended solids, most of the monitoring locations have some decline in total and soluble reactive phosphorus loads (of varying levels) for the more recent analysis period (Figures 54 and 55). As expected, given the SCRWRF's use of advanced phosphorus removal treatment methods and the City of Spokane RPWRF's use of CEPT, the biggest decline in load is about 50 percent and occurs at the Riverside monitoring location.

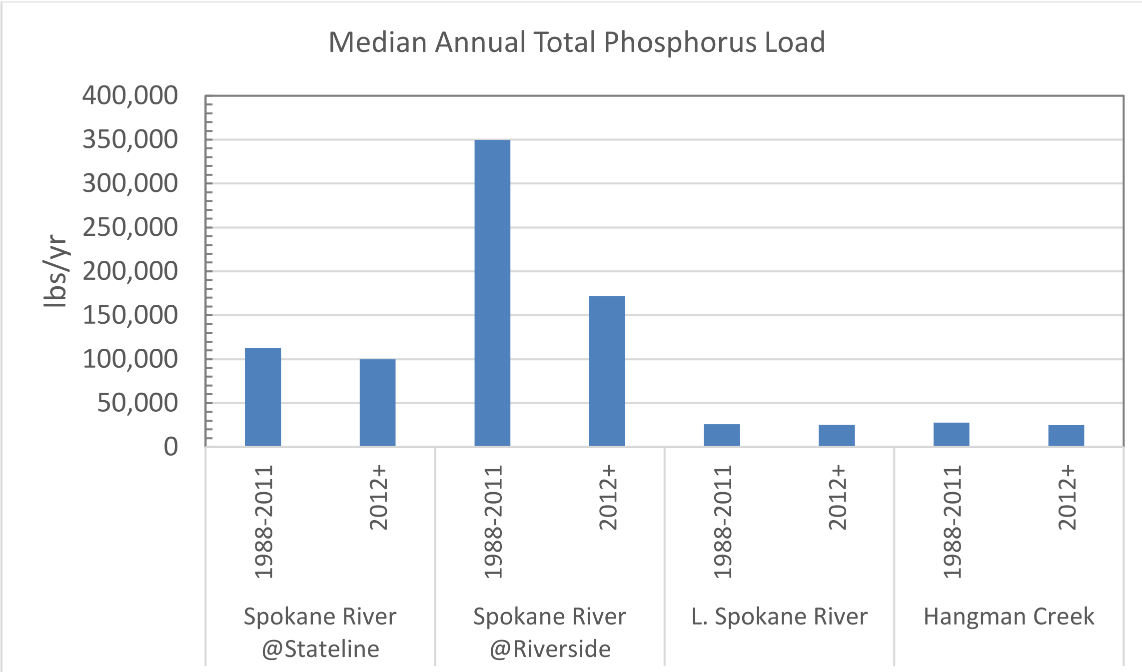

Figure 54. Comparison of recent and historic median annual total phosphorus loads in the Spokane River and tributaries

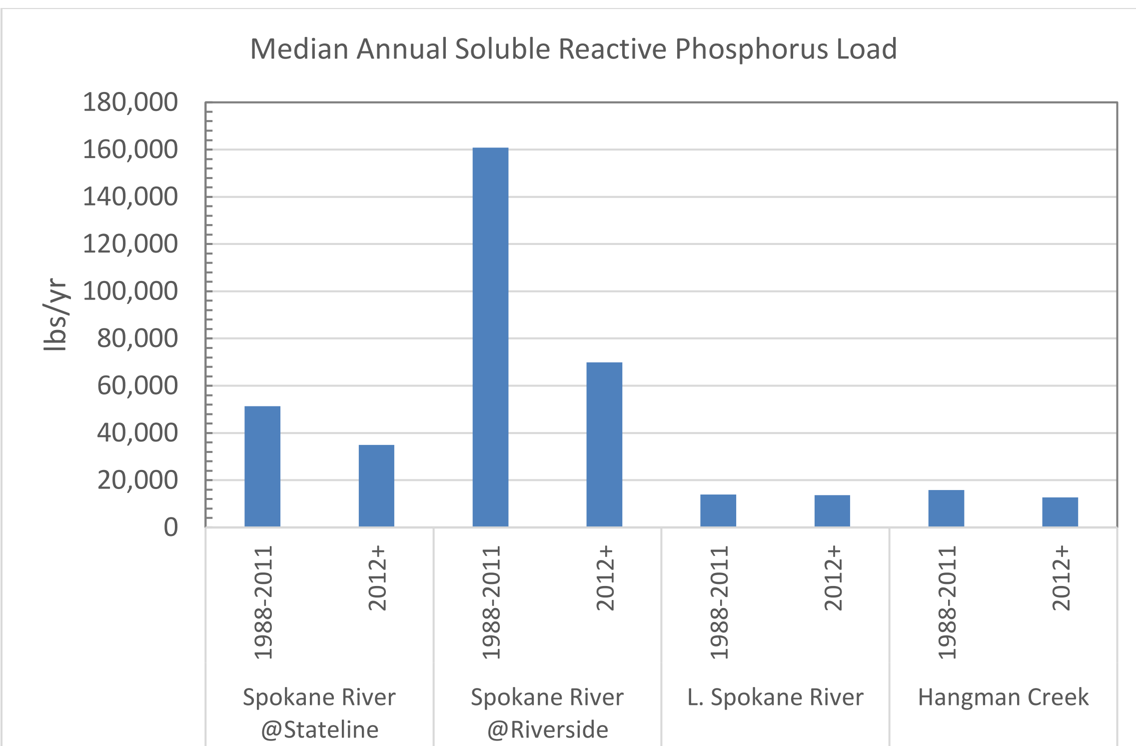

Figure 55. Comparison of recent and historic median annual soluble reactive phosphorus loads in the Spokane River and tributaries

Riverine Assessment Point

A key element of the TMDL was the inclusion of a riverine assessment point that would, in theory, parse out the contributions from upstream in the Spokane River from impacts due to Long Lake Dam's hydrologic modifications. To determine the phosphorus concentrations at the riverine assessment point, Ecology established a monitoring station immediately below Nine Mile Dam (ambient station 54A090). Flow-weighted average phosphorus at this station is combined with that at the mouth of the Little Spokane River (ambient station 55B070) to determine progress towards the target. Figure 56 compares data collected for the riverine assessment during 2010 and 2014. Even though the 0.010 mg/L total phosphorus target was exceeded nearly every month during the TMDL critical period (March through October), the concentrations appear to be declining.

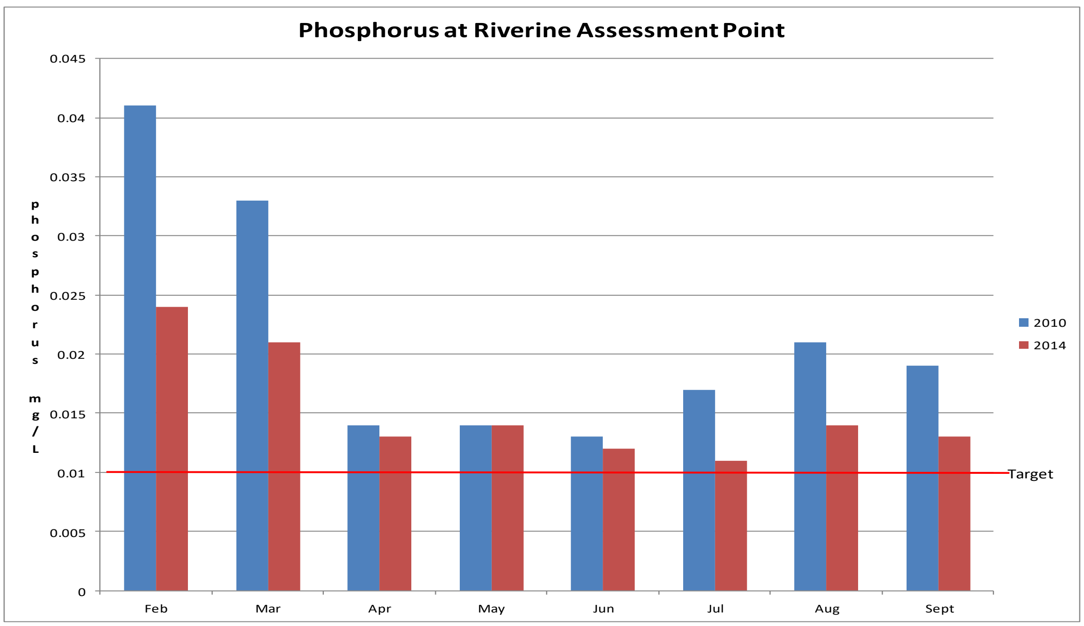

Figure 56. 2010 and 2014 average phosphorus concentrations at the riverine assessment point

2015-2016

Figure 57 reflects the trend in total phosphorus at the riverine assessment point from 2010 through 2016. During the months where total phosphorus samples were not collected at Nine Mile, the total phosphorus data from the Riverside State Park monitoring location was used. This figure better illustrates the decline in total phosphorus concentrations, although the 0.010 mg/L target continued to be exceeded during the 2015 to 2016 period.

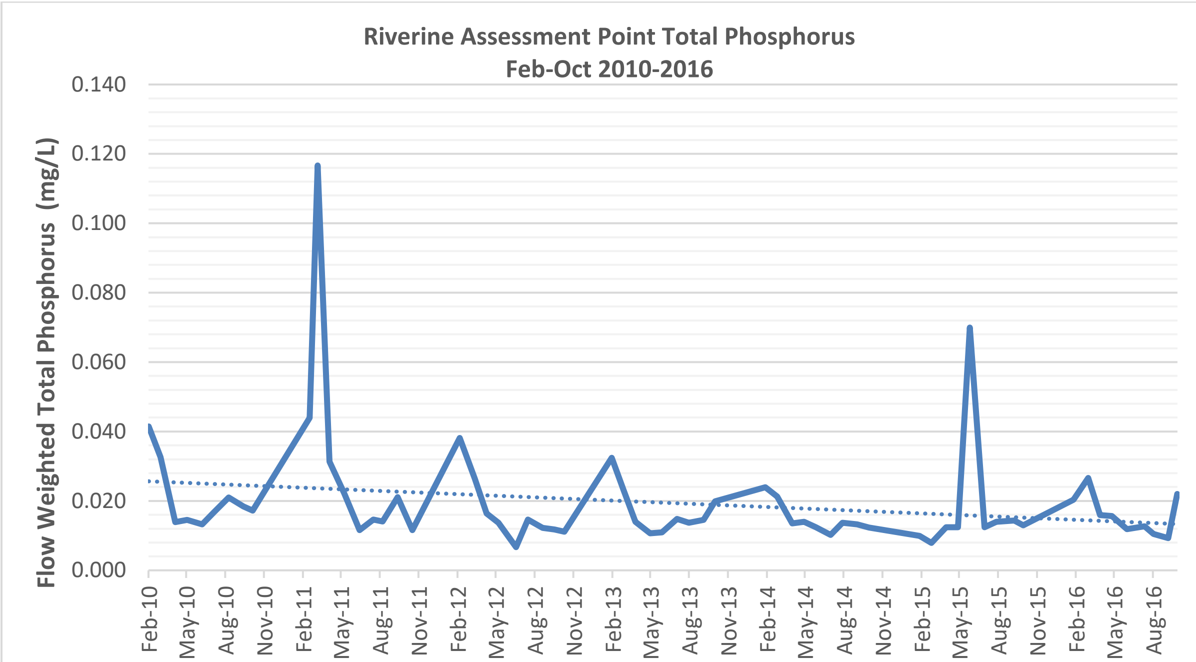

Figure 57. Riverine Assessment Point flow-weighted total phosphorus

Lake Spokane

The following discussion provides key highlights of select parameters from the Lake Spokane nutrient monitoring results from 2010 through 2016 (Avista 2017).

With regard to dissolved oxygen, average water column dissolved oxygen in 2016 ranged from 7.3 to 10.2 milligrams per liter (mg/L). Maximum dissolved oxygen concentrations ranged from 11.4 to 12.2 mg/L at the six stations, with the higher values occurring in the lacustrine zone during 2017. Over the seven-year period of 2010 – 2016, maximum dissolved oxygen concentrations among the monitoring locations had the following ranges:

- 10.7 - 14.5 mg/L in 2010
- 11.9 - 12.4 mg/L in 2011
- 11.4 - 12.5 mg/L in 2012
- 11.6 - 13.4 mg/L in 2013
- 12.0 - 14.1 mg/L in 2014
- 11.4 - 14.5 mg/L in 2015
- 11.4 - 12.2 mg/L in 2016.

Minimum dissolved oxygen concentrations of 0.0 mg/L occurred near the bottom at the two deepest stations, LL0 (~154 ft) and LL1 (~108 ft) in 2016. Minimum dissolved oxygen concentrations in 2010 – 2015 also occurred at the two deepest stations (LL0 and LL1).

The minimum dissolved oxygen concentrations near the bottom of LL0 and LL1 are associated with a small fraction of the water column, and may not reflect the average dissolved oxygen concentration throughout the entire hypolimnion. Volume weighting the dissolved oxygen concentrations is a method that provides an average concentration throughout the hypolimnion, and is calculated by the following technique:

> At each station, for each sampling day, measured dissolved oxygen concentrations from the hypolimnion (15 m and deeper) are multiplied by their associated volume of water, summed, and then divided by the total volume of water at each station from 15 m and deeper. The volumes of water were obtained from the CE-QUAL-W2 model segment volumes identified in the dissolved oxygen TMDL.

Figure 58 displays the results of the minimum volume weighted dissolved oxygen concentrations for each lacustrine station (LL0-LL2) for 2010-2016, and LL3 for 2012-2016. (Station LL3 has only a very small hypolimnion deeper than 15 m.)

With regard to total phosphorus, there are several ways to analyze data collected within a lake, including presenting the range of concentrations measured at all stations, at all depths, throughout the whole monitoring season. From this perspective, total phosphorus concentrations ranged from 3 to 122 micrograms per liter (µg/L) during 2016, with total phosphorus usually highest at stations LL0, LL1, and LL2 in the hypolimnion (49 ft. and deeper) with higher levels usually starting in July and decreasing in late August and September.

Total phosphorus concentrations can also be analyzed by isolating and averaging the concentrations measured in the epilimnion layer of the lake. Table 11 summarizes 2016 mean epilimnetic total phosphorus concentrations for the six Lake Spokane stations for various times during the year. Table 12 summarizes the mean epilimnion total phosphorus concentrations for Lake Spokane from 2010-2016 during these same times. Figure 59 shows the summer (June to September) epilimnetic mean total phosphorus concentrations. Summer mean epilimnetic total phosphorus levels in 2012 to 2016 were calculated using concentrations at 0.5 m and 5 m for stations LL0 to LL2, and concentrations at 0.5 m for stations LL3 to LL5. Summer (June to September) epilimnetic mean TP concentrations in 2016 were lower than other recent years at LL1, LL2, and LL3 and similar to those in 2014 and 2015 at LL0.

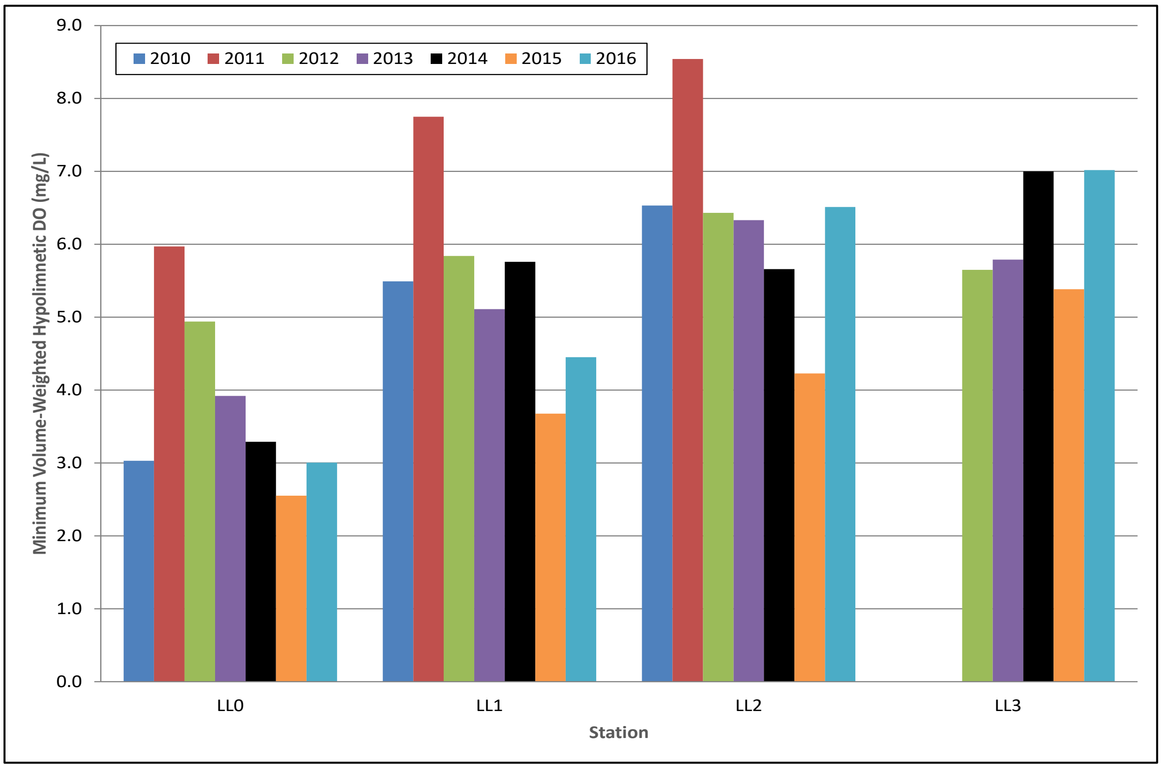

Figure 58. Minimum volume-weighted hypolimnetic (15 m and deeper) DO in Lake Spokane at stations LL0, LL1, LL2, and LL3

By applying volume weighting, which calculates the concentration relative to the volume of water it represents, total phosphorus concentrations for all stations during 2016 were below 25 µg/L. As shown in Figure 59, summer mean total phosphorus decreased slightly through the reservoir in all seven years with total phosphorus at station LL0 being the lowest (Tables 11 and 12).

Table 11. 2016 mean epilimnetic total phosphorus concentrations for Lake Spokane

Mean Epilimnetic TP (µg/L)	Lake Station					
	LL5	LL4	LL3	LL2	LL1	LL0
May	18.8	17.1	17.7	24.6	18.6	17.5
June	8.5	9.6	6.5	4.7	5.4	9.1
July – Sept.	14.0	15.4	9.0	7.5	7.9	7.0
Oct.	12.0	10.5	14.6	8.6	7.8	6.8

Table 12. Mean epilimnetic total phosphorus concentrations for Lake Spokane for 2010-2016

Mean Epilimnetic TP (µg/L)	Lake Station					
	LL5	LL4	LL3	LL2	LL1	LL0
May	16.3	16.1	17.6	16.2	15.3	14.3
June	11.9	11.1	10.9	9.7	9.0	9.6
July – Sept.	18.0	18.9	10.3	9.7	9.4	8.2
Oct.	11.6	14.0	12.8	9.0	9.1	6.9

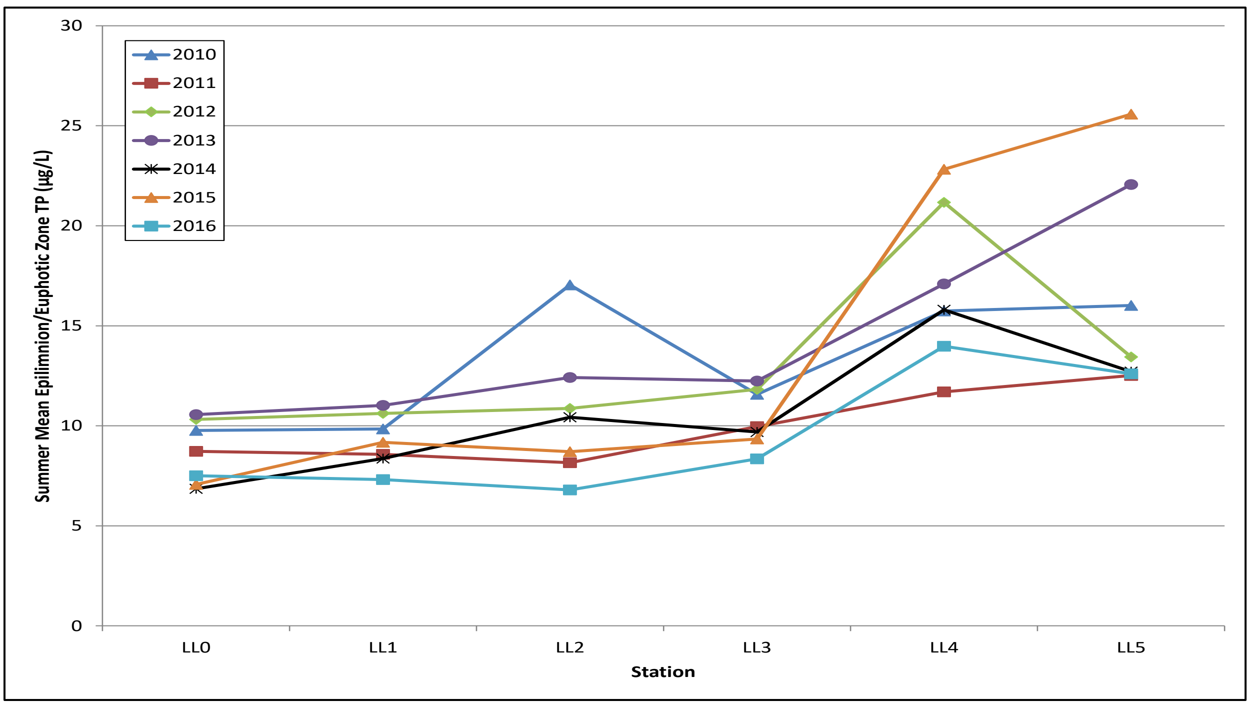

Figure 59. Summer mean epilimnion total phosphorus (TP) concentrations, 2010-2016
(Data is presented from down reservoir to up reservoir left to right.)

Chlorophyll-a is a pigment that is present in all types of algae and is an indicator of the amount of photosynthetic activity occurring in the reservoir's surface waters. Similar to total phosphorus, summer mean epilimnetic chlorophyll-a concentrations in 2012-2016 were calculated using concentrations at 0.5 and 5 m for stations LL0 to LL2, and concentrations at

0.5m for stations LL3 to LL5. Summer means for 2010 and 2011 are based on averages from euphotic zone composite samples. Chlorophyll-a concentrations at the six lake stations during 2016 ranged from 0.5 to 14.4 µg/ and transparency (Secchi disc depth) ranged from 7 to 30 feet throughout the reservoir. As shown in Figure 60, results from 2010 - 2016 indicate chlorophyll-a concentrations were highest in the lacustrine and transition zones of the reservoir during all seven years, with the exception of 2015. During 2015, chlorophyll-a concentrations were highest in the transition and riverine zones.

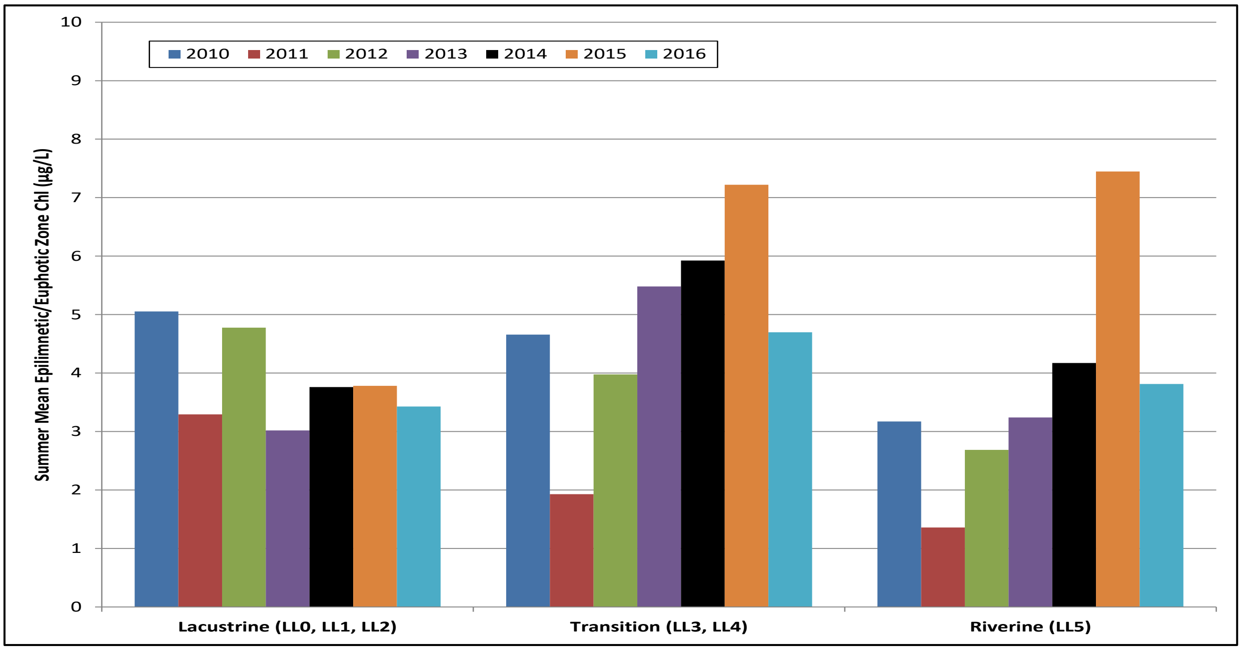

Figure 60. Summer mean epilimnion/euphotic zone chlorophyll-a concentrations, 2010-2016 (Data is presented from down reservoir to up reservoir left to right.)

Table 13 summarizes the summer (June-September) epilimnetic means for total phosphorus, chlorophyll-a, and transparency (Secchi disk depth) for each reservoir zone. Summer epilimnetic means provide a way to compare a significant amount of data across a number of years, and is a method used to assess lake water quality and trophic state.

Phytoplankton samples have been collected in Lake Spokane at 0.5 m depth since 2011. Sample collection occurred once a month in 2011, and twice per month in 2012 to 2016. Mean summer (June-September) phytoplankton biovolume are shown in Figure 61. Overall phytoplankton density and biovolume was greater at all stations in 2015 and 2016.

Table 13. 2012-2014 summer (June to September) epilimnetic means compared to 2010 and 2011 summer euphotic zone means in lacustrine, transition, and riverine zones in Lake Spokane

Year	Lacustrine (0.5, 5 m)			Transition (0.5 m)			Riverine Zone (0.5 m)		
	TP* (µg/L)	Chl** (µg/L)	Secchi (m)	TP* (µg/L)	Chl** (µg/L)	Secchi (m)	TP* (µg/L)	Chl** (µg/L)	Secchi (m)
2010	9.8	5.1	5.1	13.7	4.7	3.7	16.0	3.2	3.6
2011	9.1	3.3	5.8	10.8	1.9	4.7	12.5	1.4	4.8
2012	10.6	4.8	4.4	16.5	4.0	3.9	13.4	2.7	4.7
2013	11.3	3.0	5.7	14.7	5.5	3.9	22.1	3.2	4.1
2014	8.5	3.8	5.0	12.7	5.9	3.6	12.7	4.2	4.0
2015	8.3	3.8	5.3	16.1	7.2	3.3	25.6	7.4	2.9
2016	7.2	3.4	5.6	11.2	4.7	4.0	12.6	3.8	5.0
Average	9.3	3.9	5.3	13.7	4.8	3.9	16.4	3.7	4.2

* Total Phosphorus
** Chlorophyll-a

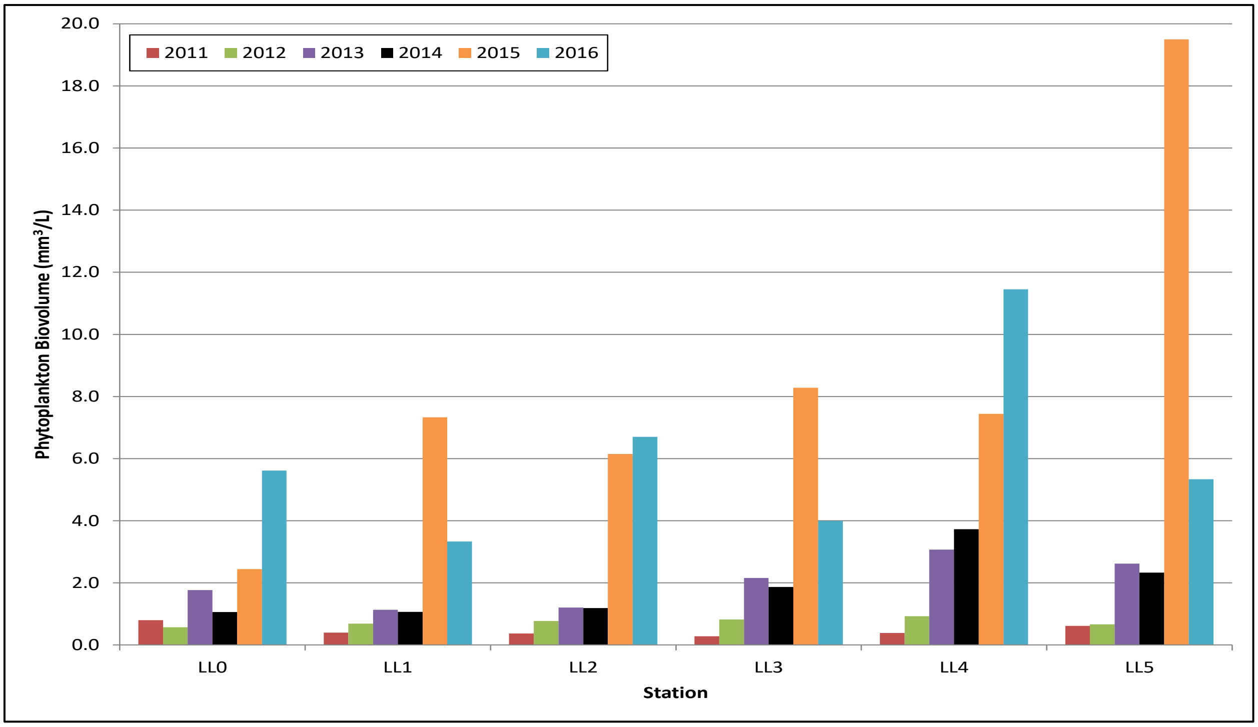

Figure 61. Summer (June-September) mean phytoplankton biovolume in Lake Spokane, 2011-2016
Note that sample analysis was conducted by Water Environmental Services in 2011 – 2014 and by EcoAnalysts in 2015 and 2016)

Avista's Lake Spokane DO Water Quality Attainment Plan Five Year Report includes an examination of all the water quality data since 2010, which can be accessed by visiting: https://www.myavista.com/-/media/myavista/content-documents/our-environment/river-documents/water-quality/ls_do_wqap_5year_report_3-24-17.pdf?la=en.

Lake Spokane Algae Bloom Sampling

The Lake Spokane Association's Technical Advisor, Galen Buterbaugh, takes samples of algae blooms only when they occur and persist more than a day. He sends the samples to the lab for toxicity analysis. Galen submitted 16 algae samples between September 2009 and the end of August 2015 to the lab to determine if the algae blooms contained the toxins anatoxin-a, microcystin, or saxitoxin. Two separate samples were sent in on Sept. 27. 2010, and Oct. 13, 2010, for a total of 18 samples submitted to the lab. Not all algae blooms contain toxins (Figure 62). The occurrence of algae blooms have declined in recent years. Since 2012 only five algae samples were taken, and four of those were from 2015 when the conditions were hot and dry. Algae blooms still occur, but they dissipate quickly and do not occur as often.

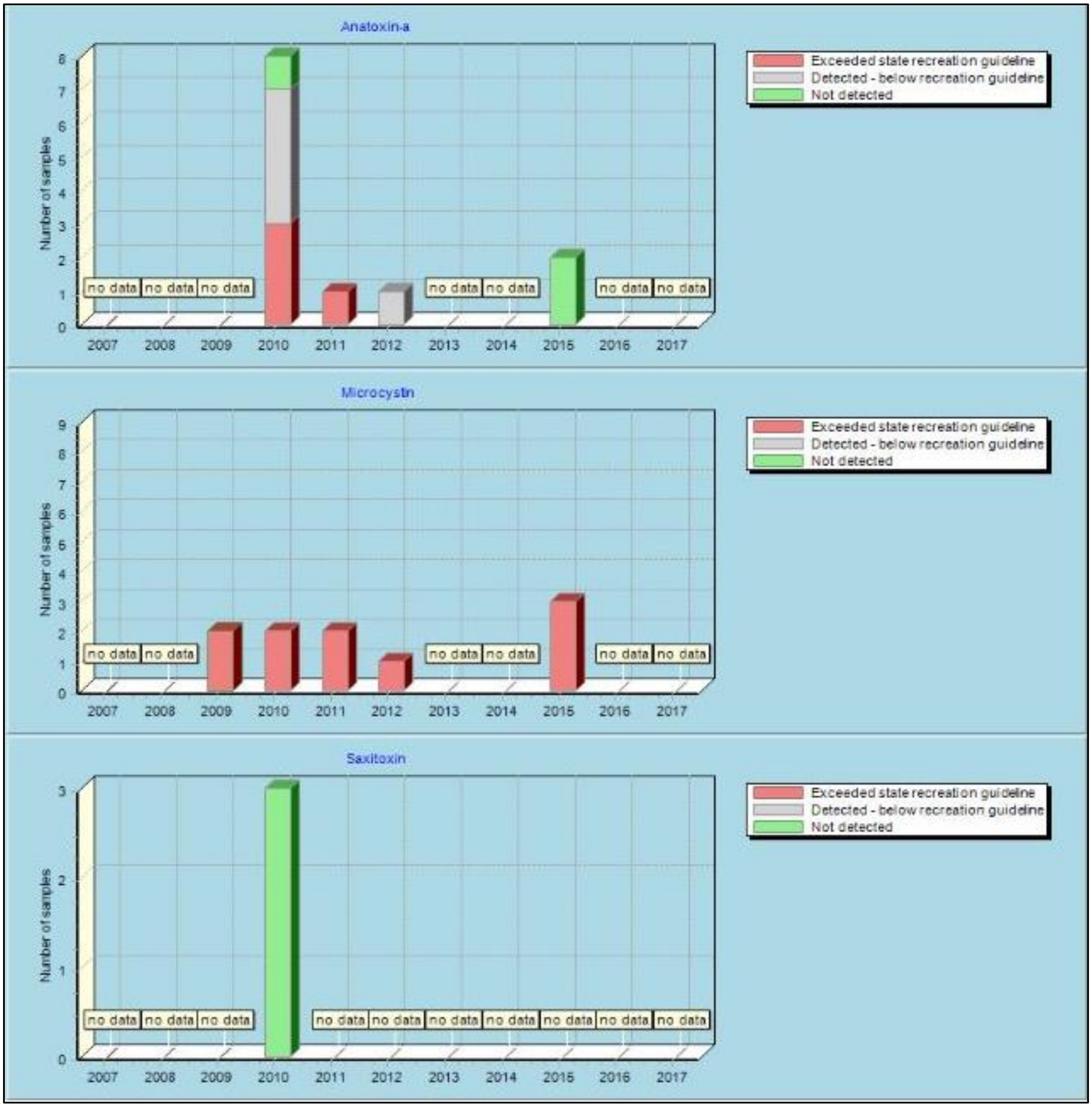

Figure 62. Results of Lake Spokane algae samples tested for toxins

Groundwater

Spokane County

Spokane County Water Resources typically monitors around 49 wells in the Spokane Valley-Rathdrum Prairie Aquifer. They collected 125 samples in 2015 and 134 samples in 2016, and tested them for total phosphorus. In 2015, 15 wells had at least one total phosphorus concentration above 0.010 mg/L. (This is the total phosphorus target at the riverine assessment point and is the value used by the City of Spokane's Environmental Programs' drinking water reports. However, the TMDL set seasonal allocations for groundwater upstream of Lake

Spokane. The allocation ranges from 0.007-0.008 mg/L total phosphorus.) Table 14 shows the number of groundwater sample sites in Spokane County that exceed 0.010 mg/L. By 2016 the number of wells exceeding 0.010 mg/L increased to 20. However, if you averaged all the samples collected at each well in 2016, only 11 of the wells exceeded 0.010 mg/L total phosphorus. In 2016, 38 of the 134 samples collected by the County exceeded 0.010 mg/L total phosphorus. These 38 samples were taken from 20 different sites.

Table 14. Number of groundwater sample sites above 0.010 mg/L total phosphorus

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
# of wells sampled	49	50	48	50	49	49	49
# sites > 0.010 mg/L	12	19	15	15	14	15	20

In 2016, Plantes Ferry Park was the monitoring well with the highest average total phosphorus concentration at 0.062 mg/L. This Plantes Ferry Park well consistently has the highest phosphorus concentrations, but they appear to be generally decreasing (Table 15). This well contains water that is hydrostatically confined and has no dissolved oxygen. The conditions in this well are highly unusual within the Spokane Valley-Rathdrum Prairie Aquifer. The East Valley High School monitoring well had the second highest concentration at 0.047 mg/L, and the City of Spokane's Ray Street well had the third highest concentration at 0.022 mg/L.

Table 15. Highest total phosphorus concentrations from groundwater wells in Spokane County

	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Total Phosphorus (mg/L)	0.352	0.282	0.150	0.076	0.068	0.052	0.062

According to Greenlund (2015), of the City of Spokane's source water wells, Ray Street has the highest concentrations for both nitrate and soluble reactive phosphorus. Table 16 shows the highest yearly soluble reactive phosphorus and nitrate concentration from the Ray Street well. The 2015 average soluble reactive phosphorus concentration among the six City of Spokane wells other than Ray Street, is 0.0026 mg/L, which is on par with 2013's average of 0.002 mg/L. According to Greenlund (2016), the majority of wells with high total phosphorus concentrations are located along the edge of the aquifer, which could be the result of runoff from the higher elevations at the edge of the aquifer (Figure 63).

Table 16. Ray Street well highest yearly soluble reactive phosphorus and nitrate concentrations

Year	**Soluble Reactive Phosphorus (mg/L)**	**Associated Date**	**Nitrate (mg/L)**	**Associated Date**
2010	0.032	1/26/2010	3.53	4/28/2010
2011	0.024	4/26/11 & 10/25/11	3.33	1/25/2011
2012	0.028	1/31/2012	3.68	10/30/2012
2013	0.026	1/29/2013	3.59	10/29/2013
2014	0.025	10/28/2014	3.23	10/28/2014
2015	0.026	1/27/2015	3.29	1/27/2015
2016	0.027	5/11/2016	3.27	1/26/2016

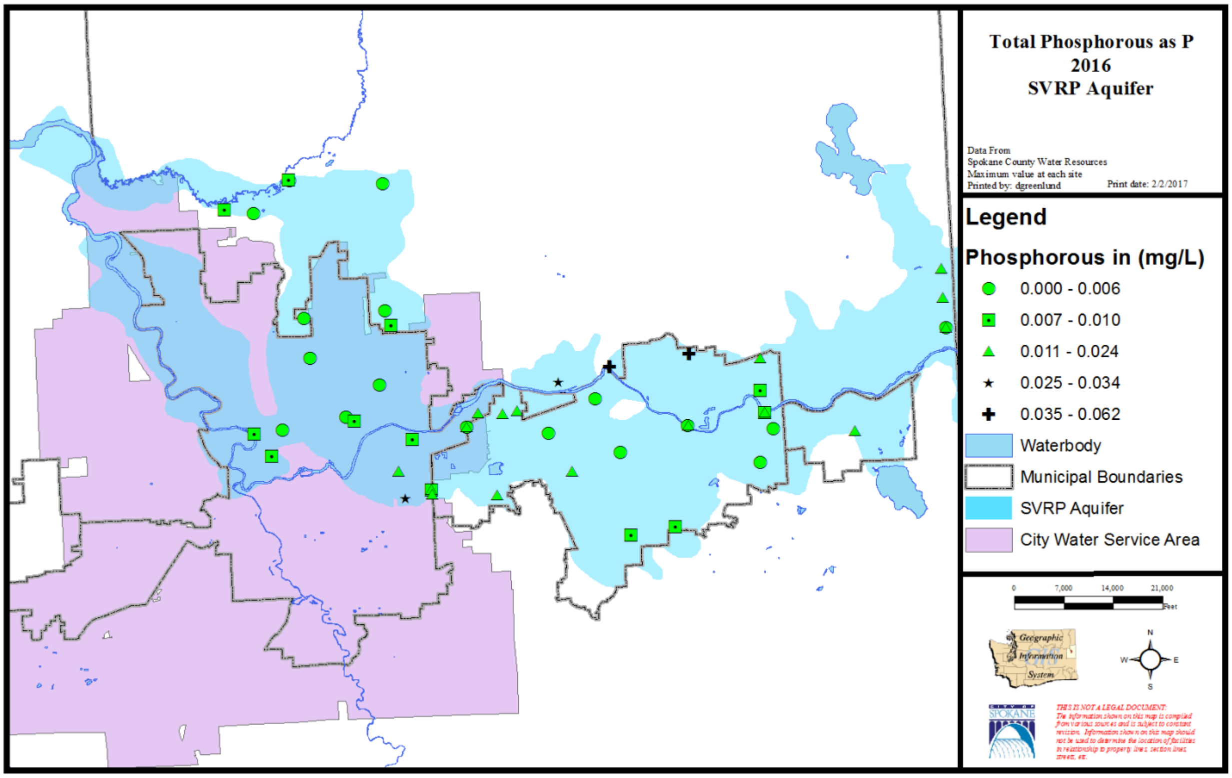

Figure 63. Total phosphorus concentrations in groundwater (Greenlund, 2017)*

**This map is produced with data courtesy of Spokane County Water Resources.*

Deep Creek

Appendix A contains the data from Ecology's groundwater monitoring piezometers in Deep Creek. Ecology opportunistically collects grab samples from Deep Creek (when it is flowing) and the Spokane River when monitoring the piezometers. That data is also located in Appendix A.

The data collected to date suggests that the Deep Creek drainage does discharge water to the Spokane River even during periods of no discernable streamflow. Ecology is planning on performing the necessary hydraulic tests on the piezometers to provide numeric flux or load estimates during the summer of 2017.

Data collected from the Deep Creek sampling effort is preliminary. Soluble reactive phosphorus ranged from 0.095 to 0.105 and, as expected, comprises most of the total phosphorus amounts observed.

Lake Spokane

The USGS (Gendaszek et. al, 2016) determined that the concentrations of nitrogen isotope measured in aquatic plants living along the shoreline at Suncrest were higher than those measured from plants located along the shoreline upstream of Suncrest (in the vicinity where the Little Spokane River enters the lake). However the highest nitrogen isotope concentrations observed were from plants taken from the shoreline downstream of Tum Tum. The study could not identify if the source of the isotope was septic systems or surface water since the USGS did not take groundwater flow measurements at these sites.

For March through April 2015, groundwater soluble reactive phosphorus concentrations from the 30 piezometers ranged from 0.008 mg/L to 0.240 mg/L. The average soluble reactive phosphorus concentration for all the samples collected was 0.056 mg/L. This average is greater than the 0.025 mg/L concentration assigned to Lake Spokane surface water runoff and groundwater in the TMDL. The USGS found no significant difference between soluble reactive phosphorus amounts measured along the shore upstream of Suncrest, adjacent to residences, or along the shoreline with residences upon a terrace. As with the nitrogen isotope data collection, USGS scientists did not collect groundwater flow measurements during this study. Therefore, it is unknown to what extent the groundwater met or exceeded total phosphorus load of 79 pounds per day for the March-May season. It is also important to note, the samples were collected only during the spring season, so we do not know what the phosphorus concentrations may be during other times of the year.

In 2016 and 2017, the Stevens County Conservation District is contracting with the USGS to continue to collect groundwater samples throughout the year to measure groundwater flow from piezometers along the Stevens County shoreline of Lake Spokane. This study should identify how many nutrients are entering Lake Spokane from groundwater along this shoreline.

Temperature, Precipitation, and Flow Data

Comparing temperature, precipitation, and flows that occurred during 2010 through 2016 with those from the TMDL critical year (2001) is important to determine the level of water quality improvement. Differences in dissolved oxygen or nutrient levels may be impacted if current conditions are wetter, drier, or hotter than when we determined the TMDL reduction targets.

Ecology gathered temperature and precipitation data from the National Weather Service's Spokane airport weather station: http://www.wrh.noaa.gov/otx/climate/lcd/lcd.php (Appendix D). An Excel spreadsheet was used to record the highest temperature for each month and then calculate the average for each calendar year. To determine the yearly total precipitation (including rain and snow), monthly total precipitation amounts were added together for each calendar year.

As shown in Figure 64, 2013 was the only year to have less precipitation than the 2001 critical year for the TMDL. In 2001, the total amount of precipitation was 13.72 inches, and 2013 had 2.36 fewer inches at 11.36. However, in 2013 there was more precipitation in June through September and less from October through December (data are also available in Appendix D). All other years we experienced more precipitation than 2001. The maximum was in 2012 with 21.32 inches of precipitation, which is 7.6 inches more than 2001. However, compared to 2012, 2001 was wetter in April, May, and August through October; the remainder of the year was drier.

Figure 64 also shows the average yearly high air temperature. The average high temperature in 2010 and 2014 are similar to 2001 (72.4^{o}F), whereas 2011 and 2013 were cooler (Figure 13). The hottest year was 2015; air temperatures were nearly five degrees warmer than 2001. In 2015, temperatures in January through March and again June through August were the hottest of the analysis period (2001 and 2010-2016). However, January through March and December 2015 were wetter than in 2001, but the summer months (June-August) received less rain than in 2001.

Since 2001, Spokane River flows have been altered by Avista's Federal Energy Regulatory Commission (FERC) license and a Washington State in-stream rule:

- In June 2009 when FERC issued Avista's license, it required Avista to discharge at least 600 cubic feet per second (cfs) of water from the Post Falls Dam from June 7 until the Tuesday after Labor Day. The only exception is if Lake Coeur d'Alene drops below a certain level during the summer, at which time Avista can reduce their discharge to no less than 500 cfs. At the corporation's Monroe Street and Upper Falls dams, they are required to pass 850 cfs of water from June 16 to September 30. These FERC requirements will prevent the Spokane River from flowing as low as it did during the 2001 critical year established by the TMDL.

- In September 2014, Ecology initiated a rule-making process to establish a minimum instream flow for the Spokane River. The rule allocates flows to protect fish habitat and other uses (Table 17). The instream flow rule went into effect at the end of February 2015, and is essentially a water right for fish habitat. Any water rights issued *after* the adoption date of the instream flow rule will be curtailed if flows fall below the instream flow. So, this rule may also help keep flows higher than they were in the summer of 2001.

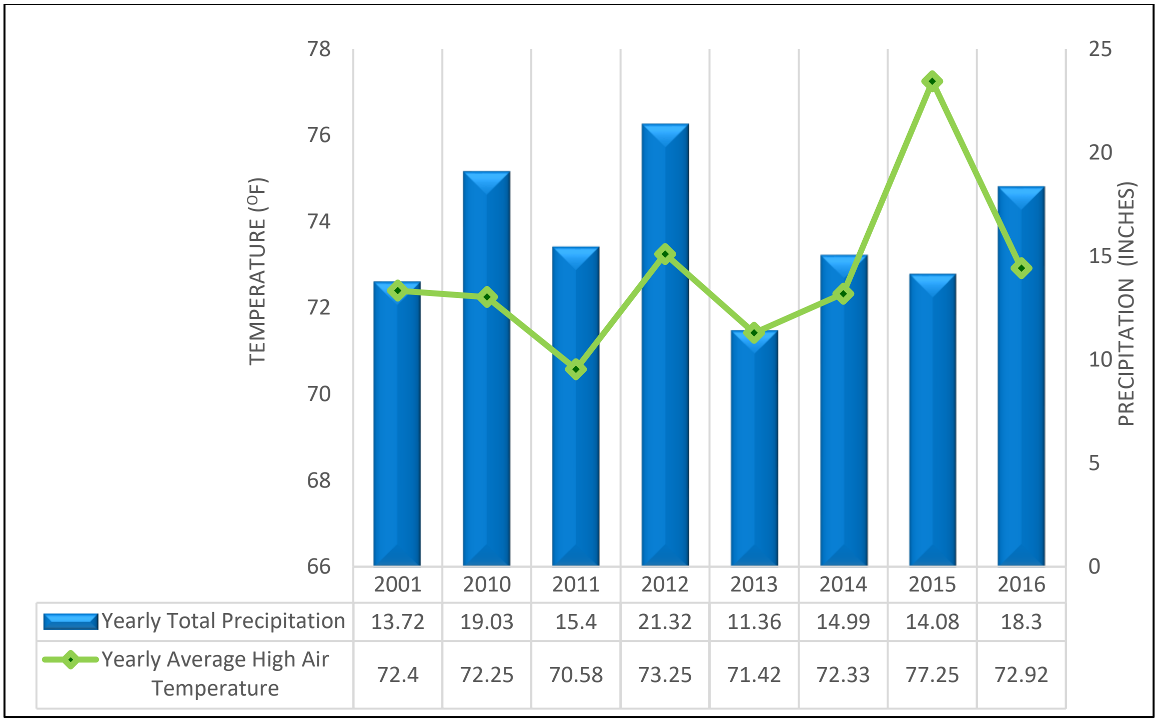

Figure 64. Precipitation data from the Spokane Airport for the TMDL critical year and 2010-2016

Table 17. Spokane River Instream Flows

Location	Time	Flow (cfs)
Spokane River at Barker Road (Greenacres)	June 16 - September 30	500
Spokane River	October 1 - March 31	1700
	April 1 – June 15	6500
	June 16 – September 30	850

Avista calculated the inflows of all incoming water by using midnight to midnight lake elevation and day average outflow at midnight as recorded at Long Lake Dam (Figure 65). Maximum inflows in Lake Spokane typically occur during March, April, and May due to spring runoff. The exception to this pattern is 2015 and 2016, which had maximum flows in February and early March, respectively. Peak flows in 2012 were the greatest of the analysis period at over 35,000 cubic feet per second (cfs) followed by 2011 with peak flows greater than 30,000 cfs. High flows in 2010 were the lowest at approximately 17,000 cfs, which nearly matches the 2001 flows, but the peak in 2010 occurred in June rather than May.

Ecology's analysis of flow conditions from 1975 through 2014 shows that the inflow conditions for 2010 through 2014 were near or above average. The data suggests annual minimum flows are declining in the Spokane River, and although this is likely to be somewhat offset by the minimum flows set for the Spokane River below Post Falls, it may also be affected by long-term trends in climate and aquifer withdrawals.

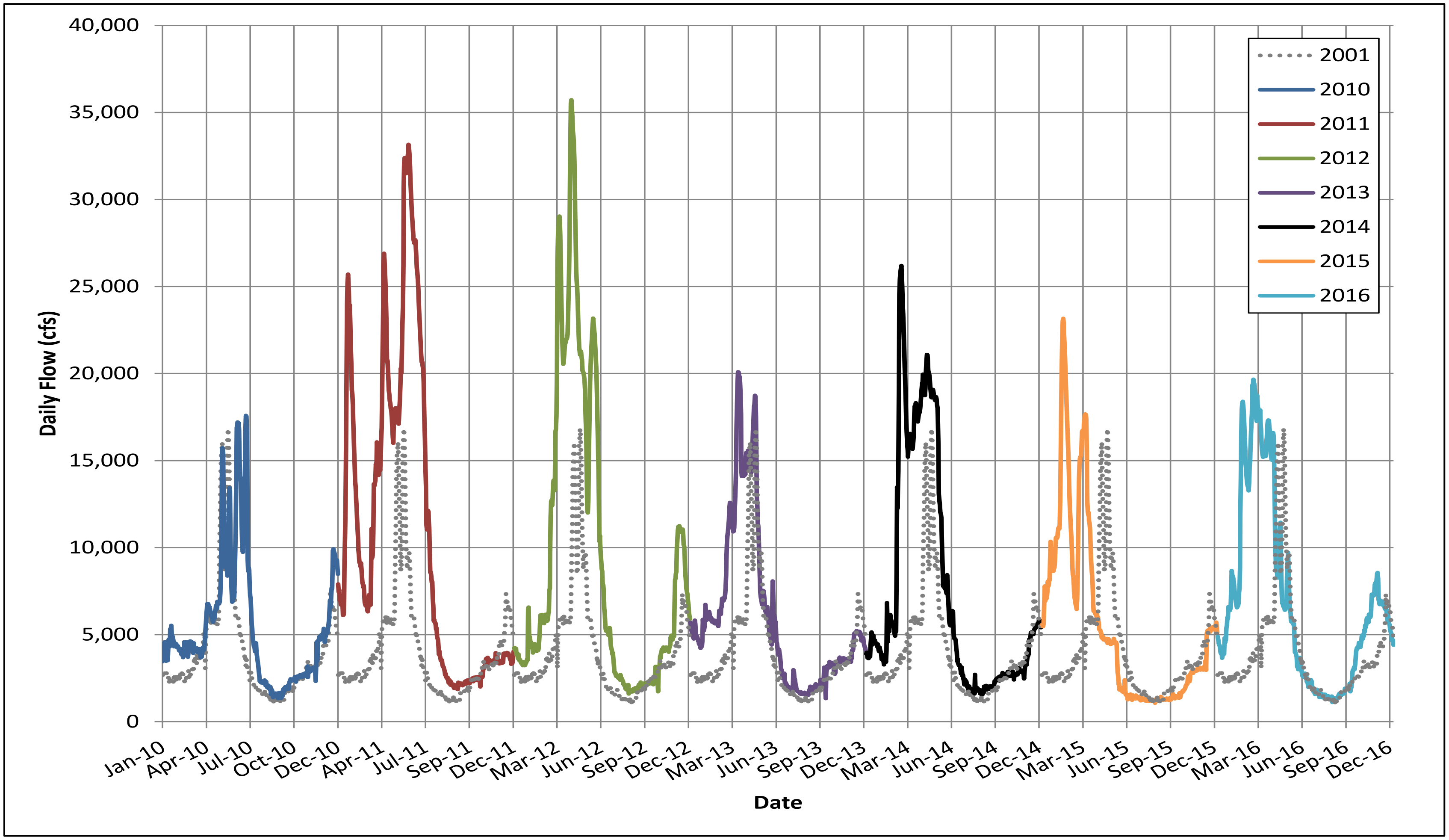

Figure 65. Total inflows into Lake Spokane 2010-2016* (Avista, 2017)

*Inflows calculated based on midnight to midnight reservoir elevation and day average outflow at midnight as recorded at Long Lake Dam.

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Progress Report

This section is intended to provide an idea of how current Spokane watershed phosphorus concentrations compare to the allocations in TMDL. Overall progress in relation to the TMDL goals and the Nonpoint Source Phosphorus Reduction Plan is also presented along with future monitoring recommendations.

Below, data observations made in the previous sections are compared to the various allocations and targets established in the TMDL. Tributary load values presented below are estimates and based on monthly data. Tributary specific TMDLs or studies are more accurate and supersede the estimates and conclusions provided below.

This section is not intended to determine compliance with the TMDL. Compliance with the TMDL will be determined during the 10-Year Assessment, which is estimated to begin no earlier than 2021.

Point Sources - Wasteload Allocations

Entities discharging into the Spokane River in Washington have wasteload allocations for total phosphorus, ammonia, and biochemical oxygen demand (Table 1). Ecology issued permits in 2011 with interim limits and a ten-year compliance schedule allowing the dischargers to make gradual progress toward achieving the allocations. The compliance schedule gives them time to choose the correct technology for their facilities and secure or plan for the required financing.

Data from the dischargers are included in Appendix C and shows that the facilities in Washington and Idaho have reduced the amount of phosphorus, ammonia, or biochemical oxygen demand they release into the Spokane River. These reductions have occurred within the first six years of implementation.

Comparing current ammonia, total phosphorus, and carbonaceous biochemical oxygen demand (CBOD) concentrations from the Washington discharger’s monthly discharge reports with the TMDL allocations show that the dischargers are close to meeting the wasteload allocations. Kaiser Aluminum consistently meets all three of their allocations. Spokane County’s Regional Water Reclamation Facility appears to be meeting their allocations as well. Inland Empire Paper (IEP) is meeting their ammonia limit, and is almost meeting the total phosphorus target. IEP’s challenge is the CBOD allocation, which is expected since their wastewater is from processing wood. Liberty Lake’s facility is meeting ammonia and CBOD, but remains a little high on phosphorus. The City of Spokane RPWRF is close to meeting their ammonia and CBOD targets but the phosphorus levels are higher than the allocation.

These nutrient reductions have occurred even though the SCRWRF is the only facility using tertiary treatment. Liberty Lake is currently constructing their tertiary treatment facility, and it should be online in 2018. The remaining three facilities (Kaiser, IEP, and the City of Spokane) are continuing to design or initiate preliminary construction for their upgrades. All facilities have compliance schedules to meet the TMDL wasteload allocations which are expected to be met by March 2021.

The nutrient reductions achieved by the dischargers to date are reflected in the data from the four monitoring locations on the Spokane River. Figure 47 and Table 10 show the reductions in average total phosphorus concentrations achieved between 2000 and 2013-2014 and 2015-2016 at the monitoring sites. Total phosphorus concentrations at the riverine assessment point are also trending lower and is discussed in more depth below.

Nonpoint Sources - Load Allocations

TMDLs assign load allocations to nonpoint sources of pollution. The load allocations for the Spokane TMDL were assigned to the three tributaries (Hangman Creek, Little Spokane River, and Deep Creek), groundwater upstream of Lake Spokane, and the Lake Spokane watershed combined with groundwater. The allocations depend on the season and are divided into March-May, June, and July-October. Allocations exist for both total phosphorus concentration and load.

Nonpoint source loading amounts (determined by multiplying flow by concentration) included in this report are representative of a single point in time and may not be representative of conditions. Ecology collects samples once a month from the mouths of the tributaries, so much of the variability in nutrient concentration and flow may be missed. More frequent data collection, such as that planned for the 10-Year Assessment, would be required to determine compliance with the concentration and load allocations.

Discussion of the progress each tributary or segment is making toward their respective allocation follows. Because weather conditions in 2015 were hot and dry, a brief comparison of data from this year in relation to the load allocation, which is based on a low-flow year, is also provided.

Hangman Creek

The total phosphorus concentration allocations for Hangman Creek range from 0.113 mg/L during March through May to 0.030 mg/L in July through October. In general, total phosphorus concentrations have declined since 2010 (Appendix A, Table A-6). Since 2010, Hangman Creek met the allocation in the March through May time period 43 percent of the time, 57 percent in June, and 71 percent of the time in July through October. We see from Figures 36 through 38 that total phosphorus concentrations, for the most, are related to flow volume. Therefore, exceedances are likely due to high flow and runoff events such as that produced during the storm event in June 2015.

Total Phosphorus load allocations for Hangman Creek from the TMDL are listed in Table 18 along with loading estimates from 2012 to 2016. The load estimates are based on seasonal average total phosphorus concentrations at the mouth of Hangman Creek and the average seasonal flow for each year. These loading estimates illustrate the variability in Hangman Creek that is the result of flow changes and the amount of run-off. During July through October, the loads appear to be decreasing and fluctuate less, which is to be expected during low flow conditions. However, because the loads in general decreased from 2012 to 2016 during July through October season, this may infer that efforts to reduce nutrients are working, but may also be confounded by weather patterns. The continuing challenge is to reduce run-off and streambank erosion which carry phosphorus and other pollutants during higher flows.

Table 18. 2012-2016 Hangman Creek total phosphorus loads and TMDL load allocations

Season	Allocation (lb/day)	2012 (lb/day)	2013 (lb/day)	2014 (lb/day)	2015 (lb/day)	2016 (lb/day)
March – May average	140.2	147.8	116.0	123.0	44.6	199.7
June	7.5	16.9	10.1	7.4	12.7	5.0
July – October average	1.4	5.2	3.2	1.6	0.4	0.7

When comparing allocations during low flow years (the Allocation and 2015 columns in Table 18), we see that in 2015 the only exceedance of the load allocations appears in June, which was from a storm event. The same holds true when comparing concentrations. However, the meteorological conditions are a likely factor in the apparent compliance with the allocations. January through March 2015 was wetter and warmer than in 2001, so the precipitation likely fell as rain and soaked into the ground resulting in little run-off, whereas in 2001 snow accumulated and once it melted, run-off likely occurred.

Little Spokane River

The following comparisons between recent data and the TMDL allocations will be outdated once Ecology completes the draft dissolved oxygen and pH TMDL for the Little Spokane River. The draft TMDL should be available in late 2018. The conclusions in the TMDL will supersede the following information since the TMDL is based on a more robust data set than what was used for this comparison.

The total phosphorus concentration allocations for the Little Spokane River range from 0.034 mg/L in March through May to 0.016 mg/L in July through October. The number of concentration allocation exceedances appear to have declined since 2012. Since then, total phosphorus concentrations have typically exceeded the allocation during the March through May timeframe. There have been no violations of the July through October concentration allocation since 2011. The only year appearing to meet the concentration allocations for all three seasons is 2014.

Total Phosphorus load allocations for the Little Spokane River from the TMDL are listed in Table 19 along with average loading estimates from 2012 to 2016. The load estimates are based on seasonal average total phosphorus concentrations at the mouth of the Little Spokane River and the average seasonal flow for each year. You can see that the June 2015 storm event captured during the routine monitoring greatly increased the loading. If we did not sample right after that June storm, it may have appeared as if the June load allocation had been achieved. However, because the storm event was monitored and there is a large amount of variability in the March to May seasonal load, we can see that more work is likely needed to control pollutants from run-off in the watershed. The load allocation for the July through October season appears to have been met since 2014, and will be verified in the draft Little Spokane River TMDL and during the 10-Year Assessment.

Table 19. 2012-2016 Little Spokane River total phosphorus loads and TMDL load allocations

Season	Allocation (lb/day)	2012 (lb/day)	2013 (lb/day)	2014 (lb/day)	2015 (lb/day)	2016 (lb/day)
March – May average	102.5	250.6	176.1	91.1	92.7	232.9
June	53.9	110.1	60.2	60.1	650.6	38.8
July – October average	32.2	38.3	40.6	26.8	19.2	20.9

When comparing allocations from low flow years (see the Allocation and 2015 columns in Table 19), June 2015 appears to be the only season when the allocation was not met. Although June 2015 was both drier and hotter than in 2001, the higher load resulted from the run-off conditions during a storm event. It is unclear if the drier weather conditions contributed to the lower loads during the March to May and July to October seasons. In general, as with Hangman Creek, the data suggest that high flows and run-off carry higher total phosphorus concentrations.

Deep Creek

Preliminary data suggests that the assumptions Ecology made during development of the TMDL about nutrient contributions to the Spokane River from the Deep Creek and Coulee Creek system are incorrect. Total phosphorus concentrations appear to be lower in the spring and higher during the other times of the year. To illustrate this, Coulee Creek total phosphorus concentrations during the June and July through October seasons were higher than the allocations, but total phosphorus during the March through May season was lower than the allocation.

Approximately seven miles upstream from the confluence with the Spokane River, Deep Creek appears to have lower concentrations than all the seasonal allocations. Very preliminary data taken near the mouth during the groundwater study shows that the total phosphorus concentration was higher than the allocation.

We are working to determine the phosphorus contribution from the Deep Creek watershed to the Spokane River. Little conclusions can be drawn by comparing the sparse and preliminary data from Deep and Coulee creeks to the TMDL targets. Flow data were not collected when the samples were taken, so loading estimates are not possible. Any conclusions are further complicated by the fact that both creeks have infrequent and brief surface flows that reach the Spokane River.

Groundwater

Total phosphorus concentrations in groundwater may be declining. Table 16 shows that the highest total phosphorus concentration in groundwater from one highly unusual well sampled by Spokane County declined from 0.352 mg/L in 2010 to 0.062 mg/L in 2016. Some wells have total phosphorus levels higher than the seasonal allocations for groundwater upstream of Lake Spokane, with most wells typically around 0.010 mg/L. The TMDL allocation ranges from 0.0081 to 0.0076 mg/L depending on the season.

Soluble reactive phosphorus concentrations in groundwater from the northern shore of Lake Spokane also appear higher than the TMDL target. As discussed earlier, in the Suncrest area groundwater collected in the spring of 2015 had soluble reactive phosphorus average concentrations of 0.056 mg/L. This concentration is double that of the 0.025 mg/L allocation, although the TMDL allocation is for total phosphorus. The USGS's ongoing groundwater sampling effort is crucial to understanding if the 2015 data is typical, and determining the groundwater phosphorus loading to the lake.

Spokane River and Riverine Assessment Point

As discussed in the Data Observation sections, the summer total phosphorus concentrations in the river, with the exception of a few samples, are trending downward at the Idaho-Washington state line, Greene Street, Riverside State Park (see Figure 47 and Table 10), and the riverine assessment point below Nine Mile Dam (Figure 57). Since 2000, Greene Street and 'below Nine Mile Dam' locations continue to see drops in August and September average total phosphorus concentrations. The average concentration at Greene Street in 2000 was 0.013 mg/L and the 2015-2016 average was 0.004 mg/L; a 71 percent decline. Below Nine Mile Dam, the average concentration was 0.024 mg/L and in 2015-2016 the average was 0.013 mg/L; a 46 percent reduction.

In terms of loading, the largest total phosphorus load reduction was observed at the Riverside State Park monitoring location, which is due to both the diversion of water from the City of Spokane's RPWRF to Spokane County's SCRWRF and the City of Spokane RPWRF's use of chemically enhanced primary treatment. This reduction is nearly 49 percent! Figure 66 shows the decline in total phosphorus concentrations since 2012 at Riverside State Park. This figure also shows that there is less variability in concentrations since 2012, despite the fact that the Riverside State Park monitoring location is also downstream of Hangman Creek and 2012 was a high flow year with over four and a half inches of rain in March. Figure 66 shows about a 0.025 mg/L reduction in total phosphorus in March between 1988-2010 and 2012-2016 timeframes. This could infer that the Spokane River buffers the impact of Hangman Creek, upstream point sources are the dominant influence at Riverside State Park, nutrient reduction activities are having the desired effect, or a combination of these.

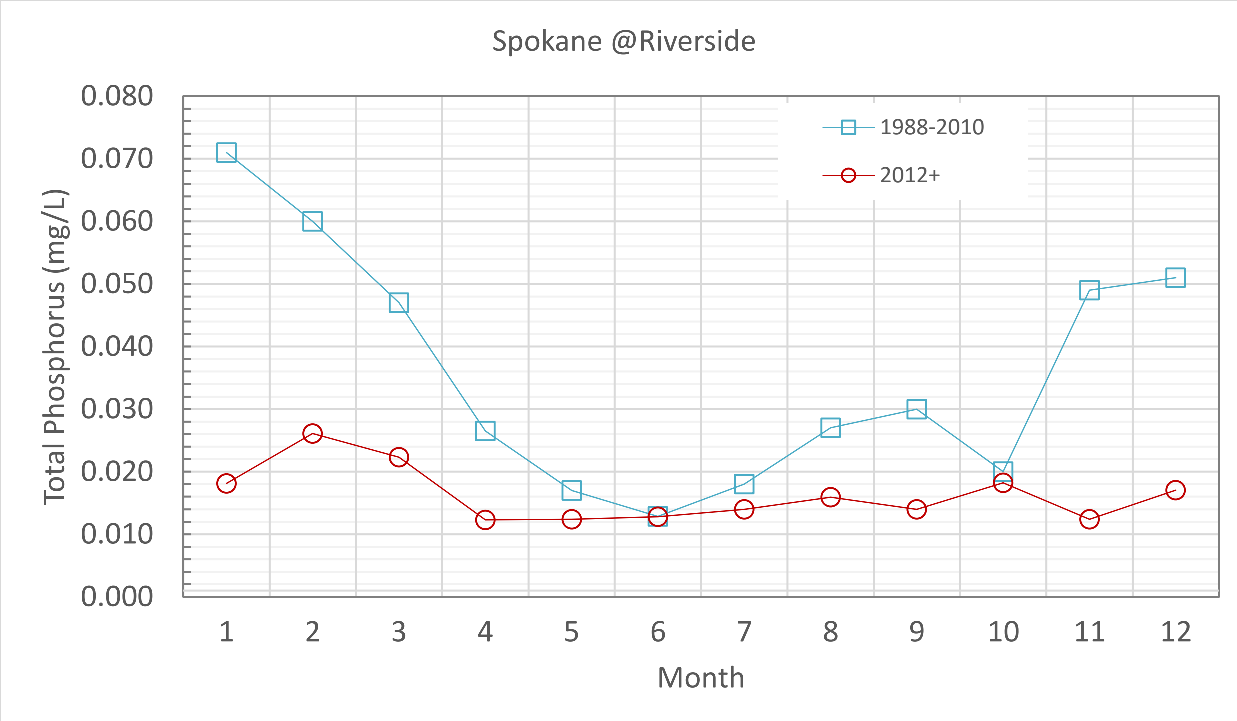

Figure 66. Monthly total phosphorus concentrations in the Spokane River at Riverside State Park

When the Spokane River and tributary monitoring locations drainage areas are normalized, we see Hangman Creek and the Little Spokane River carry the highest suspended solids load typically in March (Figure 49), which coincides with the time of year these creeks carry the highest phosphorus load (Figure 51). Therefore, total phosphorus loads carried by these creeks are associated with sediment so we need to work to control run-off and erosion during high flows and storm events.

At the riverine assessment point downstream of the Nine Mile Dam, total phosphorus concentrations at this assessment point have not yet met the 0.01 mg/L (10 µg/L) target established by the TMDL. Since April 2014, the majority of the average flow-weighted total phosphorus concentrations are less than 0.020 mg/L. The trendline associated with the data is also less than 0.020 mg/L (Figure 57). The June 2015 storm event that we captured in the Little Spokane River, was evident in Figure 57 which seems to suggest that the Little Spokane River has a big impact on the Riverine Assessment Point.

Lake Spokane

The two deepest and furthest downstream Lake Spokane monitoring sites (LL1 and LL0) continue to experience the lowest dissolved oxygen levels in the hypolimnion. Years with higher flows, such as 2011, help keep dissolved oxygen levels in this bottom layer higher. In the past seven years, minimum volume-weighted dissolved oxygen in the hypolimnion near Long Lake Dam ranged from about 2.5 to almost 6 mg/L (Figure 58), with 2015 levels being the lowest. Minimum volume-weighted dissolved oxygen concentrations in the hypolimnion were lowest at all stratified stations in 2015 due to the early run-off and hot, dry conditions.

Mean summer total phosphorus concentrations in the epilimnion show a slight downward trend through the reservoir (Figure 67). In other words, LL5 near Nine Mile typically has higher total phosphorus concentrations in the top layer of the lake, and LL0 near Long Lake Dam has the lowest concentrations. Figure 67 also shows that 2016 had some of the lowest total phosphorus concentrations in the epilimnion, or top layer of the lake, during the previous seven years.

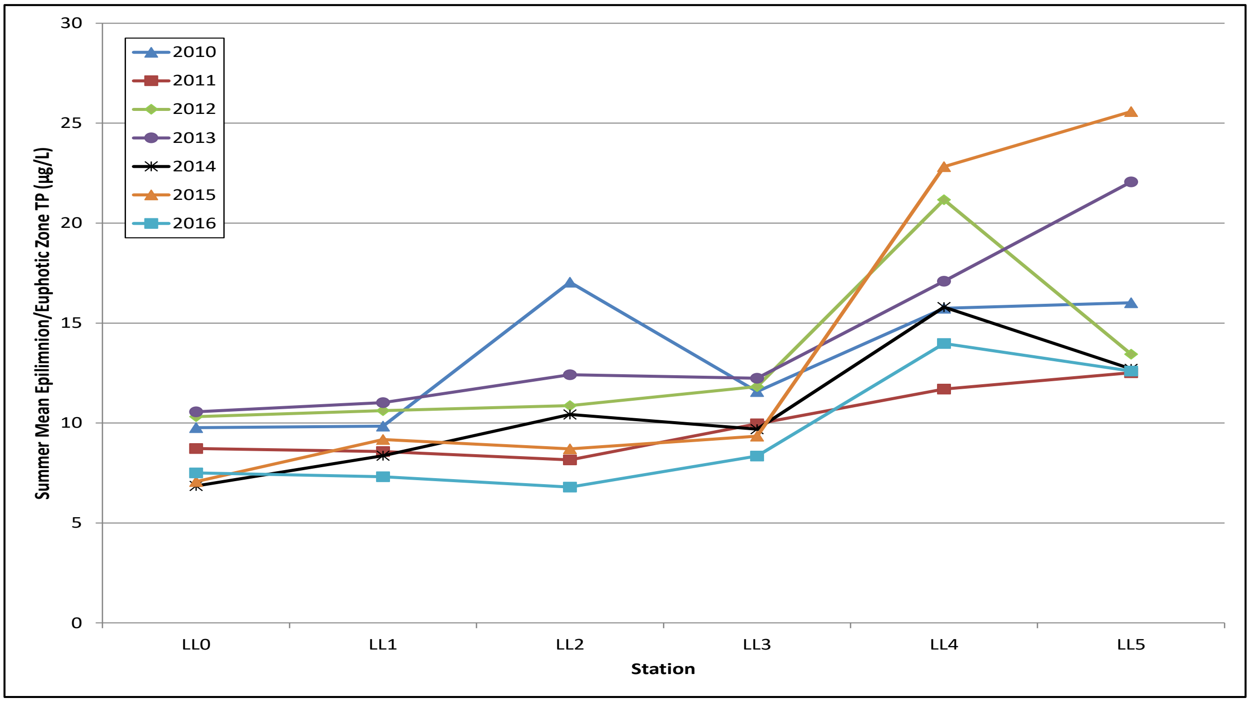

Figure 67. Summer mean epilimnion total phosphorus (TP) concentrations, 2010-2016
(Data is presented from down reservoir to up reservoir left to right.)

Welch et. al. (2015) compared Lake Spokane data recently collected by Ecology and Avista (2010-2014) with historic data (1972 to 1985) compiled in Patmont (1987). The comparison indicated that Lake Spokane has recovered from hyper-eutrophy to meso-oligotrophy and that annual volume weighted average minimum hypolimnetic dissolved oxygen has greatly increased between these two timeframes. The study also found that detection of future improvements of hypolimnetic dissolved oxygen may be masked by annual variable flows and concentrations and impacts of varying hydraulic residence times.

Perhaps another indicator to show improvements is in the frequency of toxic algae blooms. As mentioned earlier, only five algae samples have been taken and submitted to the lab for toxicity analysis since 2012. Four of those five samples were taken in 2015 when conditions were unusual due to an early run-off and hot, dry weather. Three of the four samples tested positive for microcystin, which is a toxin. Previous to 2012, 13 algae samples were collected since 2009. Therefore, the frequency of algae blooms that persist long enough to be sampled for toxicity is decreasing in the lake.

In summary, the implementation activities seem to be reducing nutrients, which is most evident during the July through October timeframe. However, the low precipitation, hot summers experienced recently likely play a role in the observed reductions. Much work remains to be done to control total phosphorus from nonpoint sources during runoff and storm event conditions.

TMDL Milestones

The Introduction section of this report listed the five-, ten-, and fifteen-year TMDL milestones. Comparing the first six years of implementation with the five-year milestones shows that implementation is generally on target:

- NPDES permittees are operating within interim limits, including submitting best management or annual plans, and making progress toward installing tertiary treatment. The need for the dischargers to start, continue, or complete target pursuit actions is uncertain, since the allocations may be met by installing tertiary treatment.

- Avista sent their Ecology-approved Dissolved Oxygen Water Quality Attainment Plan to FERC in the beginning of October 2012.

- Multiple non-discharger groups are working to reduce nonpoint source pollution. The group of 21 entities participating in the Greater Spokane Regional Conservation Partnership Program dedicating over $14 million toward nonpoint source reduction provides an excellent example. Over 300 nonpoint source reduction projects have been completed between 2010 and 2016. These projects reduce pollution from a variety of sources, such as on-site septic systems, livestock, residential yards, grain crops, and forestry.

- As described previously, many groups collect water quality data throughout the basin. Ecology continues to monitor at least five locations monthly.

- Work on the tributary TMDLs is progressing. Ecology should have a draft of the Little Spokane River dissolved oxygen and pH TMDL ready in late 2018. Targeted studies are underway in the Hangman Creek watershed to help understand possible sources. However, nonpoint source reduction work continues to take place in the tributaries.

Nonpoint Source Phosphorus Reduction Plan

The Spokane River Watershed Nonpoint Source Phosphorus Reduction Plan (NPS Plan) (Geoengineers, et al 2011) recommended several best management practices (BMPs) and nonpoint source reduction activities within each sub-basin. The plan took a comprehensive look at land uses and applicable BMPs. The plan prioritized working along Hangman Creek, the Little Spokane River, and the upper Spokane River in Washington. Establishing buffers and stabilizing stream banks are the top recommended BMPs in each sub-basin because of the low cost and effectiveness in reducing nutrients.

From protecting riparian areas to direct seeding, infiltrating stormwater, and rehabilitating forest roads, the actions taken to reduce nutrients are consistent with the NPS Plan recommendations. As demonstrated previously, various groups have completed several projects that planted and protected riparian buffers; advanced direct seeding; reduced stormwater; and improve forest roads.

Monitoring Recommendations

Over nine different entities monitor some part of the basin, so the primary recommendation is to hold monitoring coordination meetings to discuss:

- How to enhance current monitoring efforts, such as coordinating sample collection on one day to get a synoptic data set of the entire basin.
- Verify who is collecting what data.
- Identify any other data the entities should collect or do while monitoring.
- Identify data gaps.
- Determine if resources should be refocused.

Another recommendation is to sample for phosphorus and other nutrients in the tributaries and river during springtime high flows. Nutrients carried by the high flows can linger in Lake Spokane and become trapped when the lake stratifies. Understanding where high nutrient concentrations come from in the spring can pinpoint where implementation efforts should occur.

Monitoring groundwater along Lake Spokane shorelines with housing developments, such as the Nine Mile community is recommended. If groundwater is found to contain low levels of nutrients, the monitoring results can be used for future model updates or sensitivity analyses. On the other hand, if groundwater contains higher nutrient levels, then working with the communities to reduce the nutrients will lead to water quality improvements in the lake.

2015-2016 Update
The Spokane Dissolved Oxygen TMDL Monitoring Workgroup met several times during the last biennium. This group drafted a 10-Year Assessment Goals and Objectives working document. This document contains various objectives for determining if the implementation actions led to increased dissolved oxygen in Lake Spokane. Some objectives require a comparison to a baseline condition; therefore, some monitoring recommendations from this document are:

- Evaluate the number and frequency of blue-green algae blooms.
- Conduct studies to determine if beneficial uses protected by the water quality standards are protected.
- Collect water quality data for specific parameters at specific locations over time to conduct a trend analysis.

Ecology is performing a literature search in an effort to identify various methods to assess if the implementation actions have resulted in success with the TMDL. The literature search should be complete in spring 2018 and may identify additional monitoring recommendations.

As part of planning for the 10-Year Assessment, Ecology will need to assess how frequently data should be collected. Samples will need to be taken more than once a month during some months of the year in order to capture the variability in water quality.

Funding

The amount of money groups have spent toward reducing phosphorus is significant, and the amount will greatly increase within the next several years. The resources being applied to implementation activities indicates the community's dedication and level of effort toward improving water quality.

Between 2010 and 2016, Ecology provided almost $211 million toward water quality improvement in the entire Spokane basin (the Spokane River, Hangman Creek watershed, Little Spokane River watershed, and Lake Spokane). Ecology's funding includes grants, loans, and forgivable principal among five general categories to improve water quality (Figure 68):

- Reducing combined sewer overflows
- Upgrading wastewater treatment plants
- Treating and reducing stormwater
- Replacing or removing septic systems
- Installing nonpoint source best management practices

Comparing the amount of money spent on each category is not necessarily representative of how much work all the groups accomplished. This is because there is a large disparity between project costs. For example, a wastewater treatment plant upgrade is much more expensive than installing nonpoint source best management practices such as erecting fences and planting trees and shrubs. A list of Ecology funded projects is provided in Appendix E. A summary of the number of projects and Ecology money spent by project category is included in Table 20. As of 2016, stormwater projects are the most common with 35 projects, followed by 20 nonpoint source projects and 17 wastewater treatment projects. It is unknown how much of the available funding recipients have spent.

Ecology supplies only some of the money used to improve water quality in the basin. Many other sources also contribute, such as funding recipients, businesses (which do not qualify for Ecology funding), the Washington State Conservation Commission, landowners and rate payers, Washington State Department of Commerce, the State of Idaho, etc. For example, Ecology grant recipients are required to contribute 25 percent match toward the project. For the eight non-point source projects awarded between 2015 and 2016, the recipients must collectively add over $345,000 as either cash match or in-kind contributions. In addition, loan recipients must pay back the loan. Table 21 provides a list of non-Ecology funding that some entities within the Spokane basin have contributed toward water quality improvement. The total amount of non-Ecology funding listed is over $226 million. Not accounted for in Table 21 are the hours volunteers have spent on some projects such as the annual Willow Warrior event, or working on behalf of The Lands Council.

Finally, as indicated previously, efforts to reduce nutrients in the Spokane basin began before 2010, so the amount of money spent toward water quality improvement is much higher than indicated here. The following list is a small example of the funding spent between 2001 and 2009:

- The City of Spokane spent over $107 million on upgrades to the Riverside Park Water Reclamation Facility to improve effluent water quality; $6 million to reduce combined sewer overflows; $1.7 million to reduce stormwater flows; and $4.3 million on sanitary sewer aquifer protection projects.
- The City of Spokane and Spokane County contributed $55 million toward their Septic Tank Elimination Program.
- Collectively, the City of Post Falls, Hayden Area Regional Sewer Board, and Liberty Lake Sewer and Water District funded $15.6 million in wastewater treatment upgrades.

Figure

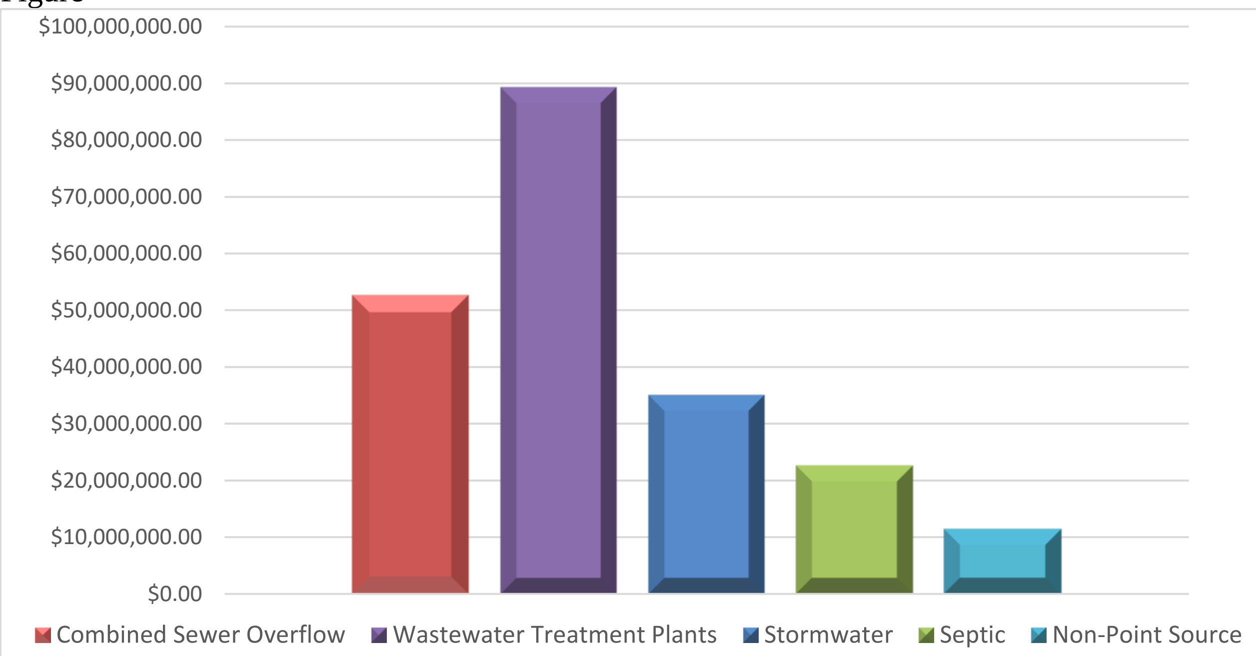

Figure 68. Ecology funding in the Spokane watershed by project category

Table 20. Ecology funding by project category in the Spokane watersheds

Funding Category	2010-2014		2010-2016		Increase Since 2014
	# projects	Funding	# Projects	Funding	
Nonpoint Source	11	$ 9,931,897	20	$ 11,464,468	$ 1,532,571
Septic replacement / sewer hook-up	3	$ 21,691,000	4	$ 22,571,409	$ 880,409
CSO	8	$ 44,244,957	11	$ 52,664,272	$ 8,419,315
Stormwater	18	$ 22,976,729	35	$ 35,083,995	$ 12,107,266
Municipal Wastewater Treatment	10	$ 32,435,145	17	$ 89,243,818	$ 56,808,673
Totals	$131,279,728		$211,027,962		$79,748,234

Table 21. Non-Ecology funding spent by category

Type	Entity	Activity or Project Name	Expenses 2010-2014	Funding Source	2010 - 2016 Category Totals
Nonpoint Source	Spokane Conservation District	Spokane County Livestock and Land Program	$30,000	landowners & SCD	
	Spokane Conservation District	Bear Creek Livestock BMP Continuation	$42,000	landowners & SCD	
	Spokane Conservation District	Hangman Creek Phosphorus Reduction	$32,000	landowners & SCD	
	Spokane Conservation District	Hangman Creek TMDL Implementation Project	$62,500	landowners & SCD	
	Inland Northwest Land Conservancy	Hangman Creek private land conservation and restoration	$60,242	Private foundations and individuals	$ 226,742
Septic	City of Spokane	Haven Street Septic Removal	$96,000	Utility Rates	$96,000
Combined Sewer Overflow	City of Spokane	CSO Basins 38-39-40 Control Facilities	$2,000,000 $1,836,500	PWTF Utility Rates	
	City of Spokane	CSO Basin 10 Control Facility	$653,200	Utility Rates	
	City of Spokane	CSO Basin 34-2 and 34-3 Control Facilities	$627,300	Utility Rates	
	City of Spokane	CSO Weir Modifications	$1,349,800	Utility Rates	$ 6,466,800
Stormwater	City of Spokane	Lincoln SURGE	$1,131,500	Utility Rates	
	City of Spokane	Broadway SURGE	$362,200	Utility Rates	
	City of Spokane	14th and Lindeke Stormwater Improvements	$236,200	Utility Rates	
	City of Spokane	16th Ave from Chestnut to Inland Empire Way	$147,200	Utility Rates	
	City of Spokane	SVI Stormwater Improvements	$61,200	Utility Rates	
	City of Spokane	Kendall Yards Stormwater Tank	$128,600	Utility Rates	
	City of Spokane	Summit-Nettleton (formerly Bridge Avenue) LID project	$197,200	Utility Rates	
	City of Spokane	Hazel's Creek LID Demonstration Project and Third Detention Pond	$693,600	Utility Rates	
	City of Spokane	Street Tree Inventory	$250,000	Utility Rates	
	City of Spokane	Vactor Waste Decant Facility	$769,900	Utility Rates	$3,977,600
Municipal and Industrial Wastewater Treatment Plants	Kaiser	Conversion to air cooling - discharge reduction	$733,000 [1]	Industry	
	HARSB	PHASE IIIC -Oxidation Ditch/Clarifier	$ 66,489	Cap Fees	
	HARSB	Long Range Facility Plan	$ 254,047	User/Cap Fees	
	HARSB[2]	Biological Nutrient Removal Phase I Facility Upgrade	$ 8,426,552	Entity DEQ Loans/Cap Fees/ User Fees	
	City of Post Falls	2011 Facility Plan	$ 214,000	Ratepayers	

Type	Entity	Activity or Project Name	Expenses 2010-2014	Funding Source	2010 - 2016 Category Totals
	City of Post Falls	2011 AlgEvolve Pilot Test	$ 56,000	Ratepayers	
Municipal and Industrial Wastewater Treatment Plants (cont.)	City of Post Falls	2014 Phase I Design	$ 720,000	Ratepayers	
	City of Post Falls	2014 Phase I Construction	$ 13,974,714	Ratepayers/Idaho SRF loan	
	City of Spokane[3]	Riverside Park Water Reclamation Facility Upgrades	$42,030,600	Utility Rates	
	Spokane County[3]	Spokane County Regional Water Reclamation Facility project	$170,000,000	Ratepayers	$ 236,475,402

[1] Cost does not include third party costs for modifications to an on-site leased facility

[2] HARSB Construction Costs are through 2/2015, with estimated phase 1 total $15,756,914.37;
Due to being a Joint Resolution Non Taxing Entity HARSB cannot Bond or take out Loans

[3] Capital costs only. Does not include operations and maintenance or finance charges.

Future Outlook

Nonpoint sources

Ecology plans to continue tracking nonpoint source BMP implementation activities that groups in Washington and Idaho complete each year. Implementation partners will continue to provide a list of their completed activities to Ecology. Ecology will combine all the information into a master spreadsheet. In late 2015 or 2016, the Spokane River Forum will use the database to create an interactive map showing the locations of the BMPs. The map will be available online so the public can see what work has been accomplished and where. Ecology will also use the map to help identify where to focus future education or BMP installation activities.

Ecology is working with the Spokane Dissolved Oxygen TMDL Nonpoint Source Workgroup (NPS Workgroup), which is a subset of the advisory group. The NPS Workgroup is meeting to establish interim targets or milestones that indicate measurable progress toward achieving the TMDL allocations. Ecology expects the milestones to be in place by 2016.

For projects completed beginning in 2015, the NPS Workgroup decided to use a simple spreadsheet model, STEPL, to estimate the phosphorus reductions from implementation projects. STEPL stands for Spreadsheet Tool for the Estimation of Pollutant Load. The purpose for using this model is to have a consistent methodology for tracking progress that everyone working to install BMPs can use. The phosphorus reduction tool helps us by:

- Recording how much phosphorus is being prevented from entering surface water due to the BMPs.
- Identifying effective BMPs.
- Demonstrating the level of effort to control nonpoint source pollutants.
- Being consistent so we can compare different parts of the watershed.

STEPL will not gauge compliance with the TMDL; only monitoring data gathered from established monitoring sites at the mouth of the tributaries will be used to determine compliance.

Another activity expected to help with TMDL compliance is that Stevens County is in the process of updating their Shoreline Master Program (SMP). The SMP plans for development while providing protections for shorelines so they are able to resist erosive forces of water as well as retain vegetation to filter and take up nutrients. This SMP update will apply to the northern shoreline of Lake Spokane, which will help control nutrients from new or expanding developments.

Ecology anticipates that work to reduce nonpoint sources of phosphorus will gain momentum in the coming years. As more people become aware of the BMPs that both reduce nutrient pollution and provide benefits to them, the amount of implementation activities will increase. Outreach activities and data from monitoring projects are essential to increasing the public's awareness, and should be a focus for groups working to reduce nonpoint sources of phosphorus.

2015-2016 Update

The implementation tracking database is being revised to include the ability to track measures for related initiatives, namely the Regional Conservation Partnership Program (RCPP) and Voluntary Stewardship Program (VSP). The TMDL, RCPP, and VSP call for the application of similar best management practices, but they have different accountability measures. Instead of having three databases that track the same things, it seemed more prudent to have one database that was capable of reporting information different ways. Therefore, the decision was made to take a step backward and create a database that would fulfill the needs of all three initiatives. The online GIS map of the implementation projects is also delayed, but Ecology anticipates the map should be available online sometime in 2019.

The three initiatives, particularly the RCPP program, should result in the adoption or application of a significant number of BMPs that will improve water quality. RCPP is available in Washington and Idaho, and although the BMPs could be widely distributed, over $15 million are targeted for water quality improvement. Ecology believes this investment and work will result in nutrient reductions over time.

The NPS Workgroup established some interim targets and proposed measures to meet those targets (Table 22). For most measures, the database upgrade is needed to provide accurate information. This is because some of the metrics are not yet reported consistently. For example, streambank restoration and riparian planting are currently reported in feet, acres, or miles. To track contiguous areas with BMPs, the online map will be needed to determine that information. A more robust discussion of the completed BMPs in comparison to the goals in Table 22 is anticipated in the 2017-2019 biennial report.

Table 22. Nonpoint source interim targets and measures

Interim Targets	Measure / Goal
Type and # of BMPs Installed	# of feet of additional streambank restoration on (each?) tributary
	# of square feet of riparian buffer
	Number of acres of direct seed
	# acres of impervious ground treated
	acceptable ratio of what is planted to what is established
Increase in Public's Perception & Knowledge	__% of public attitude change
	# of education materials distributed
	# of landowners worked with
	# of BMP pledges
Increase # of Areas with Contiguous BMPs	

Unfortunately the STEPL model has not been applied to many of the completed nonpoint projects. Only those BMPs installed with federal grants or state money used to match the federal grants, have used STEPL, but that information has not been reported for use in this report. Water Quality monitoring activities continue, so there are some data to help us track progress of nonpoint reductions. For example, there have been a lot of data collected on the Little Spokane River in preparation for the TMDL, targeted studies are beginning in Hangman, and the Regional

Conservation Partnership Program includes edge-of-field monitoring. These data should help to answer questions about nonpoint source reductions, identify potential sources, and target areas for future implementation activities.

Point Sources

Washington State point source dischargers (Liberty Lake Sewer and Water District, Kaiser Aluminum, Inland Empire Paper, and the City of Spokane) will continue following their compliance schedules to meet TMDL reductions for phosphorus, ammonia, and carbonaceous biochemical oxygen demand. Next steps in the compliance schedules include developing engineering reports, and plans and specifications for new tertiary treatment. Timelines for installing treatment technology vary slightly amongst the dischargers, but the target to meet the final water quality-based effluent limits in 2021 is consistent among the dischargers. Ecology's role in the compliance schedules is to approve reports and plans submitted, as well as reissue the NPDES permits in 2016 with interim limits.

Ecology will reissue stormwater permits in 2019 to the City of Spokane, City of Spokane Valley, Spokane County, and Washington State Department of Transportation (WSDOT). Although the permit for WSDOT is different from the three municipalities, all the permits require monitoring for nutrients and applying stormwater best management practices (BMPs) to reduce nutrients if needed.

According to the Idaho permits, construction of tertiary treatment facilities must be completed by November 30, 2022. Compliance with final effluent limits is set for 2024.

2015-2016 Update

In 2016 in the midst of reissuing the Washington dischargers' NPDES permits, new water quality standards for toxics, such as PCBs, were adopted. These changes prompted Ecology to administratively extend the permits. However, the compliance schedules established in the permits for meeting the TMDL allocations remain in effect. Ecology will continue to expect the permittees to meet the final effluent limits in 2021.

Adaptive Management

Ecology uses adaptive management in TMDLs to assess whether the actions identified to solve the documented pollution problems are the correct ones and whether they are working. Adaptive management allows the fine-tuning of actions to make them more effective; trying new strategies if scientific evidence suggests they could help achieve compliance; or adjusting schedules or plans for installing control actions. The TMDL states that biennial reports, such as this document, should lead to "course correction actions" such as dropping unproductive efforts and adding or enhancing productive ones. At this time, Ecology does not detect any necessary alterations in implementation activities, especially since actions taken to date seem to have resulted in reductions in phosphorus concentrations.

Potential decisions, such as modification of required phosphorus allocations, target pursuit actions, or water quality standards, will not occur until after the ten-year assessment process (Moore and Ross, 2010). Decisions about any adjustments will be based upon an evaluation of the data collected for the target pursuit actions, the biennial reports, and ten-year assessment. Ecology will collaborate with the Spokane River TMDL Advisory Committee when deciding upon any modifications or appropriate actions for the second ten-year implementation period.

Ten-Year Assessment

The concept of a ten-year assessment was developed while working with the Spokane River dissolved oxygen TMDL Advisory Committee. As such, Ecology does not have an established protocol for a ten-year assessment. The TMDL (Moore and Ross 2010) characterizes the ten-year assessment as a data-based, objective review conducted on the data summaries collected to date, monitoring information, and the CE-QUAL-W2 model or its successor. The TMDL also states that the assessment will give particular attention to Lake Spokane's hypolimnion (lowest) layer. The ten-year assessment will consider factors such as how long the treatment technology has been in operation, and whether sufficient data are available to determine river conditions and dissolved oxygen response. This assessment for the TMDL will begin no sooner than 2021.

2015-2016 Update

Ecology has been working with the Spokane Dissolved Oxygen TMDL Monitoring Workgroup (Monitoring Workgroup) to identify goals and objectives of the 10-Year Assessment. The group has a working draft of the goals and objectives in place. The group could update the working draft based on the findings of the literature search currently being performed by Ecology. The purpose of the literature search is to find out if there are other measures or data analysis methods applicable to the Spokane dissolved oxygen TMDL that could help show success in meeting the targets.

The Monitoring Workgroup and Ecology have a flowchart of the steps that will lead up to the 10-Year Assessment. The literature search is one of the identified steps. Other steps include holding a model workshop to determine how the model can support the 10-Year Assessment, identifying monitoring data gaps and needs, collecting data, and preparing quality assurance plans to guide additional work.

2020 TMDL Goals

The TMDL stated the ten-year goals would be accomplished by 2020; however, some goals are slightly delayed since Ecology did not reissue permits with compliance schedules until 2011.

- Achieving the 10 μg/L total phosphorus concentration at the riverine assessment point (downstream of Nine Mile Dam) by 2020 may be achievable. However, consistently meeting the 10 μg/L total phosphorus target may require optimization of all tertiary treatment facilities, and increased reductions in nutrients from Hangman Creek and the Little Spokane River.

- The Washington dischargers will likely have their new technology installed, but due to the need for time to get the plant running properly (called optimization), the dischargers have until 2021 to meet their TMDL allocations. This date is within the permitted ten-year compliance schedule because Ecology did not issue the NPDES permits until late 2011. In 2016, rather than re-issuing the permits, Ecology administratively extended them to address a change in water quality standards resulting from changes to the Human Health Criteria. Ecology plans on issuing Administrative Orders in 2018 to the permittees to continue carrying out the compliance schedule in their permits. Ecology continues to expect that the permittees will achieve TMDL allocations by the end of 2021.

- Avista's water quality attainment plan extends until 2022, so a final evaluation of their activities to improve dissolved oxygen will come after 2020. However, Avista's attainment plan includes annual monitoring to detect nutrient reductions from their activities, so they will have some preliminary information available by 2020.

2025 TMDL Goals

The fifteen-year goal of applying 75 to 100 percent of the necessary BMPs in the Hangman Creek watershed by 2025 is lofty. It is too early to assess whether the target will be met. Eight years remain to implement BMPs, and several groups are expending a lot of effort to expand the application of BMPs within the watershed. The good news is that nutrient concentrations in the watershed appear to be decreasing, so the efforts of the landowners who have installed BMPs is helping.

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Appendices

Appendix A. Monitoring Data

Ecology Ambient Monitoring Data 2010-2016

City of Spokane Data

Ecology Ambient Monitoring Data 2010-2016

The definitions below apply to all of the following tables:

J = estimated value

U = not detected at the reported level

Table A- 1. 57A240 Spokane River @ Lake Coeur d'Alene

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	8:45	60		4		0.01	U	0.023		0.004		11.5		7.99		1				0.005	U	0.12		0.5	
2/8/2010	8:15	58		1	J	0.01	U	0.03		0.005		11.4				2		4		0.007		0.12		1.8	
3/8/2010	8:20	62		1		0.01	U	0.026		0.003	U	11.5		7.87		4		6.8		0.008		0.12		2.5	
4/12/2010	8:30	64		1	U	0.01	U	0.016		0.004		11.4		7.88		1	U			0.005	U	0.09		0.6	
5/10/2010	8:20	58.9		5		0.01	U	0.01	U	0.003		11.2		7.92		2		8.7		0.007		0.05		0.8	
6/14/2010	8:00	56		1	U	0.01	U	0.01	U	0.003	U	10.2		8.19		1	U	14		0.005		0.09		0.7	
7/13/2010	8:45	62		2		0.01	U	0.01	U	0.003		8.5		7.92		2		19		0.009		0.11		0.8	
8/16/2010	8:40	56	J	3		0.01	U	0.01	U	0.004		8.19		7.87		1	U	22		0.007		0.13		0.6	
9/20/2010	9:10			23		0.01	U	0.01	U	0.003	U	8.5		7.44		1	U	17		0.006		0.14		0.6	

Table A- 2. 57A150 Spokane River @ State Line

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	10:15	56		2		0.024		0.06		0.006		12.4		7.58		2				0.01		0.19		0.7	
2/8/2010	9:00	56		1	J	0.013		0.051		0.006		12				2		4.2		0.009		0.15		0.7	
3/8/2010	9:05	58		1	U	0.01	U	0.048		0.003	U	11.8		7.73		2		6.9		0.01		0.19		0.8	
4/12/2010	9:15	58		2	J	0.015		0.044		0.003		11.5		7.66		2				0.007		0.14		1.8	
5/10/2010	9:00	59.8		2		0.015		0.019		0.003	U	11.1		7.75		2		8.9		0.007		0.11		0.9	
6/14/2010	8:50	52		10		0.01	U	0.012		0.003	U	9.89		7.71		2		15		0.007		0.1		1	
7/13/2010	9:30	50		7		0.01	U	0.038		0.004		7.9		7.87		2		21		0.012		0.11		1.1	
8/16/2010	10:00	60	J	5		0.01	U	0.178		0.01		7.8		7.7		1	U	22		0.018		0.26		0.5	U
9/20/2010	10:00			36		0.01	UJ	0.091		0.004		9.5		7.06		2	U	17		0.009		0.18		0.7	
10/12/2010	10:15	66		1		0.017		0.072		0.006		9.1		8.01		1		15		0.011		0.22		0.6	
11/8/2010	11:45	60		1		0.022		0.062				10.3		8.08		1		11		0.02		0.21		1.4	
12/20/2010	12:10	66		2		0.025		0.045		0.006		11.91		7.21		2		4.6		0.009		0.12		1	
1/18/2011	8:45	54		4		0.02		0.04		0.004		12.9		7.92		8		3.8		0.012		0.12		3.1	
2/23/2011	10:20	56		17		0.034		0.088		0.007		12.6		7.74		2		2.2		0.015		0.19		2.7	
3/14/2011	12:00	74		1		0.03		0.097		0.006		12.1		8.43		2		3.4		0.015		0.2		3.5	
4/11/2011	9:55	54		1	U	0.043		0.1		0.01		13.63		7.96		2		4.1		0.014		0.28		3.6	
5/16/2011	10:10	50		3		0.018		0.023		0.004		12.02		7.49				9.2		0.016		0.12		3.3	
6/21/2011	8:05	44		1		0.013		0.01	U	0.009		11.8		7.6		2		13		0.015		0.14		1.3	
7/24/2011	10:30																								
8/15/2011	9:50																								
9/19/2011	10:00	48		10		0.01		0.083		0.005		8.5		7.33		1		19		0.009		0.18		0.6	
10/26/2011	7:30																								
11/30/2011	7:35	58.1		1		0.035		0.067		0.007		10.72		7.92	J	2		6.5		0.013		0.16		1.2	
12/13/2011	7:45	50		1	U	0.033		0.046		0.007		11.25		7.21		2		4.9		0.01		0.13		0.8	
1/10/2012	8:00	45		2	J	0.026		0.055						7.67		2		4.3		0.009		0.1		0.7	
2/14/2012	8:15			1	U	0.061		0.042		0.005		12.52				1	U	3.4		0.01		0.14		0.5	U
3/20/2012	7:15	51		1	U	0.019		0.022		0.003		12.62		7.4		5		3.3		0.012		0.09		1.4	
4/17/2012	7:30	55		1	J	0.015		0.015		0.003		13.13		7.56		3		4.6		0.011		0.07		1.4	
5/14/2012	11:15	46		1	U	0.01	U	0.01	U	0.003		11.71		7.6		3		11		0.012		0.11		2.2	
6/25/2012	11:40	43		5		0.014		0.018		0.004		9.9		7.61		2		15		0.007		0.05		0.9	
7/23/2012	11:15	43		9		0.02		0.061		0.003		7.63		7.63		1		24		0.01		0.13		0.8	
8/27/2012	11:10	49		6		0.014		0.152		0.003	U	8.18		7.77		1	U	22		0.008		0.23		0.6	
9/24/2012	11:15	49		3		0.01	U	0.086		0.004		8.88		7.78		1		18		0.007		0.16		0.7	
10/17/2012	13:15	50		8		0.014		0.09		0.004		10		7.59		1	U	13		0.009		0.15		0.6	
11/7/2012	13:15	47		1	U	0.01		0.038		0.004		10.28		7.79		2		11		0.01		0.1		0.5	U
12/5/2012	12:35	47		1	U	0.017		0.029		0.003		12.121		7.56		3		8.2		0.01		0.09		0.7	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/9/2013	14:41	51		7		0.044		0.068		0.004		12.1		7.42		2		4.9		0.008		0.15		0.7	
2/6/2013	12:50	49		1	U	0.026		0.055		0.003		12.56		7.73		2		4.1		0.009		0.14		0.7	
3/6/2013	12:31	51		1	U	0.025		0.05		0.003		12.22		7.68		2		3.7		0.009		0.14		1.1	
4/3/2013	12:28	53		1	U	0.013		0.014		0.003		12.6		7.63		2		5.4		0.007		0.09		0.7	
5/8/2013	13:08	50		1	U	0.01	U	0.01	U	0.003		11.5	J	7.78		2		10		0.008		0.06		1.2	
6/5/2013	13:45	47		2		0.01	U	0.03		0.004		9.7		7.97		1		16		0.008		0.11		0.6	
7/10/2013	13:10	49		4		0.017		0.066		0.003				7.72		1	U	24		0.006		0.14		0.7	
8/7/2013	13:50	51		4		0.01	U	0.067		0.003	U	8.8		7.78		1	U	24		0.007		0.14		0.6	
9/11/2013	13:15	52		7		0.01	U	0.093		0.003	U	8.8		7.94		1	U	23		0.006		0.18		0.6	
10/15/2013	13:20	53		4		0.01	U	0.102		0.003	U	9.6		8.04		1		14		0.008		0.17		0.6	
11/5/2013	12:05	54		11		0.013		0.066		0.003	U	10.4		7.5		1	U	8.5		0.008		0.14		0.6	
12/3/2013	13:10	53		2		0.026		0.055		0.004		11.2		7.55		1	U	5.5		0.01		0.13		0.5	U
1/7/2014	11:55	54		6		0.03		0.045		0.003	U	11.9		7.5		2		2.9		0.007		0.12		0.8	
2/4/2014	12:35	55		1	U	0.028		0.06		0.004		12.4		7.52				1.9		0.008		0.15		0.7	
3/4/2014	12:10	58		1	U	0.047		0.039		0.004		12.3		7.47		2		2.1	J	0.01		0.14		1	
4/8/2014	13:00	57		1	U	0.01	U	0.013		0.003	U	12.4		7.43		2		6.2	J	0.009		0.09		1.7	
5/6/2014	12:15	49		13		0.017		0.734		0.02		11.6		7.43		14		8		0.035		0.84		5.1	
6/3/2014	12:40	44		3		0.01	U	0.01		0.003		9.5		7.62		2		16		0.009		0.08		0.7	
7/8/2014	12:10			2		0.015				0.003		8		7.59		2		22		0.008		0.12		0.7	
8/5/2014	13:05	50		6		0.011		0.107		0.003	U	7.5		7.8		1	U			0.007		0.19		0.6	
9/9/2014	12:40	50		5		0.01	U	0.091		0.003		8.7		8.03		1		20		0.007		0.16		0.5	U
10/7/2014	12:40	51		3		0.021		0.095		0.004		9.1		7.8		2		17		0.009		0.19		0.5	U
11/4/2014	11:35	52		8		0.012		0.094		0.005		9.7		7.5		1		11		0.011		0.17		0.5	U
12/2/2014	12:20	52		1	U	0.018		0.064		0.003		10.7		7.46		2		5.1		0.006		0.13		0.5	U
1/6/2015	13:00	54		5		0.024		0.055		0.004				7.46		1				0.0072		0.117		0.8	
2/3/2015	11:40	54		1	U	0.01	U	0.039		0.0031		12.04		7.55		1				0.0064		0.092		0.6	
3/3/2015	11:45	53		1	U	0.012		0.038		0.003	U	12.14		7.44		1				0.0084		0.098		0.7	
4/7/2015	12:40	51		1	U	0.015		0.059		0.0032		11.8		7.5		2				0.0086		0.112		1.3	
5/5/2015	12:15	51		1	U	0.021		0.047		0.0032		10.35		7.6		2		12.35		0.0116		0.138		0.9	
6/2/2015	12:00	53		14		0.017		0.053		0.0039		8.46		7.67		2		19.62		0.0095		0.127		0.8	
7/7/2015	12:20	62		12		0.022		0.203		0.0215		7.72		8.1		1		25.99		0.0307		0.298		0.6	
8/4/2015	13:09	66		36		0.015		0.222		0.0249		8.71		8.68		1		23.97		0.0364		0.335		0.9	
9/15/2015	14:00	65		4		0.014		0.26		0.0115		9.3		7.83		1		17.7		0.0198		0.386		0.6	
10/6/2015	12:45	63		6		0.013		0.304		0.0048		9.5		7.49		1		15.7		0.011		0.41		0.6	
11/17/2015	13:20	58		3		0.026		0.12		0.005		10.4		6.99		1		9		0.0097		0.21		0.6	
12/8/2015	13:15	55		4		0.011		0.126		0.0036		10.5		7.05		2		6.9		0.008		0.216		0.9	
1/5/2016	12:30	53		2		0.01	U	0.1		0.0039		11.4		7.38		1	U	4.2		0.0077		0.162		0.5	U

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
2/2/2016	12:10	54		1	U	0.013		0.068		0.0033		12.3		7.01		2		3.9		0.0066		0.141		0.7	
3/8/2016	12:46	55		1	U	0.01	U	0.062		0.003	U	12.5		7.11		2	U	4.3		0.0071		0.137		0.9	
4/5/2016	12:45	54		1	U	0.01	U	0.059		0.003	U	12.5		7.19		2		6.1		0.0108		0.139		1.2	
5/3/2016	12:15	50		2		0.01	U	0.035		0.003	U	10		7.66		2		13.8		0.0103		0.101		1	
6/7/2016	12:40	48		1	U	0.014		0.036		0.0032		9.2		7.71		1		19.7		0.01		0.125		0.8	
7/16/2016	14:00	53		20		0.012		0.169		0.003	U	8.8		7.73		2		20.2		0.0083		0.24		0.5	U
8/9/2016	13:50	57		36		0.01	U	0.226		0.003	U	8.4		7.80		1	U	21.8		0.0074		0.317		0.6	
9/13/2016	13:20	55		4		0.01	U	0.161		0.003	U	9.2		7.96		2		18.3		0.0054		0.246		0.5	U
10/4/2016	13:00	54		6		0.01		0.142		0.003	U	9.4		7.64		1		16		0.0078		0.22		0.7	
11/15/2016	12:55	53		4		0.01	U	0.04		0.003	UJ	10.2		7.60		1		10.9		0.0076		0.111		0.5	U
12/6/2016	13:55	54		1	U	0.01	U	0.07		0.003	U	10.9		7.43		1	U	6.9		0.0061		0.132		0.5	U

Table A- 3. 57A146 Spokane River @ Sullivan Road

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	10:45	68		1	U	0.029		0.137		0.006		12.3		7.59		2				0.011		0.26		0.7	
2/8/2010	9:40	64		1	J	0.015		0.109		0.005		11.8				1		4.8		0.008		0.22		0.7	
3/8/2010	9:40	62		1	U	0.01	U	0.077		0.003	U	11.4		7.73		2	J	6.8		0.009		0.18		0.9	
4/12/2010	10:30	58		1	J	0.01	U	0.048		0.003		11.6		7.66		3	J			0.007		0.14		1.1	
5/10/2010	9:40	60		1		0.01	U	0.018		0.003	U	10.8		7.66		2		9.1		0.007		0.09		1.1	
6/14/2010	10:15	54		5		0.01	U	0.017		0.003		9.49		7.58		3	J	15		0.007		0.1		1.4	
7/13/2010	10:10	58		8		0.01	U	0.078		0.004		7.9		7.77		2		20		0.012		0.17		0.9	
8/16/2010	10:40	102	J	10		0.01	U	0.324		0.008		8		7.68		1	U	19		0.013		0.41		0.7	
9/20/2010	10:50			170		0.01	U	0.213		0.005		9		7.77		1		16		0.009		0.32		0.8	

Table A- 4. 57A140 Spokane River @ Plantes Ferry Park

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	11:30	106		4		0.028		0.306		0.006		11.4		7.72		6				0.01		0.42		0.9	
2/8/2010	10:15	98		1	J	0.017		0.26		0.005		11.2				2		4.7		0.01		0.37		0.7	
3/8/2010	10:10	90		1	U	0.01	U	0.216		0.003	U	10.9		7.74		2		7.1		0.009		0.3		1.3	
4/12/2010	11:00	74		1	U	0.01	U	0.12		0.004		11.2		7.67		2				0.007		0.21		0.9	
5/10/2010	10:20	68		1	UJ	0.01	U	0.058		0.003	U	10.7		7.58		2		9.3		0.007		0.13		1	
6/14/2010	11:00	62		3		0.01	U	0.058		0.003	U	9.39		7.59		2		15		0.006		0.16		1	
7/13/2010	10:45	82		6		0.011		0.249		0.004		8		7.86		2		19		0.013		0.36		1	
8/16/2010	11:30	192	J	3		0.01	U	0.752		0.006		8.4		8.01		1	U	15		0.008		0.81		0.5	U
9/20/2010	11:10			19		0.01	U	0.506		0.005		8.8		7.79		2		14		0.008		0.67		0.6	

Table A- 5. 57A123 Spokane River @ Sandifer Bridge

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	12:20	132		220	J	0.01	U	0.401		0.006		11.9		8.05		2				0.008		0.46		0.8	
2/8/2010	12:30	124		150		0.01	U	0.344		0.005		11.6				2		5.7		0.009		0.43		0.9	
3/8/2010	11:15	112		3	U	0.01	U	0.336		0.003	U	11.1		7.94		2		8.8		0.008		0.39		0.7	
4/12/2010	11:55	88		1		0.01	U	0.184		0.003		12.3		7.77		2				0.007		0.25		0.9	
5/10/2010	11:15	75.8		230	J	0.01	U	0.102		0.003	U	12.1		7.87		2		9.5		0.009		0.2		1.7	
6/14/2010	11:50	72		14		0.01	U	0.106		0.003	U	10.8		7.74		2		15		0.007		0.19		1.2	
7/13/2010	11:50	104		18		0.01	U	0.345		0.003		8.5		8.03		1		18		0.011		0.41		0.6	
8/16/2010	12:30	206	J	8		0.01	U	0.783		0.005		8.8		8.23		1	U	16		0.008		0.87		0.6	
9/20/2010	12:30			500	G	0.01	U	0.613		0.004		9.69		8.18		1	U	14		0.008		0.69		0.5	

Table A- 6. 56A070 Hangman Creek @ Mouth

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	13:00	212		43		0.098		3.08		0.109		12.8		7.92		14				0.22		3.2		85	
2/8/2010	13:00	258		27	J	0.01	U	3.86		0.068		11.6				11		4.4		0.117		4.5		22	
3/8/2010	11:40	270		1		0.01	U	1.95		0.025		11.2		8.23		5	J	8.6		0.054		3.41		8.6	
4/12/2010	12:15	238		10		0.01	U	1.15		0.036		11		8.17		5				0.067		1.34		12	
5/10/2010	11:45	161		4		0.011		0.597		0.044		10		8.03		9		13		0.105		0.81		21	
6/14/2010	12:15	206		59		0.017		0.595		0.068		8.28		7.97		15		19		0.131		0.95		25	
7/13/2010	12:20	266		26		0.01	U	0.224		0.008		11.8		8.73		4		19		0.033		0.48		2.2	
8/16/2010	13:00	435		22		0.01	U	0.84		0.019		11.2		8.44		3		18		0.035		1.06		1.6	
9/20/2010	13:30			130		0.01	U	0.812		0.015		11.9		8.51		4		15		0.028		1.13		2.7	
10/12/2010	11:30	384		24		0.01	U	0.71		0.018		12.2		8.4		1		9.9		0.028		0.98		0.8	
11/8/2010	12:30	356		14		0.01	U	0.564		0.016		12		8.37		1		7.2		0.024		0.64		1.2	
12/20/2010	13:45	214		51		0.054		4.26		0.09		12.81		7.71		5		0.5		0.147		4.94		27	
1/18/2011	10:00	112		340		0.044		3.64		0.085		11.4		8.11	J	172	J	4.8		0.372		4.18		190	
2/23/2011	12:30	220		15		0.01	U	4.77		0.063		12.4		7.81		10	J	1		0.116		5.11		27	
3/14/2011	13:00	152		200		0.025		5.25		0.082		12.3		7.67		203	J	5.2		0.33		5.27		150	
4/11/2011	11:30	180		3	U	0.02		2.99		0.064		14.84		7.53		18		8.6		0.118		3.19		25	
5/16/2011	11:20	192		140		0.027		1.5		0.043		9.49		7.97		13		13		0.093		1.79		13	
6/21/2011	9:15	288		31		0.03		1.44		0.028		8.69		8.41		4		17		0.048		1.83		2.9	
7/24/2011	11:10	313		23		0.019		0.674		0.021		11.7		8.45		9	J	18		0.064		0.97		2.9	
8/15/2011	11:00			16		0.018		0.824		0.033		13.3		8.56		3		17		0.043		1.06		1.7	
9/19/2011	12:00	396		14		0.015		0.862		0.029		10.8		8.32		2		16		0.036		1.09		1	
10/24/2011	14:45	444		5		0.022		0.922		0.02		13		8.63		4	J	10		0.029		1.21		1	
11/28/2011	16:05	353		6		0.01	U	2		0.019						2		4.1		0.029		2.26		1.1	
12/12/2011	16:15	417		1		0.01	U	2.32		0.026		13.79		8.45		3		1.8		0.031		2.54		1.4	
1/25/2012	13:30			12		0.032		3.13				13.05				7		1.8				3.46		9.5	
2/22/2012	14:20	240	J	7		0.023		5.11		0.063		12.3	J	8.16	J	10		3.1	J	0.159		5.24		50	
4/16/2012	16:00	182		16		0.011		2.46		0.057		10.5		8.02		11		9.9		0.107		2.66		17	
5/14/2012	16:20	247		11		0.013		1.77		0.046		9.39		8.42	J	7		19		0.081		1.87		9.9	
6/25/2012	17:15	262		54		0.01	U	0.635		0.022		10.7		8.99		4		21		0.043		0.55		2.3	
7/23/2012	16:15	333		110		0.022		0.755		0.055		10.15		8.73		4		22		0.075		0.97		1.7	
8/27/2012	16:50	389		15		0.015		0.901		0.034		11.31		8.69		5	J	20		0.041		1.06		1.5	
9/24/2012	16:10	384		19		0.016		0.805		0.02		13.88		8.82		2		16		0.027		0.87		1.1	
10/17/2012	16:10	375		22		0.012		0.73		0.02		12.3		8.73		1		12		0.026		0.91		1.2	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
11/7/2012	16:00	358		6		0.01	U	0.905		0.023		12.19		8.72		1		9.6		0.029		1.1		0.8	
12/5/2012	15:20	172		####	J	0.039		5.1		0.079		12.63		7.82		86		5.5		0.349		4.76		210	
1/9/2013	17:20	265		16		0.012		3.97		0.052		12.8		8.01		4		1.5		0.072		4.1		7.2	
2/6/2013	15:58	186		26		0.019		8.46		0.085		12.46		7.81		29		3.3		0.161		8.45		45	
3/6/2013	15:54	155		11		0.013		3.37		0.056		11.667		7.9		36		4.3		0.142		3.63		37	
4/3/2013	15:48	177		2		0.01	U	1.69		0.03		10.9		8.22		7		13		0.059		1.9		13	
5/8/2013	16:28	250		7		0.012		0.816		0.02		11.1		9.07		5		21		0.038		1.1		3.4	
6/5/2013	15:16	311		23		0.029		0.593		0.021		10.2		8.15		5		22		0.042		0.88		2.1	
7/10/2013	17:22	372		27		0.022		0.623		0.04		11.36		8.79		5		23		0.056		0.95		1.9	
8/7/2013	17:46	383		68		0.026		0.674		0.029		11.9		8.8		4		24		0.035		0.94		1.2	
9/11/2013	16:25	396		30		0.017		0.751		0.02		12.8		8.72		1		20		0.029		1.01		0.7	
10/15/2013	16:35	361		13		0.01	U	0.568		0.014		13.3		8.8		2		11		0.021		0.73		0.8	
11/5/2013	15:20	408		100		0.067		0.653		0.018		12.4		8.46		4		4.6		0.036		0.88		4.4	
12/3/2013	16:05	328		6		0.01	U	1.15		0.016		13.9		8.47		3		0.2		0.026		1.31		1.5	
1/7/2014	15:10	266		5		0.032		1.87		0.055		12.7		8.05		5		0.5		0.1		2.12		30	
2/4/2014	16:25			1	U	0.019		2.11		0.066		12.9		8.12		4		0		0.091		2.2		9.4	
3/4/2014	15:10	270		25		0.031		2.39		0.068		12.3		7.92		13		1.6	J	0.116		2.66		23	
4/8/2014	16:47	180		2		0.01	U	1.43		0.035		9.6		8.15		7		14	J	0.076		1.62		16	
5/6/2014	15:15	189		12		0.013		0.388		0.022		9.9		8.75		6		16		0.058		0.63		9.2	
6/3/2014	16:10	312		48		0.019		0.344		0.012		9.6		8.71		6		23		0.038		0.68		2.6	
7/8/2014	15:25	371		52		0.018		0.46		0.017		11.4		8.78		4				0.03		0.75		1.7	
8/5/2014	16:15	424		26		0.019		0.725		0.013		12.2		8.68		5		23		0.02		0.95		2.2	
9/9/2014	15:30	433		17		0.014		0.816		0.011		13		8.67		4		17		0.037		0.99		0.8	
10/7/2014	15:40	425		16		0.014		0.745		0.011		12.3		8.59		1		14		0.018		0.9		0.9	
11/4/2014	14:40	374		110		0.014		0.57		0.025		11.1		8.38		2		9.1		0.033		0.72		2.8	
1/6/2015	15:45	267		59		0.037		2.27		0.0573		12.64		7.97		4				0.0963		2.79		16	
2/3/2015	15:10	188		13		0.01	U	30.5		0.0538		11.84		7.96		10				0.0912		3.62		16	
3/3/2015	14:55	238		5		0.01	U	3.27		0.0445		12.04		8.1		4				0.0715		3.81		10	
4/7/2015	16:15	184		21		0.011		2.65		0.0327		10.1		8.18		11				0.0717		2.68		15	
5/5/2015	15:09	281		3		0.014		0.65		0.0048		10.95		8.9		2	U	17.4		0.0194		0.902		1.1	
6/2/2015	15:15	308		24		0.03		0.939		0.0439		9.25		8.56		6		19.83		0.0739		1.28		9.7	
7/7/2015	15:35	419		21		0.018		0.432		0.0145		12.39		8.63		2		24.17		0.0259		0.656		1.7	
8/4/2015	15:59	430		14		0.012		0.593		0.006		12.38		8.71		3		22.15		0.0152		0.764		1.2	
9/15/2015	17:15	442		24		0.011		0.582		0.0064		13.3		8.56		3		15.7		0.013		0.749		2.3	
10/6/2015	17:40	407		7		0.01	U	0.529		0.0057		13.6		8.55		2	U	11.2		0.0119		0.681		1.1	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
12/8/2015	16:20	349		140		0.01	U	0.362		0.0193		12.4		8.20		4		3.3		0.0318		0.568		2	
2/2/2016	15:45	170		17		0.01	U	6.55		0.0818		12.2		7.22		8		2.5		0.119		6.85		19	
3/8/2016	15:40	158		110		0.01	U	4.61		0.0743						36		6.6		0.181		4.61		65	
4/5/2016	16:20	198		4		0.01	U	3.94		0.0413		13.2		7.89		7		11		0.0779		4.24		9.7	
5/3/2016	15:12	291		9		0.012		1.85		0.0101		10.4		8.84		2		19.8		0.0302		2.35		1.6	J
6/7/2016	16:10	335		31		0.02		0.232		0.0123		11.6		8.97		2		24		0.0346		0.612		1.2	
7/19/2016	17:33	374		46		0.011		0.3		0.0066		11.9		8.78		1		18.6		0.019		0.555		0.7	
8/8/2016	15:45	413		14		0.01	U	0.42		0.0075		13.4		8.76		2		18		0.0108		0.674		0.9	
9/12/2016	15:45	423		20		0.01		0.491		0.0072				8.62		1		14		0.0135		0.746		0.6	
10/3/2016	14:55	399		19		0.013		0.473		0.0076		12.8		8.52		1		10.7		0.0169		0.679		0.6	
11/14/2016	14:30	316		30		0.012		2.06		0.0337		11.6		8.28		1		8.8		0.0542		2.26		4.4	
12/5/2016	15:10	220		59		0.01	U	5		0.0657		12.9		7.88		5		2.2		0.116		5.01		16	

Table A- 7. 54A130 Spokane River @ Fort Wright Bridge

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	13:30	140		150	J	0.01	U	0.534		0.011		12.1		8.07		3				0.019		0.61		4.4	
2/8/2010	14:10	136		100		0.01	U	0.561		0.009		11.7				3		6.1		0.014		0.66		2.2	
3/8/2010	12:30	122		1	U	0.01	U	0.392		0.003	U	11.3		8.3		2	J	9		0.011		0.44		1.2	
4/12/2010	12:50	94		1	U	0.01	U	0.219		0.004		12.1		7.86		3				0.008		0.29		1.7	
5/10/2010	12:10	77.8		120		0.01	U	0.111		0.003	U	12		7.95		2		9.8		0.009		0.18		1.5	
6/14/2010	12:45	76		7		0.01	U	0.121		0.003		10.8		8.02		3		15		0.008		0.2		1.5	
7/13/2010	12:45	108		8		0.01	U	0.352		0.004		8.69		8.27		1		19		0.01		0.45		0.6	
8/16/2010	14:15	194		2		0.01	U	0.83		0.005		9		8.34		1		17		0.009		0.9		0.7	
9/20/2010	14:05			420	J	0.01	U	0.636		0.004		10.4		8.29		2		14		0.008		0.78		0.6	

Table A- 8. 54A120 Spokane River @ Riverside State Park

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	13:55	156		120	J	0.015		1.15		0.062		11.9		8.07		3				0.075		1.25		4.4	
2/8/2010	15:40	146		110		0.019		1.05		0.056		11.8				3		6		0.067		1.2		1.9	
3/8/2010	13:10	132		1	U	0.01	U	0.915		0.043		11.3		8.17		2		9.1		0.053		0.96		1.1	
4/12/2010	13:30	100		1	U	0.01	U	0.524		0.007		12		7.81		3	J			0.014		0.6		2.4	
5/10/2010	13:00	84		75		0.01	U	0.29		0.004		11.6		7.66		2		10		0.012		0.34		1.3	
6/14/2010	13:30	82		20		0.01	U	0.277		0.003		11.11		7.8		2		15		0.01		0.38		1.6	
7/13/2010	13:15	140		11		0.01	U	0.809		0.006		8.8		8.19		1		19		0.017		0.85		0.7	
8/16/2010	14:45	214		3		0.01	U	2.23		0.013		9.9		8.29		8		17		0.053		2.94		1	
9/20/2010	14:40			400	G	0.01	U	1.57		0.01		10.3		7.27		3		14		0.016		1.75		1.6	
10/12/2010	12:20	174		20		0.01	U	1.16		0.006		10.5		8.31		1		13		0.018		1.32		0.6	
11/8/2010	13:00	158		14		0.01	U	1.08		0.047		10.5		8.08		2		10		0.062		1.13		0.9	
12/20/2010	14:40	92		220	J	0.018		0.438		0.015		12.61		7.61		4		5.6		0.022		0.58		1.9	
1/18/2011	10:50	72		51		0.021		0.615		0.023		14.1		8.35	J	30		4.3		0.07		0.71		22	
2/23/2011	13:20	110		1400	J	0.026		0.707		0.034		12.8		7.75		7	J	3.5		0.045		0.81		3.6	
3/14/2011	13:40	106		23		0.02		1.58		0.046		12.1		7.74		56	J	4		0.123		1.73		35	
4/11/2011	12:20	68		1		0.016		0.336		0.019		15.05		7.26		4		5.1		0.031		0.46		4.8	
5/16/2011	12:00	58		64		0.01	U	0.204		0.006		12.72		7.44		7	J	9.7		0.021		0.27		3.9	
6/21/2011	10:10	66		3	U	0.01	U	0.218		0.004		12.9		7.71		2		13		0.011		0.3		1.5	
7/24/2011	12:00	122		19		0.01	U	0.76		0.005		10.8		7.93		1		16		0.014		0.75		0.6	
8/15/2011	11:45			10		0.01		1.7		0.009		10		8.23		1		16		0.014		1.8		0.5	U
9/19/2011	12:45	227		57		0.01	U	1.64		0.012		9.8		8.34		1		14		0.023		1.75		0.6	
10/24/2011	14:00	188		160		0.01	U	1.19		0.006		9.9		7.96		1		11		0.011		1.23		0.5	
11/28/2011	15:35	155		1300	J	0.01	U	1.05		0.008						1		7.7		0.022		1.07		0.6	
12/12/2011	15:30	139		26		0.015		0.771		0.013		12.11		8.06		2		5.8		0.022		0.87		0.6	
1/9/2012	16:30	136		82	J	0.011		0.922						8.06		2		6.1		0.022		1		1.7	
2/13/2012	17:10	133	J	500	J	0.013		1.25		0.016		12.32				4		5.9		0.029		1.34		4.2	
3/19/2012	16:40	69		5		0.019		0.339		0.007		13.73		7.6		11		4.1		0.023		0.42		5.5	
4/16/2012	14:45	70		8		0.011		0.219		0.005		14.64		7.67		6	J	6.1		0.015		0.28		2.2	
5/14/2012	15:35	68		2		0.01	U	0.181		0.005		12.52		7.75	J	6		12		0.013		0.28		2.3	
6/25/2012	16:30	82		3		0.01	U	0.319		0.004		11		7.88		2		16		0.005		0.36		1	
7/23/2012	15:30	142		22	J	0.01	U	0.899		0.008		8.74		8.32		1		20		0.013		0.96		0.6	
8/27/2012	16:05	241		5		0.01	U	1.85		0.007		10		8.42		1	U	16		0.012		1.8		0.5	U
9/24/2012	15:15	200		15		0.022		1.4		0.005		10		8.45		1		15		0.012		1.44		0.6	
10/17/2012	15:35	201		31		0.016		1.43		0.004				8.47		2		12		0.011		1.55		0.5	U
11/7/2012	15:25	121		13		0.013		0.691		0.005		11.083		8.2		1		11		0.01		0.76		0.5	U
12/5/2012	14:35	72		32		0.017		0.413		0.007		12.32		7.79		5		8.3		0.02		0.47		5.8	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/9/2013	16:25	132		31		0.021		0.79		0.008		12.1		7.81		2		5.9		0.018		0.82		1.7	
2/6/2013	15:25	112		4		0.013		1.65		0.016		12.56		7.94		5		5.3		0.032		1.8		6.3	
3/6/2013	15:10	101		7		0.011		0.771		0.009		12.53		7.97		3		5.1		0.019		0.89		3.3	
4/3/2013	14:57	76		4	J	0.01	U	0.281		0.007		13.3		7.8		3		6.9		0.013		0.35		1.5	
5/8/2013	15:45	70		1	U	0.01	U	0.209		0.004		12.2	J	7.84		3		11		0.009		0.26		1.2	
6/5/2013	16:31	106		2		0.01	U	0.511		0.007		10.51		8.14		1		16		0.013		0.59		0.6	
7/10/2013	15:57	189				0.01	U	1.26		0.009		10.15		8.35		1	U	19		0.018		1.32		0.6	
8/7/2013	16:58	199		15		0.01	U	1.46		0.007		10		8.36		1		19		0.013		1.53		0.6	
9/11/2013	15:45	220		31		0.01	U	1.7		0.006		10.4		8.4		2		18		0.014		1.74		0.5	U
10/15/2013	15:20	236		50		0.016		1.45		0.011		9.6		8.13		4		12		0.021		1.46		1.5	
11/5/2013	13:50	155		9		0.01	U	0.902		0.011		10.7		7.95		1		8.4		0.016		0.93		0.5	U
12/3/2013	14:50	146		14		0.013		0.802		0.011		11.5		7.94		2		6.2		0.015		0.86		0.6	
1/7/2014	13:45	156		10		0.029		0.933		0.018		11.8		7.82		2		4.8		0.025		1.03		1.1	
2/4/2014	15:00	155		14		0.029		0.919		0.017		12		7.83		4		3.7		0.024		1		1	
3/4/2014	13:50	133		56		0.031		0.652		0.01		12.4		7.74		7		3.7	J	0.021		0.73		3.1	
4/8/2014	14:55	78		56		0.01	U	0.239		0.005		12.5		7.52		4		7.4	J	0.012		0.31		2.7	
5/6/2014	13:53	66		16		0.02		0.169		0.004		12.3		7.6		5		8.7		0.014		0.23		2	
6/3/2014	14:45	81		22		0.012		0.284		0.004		9.8		7.88		3		17		0.012	J	0.35		0.8	
7/8/2014	13:50	148		5				0.793		0.006		8.6		7.98		2		19		0.01		0.85		0.7	
8/5/2014	14:50	254		7				1.57		0.008		9.1		8.42				18		0.015		1.73			
9/9/2014	14:15	237		8		0.012		1.74		0.008		9.5		8.4		3		15		0.014		1.77		0.8	
10/7/2014	14:20	189		14		0.015		1.15		0.007		9.8		8.16		3				0.012		1.19		0.9	
11/4/2014	13:15	190		48		0.011		1.12		0.01		9.7		8		2		11		0.014		1.18		0.8	
12/2/2014	14:05	140		7		0.041		0.698		0.007		11.2		7.91		3		5.3		0.011		0.79		0.8	
1/6/2015	15:10	104		73		0.021		0.511		0.0047		12.34		7.69		2				0.0127		0.584		1.3	
2/3/2015	14:05	83		1	U	0.01	U	0.339		0.0046		12.94		7.76		2				0.0094		0.394		0.8	
3/3/2015	13:45	93		1	U	0.01	U	0.397		0.0036		13.03		7.77		1	U			0.0096		0.472		0.8	
4/7/2015	15:30	83		7		0.011		0.412		0.0043		12.5		7.66		2				0.0113		0.447		1.6	
5/5/2015	14:25	123		1	u	0.01	U	0.673		0.004		10.25		8.06		2	U	13.26		0.0113		0.706		1.1	
6/2/2015	14:40	118		54		0.01	U	0.595		0.005		9.25		8.17		2		18.01		0.0131		0.665		0.8	
7/7/2015	15:00	267		10		0.042		2.4		0.0221		9.54		8.41		2		17.71		0.0342		2.4		0.5	U
8/4/2015	15:24	283		12		0.01	U	2.55		0.0107		10		8.49		1		16.49		0.0193		3.1		0.7	
9/15/2015	16:31	290		10		0.012		2.53		0.011		10.4		8.3		2		13		0.0186		2.79		0.5	U
10/6/2015	17:00	268		4		0.01		2.51		0.0127		10.8		8.27		2		12.5		0.0203		2.51		0.5	U
11/17/2015	16:10	153		3		0.027		0.954		0.005		10.9		7.51		3		9.3		0.0124		1.03		0.7	
1/5/2016	15:40	125		5		0.01	U	0.795		0.0042		11.6		7.3		1		5.2		0.0137		0.844		0.5	U
2/2/2016	15:05	90		56		0.01	U	0.788		0.0088		12.8		7.05		3		4.6		0.0159		0.878		2.3	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
3/8/2016	15:00	77		39		0.01	U	0.48		0.0162		13.8				3		5.1		0.0223		0.527		4.9	
4/5/2016	15:35	78		86		0.01	U	0.382		0.0044		10.3		7.33		2		7		0.0123		0.454		1.4	
5/3/2016	14:30	98		18		0.015		0.364		0.0034		10.5		7.94		2		15.2		0.0152		0.503		0.8	J
6/7/2016	15:25	106		14		0.01	U	0.499		0.0041		9.4		8.11		2		18.8		0.014		0.626		0.8	
7/19/2016	16:55	207		67		0.01	U	1.44		0.0058		9.9		8.36		2		15.4		0.014		1.42		0.5	U
8/9/2016	16:30	280		9		0.01	U	2.63		0.0096						1		14.5		0.0189		2.78		0.5	U
9/13/2016	15:50	254		16		0.01	U	2.2		0.0077		10.6		8.45		1		14		0.0149		2.33		0.5	U
10/4/2016	16:00	222		38		0.01	U	1.87		0.0097		10.3		8.31		1		12.5		0.0231		1.8		0.5	U
11/15/2016	14:55	98		61		0.01	U	0.434		0.0035		11.2		7.98		2		11		0.0094		0.48		0.8	
12/6/2016	16:25	107		83		0.01	U	0.667		0.0073		12.2		7.82		1		6.9		0.0162		0.674		1.1	

Table A-9. 54B100 Deep Creek @ Garfield Road Bridge

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
10/14/2013	15:05	382		12		0.01	U	3.61		0.051		11.4		8.38		2		7		0.052		3.66		1.3	
11/4/2013	16:15	454		1	U			2.62		0.012		13.1		8.87		3		5.3		0.014		2.53		0.5	U
12/2/2013	15:15	463		2		0.01	U	2.99		0.026		12.7		8.75		1	U	3.8		0.026		2.97		0.5	U
1/6/2014	15:20	459		1	U	0.01	U	2.96		0.027		14.8		8.72		1		0.3		0.025		3.15		0.5	U
2/3/2014	15:19	456		1	U	0.01	U	2.87		0.028		13.8		8.94		1		3.5		0.026		2.91		0.5	U
3/3/2014	16:25	474		2		0.01	U	3.66		0.06		11.2		8.34		2		4.5	J	0.056		3.8		1.1	
4/7/2014	15:25	458		1	U	0.014		2.77		0.017		11.7		8.88		3		14	J	0.028		3.01		1	
5/5/2014	15:22	446		7		0.01	U	2.41		0.007		13.2		9.01		2		12		0.012		3.24		0.6	
6/2/2014	15:10	433		16	J	0.01	U	2.38		0.007		12.3		8.88		3		17		0.011		2.55		0.5	U
7/7/2014	16:05	455		150	J	0.018		2.39		0.009		10		8.65		7		17		0.018		2.57		0.8	
8/4/2014	15:05	453		49		0.02		2.18		0.009		12		8.7		11		16		0.012		2.39		1.5	
9/8/2014	14:40	474		14		0.011		0.77		0.011		12.4		8.64		5		11		0.015		2.41		0.6	
10/6/2014	14:25	481		29		0.01	U	2.28		0.013		11.8		8.44		1		12		0.013		2.56		0.5	UBottom of Form
4/6/2015	14:45	430		1	U	0.01	U	2.22		0.0153		11.3		8.41		1	U			0.0177		2.28		0.5	U

Table A- 10. 54C050 Coulee Creek @ N Brooks Road

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
10/14/2013	15:50	511		12		0.01	U	3.12		0.04		7.6		7.74		1	U	10		0.039		2.75		0.5	U
11/4/2013	15:20	418		5				4.12		0.053		12.2		8.4		1	U	3.5		0.055		3.78		0.5	U
12/2/2013	14:35																								
1/6/2014	14:50																								
2/3/2014	14:50																								
3/3/2014	15:45	419		3		0.016		4.37		0.076		12.1		8.07		4		0	J	0.083		4.49		2.3	
4/7/2014	14:35	393		3		0.01	U	3.01		0.03		12.1		8.59		3		12	J	0.037		3.17		1.5	
5/5/2014	14:45	372		13		0.021		2.31		0.026		12.2		8.67		2		12		0.032		2.84		1	
6/2/2014	14:30	345		34		0.032		1.63		0.045		9.7		8.45		4		17		0.054		1.86		1.3	
7/7/2014	15:25	334		140		0.022		1.15		0.073		6.9		8		12		19		0.081		1.33		2.3	
8/4/2014	14:20	328		180		0.048		0.488		0.085				7.6		1		19		0.08		0.68		0.7	J
11/3/2014	14:10	323		16		0.01	U	1.59				10.1		7.98		1	U					1.67		1.1	
2/2/2015	14:15	399		7		0.01	U	2.75		0.0668		12.04		8.35		1	U			0.064		2.95		0.6	
3/2/2015	14:25	385		1	U	0.010		2.59				13.43		8.49		1	U					2.95		0.5	U
4/6/2015	14:05	380		8		0.014		2.6		0.0374		12.2		8.43		1				0.0391		2.73		0.7	
5/4/2015	15:40	360		7		0.018		1.45		0.021		12.14		8.74		2		14.7		0.0332		1.59		0.7	
6/1/2015	14:15	346		70		0.026		0.773		0.0837		7.76		8.06		2		17		0.0883		1.01		1.3	

Table A- 11. AHL153 Spokane River piezometer downstream of Deep Creek

date	Alkalinity	Chlorides	NO2/NO3	SRP	Tot Phos	TPN
9/27/16	333	3.23	0.144	0.0907	0.0946	0.191
1/24/17	259	0.16	0.01u	0.0428	0.0801	0.034

Table A- 12. AHL154 Deep Creek piezometer closest to mouth

date	Alkalinity	Chlorides	NO2/NO3	SRP	Tot Phos	TPN
9/27/16	155	2.13	0.622	0.0945	0.0974	0.704
1/24/17	154	0.95	0.658	0.0968	0.094	0.653

Table A- 13. AHL 155 Deep Creek piezometer upstream of AHL 154

date	Alkalinity	Chlorides	NO2/NO3	SRP	Tot Phos	TPN
9/27/16	148	2.11	0.726	0.101	0.102	0.840
1/24/17	145	1.91	0.72	0.105	0.103	0.745

Table A- 14. Deep Creek grab sample above piezometers

date	Alkalinity	Chlorides	NO2/NO3	SRP	Tot Phos	TPN
9/27/16	156	2.10	0.298	0.0585	0.0622	0.383
10/19/16	149	2.13	0.275	0.0627	0.0659	0.333
1/24/17	148	0.12	0.405	0.0846	0.0832	0.449

Table A- 15. Spokane River grab sample near piezometer

date	Alkalinity	Chlorides	NO2/NO3	SRP	Tot Phos	TPN
1/24/17	63.1	0.48	1.48	0.0242	0.0265	1.55

Table A- 16. 54A090 Spokane River @ Nine Mile Bridge

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	14:45	166		65	J	0.016		1.12		0.057		11.6		7.99		6				0.071		1.25		6.7	
2/8/2010	16:20	154		140		0.014		0.897		0.034		11.8				6		5.6		0.043		1.03		2.8	
3/8/2010	14:00	140		3	U	0.01	U	0.75		0.023		10		8.01		4	J	8.3		0.034		0.79		1.7	
4/12/2010	14:30	106		1	U	0.01	U	0.441		0.007		11.7		7.89		4				0.013		0.52		1.6	
5/10/2010	13:30	85.4		120		0.01	U	0.234		0.004		11.3		7.84		3		10		0.014		0.29		1.5	
6/14/2010	14:20	84		6		0.01	U	0.262		0.004		10.5		7.88		3		15		0.012		0.36		1.7	
7/13/2010	14:15	124		8		0.01	U	0.651		0.006		9.5		8.16		2		18		0.017		0.69		0.7	
8/16/2010	15:30	217		11		0.01	U	1.46		0.012		9.69		8.26		3		18		0.023		1.57		0.9	
9/20/2010	15:40			400		0.01	U	1.18		0.012		10.3		7.99		3		14		0.021		1.24		1.1	
10/15/2013	15:20	236		50		0.016		1.45		0.011		9.6		8.13		4		12		0.021		1.46		1.5	
11/5/2013	13:50	155		9		0.01	U	0.902		0.011		10.7		7.95		1		8.4		0.016		0.93		0.5	U
12/3/2013	14:50	146		14		0.013		0.802		0.011		11.5		7.94		2		6.2		0.015		0.86		0.6	
1/7/2014	13:45	156		10		0.029		0.933		0.018		11.8		7.82		2		4.8		0.025		1.03		1.1	
2/4/2014	15:00	155		14		0.029		0.919		0.017		12		7.83		4		3.7		0.024		1		1	
3/4/2014	13:50	133		56		0.031		0.652		0.01		12.4		7.74		7		3.7	J	0.021		0.73		3.1	
4/8/2014	14:55	78		56		0.01	U	0.239		0.005		12.5		7.52		4		7.4	J	0.012		0.31		2.7	
5/6/2014	13:53	66		16		0.02		0.169		0.004		12.3		7.6		5		8.7		0.014		0.23		2	
6/3/2014	14:45	81		22		0.012		0.284		0.004		9.8		7.88		3		17		0.012	J	0.35		0.8	
7/8/2014	13:50	148		5				0.793		0.006		8.6		7.98		2		19		0.01		0.85		0.7	
8/5/2014	14:50	254		7				1.57		0.008		9.1		8.42				18		0.015		1.73			
9/9/2014	14:15	237		8		0.012		1.74		0.008		9.5		8.4		3		15		0.014		1.77		0.8	
10/7/2014	14:20	189		14		0.015		1.15		0.007		9.8		8.16		3				0.012		1.19		0.9	
11/4/2014	13:15	190		48		0.011		1.12		0.01		9.7		8		2		11		0.014		1.18		0.8	
12/2/2014	14:05	140		7		0.041		0.698		0.007		11.2		7.91		3		5.3		0.011		0.79		0.8	
1/6/2015	14:40	103		31		0.026		0.408		0.0056		12.24		7.73		3				0.011		0.477		1	
2/3/2015	13:25	84		1	U	0.018		0.299		0.0051		12.54		7.76		3				0.0094		0.359		1.1	
3/3/2015	13:10	96		1	U	0.01	U	0.357		0.0041		12.74		7.74		1	U			0.0071		0.425		1	
4/7/2015	14:55	86		1	U	0.011		0.376		0.0045		12		7.74		2				0.0116		0.416		1.6	
5/5/2015	13:45	128		1	U	0.01	U	0.634		0.004		9.95		7.89		2		12.45		0.0116		0.659		0.8	
6/2/2015	13:40	129		140		0.016		0.717		0.0061		8.36		7.73		3		17.4		0.0166		0.796		1.3	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
7/7/2015	14:25	268		26		0.01	U	1.88		0.0072		9.64		8.48		2		18.41		0.0132		1.96		0.8	
8/4/2015	14:50	287		11		0.01	U	2.21		0.0033		11.29		8.77		4		17.81		0.0158		2.27		1.3	
9/15/2015	15:45	294		17		0.046		2.39		0.01		9.5		8.2		1	U	14.1		0.016		2.47		0.5	U
10/6/2015	15:20	271		2		0.012		2.07		0.0115		10.4		8.22		1		12.3		0.0145		2.18		0.6	
11/17/2015	15:15	165		8		0.01	U	1		0.0068		10.7		7.57		2		9.1		0.0114		1.05		0.5	U
12/8/2015	15:25	180		270	J	0.033		1.37		0.0123		10.2		7.63		3		7.9		0.0242		1.45		2.9	
1/5/2016	15:00	131		6		0.014		0.756		0.0057		10.6		7.36		1	U	4.9		0.0112		0.803		0.6	
2/2/2016	14:25	92		60		0.01	U	0.755		0.0093		12.3		7.19		4		4.6		0.019		0.841		2.5	
3/8/2016	14:15	75		58		0.01	U	0.497		0.0136		13.2				5		5.2		0.0255		0.56		5.6	
4/5/2016	13:55	81		72		0.01	U	0.387		0.0045		12.9		7.42		2		7.3		0.0142		0.471		1.6	
5/3/2016	13:50	104		22		0.01	U	0.322		0.0035		10.4		7.95		2		15.6		0.0147		0.484		0.8	
6/7/2016	14:50	109		42		0.01	U	0.454		0.0043		9.2		8.02		2		18.5		0.0113		0.571		0.8	
7/19/2016	16:02	226		29		0.01	U	1.67		0.0062		9.4		8.36		1		16.3		0.0128		1.67		0.5	U
8/9/2016	15:50	280		6		0.01	U	2.12		0.0078				8.33		1		15.2		0.0109		2.2		0.5	U
9/13/2016	15:00	255		8		0.01	U	1.63		0.0057		10.9		8.45		1		13.8		0.0092		1.74		0.6	

Table A- 17. 55B070 Little Spokane River near mouth

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	15:15	288		26		0.01	U	1.3		0.02		10.3		8.2		7				0.026		1.42		2.7	
2/8/2010	16:45	280		19		0.01	U	1.15		0.02		10.19				7		7.1		0.029		1.29		2.6	
3/8/2010	14:25	274		1		0.01	U	1.19		0.011		11		8.2		8	J	10		0.023		1.23		2.9	
4/12/2010	15:00	244		5		0.01	U	0.94		0.014		10		8.14		8	J			0.023		1.03		4	
5/10/2010	14:20	251		3		0.01	U	0.934		0.011		9.69		8.23		6		12		0.022		1.05		1.8	
6/14/2010	15:00	228		47		0.01	U	0.749		0.018		9.09		8.08		9	J	16		0.032		0.94		4.4	
7/13/2010	14:45	258		21		0.01	U	0.909		0.009		10.1		8.46		2		16		0.02		0.97		1.1	
8/16/2010	16:30	243		14		0.01	U	1.13		0.011		9.9		8.43		2		16		0.016		1.2		0.9	
9/20/2010	16:30			26	G	0.01	U	1.17		0.008		9.9		8.25		3		13		0.01		1.28		0.9	
10/12/2010	13:45	275		17		0.01	U	1.14		0.012		10.3		8.35		2*		11		0.015		1.27		1.1	
11/8/2010	13:55	275		17		0.01	U	1.19		0.012		9.8		8.15		3		8.9		0.015		1.29		0.8	
12/20/2010	15:55	248		17		0.02		1.06		0.018		10.81		7.98		7		4.2		0.034		1.2		4.2	
1/18/2011	11:40	174		100		0.023		0.819		0.061		11.1		7.97		20	J	1.8		0.111		0.9		21	
2/23/2011	14:45	246		6		0.01	U	1.02		0.017		10.5		8.09		7		5.1		0.03		1.09		4.1	
3/14/2011	14:30	206		14		0.015		0.768		0.031		10.3		7.77		15	J	6.9		0.069		0.93		13	
4/11/2011	13:15	180		10		0.01		0.421		0.014		11.51		7.96		8	J	9.9		0.03		0.6		4.2	
5/16/2011	13:10	170		82		0.018		0.446		0.029		8.88		7.58		7	J	12		0.051		0.6		4.1	
6/21/2011	11:10	230		6		0.018		0.787		0.021		10.3		8.04		10		15		0.036		0.92		4.8	
7/24/2011	12:45	175		18		0.013		1.03		0.012		10.1		7.71		4		15		0.021		1.1		1.6	
8/15/2011	12:40			34		0.013		1.2		0.016		9.8		8.29		3		15		0.017		1.23		0.9	
9/19/2011	13:15	282		28		0.01	U	1.23		0.012		9.4		8.14		3		13		0.013		1.34		0.8	
10/24/2011	13:10	287		10		0.01	U	1.22		0.012		10.3		8.21		3		10		0.015		1.31		0.8	
11/28/2011	15:00	266		9		0.01	U	1.21		0.013						4	J	6.9		0.019		1.3		1.6	
12/12/2011	15:05	292		4		0.01	U	1.38		0.014		10.74		8.19		6		5.8		0.019		1.44		1.9	
1/9/2012	15:45	261		3		0.014		1.32						8.26		6		6.6		0.021		1.38		1.9	
2/13/2012	16:30	233	J	91		0.036		1.05		0.048		10.7				22		6.3		0.084		1.22		8.9	
3/19/2012	16:00	193		9		0.023		0.67		0.034		9.79		7.83		30	J	6.2		0.06		0.85		11	
4/16/2012	14:00	172		14		0.01	U	0.41		0.016		10.3		7.89		11	J	9.4		0.034		0.53		4.2	
5/14/2012	14:50	219		13						0.024		9.19		8.1		17		14		0.042				4.6	
6/25/2012	15:35	216		43		0.01	U	0.771		0.019		9.4		8.26		9		16		0.029		0.84		3.4	
7/23/2012	14:40	243		87		0.01	U	0.954		0.012		9.44		8.39		7		17		0.024		1.04		1.9	
8/27/2012	15:20	262		28		0.01	U	1.13		0.011		9.49		8.34		4		15		0.013		1.19		1.2	
9/24/2012	14:35	275		28		0.01	U	1.17		0.008		9.49		8.33		5		13		0.013		1.16		1.5	
10/17/2012	14:45	278		26		0.01	U	0.126		0.007		9.9		8.3		3		11		0.011		1.3		1.3	
11/7/2012	14:45	265		14		0.01	U	1.19		0.013		9.87		8.26		4		9.9		0.019		1.26		1.4	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
12/5/2012	13:55	236		16		0.016		1		0.019		10.2	J	8.15		7		7.6		0.032		1.13		3.2	
1/9/2013	15:50	246		15		0.014		1.13		0.016		10.7		8.05		7		5.9		0.023		1.23		2.5	
2/6/2013	14:25	230		28		0.012		1.08		0.017		11.06		8.16		10		6.6		0.032		1.14		5.7	
3/6/2013	14:30	207		13		0.013		0.862		0.019		10.71		8.09		14		6.1		0.039		1.01		8	
4/3/2013	13:50	191		12		0.01	J	0.594	J	0.018		9.5		7.99		16		11		0.043		0.67	J	7.1	
5/8/2013	14:29	224		15		0.014		0.804		0.019		9		8.15		13		16		0.031		0.9		5.1	
6/5/2013	15:10	251		8		0.01	U	0.936		0.012		10		7.99		6		16		0.019		1.09		2	
7/10/2013	14:30	259		28		0.01	U	0.986		0.014		9.95		8.35		4				0.017		1.07		1.3	
8/7/2013	15:30	274		58		0.01	U	1.11		0.013		10		8.33		2		16		0.017		1.25		0.6	
9/11/2013	14:31	283		36		0.01	U	1.12		0.009		10.3		8.25		4	J	15		0.016		1.23		0.9	
10/15/2013	14:41	280		33		0.01	U	1.55		0.009		9.7		8.23		3		11		0.015		1.26		1	
11/5/2013	13:13	278		1	U	0.01	U	1.13		0.008		10		8.21		3		7.9		0.012		1.27		0.9	
12/3/2013	14:25	271		12		0.01	U	1.25		0.013		10.6		8.22		4		5.3		0.021		1.35		1.5	
1/7/2014	13:05	276		17		0.012		1.42		0.014		10.5		8.21		6		5.4		0.018		1.44		1.4	
2/4/2014	14:30	276		8		0.014		1.39		0.016		10.7		8.23		8		4.5		0.024		1.4		2.8	
3/4/2014	13:20	271		12		0.014		1.31		0.015		10.8		8.12		10		6.3	J	0.025		1.36		3.4	
4/8/2014	14:25	210		3		0.01	U	0.733		0.017		9.2		7.98		16		12	J	0.036		0.87		5.7	
5/6/2014	13:25	211		1	U	0.013		0.016		0.004		8.8		8.03		2		12		0.012		0.08		1.7	
6/3/2014	14:20	253		25		0.017		0.95		0.011		9		8.36		6		17		0.022		1.08		1.9	
7/8/2014	13:20	274		33		0.011		1.04		0.011				8.25		5		17		0.016		1.15		1.6	
8/5/2014	14:25	286		35		0.01	U	1.1		0.009		9		8.29		3		16		0.01		1.21		0.9	
9/9/2014	13:45	288		27		0.01	U	1.18		0.007		9.5		8.33		2		13		0.011		1.21		0.7	
10/7/2014	13:55	287		10		0.01	U	1.17		0.008		9.3		8.17				12		0.014		1.22		0.9	
11/4/2014	12:45	292		31				1.18		0.011		9.3		8.15				9.5		0.013		1.4		1.1	
12/2/2014	13:35	283		13		0.015		1.19		0.012		10.6		8.28		4		5.2		0.015		1.31		1.4	
1/6/2015	14:00	279		36		0.017		1.3		0.0132		10.35		8.13		6				0.0164		1.36		2.1	
2/3/2015	13:00	271		12		0.01	U	1.15		0.0153		9.95		8.27		6				0.0203		1.25		2.6	
3/3/2015	12:45	245		5		0.011		0.963		0.0126		10.25		8.16		7				0.0212		1.12		3	
4/7/2015	14:30	233		10		0.014		0.92		0.0148		9.9		8.19		10				0.0261		0.987		3.7	
5/5/2015	13:20	261		8		0.01	U	0.685		0.0097		9.35		8.34		5		13.15		0.0196		1.04		2	
6/2/2015	13:15	239		200	G	0.04		0.91		0.0496		7.36		7.9		254		14.27		0.397		1.04		240	
7/7/2015	13:43	279		34		0.011		1.09		0.0079		9.54		8.4		2		16.29		0.0102		1.15		0.9	
8/4/2015	14:29	286		40		0.024		1.17		0.0056		10		8.47		1		15.48		0.0093		1.18		0.6	
9/15/2015	15:12	291		18		0.025		1.15		0.0068		10.1		8.31		2		11.9		0.0104		1.27		0.7	
10/6/2015	14:45	277		12		0.01	U	1.17		0.0068		10.3		8.24		2		10.9		0.009		1.27		0.5	U
11/17/2015	14:30	286		16		0.015		1.34		0.0079		10.1		7.96		3		8.8		0.0105		1.31		1.1	

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
12/8/2015	14:40	262		230	J	0.022		1.37		0.0334		9.6		7.65		13		6.9		0.0536		1.4		6.1	
1/5/2016	14:25	255		8		0.013		1.26		0.0124		11.3		7.98		6		5.7		0.0183		1.3		2	
2/2/2016	13:50	212		11		0.01	U	0.973		0.0262		10.4		7.54		10		5.1		0.0397		1.15		6.3	
3/8/2016	13:45	183		16		0.011		0.635		0.0234		10				13		7.2		0.0448		0.786		7.7	
4/5/2016	14:25	190		7		0.016		0.671		0.0201		9.6		7.72		10		10.3		0.0413		0.844		3.7	
5/3/2016	13:23	245		14		0.01	U	0.753		0.003	U	9		8.22		7		14.4		0.0292		0.971		2.1	
6/7/2016	14:20	264		22		0.01	U	0.909		0.0075		9.7		8.46		3		17.5		0.0169		1.09		0.9	
7/19/2016	15:32	275		51		0.010		1.08		0.0059		9.8		8.37		3		14		0.0121		1.15		0.6	
8/9/2016	15:00	283		36		0.01	U	1.11		0.0065		9.6		8.29		2		13.5		0.0089		1.18		0.5	U
9/13/2016	14:20	291		12		0.01	U	1.23		0.008		10.1		8.36		2		12.1		0.0095		1.3		0.6	
10/4/2016	14:55	288		17		0.01	U	1.16		0.0074		10		8.25		2		10.3		0.0118		1.22		0.5	U
11/15/2016	14:00	265		16		0.01	U	1.1		0.012		9.8		8.17		2		9.8		0.0175		1.13		0.8	
12/6/2016	15:50	260		5		0.010		1.1		0.0144		11.2		8.19		4		5.5		0.021		1.17		1.4	

Table A- 18. 54A070 Spokane River @ Long Lake

date	time	COND (umhos/cm)		FC (#/100ml)		NH3_N (mg/L)		NO2_NO3 (mg/L)		OP_DIS (mg/L)		OXYGEN (mg/L)		PH (pH)		SUSSOL (mg/L)		TEMP (deg C)		TP_P (mg/L)		TPN (mg/L)		TURB (NTU)	
1/11/2010	16:20	174		1		0.024		0.971		0.043		11.3		8.06		2				0.055		1.1		3.8	
2/8/2010	18:00	168		3		0.023		1		0.044		10.6				5		5.6		0.062		1.1		7.1	
3/8/2010	15:25	172		1	U	0.01	U	1.05		0.03		11.4		8.07		4	J	8.2		0.043		1.1		2.5	
4/12/2010	16:05	150		1	U	0.01	U	0.655		0.008		11.7		8.28		6	J			0.019		0.74		2.5	
5/10/2010	15:45	98.1		1		0.01		0.297		0.003		11.5		8.12		4		10		0.016		0.42		2.7	
6/14/2010	16:00	80		2		0.014		0.176		0.004		10.6		7.93		3		15		0.012		0.33		1.9	
7/13/2010	15:50	90		1	U	0.021		0.327		0.005		8.9		7.93		1		18		0.02		0.46		1.1	
8/16/2010	17:30	164		1	U	0.01	U	0.849		0.013		6.7		7.77		1	U	19		0.02		0.9		0.7	

City of Spokane Data

Table A- 19. City of Spokane Combined Sewer Overflow Data*

Discharge Location	Sample Date	BOD (mg/L)	CBOD (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	NO3+NO2 as N (mg/L)	NH3-N (mg/L)	notes
CSO 6	11/7/2013	62	55	151	1.81	0.679	4.519	
CSO 6	1/8/2014	37		159	1.21	0.039	3.830	
CSO 6	2/12/2014			277	4.55	0.703	3.678	
CSO 6	4/24/2014	53	56	200	1.94	0.405	7.223	
CSO 6	6/17/2014			155	1.233	0.118	2.727	
CSO 34	5/21/2013	104	124	246	1.5		8.023	
CSO 34	6/20/2013	73	64	113	2.27		9.429	grab
CSO 34	6/20/2013	103	51	123	1.26		3.469	composite
CSO 34	8/1/2013	74	64	328	2.03		4.812	
CSO 34	9/4/2013	112	106	466	2.57		3.396	
CSO 6 AVG:		50.7	55.5	188.4	2.149	0.389	4.395	
CSO 34 AVG:		93.2	81.8	255.2	1.926		5.826	
CSO Combined AVG:		77.3	74.3	221.8	2.037	0.389	5.111	

* From the City of Spokane RPWRF Lab.

Table A- 20. City of Spokane stormwater data*

Discharge Location	Sample Date	BOD (mg/L)	CBOD (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	NO3+NO2 as N (mg/L)	NH3-N (mg/L)	notes
Cochran Basin	10/15/2012	18		140	0.732		0.3843	
Cochran Basin	10/25/2012	15		75	0.445		0.035	
Cochran Basin	11/3/2012	8		55	0.337		0.007	
Cochran Basin	11/8/2012	11		48	0.296		0.007	
Cochran Basin	11/12/2012	17		260	0.625		0.3676	
Cochran Basin	11/19/2012	8		40			0.007	
Cochran Basin	12/4/2012	9		100	0.367		0.0052	
Cochran Basin	12/24/2012	16		508	1.39		0.6926	
Cochran Basin	1/8/2013	21		269	0.867		0.7677	
Cochran Basin	1/25/2013	34		668	1.97		0.897	
Cochran Basin	2/22/2013	21	17.91	608	1.69		0.2381	
Cochran Basin	3/6/2013			1388	2.92		0.3778	
Cochran Basin	3/20/2013	15	11	566	1.39		0.3277	
Cochran Basin	5/13/2013			187	0.937		1.2764	
Cochran Basin	5/21/2013	27	27	263	0.557		0.1964	
Cochran Basin	6/19/2013	12	9	120	0.436		0.1199	
Cochran Basin	11/7/2013	15	14	80	0.409	0.3928	0.0189	
Cochran Basin	1/8/2014	24	20	195	0.643	0.3682	0.9049	
Cochran Basin	2/11/2014	22	20	189	0.769	0.491	0.97	
Cochran Basin	4/17/2014	10	8	76	0.343	0.5178	0.3213	
Cochran Basin	6/3/2014	32	26	782	1.84			
Cochran Basin	6/17/2014			79	0.428	0.1129	0.1318	
Cochran Basin	8/10/2016			660	0.571		0.1042	
Cochran Basin	10/14/2016			49	0.208		0.0250	
Cochran Basin	10/27/2016		9	18	0.194		0.0250	

Discharge Location	Sample Date	BOD (mg/L)	CBOD (mg/L)	TSS (mg/L)	Total Phosphorus (mg/L)	NO3+NO2 as N (mg/L)	NH3-N (mg/L)	notes
Washington Basin	2/22/2013	17	13.91	500	1.42		0.3561	
Washington Basin	3/6/2013			1766	4.18		0.4444	
Washington Basin	5/13/2013			207	1.02		0.2879	
Washington Basin	5/21/2013	33	32	229	0.735		0.5573	
Washington Basin	6/19/2013	10	8	61	0.286		0.0526	
Cochran Basin AVG:		17.6	16.2	287	0.823	0.377	0.324	
Washington Basin AVG:		20.0	18.0	553	1.53		0.340	
Stormwater AVG:		18.0	16.6	330	0.940	0.377	0.327	

*From the City of Spokane RPWRF Lab.

Appendix B. Nonpoint Source Success Stories

The following pages highlight activities that have helped reduce nonpoint sources of phosphorus in the Spokane River and Lake Spokane basin. Ecology writes up the information about the projects as success stories in order to share them with the public. For other success stories throughout the state, visit: http://www.ecy.wa.gov/programs/wq/wqstories/index.html.

A Focused Assistance Program in Hangman Creek Watershed: Motivated producers make strides toward cleaner water
https://fortress.wa.gov/ecy/publications/SummaryPages/1010074.html

Lake Spokane Shoreline Goes Au Naturel: What happens when you return to the basics?
https://fortress.wa.gov/ecy/publications/SummaryPages/1410044.html

Ecology Joins Partners in Educational Mission: Regional experts help students understand complex watershed issues
https://fortress.wa.gov/ecy/publications/SummaryPages/1210018.html

Appendix C. Discharger Monitoring Graphs

Data presented herein are presented as monthly averages for purposes of clearly illustrating trends in concentrations over time; permit compliance limits vary seasonally and have changed over the duration of the dataset. Monthly averages should not be compared to TMDL allocations or permit limits since those are based on seasonal averages.

Washington State Dischargers

Inland Empire Paper Company

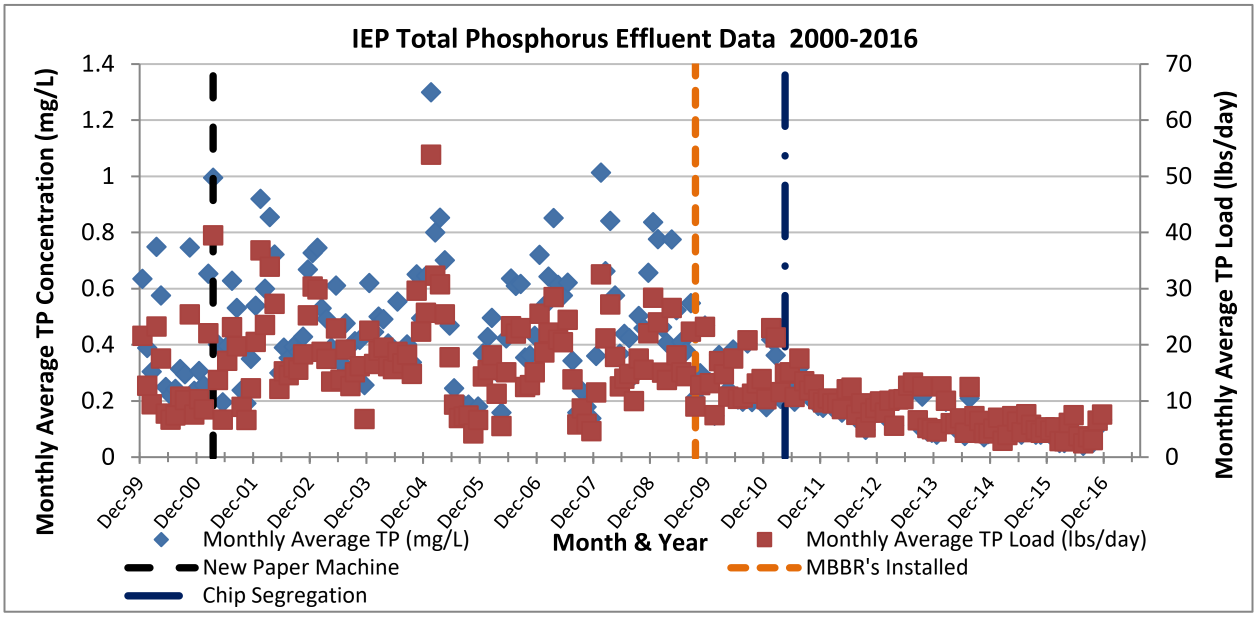

Figure C- 1. IEP Total Phosphorus Effluent Data 2000-2016

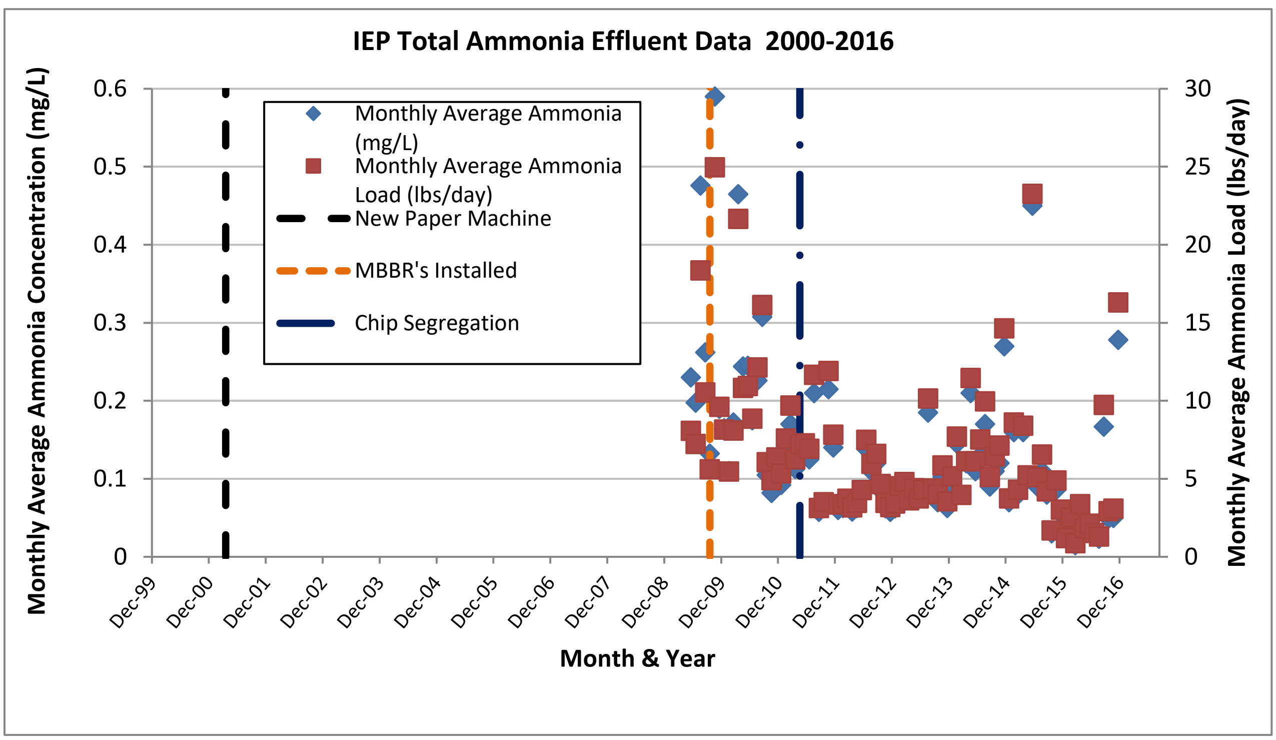

Figure C- 2. IEP Total Ammonia Effluent Data 2000-2016

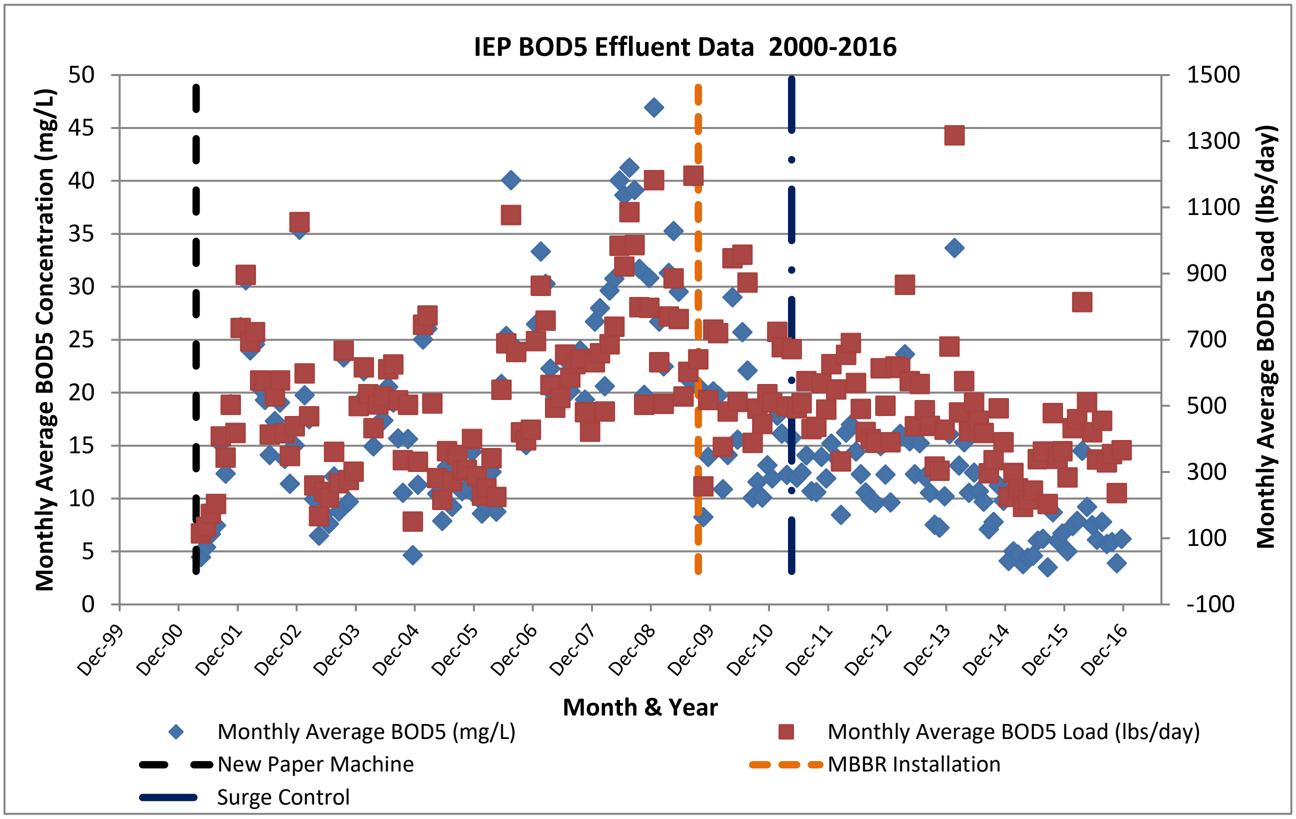

Figure C- 3. IEP BOD5 Effluent Data 2000-2016

Kaiser Aluminum, Inc.

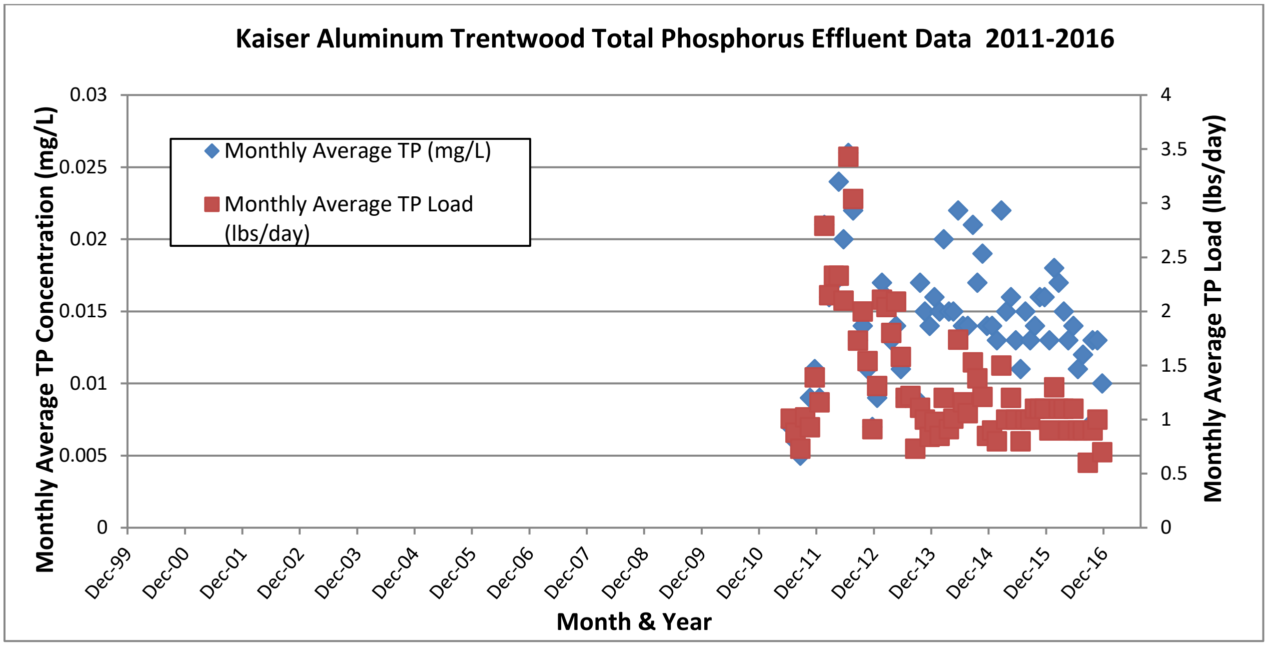

Figure C- 4. Kaiser Aluminum Trentwood Total Phosphorus Effluent Data 2011-2016

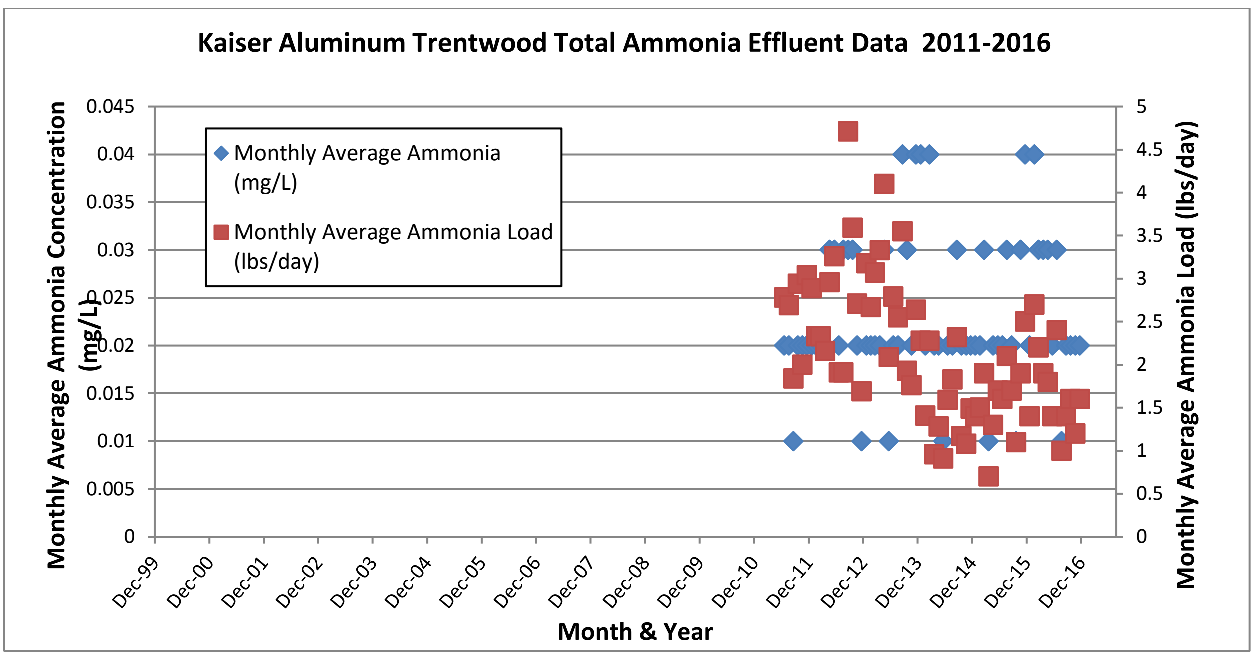

Figure C- 5. Kaiser Aluminum Trentwood Total Ammonia Effluent Data 2011-2016

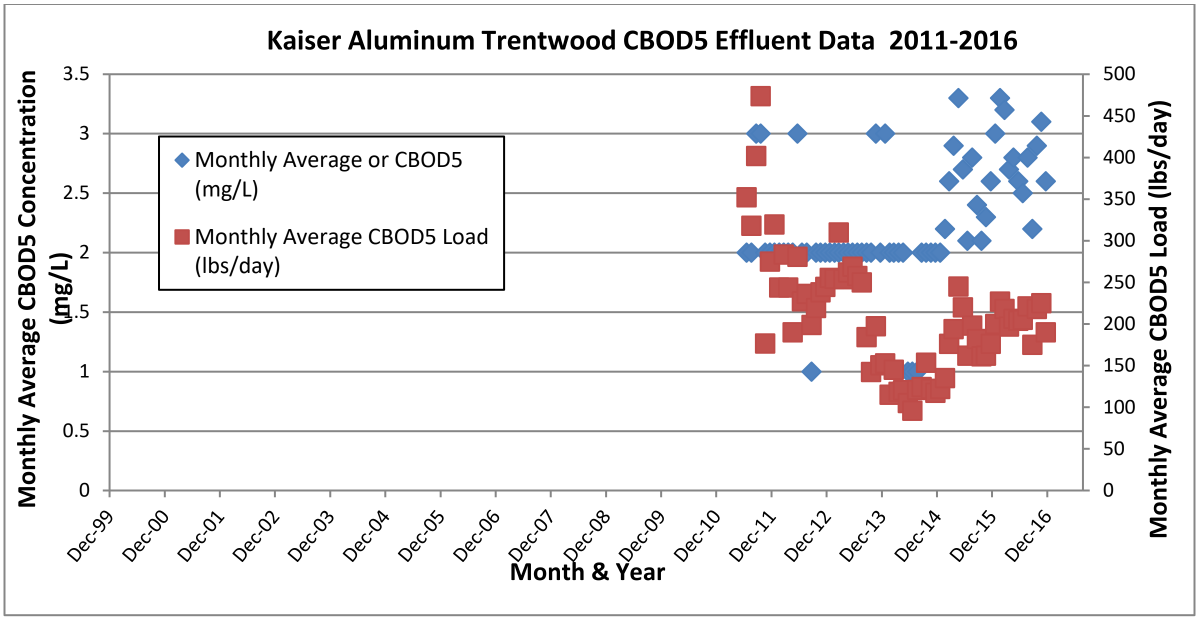

Figure C- 6. Kaiser Aluminum Trentwood CBOD5 Effluent Data 2011-2016

Liberty Lake Sewer & Water District

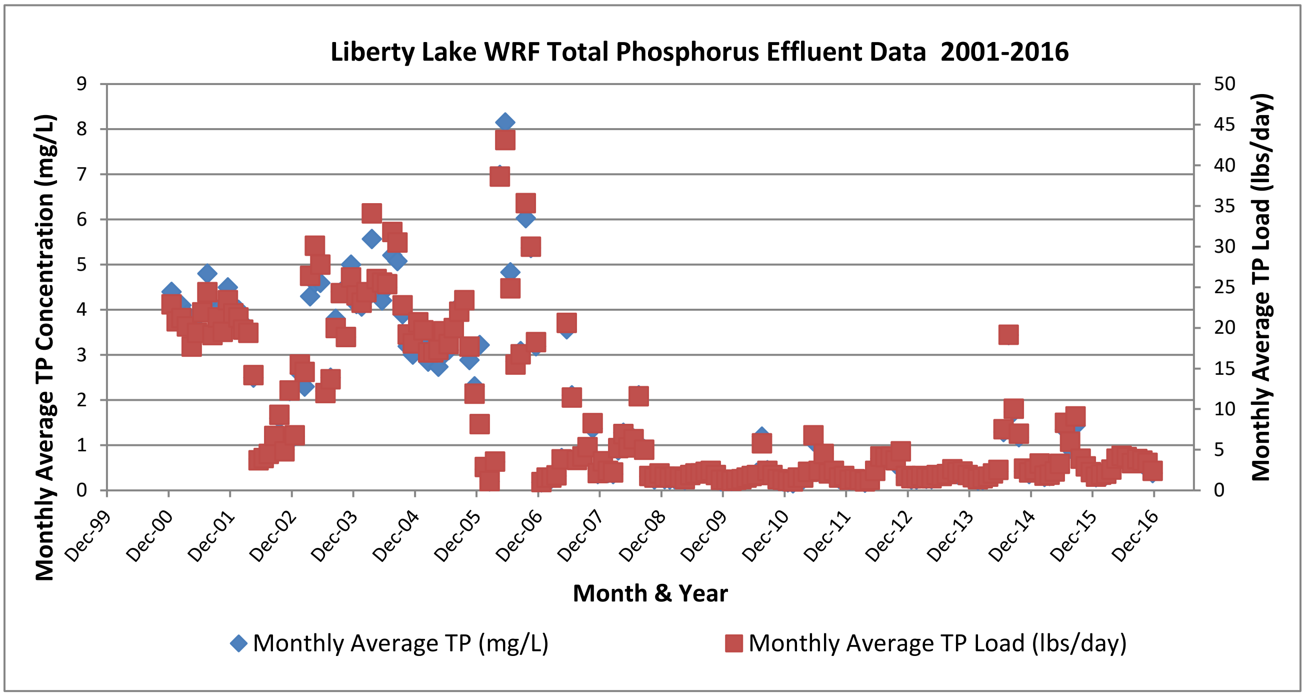

Figure C- 7. Liberty Lake WRF Total Phosphorus Effluent Data 2001-2016

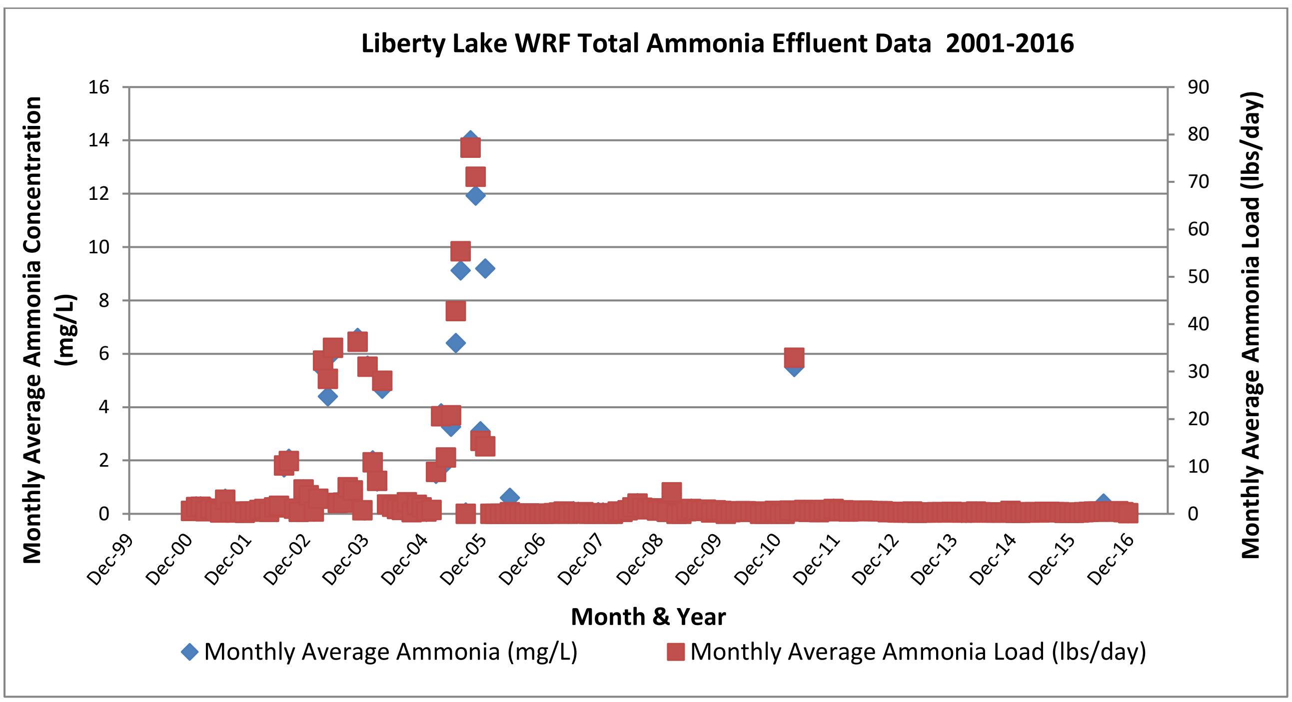

Figure C- 8. Liberty Lake WRF Total Ammonia Effluent Data 2001-2016

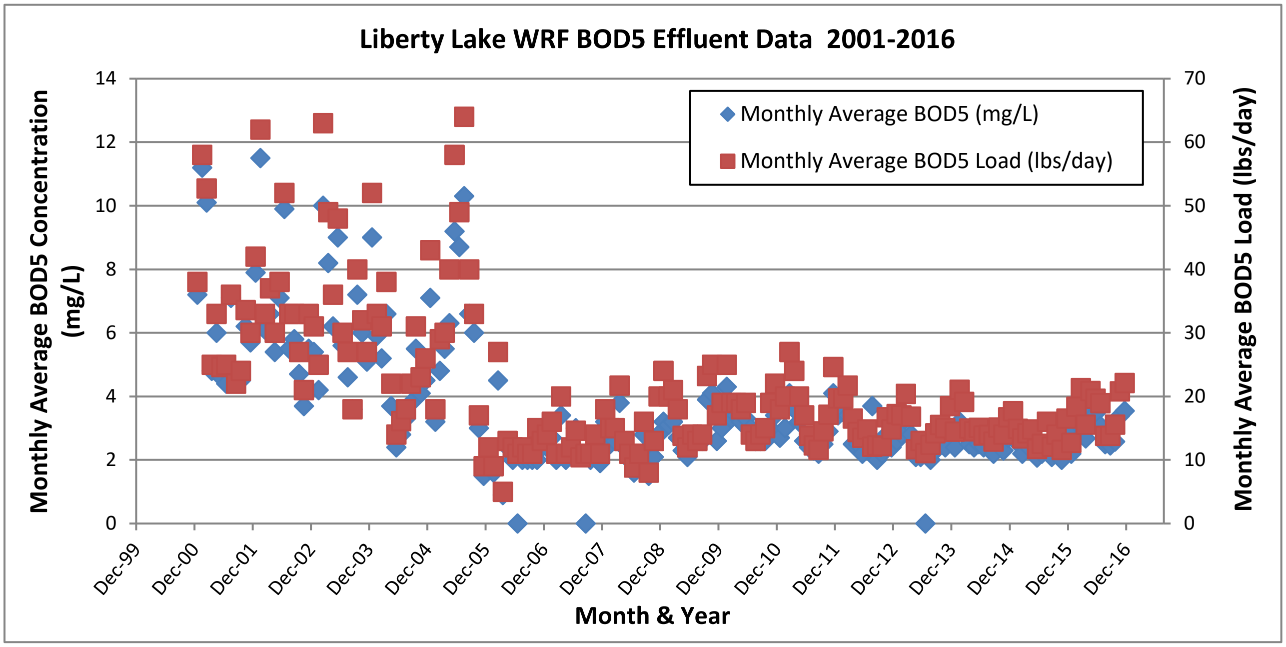

Figure C- 9. Liberty Lake WRF BOD5 Effluent Data 2001-2016

Riverside Park Water Reclamation Facility (City of Spokane)

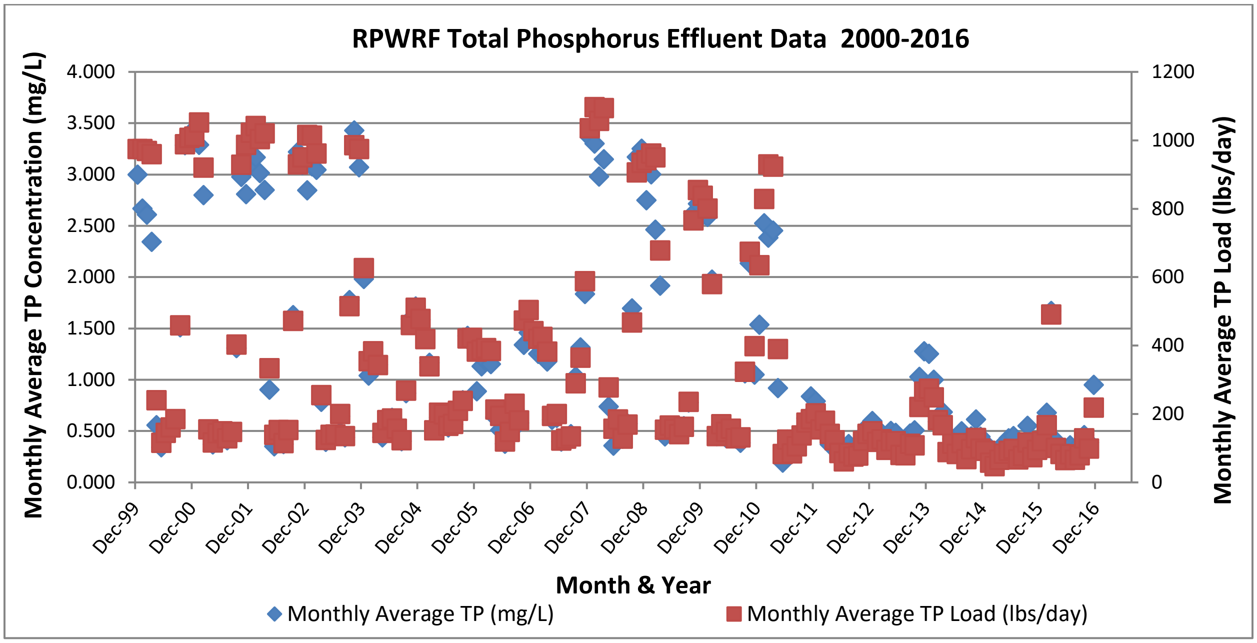

Figure C- 10. RPWRF Total Phosphorus Effluent Data 2000-2016*

*Beginning in June 2011, RPWRF began using chemically enhanced primary treatment (CEPT). With CEPT, the City adds alum as well anionic polymer ahead of the primary clarifiers to aid in solids and phosphorus removal (before, alum was only used in the secondary process for phosphorus removal). The use of CEPT has allowed the City to increase its treatment capacity while reducing phosphorus in its effluent. Initially, CEPT was implemented as a short-term pilot project, but with its success in reducing phosphorus levels, the City will likely continue to use CEPT up through the startup of the next-level treatment process.

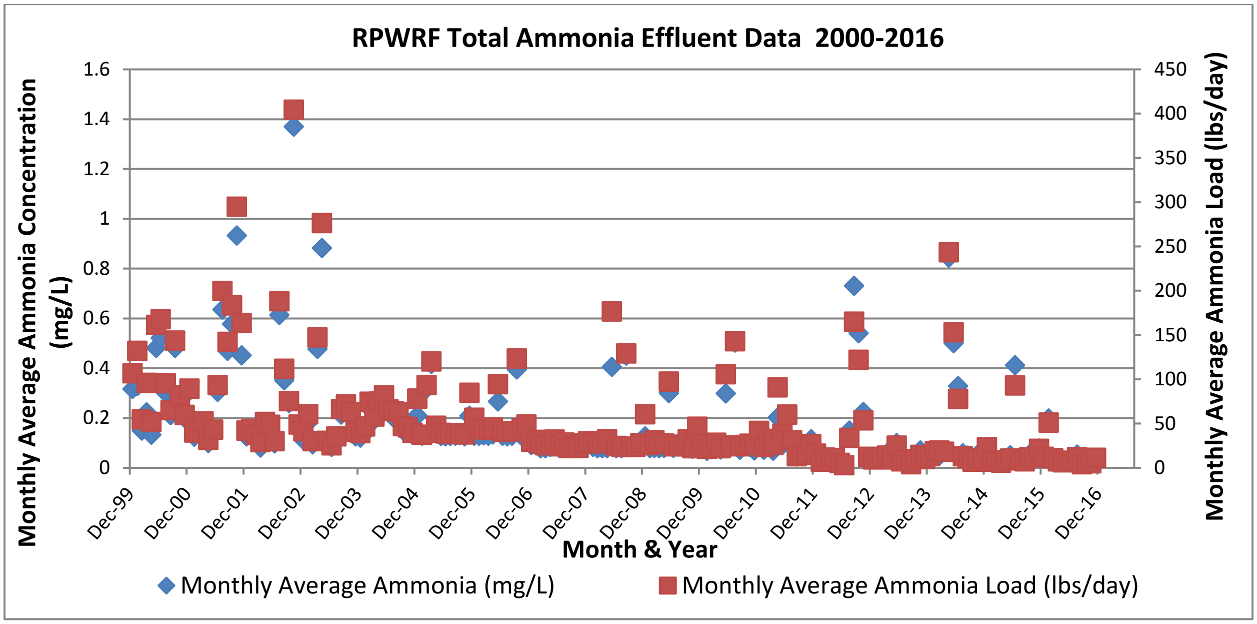

Figure C- 11. RPWRF Total Ammonia Effluent Data 2000-2016

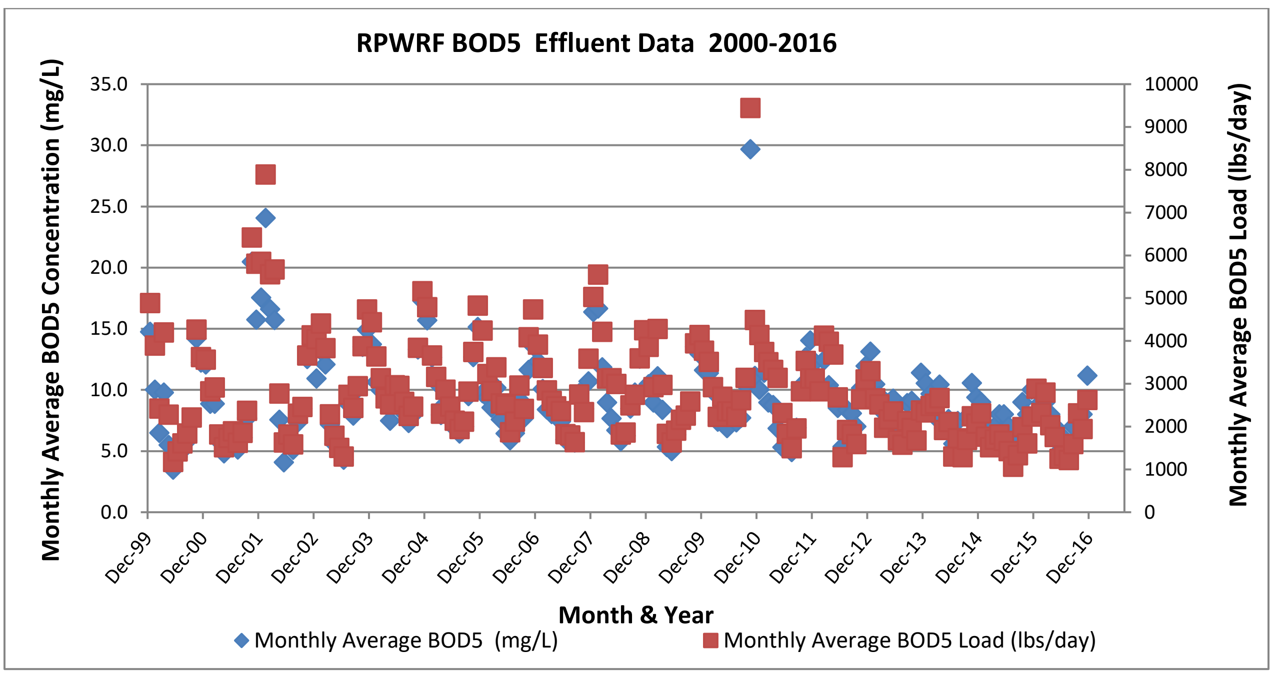

Figure C- 12. RPWRF BOD5 Effluent Data 2000-2016*

* RPWRF has historically monitored for BOD5, but has a final effluent limit for CBOD5. RPWRF began monitoring both BOD5 and CBOD5 in July 2014 to determine a BOD/CBOD relationship and will eventually transition to monitoring just CBOD5.

Spokane County Regional Water Reclamation Facility

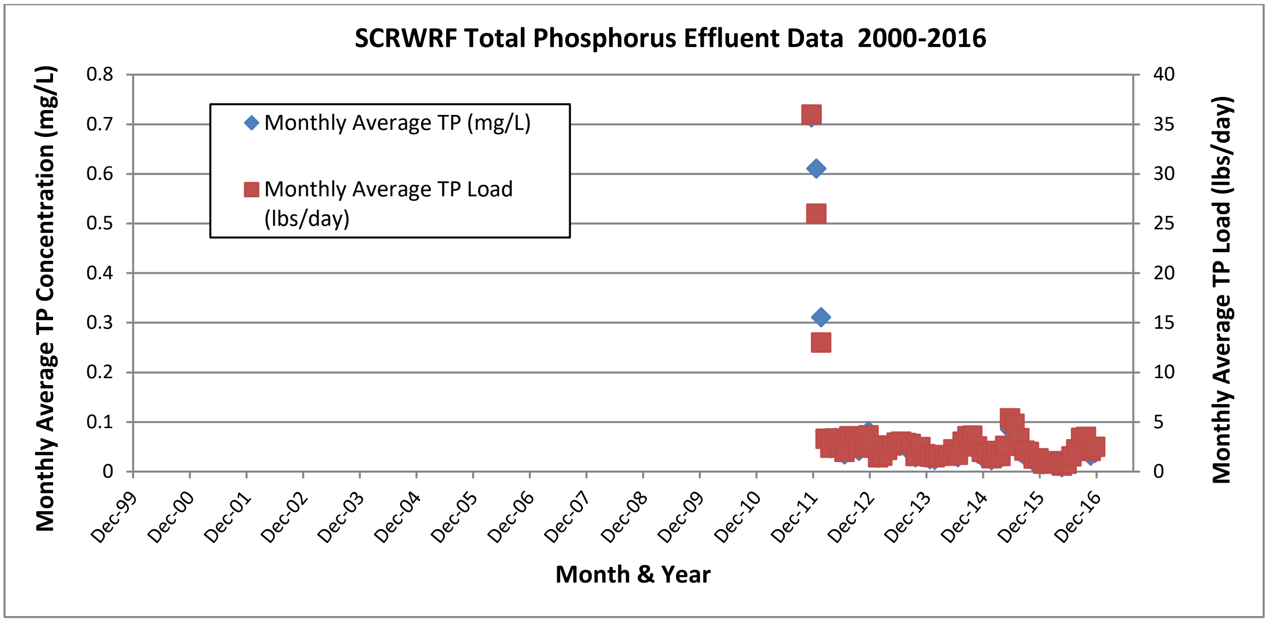

Figure C- 13. SCRWRF Total Phosphorus Effluent Data 2000-2016

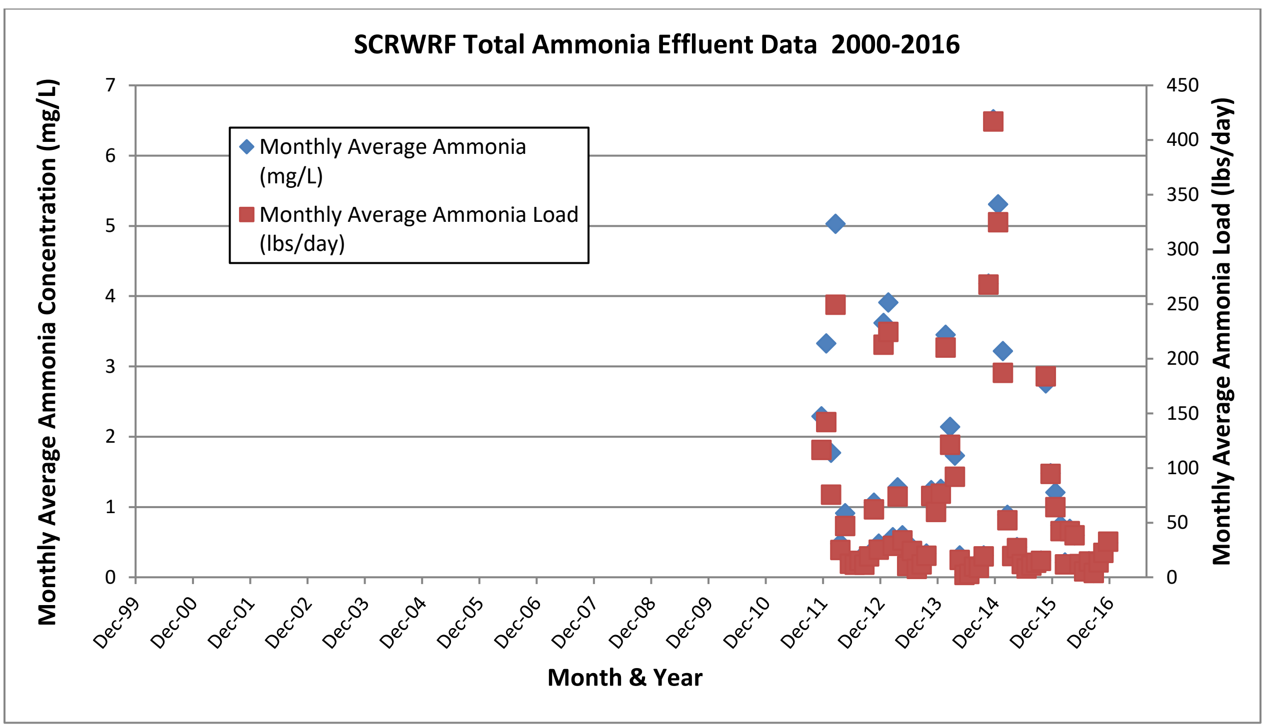

Figure C- 14. SCRWRF Total Ammonia Effluent Data 2000-2016

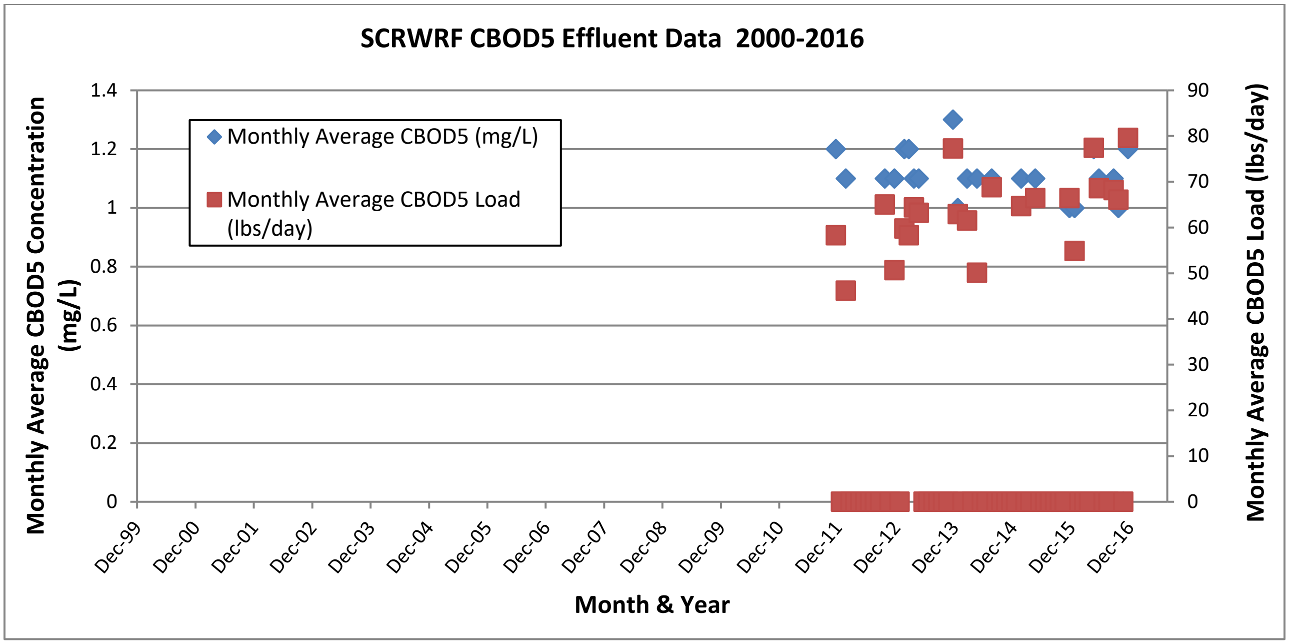

Figure C- 15. SCRWRF CBOD5 Effluent Data 2000-2016

Idaho Dischargers

City of Coeur d'Alene

City of Post Falls

Hayden Area Regional Sewer Board

City of Coeur d'Alene

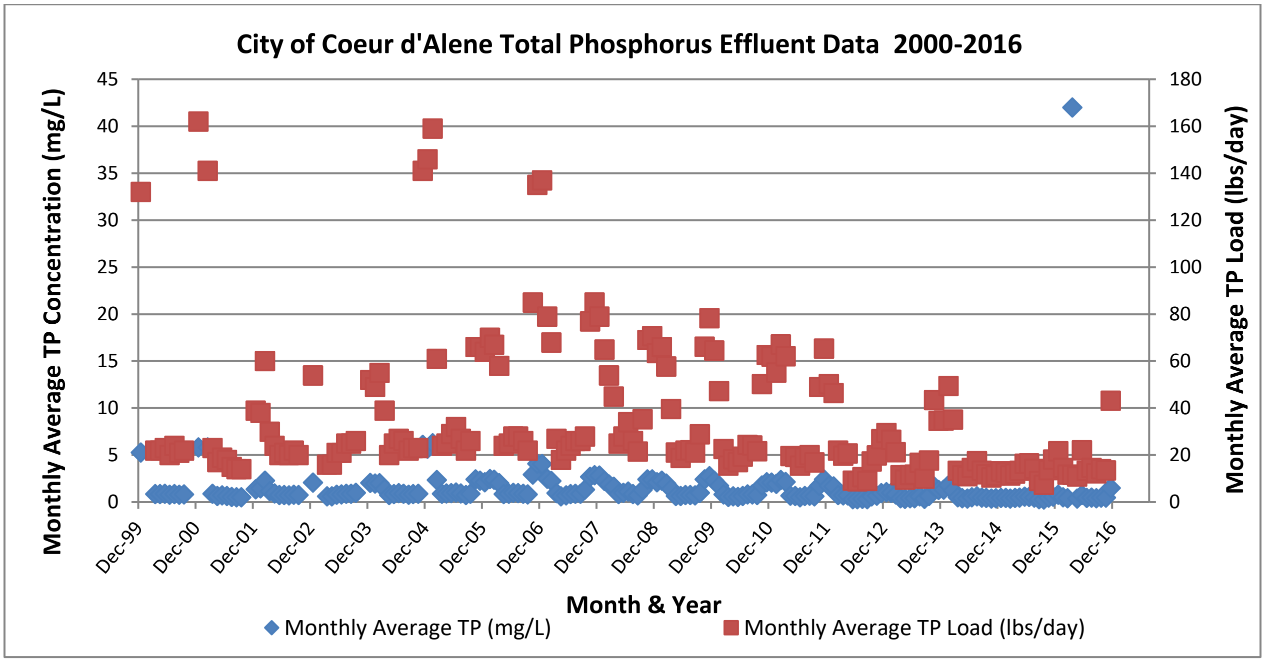

Figure C- 16. City of Coeur d'Alene Total Phosphorus Effluent Data 2000-2016

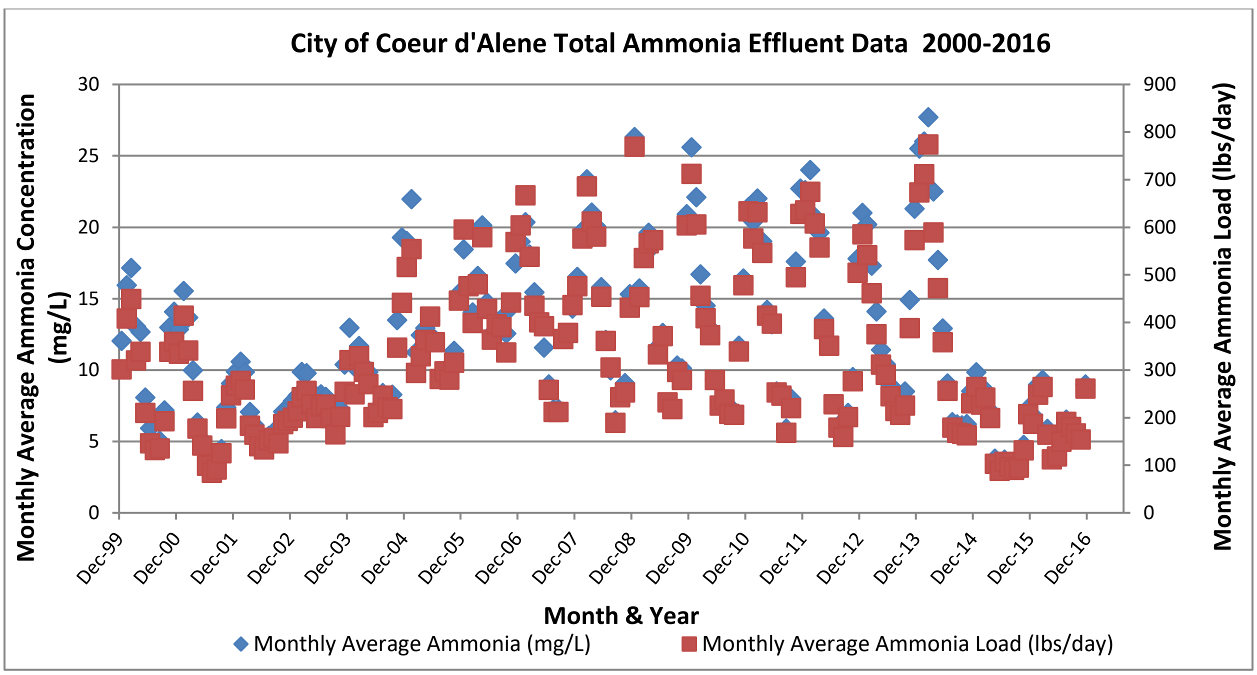

Figure C- 17. City of Coeur d'Alene Total Ammonia Effluent Data 2000-2016

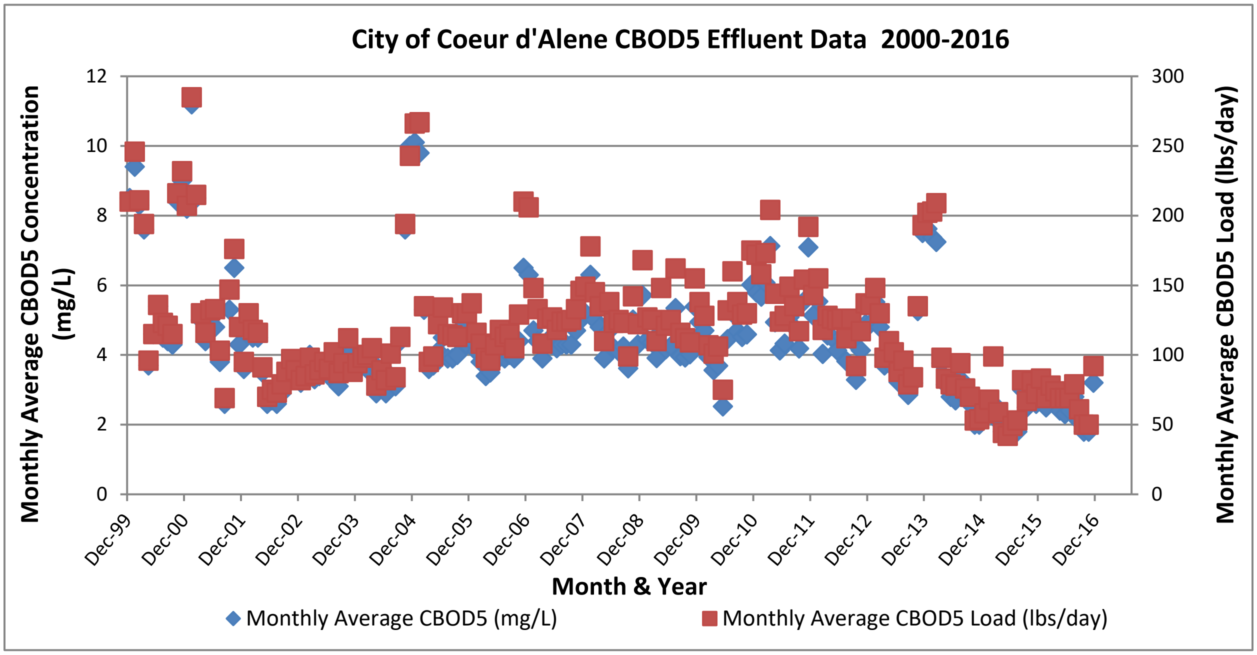

Figure C- 18. City of Coeur d'Alene CBOD5 Effluent Data 2000-2016

City of Post Falls

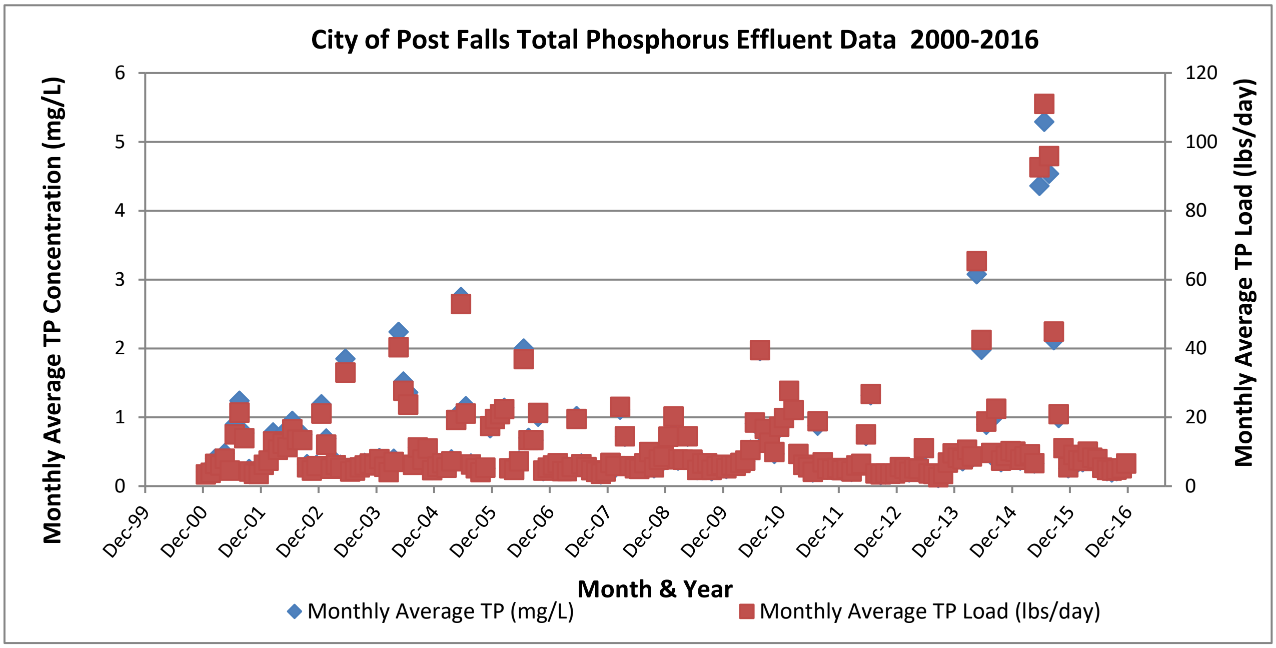

Figure C- 19. City of Post Falls Total Phosphorus Effluent Data 2000-2016

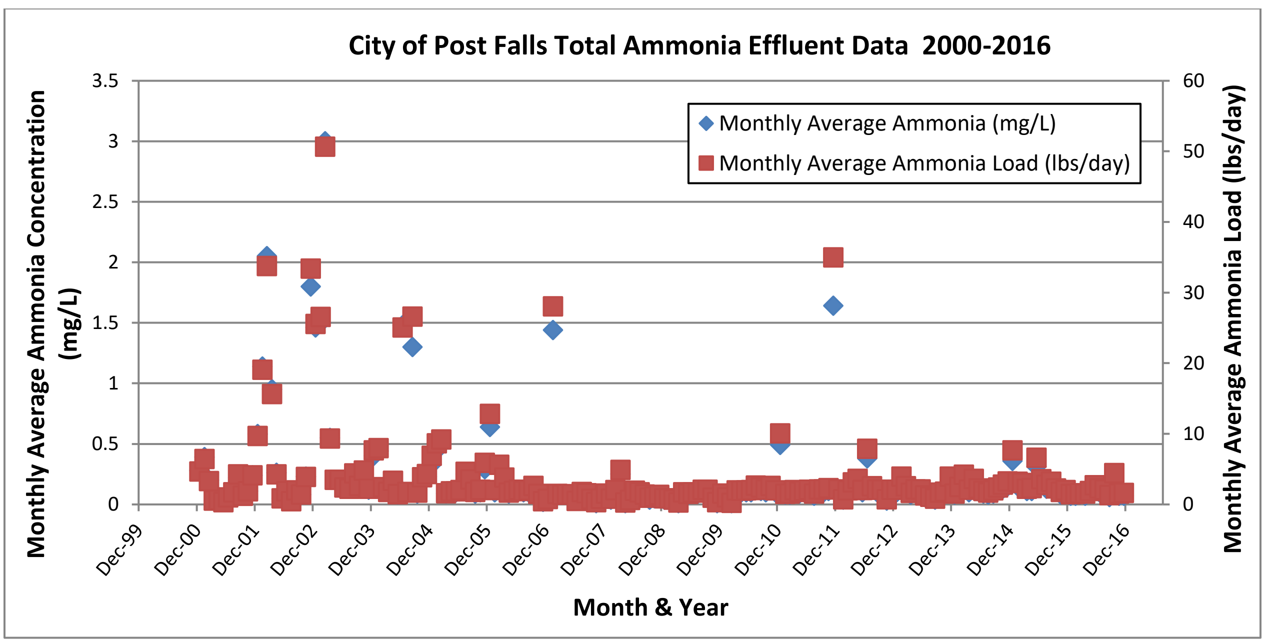

Figure C- 20. City of Post Falls Total Ammonia Effluent Data 2000-2016

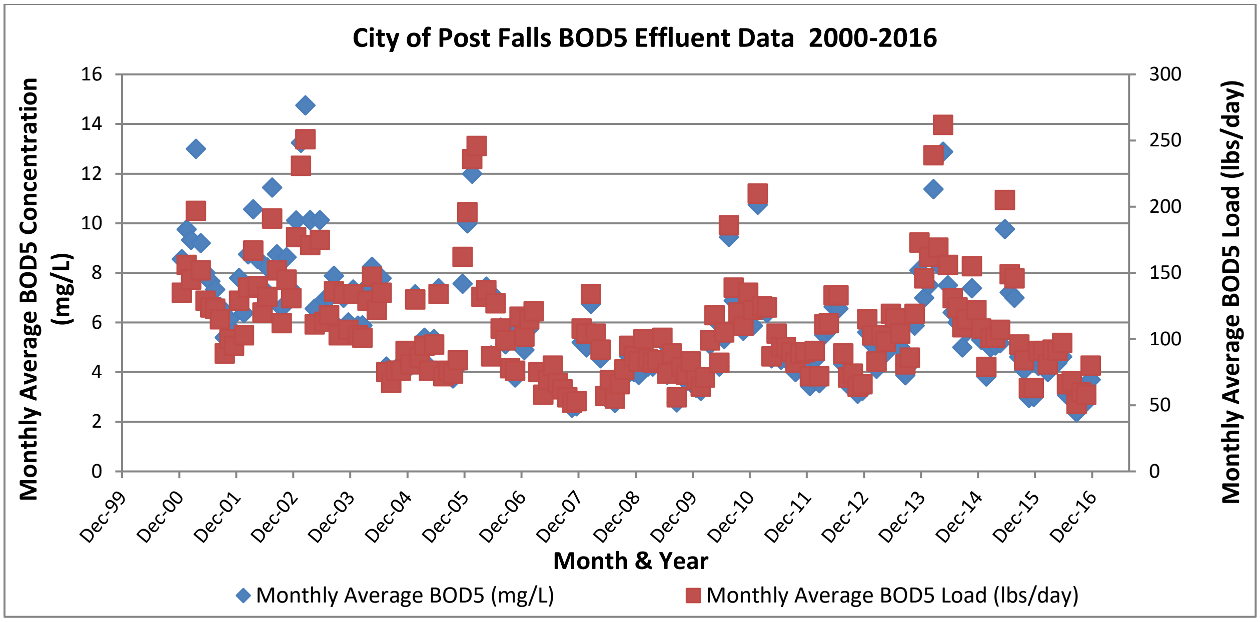

Figure C- 21. City of Post Falls BOD5 Effluent Data 2000-2016

Hayden Area Regional Sewer Board

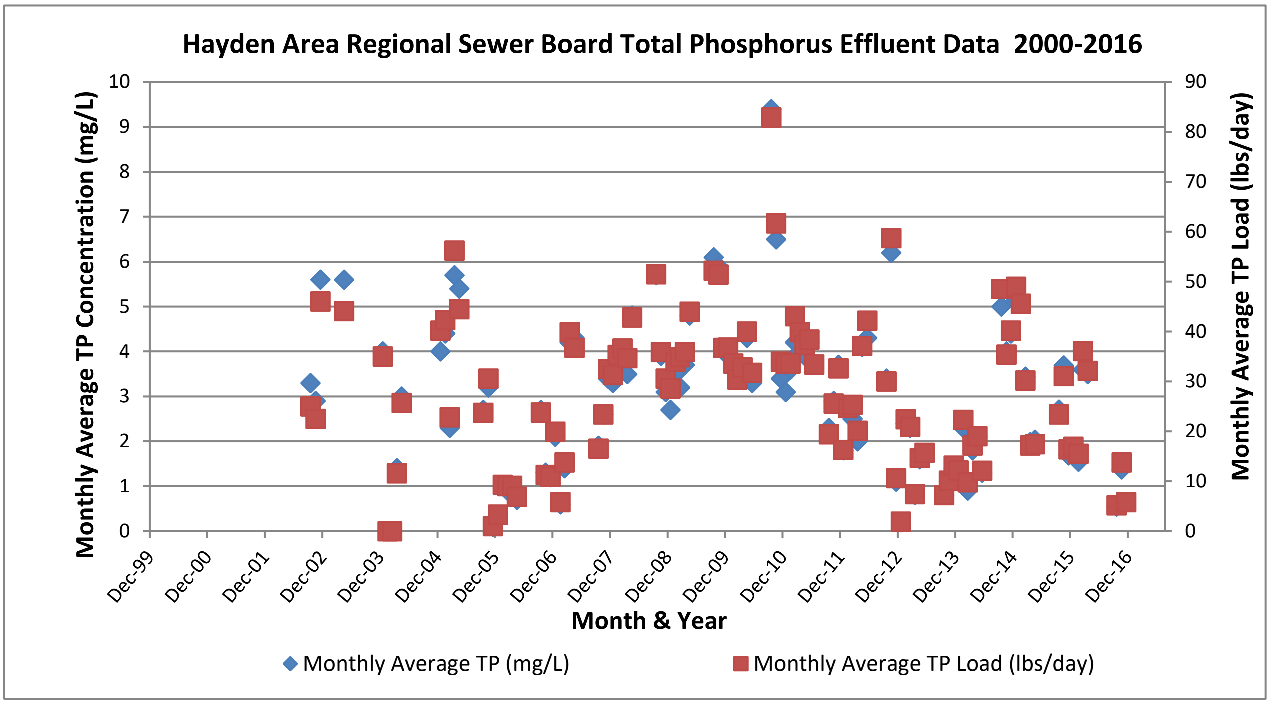

Figure C- 22. Hayden Area Regional Sewer Board Total Phosphorus Effluent Data 2000-2016

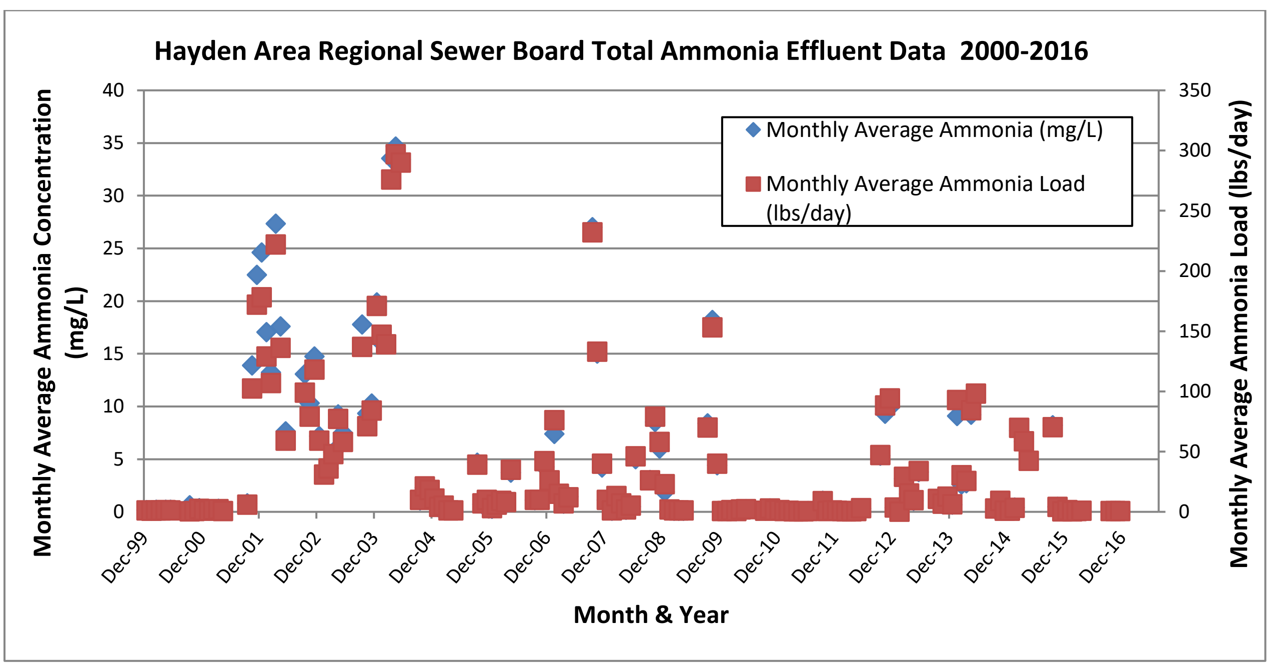

Figure C- 23. Hayden Area Regional Sewer Board Total Ammonia Effluent Data 2000-2016

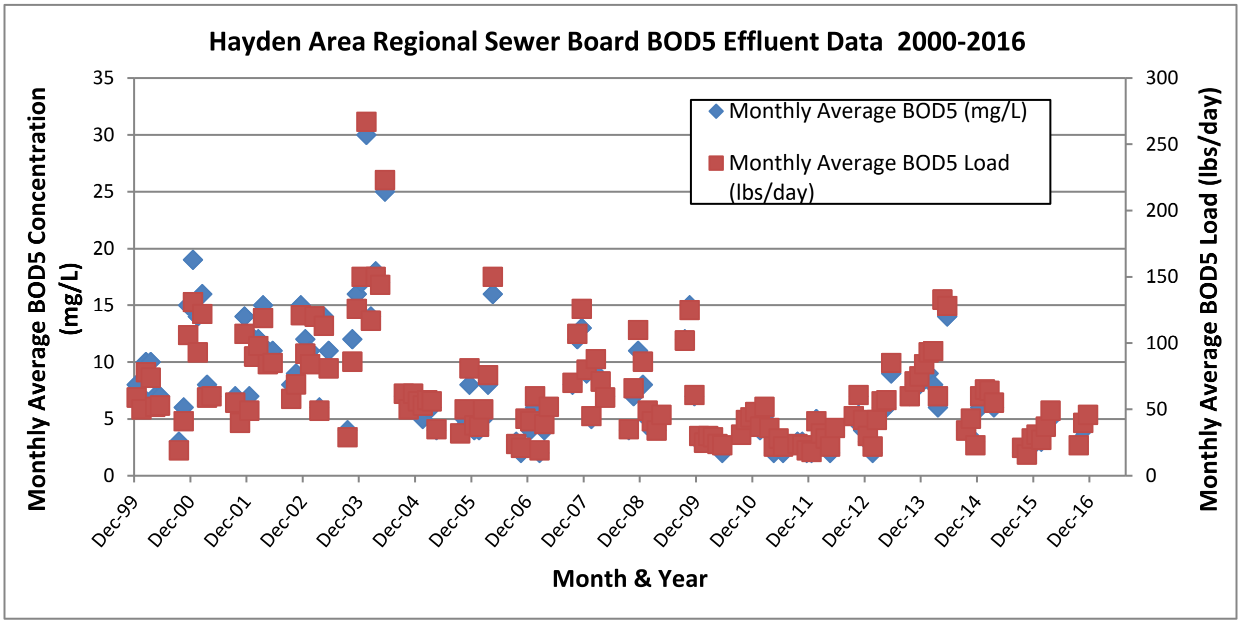

Figure C- 24. Hayden Area Regional Sewer Board BOD5 Effluent Data 2000-2016

Appendix D. Temperature and Precipitation Data

Temperature and Precipitation Data

http://www.wrh.noaa.gov/otx/climate/lcd/lcd.php

Spokane, WA Airport Weather Station

Shaded area = 2001 TMDL Critical Year

Black bold numbers = calendar year totals

Date	Average monthly temp (ºF)	High temp (ºF)	Low temp (ºF)	Total precip (inches)	Yearly average temp (ºF)	Yearly high temp (ºF)	Yearly average high temp (ºF)	Yearly low temp (ºF)	Yearly total precip (inches)
Jan-01	27.1	41	9	0.63					
Feb-01	26.8	40	7	0.66					
Mar-01	39.1	63	20	1.37					
Apr-01	43.6	77	23	1.71					
May-01	55.4	90	27	0.8					
Jun-01	58.7	89	38	1.1					
Jul-01	68.4	98	41	0.28					
Aug-01	71.1	99	44	0.26					
Sep-01	63.3	89	38	0.17					
Oct-01	45.9	78	29	2.1					
Nov-01	39.9	61	24	2.61					
Dec-01	28.1	44	10	2.03	**47.3**	**99**	**72.4**	**7**	**13.72**
Jan-10	35.1	51	16	1.54					
Feb-10	37.9	53	23	1.28					
Mar-10	41.2	64	22	1.2					
Apr-10	46.8	75	26	1.21					
May-10	51.3	81	29	2.15					
Jun-10	59.1	83	43	2.56					
Jul-10	68.9	95	45	0.36					
Aug-10	68.5	93	44	0.21					
Sep-10	59.8	85	41	0.69					
Oct-10	49.7	81	30	1.54					
Nov-10	33.1	60	-10	3.1					
Dec-10	29.4	46	-7	3.19	**48.4**	**95**	**72.25**	**-10**	**19.03**
Jan-11	29.2	51	-4	2.43					
Feb-11	28.9	52	-10	1.14					
Mar-11	39.3	59	26	3.25					
Apr-11	41.5	63	28	1.81					
May-11	52	79	32	1.83					
Jun-11	59	85	39	0.57					
Jul-11	66.7	91	46	0.53					
Aug-11	70.8	94	48	0.23					
Sep-11	65	93	40	0.14					
Oct-11	48.1	75	23	0.73					
Nov-11	35.1	56	18	1.73					
Dec-11	28.6	49	15	1.01	**47.0**	**94**	**70.58**	**-10**	**15.4**

Temperature and Precipitation Data

http://www.wrh.noaa.gov/otx/climate/lcd/lcd.php

Spokane, WA Airport Weather Station

Date	Average monthly temp (ºF)	High temp (ºF)	Low temp (ºF)	Total precip (inches)	Yearly average temp (ºF)	Yearly high temp (ºF)	Yearly average high temp (ºF)	Yearly low temp (ºF)	Yearly total precip (inches)
Jan-12	30	53	9	1.81					
Feb-12	32.7	48	6	1.68					
Mar-12	38.6	63	21	4.56					
Apr-12	48.3	81	26	1.39					
May-12	53.9	86	30	0.69					
Jun-12	59.6	85	38	2.86					
Jul-12	72.1	98	43	0.84					
Aug-12	71.6	97	47	0.13					
Sep-12	63.4	86	35	T					
Oct-12	48.5	76	30	1.54					
Nov-12	38.9	57	20	3.24					
Dec-12	31.2	49	9	2.58	**49.1**	**98**	**73.25**	**6**	**21.32**
Jan-13	24.7	43	4	1.63					
Feb-13	33.8	50	21	0.74					
Mar-13	41.2	68	22	0.82					
Apr-13	46	73	21	0.94					
May-13	56.9	86	30	0.8					
Jun-13	61.7	91	44	1.86					
Jul-13	73.9	99	51	T					
Aug-13	72.2	92	52	0.68					
Sep-13	63	92	42	1.56					
Oct-13	45.7	67	25	0.09					
Nov-13	34.8	52	15	1.56					
Dec-13	25.7	44	-2	0.68	**48.3**	**99**	**71.42**	**-2**	**11.36**
Jan-14	29.6	47	13	1.01					
Feb-14	26	46	-5	1.81					
Mar-14	39.6	56	11	2.88					
Apr-14	46.9	72	31	1.14					
May-14	57.7	80	37	0.56					
Jun-14	61.7	85	44	1.84					
Jul-14	75.7	100	48	0.18					
Aug-14	72.2	98	52	0.58					
Sep-14	63.1	88	39	0.26					
Oct-14	53.3	80	35	1.42					
Nov-14	34.6	59	10	1.34					
Dec-14	32.8	57	8	1.97	**49.4333**	**100**	**72.33**	**-5**	**14.99**

Monthly Total Precipitation (inches)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Total Precipitation	# Min	# Max
2001	0.63	0.66	1.37	1.71	0.8	1.1	0.28	0.26	0.17	2.1	2.61	2.03	13.72	2	0
2010	1.54	1.28	1.2	1.21	2.15	2.56	0.36	0.21	0.69	1.54	3.1	3.19	19.03	0	1
2011	2.43	1.14	3.25	1.81	1.83	0.57	0.53	0.23	0.14	0.73	1.73	1.01	15.4	1	1
2012	1.81	1.68	4.56	1.39	0.69	2.86	0.84	0.13		1.54	3.24	2.58	21.32	1	4
2013	1.63	0.74	0.82	0.94	0.8	1.86		0.68	1.56	0.09	1.56	0.68	11.36	3	2
2014	1.01	1.81	2.88	1.14	0.56	1.84	0.18	0.58	0.26	1.42	1.34	1.97	14.99	2	1
2015	1.91	1.04	2.43	0.53	0.85	0.07	0.19	0.18	0.52	1.14	0.77	4.45	14.08	2	1
2016	2.74	0.72	3.3	0.32	0.78	0.51	0.27	0.16	0.21	6.23	1.57	1.49	18.3	1	2
Min	**0.63**	**0.66**	**0.82**	**0.32**	**0.56**	**0.07**	**0.18**	**0.13**	**0.14**	**0.09**	**0.77**	**0.68**			
Max	**2.74**	**1.81**	**4.56**	**1.81**	**2.15**	**2.86**	**0.84**	**0.68**	**1.56**	**6.23**	**3.24**	**4.45**			
Ave	1.71	1.13	2.48	1.13	1.06	1.42	0.38	0.30	0.51	1.85	1.99	2.18			

Monthly High Temperature (ºF)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Average High Temperature	# Min	# Max
2001	41	40	63	77	90	89	98	99	89	78	61	44	72.42	2	1
2010	51	53	64	75	81	83	95	93	85	81	60	46	72.25	1	1
2011	51	52	59	63	79	85	91	94	93	75	56	49	70.58	3	1
2012	53	48	63	81	86	85	98	97	86	76	57	49	73.25	0	0
2013	43	50	68	73	86	91	99	92	92	67	52	44	71.42	2	0
2014	47	46	56	72	80	85	100	98	88	80	59	57	72.33	1	2
2015	55	58	70	78	83	105	100	100	89	75	58	56	77.25	0	6
2016	47	55	65	85	82	96	97	93	83	67	64	41	72.92	3	2
Min	**41**	**40**	**56**	**63**	**79**	**83**	**91**	**92**	**83**	**67**	**52**	**41**			
Max	**55**	**58**	**70**	**85**	**90**	**105**	**100**	**100**	**93**	**81**	**64**	**57**			
Ave	48.50	50.25	63.50	75.50	83.38	89.88	97.25	95.75	88.13	74.88	58.38	48.25			

Appendix E. Ecology Grant and Loan Funding

Type	Recipient Name	Loan/Grant Agreement Title	Grants*	Loan**	Total	Category Totals
Non-Point Source	Pend Oreille Conservation District	Little Spokane River Watershed Restoration	$213,747		$213,747	
	Spokane Conservation District, Stevens Co Conservation District, Lake Spokane Landowners Association, Ecology	Lake Spokane Shoreline Implementation and Education Project	$41,892		$41,892	
	Spokane Conservation District	Spokane County Livestock and Land Program	$250,000	$100,000	$350,000	
	Spokane County Conservation District	Bear Creek Livestock BMP Continuation	$168,750		$168,750	
	Spokane County Conservation District	Conservation Tillage Sediment Reduction Program		$43,375	$43,375	
	Spokane County Conservation District	Direct Seed Loan Program	$73,765	$8,333,398	$8,407,163	
	Spokane County Conservation District	Hangman Creek Phosphorus Reduction	$128,000		$128,000	
	Spokane County Conservation District	Hangman Creek TMDL Implementation Project	$250,000		$250,000	
	Spokane, City of	Garden Springs Creek Restoration	$154,345		$154,345	
	The Lands Council	Riparian Restoration in Hangman Creek	$75,000		$75,000	
	Stevens County Conservation District	South Stevens Education & Monitoring	$99,625		$99,625	
	Spokane, City of	Spokane Gorge Restoration	$180,000		$240,000	
	Spokane Conservation District	Spokane NPS Reduction Implementation and BMP Database	$250,000		$333,333	
	Stevens County Conservation District	Stevens County BMP Implementation Project	$79,215		$111,832	
	Stevens County Conservation District	Lake Spokane Floating Islands / Treatment Wetlands	$49,999		$74,167	

Type	Recipient Name	Loan/Grant Agreement Title	Grants*	Loan**	Total	Category Totals
Non-Point Source (cont.)	Stevens County Conservation District	Lake Spokane Phosphorus Input II	$250,000		$333,333	
	The Lands Council	Riparian Restoration in the Little Spokane River Watershed	$74,430		$99,240	
	The Lands Council	Riparian Restoration & Stormwater Education in the Hangman Creek Watershed	$208,000		$277,333	
	Newman Lake Flood Control Zone District	Newman Lake Eurasian Milfoil Control Demonstration Project	$24,999		$33,333	20 projects
	Spokane River Forum	Hangman Creek Water Quality Video	$30,000		$30,000	$11,464,468
Septic	Airway Heights, City of	The Septic Tank Elimination Project	$133,316	$757,684	$891,000	
	Spokane Conservation District	Spokane County Septic Tank Replacement Loan Program	$350,000	$450,000	$800,000	
	Spokane County & City of Spokane	Spokane-Rathdrum Prairie Aquifer Protection Project	$20,000,000		$20,000,000	4 projects
	Vera Water and Power	Sun Acres LOSS Decommission / Spokane County System Connection		$880,409.00	$880,409.00	$22,571,409
Combined Sewer Overflow	Spokane, City of	CSO 34-1 Project		$3,478,000	$3,478,000	
	Spokane, City of	CSO 41 Control Facility		$4,968,000	$4,968,000	
	Spokane, City of	CSO Basin 10 Abatement Project		$957,519	$957,519	
	Spokane, City of	CSO Basin 20		$4,521,400	$4,521,400	
	Spokane, City of	CSO Basin 26 Control Facility		$1,195,000	$1,195,000	
	Spokane, City of	CSO Basin 33-2 Control Facility		$4,270,800	$4,270,800	
	Spokane, City of	CSO Basin 34-2 and 34-3 Control Facilities		$20,719,000	$20,719,000	
	Spokane, City of	CSO Basins 38-39-40 Control Facilities		$4,135,238	$4,135,238	
	Spokane, City of	CSO Basin 233-2 Control Facility		$4,824,586	$4,824,586	
	Spokane, City of	Rebecca Control Facility for CSO Basin 41		$2,393,870	$2,393,870	11 projects
	Spokane, City of	River Infiltration Reduction		$1,200,859	$1,200,859	$52,664,272
Stormwater	Spokane County	2013-15 Municipal Stormwater Capacity Grant Program	$170,000		$170,000	

Type	Recipient Name	Loan/Grant Agreement Title	Grants*	Loan**	Total	Category Totals
Stormwater (cont.)	Spokane County	Country Homes Boulevard Restoration Project	$1,750,000		$1,750,000	
	Spokane County	Municipal Stormwater Capacity Grant Program	$484,027		$484,027	
	Spokane County	Spokane County Regional Decant Facility	$684,000		$684,000	
	Spokane County	Spokane County UIC/Water Quality Retrofit Project	$206,250		$206,250	
	Spokane Valley, City of	2013-15 Municipal Stormwater Capacity Grant Program	$170,000		$170,000	
	Spokane Valley, City of	Spokane Valley Regional Decant Facility	$735,000		$735,000	
	Spokane Valley, City of	Sprague Avenue UIC Elimination	$666,622		$666,622	
	Spokane Valley, City of	Sullivan Bridge Drain Retrofit	$237,375		$237,375	
	Spokane Valley, City of	Phase II Stormwater Pass-through Grant Program	$50,000		$50,000	
	Spokane, City of	Cannon Hill Pond Retrofit		$277,000	$277,000	
	Spokane, City of	Hazel's Creek Downstream Conveyance LID Demonstration Project	$183,710	$1,428,960	$1,612,670	
	Spokane, City of	River Runoff Reduction Phases 1 and 2		$1,372,800	$1,372,800	
	Spokane, City of	Summit Low-Impact Urban Retrofit Project		$1,848,985	$1,848,985	
	Spokane, City of	Summit-Nettleton (formerly Bridge Avenue) LID project	$342,000		$342,000	
	Spokane, City of	Wet Weather Integrated Strategic Planning		$5,220,000	$5,220,000	
	Spokane, City of	Cochran Basin River Runoff Reduction & stormwater conveyance	$2,000,000	$5,100,000	$7,100,000	
	Spokane, City of	Phase II Stormwater Pass-through Grant Program	$50,000		$50,000	
	Spokane, City of	Sharp Avenue Stormwater Improvement Project		$1,260,000	$1,680,000	
	Spokane, City of	Monroe/Lincoln Stormwater Project		$749,250	$999,000	

Type	Recipient Name	Loan/Grant Agreement Title	Grants*	Loan**	Total	Category Totals
Stormwater (cont.)	Spokane, City of	Trent Avenue Stormwater Retrofit		$189,750	$253,000	
	Spokane, City of	East Sprague Stormwaer Retrofits		$601,500	$802,000	
	Spokane, City of	Pettet Drive MS4 Elimination		$450,000	$600,000	
	Spokane, City of	Riverside Park Water reclamation Facility LID		$347,625	$463,500	
	Spokane, City of	Havana Street Stormwater Improvements		$761,550	$1,015,400	
	Spokane, City of	High Drive Stormwater Improvements	$242,000	$1,047,000	$1,289,000	
	Spokane County - Stormwater Utility	Country Homes - Wall to Division Stormwater Retrofit		$427,278	$569,704	
	Spokane County - Stormwater Utility	Market Street - Francis to Lincoln Stormwater Retrofit		$666,750	$889,000	
	Spokane County - Stormwater Utility	Hawthorne Road East Stormwater Retrofit		$667,626	$890,168	
	Spokane County - Stormwater Utility	Hastings Road Stormwater Retrofit		$677,591	$903,455	
	Spokane County - Stormwater Utility	Monroe Street Stormwater Retrofit		$629,404	$839,206	
	Spokane County - Stormwater Utility	Hawthorne West Stormwater Retrofit		$610,375	$813,833	
	Spokane County - Stormwater Utility	2015-2017 Biennial Stormwater Capacity Grant	$25,000		$25,000	
	Spokane, City of	2015-2017 Biennial Stormwater Capacity Grant	$50,000		$50,000	35 projects
	Spokane Valley, City of	2015-2017 Biennial Stormwater Capacity Grant	$25,000		$25,000	$35,083,995
Municipal Wastewater Treatment Plants	Airway Heights, City of	Water Reclamation and Recharge Project	$2,923,104	$9,026,454	$11,949,558	
	Airway Heights, City of	City of Airway Heights WasteWater Treatment Reclamation and Recharge Project (Phase 1B)		$13,646,092	$13,646,092	
	Deer Park, City of	Deer Park Aerated Lagoon Screening and Aeration Project	$1,126,540	$593,952	$1,720,492	

Type	Recipient Name	Loan/Grant Agreement Title	Grants*	Loan**	Total	Category Totals
Municipal Wastewater Treatment Plants (cont.)	Deer Park, City of	Effluent Reuse Feasibility Study/Sewer Plan Update	$30,000	$30,000	$60,000	
	Deer Park, City of	Wastewater Storage Lagoon #1 and #2 Upgrade		$300,375	$300,375	
	Liberty Lake Sewer and Water District	Engineering Report		$82,073	$82,073	
	Liberty Lake Sewer and Water District	Water Reclamation Plant Upgrades – Phase II		$900,000	$900,000	
	Rockford, Town of	Rockford Wastewater Treatment Facility Improvements Project	$1,805,343	$1,093,911	$2,899,254	
	Tekoa, City of	Infiltration and Inflow Reduction Improvements	$824,102		$824,102	
	Tekoa, City of	Tekoa Infiltration and Inflow Reduction Design Project	$53,199		$53,199	
	Deer Park, City of	Wastewater Storage Lagoon #1, #2, and #3 Construction Upgrade		$9,139,932		
	Liberty Lake Sewer and Water District	Water Reclamation Facility Upgrades, Phase 2		$15,916,417		
	Sacheen Lake Water and Sewer District	Sacheen Lake Wastewater Collection and Treatment Project		$12,209,502		
	Spokane, City of	Riverside Park Water Reclamation Facility (RPWRF) Digester		$15,203,822		
	Cheney, City of	City of Cheney Reclaimed Water Engineering Report		$112,000		
	Spokane, City of	Riverside Interceptor Protection		$4,200,000		17 projects
	Town of Spangle	Spangle Wastewater Treatment Plant		$27,000		$89,243,818
					Total:	**$211,027,963**

* Includes grants and loans with forgivable principle but amounts do not include recipient's required match

** Loans are repaid by recipients