Wenatchee River Watershed Dissolved Oxygen and pH Total Maximum Daily Load

Water Quality Implementation Plan -- DRAFT

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Cover photo: A boater enters "Hobo's Gulch" on the Wenatchee River as he glides past the Leavenworth Wastewater Treatment Plant

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Wenatchee River Watershed Dissolved Oxygen and pH Total Maximum Daily Load

Water Quality Implementation Plan – DRAFT

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Wenatchee River Watershed

The study area for this TMDL consists of the Wenatchee River watershed Figure 1, which is also referred to as Water Resource Inventory Area (WRIA) 45.

The water quality impairments addressed by this TMDL occur in:

- The lower Wenatchee River watershed below the city of Leavenworth and above the confluence with the Columbia River.
- The Icicle Creek watershed below the Leavenworth National Fish Hatchery.

Although most violations of pH and dissolved oxygen (DO) occur in the lower portion of the Wenatchee River and tributaries, upstream pollution sources contribute to downstream violations. The impairments typically occur during periods of seasonally low flow. Most water quality violations for DO and pH occur in August through October, although impairments also occur during the pre-runoff period in the spring.

Impaired waters on 303(d) list

Streams identified with impaired beneficial uses and water bodies on Washington State's 303(d) list of impaired waters are those streams that are not meeting state water quality standards. Table 3 presents the current 2008 303(d) listed water bodies in the Wenatchee River watershed for DO and pH. Ecology's River and Stream Monitoring Program and the Chelan County Conservation District collected water quality data that identified DO and pH impairments in the Wenatchee River, Icicle Creek, and Brender Creek. As a result, these waters were added to the 1996 and 1998 303(d) lists for DO and pH. Additional information collected for this TMDL showed that DO and pH violations occurred at other locations in the watershed. These water quality impaired streams were added to the 2004 and 2008 303(d) list.

Table 1. Project area water bodies on the 2004 and 2008 303(d) List *(Category 5 listings).*

Water Body*	Parameter	Medium	Listing ID	Township	Range	Section
Brender Creek	DO	Water	8406	23N	19E	05
Icicle Creek		Water	8416	24N	17E	24
Wenatchee River		Water	10705	25N	17E	09
Icicle Creek	pH	Water	8417	24N	17	24
Mission Creek		Water	34799	23N	19E	04
			11282	23N	19E	05
No Name Creek		Water	41819		--	
Peshastin Irrigation Return[1]		Water	41823		--	
Van Creek		Water	41834	25N	18E	24
Wenatchee River		Water	10702	23N	20E	28
			41269	23N	19E	11

The designated uses protected by state DO and pH criteria in the Wenatchee include salmonid spawning, rearing and migration.

The Endangered Species Act lists three species of fish as endangered or threatened in the Wenatchee River watershed.

- The Upper Columbia River population of Chinook salmon (*Oncorhynchus tshawytscha*) is listed as endangered.
- The Upper Columbia River population of steelhead trout (*Oncorhynchus mykiss*) is listed as endangered.
- Upper Columbia River population of bull trout (*Salvelinus confluentus*) is listed as threatened.

TMDL process overview

The Clean Water Act requires that a total maximum daily load (TMDL) be developed for each of the water bodies on the 303(d) list. The TMDL identifies pollution problems in the watershed and then specifies how much pollution needs to be reduced or eliminated to achieve clean water. Then Ecology works with the local community to develop an overall approach to control the pollution, called the implementation strategy, and a monitoring plan to assess effectiveness of the water quality improvement activities. Once EPA approves the TMDL, a w*ater quality implementation plan* must be developed within one year. This plan identifies specific tasks, responsible parties and timelines for achieving clean water.

TMDL = Loading Capacity = sum of all Wasteload Allocations + sum of all Load Allocations + Margin of Safety

[1] Name changed from Pioneer Irrigation Return to Peshastin Irrigation Return on 1/19/06.

Implementation strategy

The Department of Ecology (Ecology) recently submitted the *Wenatchee River Watershed pH, Dissolved Oxygen and Phosphorus Total Maximum Daily Load* (TMDL) to the U.S. Environmental Protection Agency (EPA). EPA approved the TMDL on August 25, 2009.

The primary goal of following a TMDL implementation plan is to meet water quality standards which protect designated uses. The TMDL calls for significant reductions in total phosphorus from sources to the Wenatchee River.

TMDLs categorize pollutant sources into point sources and nonpoint sources. Point source implementation involves permitted facilities reaching certain pollutant load reductions, called wasteload allocations, through actions managed by the National Pollutant Discharge Elimination System (NPDES). NPDES permit management is delegated by EPA to Ecology for all point sources in the Wenatchee River watershed except the Leavenworth National Fish Hatchery. Ecology and EPA will work with individual permit holders to prioritize and implement water quality based effluent limits in each NPDES permit.

Nonpoint sources may reach their reduction targets, called load allocations, through implementation of a variety of projects, which are generally voluntary. Nonpoint source projects can be categorized, and locally prioritized, within three different general types of project:

1. Reduce pollutant loading from nonpoint sources by implementation of best management practices (BMPs) and elimination of un-permitted discharge by enforcement of clean water laws.

2. Maintain a watershed's ability to keep water healthy by protection of existing ecological functions such as riparian zones, wetlands and floodplains.

3. Increase a watershed's ability to keep water healthy by restoration of ecological functions such as riparian zones, wetlands and floodplains.

Two existing planning processes have prioritized actions to be completed in the Wenatchee River watershed that will improve water quality. The Wenatchee Watershed Planning Unit's final detailed implementation plan provides a list of projects to improve water quality, stream flow and habitat in the Wenatchee River watershed that, if achieved, will contribute to meeting TMDL targets for pH and dissolved oxygen the Wenatchee River. Also, the Wenatchee Sub-basin plan under the Upper Columbia Salmon Recovery, Chelan County and Yakama Nation provides an inventory of habitat improvement projects that, if completed, will benefit water quality in the Wenatchee River and its tributaries.

Pollution sources and organizational actions, goals, and schedules

Full compliance with water quality standards is expected to occur by the year 2019, or ten years after TMDL final approval. Ecology and the stakeholders will conduct monitoring and evaluation of the data throughout the ten-year compliance implementation period. The monitoring will be performed in accordance with a quality assurance project plan (QAPP). Ecology and clean-up participants anticipate the following schedule.

Table 2. Overall WQIP schedule

Phases and Targets	Description	Timeline
Phase 1	Point and nonpoint source reductions. Data collection and model calibration	2009-2013
First Target	Reduction in 50% of nonpoint source loading.	2014
Phase 2	Modify load and wasteload allocations if appropriate. Identify any addition point and nonpoint source reductions.	2014-2015
Phase 3	Implement additional load reductions.	2015-2019
Second Target A	NPDES permit compliance	2019
Second Target B	Reduction in the rest of nonpoint source loading	2019
Final Target	Achieve water quality standards	2019

Measuring progress toward goals

Ecology and the Wenatchee Watershed Planning Unit started the Wenatchee River Watershed Dissolved Oxygen and pH TMDL to address water quality standards violations of pH and dissolved oxygen in the Wenatchee River and some of its tributaries. The TMDL identified phosphorus reduction levels anticipated to limit periphyton growth in the Wenatchee River. Monitoring dissolved oxygen and pH values will be the primary strategy to track progress of the TMDL implementation approach. TMDL targets will be achieved when water quality standards are met for both dissolved oxygen and pH. Ecology will evaluate the need for collection and evaluation of dissolved oxygen and pH data every five years to assess progress toward meeting TMDL targets.

All monitoring for this TMDL should be conducted using methodology and analytical techniques comparable to the original methodology used by Ecology in the original technical analysis. In addition, monitoring conducted related to this TMDL should comply with the Water Quality Data Act of 2004, codified in RCW 90.48.570 through 90.48.590, and Ecology's Water Quality Program Policy 1-11. Also, monitoring related to this TMDL should be conducted after the completion of a quality assurance project plan (QAPP) that meets Ecology requirements for the collection of high quality data. Any divergence from Ecology's original methodology should be clearly explained in QAPPs and final monitoring reports.

Monitoring projects can be conducted at various scales based primarily on the objective of the project. Sometimes an organization's jurisdictional area determines the spatial scale and objectives of a monitoring project. Post-TMDL monitoring usually can be categorized as TMDL effectiveness monitoring and implementation project monitoring. Monitoring can include the tracking of locations and numbers of particular types of implementation projects, and it can include measurement of changing environmental conditions such as fish tissue concentrations. Monitoring activities associated with this TMDL include interim monitoring, effectiveness monitoring, and implementation plan monitoring. These monitoring activities are described in the following sections.

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What is a Total Maximum Daily Load (TMDL)

Federal Clean Water Act requirements

The Clean Water Act (CWA) established a process to identify and clean up polluted waters. It requires each state to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of narrative and numeric criteria which are considered in relation to protection of designated uses, such as cold water biota and drinking water supply.

Every two years, states are required to prepare a list of water bodies – lakes, rivers, streams, or marine waters – that do not meet water quality standards. This list is called the 303(d) list. To develop the list, Ecology compiles its own water quality data along with data submitted by local state and federal governments, tribes, industries, and citizen monitoring groups. This is called a water quality assessment. All data are reviewed to ensure that they were collected using appropriate scientific methods before the data are used to develop the 303(d) list. The 303(d) list is part of the water quality assessment.

The water quality assessment tells a more complete story about the condition of Washington's water. The assessment divides water bodies into five categories:

Category 1 – Meets standards for parameter(s) for which it has been tested.

Category 2 – Waters of concern.

Category 3 – Waters with no data available.

Category 4 – Polluted waters that do not require a TMDL because:

- 4a. – Has an approved TMDL and it is being implemented.
- 4b. – Has a pollution control plan in place that should solve the problem.
- 4c. – Is impaired by a non-pollutant such as low water flow, dams, and culverts.

Category 5 – Polluted waters that require a TMDL – the 303d list.

TMDL process overview

The Clean Water Act requires that a total maximum daily load (TMDL) be developed for each of the water bodies on the 303(d) list. The TMDL identifies pollution problems in the watershed and then specifies how much pollution needs to be reduced or eliminated to achieve clean water. Then Ecology works with the local community to develop an overall approach to control the pollution, called the implementation strategy, and a monitoring plan to assess effectiveness of the water quality improvement activities. Once EPA approves the TMDL, a w*ater quality implementation plan* (WQIP) must be developed within one year. This plan identifies specific tasks, responsible parties and timelines for achieving clean water.

Elements required in a TMDL

The goal of a TMDL is to ensure the impaired water will attain water quality standards in order to protect the designated uses. A TMDL includes a written, quantitative assessment of water quality problems and of the pollutant sources that cause the problem and an analysis of how the designated uses are being impaired. The TMDL determines the amount of a given pollutant that can be discharged to the water body and still meet standards (the loading capacity) and allocates that load among the various sources. The TMDL must account for both point source and non-point source discharges.

If the pollutant comes from a discrete source (referred to as a point source) such as a municipal or industrial facility's discharge pipe, that facility's share of the loading capacity is called a wasteload allocation. Wasteload allocations will be addressed in each discharger's respective NPDES permit. If it comes from a set of diffuse sources (referred to as a nonpoint source) such as general urban, residential, or farm runoff, the cumulative share is called a load allocation. Non-point sources are largely addressed on a voluntary basis.

The TMDL must also consider seasonal variations and include a margin of safety that takes into account any lack of knowledge about the causes of the water quality problem or its loading capacity. A reserve capacity for future loads from growth pressures is sometimes included as well. The sum of the wasteload and load allocations, the margin of safety and any reserve capacity must be equal to or less than the loading capacity.

Identification of the contaminant loading capacity for a water body is an important step in developing a TMDL. EPA defines the loading capacity as "the greatest amount of loading that a water body can receive without violating water quality standards" (EPA, 2001). The loading capacity provides a reference for calculating the amount of pollution reduction needed to bring a water body into compliance with standards. The portion of the receiving water's loading capacity assigned to a particular source is a load or wasteload allocation. By definition, a TMDL is the sum of the allocations, which must not exceed the loading capacity.

TMDL = Loading Capacity = sum of all Wasteload Allocations + sum of all Load Allocations + Margin of Safety

What part of the process are we in?

The Environmental Protection Agency approved the Wenatchee River Watershed Dissolved Oxygen and pH TMDL in August of 2009. This WQIP is a detailed plan for managing the reduction of pollutant loading (phosphorus) to the Wenatchee River and conducting other activities that have the potential to improve dissolved oxygen and pH in Icicle Creek and the Wenatchee River.

This plan is not the last document in the TMDL process. It is expected that implementation of the TMDL will generate progress reports that document adaptive implementation results and effectiveness monitoring reports. As part of this TMDL and WQIP, Ecology and the cleanup partners anticipate using an adaptive management approach that will assure that the designated uses are protected in the most efficient and effective manner. The adaptive management approach will be supported by, but not be limited to, data collection and analysis that:

- Further assesses the assimilative capacity of the Wenatchee River and its tributaries in order to adapt waste load allocations if necessary.
- Compare computer simulated changes (using Qual2k) in water quality to actual changes in water quality after pollutant sources have been reduced.
- Determine the most effective ways to comply with water quality standards.

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Why Ecology is Conducting a TMDL in This Watershed

Overview

Ecology prepared the TMDL to set pollution reduction targets that will bring the Wenatchee River, Icicle Creek, and other tributaries into compliance with Washington State water quality standards for dissolved oxygen (DO) and pH. Correcting DO and pH problems in these streams is important for the protection of impaired designated uses such as fish and other valuable aquatic species listed under the Endangered Species Act.

Ecology's River and Stream Monitoring Program and the Chelan County Conservation District collected water quality data that identified DO and pH impairments in the Wenatchee River, Icicle Creek, and Brender Creek. As a result, these waters were placed on the 1996 and 1998 303(d) lists for DO and pH. Additional information collected for this TMDL showed that DO and pH violations occurred at other locations in the Wenatchee watershed. These water quality impaired stream locations were added to the 2008 303(d) list. Ecology developed the TMDL to address all water quality violations for DO and pH in the Wenatchee River watershed for the 2008 list.

This TMDL document, *Wenatchee River Watershed Dissolved Oxygen and pH Total Maximum Daily Load: Water Quality Improvement Report*, presents the following elements:

- A summary of findings from the 2006 DO and pH technical study (Carroll et al., 2006).
- Updated and additional technical analyses completed after the 2006 DO and pH technical study.
- A quantitative framework for improving water quality in the watershed. This framework (1) describes a natural condition range for phosphorus, and (2) allocates phosphorus loads to sources in the Wenatchee River watershed that will improve DO and pH levels and meet water quality standards.
- An implementation strategy that describes (1) the roles of organizations with responsibility to improve water quality, and (2) the means through which these organizations will address the water quality issues, including adaptive management that will assure the designated uses will be protected in the most efficient and effective manner. The adaptive management approach will include, but is not limited to, robust data collection and analyses to: further assess the assimilative capacity of the Wenatchee River, validate the proposed wasteload allocation changes in water quality (caused by variations or changes in source loadings), make recommendations to change the proposed wasteload allocations (if supported by the additional data collection and analyses) and to determine the most effective ways to comply with water quality standards.

Wenatchee River Watershed

The study area for the TMDL consisted of the Wenatchee River watershed (Figure 1), which is also referred to as Water Resource Inventory Area (WRIA) 45.

The water quality impairments addressed by the TMDL occur in:

- The lower Wenatchee River watershed below the city of Leavenworth and above the confluence with the Columbia River.
- The Icicle Creek watershed below the Leavenworth National Fish Hatchery.

Although most violations of pH and dissolved oxygen occur in the lower portion of the Wenatchee River and tributaries, upstream pollution sources contribute to downstream violations. The impairments typically occur during periods of seasonally low flow. Most water quality violations for DO and pH occur in August through October, although impairments also occur during the pre-runoff period in the spring.

There is a mixture of federal, state, county and private land ownership throughout the Wenatchee River watershed. Most of the upper watershed is federally-owned land managed as the Wenatchee National Forest by the United States Department of Agriculture's Forest Service (USFS).

Annual average precipitation varies throughout the watershed, and is usually related to elevation and proximity to the crest of the Cascade Mountains. Near the crest of the mountains, the watershed receives up to 150 inches per year of precipitation as rain and snow. Near the city of Wenatchee, the watershed receives only eight inches of precipitation as rain and snow.

The climate of the watershed affects the flow of the mainstem Wenatchee River with peak run-off occurring in May and June charged by snowmelt from the upper portion of the watershed. Low flows occur in August and September after alpine snows have melted and Pacific Ocean high-pressure systems dominate the area with relatively dry weather. Figure 2 presents the monthly average flow patterns for various sites in the Wenatchee River watershed.

The Endangered Species Act lists three species of fish as endangered or threatened in the Wenatchee River watershed.

- The Upper Columbia River population of Chinook salmon (*Oncorhynchus tshawytscha*) is listed as endangered.
- The Upper Columbia River population of steelhead trout (*Oncorhynchus mykiss*) is listed as endangered.
- Upper Columbia River population of bull trout (*Salvelinus confluentus*) is listed as threatened.

Many planning activities provide habitat improvement strategies for the above-listed species, and although dissolved oxygen and other water quality parameters, such as temperature, were listed as potential limiting factors, it is the Clean Water Act's obligation to protect water quality for aquatic life uses. Implementing this plan is an important portion of a very large effort to protect and restore fish populations in the Wenatchee River watershed. Achieving the water quality standards targeted by the TMDL will promote fish health and survival of these species, non-listed salmonids, other fish species, and non-fish species.

The waste load and load allocations for the TMDL are based on 7Q10 stream flow probability.

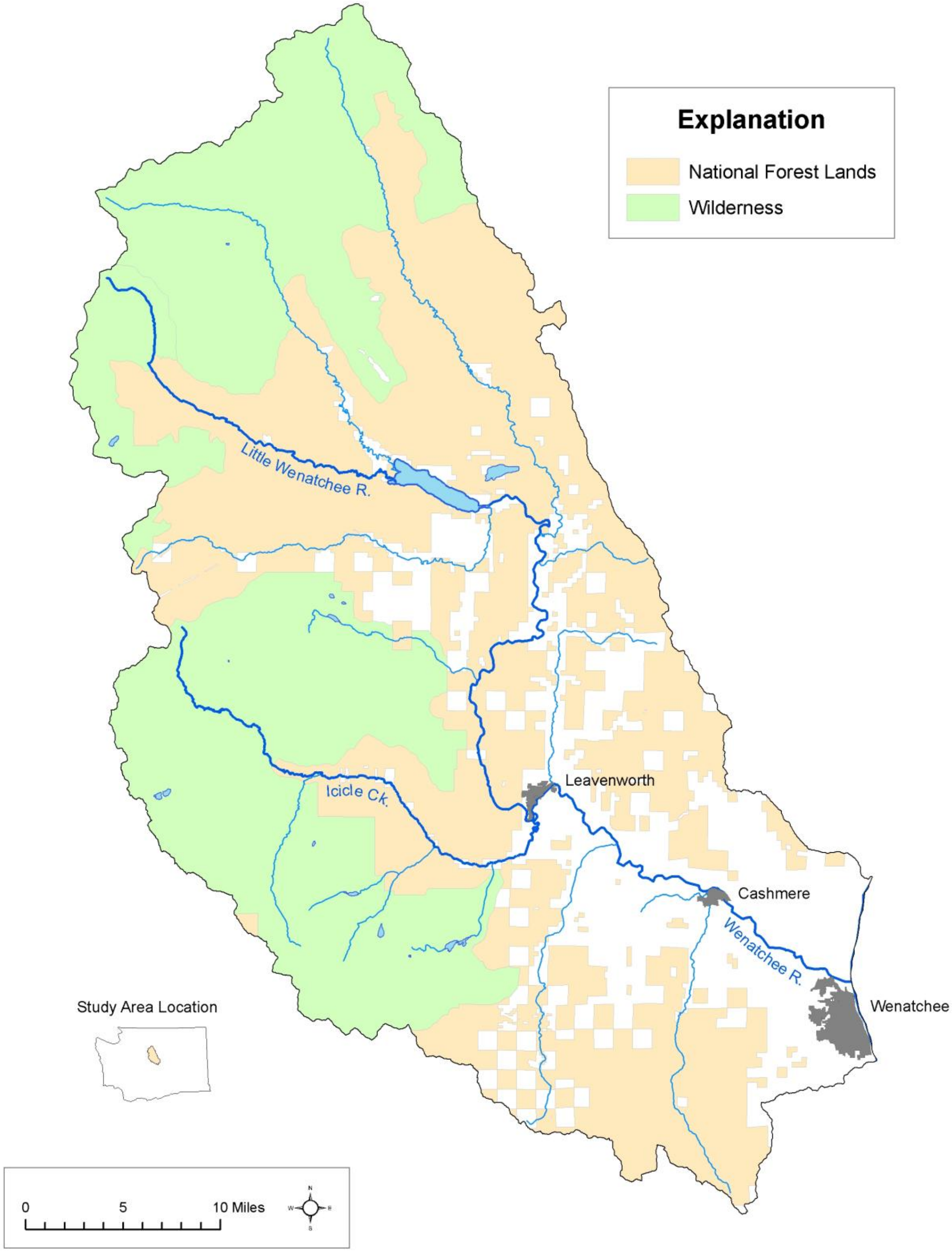

Figure 1. Map of the Wenatchee River Watershed

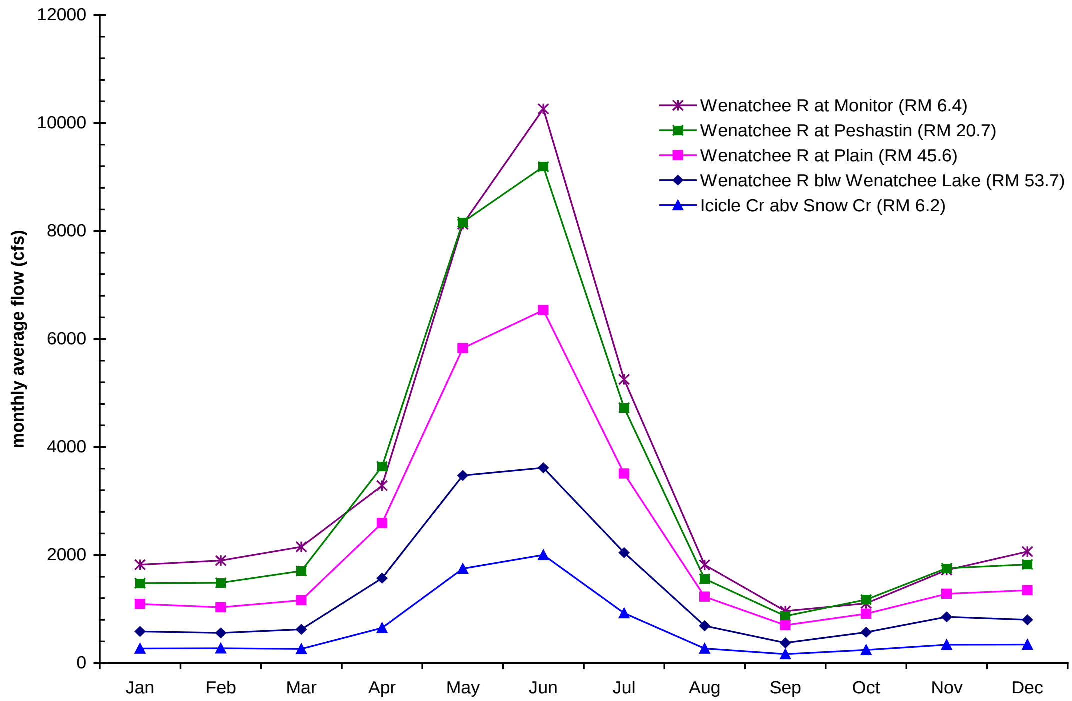

Figure 2. Monthly average flow at various gauges in the Wenatchee River Watershed

Pollutants addressed by the TMDL

The lower Wenatchee River and lower Icicle Creek do not meet Washington State water quality standards for DO and pH during low streamflow conditions. Results of water quality data analysis and of water quality modeling indicate that excessive nutrient loading to the lower sections of the Wenatchee River and Icicle Creek cause these violations. Analysis also shows that phosphorus is the limiting nutrient in these streams. *The Wenatchee River Basin Dissolved Oxygen, pH and Phosphorus TMDL Study* (Carroll et al., 2006) concluded that lowering phosphorus contributions to the lower Wenatchee River and Icicle Creek would improve DO and pH conditions in these water bodies.

The TMDL sets phosphorus loading capacities for the lower Wenatchee River and Icicle Creek that, if achieved, are predicted to result in meeting water quality standards for DO and pH in the Wenatchee River and Icicle Creek. This adaptive management implementation plan is intended to validate the proposed wasteload and load allocations.

Impaired waters on 303(d) list

Streams identified with impaired beneficial uses and water bodies on Washington State's 303(d) list of impaired waters are those streams that are not meeting state water quality standards. Table 3 presents the current 2008 303(d)-listed water bodies in the Wenatchee River watershed for DO and pH. Ecology's River and Stream Monitoring Program and the Chelan County Conservation District collected water quality data that identified DO and pH impairments in the Wenatchee River, Icicle Creek, and Brender Creek. As a result, these waters were added to the 1996 and 1998 303(d) lists for DO and pH. Additional information collected for this TMDL showed that DO and pH violations occurred at other locations in the watershed. These water quality impaired streams were added to the 2004 and 2008 303(d) list.

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Van Creek		Water	41834	25N	18E	24
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			41269	23N	19E	11

[2] Name changed from Pioneer Irrigation Return to Peshastin Irrigation Return on 1/19/06.

What Will Be Done

Implementation strategy

The Department of Ecology (Ecology) recently submitted the *Wenatchee River Watershed pH, Dissolved Oxygen and Phosphorus Total Maximum Daily Load* (TMDL) to the US Environmental Protection Agency (EPA). EPA approved the TMDL on August 25, 2009.

The primary goal of following a TMDL implementation plan is to meet water quality standards which protect designated uses. The TMDL calls for significant reductions in total phosphorus from sources to the Wenatchee River.

TMDLs categorize pollutant sources into point sources and nonpoint sources. Point source implementation involves permitted facilities reaching certain pollutant load reductions, called wasteload allocations, through actions managed by the National Pollutant Discharge Elimination System (NPDES). NPDES permit management is delegated by the EPA to Ecology for all point sources in the Wenatchee River watershed except the Leavenworth National Fish Hatchery. Ecology and EPA will work with individual permit holders to prioritize and implement water quality based effluent limits in each NPDES permit.

Nonpoint sources may reach their reduction targets, called load allocations, through implementation of a variety of projects, which are generally voluntary. Completion of these projects often begin as a result of increased awareness of water quality problems as an outcome of TMDL development and its associated outreach and education conducted by Ecology and local partners. Education and outreach are important steps toward completing many nonpoint source reduction projects. Nonpoint source projects can be categorized, and locally prioritized, within three different general types of project:

1. Reduce pollutant loading from nonpoint sources by implementation of Best Management Practices (BMPs) and elimination of un-permitted discharge by enforcement of clean water laws.

2. Maintain a watershed's ability to keep water healthy by protection of existing ecological functions such as riparian zones, wetlands and floodplains.

3. Increase a watershed's ability to keep water healthy by restoration of ecological functions such as riparian zones, wetlands and floodplains.

Two existing planning processes have prioritized actions to be completed in the Wenatchee River watershed that will improve water quality. The Wenatchee Watershed Planning Unit's final detailed implementation plan provides a list of projects to improve water quality, stream flow, and habitat in the Wenatchee River watershed that, if achieved, will contribute to meeting TMDL targets for pH and dissolved oxygen the Wenatchee River. Also, the Wenatchee Sub-basin plan under the Upper Columbia Salmon Recovery, Chelan County and Yakama Nation provides an inventory of habitat improvement projects that, if completed, will benefit water quality in the Wenatchee River and its tributaries.

Pollution sources and organizational actions, goals, and schedules

Full compliance with water quality standards is expected to occur by the year 2019, or ten years after TMDL final approval. Ecology and the stakeholders will conduct monitoring and evaluation of the data throughout the ten-year compliance implementation period. The monitoring will be performed in accordance with a quality assurance project plan (QAPP). Ecology and clean-up participants anticipate the following schedule.

Table 4. Overall WQIP schedule

Phases and Targets	Description	Timeline
Phase 1	Point and nonpoint source reductions. Data collection and model calibration	2009-2013
First Target	Reduction in 50% of nonpoint source loading.	2014
Phase 2	Modify load and wasteload allocations if appropriate. Identify any addition point and nonpoint source reductions.	2014-2015
Phase 3	Implement additional load reductions.	2015-2019
Second Target A	NPDES permit compliance	2019
Second Target B	Reduction in the rest of nonpoint source loading	2019
Final Target	Achieve water quality standards	2019

Ecology and the cleanup partners believe that the proposed adaptive management approach will be scientifically defensible and provide the greatest level of protection of the resources. As indicated, the cleanup partners anticipate implementing early actions that will have an immediate reduction in phosphorus loading in Phase 1 of the schedule. The partners expect that this will provide empirical data that will allow the model to be validated and the appropriate loading allocations to be verified. If necessary, Ecology will work with the cleanup partners to evaluate changes to loading allocations contained in the TMDL based on the data collected in Phase 1.

Numerical targets describing phosphorus load and waste load allocations were developed using a Qual2k water quality model and provided in the TMDL submitted to EPA. Stakeholders in the Wenatchee River watershed will perform additional data collection, model calibration and model validation during Phase 1 to insure load reductions will result in water quality improvements as predicted by the Qual2k model. They will conduct programs that reduce phosphorus loading from point and nonpoint sources, with the goal of meeting water quality standards which protect designated uses.

A series of proposed activities are included in the WQIP to meet water quality standards by 2019, and are discussed in the following sections. A master schedule has been developed for these activities and is presented in Table 5. More detailed schedule information for each of the activities is presented in the following sections as well.

Table 5. WQIP master schedule

Activity	Title	Responsible Entity	Estimated Potential Range of Phosphorus Reduction	Estimated Potential Ranges of Costs	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Completion Date
	Supporting Phosphorus Reduction Activities															
SPR-1	Quantification of P Load Reductions and Refined Cost Estimates	Chelan County, Ecology	0	$20,000 to $50,000												2010
SPR-2	Ongoing Flow & Water Quality Monitoring, Model Calibration & Update	Chelan County, Ecology	0	$85,000 to $175,000												2014
SPR-3	Implementation and TMDL Adjustment (Modify WLAs, if appropriate)	Chelan County	0	$5,000 to $25,000												2015
	Regional Phosphorus Management Activities															
RPM-1	Public Education and Outreach Programs	Chelan County, Cascadia Conservation District (CCD)	Unknown	$5,000 to $10,000												
RPM-2	Addressing Phosphate Dishwashing and Detergent Products	Chelan County, Cascadia Conservation District (CCD)	Unknown	$10,000 to $25,000												2010
RPM-3	Fertilizer Reduction Evaluation for Established Lawns	Chelan County	Unknown	$10,000 to $25,000												2010
RPM-4	Wenatchee River Phosphorus Exchange	Ecology, Leavenworth, PUD, Cashmere	Unknown	$50,000 to $100,000												2010
RPM-5	Stormwater Source Control and Treatment, City and County Ordinances	Chelan County, Leavenworth, PUD, Cashmere	Unknown	$5,000 to $20,000												2010
RPM-6	Low Phophorous Treatment Technology Pilot Testing	Leavenworth, PUD, Cashmere	Unknown	$20,000 to $200,000												2015
RPM-7	Reclaimed Effluent Reuse Program Development	Leavenworth, PUD, Cashmere	Unknown	$50,000 to $150,000												2015
RPM-8	Bio-Available Phosphorus	Leavenworth, PUD, Cashmere	Unknown	$50,000 to $100,000												2015
	Point Source Activities															
	Leavenworth WWTP															
PSL-1	Facility Planning	Leavenworth	0	$3.7 M to $5.6 M												2011
PSL-2	Process Enhancements	Leavenworth	0													2013
PSL-3	Pilot Testing	Leavenworth	0													2015
PSL-4	Facility Planning & Possible Design	Leavenworth	0													2017
PSL-5	Construction of Possible WWTP Improvements	Leavenworth	6.9 to 7.7 kg/day													2019
	Peshastin/Dryden WWTP															
PSP-1	Facility Planning	PUD	0	$6.75 M to $9 M												2010
PSP-2	Process Enhancements	PUD	0													2012
PSP-3	Pilot Testing	PUD	0													2014
PSP-4	Facility Planning & Possible Design	PUD	0													2016
PSP-5	Construction of Possible WWTP Improvements	PUD	1.6 to 1.8 kg/day													2019
	Cashmere WWTP															
PSC-1	Facility Planning	Cashmere	0	$25.2 M to $33.6 M												2010
PSC-2	Industrial Pretreatment Planning	Cashmere	0													2010
PSC-3	WWTP Design	Cashmere	0													2011
PSC-4	Phase I WWTP Construction	Cashmere	0													2014
PSC-5	Interim Plant Optimization	Cashmere	0													2017
PSC-6	Phase II WWTP Construction - Phosphorus Removal	Cashmere	14.0 to 15.5 kg/day													2019
	Leavenworth National Fish Hatchery															
PSF-1	Phophorous Reduction or Exchange	Ecology	0	Unknown												2017
	Industrial Non-Contact Cooling Water Dischargers															
PSI-1	Facility Planning and Evaluation	Ecology	0	$1 M to $8 M												2011
PSI-2	Bench and Pilot Scale Testing	Ecology	0													2014
PSI-3	Planning and Final Improvement Plan	Ecology	0													2016
PSI-4	Possible Facility Improvements and Modifications	Ecology	0.07 to 0.08 kg/day													2019
	Non-Point Source Activities															
NPS-1	Tributary Land Use Mapping	Ecology, Chelan County	Unknown	$5,000 to $15,000												2010
NPS-2	Agricultural Practices Investigation	Ecology, Chelan County, Cascadia Conservation District (CCD)	Unknown	$50,000 to $70,000												2010
NPS-3	Groundwater Investigation Related to Agricultural Practices	Ecology, Chelan County	Unknown	$50,000 to $70,000												2012
NPS-4	Public Education Campaign	Ecology, Chelan County, Cascadia Conservation District (CCD)	Unknown	$20,000 to $35,000												2011
NPS-5	Voluntary BMP Implementation Campaign & Effectiveness Monitoring	Ecology, Chelan County, Cascadia Conservation District (CCD)	Unknown	$50,000 to $80,000												2011
NPS-6	Livestock Practices and Loading Estimate	Ecology, Chelan County, Cascadia Conservation District (CCD)	Unknown	$10,000 to $25,000												2010
NPS-7	Quantify Runoff Loading from Industrial Land Application	Ecology, Chelan County	Unknown	$15,000 to $25,000												2010
	Miscellaneous Activities															
MA-1	Stream Flow and Habitat Improvements	Chelan County	Unknown	$55,000 to $70,000												*2013*
MA-2	Upper Columbia Salmon Recovery - Inventory	Chelan County	Unknown	$2,500 to $5,000												*2009*
MA-3	Evaluate Forestry Practices	Ecology, Chelan County	Unknown	$2,000 to $50,000												2010
MA-4	Quantify Sediment-Phosphorus Relationship in Forested Areas	Ecology, Chelan County	Unknown	$15,000 to $22,500												2012
MA-5	Alternatives to Septic Systems	Chelan County	Unknown	$55,000 to $100,000												2012
MA-6	Soil Capacity Assessment for On-Site Systems	Chelan County	Unknown	$20,000 to $35,000												2011
MA-7	Septic System Locations and Densities Ordinance	Chelan County	Unknown	$20,000 to $25,000												2012
MA-8	Construction Stormwater Runoff Technical Assistance Program	Chelan County	Unknown	$55,000 to $75,000												2011
MA-9	Identify Irrigation Return Water Loadings & Remedies to Reduce Loading	Ecology, Chelan County	Unknown	$20,000 to $30,000												2011
MA-10	Evaluate Various Septic System Loadings and Alternatives	Chelan County	Unknown	$90,000 to $140,000												2011
MA-11	Groundwater Control Evaluation for Closed Landfills	Chelan County	Unknown	$15,000 to $25,000												2011

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Supporting phosphorus reduction activities

There are supporting activities to be undertaken as part of the implementation plan, in addition to those projects and best management practices designed to provide a direct phosphorus reduction. These supporting activities, while not having a specific phosphorus reduction value, are tangible WQIP activities. These activities include monitoring and data collection, data assessment, tools and modeling, and adaptive management. Understanding how the system responds as activities are implemented throughout the watershed will be critical to measuring progress and success.

The phased approach includes these activities, many of which start in Phase 1. Phase 1 includes point and non-point source reduction activities, data collection continued, and model calibration begins. The adaptive management strategy also relies on many of these activities. The adaptive management approach will be supported by, but not limited to, data collection and analysis as outlined by Ecology (Manning, 2009) that:

- Further assesses the assimilative capacity of the Wenatchee River and its tributaries in order to adapt waste load allocations if necessary.
- Compares computer simulated changes (using QUAL2K) in water quality to actual changes in water quality after pollutant sources have been reduced.
- Determines the most effective ways to comply with water quality standards.

SPR-1 Quantification of phosphorus load reductions and refined cost estimates

Each of the activities includes an initial estimation of the potential phosphorus load reductions and associated potential ranges of costs to achieve that level of phosphorus reduction. However, the estimates range widely for the activities, with many of the activities not related to point sources having an unknown potential phosphorus load reduction. This activity provides for the effort necessary to improve the estimations for activities in this plan.

While the activities may be undertaken without greater understanding of the potential phosphorus reductions, additional research and data to quantify the reductions would provide better information for making good management decisions. Methods to quantify potential phosphorus include literature research, reports on field performance of BMPs and activities, and models such as the Simple Method.

The information from the quantification of phosphorus load reductions and refined cost estimates activity will allow for additional cost-optimization of the activities. This helps to focus money and efforts on sources and management activities that have the potential to achieve the greatest load reductions in the least amount of time.

Activity: Research and improve quantification estimates for potential phosphorus load reductions associated with the activities, and refine the potential cost estimates for these activities.

Timeline: Within first year of implementation, to provide additional guidance on selecting and prioritizing activities.
Range of Cost: $20,000 - $50,000
Lead: Chelan County

SPR-2 Ongoing flow and water quality monitoring, model calibration and update

Ongoing flow monitoring

Information about flows is important to assessing the water quality conditions. Gauging stations that collected flow data used in the TMDL will be continued to ensure continuity of data. The lead for this task will coordinate with the United State Geological Survey (USGS) and Ecology to ensure that data collection from these gauging stations is continued. Measurements of flow from unmeasured tributaries and/or identified sources will be important to quantifying and tracking phosphorus loads. These measurements may need to be continuous or timed with water sampling events. The lead for this task will review monitoring plans and coordinate the leads collecting the data to ensure that flow measurements are coordinated with water quality monitoring program.

Flow conditions for the existing and additionally collected flow data will be computed. These conditions may include the calculation of flow duration and flow frequency statistics such as 1Q10, 7Q2, 7Q10, 30Q2, and 30Q10. This information will be useful for examining and defining critical flow periods. The lead for this task will coordinate with the stakeholders on developing and agreeing on a method that will define the critical period or periods.

Activity: Ensure flow monitoring is continued and coordinated with other monitoring efforts to develop and refine a method for determining critical periods.
Timeline: Critical periods first year, flow monitoring annually confirm with USGS/Ecology, flow monitoring for sampling on-going as needed.
Range of Cost: $5,000 - $10,000
Lead: Chelan County

Activity: Continue and improve flow monitoring program as performed during period used for the TMDL
Timeline: Ongoing
Range of Cost: $25,000 - $40,000
Lead: Ecology and USGS

Water quality data

Water quality will be tracked through ambient monitoring and targeted pollution source identification. Monitoring of surface waters and identification of potential pollution sources will be instrumental to the success of this WQIP. Monitoring is needed during all phases of the TMDL to identify polluted areas, contributing sources, and to verify that corrective actions have been, and remain effective in protecting local waters. Two types of water quality monitoring are needed to implement the water quality implementation: pollution source detection monitoring and effectiveness monitoring.

Source detection monitoring is used to pinpoint location and relative severity of suspected pollution sources. It allows local government and private groups to focus BMP implementation resources where they are needed most. Source detection monitoring is used when pollution sources are not obvious and additional data is needed to track down the unknown or suspected causes. When high phosphorus levels are observed, additional sampling can help to track the source down to a discrete geographic area. Events that typically trigger the need for targeted monitoring include:

- When ambient water quality monitoring has identified high phosphorus levels on either a consistent or a sporadic basis.
- Where potential sources of phosphorus are identified and need to be verified. Examples of potential problem areas include areas where soil erosion is occurring, poorly managed animal confinement/recreation areas, failing onsite septic systems, or illicit discharges.

TMDL effectiveness monitoring indicates whether or not pH and DO levels are trending toward water quality standards to protect designated uses. This can be accomplished in two ways: 1) by directly measuring the reduction of nutrients suspected of causing the water quality impairment from individual nutrient sources, or 2) by indirectly measuring the success of this plan by monitoring water quality in the Wenatchee River and its tributaries. This will require both Ecology and stakeholders to conduct effectiveness monitoring to determine whether this WQIP is working. NPDES permit holders should also conduct effectiveness monitoring.

Future monitoring and data collection will be necessary to assess changes in water quality conditions. New water quality data gathered in the course of the adaptive management program will provide the necessary information for prioritizing and selecting the activities to implement, and determine whether changes to the TMDL are warranted. The monitoring program by Ecology should be reviewed annually, prior to the critical monitoring seasons of spring and summer, and updated for ongoing and new activities. Stakeholders should coordinate with Ecology on additional location and times for monitoring that either they can perform, or fund the field collection and laboratory analysis to further strengthen the dataset.

Monitoring locations should be added where activities are implemented, to be able to evaluate the success and reduction in total phosphorus from that activity. Identify new locations for monitoring based on field observations, previous years data, and effectiveness monitoring. Critical areas to monitor initially include identifying non-point sources of phosphorus near Dryden, Cashmere and in tributaries. Selection of monitoring locations should be coordinated and associated with the adaptive management plan. The monitoring should match with the plans to develop and implement controls through new and existing regulatory programs to reduce phosphorus inputs to surface and groundwater from other point sources.

The monitoring should be designed and conducted to identify the source of phosphorus from a variety of sources including point and non-point, surface water and groundwater, and perennial, intermittent, and ephemeral sources. Additional groundwater monitoring should be conducted, especially for groundwater in the Dryden and Cashmere reaches (as identified in the TMDL technical report), along with developing BMPs to address these specific sources.

As data is collected, they should be maintained in a database or some other format for long-term recovery and use. A separate database may be created and maintained for the lower Wenatchee River watershed, or the data could be maintained by Ecology in either the existing environmental information management (EIM) database or some other format. The new data should be assessed annually, at a minimum, as assessed in previous years, and for specific implementation activities, to evaluate progress and make adaptive management decisions.

Data from all monitoring and implementation activities will be reviewed each year. Each organization will attend an annual meeting, each fall or spring, to present their data from the previous year. The purpose of these meetings is to review data and determine trends so organizations can decide what actions (if any) are needed to meet water quality standards. These meetings also ensure that the same sites are not monitored by multiple entities, all data collected is comparable, and the community is aware of other monitoring efforts. The Ecology TMDL coordinator will work with the cleanup partners to make arrangements for the annual meetings and coordinate communication among the organizations.

Activity: Develop an agreement with Ecology to annually review the water quality monitoring plan. Develop an agreement for each stakeholder to contribute to a fund for additional monitoring. Negotiate and develop an agreement with Ecology on the long-term storage and retrieval of water quality monitoring data. Develop an annual report format with minimum standard text, tables and figures to assess new water quality data each year.
Timeline: Annually
Range of Cost: $5,000 - $15,000
Lead: Chelan County

Activity: Continue and improve ambient monitoring program as performed for the data collected for the TMDL. Coordinate and schedule annual meeting to review data, progress, and upcoming implementation activities.
Timeline: Ongoing
Range of Cost: $30,000 - $50,000
Lead: Ecology

Analytical tools

The tools used to develop the TMDL were an important component of the process of assessing the data and determining the load reductions. Since the tools used are an important component of the subsequent conclusions, a re-evaluation of both their implementation and use, along with their potential usefulness as part of the adaptive management phase, is warranted. Re-evaluating the modeling tools used for the TMDL would include use of the latest version of the QUAL2K model; appropriateness and ability to represent actual conditions; the fundamental assumptions used in the selection of flows and dates for modeling; and the sensitivity of the model to selected inputs and coefficients. This evaluation would also be useful for determining if the model could be used for alternative scenario analysis, upgraded with data collected in the future, or if other tools should be applied to answer questions the current model is incapable of answering.

The translation from model results to targeted reductions was a fairly simple uniform reduction for point and non-point source categories in the TMDL. Alternative scenarios could be simulated to find creative combinations that also are predicted to meet the water quality targets in the Wenatchee River while protecting designated uses. These alternatives could then be analyzed to consider cost, effectiveness, and implementation advantages. Water quality improvements could potentially be undertaken more quickly and at less cost.

Part of evaluating the effectiveness and overall understanding of the response of the river to phosphorus reductions will include the continued use of the QUAL2K model. Ecology will work with the watershed communities to evaluate the need to update the model to the latest version with the latest data at least once every three years. New information about critical flow and water quality data will be incorporated into the modeling. The response of the model to these conditions will be examined and compared with monitoring observations. This information will be useful to modifying and selecting the next implementation activities and best management practices in the watershed; changes to the monitoring programs; and determining the path forward to achieving water quality improvement and meeting water quality standards.

Activity: Re-evaluate the model to various criteria and determine current and future functionality. Consider using the model to evaluate alternative scenarios.
Timeline: Assess annually, review recent flow and water quality data. If low flow/poor water quality consider additional modeling, and review implementation progress to alternative scenarios for modeling.
Range of Cost: $15,000 - $50,000
Lead: Point Dischargers

Activity: Update the QUAL2K model with the latest version, knowledge, flow and water quality data.
Timeline: Assess annually, review recent flow and water quality data. If low flow/poor water quality consider additional modeling, at a minimum update the model once every three years.
Range of Cost: $5,000 - $10,000
Lead: Ecology

SPR-3 Implementation and TMDL adjustments

During the course of implementation, true adaptive management requires adjustments to the implementation plan and potentially the TMDL as new information is gathered and the understanding of system responses and cause and effect relationships improve. Adaptive management is the process by which strategies can be changed if it is determined that the implementation approach currently in place is not being implemented, or water quality goals set forth in the WQIP are not being met.

Natural systems are complex and dynamic. The way a system will respond to human management activities is often unknown and can only be described as probabilities or possibilities. Adaptive management involves testing, monitoring, evaluating applied strategies, and incorporating new knowledge into management approaches that are based on scientific findings. In the case of TMDLs, Ecology uses adaptive management to assess whether the actions identified as necessary to solve the identified pollution problems are the correct ones and whether they are working. As actions are implemented, the system will respond, and it will also change. Adaptive management allows for actions to be fine-tuned to make them more effective, and to try new strategies if there is evidence that a new approach could help achieve compliance.

If implementation activities are not producing expected or required results, Ecology or another organization may choose to conduct additional studies to identify the significant sources of total phosphorus. If the causes can be determined, implementation of additional BMPs, educational efforts, or a combination of these will likely be taken. However, if some unforeseen event affects the landscape, such as a wildfire, the timelines to meet the load allocations in this TMDL may need modification. It is ultimately Ecology's responsibility to assure that TMDL implementation is actively pursued and water quality standards are achieved.

Selection of implementation activities is partially dependent on knowledge of the effectiveness of the best management practice. Effectiveness monitoring and tracking BMP results is included under the section Effectiveness Monitoring Plan. A QAPP will be prepared for this monitoring plan to demonstrate that the data collected met quality standards for use in TMDL review, validation, and implementation adaptive management.

Activity: Develop the framework for integrating and updating the implementation plan and TMDL with the results from future data collection and assessment. Determine, how, when, what criteria, etc., will be necessary to revise and create updated versions. Prepare the QAPP for the monitoring plan.

Timeline: QAPP first year, Adaptive management annually
Range of Cost: $5,000 - $25,000
Lead: Chelan County

Regional phosphorus management

A number of regional phosphorus control strategies could be considered to reduce phosphorus loadings in the watershed, and influence wastewater and untreated effluent discharges. The following sections provide brief descriptions of some of the phosphorus management efforts that could be considered for load reduction and/or to establish the technical foundation for further phosphorus control activities.

RPM-1 Public education and outreach programs

There are a number of potential phosphorus reductions in the watershed that will likely occur through voluntary actions and best practices. For success to occur on voluntary actions, the development and implementation of a robust public education and outreach program that addresses sources of phosphorus in the watershed is essential. The initial effort will be to identify and quantify potential phosphorus reductions, and then tailor the public education and outreach program to focus on the most effective areas to provide load reductions. Examples of potential practices that may require education and outreach are residential yards and gardens, hobby farms, city and county parks departments, and business owned landscapes. Other areas that could be addressed are identifying appropriate BMPs for county, cities and state DOT to reduce non-point phosphorus from roads and parking lots, construction activities for the development community, and technical assistance through farm plans and BMPs for the agricultural community. Additionally, discussions and agreements with irrigation districts to reduce nutrient inputs, as well as water conservation through domestic and agri-business practices throughout the watershed, may be appropriate.

Activity: Develop programs to educate, promote, and outreach to everyone in the watershed to adopt practices to reduce loading of phosphorus to the river.
Timeline: Ongoing
Range of Cost: $5,000 - $10,000
Lead: Chelan County and Cascadia Conservation District (CCD)

RPM-2 Addressing phosphate dishwashing and detergent products

Source control programs target phosphorus reduction in wastewater, so there is less phosphorus that must be removed through biological, physical/chemical, and mechanical treatment. One example of phosphorus reduction through source control is the state of Washington's statewide phosphate dishwashing detergent ban. This ban was signed by the Governor and took effect first in Spokane County, Clark County, and Whatcom County in 2008. It will go into effect statewide by 2010. However, it does not apply to the sale or distribution of detergents for commercial and industrial use. A ban on phosphates in dishwashing and detergent products would also reduce phosphate loading from on-site septic systems that are located adjacent to a water body and in hydraulic continuity with the river or stream.

Recent studies indicate that each dishwasher generates wastewater phosphorus of 10.2 grams/week (Hanrahan and Winslow, 2004). The total load of phosphorus removed from the influent to wastewater treatment plants and on-site septic systems may be estimated to quantify the potential reduction in the Wenatchee River watershed.

The Wenatchee Watershed Planning Unit recommended in the final detailed implementation plan that the county and cities consider banning sale of high phosphorus detergents.

Activity: Develop county-wide (including cities) ordinances banning phosphate detergents
Timeline: Identification and ordinance development, if warranted, June 2010. Ordinances adopted - September 2010.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $10,000 – $25,000
Lead: Chelan County and Cascadia Conservation District (CCD)

RPM -3 Fertilizer reduction evaluation for established lawns

Lawn fertilizer restrictions are often discussed in watersheds sensitive to nutrient enrichment. Residential fertilizers are often over-applied, and the phosphorus in fertilizer is generally unnecessary for established lawns. Some states have even taken steps to ban phosphorus in lawn fertilizer. Overland flow from stormwater runoff can either infiltrate to the groundwater or can flow to the nearest surface water body. This runoff can be laden with high concentrations of nutrients accumulated by flowing over fertilized lawns and fields. To focus appropriate measures or steps in proper fertilizer management, the potential loading to the Wenatchee River needs to be quantified and reasonable reductions assessed.

Activity: Quantify loading and identify reduction impacts in order to develop a county-wide (including cities) ordinance addressing lawn applications of fertilizers for established lawns
Timeline: September 2009 begin identification and development. September 2010 implement ordinances, if warranted.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $10,000 – $25,000
Lead: Chelan County

RPM-4 Wenatchee River phosphorus exchange

Develop a phosphorus exchange program that allows Wenatchee River total phosphorus loading to be shared through a General Permit for all dischargers in the watershed. The objective of the exchange is to provide a flexible way to achieve Wenatchee River water quality goals in the most cost effective manner. Dischargers may choose to achieve compliance with their wasteload allocation by implementing treatment technology, by exchanging a phosphorus load reduction with another point source discharger (water quality offset), by exchanging a phosphorus load reduction from a nonpoint source (water quality offset), or all of these methods. The initial wasteload allocation will be based on the final Wenatchee River TMDL and will be tracked and adjusted as appropriate, based on the on-going monitoring effort in the adaptive management plan. Equivalency between loadings will be based on use of the QUAL-2K water quality model for the Wenatchee River, as modified and improved in the on-going adaptive management implementation plan based on the results of the monitoring program.

Activity: Formulate a phosphorus exchange program to facilitate load reductions in a flexible and cost effective manner.
Potential Phosphorus Load Reduction: Accomplishes the Wenatchee River TMDL
Range of Cost: $50,000 - $100,000
Lead: Dischargers in collaboration with Ecology

RPM-5 Stormwater source control and treatment, city and county ordinances

Phosphorus loads may be reduced through controlling stormwater runoff. The national average total phosphorus concentrations transported in stormwater in arid regions was reported as 320 µg/L and between 365 µg/L and 391 µg/L in residential and commercial areas in Oregon (Ecology 2004). The adoption, design, and implementation of phosphorus reducing stormwater best management practices (BMPs) will help limit the phosphorus loading from stormwater runoff. For example, the Stormwater Management Manual for Eastern Washington (SMMEW) provides a menu of treatment train options for stormwater for new development and re-development that is located within a phosphorus-limited watershed. Such a menu of treatment train options could be provided for the Wenatchee River watershed. This could include developing an engineered soil for stormwater treatment to be used in stormwater BMPs, which may have coincidental benefit in reducing phosphorus contributions to groundwater. Treatment technologies can reduce total phosphors loading by as much as 50% (Ecology 2004). Updated BMPs to control stormwater phosphorus loadings would need to be adopted as local development standards by local jurisdictions to be effective. This measure was also recognized by the Wenatchee Watershed

Planning Unit (WWPU) in their final phase iv detailed implementation plan (WWPU, 2008) by recommending that the county, municipalities and developers apply BMPs provided in the SMMEW. These may also need to be applied subsequently in retrofit situations to realize further phosphorus reductions. Chelan County and the local cities should also give consideration to phosphorus reductions that can be achieved through low impact development (LID) features.

Activity: Update city and county ordinances to require stormwater BMPs that are in the Stormwater Management Manual for Eastern Washington (Ecology 2004); consider including LID for new and re-development. Consider use of stormwater retrofits for phosphorus removal in existing areas, as an adaptive management strategy, as needed.
Timeline: Begin development of county-wide (including cities) ordinances September 2009. Adopt ordinance changes by January 2011.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $5,000 - $20,000
Lead: Chelan County and municipalities in collaboration with developers

RPM-6 Low phosphorus treatment technology pilot testing

Advanced treatment technology pilot testing for low phosphorus effluent may be required to determine the best treatment technology selections for Wenatchee River dischargers. Joint conduct of treatment technology studies could reveal areas for potential collaboration among dischargers for the selection and procurement of common technologies. This could provide advantages to stakeholders and other entities impacted by the TMDL in terms of shared procurement, standby and replacement parts, instrumentation and control, and operations and maintenance.

Activity: Develop a low-phosphorus treatment technology pilot study for the purposes of technology selection based on local wastewater chemistry in the Wenatchee River watershed.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $20,000 - $200,000
Lead: Municipal dischargers

RPM-7 Reclaimed effluent reuse program development

Treatment technologies for low effluent phosphorus will include chemical precipitants and advanced filtration. These treatment process requirements for phosphorus will meet the regulatory requirements for Class A reclaimed water production in Washington State. Class A reclaimed water can be used with few restrictions as a substitute for non-potable water uses such as urban irrigation, cooling water, etc.

Activity: Develop a reclaimed water reuse plan for the Wenatchee River watershed for seasonal load diversion from surface water to land for seasonal irrigation or recharge, and/or year around diversion to industrial or commercial uses.

Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $50,000 - $150,000

Lead: Municipal dischargers

RPM-8 Bio-available phosphorus

Wastewater treatment facilities that produce effluent with extremely low phosphorus concentrations may remove bio-available phosphorus and the remaining phosphorus that is discharged to the river may not be bio-available. If so, credit might be provided for a portion of the amount of phosphorus remaining following advanced treatment, as long as it is demonstrated to not be bio-available. Recent testing of phosphorus speciation in other communities in the region suggests that the soluble, nonreactive phosphorus concentration in municipal wastewater is between 0.010 mg/L and 0.015 mg/L.

Activity: Conduct phosphorus bioassay study to investigate the bioavailability of local wastewater effluent at low phosphorus concentration (using either samples from pilot testing or laboratory filtered samples from existing discharges).
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $50,000 - $100,000
Lead: Municipal dischargers

Point sources

Specific efforts to control point sources are not defined in the TMDL. However, the TMDL does identify loading source categories, including current discharge at municipal wastewater treatment plants (WWTPs) and non-contact cooling water discharges. Point sources are discharges allowed under a National Pollutant Discharge Elimination System (NPDES) permit. The TMDL loads and targets at critical low-flow conditions are shown in Table 6 (Ecology, 2008).

Table 6. Summary of total phosphorus waste load allocations[a]

Loading Source Category	Current Phosphorus Load (kg/day)	Percent Reduction	Total Phosphorus Load (kg/day	Target Load Reduction (kg/day)
Current discharge at municipal WWTPs	27.37	98.6	0.39	26.98
Non-contact cooling water discharges	0.112	75	0.0281	0.0835
Leavenworth National Fish Hatchery	1.25	62	0.48	0.77

[a] (Ecology, 2009)

The point sources identified in the TMDL include wastewater treatment plants, fruit storage facilities, and the Leavenworth National Fish Hatchery (LNFH). The WWTPs or Publicly Owned Treatment Works (POTWs) are operated by the cities of Leavenworth and Cashmere, and by the PUD No. 1 of Chelan County. Loads for each of these were identified in the TMDL and are shown in Table 7. Loads for three sources of non-contact cooling water were also identified in the TMDL and are shown in Table 6.

Table 7. Summary of total phosphorus load allocations for identified point sources[b]

Tributary Loads	Current Phosphorus Load (kg/day)	Percent Reduction	Total Phosphorus Load Allocation (kg/day)	Target Load Reduction (kg/day)
NPDES Point Source Loads (90th percentile)				
Leavenworth POTW	9.55	98.5	0.146	9.404
Peshastin POTW	2.05	99.0	0.021	2.029
Cashmere POTW	14.97	98.5	0.225	14.745
Cashmere POTW lagoon leak (estimated)	0.837	98.5	0.012	0.825
General Permit Loads (Non-Contact Cooling Water)				
Blue Bird	0.0296	15.2	0.0251	0.0045
Blue Star	0.0025	60	0.001	0.0015
Bardin Growers	0.0795	97.5	0.002	0.0775

[b] (Ecology, 2009)

The implementation schedule and outline for the WQIP was presented earlier. Each of the point source dischargers will likely engage in the planning phase of the WQIP to evaluate the impacts and possible improvements required to reduce phosphorus discharges from their facilities. For municipalities, wastewater facility plans will likely be amended to address the phosphorus reductions, and industrial dischargers will also need to engage in similar planning efforts to address phosphorus load reductions.

Simultaneously, data collection will continue to evaluate changing water quality conditions in the Wenatchee River and allow ongoing calibration of the QUAL2K model. These water quality changes may impact the TMDL and WLAs. Continued data collection and re-calibration of the model is integral to the planning efforts of the point source dischargers, as wastewater and non-contact cooling water management alternatives will depend on future WLAs. As a result, point source dischargers' plans for managing phosphorus may change as modifications to the TMDL occur.

PSL-1 through PSL-5 City of Leavenworth wastewater treatment plant

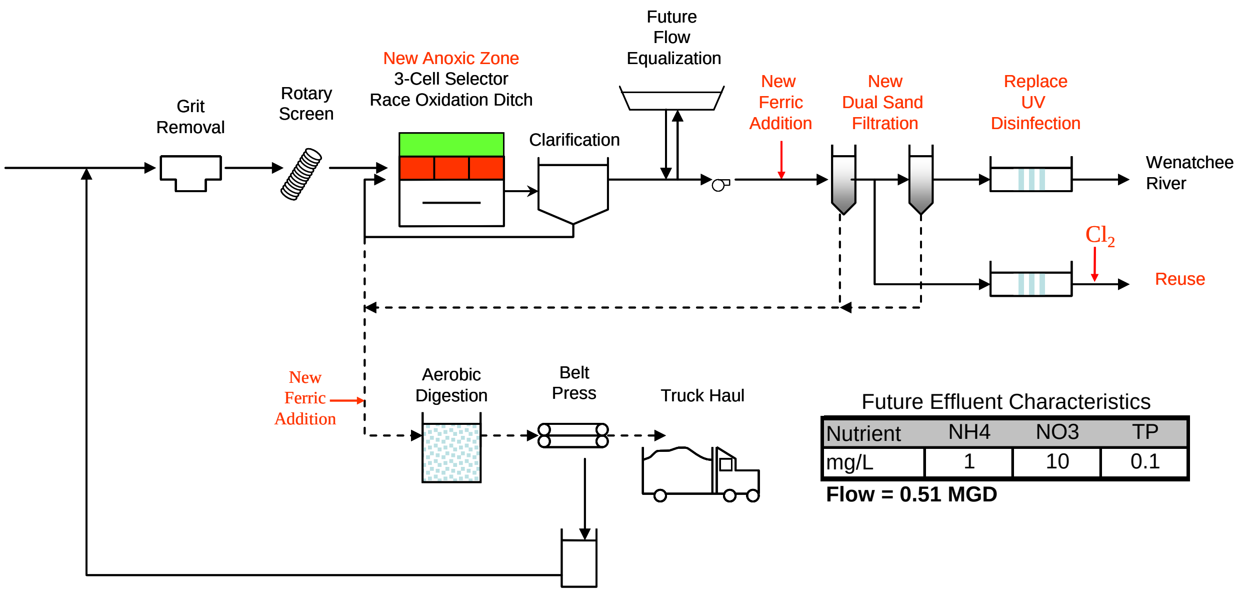
The city of Leavenworth WWTP is a highly adaptable facility with separated unit processes that can be adjusted and supplemented to provide biological nutrient removal. The current treatment process already provides some degree of biological nutrient removal, while process enhancements may provide even greater nutrient removal. Process enhancements or minor WWTP modifications alone may not provide the total necessary phosphorus reductions to meet future WLAs and water quality requirements in the Wenatchee River, but may significantly reduce phosphorus loading to the river from the WWTP discharge. WWTP modeling, during the facility planning phase of the WQIP, will provide some indication of potential effectiveness of process enhancements to improve phosphorus removal. Benefits of the process enhancements could be evaluated throughout the water quality monitoring of implementation strategies for effectiveness and additional model calibration.

Process enhancements for further nutrient removal may be possible by directing return-activated sludge (RAS) into a formalized anaerobic zone in order to promote the production of volatile fatty acids (VFAs) that are required to foster a biological phosphorus removal process to take place. The extent of further phosphorus removal will be specific to the WWTP facility. After facility planning is completed, a phase of pilot testing would be useful to verify the performance of such enhancements and/or modifications.

With load allocations from the TMDL driving effluent phosphorus concentrations potentially below 100 µg/L, process enhancements alone may or may not meet phosphorus limits. Nutrient removal at the limits of technology would be necessary, including chemical feed and effluent filtration following the existing secondary clarifiers. Leavenworth has not expressed interest in membrane technology, so one possible treatment process includes multi-stage effluent filtration with chemical addition (alum or ferric). Table 8 provides a summary of process needs for the city, followed by Figure 3 which depicts the future treatment layout. This table and layout is based on the current WLAs in the draft TMDL. Ongoing adaptive management efforts, such as QUAL2K model calibration, may ultimately impact WLAs and subsequent process or infrastructure modifications at the WWTP.

Table 8. Summary of city of Leavenworth wastewater treatment plant

Facility	Need/Comment
Influent	Project influent below current plant capacity. Sized improvements to maintain current capacity.
Headworks	No redundancy
Activated Sludge	Convert to BioP and Denitrification. Aerobic zone appears adequate. No redundancy. Reduce design SRT from 19 to 15 days. Requires additional Anoxic zone (0.3 MG) with pumping (2 mgd)
Secondary Clarifier	Total Area appears adequate May need upgraded hydraulics
Flow equalization	Reduce peak flows to max day. Provide stable operation for low phosphorus.
Filtration	Two stage filtration using moving bed filtration
UV Disinfection	Replace aged UV equipment.
Reuse Requirements	Add UV for Reuse requirements keep separate stream. Add residual chlorine
Solids	Capacity appears adequate. Increase dewatering operation.



Future Effluent Characteristics

Nutrient	NH4	NO3	TP
mg/L	1	10	0.1

Flow = 0.51 MGD

Figure 3. Future treatment schematic

Individual upgrade costs for required improvements to the city of Leavenworth's WWTP may vary significantly depending on final WLAs and required enhancements and modifications to meet WLAs. The total projected capital cost of improvements is approximately $4.3 million if the current WLAs do not change. A timeline is also provided to show a possible implementation schedule in line with the WQIP. Changes to the TMDL and WLAs could change milestones shown in the timeline and/or Leavenworth's course of action.

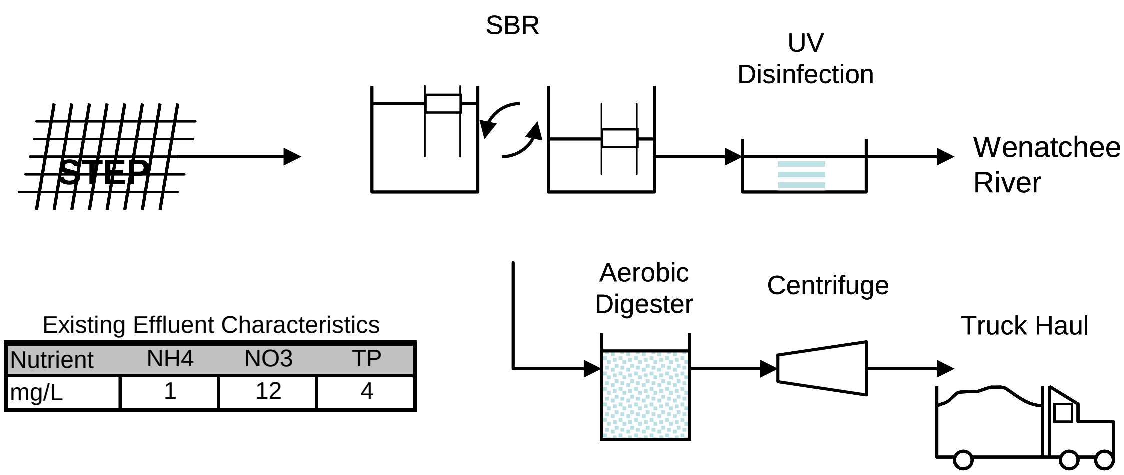
Potential Phosphorus Load Reduction: 7.7 kg/day

Timeline:	**Facility Planning**	**2009 - 2011**
	Process Enhancements	**2012 – 2013**
	Pilot Testing	**2014 – 2015**
	Facility Planning & Possible Design	**2016 – 2017**
	Construction of Possible WWTP Improvements	**2018 - 2019**

Range of Cost: $3.7 - $5.6 million
Lead: City of Leavenworth

PSP-1 through PSP-5 Peshastin/Dryden wastewater treatment plant

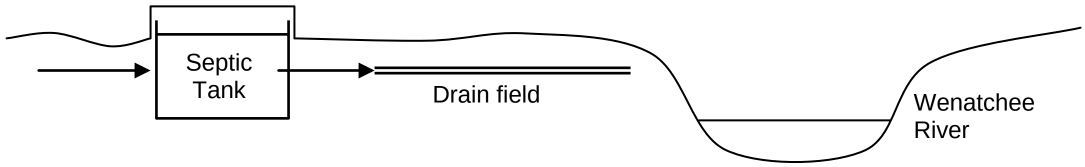
The Peshastin facility receives waste from the local customers in a septic tank effluent pump (STEP) system. Customers use District-owned and maintained septic tanks that discharge to the Peshastin system. As shown in Figure 4, the Peshastin facility is a sequencing batch reactor that uses UV disinfection prior to discharge to the Wenatchee River. Solids from the process are held in an aerobic digester and dewatered through a small centrifuge, and then truck hauled to a regional composting facility.



Nutrient	NH4	NO3	TP
mg/L	1	12	4

Figure 4. Existing treatment schematic of the Peshastin facility

The facility at Dryden is a community septic and drainfield that receives flow from 42 residential connections. Figure 5 shows the relatively simple treatment process and its proximity to the Wenatchee River. The groundwater/surface water interaction potential may cause a nonpoint source of phosphorus loading to the river, as discussed in the TMDL study.



Existing Effluent Characteristics

Nutrient	NH4	NO3	TP
mg/L	20	0	4

Figure 5. Existing treatment schematic of the Dryden facility

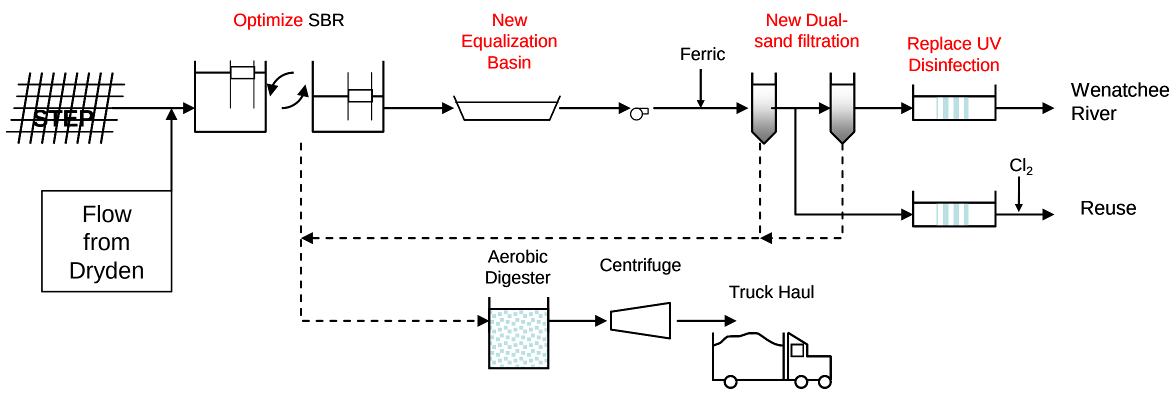
The Dryden facility could implement measures to meet the phosphorus TMDL requirements on its own. Alternatively, Dryden wastewater flows could be routed to Peshastin, and the Peshastin facility and/or treatment process could be upgraded to meet the TMDL requirements. In addition to treating significantly more flow than Dryden, Peshastin's facility is highly adaptable for incorporating biological nutrient removal and other advanced treatment processes. Under the existing operation, the facility has some degree of biological phosphorus removal. Similar to the Leavenworth WWTP, process enhancements to the existing system may be possible to improve phosphorus removalm but most likely won't meet WLAs below 100 µg/L. Adding or directing the RAS into a formalized anaerobic zone, in order to promote the production of VFAs that are required for the biological phosphorus removal process, would also lead to increased phosphorus removal. Potential changes to the current WLAs at the same time will dictate necessary plant process modifications and improvements.

Chelan County PUD is currently in the facility-planning phase and evaluating impacts of the TMDL on its WWTP. This facility planning will extend into 2010. This facility planning effort will evaluate possible improvements to meet current WLAs in the TMDL. A process enhancement period and pilot testing would likely follow the planning phase similar to Leavenworth.

To meet the current TMDL requirements, enhanced nutrient removal approaching the limits of technology would be necessary and require the use of multi-stage effluent filtration, with the addition of ferric chloride or membrane technology. It was assumed that an upgraded facility, designed to meet phosphorus limits from the Wenatchee River TMDL, would include effluent filtration and produce Class A reuse water that could be marketed and used locally to supplant irrigation or other non-potable water use needs. Based on the current WLAs, Table 9 provides a summary of process needs for Peshastin, followed by Figure 6 depicting the future treatment layout.

Table 9. Summary of Peshastin/Dryden wastewater treatment plant

Facility	Need/Comment
Influent	STEP feed reduces TSS. Flow with Dryden increases required capacity (0.11 vs. 0.09 mgd) but lowers TSS offset load.
Headworks	No headworks. STEP system
SBR	Capacity appears adequate. May need some upgrades in aeration.
Flow Equalization	Attenuate SBR effluent to provide steady flow to tertiary process. Reduce peak flows to max day.
Filtration	Two stage filtration using moving bed filtration
UV Disinfection	Need to upgrade UV for increased flow.
Reuse Requirements	Upgrade UV to meet Reuse requirements.
	Add residual chlorine
Solids Handling	Aerobic digester is marginal. Retain current operation, knowing that solids processing is marginal.



Future Effluent Characteristics

Nutrient	NH4	NO3	TP
mg/L	1	12	0.05

Flow = 0.12 MGD

Figure 6. Future treatment schematic for Peshastin/Dryden facility

Individual upgrade costs for required improvements to the Peshastin facility may vary significantly depending on final WLAs and required enhancements and modifications to meet WLAs. The total projected capital cost of improvements is approximately $7.5 million for the improvements highlighted inFigure 6. A timeline is also provided to show a possible implementation schedule in line with the WQIP. Changes to the TMDL and WLAs could change milestones shown in the timeline and/or Peshastin's course of action.

Potential Phosphorus Load Reduction: 1.8kg/day

Timeline:	**Facility Planning**	**2009 - 2010**
	Process Enhancements	**2011 – 2012**
	Pilot Testing	**2013 – 2014**
	Facility Planning & Possible Design	**2015 – 2016**
	Construction of Possible WWTP Improvements	**2017 - 2019**

Range of Cost: $6.75 - $9 million
Lead: Chelan County PUD

PSC-1 through PSC-6 City of Cashmere wastewater treatment plant

The city of Cashmere lagoon system is not easily adaptable to biological nutrient removal for low levels of effluent phosphorus. Combined with the requirement from Ecology to either remove the leaking lagoon system from service, or rebuild it with an approved liner, the most likely scenario is to reconstruct the facility into a new mechanical nutrient removal facility.

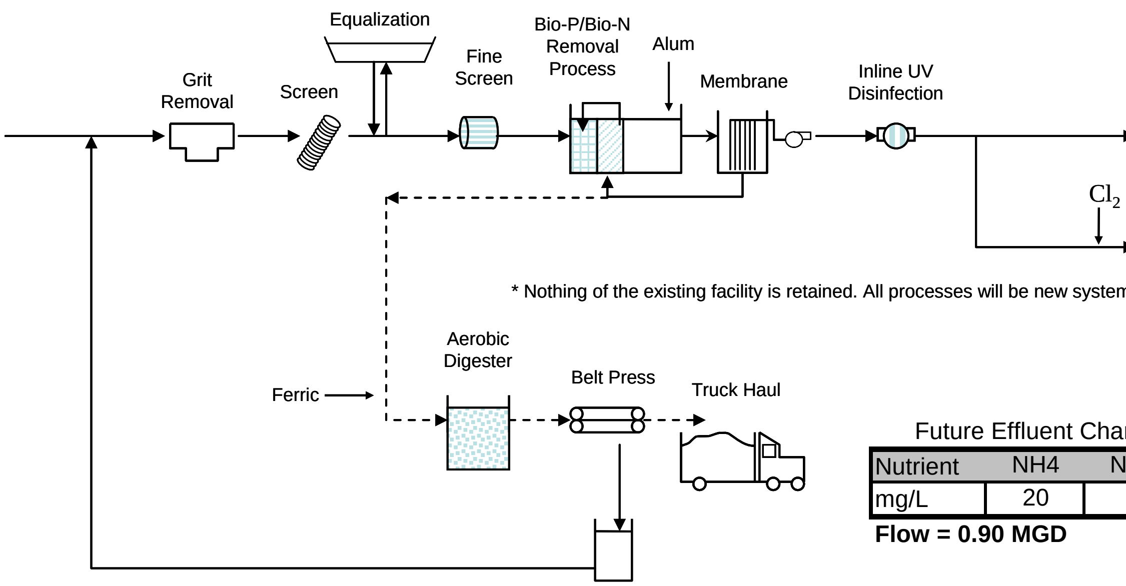
This would require the construction of multi-stage effluent media filters or a membrane treatment system at the limits of treatment technology to meet the current draft TMDL load allocations. Like the identified improvements for the city of Leavenworth and the Peshastin facility, the plant would be able to produce Class A reclaimed water that might be used to supplement irrigation or other non-potable water needs in or around the city. Table 10 provides a summary of possible process upgrades for Cashmere, followed by Figure 7 depicting the future treatment process schematic upgrades.

Cashmere is currently in the facility planning stage and while the improvements discussed here may have the ability to meet TMDL requirements, other alternatives may be available to Cashmere depending on cost, facility location and other factors. For example, it may be possible to reduce phosphorus loads to the WWTP by reducing phosphorus loads from industrial dischargers. Crunch Pak and Blue Star discharge wastewater to the WWTP, so additional pretreatment by these facilities to remove phosphorus may be a cost-effective approach to allowing Cashmere meet TMDL requirements.

Cashmere may implement WWTP improvements in phases. For example, if Cashmere desires to build a new mechanical treatment facility that will have the flexibility to incorporate phosphorus removal at a later date, it can build the mechanical plant initially while incorporating phosphorus removal improvements during a later phase timed with phosphorus removal requirements dictated by the final TMDL.

Table 10. Summary of city of Cashmere Wastewater treatment plant

Facility	Need/Comment
Influent	Current conditions.
Headworks	Conventional (flow measurement, grit, screen)
Flow Equalization	Provide steady flow to MBR
MBR	Complete MBR technology with fine screen, biological nitrogen and phosphorus removal, membrane facilities. Include alum addition for phosphorus removal backup.
UV Disinfection	Inline UV following MBR
Reuse Requirements	Effluent will meet Reuse quality. Reduce chemical feed during reuse season. Add small amount hypochlorite for residual chlorine.
Solids Handling	Aerobic digestion for simple operation.



Future Effluent Characteristics

Nutrient	NH4	NO3	TP
mg/L	20	0	0.1

Flow = 0.90 MGD

Figure 7. Future treatment schematic

Individual upgrade costs for required improvements to the city of Cashmere's WWTP applied only available cost information, and may vary significantly depending on final WLAs and required enhancements and modifications to meet WLAs. The total projected capital cost of improvements is approximately $28 million for the improvements shown in Figure 7. It is assumed for timeline purposes that WWTP would be phased to include phosphorus removal at a later date.

Potential Phosphorus Load Reduction: 15.5 kg/day

Timeline:	**Facility Planning**	**2009 – 2010**
	Industrial Pretreatment Planning	**2010**
	WWTP Design	**2010 – 2011**
	Phase I WWTP Construction	**2012 – 2014**
	Interim Plant Optimization	**2015 - 2017**
	Possible Phase II WWTP Construction	**2018 - 2019**

Range of Cost: $25.2 - $33.6 million
Lead: City of Cashmere

PSF-1 Leavenworth National Fish Hatchery

Activity: The Leavenworth National Fish Hatchery (LNFH) currently discharges approximately 25 to 30 mgd and 1.27 kg/d of phosphorus to Icicle Creek. The target phosphorus WLA for LNFH is 0.48 kg/d, a 62% reduction. This WLA is equivalent to a 5.2 µg/L total phosphorus concentration and phosphorus removal technology limits will not allow LNFH to meet this WLA. In fact, LNFH's current phosphorus discharge concentration of approximately 14 µg/L is already below the limits of technology. As a result, alternative effluent management will be required by LNFH. Such alternatives might include effluent phosphorus trading or reclaimed water use; however, these activities would likely only relieve LNFH of the phosphorus WLA to a small degree, since LNFH's discharge flows are so high.

Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Currently unknown.
Lead: Leavenworth National Fish Hatchery

PSI-1 through PSI-4 Industrial non-contact cooling water discharges

Bardin Farms Corporation (Monitor, WA), Blue Star Growers, Inc. (Cashmere, WA) and Blue Bird, Inc. (Peshastin, WA) store and pack fresh fruit. These facilities use water for mechanical heating and cooling equipment which is discharged as non-contact cooling water (NCCW) to the Wenatchee River under NPDES general permits. Facilities commonly add chemicals (which may contain phosphorus) to the NCCW to prevent corrosion, scaling and biological fouling in boilers, cooling towers, refrigeration systems, and related equipment. Sampling in December 2004 evaluated total and inorganic phosphorus in the fruit packers' discharge while documenting which of those dischargers add chemicals to their NCCW. Results of this sampling are presented in Table 11.

Table 11. Total and inorganic phosphorus in non-contact cooling water discharges.

Facility	Permitted Discharge Point	Chemicals Added?	Inorganic-P (µg/L)	Total P (µg/L)	Percent Inorganic	Total P Wasteload Allocation (µg/L)
Blue Bird	796A 796C 796D 796E 796B	No No No No Yes	40.7 45.6 40.5 41.7 189	40.7 45.6 40.5 41.7 2,380	100 100 100 100 8	40.7 45.6 40.5 41.7 90
Blue Star	8	Yes	139	240	58	90
Bardin Farms	786A 786B	Yes Yes	175 150	2,920 3,300	6.0 4.5	90 90

[c] (Ecology, 2009)

Table 11 shows that no phosphorus reduction will be required of Blue Bird's NCCW that does not utilize chemical addition (796A, 796C, 796D, 796E), yet a significant reduction will be required of its 796B NCCW discharge. Similarly, Blue Star and Bardin Farms, who add chemicals to their NCCW, will need to make a significant phosphorus reduction in their NCCW to 90 µg/L.

NCCW phosphorus sampling results generally show that the total phosphorus concentration for dischargers who add chemicals to their NCCW is approximately one to two orders of magnitude greater than those who do not add chemicals. The phosphorus in NCCW resulting from chemical addition is mostly organic (generally greater than 90%) while the phosphorus content of the NCCW for facilities that do not add chemical is essentially inorganic (ortho-phosphate). It is also worth noting from historical Blue Bird and Bardin Farms NCCW sampling data that their discharges have low TSS (generally non-detectable with occasional spikes up to 10 mg/L) and essentially non-detectable BOD (less than 5 mg/L). Because the TSS is low and organic phosphorus fraction is high, a significant portion of the total phosphorus in the NCCW streams using chemical addition is dissolved organic phosphorus.

Phosphorus reduction for continued Wenatchee River discharge

If continued discharge to the Wenatchee River is desired by Blue Bird, Blue Star and Bardin Farms, phosphorus reduction measures will be required to meet the current TMDL and WLAs. The easiest means for achieving this reduction is by source reduction or chemical substitution. NCCW phosphorus discharge could be reduced by either eliminating chemical addition to the NCCW or substituting the chemicals used with chemicals or processes that do not contain phosphorus nor increase phosphorus concentration during NCCW use.

Non-chemical technologies also exist for treating NCCW including Ultrasound, Pulse-Power and Ozone (*Fact Sheet for the Fresh Fruit Packing General Permit*, Washington Department of Ecology, effective July 2009). Use of these technologies could eliminate the need for chemical addition to NCCW if they can successfully control corrosion, scaling and biological fouling in the equipment where NCCW is used. The applicability and feasibility of these technologies and chemical substitutions would need to be evaluated on a case-by-case basis. Pilot testing could be done to evaluate their effectiveness at protecting mechanical heating and cooling equipment.

Chemical precipitation of phosphorus in the wastewater treatment industry is widely practiced. Chemicals such as alum and ferric chloride will react with phosphate to form a precipitate that can be physically separated from the wastewater. However, these chemicals and others used for phosphorus removal will not react with organic phosphorus. As noted earlier, greater than 90% of the phosphorus in the NCCW that have chemical additives is typically organic, so chemical precipitation is not a viable alternative for the fruit processors to meet required phosphorus reductions.

Since biological and chemical methods would not be feasible for removal of phosphorus from NCCW, the final available method would be physical removal of phosphorus (namely the dissolved organic fraction) using a membrane process such as reverse osmosis (RO). RO is capable of producing extremely high-quality water absent of nearly all dissolved minerals and species. At the same time, RO is costly. Assuming RO were needed to meet the fruit processors' current TMDL WLAs, total costs for all processors could be on the order of $1 to $8 million, depending on the scope of necessary improvements. Other less expensive means for meeting the WLAs could be used; however, more planning, investigation and possibly pilot testing will be needed to evaluate these alternatives.

Potential Phosphorus Load Reduction: 0.084 kg/day

Timeline:	**Facility Planning and Evaluation**	**2009 – 2011**
	Bench and Pilot Testing	**2012 – 2014**
	Planning and Final Improvement Plan	**2015 - 2016**
	Possible Facility Improvements & Modifications	**2017 - 2019**

Range of Cost: $1 to $8 million

Nonpoint sources

While the TMDL indicates the need for total phosphorus reductions, the best management practices to reduce nonpoint sources are not defined. However, the TMDL does identify loading source categories including loads from broad categories that include various nonpoint sources which include tributaries, irrigation-management return flow, and diffuse loads. The TMDL loads and targets are shown in Table 12 (Ecology, 2009).

Table 12. Summary of total phosphorus load allocations[d]

Loading Source Category	Current Phosphorus Load (kg/day)	Percent Reduction	Total Phosphorus Load (kg/day)	Target Load Reduction (kg/day)
Tributaries	1.75	49	0.90	0.85
Irrigation-management return flow	0.29	10	0.26	0.03
Diffuse loads	19.23	60	7.54	11.69
Diffuse loads (Icicle Creek)	0.19	32	0.13	0.06

[d] (Ecology, 2009) Current Phosphorus Load, Percent Redefined, and Target Load; TP Load calculated.

Much of a diffuse phosphorus load can enter the watershed through shallow groundwater, which may have been degraded from human activities from 2002 through 2003. Ecology placed 54 mini-piezometers and gathered enough groundwater hydraulic data to determine the flow exchange between the groundwater and the surface water with a high degree of spatial resolution, along the river (Ecology, 2007). Groundwater-quality sampling was performed near the river and tributaries. Ecology (2007) found that there is constant communication between the river and the unconfined aquifer. Along the studied stretch of river there are several changes between gaining reaches and losing reaches, and some reaches change depending upon the season.

The mean ortho-phosphate value calculated in the upper watershed was approximately 14 μg/L (Ecology 2007). This may be the natural background concentration of phosphate, likely from the area's geology. The phosphate concentrations were elevated slightly in Icicle Creek and the Leavenworth area. Phosphorus concentrations continue to increase near Peshastin and Cashmere (Ecology, 2007). Phosphorus in the groundwater was similar to concentrations found in the river water. The similar phosphate concentrations, along with information that water flows between the surface and the ground, indicates that many of the groundwater samples may have been essentially sampling river water in shallow groundwater. Additional study will likely be needed to quantify loadings from specific activities that may contribute to diffuse sources. Specifically, additional groundwater sampling will be needed in the upper reaches of the river and its tributaries, as well as upgradient and downgradient of specific activities. Several studies are included in this section to quantity loadings and to determine effectiveness of controls.

Reducing nonpoint sources will be implemented adaptively. Monitoring and quantification of nonpoint source loadings will be conducted to provide baselines. Concurrently, proposed actions should focus on those that are most likely to have the most significant load reductions. As the results of the proposed monitoring and quantification of sources becomes available, the information will be used to target the next highest priority source control activities. Once actions have been implemented, their effectiveness will be monitored and will provide feedback for the next round of actions. The adaptive management strategy proposed here also allows for voluntary actions to be implemented while ordinance changes are adopted. An adaptive management strategy was proposed by the WWPU in the 2008 Detailed Implementation Plan (WWPU, 2008)

NPS-1 Tributaries land use mapping

The tributaries include a wide variety of land uses for which to implement best management practices. These land uses include urban, suburban and rural areas, agriculture, forestry, and rangeland. Control of nonpoint sources from these land uses will have both some similarities and some uniqueness. All will likely have potential stormwater best management practices as options to reduce nutrient transport in runoff from rainfall and snowmelt. In all tributaries, construction best management practices should be implemented to minimize nutrient transport from disturbed areas. Alternatively, each of these typically has unique stakeholders, agency involvement, and best management activities associated specifically with the land use. Therefore, each of these land uses along, with best management practices, is described under separate headings.

Specific tributaries identified in the TMDL to target for nonpoint source reductions include Brender Creek, Chumstick Creek, Icicle Creek, Peshastin Creek, and Mission Creek. It is unclear if these creeks were identified because of available monitoring data, drainage area, flow, or specific activities occurring with the sub basin. As recommended in the final detailed implementation plan [Wenatchee Watershed Planning Unit (WWPU), 2008], potential non-point sources along the tributaries need to be identified. Specifically, land uses along these creeks need to be mapped and examined to assess potential sources and loadings. The next step could be to do a windshield level survey to rapidly field check mapped information to on the ground activities and evaluate if best management practices are feasible for reducing phosphorus. If there appears to be feasible activities, then additional surveys and the implementation of monitoring could be undertaken to gather specific phosphorus data and quantify the loadings.

The five identified creeks loads that were provided in the TMDL are shown in Table 13. Load reduction targets were not computed in the TMDL for these individual creeks so the overall tributary reduction of 49% was applied evenly to all the creeks in Table 13.

Table 13. Summary of total phosphorus loads for identified tributaries[e]

Tributary Loads	Current Phosphorus Load (kg/day)	Percent Reduction	Total Phosphorus Load (kg/day)	Target Load Reduction (kg/day)
Brender Creek	0.339	49	0.173	0.166
Chumstick Creek	0.097		0.049	0.048
Icicle Creek	0.802		0.409	0.393
Mission Creek	0.354		0.181	0.173
Peshastin Creek	0.153		0.078	0.075

[e] (Ecology, 2009) Current Phosphorus Load and Percent Reduction; Load and Reduction calculated.

Activity: Investigate source of TMDL tributary loads. Perform baseline mapping to identify land uses and potential sources. Perform windshield survey to confirm mapping and identify potential sources in the field. Data collection and mapping should also include such information as residences on septic systems, locations of community septic system drain fields, number and locations of hobby and commercial farms, types of farming activities, number of animals on site. Augment current GIS information with information on practices on a parcel-by-parcel basis. Prioritize creeks for further analysis and assess specific projects for quantifying phosphorus loads.
Timeline: Land use mapping and data analysis complete by December 2010
Potential Phosphorus Load Reduction**:** Currently unknown.
Range of Cost: Initial assessment $5,000 - $15,000
Lead: Chelan County

NPS-2 Agricultural practices investigation

Agricultural practices can contribute phosphorus loads to the river. Implementing best management practices for areas currently not practicing them is an activity to minimize this loading and is a potential reduction. In a similar watershed in Idaho, 70 to 80 % of nutrient loading was found to occur during snow melt and storm event run-off (IDEQ, 2000). Many activities may already be implemented such as fencing livestock from the streams, tight controls on the use and minimization of fertilizer and manure application, and containing all irrigation water on the fields. The current extent of BMP implementation and non-implementation on hobby and commercial farms and orchards should be investigated and mapped on GIS, and estimates of potential loading made based on literature values.

Activity: Investigate current agricultural practices on hobby and commercial farms and orchards. Coordinate and obtain information from local NRCS Reclamation and other field agent(s); and estimate loading from the literature and results of mapping.
Timeline: Investigation of practices and estimated loadings complete – June 2010.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Initial assessment $50,000 - $70,000
Lead: Chelan County and Cascadia Conservation District (CCD)

NPS-3 Groundwater investigation related to agricultural practices

Greater investigation is needed of the impact of agricultural activities on phosphorus loading to the groundwater and discharge to surface water. Groundwater samples could be located both upgradient and downgradient of areas using different types of agricultural practices. This could yield information on average phosphate loading from each type of land use sampled as well as deduce the practices that contribute the most and the least amount of phosphate to the groundwater, allowing subsequent targeting of actions to reduce loadings.

Activity: Conduct groundwater monitoring investigation upgradient and downgradient of agricultural land uses. Ensure parcel by parcel practices are documented to link practices with concentrations. Estimate loading from the results and compare with literature.

Timeline: Groundwater investigation– October 2012.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $50,000 - $70,000
Lead: Chelan County
NPS-4 Public education campaign and
NPS-5 Voluntary BMP implementation campaign and effectiveness evaluation

To manage agricultural sources adaptively, two activities should be conducted simultaneously with the investigation: a public education campaign directed at both commercial and hobby farmers; and a campaign to achieve voluntary BMP implementation. Both public education and voluntary BMP implementation were also measures recommended in the final detailed implementation plan (WWPU, 2008). The integration of these two campaigns can serve to raise awareness and build community support. One way to target the greatest reductions is to phase the campaigns in relation to the distance of the farming activities to the stream or river. For example, the Cascade Reservoir TMDL Implementation Plan (IDEQ, 2000) used the following scheme:

- Tier 1 – All lands within 150 feet of either side of a stream
- Tier 2 – Lowlands, mostly irrigated corps and livestock farms

- Tier 3 – Uplands, mostly non-irrigated agriculture

Activity: Develop and implement public education campaign
Timeline: Public education campaign developed and begun implementing - December 2010.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Education campaign development and implementation $20,000 - $35,000/year
Lead: Chelan County and Cascadia Conservation District (CCD)

Activity: Develop and implement voluntary program to encourage BMP implementation
Timeline: Voluntary BMP campaign developed and begun implementing - December 2010.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Campaign development and implementation $20,000 - $35,000/year
Lead: Cascadia Conservation District

Finally a BMP effectiveness monitoring program could be developed as recommended by the final detailed implementation plan (WWPU, 2008). This program could both investigate the extent of BMP implementation on a site-by-site basis, and conduct water quality monitoring upstream and downstream of known areas of BMP implementation.

Activity: BMP Effectiveness and associated water quality monitoring
Timeline: Effectiveness monitoring in place - December 2010.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: BMP effectiveness and water quality monitoring $30,000 - $45,000/year
Lead: Cascadia Conservation District

NPS-6 Livestock practices and loading estimate

Riparian corridors should be fenced to limit livestock, with access to streams, to either design watering access points or off-stream water. An estimate of the phosphorus loading from livestock could be estimated from the number of livestock raised in the watershed.

Activity: Investigate current practices, estimate livestock quantity, and quantify potential loading.
Timeline: Initial assessment and loading estimate – December 2010
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Initial assessment and loading estimate $10,000 - $25,000
Lead: Chelan County and Cascadia Conservation District (CCD)

NPS-7 Quantify runoff loading from industrial land application

A source identified in the TMDL is spray fields used to dispose of fruit packing wastewater. These facilities should have best management practices, including containment berms, to prevent the runoff of water from the field, and restricted flow rates to minimize saturated soils and infiltration to groundwater. Existing practices, concentrations of total phosphorus in the wastewater spray, potential runoff volumes, and potential groundwater infiltration would need to be examined to potentially quantify the total phosphorus load reaching the Wenatchee River.

Activity: Investigate current practices and quantify volume of wastewater applied. Working with Ecology, quantify phosphorus loading to groundwater and potential hydraulic connectivity with surface water. Also calculate potential volume of stormwater/wastewater runoff and necessary berms to contain water on the field. Work with Ecology and industry to adjust permit conditions, as necessary to reduce loading.
Timeline: Identify practices and quantify loading – December 2010. Permit re-issuance within five years.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Initial assessment $15,000 - $25,000
Lead: Chelan County in collaboration with Ecology

Miscellaneous activities

MA-1 Stream flow and habitat

The Wenatchee Watershed Planning Unit's final detailed implementation plan provides a list of projects to improve water quality focused on stream flow and habitat improvements that may benefit water quality and contribute to meeting TMDL targets for pH and dissolved oxygen in the Wenatchee River.

The final detailed implementation plan places emphasis on water conservation for improving stream flow, recognizing that water conservation methods can also improve water quality. The implementation of water conservations measures can reduce the phosphorus loading, assuming that the conserved water is of lower concentration than that currently in the receiving water. Conservation measures identified by the WWPU include:

- Providing irrigators incentives to conserve water.
- Promoting water conservation BMPs for the agricultural community.
- Educating domestic and agricultural users about water conservation.
- Implementing a fee structure for water that promotes conservation.
- Encouraging the cities and the county to develop policies that will conserve water (e.g., drought tolerant landscaping, maximum lawn sizes).

Activity: Develop and implement a county-wide water conservation program that provides water conservation education to users (domestic, agricultural, irrigation). This program should be on-going.
Timeline: Program developed, and resourced for on-going implementation.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $55,000 - $70,000/year
Lead: Chelan County

The final detailed implementation plan proposes investigation of groundwater and surface water interactions. These investigations could be conducted collaboratively with the groundwater loading studies recommended in this document (e.g., septic, agricultural, and forestry loading studies). More robust studies would provide an overall cost savings and would provide needed information. No additional activities are proposed, scheduled, or calculated here. However, the watershed would be served best with a single entity responsible to ensure that groundwater/surface water interaction studies include collaborative aspects to them.

The WWPU's final detailed implementation plan proposes to control sediment from forested lands. They proposed road reconstruction and relocation, as well as implementation of sediment control BMPs. Because phosphorus sorbs onto sediment particles, controlling sediment from forested lands can reduce phosphorus loading. These activities are identified in the final detailed implementation plan and are not calculated here. The need for additional measures and study following the 2009 Ecology evaluation is described in the Forestry section of this document.

MA-2 Upper Columbia salmon recovery

The Wenatchee Sub-basin plan calls for an inventory of habitat improvement projects that if completed, will impact water quality in the Wenatchee River and its tributaries. The impacts can be both from flow modifications and to nutrient and organic matter additions related to fish rearing sites.

Activity: Monitor Upper Columbia Salmon Recovery efforts and projects.
Timeline: Ongoing
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $2,500 - $5,000
Lead: Chelan County

MA-3 Evaluate forestry practices

The state's forest practices regulations will be relied upon to bring waters into compliance with the load allocations established in this TMDL on private and state forestlands. As part of the 1999 Forests and Fish agreement (www.dnr.wa.gov/forestpractices/rules/forestsandfish.pdf), Ecology agreed to use the forest practices regulations to implement TMDLs. The effectiveness of the Forests and Fish program is being assessed through a formal adaptive management program. The success of this TMDL will be assessed using monitoring data from streams in the watershed.

Ecology will formally review the effectiveness of the forest practices program in 2009. As part of this review, Ecology will determine if the state's forest practices program can be relied on to bring water quality into compliance with the state water quality standards. If the current program is not found to be adequate, Ecology will suggest any needed changes to the Forest Practices Board, or revise this TMDL implementation plan as necessary, to achieve compliance.

Activity: Evaluate existing practices.
Timeline: January 2010
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Initial assessment $2000 - $50,000 (Ecology's budget)
Lead: Ecology

MA-4 Quantify sediment-phosphorus relationship in forested areas

Following the effectiveness evaluation, it may be necessary to quantify the phosphorus loading associated with forest practices and managed the sources adaptively. Construction and use of roadways represent a major source of sediment from timber harvest activities (IDEQ, 2000). A study to quantify the relationship between sediment associated with phosphorus in run-off from these roads can help determine whether additional measures should be taken.

Activity: Quantify relationship between sediment and phosphorus in forested areas
Timeline: Study complete – January 2012
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Water quality study $30,000 - $45,000 over two years
Lead: Chelan County

MA-5 Alternatives to septic systems

One source of phosphorus from suburban/rural areas is wastewater, which is typically disposed of by using on-site septic systems. This source may connect with the diffuse source or groundwater loading. One method of reducing on-site septic system loading, without complete elimination of the system, is by reducing the phosphorus used in the household and disposed of through the system. An option is a phosphate ban through the reduction or elimination of phosphorus in dishwashing detergents, laundry detergents, and other soaps used in the home.

Activity: Implementation of a phosphate ban ordinance.
Timeline: Ordinance development complete June 2010. Ordinances Adopted - September 2010.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Initial assessment $5,000 - $10,000
Lead: Chelan County

A septic system impact analysis could be performed to determine the impacts from septic systems on groundwater that discharges to the surface water. This study could assess the impact of septic systems in the watershed, evaluate alternative treatment technologies, and determine criteria for implementing various alternatives in high impact or high risk zones, such as the Peshastin Creek watershed, or the lower portion of the Wenatchee River (described in Diffuse Sources). The project should be divided into two phases. The first phase would be to inventory existing septic systems on a household, parcel, or neighborhood basis and map those systems, along with other relevant information (such as system age), on a Geographic Information System (GIS) map. The outcome of the first phase would be to identify zones of high risk for impacts to groundwater, which would then transport phosphate to the river. This study should be conducted in concert with the study to assess soil capacity to handle on-site systems (see next activity below this one).

One of the tools that could be used to assess loadings is to use the 2010 census data to recalculate population densities and growth trends within the watershed. Along with the septic system study, the new GIS data from the census could be used for a more detailed urban/suburban groundwater phosphate loading analysis.

The second phase would be intended to develop options to mitigate impacts from conventional septic systems, which could include identifying appropriate alternative technologies and methods by which those technologies could be applied, such as installing sewers in more areas, or providing financial incentives for septic system upgrades or replacement.

Activity: Assess septic system impacts on groundwater that discharge to surface water. Identify alternatives that reduce phosphorus loading and associated funding sources.
Timeline: Assessment complete - December 2011. Alternatives and funding identified December 2012.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $50,000 - $90,000
Lead: Chelan County

MA-6 Soil Capacity assessment for on-site systems

The WWPU's final detailed implementation plan recommended that an assessment of the soil's capacity to handle on-site systems be conducted (WWPU, 2008). This assessment should evaluate the leaching potential of various soil types, depth to groundwater, and proximity to the stream or river to predict a maximum density of drainfields to prevent phosphate leaching to the groundwater in connectivity to surface water. Once the study has been conducted, the Health District should consider modifying their regulations to prescribe where on-site septic systems can and cannot be located, and the maximum densities that will prevent further phosphorus loading to the WRIA.

Activity: Assess soil capacity for on-site systems to prevent phosphorus loading to the river
Timeline: Assessment complete - December 2011.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $20,000 - $35,000
Lead: Chelan County in collaboration with Chelan Douglas Health District

MA-7 Septic system locations and densities ordinance

Activity: Develop and adopt ordinance standards for new septic system locations and densities, as needed
Timeline: Ordinance adopted - December 2012.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $20,000 - $25,000
Lead: Chelan County in collaboration with the Health District

MA-8 Construction stormwater runoff technical assistance program

In addition to the options described in the Regional Phosphorus Management section of this document, the WWPU recognized that load reductions could be realized if construction activities are better controlled (WWPU, 2008). Sediment-laden run-off from construction activities, from clearing and grubbing, and through final site stabilization can carry phosphorus that is adsorbed to the soil particles. The Construction Stormwater General Permit, administered by Ecology, requires all construction sites that disturb one acre or greater and discharge to a surface water body to apply best management practices (BMPs). The BMPs, when properly and consistently applied, can reduce sediment load and associated phosphorus by orders of magnitude. The WWPU recommended working with the construction industry to provide technical assistance that will improve proper BMP use. The city of Wenatchee and Chelan County, as part of its Phase II Municipal Stormwater General Permit, are required to review construction site plans and inspect construction sites for appropriate implementation of the stormwater site plans. Chelan County and the other municipalities could develop and implement a technical assistance program in conjunction with Ecology and the city of Wenatchee's program to assist developers and their contractors in complying with the regulations while reducing loading.

Activity: Develop and implement a technical assistance program for the construction industry
Timeline: Program developed and being implemented - December 2011. On-going.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: \$55,000 - \$75,000/year
Lead: Chelan County and local jurisdictions in collaboration with city of Wenatchee, Ecology, and developers

MA-9 Identify irrigation return water loadings & remedies to reduce loading

The return flows identified in the TMDL are Cascade Orchard; Icicle Irrigation spill at Stines Hill; Icicle Irrigation spill at Fairview Canyon; Jones Shotwell spill return; and Wenatchee Reclamation District spill. A map of these locations would be helpful in identifying potential alternative options for using the flow rather than discharging to streams. The elimination of the phosphorus from any one of these spills would meet the targeted reduction for irrigation return flows.

Additionally identified was Icicle Irrigation spill near Leavenworth, although the load was reported as 0.000. The Chiwawa Irrigation District was also identified as having total phosphorus load additions within its conveyance system.

Alternatives to irrigation return flows include leaving the water in the river; not diverting as much water by conservation measures and metering; removing marginal land from production; and getting water from other sources such as the reuse of wastewater. The return flows could also be pumped back into the irrigation system to be used instead of discharged to the river. The return flows could be discharged to wetlands, although this is not a promising alternative as loads may still reach the river, are difficult to maintain, and can at times generate and release more phosphorus. Conservation measures and metering appear to have already been well implemented in the watershed. Since most irrigation is sprinkler irrigation, these irrigation spill returns may not be irrigation drains but rather groundwater drains and flows from the canyons. The source of the water needs to be identified.

The six identified irrigation spill returns loads that were provided in the TMDL are shown in Table 14. Load reduction targets were not computed in the TMDL for these individual returns so the overall tributary reduction of 10% was applied evenly to all the returns in Table 14.

Table 14. Summary of total phosphorus loads for identified irrigation spill returns[f]

Tributary Loads	Current Phosphorus Load (kg/day)	Percent Reduction	Total Phosphorus Load (kg/day	Target Load Reduction (kg/day)
Cascade Orchard	0.059	10	0.053	0.006
Icicle Irrigation spill near Leavenworth	0.000		0.00	0.000
Icicle Irrigation spill at Stines Hill	0.031		0.028	0.003
Icicle Irrigation spill at Fairview Canyon	0.047		0.042	0.005
Jones Shotwell spill return	0.044		0.040	0.004
Wenatchee Reclamation District spill	0.107		0.096	0.011

[f] (Ecology, 2009) Current Phosphorus Load and Percent Reduction; Load and Reduction calculated.

The Wenatchee Watershed Detailed Implementation Plan (WWPU, 2008) recommends working with irrigation districts to reduce nutrient inputs into the irrigation return flows. Irrigation districts may also be helpful in identifying landowners who would be willing to implement BMPs. Alternatively irrigation districts may evaluate treatment alternatives for the return flow.

Activity: Identify sources of water labeled as irrigation spill returns, assess sources of loading, and work with irrigation districts to develop and implement remedies.
Timeline: Assessment complete – June 2011
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $20,000 to $30,000
Lead: Chelan County

MA-10 Evaluate various septic system loadings and alternatives to these systems

Diffuse flows include groundwater discharge to surface waters. The diffuse loads in the TMDL were estimated by reach of river (between two river miles). These reaches are identified as Leavenworth, Peshastin, Dryden, Cashmere, and Monitor. The loads by reach are shown in Table 15.

Table 15. Summary of total phosphorus loads for identified groundwater reach gains[g]

Tributary Loads	Current Phosphorus Load (kg/day)	Percent Reduction	Total Phosphorus Load (kg/day	Target Load Reduction (kg/day)
Diffuse load between RM 26.2 and RM 21.0 (Leavenworth)	1.944	60	0.778	1.166
Diffuse load between RM 21.0 and RM 17.2 (Peshastin)	2.583		1.033	1.550
Diffuse load between RM 17.2 and RM 14.1 (Dryden)	4.478		1.791	2.687
Diffuse load between RM 14.1 and RM 10.8	2.856		1.142	1.714
Diffuse load between RM 10.8 and RM 6.5 (Cashmere)	7.036		2.814	4.222
Diffuse load between RM 6.5 and RM 2.8 (Monitor)	0.335		0.134	0.201

[g] (Ecology, 2009) Current Phosphorus Load and Percent Reduction; Load and Reduction calculated.

One source of groundwater pollution may be on-site septic systems which are commonly used in non-urban areas including portions of the lower Wenatchee River watershed (Ecology, 2008). On-site septic systems may be used for a single home or larger systems for a community. One larger system identified in the lower Wenatchee River watershed is the system for Dryden, which may be leaching phosphorus into the Wenatchee River via groundwater. The proximity to the river and the potential groundwater/surface water interaction has been identified as a nonpoint source of phosphorus loading to the river as documented in the TMDL study.

“The facility at Dryden is a community septic and drainfield that receives flow from 42 residential connections” (HDR, 2009). The existing effluent characterization indicates the total phosphorus concentration is 4 mg/L. Removal of this large on-site septic system by piping the effluent to a wastewater treatment facility would potentially eliminate a loading of total phosphorus to the river.

Activity: Perform septic analysis to quantify the loading and develop alternatives to the current on-site septic system operated by the Chelan County PUD.
Timeline: Analysis and loading study complete – December 2010
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $20,000 to $40,000
Lead: Chelan County PUD

There are at least two communities with on-site septic systems that are located adjacent to tributaries – one along Peshastin Creek and the other along Icicle Creek. Septic tank/soil retention systems may be a significant source of phosphorus to shallow groundwater, particularly if there is inadequate retention time in soils and the subsurface is hydraulic connectivity with the creeks. Alternatives to disposal adjacent to the creeks should be investigated and an alternative selected. Simultaneously, funding sources for the potential alternatives should be identified.

To quantify the phosphorus reduction achieved, a monitoring program should be scoped and implemented prior to and following implementation of the selected alternative. The monitoring program should assess phosphorus loading upstream and downstream from the drainfields on a quarterly basis with additional monitoring during spring thaw.

Activity: Conduct alternatives analysis and identify alternatives and funding sources. Scope and begin monitoring program
Timeline: Alternatives analysis complete, potential funding sources identified and recommended alternative selected, monitoring program begun - December 2010. Funding identified and secured – December 2011.
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: Alternatives analysis and monitoring program $50,000 - $70,000
Lead: Chelan County

Other areas with higher densities of on-site septic systems include the floodplain opposite the river bank from the Dryden Landfill and the Cashmere reach of the river. Additionally, along the Cashmere reach there may be contributions from leakage from the wastewater treatment lagoons and the sanitary sewer collection system.

Figure 8. Adjacent to Dryden landfill

The area across from the Dryden Landfill appears to have 5-6 residences and potentially other structures downstream of the site. The most likely course of action would be to collect the flows and include them in the solution for the Dryden facility, whether that means conveying it to Peshastin or coming up with an individual treatment solution for Dryden. This location would be a very expensive stand-alone treatment.

Figure 9. Trailer park near Stine Hill

The trailer park at the base of Stine Hill appears to have 25-30 densely spaced trailer homes with an additional 20-30 residences surrounding the trailer park, all unsewered. The alternatives for reducing nutrient loads to the river would be based on cost effectiveness.

Parcels are shown in Figure 10. Many areas beyond the river corridor do not have taxed improvements recorded; those that do are shown in blue. The green outlines are city limits. The parcels do have some additional information including property type from which to do analysis on the number of potential septic systems and loadings. The dark blue circles indicate locations of "large" on-site septic systems.

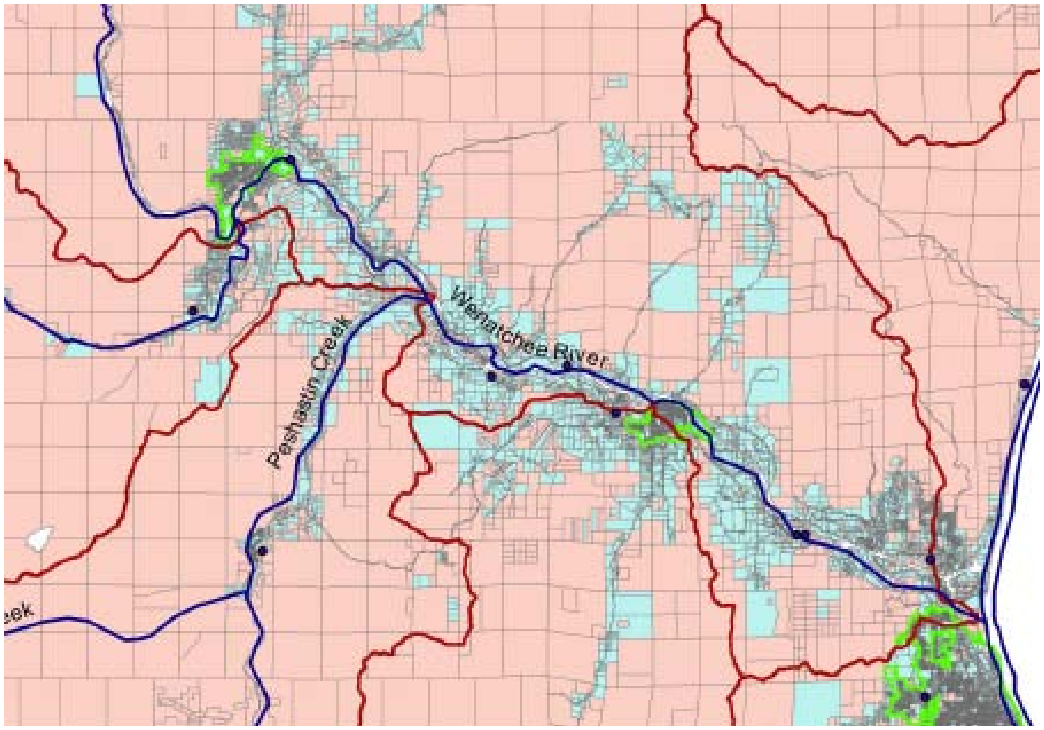


Figure 10. Improved parcels with high probability of on-site septic systems

Activity: Provide initial estimation of loading and alternative treatment options. Potentially perform septic analysis to quantify the loading and develop alternatives to the current on-site septic system.
Timeline: Estimate of loading and alternatives in conjunction with assessment of soil capacity for on-site systems to prevent phosphorus loading to the river
Timeline: Assessments complete - December 2010
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $20,000 to $30,000
Lead: Chelan County in collaboration with Chelan Douglas Health District

MA-11 Groundwater control evaluation for closed landfills

Three closed landfills were identified in the TMDL as diffuse nonpoint sources. They are the Dryden Landfill owned by Chelan County, the old Dryden dump, and the old Cashmere dump. "All three of these landfills are located on land parcels adjacent to the mainstem lower Wenatchee River" (Ecology, 2008). Monitoring well data may be available to characterize and quantify the phosphorus concentrations downstream of these landfills. Additional information about the size of the landfill and the flow rate and volume of groundwater would need to be compiled for analyzing potential options such as pumping and treating the groundwater or installing a barrier to groundwater movement to the river.

Activity: Preliminary assessment if potential alternatives to control groundwater are feasible.
Timeline: Preliminary assessment – December 2011
Potential Phosphorus Load Reduction: Currently unknown.
Range of Cost: $15,000 to $25,000

Estimated cost of reductions

Cost estimation assumptions

A common set of economic analysis assumptions is required for consistent consideration of phosphorus reduction efforts from each of the source groups. In terms of capital costs, all estimates should be formed under the same assumptions for the base date of the estimates for reference and future updates. The scope of the cost estimates should be consistent and include the same base assumptions for contents. When using historical costs as the basis of new estimates, it is important to consider whether reference information includes all applicable costs. For example, total project costs, as opposed to bare construction costs, include allowances for the following: construction contractor overhead and profit; mobilization/demobilization, engineering, legal, and administrative costs; land acquisition; provision for sales tax/public works utilities tax; and adequate contingencies. Table 16 includes a summary of capital and operations and maintenance costs for phosphorus reduction activities described in the above sections.

Table 16. Summary of potential costs for implementation of phosphorus reduction activities

Source/Activity	Capital Cost (Pending Funding) ($)[a]	Capital Cost (Funded) ($)[a]	Total Capital Cost ($)[a]	Operations and Maintenance ($/yr)
Regional Activities	450,000	0	450,000	
Non-Point Source Activities	270,000	0	270,000	
Leavenworth WWTP	6,000,000	0	6,000,000	500,000
Peshastin/Dryden WWTP	9,000,000	0	9,000,000	300,000
Cashmere WWTP	25,000,000	0	25,000,000	700,000
Industrial NCCW	8,000,000	0	8,000,000	1,000,000
Miscellaneous Activities	330,000	0	330,000	
Total	49,000,000	0		

[a]Some project costs have been funded previously. Pending funding indicates new budget resources are required. Assumes estimated costs are based on a 2008 Seattle Area Engineering News Record construction cost index (ENR-CCI) of 8,642.

Consideration should be given to unified assumptions for the components of capital cost estimates. As an example, municipal utility capital improvement programs typically utilize standardized assumptions in estimating costs to provide consistency, a basis for comparisons, and ease in developing future updates. Cost indices, such as the Engineering News Record Construction Cost Index (ENR-CCI), are frequently used to establish a date reference and a basis for updates. For example, a December 2008 Seattle Area ENR-CCI value is 8,642. Providing an allowance for contingencies is a sound practice for project budgeting. Contingencies account for accuracy in estimating, unknowns at the time of estimating, and potential changes in the scope of work and actual field conditions. Typically, contingency allowances range from 10 to 20 percent of construction costs, depending upon the level of development of the cost estimates. For projects that require contracting with a constructor, allowances must also be made for mobilization and demobilization of work crews and general contractor overhead and profit. Typically, mobilization, surety bonds, and liability insurance costs range from 3 to 5 percent of the construction costs. General contractor overhead and profit generally ranges from 15 to 20 percent of construction costs. Project management, administration, design services, and legal services may all be required components of a program to undertake water quality improvements. Typically, these allied costs account for 25 to 30 percent of the total installed cost of capital projects. While all of these costs are not applicable to every project, this summary identifies important considerations for cost estimates.

Economic analysis

The purpose of conducting economic analysis of project costs is to compare options and their effectiveness. Life cycle cost analysis allows projects of varying capital and operations costs to be compared. When combined with phosphorus removal effectiveness, project costs can be compared in terms of their economic benefit per unit of phosphorus removed. Additional cost information and assumptions are necessary for complete life cycle analysis. These include annual operations and maintenance cost estimates for projects and estimated effective lives for BMPs/projects.

Preliminary estimates of operation and maintenance costs have been developed for some of the projects and BMPs, as shown in Table 11, based on previous studies for the Wenatchee Regulatory Strategy Group. The annual costs for wastewater treatment may be $350,000 to $450,000 per 1,000 gallons treated per year.

Table 16 combines capital and operations and maintenance costs from Table 15 with the phosphorus reduction values for the point and nonpoint sources. Costs are shown by source with estimated reductions in mass units of phosphorus per year (kg/yr). Two approaches to using economic analysis to compare the cost effectiveness of phosphorus reduction measures are presented in Table 17. The first is a simple combination of capital cost divided by phosphorus reduction in kilograms per year, resulting in a measure of the initial capital cost per rate of annual phosphorus reduction ($/kg/yr). This approach does not account for annual operations and maintenance costs, nor does it account for the continuing phosphorus reduction benefit that projects/BMPs provide in subsequent years over their useful lives.

The second approach to comparing cost effectiveness utilizes both capital and annual operations and maintenance costs in combination with phosphorus reduction. Inclusion of annual operating costs with assumptions about project life and duration of effectiveness allows the economic analysis to be extended to consider life cycle costs. In Table 16, capital and annual operations and maintenance costs are used to calculate equivalent annual costs using assumptions about useful project lives and the time value of money. An interest rate of 7 percent has been assumed, and useful lives vary depending upon the nature of the BMPs and projects. Life cycle costs are divided by annual phosphorus reductions rates (kg/yr) to calculate a unit cost for removal, resulting in a measure of the capital and operations and maintenance costs per unit of phosphorus reduction ($/kg).

Table 16 assumes a 20-year life for point source projects and sewer hookups for septic systems. Life cycles for nonpoint source measures have been estimated by the source work groups. Tier 1 agriculture projects are expected to have an average 15-year life. Tier 2 and 3 agriculture projects are expected to have an average 20-year life. Changes to grazing allotments on forested land are considered permanent; a 20-year life is used to calculate cost per kilogram reduced for forestry grazing improvements. Forestry roads are assumed to have a 15-year life. Subdivision road and non-subdivision road improvements are assumed to have a useful life of 20 years. Useful lives of urban and rural residential stormwater BMPs vary from 10 to 50 years. A 50-year useful life has been chosen for cost calculations based on the projected useful life of vegetated swales and filter strips.

Table 17. Economic analysis and comparison of unit costs for phosphorus reduction activities

Source	**Total Capital Cost ($)[a]**	**Operations and Maintenance ($/yr) [a]**	**Estimated P Reduction (kg/yr) [b]**	**Capital Cost per P Reduction Rate ($/kg/yr) [c]**	**Equivalent Annual Cost ($/yr) [d]**	**Cost per Kilogram ($/kg) [e]**
Regional Activities	450,000		unknown			
Non-Point Source Activities	270,000		unknown			
Leavenworth WWTP	6,000,000	500,000	3,431	1,749		
Peshastin/Dryden WWTP	9,000,000	300,000	730	12,329		
Cashmere WWTP	25,000,000	700,000	5,658	4,419		
Industrial NCCW	8,000,000	1,000,000	30.7	260,926		
Miscellaneous Activities	330,000		unknown			
Total	49,000,000					

[a] Capital and operations and maintenance costs from Table 14.
[b] Estimated phosphorus reduction values from Table 14.
[c] Calculated as follows: (Initial capital cost, $)/(Annual phosphorus reduction rate, kg/yr) = $/kg/yr.
[d] Calculated as follows: (Initial Capital Cost, $)*(Capital recovery factor [Int*(1+Int)^n/(1+Int)^n-1])+(Annual O&M cost, $/yr) =($/yr). The factor Int is the annual interest rate (assumed to be 7 percent) and the factor n is the years of useful life.
[e] Calculated as follows: (Equivalent annual cost, $/yr)/(Annual phosphorus reduction rate, kg/yr) = $/kg.

Adaptive management

As part of this TMDL water quality improvement plan (WQIP), Ecology and the cleanup partners anticipate using an adaptive management approach that will assure that the designated uses will be protected in the most efficient and effective manner. The adaptive management approach will include, but is not limited to, robust data collection and analyses to further assess the assimilative capacity of the Wenatchee River; validate the proposed wasteload allocation specified in the TMDL; compare computer-simulated changes (using QUAL2K) in water quality to actual changes in water quality (caused by variations or changes in source loadings); make recommendations to change the proposed wasteload allocations (if supported by the additional data collection and analyses); and determine the most effective ways to comply with water quality standards.

Monitoring progress

Monitoring and evaluation will occur throughout the ten-year compliance implementation period. It will be part of the WQIP, and will be done in accordance with a quality assurance project plan (QAPP). Ecology and the cleanup partners anticipate the following schedule in Table 18:

Table 18. Overall WQIP schedule

Phases and Targets	Description	Timeline
Phase 1	Point and nonpoint source reductions. Data collection and model calibration.	2009-2013
First Target	Reduction in 50% of nonpoint source loading.	2014
Phase 2	Modify load and wasteload allocations if appropriate. Identify any addition point and nonpoint source reductions.	2014-2015
Phase 3	Implement additional load reductions.	2015-2019
Second Target A	NPDES permit compliance	2019
Second Target B	Reduction in the rest of nonpoint source loading	2019
Final Target	Achieve water quality standards	2019

Ecology and the cleanup partners believe that the proposed adaptive management approach will be scientifically defensible and provide the greatest level of protection of the resources. As indicated, the cleanup partners anticipate implementing early actions that will have an immediate reduction in phosphorus loading in Phase 2 of the schedule. The partners expect that this will provide empirical data that will allow the model to be validated and the appropriate loading allocations to be verified. If necessary, Ecology will work with the cleanup partners to evaluate whether changes in the loading allocations contained in the TMDL based on the data collected in Phases 1 and 2.

Water quality standards should be achieved by 2019. Partners will work together to monitor progress towards these goals, evaluate successes, obstacles, and changing needs, and make adjustments to the cleanup strategy as needed.

It is ultimately Ecology's responsibility to assure that cleanup is actively pursued and water quality standards are achieved.

See the *Monitoring Plan* section in this report.

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Funding Opportunities

A wide variety of potential funding sources exist for the water quality improvement projects in the Wenatchee River watershed. There is also the potential for collaborating with other planning processes to maximize efficiency. Implementation activities are varied and funding sources appropriate for some projects may not be suitable for others. Therefore, a more detailed analysis of available funding sources is needed as part of the WQIP.

Public sources of funding are administered by federal and state government programs. Private sources of funding normally come from private foundations. Foundations provide funding to nonprofit organizations with tax-exempt status. Forming partnerships with government agencies, nonprofit organizations, and private businesses can effectively maximize funding opportunities.

The U.S. Department of Natural Resources Conservation Service (NRCS) and the U.S. Department of Agriculture Farm Service Agency (FSA) administer federal non-regulatory programs such as the:

- Conservation Reserve Program.
- Conservation Reserve Enhancement Program.
- Continuous Conservation Reserve Program.
- Environmental Quality Incentives Program.
- Wildlife Habitat Incentives Program.
- Grassland Reserve Program.
- Wetlands Reserve Program.
- Conservation Security Program.

Potential funding sources available through Ecology's water quality financial assistance programs include:

- Centennial Clean Water Fund grants.
- Section 319 grants for nonpoint source reductions.
- State Revolving Fund loans.
- Terry Husseman Grants (Coastal Protection Funds).
- 319 Direct Implementation Fund.

Financial assistance for wastewater and stormwater projects is available through the following organizations:

- Washington State Department of Community, Trade and Economic Development.
- Public Works Board.
- USDA Rural Development.
- Washington State Department of Health.

These organizations provide funding for the Public Works Trust Fund, Community Development Block Grants, and Drinking Water State Revolving Fund. Ecology provides loans to cities for upgrades or improvements to their wastewater treatment plants and stormwater projects.

Ecology gives grants to communities for wastewater treatment plant upgrades when they can show an economic burden to rate payers.

Other funding sources available to some groups in the Wenatchee River watershed are the Salmon Recovery Funding Board, the Bonneville Power Administration, and the Bonneville Power Foundation.

Multiple sources of financial assistance for water cleanup activities are available through Ecology's grant and loan programs, local conservation districts, and other sources. Refer to the website (www.ecy.wa.gov/programs/wq/tmdl/TMDLFunding.html) for a list and descriptions of funding sources.

Measuring Progress toward Goals

Ecology and the Wenatchee Watershed Planning Unit started the Wenatchee River Watershed Dissolved Oxygen and pH TMDL to address water quality standards violations of pH and dissolved oxygen in the Wenatchee River and some of its tributaries. The TMDL identified phosphorus reduction levels anticipated to limit periphyton growth in the Wenatchee River. Monitoring dissolved oxygen and pH values will be the primary strategy to track progress of the TMDL implementation approach. TMDL targets will be achieved when water quality standards are met for both dissolved oxygen and pH. Ecology will evaluate the need for collection and evaluation of dissolved oxygen and pH data every five years to assess progress toward meeting TMDL targets.

All monitoring for this TMDL should be conducted using methodology and analytical techniques comparable to the original methodology used by Ecology in the original technical analysis. In addition, monitoring conducted related to this TMDL should comply with the Water Quality Data Act of 2004 codified in RCW 90.48.570 through 90.48.590 and Ecology's Water Quality Program Policy 1-11. Also, monitoring related to this TMDL should be conducted after the completion of a quality assurance project plan (QAPP) that meets Ecology requirements for the collection of high quality data. Any divergence from Ecology's original methodology should be clearly explained in QAPPs and final monitoring reports.

Monitoring projects can be conducted at various scales based primarily on the objective of the project. Sometimes an organization's jurisdictional area determines the spatial scale and objectives of a monitoring project. Post-TMDL monitoring usually can be categorized as TMDL effectiveness monitoring and implementation project monitoring. Monitoring can include the tracking of locations and numbers of particular types of implementation projects, and it can include measurement of changing environmental conditions such as fish tissue concentrations. Monitoring activities associated with this TMDL include interim monitoring, effectiveness monitoring, and implementation plan monitoring. These monitoring activities are described below.

Performance measures and targets

Effectiveness monitoring plan

The TMDL includes waste load allocations necessitating expenditures by communities in the Wenatchee River watershed that would require substantial monetary outlays of public funds. As described above, the point source dischargers will need to complete activities to reduce phosphorus loading to the Wenatchee River during the critical seasons. It is anticipated that through use of adaptive management, the point source dischargers will be able to achieve compliance with TMDL goals.

Effectiveness monitoring plans include means to evaluate whether implementation of the TMDL achieves the TMDL's target(s) for reducing nutrient loading. The success of the TMDL will primarily be determined by measuring dissolved oxygen and pH conditions in the Wenatchee River. Success of this WQIP may also be assessed by measuring the daily loading of phosphorus to the Wenatchee River and its tributaries where load allocations and wasteload allocations were set by the TMDL. Water quality monitoring will be used to demonstrate if water quality standards have been met during and after the implementation measures have been completed, including non-point source implementation measures.

Plans to measure the effects of the implementation activities will be important for evaluating progress and assessing actions as part of the adaptive management program. The monitoring plan should include monitoring all implementation activities including construction, maintenance, and performance. Compliance monitoring will be needed throughout the 10-year compliance implementation period and be in accordance with a quality assurance project plan (QAPP).

Entities with enforcement authority will be responsible for following up on any enforcement actions. Stormwater permit holders will be responsible for meeting the requirements of their permits. Those conducting restoration projects or installing BMPs will be responsible for monitoring plant survival rates and maintenance of improvements, structures and fencing.

Ecology has continuously monitored the water quality in the Wenatchee River watershed since 1978, with some data as far back as 1960. The monitoring plan outlines a proposed coordinated monitoring strategy for the implementation of the TMDL allocation to improve water quality and the quality of runoff from contributing areas.

Implementation plan monitoring has two major components: watershed monitoring, which includes both in-stream sub-watershed monitoring, and BMP monitoring. Ecology has primary responsibility for the former, while designated management agencies have primary responsibility for the latter. Watershed monitoring measures the success of the implementation measures in achieving the TMDL goals. BMP monitoring measures the success of individual phosphorus reduction projects. The monitoring plan has five objectives:

- Evaluation of watershed nutrient sources, baseline conditions, and loadings.
- Evaluate trends in water quality data.
- Evaluate the effectiveness of BMPS, such as constructed wetlands and detention ponds, in reducing phosphorus loading to the river and/or tributaries.
- Expand the database of flow and nutrient load information during the critical seasons in order to more accurately determine phosphorus loading to the river.
- Expand the database of water quality information from tributaries.

Sub-watershed monitoring

Success in reducing the current annual load of total phosphorus will be measured by comparing individual tributary loads with the measured contributions monitored at or near the mouth of these tributaries. The monitoring should include the five identified stations and is designed to quantify nutrient contributions from each of these sub-watersheds that drain into Wenatchee River. A monitoring schedule will need to be developed for each of these stations. The schedule should include critical periods such as high flows, low flows, or other periods of potentially high phosphorus loads. The parameters to be monitor need to be defined but should include flow, conductivity, pH, temperature, and dissolved oxygen measurements taken during sample collection when water samples are collected for analysis.

River response monitoring

River response monitoring measures the effectiveness of the TMDL and implementation measures. River monitoring, in addition to Ecology's planned monitoring, will need to be scheduled and should include physical, chemical and microbiological parameters. The existing monitoring stations in the river establish baseline conditions for the river. Additional monitoring locations may be considered if necessary. Ecology monitoring is expected to continue throughout the implementation process (through 2018 with extensions to the schedule to be determined at that time), as outlined in the TMDL, and will provide a comprehensive assessment of changes in phosphorus loading within the watershed.

BMP/project effectiveness monitoring

Site or BMP-specific monitoring may be included as part of specific treatment projects if determined appropriate and justified, and will be the responsibility of the designated project manager or grant recipient. The objective of an individual project monitoring plan is to verify that BMPs are properly installed, being maintained, and working as designed. Monitoring for phosphorus reductions at individual projects will consist of spot checks, annual reviews and evaluation of advancement toward reduction goals. Evaluation of advancement toward reduction goals will be accomplished using a project tracking system and annual reports.

Individual entities and source groups constructing BMP projects should include budget allowances for a monitoring program (qualitative and/or quantitative) for the project site. Those entities will be responsible for collection of data and reporting monitoring results to Ecology or otherwise designated responsible data tracking party. This data will be used to evaluate the effectiveness of the BMP project. Results will be used to recommend or discourage similar projects in the future and to identify specific sub-watershed, or reservoir, monitoring information that indicate the implementation plan is not achieving expected results.

Monitoring progress and adaptive implementation monitoring

Monitoring is an important element of implementation. Monitoring of DO and pH should occur during the critical period outlined in this TMDL. The critical period of this TMDL is March through October except during high flows (June), when phosphorus is diluted by cleaner snowmelt and algae growth is limited by high flows, low nutrients, and colder water. Results of monitoring should be compared to the water quality standard relative to the time of sampling and location of sampling.

Monitoring of phosphorus concentrations should be accompanied by streamflow volume monitoring (discharge) to track the amount of phosphorus loading to the Wenatchee River and Icicle Creek.

Quality assurance (QA) project plans must be prepared for all monitoring conducted related to TMDLs. The QA project plan should follow Ecology guidelines (Lombard and Kirchmer, 2004), paying particular attention to consistency in sampling and analytical methods. In addition, monitoring conducted related to this TMDL should comply with the Water Quality Data Act codified in RCW 90.48.570 through 90.48.590 and Ecology's Water Quality Program Policy 1-11. Ecology is responsible for effectiveness monitoring programs that will determine if TMDL targets are being met.

Monitor the implementation actions and how they are maintained.

Compliance monitoring will be needed when water quality standards are believed to be achieved.

Entities with enforcement authority will be responsible for following up on any enforcement actions. Stormwater permit holders will be responsible for meeting the requirements of their permits. Those conducting restoration projects or installing BMPs will be responsible for monitoring plant survival rates and maintenance of improvements, structures and fencing.

Reasonable Assurances

When establishing a TMDL, reductions of a particular pollutant are allocated among the pollutant sources (both point and nonpoint) in the water body. For the *Wenatchee River Watershed Dissolved Oxygen, pH and Phosphorus TMDL* (Carroll et al., 2006), both point and nonpoint sources contribute to the phosphorus load. TMDLs (and related action plans) must show "reasonable assurance" that contributions from these sources will be reduced to their allocated amounts. Education, outreach, technical and financial assistance, permit administration, and enforcement will all be used to ensure that the goals of this TMDL (water clean-up plan) are met.

Ecology believes that the following activities already support this TMDL and add to the assurance that DO and pH in the Wenatchee River watershed will meet conditions provided by Washington State water quality standards. This assumes that the activities described below are continued and maintained.

The goal of the TMDL is to set targets and provide a strategy to meet the state's water quality standards for DO and pH in Wenatchee River watershed surface waters. There is considerable interest and local involvement toward resolving water quality problems in the watershed. Numerous organizations and agencies are already engaged in stream restoration and source correction actions that will help resolve the DO and pH problem. The following activities and resources assist in the effort to provide reasonable assurance that the nonpoint source TMDL goals will be met by 2019 (or ten years after the final TMDL is issued).

1. Many members of the Wenatchee Watershed Water Quality Technical Subcommittee and Wenatchee Watershed Planning Unit conducted education activities in schools and at other events.

2. Technical assistance is available from various organizations in the Wenatchee River watershed. The Cascadia Conservation District (CCD) and U.S. Department of Natural Resources Conservation Service (NRCS) can provide technical assistance for farmers and ranchers. Technical assistance with on-site septic tank management can be obtained by contacting the Chelan-Douglass Health District.

3. The CCD and NRCS have various programs to provide financial assistance to promote agricultural best management practices (BMPs) that reduce nonpoint pollution from agricultural activities. The CCD received in the past, and is currently the recipient of a Centennial Clean Water Fund grant to assist with developing and implementing TMDLs in the Wenatchee River watershed. The CCD leads several projects that have the potential to reduce inorganic-P loading to the Wenatchee River and Icicle Creek.

4. Chelan County Natural Resources provides incentive money to complete riparian restoration activities. In addition, they have arranged to complete septic tank replacement demonstration projects in the Mission Creek watershed to promote awareness of nonpoint source control in that area.

5. The CCD monitors water quality in the Mission Creek watershed and in other tributaries to the Wenatchee River. Ecology maintains several stream gauges in the Wenatchee River watershed that can be used for collection of streamflow data.

6. The Wenatchee Watershed Management Plan provides several recommendations for reducing both point and nonpoint sources of phosphorus to streams in the Wenatchee River watershed.

7. Ecology instructed the Chelan County Public Utility District (PUD) to:
    - o Demonstrate that its community drain field at Dryden is not within hydraulic continuity of the Wenatchee River, or
    - o Upgrade its wastewater treatment facility to protect water quality standards.

8. Ecology's participation in a regulatory strategy development uncovered several potential nonpoint sources of phosphorus that may be discharging to the Wenatchee River. The potential sources include:

Potential nonpoint sources in the Dryden Reach:

- The Dryden Landfill (owned by Chelan County).
- On-site septic systems concentrated on the floodplain on the opposite river bank from the Dryden Landfill.
- The Dryden dump.
- The Dryden community drainfield owned and operated by the Chelan County PUD.
- Run-off and sprayfield run-off associated with warehouse spray fields, and fruit treatment areas, and grounds.

Potential nonpoint sources in the Cashmere Reach:

- Old Cashmere dump.
- Cashmere's leaking wastewater treatment lagoons.
- On-site septic systems leaking to surface waters.
- Leaking sanitary sewer collection systems.

Chelan County, the city of Cashmere, the Chelan County PUD, the city of Leavenworth, and the city of Wenatchee all expressed interest in the investigation of the above nonpoint source phosphorus loads as part of the development of an implementation strategy. Results of nutrient sampling may be useful for developing the water quality implementation plan.

Ecology is authorized under Chapter 90.48 RCW to impose strict requirements or issue enforcement actions to achieve compliance with state water quality standards. However, it is the goal of all participants in the Wenatchee River watershed TMDL process to achieve clean water through voluntary control actions.

Ecology will consider and issue notices of noncompliance, in accordance with the Regulatory Reform Act, in situations where the cause or contribution to the cause of noncompliance with water quality standards can be established.

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Summary of Public Involvement Methods

The Wenatchee River Watershed dissolved oxygen and ph total maximum daily load project development is founded on the publication of five documents. Ecology published two quality assurance project plans (QAPP) (Billhmer et. al., 2002 and Billhimer et. Al., 2003), a technical report (Carroll, O'Neal and Golding, 2006), a water quality improvement report (WQIR) (Carroll and Anderson 2009) and this water quality implementation plan. Each document was developed with input from staff members and elected officials representing local, state and federal government. The Wenatchee Watershed Planning Unit was an important contributor to this project. The planning unit is an important connection to the public community of the Wenatchee River watershed.

Implementation of the actions outlined in this plan will require varying levels of public outreach and involvement in order to be successful. This effort will be coordinated with the Wenatchee Watershed Planning Unit and its Water Quality Technical Subcommittee. This input from a wide variety of local stakeholders will ensure that the outreach actions are appropriate and effective. Responsible entities should seek opportunities to collaborate with other outreach efforts, especially related to the implementation of other water quality actions, salmon recovery, and instream flow actions taking place throughout the watershed, to ensure consistency and to coordinate funding.

The public was invited to directly participate in the project by reviewing and providing comments on the WQIR during a sixty day public comment from October 1 2008 to November 30th 2008.

Throughout the development of this TMDL project, the Cascadia Conservation District (CCD) conducted extensive outreach. Ecology, CCD, and local organizations hosted workshops, provided presentations and attended meetings and events to keep people informed as different steps in the TMDL process were completed.

Ecology worked with the Wenatchee Watershed Water Quality Technical Subcommittee throughout the development of this TMDL. This assured that information about the TMDL was readily distributed when it became available. Ecology met at least seven times per year with the subcommittee since 2002.

Ecology and CCD presented educational information at the Leavenworth National Fish Hatchery's Salmon fest during most years of TMDL development.

Ecology provided funding for the development of a regulatory strategy process, which led to the development of this WQIP. The regulatory strategy group consisted of representatives from Ecology, Chelan County, city of Wenatchee, Cashmere, Leavenworth and Chelan Public Utility District Number 1. The workgroup members consisted of agency staff and elected officials.

A public comment period was open for this document from ________________________.

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Appendices

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Appendix A. Glossary, acronyms, and abbreviations

303(d) List: Section 303(d) of the federal Clean Water Act requires Washington State periodically to prepare a list of all surface waters in the state for which designated uses of the water – such as for drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality limited estuaries, lakes, and streams that fall short of state surface water quality standards, and are not expected to improve within the next two years.

Best Management Practices (BMPs): Physical, structural, and/or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

Clean Water Act (CWA): Federal Act passed in 1972 that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the CWA establishes the TMDL program.

Designated Uses: Designated uses are those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained.

Load Allocation (LA): The portion of a receiving waters' loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading Capacity: This is the greatest amount of a substance that a water body can receive and still meet water quality standards.

Margin of Safety (MOS): Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

National Pollutant Discharge Elimination System (NPDES): National program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

Nonpoint Source: Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the NPDES program. Any unconfined or diffuse source of contamination or any other source of water pollution not defined as a "point source" in section 502(14) of the Clean Water Act.

Phase II Stormwater Permit: The second phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to smaller municipal separate storm sewer systems (MS4s) and construction sites over one acre.

Point Source: Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or is likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Salmonid: Any fish that belong to the family *Salmonidae, w*hich is basically, any species of salmon, trout, or char. www.fws.gov/le/ImpExp/FactSheetSalmonids.htm

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snow melt. Stormwater can also come from hard or saturated grass surfaces such as lawns, pastures, playfields, and from gravel roads and parking lots.

Surface waters of the state: Lakes, rivers, ponds, streams, inland waters, saltwaters, wetlands and all other surface waters and water courses within the jurisdiction of the state of Washington.

Total Maximum Daily Load (TMDL): A distribution of a substance in a water body designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: 1) individual wasteload allocations (WLAs) for point sources, 2) the load allocations (LAs) for nonpoint sources, 3) the contribution of natural sources, and 4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Wasteload Allocation (WLA): The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. WLAs constitute one type of water quality-based effluent limitation.

Watershed: A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

{Author, delete all acronyms and abbreviations that don't apply to this report:}

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

BMPs	Best management practices
cfs	Cubic feet per second
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System software

NPDES	National Pollutant Discharge Elimination System
RM	River mile
TMDL	Total Maximum Daily Load (water cleanup plan)
USFS	United States Forest Service
USGS	United States Geological Survey
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resources Inventory Area
WWTP	Wastewater treatment plant

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
cms	cubic meters per second, a unit of flow.
dw	dry weight
ft	feet
g	gram, a unit of mass
kcfs	1000 cubic feet per second
kg	kilograms, a unit of mass equal to 1,000 grams.
kg/d	kilograms per day
km	kilometer, a unit of length equal to 1,000 meters.
l/s	liters per second (0.03531 cubic foot per second)
m	meter
mg	million gallons
mgd	million gallons per day
mg/d	milligrams per day
mg/Kg	milligrams per kilogram (parts per million)
mg/L	milligrams per liter (parts per million)
mg/L/hr	milligrams per liter per hour
mL	milliliters
µg/g	micrograms per gram (parts per million)
ug/Kg	micrograms per kilogram (parts per billion)
µg/L	micrograms per liter (parts per billion)

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Appendix B. Response to public comments

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