Walla Walla Watershed Bacteria, pH, and Dissolved Oxygen Total Maximum Daily Load Effectiveness Monitoring

Water Quality Study Design (Quality Assurance Project Plan)

August 2014

Publication No. 14-03-114

DEPARTMENT OF
ECOLOGY
State of Washington

Publication and Contact Information

Each study conducted by the Washington State Department of Ecology (Ecology) must have an approved Quality Assurance Project Plan. The plan describes the objectives of the study and the procedures to be followed to achieve those objectives. After completing the study, Ecology will post the final report of the study to the Internet.

The plan for this study is available on the Department of Ecology's website at https://fortress.wa.gov/ecy/publications/SummaryPages/1403114.html

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Study Codes

Data for this project are available at Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim. Search Study ID JROS0025.

Ecology's Activity Tracker Code for this study is 14-009.

Water Resource Inventory Areas (WRIAs) addresses in this study

See Study Area section.

Cover photo: Walla Walla River near Walla Walla, (Ross 2014)

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Table of Contents

List of Figures and Tables

Abstract

The Walla Walla River and several of its tributaries were placed on Washington State's list of impaired waters in 1996 and 2004 for not meeting water quality standards for temperature, pH, dissolved oxygen, PCBs, chlorinated pesticides, and fecal coliform. As a result of these listings, the Washington State Department of Ecology (Ecology) developed four Total Maximum Daily Load (TMDL) water quality improvement reports that were approved by the U.S. Environmental Protection Agency in 2007.

In 2008, Ecology's Water Quality Program published a water quality implementation plan (WQIP) for the Walla Walla TMDLs (Baldwin et al., 2008). To measure progress toward meeting allocations identified in the TMDLs, the WQIP outlined performance measures and targets that should be evaluated through effectiveness monitoring.

This effectiveness monitoring Quality Assurance Project Plan describes a technical study that will be conducted in a phased approach, because of the magnitude of the project. The study will monitor and compare bacteria, nutrients, dissolved oxygen and pH with expected target reductions outlined in the implementation plan.

Up to 34 sites will be visited a total of 18 times across the 12-month duration of this project. The sites will provide sufficient geographical coverage and water quality data to evaluate progress in meeting interim targets for the pH, dissolved oxygen, and bacteria TMDLs set forth in the 2008 WQIP. Although we are not addressing temperature TMDL targets at this time, we will deploy temperature thermistors at most sampling locations to collect data for use in future studies.

Field surveys will sample for streamflow, pH, dissolved oxygen, conductivity, and temperature. Samples will also be collected for laboratory analysis for analysis for fecal coliform bacteria, total persulfate nitrogen, ammonia nitrogen, nitrate and nitrite nitrogen, orthophosphate (soluble reactive phosphorus), and total phosphorus.

What is TMDL Effectiveness Monitoring?

TMDL process

The Total Maximum Daily Load (TMDL) process typically includes the following steps:

1. Scientific study to characterize the pollution parameters identified in the Section 303(d) list of impaired water bodies and to identify pollutant sources.
2. Modeling pollutant impacts on the environment and quantifying the extent of impairment.
3. Estimating the loading capacity of the receiving water to assimilate pollutants and still meet Washington State water quality standards.
4. Determining the TMDL of pollutants by allocating the loading capacity to wasteload allocations for point sources (discrete sources that receive a National Pollutant Discharge Elimination System (NPDES) permit) and to load allocations for nonpoint (diffuse) sources.
5. Developing a Summary Implementation Strategy (SIS) describing the approach for meeting pollutant allocations and complying with water quality standards.
6. Submitting the TMDL and SIS to the U.S. Environmental Protection Agency (EPA) for approval.

Based on the approved TMDL, an implementation plan is developed to correct pollution problems identified in the TMDL. Community involvement is encouraged during this period, as pollution control strategies are reviewed and converted into solutions and activities that are economically feasible and capable of early implementation. These implementation activities are continued, as necessary, to meet and maintain compliance with state water quality standards. Periodic monitoring, effectiveness monitoring, is used to determine the progress of the TMDL implementation activities.

TMDL effectiveness monitoring

TMDL effectiveness monitoring is a fundamental component of any TMDL implementation activity. It measures to what extent the water body has improved and whether it has been brought into compliance with the state water quality standards. Effectiveness monitoring takes a holistic look at TMDL implementation, watershed management plan implementation, and other watershed-based cleanup efforts. Success may be measured against TMDL load allocations or targets, correlated with baseline conditions or desired future conditions.

The TMDL effectiveness evaluation benefits by providing:

- A measure of progress toward implementation of recommendations - how much watershed restoration has been achieved and how much more effort is required.

- More efficient allocation of funding and optimization in planning and decision-making.
- Discussion of recommendations or restoration activities that worked and identifying which restoration activities achieved the most success for the money spent.
- Technical feedback to refine the initial TMDL model, best management practices, nonpoint source plans, and permits.

All monitoring activities will support the broad-based goals for determining effectiveness for watershed-based pollution control plans. These are to determine if: (1) water quality standards and targets are being met and/or if progress is being made toward meeting standards and targets, (2) improvements in water quality are linked to water cleanup activities and (3) the current implementation strategy is sufficient (Collyard and Onwumere, 2013).

Implementation monitoring

The Walla Walla Watershed Planning Unit's Water Quality Subcommittee prioritized areas in the watershed for work to begin (Figure 1). Stream reaches that do not meet several water quality standards and have severe problems (such as highly erodible land) are *priority restoration zones*. Stream reaches that only have one water quality problem are *secondary restoration zones*. Some reaches are *primary protection zones* because they are in relatively good condition and should be protected. The stretch of Mill Creek from east of the city of Walla Walla to its confluence with the Walla Walla River is a secondary restoration reach because the restoration challenges are so complex and unique that the solutions will probably be unlike any others in the watershed. Work is also important in upland areas. Much of the work in upland areas will center on reducing erosion and nutrients through changes in farm management. The Water Quality Subcommittee recommended several practices for urban and rural areas. Some of the actions include correct application of lawn fertilizers; composting; planting trees and shrubs along streams; and limiting pet and livestock access to streams.

Over 14 organizations committed to help improve water quality in the Walla Walla watershed. Appendix A includes actions these groups will use, such as educating the public, restoring native plants along streams, following a stormwater management plan, identifying stormwater discharges to streams, obtaining conservation easements, and installing off-site water systems and fencing.

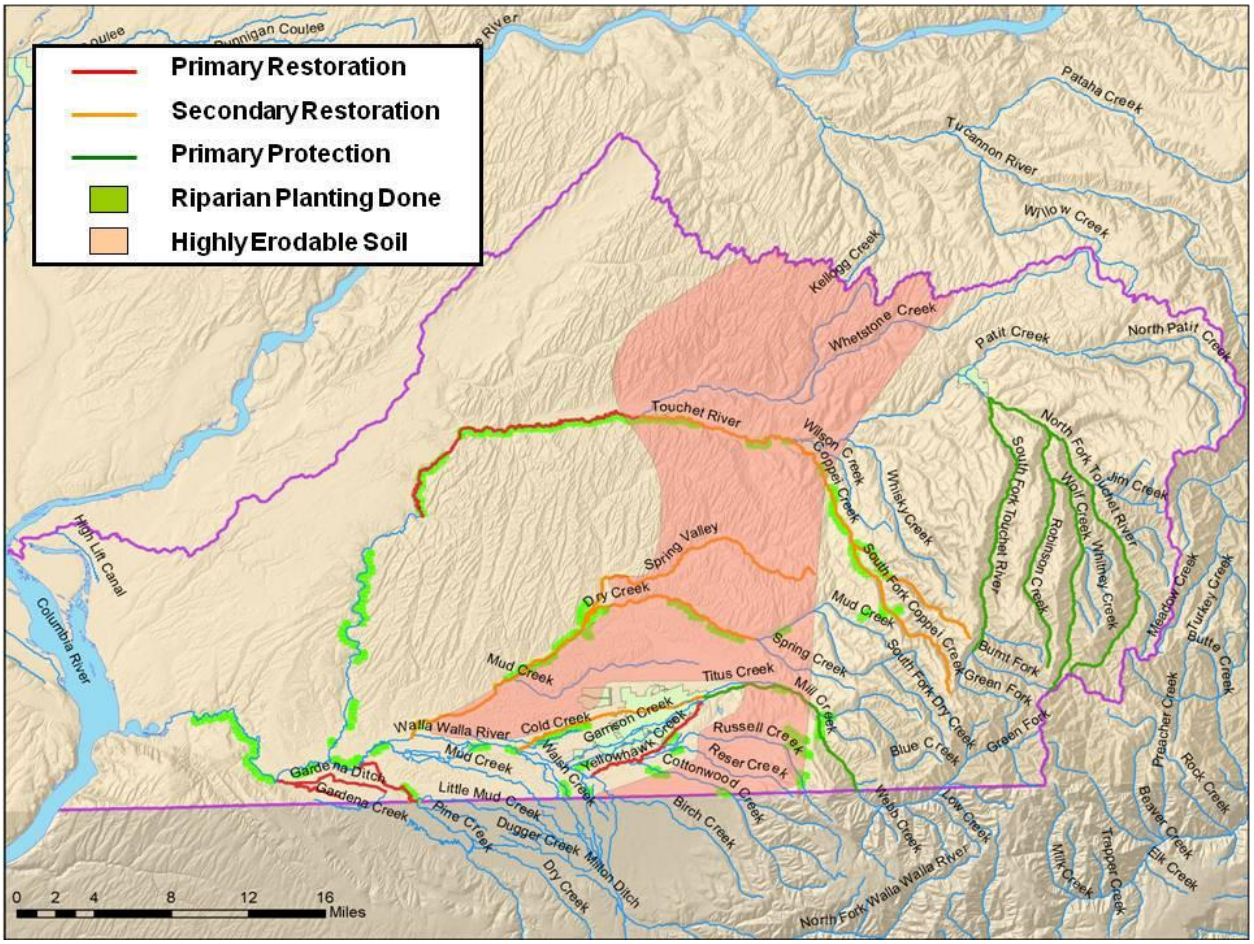

Figure 1. Walla Walla Watershed restoration zones.

Table 1. WRIA 32 implementation projects summary.

Project Proponent	Number of projects	Total acres	Total feet fence	Total feet streambank	Number of plantings
Walla Walla CD CREP	>150	>3200	>67000	>900000	>1.5 million
Kooskooskie Commons	19	~4		>11000	
CURB	39	3.5		>10000	
Columbia CD CREP		>1000		>290000	

Municipal wastewater and stormwater

In the Walla Walla watershed, the point sources are the wastewater treatment plants for the cities of Dayton, College Place, and Walla Walla. Although the city of Waitsburg's wastewater treatment plant discharges to a wetland, the wetland is adjacent to the Touchet River. Since the wetland is closely connected to the river, the city of Waitsburg has an NPDES permit.

Ecology also issues state waste discharge permits. These permits apply to municipal wastewater treatment plants− industrial and commercial facilities that apply wastewater onto the ground. State waste discharge permits do not receive wasteload allocations in TMDLs.

Table 2 provides a list of NPDES and state waste discharge permits in the Walla Walla watershed. Wasteload allocations in the four Walla Walla TMDLs were incorporated into the city's NPDES or stormwater permit.

Table 2. NPDES Permits in WRIA 32.

Entity	Discharge to	Type of Permit	Permit Number	Permit Expiration
City of Dayton	Touchet River	NPDES IP	WA0020729	9/30/2016
City of College Place	Garrison Creek	NPDES IP	WA0020656	12/31/2018
City of Waitsburg	Wetlands adj to Touchet River	NPDES IP	WA0045551	3/23/2010
City of Walla Walla	Mill Creek	NPDES IP	WA0024627	6/30/2017
City of Walla Walla	varies	Phase II Stormwater	WAR04-6508	7/31/2014
Walla Walla County	varies	Phase II Stormwater	WAR04-6509	7/31/2014
Washington Dept of Transportation	varies	Phase II Stormwater	WAR043000	3/06/2014
Walla Walla Water District #2	ground	State Waste Permit	ST 8040	9/30/2014

Table 3 provides a list of the wasteload allocations assigned to the wastewater treatment plants. Wastewater treatment plants receiving allocations will have ten years from the completion of the WQIP, in 2008, to meet water quality standards. These entities are also required to develop ordinances or other regulatory measures that prohibit illicit discharges, regulate construction activities, and implement post-construction protections to reduce stormwater impacts. Additional information on the Phase II Municipal Stormwater Permits can be found at: www.ecy.wa.gov/programs/wq/stormwater/municipal/index.html

Table 3. Wasteload allocations assigned by the Walla Walla TMDLs.

City	Parameter	Wasteload allocation	TMDL Critical period
Dayton Wastewater Treatment Plant	Chlorinated Pesticides & PCBs	Did not include in the study.	January - June
	Fecal coliform	Current permit limits	June - October
	Temperature	21.8 ^{o}C	July - August
	pH & Dissolved Oxygen	• 0.28 lb/day for dissolved inorganic nitrogen (sum of nitrate, nitrite, and ammonia). • 0.20 lb/day for organic nitrogen. • 0.13 lb/day for soluble reactive phosphorus. • 0.09 lb/day for organic phosphorus.	May - October
College Place Wastewater Treatment Plant	Chlorinated Pesticides & PCBs	• PCBs: 0.0011 gm/day • TSS: current permit limits	January - June
	Fecal Coliform	2005 permit limits	June - October
	Temperature	Current permit limits	July - August
	pH & Dissolved Oxygen	Remove effluent from receiving waters	May - October
Walla Walla Wastewater Treatment Plant	Chlorinated Pesticides & PCBs	• PCBs: 0.0062 gm/day • TSS: current permit limits	January - June
	Fecal Coliform	Current permit limits (does not discharge during this time)	June - October
	Temperature	Does not discharge during this time and is in compliance	July - August
	pH & Dissolved Oxygen	Does not discharge during this time and is in compliance	May - October
Waitsburg Wastewater Treatment Plant	Chlorinated Pesticides & PCBs	Did not include in the study.	January - June
	Fecal Coliform	n/a – discharges to wetland	June - October
	Temperature	n/a – discharges to wetland	July - August
	pH & Dissolved Oxygen	Requires further investigation to determine if the treatment plant's wetland is a source of nutrients. If so, prevent groundwater continuity between the wetland and the Touchet River.	May - October

Background

The Washington State Department of Ecology (Ecology) is required, under Section 303(d) of the federal Clean Water Act and implementing regulations, to periodically prepare a list of water bodies that are out of compliance with the state water quality standards. After the preparation of this list and the subsequent approval by the U.S. Environmental Protection Agency (EPA), Ecology is responsible for preparing and implementing TMDLs on these watersheds as well as evaluating the effectiveness of the cleanup plans to achieve the needed improvement in water quality.

Ecology's Water Quality Program monitoring in the early 1990s resulted in several water bodies in the Walla Walla watershed (WRIA 32) being placed on the 1998 303(d) list for water quality impairments. Ecology developed water quality monitoring plans for chlorinated pesticides and PCBs (Johnson and Era, 2002), fecal coliform bacteria and pH (Swanson and Joy, 2002) and temperature (LeMoine and Stohr, 2002). These studies led to the development of TMDLs (Johnson et al., 2004), (Joy and Swanson, 2005), (Joy et al., 2007), (Baldwin and Stohr, 2007) and water quality improvement plans (Gray et al., 2006), (Joy et al., 2006), (Joy et al., 2007), (Baldwin and Stohr, 2007). Supplemental studies to further identify potential sources of contaminates were performed in 2007 (Parsons) and 2010 (Tarbutton).

These studies and reports culminated in the publication of the *Walla Walla Watershed PCBs, Chlorinated Pesticides, Fecal Coliform, Temperature, pH and Dissolved Oxygen Total Maximum Daily Load Water Quality Implementation Plan (*Baldwin et al., 2008). The WQIP sets load allocations for pollutants entering surface waters in the basin in order to improve water quality. In addition, the WQIP outlined water quality and implementation targets and created a timeline for meeting targets in order to measure progress.

The waters of Walla Walla watershed fall primarily under the jurisdiction of Walla Walla County as well as the cities within the watershed. Since the original TMDL study, local governments, citizen groups, conservation districts, tribes, and other state and federal agencies have been actively involved in water quality protection and cleanup actions. Cleanup actions have included a combination of:

- Improved regulation management of stormwater discharges.
- Implementation of an on-site septic system operations and maintenance program.
- Technical assistance to landowners.
- Reduced livestock impacts.
- Intensified cropland conservation.
- Informational workshops and other outreach aimed at encouraging landowners to improve land use practices.

Because of the size and scope of the project, this effectiveness monitoring study will be carried out in phases. The first phase of the study will monitor fecal coliform (FC), dissolved oxygen (DO), pH, temperature, and nutrients at recommended target locations from 2014 to 2015. The second phase of the study will monitor chlorinated pesticides and PCBs in fish tissue, surface water, and sediment at recommended target locations from 2015-2016. In addition, total suspended solids and turbidity, identified as surrogate parameters to pesticides and PCBs, will be measured.

This Quality Assurance (QA) Project Plan outlines the first phase of the study design for monitoring FC, DO, pH, and nutrients in the Walla Walla basin. Results from this study will be compared with TDML targets and water quality standards. Results gleaned from this study are intended to be used to adaptive current pollution control strategies if need.

Study area

The Walla Walla River is located in the southeast corner of Washington State (Figure 2). The river extends 61 river miles (RM) from the headwaters of its north fork in Oregon to its confluence with the Columbia River in Washington. The drainage basin covers approximately 1,760 square miles and flows through four counties: Umatilla and Wallowa counties in Oregon, and Columbia and Walla Walla counties in Washington. Two-thirds of the Walla Walla drainage basin lies within Washington. The Walla Walla River headwaters are in Oregon and the last 40 miles are in Washington. In Washington, the river has a low gradient with a wide floodplain. Agriculture is the dominant land use along the Walla Walla River. Major tributaries to the Walla Walla River include the Touchet River, Mill Creek, Dry Creek, and Pine Creek.

Elevation exerts significant control over the climate in the Walla Walla basin. Temperature and precipitation gradients exist from west to east with the rise in elevation toward the Blue Mountains. Local climate varies from warm and semi-arid in the western lowlands, to cool and relatively wet at higher elevations in the Blue Mountains (HDR/EES Inc., 2005). Temperatures in the basin can easily reach 37.8 °C (100 °F) in the summer and below freezing in the winter. The lower portions of the basin receive less than 10 inches of annual precipitation, while the upper sections, in the Blue Mountains, can receive up to 60 inches of annual precipitation. Most of the precipitation falls as snow in the winter months, causing a significant accumulation of snowpack in the mountains. Spring thaw, compounded with rain showers, is the source of flooding for the basin. Significant flood events occurred in 1933, 1964, and 1996.

The four primary forks of the Touchet River (South Fork Touchet, North Fork Touchet, Wolf Fork, and Robinson Fork) originate deep in the Blue Mountains at an elevation of 6,074 feet. The four forks are mainly forested with only small farms in the valleys. The forks converge just above the city of Dayton to form the mainstem Touchet River. The Touchet River flows through the cities of Dayton, Waitsburg, and Prescott, reaching its confluence with the Walla Walla River by the town of Touchet at an elevation of 420 feet. Land use in the Touchet basin, from Dayton to the confluence of the Walla Walla River, is predominantly agricultural with both irrigated and non-irrigated crops.

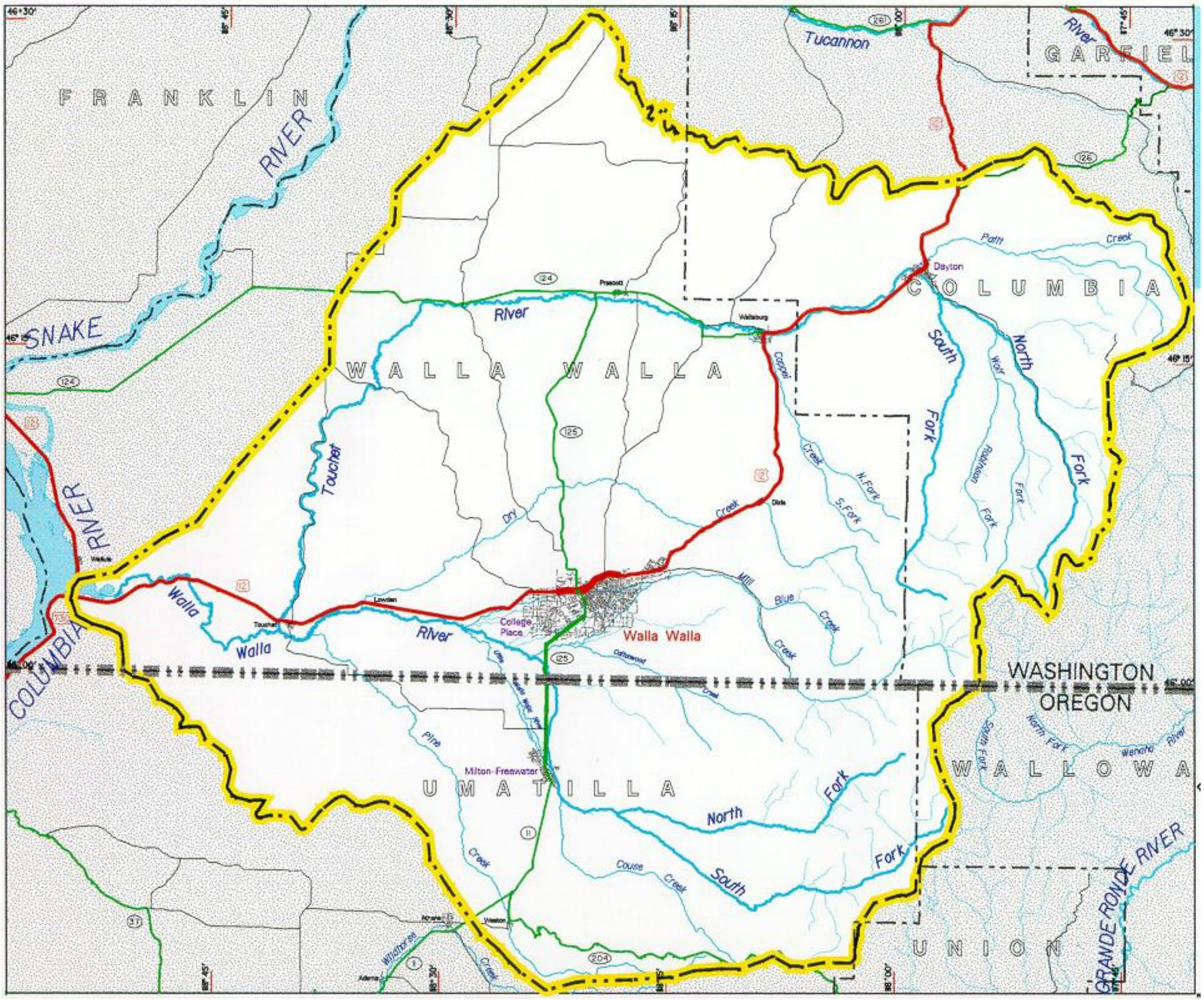

Figure 2. The Walla Walla River watershed.

(U.S. Army Corps of Engineers, 1997).

Dry Creek is located in a 239-square-mile basin with elevations from 460 feet at the confluence with the Walla Walla River near Lowden (RM 27.2) to 4,600 feet in the Blue Mountains. Dry Creek's watershed is mainly used for dryland wheat agriculture, with only sparse forests in the headwaters.

Mill Creek headwaters are located in the Blue Mountains where 22,000 acres are preserved as a drinking water source for the city of Walla Walla. The 100-square-mile drainage flows through Oregon, where a portion of the streamflow is diverted for the city of Walla Walla water supply, and then continues to the Washington border and downstream through the city of Walla Walla. Below the city of Walla Walla, Mill Creek flows through agricultural areas to the confluence with the Walla Walla River (RM 33.6). Mill Creek enters the Walla Walla River downstream of the city, near the historical Whitman Mission.

The city of Walla Walla and the Army Corps of Engineers built a control structure in the 1940s to stop catastrophic flooding during the spring months. Mill Creek is armored with energy dissipater weirs and a concrete channel through the city of Walla Walla. Portions of the creek that are not entirely concrete have revetments to stabilize the banks and a rubble bottom. In the areas with energy dissipaters, the channel is as wide as 520 feet. During the summer months, May through October, the majority of Mill Creek flow is diverted at RM 10.5 to Yellowhawk and Garrison Creeks which enter the Walla Walla River just upstream of the Mill Creek confluence. Garrison Creek winds through dense residential areas in the cities of Walla Walla and College Place before reaching agricultural areas and joining the Walla Walla River (RM 36.2). Yellowhawk Creek flows through fewer residential areas. It is joined by Russell and Cottonwood Creeks from hills to the east before joining the Walla Walla River (RM 38.2).

The Walla Walla basin contains federally designated critical habitat for bull trout and steelhead trout, both of which are listed as threatened species protected under the Endangered Species Act (ESA) (USFWS, 2005). Mendel et al. (2004) surveyed the fish populations within the Walla Walla basin, finding the highest abundances of salmonid species in Mill Creek and the North and Wolf Forks of the Touchet River. The native salmonid species they identified were mountain whitefish (*Prosopium williamsoni*), bull trout (*Salvelinus confluentus*), and rainbow/steelhead trout (*Oncorhynchus mykiss*). Most spawning habitat was found in the upper reaches, while the lower reaches of the Touchet and Walla Walla Rivers are mainly used for fish migration with little rearing capability.

The Walla Walla basin consists primarily of rolling hills interspersed with valleys. It is underlain by loess (windblown silt) formations up to 250 feet thick, except to the west where the soils are sandy. The valley floors are underlain by floodplain alluvium. Beneath the floodplain alluvium are clay units up to 500 feet thick. Most benches within the valleys and terraces on the valley sides are composed of sand and silt of the Touchet Beds deposited by catastrophic floods from glacial Lake Missoula's floods. The Columbia River basalts lie below newer sediment deposits, but are exposed at the surface in some locations. There are two major aquifers in the area: the basalts are the deep confined aquifer and the gravels are the shallow unconfined aquifer. In general, streams are in hydraulic continuity with the shallow gravel aquifer (Newcomb, 1965; Carson and Pogue, 1996).

Forest-based land uses are present in the upper watersheds, but commercial agriculture is the dominant land use in the basin. Some small farms can be found in the vicinity of urban areas. Currently, wheat, pasture, vegetables, alfalfa seed, and hay are the largest percentage of the irrigated crops. Pasture makes up roughly a quarter of irrigated lands on the Washington side of the Walla Walla basin. Other crops include onions, peas, grapes, apples, asparagus, and barley. Much natural habitat is highly altered due to historical grazing, prescribed burning, wildfires, and agriculture. Riparian vegetation is limited in most areas throughout the basin, but considerable riparian enhancement has occurred through efforts by the local community.

Most people in the Walla Walla basin live in urban areas. The most recent census results identified 59,400 people living in Walla Walla County in 2012. The major cities are College Place, Dayton, and Walla Walla, with a combined population of just over 40,000.

The cities of Walla Walla, College Place, and Dayton have wastewater treatment plants that discharge to surface water. These are regulated by NPDES permits. Walla Walla County and the city of Walla Walla qualify for stormwater permits.

Water Resource Inventory Area (WRIA) and 8-digit Hydrologic Unit Code (HUC) numbers for the study area

WRIA: 32-Walla Walla

HUC number: 17070102-Walla Walla

Impairments addressed by this study

A list of Walla Walla basin beneficial uses and definitions applicable to this study are presented in Table 1. Designated beneficial recreation uses for the Walla Walla basin include extraordinary primary contact, primary contact and secondary contact. Most of the waters in WRIA 32 are also protected for primary contact recreation use (173-201A WAC). The exceptions are Mill Creek and its tributaries above the City of Walla Walla Waterworks dam, North Fork and Wolf Fork Touchet River, and the portion of the South Fork Touchet River in or above the Umatilla national Forest, which are all protected for extraordinary primary contact. Other exceptions to the state's primary contact recreation use are Walla Walla River from its mouth to Lowden and Mill Creek from its mouth to the 13th Street bridge, which are protected for secondary contact recreation.

All designated beneficial aquatic life uses apply in the Walla Walla basin (Table 4), and locations vary throughout the watershed. Specific locations where beneficial uses apply in WRIA 32 are shown in Table 602 in *Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A WAC* (Ecology, 2011).

Table 4. Applicable beneficial uses and definitions for the Walla Walla effectiveness monitoring study.

Use Category	Definition
Recreation	
Extraordinary primary contact	Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.
Primary contact	Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.
Secondary contact	Activities where a person's water contact would be limited (e.g., wading or fishing) to the extent that bacterial infections of eyes, ears, respiratory or digestive systems, or urogenital areas would normally be avoided.
Aquatic Life Use	
Char spawning and rearing	The key identifying characteristics of this use are spawning or early juvenile rearing by native char (bull trout and Dolly Varden), or use by other aquatic species similarly dependent on such cold water. Other common characteristic aquatic life uses for waters in this category include summer foraging and migration of native char; and spawning, rearing, and migration by other salmonid species.
Core summer salmonid habitat	The key identifying characteristics of this use are summer (June 15 - September 15) salmonid spawning or emergence, or adult holding; use as important summer rearing habitat by one or more salmonids; or foraging by adult and subadult native char. Other common characteristic aquatic life uses for waters in this category include spawning outside of the summer season, rearing, and migration by salmonids.
Salmonid spawning, rearing, and migration	The key identifying characteristic of this use is salmon or trout spawning and emergence that only occur outside of the summer season (September 16 - June 14). Other common characteristic aquatic life uses for waters in this category include rearing and migration by salmonids.
Salmonid rearing and migration only	The key identifying characteristic of this use is only for rearing or migration by salmonids (not used for spawning).
Non-anadromous interior redband trout	For the protection of waters where the only trout species is a non-anadromous form of self-reproducing interior redband trout (O. mykiss), and other associated aquatic life.
Indigenous warm water species	For the protection of waters where the dominant species under natural conditions would be temperature-tolerant, indigenous, non-salmonid species. Examples include dace, redside shiner, chiselmouth, sucker, and northern pikeminnow.

A list of category 4A water bodies applicable to this study is presented in Table 5. These water bodies were part of the approved TMDL. A full list of water quality impairments is available in Washington's Water Quality Assessment 303(d)/305(b) Integrated Report Viewer (http://apps.ecy.wa.gov/wats/Default.aspx).

Table 5. 2012 Category 4A listing for bacteria, dissolved oxygen, and pH in the Walla Walla study area.

Listing ID	Waterbody	Parameter	2012 Category	LLID
41636	DRY CREEK	Bacteria	4A	1185925460511
41337	DRY CREEK	Dissolved Oxygen	4A	1185925460511
12381	GARRISON CREEK	Bacteria	4A	1184334460259
12382	GARRISON CREEK	Bacteria	4A	1184334460259
41338	GARRISON CREEK	Dissolved Oxygen	4A	1184334460259
41638	MILL CREEK	Bacteria	4A	1184778460386
41641	MILL CREEK	Bacteria	4A	1184778460386
41645	MILL CREEK	Bacteria	4A	1184778460386
41710	MILL CREEK	Bacteria	4A	1184778460386
41441	MILL CREEK	Dissolved Oxygen	4A	1184778460386
41442	MILL CREEK	Dissolved Oxygen	4A	1184778460386
41443	MILL CREEK	Dissolved Oxygen	4A	1184778460386
41469	MILL CREEK	Dissolved Oxygen	4A	1184778460386
11119	MILL CREEK	pH	4A	1184778460386
41164	MILL CREEK	pH	4A	1184778460386
41327	MILL CREEK	pH	4A	1184778460386
41329	MILL CREEK	pH	4A	1184778460386
51478	MILL CREEK	pH	4A	1184778460386
41646	MUD CREEK	Bacteria	4A	1186189460476
47208	PATIT CREEK	Dissolved Oxygen	4A	1179841463198
45739	RUSSELL CREEK	Bacteria	4A	1183463460295
41671	RUSSELL CREEK	Bacteria	4A	1183463460295
16784	TOUCHET RIVER	Bacteria	4A	1186823460337
16787	TOUCHET RIVER	Bacteria	4A	1186823460337
41245	TOUCHET RIVER	Bacteria	4A	1186823460337
41246	TOUCHET RIVER	Bacteria	4A	1186823460337
41652	TOUCHET RIVER	Bacteria	4A	1186823460337
46262	TOUCHET RIVER	Bacteria	4A	1186823460337
11099	TOUCHET RIVER	Dissolved Oxygen	4A	1186823460337
41352	TOUCHET RIVER	Dissolved Oxygen	4A	1186823460337
47256	TOUCHET RIVER	Dissolved Oxygen	4A	1186823460337
11096	TOUCHET RIVER	pH	4A	1186823460337
11103	TOUCHET RIVER	pH	4A	1186823460337
41177	TOUCHET RIVER	pH	4A	1186823460337
41178	TOUCHET RIVER	pH	4A	1186823460337

Listing ID	Waterbody	Parameter	2012 Category	LLID
41179	TOUCHET RIVER	pH	4A	1186823460337
41180	TOUCHET RIVER	pH	4A	1186823460337
41181	TOUCHET RIVER	pH	4A	1186823460337
41183	TOUCHET RIVER	pH	4A	1186823460337
41185	TOUCHET RIVER	pH	4A	1186823460337
41186	TOUCHET RIVER	pH	4A	1186823460337
41187	TOUCHET RIVER	pH	4A	1186823460337
41188	TOUCHET RIVER	pH	4A	1186823460337
41189	TOUCHET RIVER	pH	4A	1186823460337
50565	TOUCHET RIVER	pH	4A	1186823460337
50566	TOUCHET RIVER	pH	4A	1186823460337
50567	TOUCHET RIVER	pH	4A	1186823460337
50570	TOUCHET RIVER	pH	4A	1186823460337
41444	TOUCHET RIVER, N.F.	Dissolved Oxygen	4A	1179588463015
16789	WALLA WALLA RIVER	Bacteria	4A	1189393460624
41666	WALLA WALLA RIVER	Bacteria	4A	1189393460624
41668	WALLA WALLA RIVER	Bacteria	4A	1189393460624
41713	WALLA WALLA RIVER	Bacteria	4A	1189393460624
46228	WALLA WALLA RIVER	Bacteria	4A	1189393460624
46454	WALLA WALLA RIVER	Bacteria	4A	1189393460624
11113	WALLA WALLA RIVER	Dissolved Oxygen	4A	1189393460624
41366	WALLA WALLA RIVER	Dissolved Oxygen	4A	1189393460624
41370	WALLA WALLA RIVER	Dissolved Oxygen	4A	1189393460624
41374	WALLA WALLA RIVER	Dissolved Oxygen	4A	1189393460624
41472	WALLA WALLA RIVER	Dissolved Oxygen	4A	1189393460624
47269	WALLA WALLA RIVER	Dissolved Oxygen	4A	1189393460624
47273	WALLA WALLA RIVER	Dissolved Oxygen	4A	1189393460624
11114	WALLA WALLA RIVER	pH	4A	1189393460624
41191	WALLA WALLA RIVER	pH	4A	1189393460624
41194	WALLA WALLA RIVER	pH	4A	1189393460624
50580	WALLA WALLA RIVER	pH	4A	1189393460624
50584	WALLA WALLA RIVER	pH	4A	1189393460624

Water Quality Standards and Beneficial uses

The Washington State Water Quality Standards, set forth in Chapter 173-201A of the Washington Administrative Code (WAC), include designated uses and numeric and narrative water quality criteria for surface waters of the state.

Fecal coliform bacteria

Bacteria targets in the water quality standards are set to protect people who work and play in the water from waterborne illnesses, and to protect tributaries flowing to shellfish harvesting areas. In Washington, surface water quality standards use FC as an "indicator bacteria" for the state's freshwaters, e.g., lakes and streams. FC bacteria in water indicate the presence of waste from humans and other warm-blooded animals, which is more likely to contain pathogens that will cause illness in humans than waste from cold-blooded animals. Ecology's selection of FC bacteria as the indicator for pathogens in surface waters is explained in *Setting Standards for the Bacteriological Quality of Washington's Surface Water Draft Discussion Paper and Literature Summary* (Hicks, 2002). The paper reviews the use of FC as an indicator bacteria and epidemiological studies of indicator bacteria in both fresh and marine waters.

The FC criteria have two statistical components: a geometric mean and an upper limit value that 10% of the samples cannot exceed. In Washington, the upper limit statistic (i.e., not more than 10% of the samples shall exceed) has been interpreted as a 90th percentile value of the log-normalized values. The FC criteria applicable to this study are outlined in Table 6.

Table 6. Fecal coliform criteria for the Walla Walla basin.

Category	Geometric Mean	Not more than 10% (90^{th} percentile)
Extraordinary Primary contact	50 cfu/100 mL	100 cfu/100 mL
Primary contact	100 cfu/100 mL	200 cfu/100 mL
Secondary contact	200 cfu/100 mL	400 cfu/100 mL

Dissolved oxygen and pH

The health of fish and other aquatic species depends on maintaining an adequate supply of oxygen dissolved in the water. Growth rates, swimming ability, susceptibility to disease, and the relative ability to endure other environmental stressors and pollutants are all affected by oxygen levels. While direct mortality due to inadequate oxygen can occur, the state's criteria are designed to maintain conditions that support healthy populations of fish and other aquatic life in the most sensitive life stages.

Oxygen levels can fluctuate over the day and night in response to changes in climatic conditions as well as the respiratory requirements of aquatic plants and algae. Since the health of aquatic species is tied predominantly to the pattern of daily minimum oxygen concentrations, the criteria are expressed as the lowest 1-day minimum oxygen concentration that occurs in a waterbody.

The pH value is a measure of hydrogen ions in water and levels beyond the neutral range (6.5 to 8.5) increase the solubility of some contaminants such as nutrients and heavy metals, which can become toxic for humans and aquatic organisms. High pH levels can impair aquatic organisms' ability to maintain their body fluids. Dissolved oxygen is important for aquatic organisms to breathe. In addition, aquatic life's growth rates, swimming ability, susceptibility to disease, and the ability to endure other environmental stressors and pollutants are all affected by oxygen levels.

The pH and DO criteria applicable to this study are outlined in table 7.

Table 7. pH, and dissolved oxygen water quality standards for the Walla Walla basin.

Category	pH	DO Lowest 1-day minimum
Char spawning and Rearing	6.5-8.5 with <0.2 anthropogenic	9.5 mg/L
Core summer Salmonid habitat	Same as above	9.5 mg/L
Salmonid spawning, rearing and migration	6.5-8.5 with <0.5 anthropogenic	8.0 mg/L
Salmonid rearing and migration only	Same as above	6.5 mg/L
Non Anadromous interior redband trout	Same as above	8.0 mg/L
Indigenous warm water species	Same as above	6.5 mg/L

TMDL targets

Although water quality compliance is measured as meeting water quality standards, water quality targets are routinely established to assist Ecology's Water Quality managers in assessing the progress toward meeting state water quality standards. The 2008 WQIP anticipated state water quality standards to be met in 10 years from the completion of the plan for all water quality parameters except temperature (Baldwin, 2008). The WQIP also set interim targets at year 6 for FC, DO, and pH.

Working with the local stakeholders, Ecology's Water Quality Program developed specific milestones toward the goal of meeting TMDL requirements. These are summarized in Table 8, below. Specifically FC targets for the 2014-2015 study are 59% less than the original 2003 TMDL study FC geometric means and 90th percentiles. Nutrient targets are 60% less than the original TMDL dissolved inorganic nitrogen (DIN), soluble reactive phosphorus (SRP), organic nitrogen, and organic phosphorus. The targets in table 8 will be the primary basis for determining effectiveness of the WQIP to date. Data from the 2002-2003 studies will be used to develop site-specific targets for FC bacteria and nutrients. These site-specific targets will be evaluated individually and collectively as part of the final project report.

Table 8. Year 6 interim water quality targets from 2008 WQIP.

TMDL	Target Reduction
FC Bacteria (% of decrease in colonies toward target)	59%
pH & DO nutrient seasonal average mg/L (reduction from 2003 levels)	60%

Project Description

This project is designed to address year five and six interim water quality targets from table 2 of the WQIP (Baldwin et al 2008). Supporting projects have been proposed to address TMDL effectiveness in stormwater, and toxics monitoring that cannot be adequately addressed by this study due to personnel constraints. Basin-wide temperature TMDL targets have a longer timeframe and will not be addressed for several years.

This effectiveness monitoring study will require both the collection of field data as well as reports and implementation data from regionally active stakeholder groups. To evaluate progress towards meeting water quality targets and standards, target location identified in the WQIP will be monitored for FC and nutrients. These sites will provide sufficient geographical coverage to evaluate progress in meeting interim targets for the bacteria pH, and dissolved oxygen. Monitoring will occur year-round, with more frequent sampling during critical periods identified during development of the TMDLs.

Point sources will be addressed by reviewing and comparing discharge monitoring reports (DMR) with load allocations recommended in the original TMDL studies.

As part of this study, Ecology will work with the local stakeholder groups to develop a comprehensive list of pollution control actions implemented in the watershed. This data will be compared with recommendations outlined in the WQIP to assess progress towards meeting water quality cleanup and protection goals (Baldwin, 2008).

We have set a sampling and analysis goal of 100% completeness. However, there are many reasons for missing samples in a monitoring program. These include inclement weather or flooding, hazardous driving or monitoring conditions, and illness or unavailability of monitoring staff. Routinely missed samples could impart bias in expressions generated from final data. Sampling events will be rescheduled when missed in order to maintain integrity of the characterization effort. Field monitoring data loss due to equipment failure may occur; backup equipment will be available to minimize this problem.

Goals

The goals of this effectiveness monitoring project are to determine if

- Water quality standards and targets are being met and progress is being made towards meeting standards and targets.
- Improvements in water quality are linked to water cleanup activities.
- The current implementation strategy is sufficient.

Objectives

Objectives of the proposed study are as follows:

- Quantify concentrations and loadings of bacteria, nutrients and toxics (via sediment transport) in streams and rivers across WRIA 32.
- Determine if interim targets set by the 2008 TMDL Water Quality Implementation Plan have been met.
- Evaluate Discharge Monitoring Reports (DMRs) from treatment plants to determine compliance with wasteload allocations.
- Define and map land uses and confirm potential pollutant sources.
- Document and define existing pollution control measures.
- Develop implementation metrics that quantify pollution control actions.
- Show linkages between pollution control efforts and changes in water quality.
- Collect−or acquire from local groups−temperature data from the Creating Urban Riparian Buffers (CURB) grant projects.

To meet its objectives, this project will rely on data collected by Ecology staff during the 2014-2015 effectiveness monitoring study period. Data collected by other organizations during this time, meeting Ecology's data quality requirements, may also be used. Data collected will be compiled, analyzed, and presented in the final technical report.

Organization and Schedule

Table 9 lists the people involved in this project. All are employees of the Washington State Department of Ecology.

Table 9. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Mike Kuttel Water Quality Program Eastern Regional Office Phone: 509-329-3414	EAP Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Jim Ross Environmental Assessment Program Eastern Operations Section Phone: 509-329-3425	Project Manager / Principal Investigator	Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Conducts QA review of data, analyzes and interprets data, and enters data into EIM. Writes the draft report and final report.
Tom Mackie Environmental Assessment Program Eastern Operations Section Phone: 509-454-4244	Section Manager for the Project Manager	Reviews the draft QAPP and approves the final QAPP.
David Knight Water Quality Program Eastern Regional Office Phone: 509-329-3590	Unit Supervisor for the Study Area	Reviews the draft QAPP and approves the final QAPP.
Jim Bellatty Water Quality Program Eastern Regional Office Phone: 509-329-3534	Section Manager for the Study Area	Reviews the draft QAPP and approves the final QAPP.
Joel Bird Manchester Environmental Laboratory Phone: 360-871-8801	Director	Approves the final QAPP.
Joanie Skifstad Walla Walla Regional Water Testing Services Phone (509) 526-9287		Provides FC bacteria testing services.
William R. Kammin Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and the final QAPP.

QAPP: Quality Assurance Project Plan

Project Schedule

Table 10. Proposed schedule for completing field and laboratory work, data entry in EIM, and reports.

Field and laboratory work	Due date	Lead staff
Field work completed	June 2015	Jim Ross, Dan Dugger
Laboratory analyses completed	September 2015	
Environmental Information System (EIM) database		
EIM Study ID	JROS0025	
Product	Due date	Lead staff
EIM complete	December 2015	Jim Ross
Final report		
Author lead / Support staff	TBD	
Schedule		
Draft due to supervisor	April 2016	
Final report due on web	September 2016	

Budget and funding

Laboratory

31 sites will be visited a total of 18 times across the 12-month duration of this project. Table 11 summarizes lab costs for this project.

Table 11. Number of samples per parameter, estimated analytical cost per parameter, and total laboratory costs of study, 2014-2015.

Parameter	Number of samples	Number of QA samples	Total number of samples	Cost per Sample	MEL subtotal	Contract Fee
Fecal coliform MF	558	108	666	$35		$23310
Total Persulfate Nitrogen	558	72	630	$18.43	$11610.90	
Ammonia Nitrogen	558	72	630	$14.09	$8876.70	
Nitrate/Nitrite Nitrogen	558	72	630	$14.09	$8876.70	
Orthophosphate Phosphorus	558	72	630	$16.26	$10243.80	
Total Phosphorus	558	72	630	$19.50	$12285.00	
				Subtotal:	$51893.10	$23310.00
				Contracting Subtotal		$23310
				Total for Study	$75203.10	

Travel

Travel costs are estimated for two teams of two staff for three days needed for completing the surveys. Freshwater monitoring staff will need to visit gages for maintenance of continuous monitoring equipment. Meals and lodging is estimated at $26,000, and mileage is estimated to be $14,000.

The estimated project cost, adding a 10% contingency, is about $125,000.

Sampling Process Design (Experimental Design)

Overview

The study objects will be met though characterizing annual and seasonal FC, pH, DO, and nutrient concentrations and, where appropriate, loads to surface waters within the study area. FC and nutrient concentrations will be monitored at TMDL target locations (fixed-network) and other key locations within the study area from July 2014 through June 2015.

Continuous measurements of DO, pH, temperature, and conductivity will be conducted at five of Ecology and the Walla Walla Basin Watershed Council (WWBWC) stream gaging sites within the watershed and at selected fixed-network sites during the critical season (July-September).

Sample sites were selected based on TMDL targets, the geographic extent of the 303(d) listings in the watershed, and implementation of pollution control actions. Figures 3, 4, and 5 display the sampling sites and site selection criteria.

Although we are not addressing temperature TMDL targets at this time, we will deploy temperature thermistors at all sampling locations possible. These data will be used in the future to assess temperature targets in the watershed.

Details

Fixed-network

Samples will be collected at fixed-network stations for FC, total persulfate nitrogen, ammonia nitrogen, nitrate and nitrite nitrogen, orthophosphorus, and total phosphorus. Data from fixed-network will provide an estimate of the annual and seasonal averages of nutrients and FC annual and seasonal geometric mean and 90^{th} percentile statistics. Data will be used to compare with general TMDL targets outlined in table 8 and site-specific criteria to be developed for the final report. The schedule should provide approximately 18 samples per fixed site to develop statistics.

The fixed-network sites will be sampled a minimum of twice monthly during the critical seasons (July-September 2014 and May-June 2015) and once monthly from October-April 2015. A total of 32 sites will be visited a total of 18 times across the 12-month duration of this project. The proposed locations of the fixed-network sites are listed in Table 12 and shown in Figure 3.

Sites may be added or removed from the sampling plan, and sampling frequency may change depending on access and new information provided during the QA Project Plan review, field observations, and preliminary data analysis. These sites are typically situated in the middle of longer reaches of major water bodies (Mill Creek, Touchet River, Walla Walla River). The addition of verification samples will be determined by the results of data currently being collected or new information being discovered during the course of the project. This will allow the project manager the opportunity to immediately verify unexpected laboratory results or provide source identification and resolution.

Table 12. Walla Walla effectiveness monitoring sites.

Station ID	Station Description	NAD083 Latitude	NAD083 Longitude	Stream Gauge	Hydrolab[1] deployment
32SFT-08.8	SF Touchet @ Rainwater	46.1924	-117.9557		X
32SFT-00.3	SF Touchet @ Magil Lane	46.2821	-117.9577		
32NFT-00.0	NF Touchet @ mouth	46.3014	-117.9599	Ecology	X
32TOU-52.5	Touchet R above Dayton WWTP	46.013	-118.4116		
32TOU-51.2	Touchet @ Ward Rd	46.3015	-118.0135		
32COP-00.5	Coppei Ck @ Hwy 124	46.2690	-118.1675	WWBWC	X
32TOU-40.5	Touchet nr Bolles Rd (32B100)	46.2740	-118.2213	Ecology	X
32TOU-34.2	Touchet @ Hwy 125	46.2943	-118.3405		
32TOU-25.0	Touchet @ Lamar Rd	46.2883	-118.5320		
32TOU-17.8	Touchet @ Luckenbill Rd	46.2229	-118.5772		
32TOU-07.0	Touchet @ Touchet N Rd	46.1224	-118.6503		
32TOU-02.0	Touchet @ Cummins Rd	46.0571	-118.6689	Ecology	X
32MIL-24.5	Mill Ck @ Tiger Creek Rd	45.9886	-118.0695	USGS?	X
32MIL-11.5	Mill/Yellowhawk/Garrison Ck nr Reservoir Rd	46.0764	-118.2729		X
32MIL-08.9	Mill Ck @ Wilbur St	46.0690	-118.3125		
32YEL-03.5	Yellowhawk Ck @ Plaza Rd	46.0327	-118.3447		
32RUS-00.1	Russell Ck @ Plaza Rd	46.0291	-118.3447		X
32COT-01.0	Cottonwood Ck @ Plaza Rd	46.0256	-118.3461		X
32WAL-39.6	Walla Walla @ Peppers Br Rd	46.003	-118.383	WWBWC	X
32YEL-00.2	Yellowhawk Ck @ Old Milton Rd	46.0194	-118.3985	WWBWC	X
32ELW-00.6	East Br Little Walla Walla @ Springdale Rd	46.013	-118.412	WWBWC	X
32WAL-36.5	Walla Walla @ Beet Rd	46.0236	-118.4258	Ecology	X
32GAR-00.5	Garrison Ck @ Mission Rd	46.0281	-118.4282	WWBWC	X
32MIL-04.8	Mill Ck @ Gose Rd	46.0643	-118.3886		
32MIL-00.5	Mill Ck @ Sweagle Rd	46.0416	-118.4709		X
32WLW-00.8	W Br Little Walla Walla @ Sweagle Rd	46.0343	-118.4722	WWBWC	X
32WAL-32.8	Walla Walla @ Detour Rd	46.0434	-118.4897	Ecology	X
32DRY-00.1	Dry Ck @ Dodd Farm	46.0620	-118.5862	WWBWC	X
32MUD-00.5	Mud Ck @ Borgen Rd (Barney Rd)	46.0421	-118.6147	WWBWC	X
32PIN-01.4	Pine Ck @ Sand Pit Rd	46.0281	-118.6318		X
32WAL-22.7	Walla Walla @ Touchet-Gardena Rd	46.0292	-118.6707		
32WAL-15.6	Walla Walla @ Byerly Rd	46.0378	-118.7657		
32WAL-09.3	Walla Walla River @ Pierces RV park	46.0681	-118.8241	WWBWC	

[1] Will be deployed between July 15 and September 15.
WWBWC: Walla Walla Basin Watershed Council
USGS: United States Geological Survey

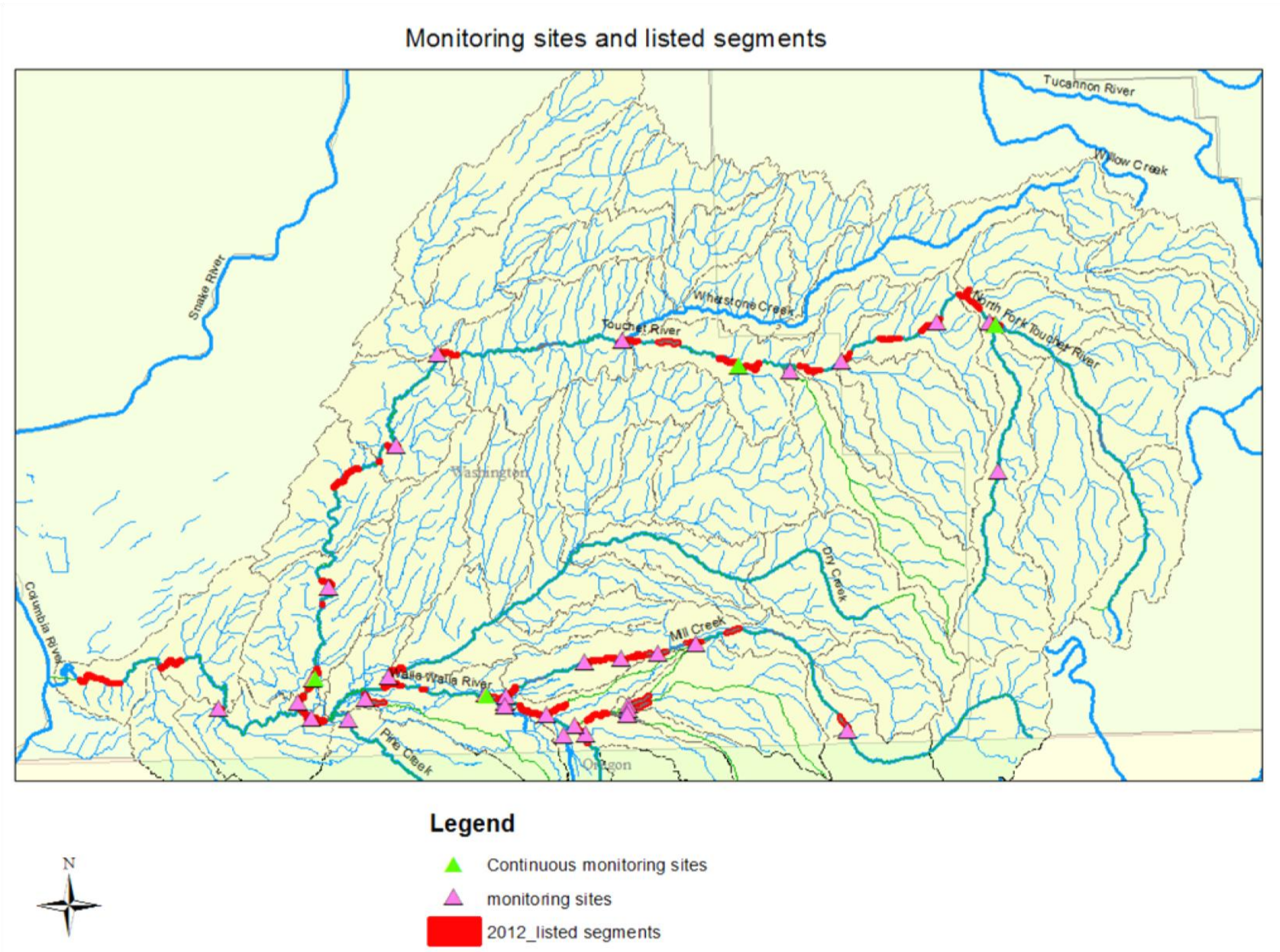

Figure 3. WRIA 32 listed segments and project sampling sites.

Continuous water quality measurements

Ecology's Freshwater Monitoring Unit currently manages five active flow gaging stations in the Walla Walla basin (Table 13). These stations will set up and collect continuous measurements for dissolved oxygen, pH, temperature, and specific conductance during the study period. The continuous water monitoring will be installed and maintained following a separate QA Project Plan and set of protocols for Ecology's statewide ambient monitoring program (Hallock, 2009).

Table 13. Ecology's active flow gaging stations in the Walla Walla basin.

Station ID	Location description	Period of record
32A105	Walla Walla @ Beet Rd.	2002-present
32A100	Walla Walla @ E. Detour Rd.	2007-present
32B075	Touchet @ Cummings Rd.	2002-present
32B100	Touchet R. @ Bolles	2002-present
32E050	N.F. Touchet River above Dayton	2002-present

Periodic continuous monitoring will also be conducted at select fixed-network sampling locations during critical periods for pH and DO. Multi-probes will be deployed spanning two-week periods to collect continuous diel data (at 15-minute intervals) for temperature, pH, dissolved oxygen, and specific conductance.

Practical constraints and logistical problems

Although it is rare, logistical problems such as excessive precipitation during typically dry periods, scheduling conflicts, sample bottle delivery errors, vehicle or equipment problems, site access issues, or the limited availability of personnel or equipment may interfere with sampling. Any circumstance that interferes with data collection and quality will be noted and discussed in the final report.

Sample schedule

Table 14 indicates the proposed starting dates for each sampling event. Each event is expected to take three days. Delays in starting the project, schedule conflicts with other projects, and staffing or laboratory capacity issues may affect actual dates, but the general plan for sample collection is expected to remain intact.

Table 14. Proposed 2014-2015 sampling schedule.

2014	July 7	July 21	Aug 4	Aug 18	Sept 8
	Sept 22	Oct 6	Nov 3	Dec 1	
2015	Jan 5	Feb 2	Feb 23	Mar 9	Apr 6
	May 4	May 18	June 1	June 15	

Sampling and Measurement Procedures

Field measurements will be taken for conductivity, temperature, pH, and DO, using a calibrated Hydrolab DataSonde® or MiniSonde® (Swanson, 2010). DO will also be collected and analyzed at 20% of the sites using the Winkler titration method (Ward and Mathieu, 2011). Hydrolab DataSonde dissolved oxygen, pH, conductivity, and temperature probes will be maintained, calibrated, and checked, as adopted from the Electronic Data Solution's *Hydrolab Maintenance and Calibration Workshop Training Manual* (2002) and Hydrolab Corporation's *DataSonde® 4 and MiniSonde® User's Manual* (1999). All probes will be cleaned, maintained, calibrated, and checked before and after each DataSonde deployment to ensure proper functioning in the field. DataSondes and their probes will be properly stored when not in use, following Hydrolab's recommendations.

A minimum of 10% of the samples will be field replicates used to assess total (field and lab) variability. Samples will be collected in the thalweg, below the water's surface.

Chain-of-custody forms and sample tags for each parameter will be prepared before each field study, adhering to Manchester Environmental Laboratory (MEL) (2008) guidelines. Information on the sample tags will include: project name, sample identification number, site identification, date, time, and parameter. Samples will be collected in appropriate containers and delivered to the laboratory along with a chain-of-custody form. Date and time will be recorded on the sample tags at the time of field collection. Information on the sample tags will match with the information on the chain-of-custody form.

Field investigations will follow applicable methods described in the Standard Operating Procedures (SOPs) developed by Ecology's Environmental Assessment Program including:

- EAP080 *Standard Operating Procedures for Continuous Temperature Monitoring of Fresh Water Rivers and Streams* (Ward, 2011)
- EAP030 *Standard Operating Procedures for the Collection of Fecal Coliform Bacteria Samples in Surface water* (Ward and Mathieu, 2011)
- EAP031 *Standard Operating Procedures for the Collection and Analysis of pH Samples* (Ward and Clishe, 2007)
- EAP032 *Standard Operating Procedures for the Collection and Analysis of Conductivity Samples* (Ward, 2011)
- EAP034 *Standard Operating Procedures for the Collection, Processing, and Analysis of Stream Samples* (Ward, 2007)
- EAP056 *Standard Operating Procedure for Measuring and Calculating Stream Discharge* (Shedd, 2011)
- EAP023 *Standard Operating Procedures for the Collection and Analysis of Dissolved Oxygen (Winkler Method)* (Ward and Mathieu, 2013)
- EAP033 *Standard Operating Procedures for Hydrolab DataSonde® and MiniSonde® Multiprobes*. (Swanson, 2010)

- EAP070 *Standard Operating Procedures to Minimize the Spread of Invasive Species* (Parsons et al., 2012)

Sample containers, preservation, and holding times are listed in Table 15. Samples will be collected according to the standard operating procedures (SOPs) for surface water sampling (Joy, 2006; Mathieu, 2006). DO sampling (Winkler method) will follow the SOP for measuring DO in surface waters (Ward and Mathieu, 2011). Grab samples for all parameters will be collected directly into pre-cleaned containers, labeled, and stored on ice.

Due to holding time issues, Walla Walla Regional Water Testing Services (WWRWTS) will be used for most of the bacteria sample analysis. Samples for bacteria analysis will be collected in pre-cleaned and sterile bottles supplied by WWRWTS and delivered to their laboratory as soon as practical after sample collection. All other samples for laboratory analysis will be shipped to MEL via overnight freight. All samples shipped or delivered to laboratories will follow chain-of-custody procedures (MEL, 2008).

Table 15. Sample containers, preservation, and holding time.

Parameter	Container	Preservative	Holding Time
Fecal Coliform	250 or 500 mL HDPE or glass autoclaved	Cool 0-6°C	24 hrs
Total Persulfate Nitrogen	125 mL clear poly	H_2SO_4 to pH <2 Cool 0-6°C	28 days
Ammonia Nitrogen	125 mL clear poly	H_2SO_4 to pH <2 Cool 0-6°C	28 days
Nitrate and Nitrite nitrogen	125 mL clear poly	H_2SO_4 to pH <2 Cool 0-6°C	28 days
Orthophosphate Phosphorus	125 mL amber poly	Filtered to 0.45 um	48 hrs
Total Phosphorus	125 mL clear poly	1:1 HCL to pH < 2 Cool 0-6°C	28 days

If practical, instantaneous flows will be measured at tributary and all other sites without continuous flow monitoring equipment when samples are taken. Discharge will be calculated by measuring velocities and depths in accordance with EAP SOP056 (Ecology, 2014). The record of instantaneous measurements at these sites will be compared to the discharge record of nearby continuous monitoring sites. Correlations will be developed or adopted from Pickett (2011) to create a continuous or partially continuous record for the sites.

Invasive species

Ecology field crew will follow EAP's SOP on minimizing the spread of invasive species (Parsons et al., 2012). The North Ocean Beaches study area is not in a region of extreme concern. Areas of extreme concern already have or could have invasive species like New Zealand mud snails that are particularly hard to remove from equipment and are especially disruptive to native ecological communities.

Quality Objectives

Quality objectives are statements of the precision, bias, and lower reporting limits necessary to meet project objectives. Precision and bias together express data accuracy. Other considerations of quality objectives include representativeness and completeness. Quality objectives apply equally to laboratory and field data collected by Ecology, to data used in this study collected by entities external to Ecology, and to other analysis methods used in this study.

Measurement quality objectives

Field sampling procedures and laboratory analyses inherently have associated uncertainty with results in data variability. Measurement quality objectives (MQOs) state the acceptable data variability for a project. Precision and bias are data quality criteria used to indicate conformance with measurement quality objectives. The term accuracy refers to the combined effects of precision and bias (Lombard and Kirchmer, 2004).

Precision is a measure of the variability in the results of replicate measurements due to random error. Random error is imparted by the variation in concentrations of samples from the environment as well as other introduced sources of variation (e.g., field and laboratory procedures). Precision for laboratory duplicate samples will be expressed as relative percent difference (RPD). Precision for field replicate samples will be expressed as the relative standard deviation (RSD) for the group of duplicate pairs (Table 18).

Bias is defined as the difference between the sample value and true value of the parameter being measured. Bias affecting measurement procedures can be inferred from the results of quality control (QC) procedures. Bias in field measurements and samples will be minimized by strictly following Ecology's measurement, sampling, and handling protocols.

Field sampling precision and bias will be addressed by submitting replicate samples. MEL will assess precision and bias in the laboratory through the use of duplicates and blanks.

Table 18 outlines analytical methods, expected precision of sample duplicates, and method reporting limits. The targets for precision of field replicates are based on historical performance by MEL for environmental samples taken around the state by the Environmental Assessment Program (Mathieu, 2006). The reporting limits of the methods listed in the table are appropriate for the expected range of results and the required level of sensitivity to meet project objectives. The laboratory's measurement quality objectives and quality control procedures are documented in the MEL *Lab Users Manual* (MEL, 2008).

Representative sampling

The study is designed to have enough sampling sites and sufficient sampling frequency to meet study objectives. Bacteria values are known to be highly variable over time and space. Sampling variability can be somewhat controlled by strictly following standard procedures and collecting quality control samples, but natural spatial and temporal variability can contribute greatly to the overall variability in the reported values. Resources limit the number of samples that can be taken at one site spatially or over various intervals of time. Laboratory and field errors are further expanded by estimate errors in certain calculations.

Completeness

EPA has defined completeness as a measure of the amount of valid data needed to be obtained from a measurement system (Lombard and Kirchmer, 2004). The goal for the North Ocean Beaches study is to correctly collect and analyze 100% of the samples for each of the sites. However, problems occasionally arise during sample collection that cannot be controlled; thus, a completeness of 95% is acceptable. Potential problems are flooding, site access problems, or sample container shortages.

Comparability

Comparability is a measure of the confidence with which one data set can be compared to another. Comparability is generally assured through consistent sampling and analysis protocols, using approved SOPs, and adhering to established data quality criteria consistent with other studies.

This study will follow the same methods and SOPs for FC, nutrients, and continuously monitored parameters as were followed in the original TMDL study (Swanson, 2003). All data used in statistical comparisons from all agencies will be assessed for precision prior to analysis. If data sets do not meet standards for precision and biases they will not be used in any analysis.

Quality Control

Total variability for field sampling and laboratory analysis will be assessed by collecting replicate samples. Replicate samples are a type of quality assurance/quality control (QA/QC) method. Sample precision and bias will be assessed by collecting replicates for 10% of all bacteria samples and 10% of all nutrient samples. MEL routinely duplicates sample analyses in the laboratory to determine laboratory precision. The difference between field variability and laboratory variability is an estimate of the sample field variability. Table 16 lists the field and lab QC samples that will be used in this project.

Table 16. Summary of field and laboratory QC procedure.

Analysis	Field blanks	Field replicates	Lab check standard	Lab blank	Lab replicate	Matrix spikes
Stream discharge	NA	1/day	NA	NA	NA	NA
pH	NA	1/day	NA	NA	NA	NA
Temperature	NA	1/day	NA	NA	NA	NA
DO	NA	1/day	NA	NA	NA	NA
Winkler DO	NA	2/day	NA	NA	NA	NA
Conductivity	NA	1/day	NA	NA	NA	NA
Fecal coliform	NA	2/day	NA	1/run	1/10 samples	NA
Total Persulfate Nitrogen	1/survey	1/day	1/run	1/run	1/10 samples	1/20 samples
Ammonia Nitrogen	1/survey	1/day	1/run	1/run	1/10 samples	1/20 samples
Nitrate and Nitrite nitrogen	1/survey	1/day	1/run	1/run	1/10 samples	1/20 samples
Orthophosphate Phosphorus	1/survey	1/day	1/run	1/run	1/10 samples	1/20 samples
Total Phosphorus	1/survey	1/day	1/run	1/run	1/10 samples	1/20 samples

Laboratory

MEL will analyze all samples. The laboratory's measurement quality objectives and QC procedures are documented in the MEL *Lab Users Manual* (MEL, 2008). Field sampling and measurements will follow QC protocols described in Ecology (1993). If any of these QC procedures are not met, the associated results may be qualified by MEL or the project manager and used with caution, or not used at all.

Field

The temperature thermistors will have a calibration check both pre- and post-study in accordance with Ecology Temperature Monitoring Protocols (Stohr, 2009). This check is done to document instrument accuracy at representative temperatures. A NIST-certified reference thermometer will be used for the calibration check. The calibration check may show that the temperature datalogger differs from the NIST-certified thermometer by more than the manufacturer-stated accuracy of the instrument (range greater than ±0.2°C or ±0.4°C).

A datalogger that fails the pre-study calibration check (outside the manufacturer-stated accuracy range) will not be used. If the temperature datalogger fails the post-study calibration check, the actual measured value will be reported along with its degree of accuracy based on the calibration check results. As a result, these data may be rejected or qualified and used accordingly.

Hydrolab MiniSonde® and DataSonde® DO, pH, and conductivity sensors will be calibrated according to the manufacturer's recommendations and the Hydrolab SOP (Swanson, 2010). The temperature sensor on these probes is factory-calibrated. Hydrolabs will be calibrated before each sampling survey and checked afterward, using certified standards and reference solutions. Hydrolab results will be accepted, qualified, rejected, or corrected, as appropriate (Table 17).

Table 17. Quality objectives for Hydrolab post-deployment checks.

Parameter	units	Accept*	Qualify	Reject*
pH	s.u.	±0.2	> ±0.2 and ≤ ± 0.5	> ±0.5
Conductivity	uS/cm	±5%	>±5% and ≤ ±15%	> ±15%
Temperature	°C	±0.2	> ±0.2 and ≤ ± 0.5	> ±0.5
Dissolved Oxygen	% saturation	±5%	>±5% and ≤ ±15%	> ±15%

*Deviation from true value

Corrective Actions

QC results may indicate problems with data during the course of the project. The lab will follow prescribed procedures to resolve the problems. Options for corrective action might include:

- Retrieving missing information.
- Re-calibrating the measurement system.
- Re-analyzing samples within holding time requirements.
- Modifying the analytical procedures.
- Requesting collection of additional samples or taking of additional field measurements.
- Qualifying results.

In addition, Hydrolab data may be corrected to a known standard or more accurate measurement. Winkler DO results are generally considered more accurate than Hydrolab DO results. For example, if diurnal DO data from a Hydrolab is plotted and shows bias from the Winkler DO check values, the whole diurnal curve may be adjusted to "fit" or overlap the Winkler values. Thus, correcting the Hydrolab results using the Winkler results will give a more accurate representation of the true diurnal curve of DO throughout the course of the 24-hour period. If Ecology decides to correct any Hydrolab data (usually DO or pH), it will be noted in the final report. If any data is corrected, the correction methods will be explained in the final report.

Data Management Procedures

Field staff will enter measurements into a water-resistant field book and then transfer to a spreadsheet program as soon as practical after returning to the office. The spreadsheets will be used for preliminary analysis and to create a table to upload data into Ecology's Environmental Information Management database (EIM). Data entries will be independently verified for accuracy by another member of the project team.

Sample result data received from MEL through Ecology's Laboratory Information Management System (LIMS) will be exported prior to entry into EIM and added to a cumulative spreadsheet for laboratory results. WWRWTS results will be entered into a spreadsheet format suitable for importation into EIM. These spreadsheets will be used to informally review and analyze data during the course of the project. Case narratives included in the data package from the laboratories will discuss any problems encountered with the analysis, corrective action taken, changes to the requested analytical method, and a glossary for data qualifiers. Laboratory QC results will also include results for laboratory duplicates, matrix spikes, and laboratory blanks. The information will be used to evaluate data quality, determine if MQOs were met, and act as acceptance criteria for project data.

All continuous data will be stored in a project database that includes station location information and data QA information. This database will facilitate the summarizing and graphical analysis of the temperature data and also create a temperature data table for uploading to the EIM geospatial database.

An EIM user study ID (JROS0025) has been created for this TMDL. All monitoring data will be available via the internet once the project data have been validated. This geospatial database is at https://fortress.wa.gov/ecy/eimreporting/. After reviewing project data for quality and finalizing the review, the EIM data engineer will upload the data.

All final spreadsheet files, paper field notes, and final products created as part of the data collection and data quality assessment process will be kept with the project data files. Any existing data or non-Ecology data used in this study must meet the same precision and bias criteria as data collected by Ecology during the study.

Elevated fecal coliform densities (> 200 cfu/100 mL) will be reported to the project manager within a week so that Ecology's Eastern Regional Office (ERO) can be notified in accordance with the official notification procedure.

The project manager or principal investigator will validate the quality of the data received from the laboratory and collected in the field in reference to the measurement quality objectives (MQO) in Table 18. The review will be performed as often as possible, but at a quarterly interval at a minimum.

Table 18. Methods and quality objectives.

Measurement	Method	Accuracy	Precision	Bias	Resolution
Field					
Velocity	Marsh McBirney	0.1 f/s	0.1 f/s	NA	0.01 f/s
pH	Hydrolab	0.1 s.u.	0.05 s.u.	0.1 s.u.	1-14 s.u.
Temperature	Hydrolab	0.1 ^{o}C	0.05 ^{o}C	0.05 ^{o}C	0-30 ^{o}C
Dissolved Oxygen	Hydrolab	0.2 mg/L	5% RSD	+5%	0.5-15 mg/L
Conductivity	Hydrolab	0.5%	5% RSD	+5%	1 umho/cm
Laboratory		**Lab spikes**	**Lab duplicates**	**Lab check standard**	
Fecal Coliform	SM9222D	NA	40% RSD	NA	1 cfu/100 mL
Total Persulfate Nitrogen	SM4500-N C	+25%	15% RSD	+10%	25 ug/L
Ammonia Nitrogen	SM4500-NH3 D	+25%	15% RSD	+10%	10 ug/L
Nitrate and Nitrite Nitrogen	SM4500-NO3 F	+25%	15% RSD	+10%	10 ug/L
Orthophosphate Phosphorus	SM4500-P F	+25%	15% RSD	+10%	2 ug/L
Total Phosphorus	SM4500-P F	+25%	15% RSD	+10%	5 ug/L

Adjustments to field or laboratory procedure or to MQOs may be necessary after such a review, and clients and QA Project Plan signature parties will be notified of major changes.

All water quality data will be entered into Ecology's Environmental Information Management (EIM) system. Data will be verified and a random 25% of the data entries will be independently reviewed for errors. If errors are detected, another 25% will be reviewed until no errors are detected. All preliminary data will be made available to ERO for disbursement after basic quality control and EIM are completed.

Audits and Reports

Accredited laboratories participate in performance and system audits of their routine procedures. The results of these audits are available on request. The preliminary monitoring results will be written up by the project manager in a technical memo to ERO.
The report and the technical memo will both contain the following elements:

- Information about the sampling locations, including geographic coordinates and maps.
- Descriptions of field and laboratory methods.
- Tables presenting all the data.
- Discussion of project data quality.
- Summary of significant findings.

The project manager is responsible for verifying data completeness before use in the technical report and entry into the EIM. The project manager is also responsible for writing and submitting the final technical report to the Water Quality Program watershed lead. The final technical report will undergo the peer review process by staff with appropriate expertise.

The final report will include analyses of results that form the basis of conclusions and recommendations. Results will include site-specific information for FC, temperature, multi-probe results, QA results, and seasonal summaries.

Data Verification and Usability Assessment

Data verification

Field staff will check field notebooks for missing or improbable measurements before leaving each site. The project workbook file containing field data will be labeled "Draft" until data verification and validation is complete. Data entry will be checked against the field notebook data for errors and omissions. Missing or unusual data will be brought to the attention of the Ecology project manager for consultation. Validated data will be moved to a separate file labeled "Final."

Laboratory-generated data reduction, review, and reporting will follow the procedures outlined in the appropriate *Lab Users Manual.* Lab results will be checked for missing and improbable data. Any estimated results will be qualified and their use restricted as appropriate. A standard case narrative of laboratory QA/QC results will be sent to the Ecology project manager for each sampling event. The project manager will review laboratory data packages and data verification reports. Based on these assessments, the data will either be accepted, accepted with appropriate qualifications, or rejected and re-analysis considered.

The field lead will check data received through LIMS for omissions against the Request for Analysis forms. Data can be in spreadsheets or downloadable tables from EIM. These tables and spreadsheets will be located in a file labeled “Draft” until data verification and validation is completed. Field replicate sample results will be compared to quality objectives in Table 14. The Ecology project manager will review data requiring additional qualifiers.

After data verification and data entry tasks are completed, all field, laboratory, and flow data will be entered into a file labeled “Final” and then uploaded into EIM. Another EAP staff member will independently review 10% of the project data in EIM for errors. If significant data entry errors are discovered, a more intensive review will be undertaken.

Both data verification and validation require adequate documentation of the process.

Data for stream temperature monitoring stations will be verified against the corresponding air temperature station to ensure the stream temperature record represents water temperatures and not temperatures recorded during a time the stream thermistor was dewatered. Measurement accuracy of individual thermistors is verified using a NIST-certified reference thermometer and field measurements of stream temperature at each thermistor location several times during the study period.

Data usability assessment

The project manager will verify that all measurement and data quality objectives have been met for each monitoring station. If the objectives have not been met, consideration will be given to qualify the data, how to use it in analysis, or whether data should be rejected. Documentation of the data quality and decisions on data usability will provide accuracy and transparency of the QA/QC procedures. The data quality assessment methods and results will be documented in individual project data files and summarized in the final technical report.

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Appendix. Glossary, Acronyms, and Abbreviations

Glossary

Anthropogenic: Human-caused.

Char: Fish of genus *Salvelinus* distinguished from trout and salmon by the absence of teeth in the roof of the mouth, presence of light colored spots on a dark background, absence of spots on the dorsal fin, small scales, and differences in the structure of their skeleton. (Trout and salmon have dark spots on a lighter background.)

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

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

Effluent: An outflowing of water from a natural body of water or from a built structure. For example, the treated outflow from a wastewater treatment plant.

Extraordinary primary contact: Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform bacteria are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100 mL).

Geometric mean: A mathematical expression of the central tendency (an average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. The calculation is performed by either: (1) taking the nth root of a product of n factors, or (2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Load allocation: The portion of a receiving water's loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

Loading capacity: The greatest amount of a substance that a water body can receive and still meet water quality standards.

Margin of safety: Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving waterbody.

Municipal separate storm sewer systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, manmade channels, or storm drains): (1) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, stormwater, or other wastes and (2 designed or used for collecting or conveying stormwater; (3) which is not a combined sewer; and (4) which is not part of a Publicly-Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

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. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

Parameter: Water quality constituent being measured (analyte).

Pathogen: Disease-causing microorganisms such as bacteria, protozoa, viruses.

Phase I stormwater permit: The first phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to medium and large municipal separate storm sewer systems (MS4s) and construction sites of five or more acres.

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: 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 are 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.

Primary contact recreation: Activities where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and water skiing.

Salmonid: Fish that belong to the family *Salmonidae*. Any species of salmon, trout, or char.

Sediment: Soil and organic matter that is covered with water (for example, river or lake bottom).

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 snowmelt. 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, salt waters, wetlands and all other surface waters and water courses within the jurisdiction of Washington State.

Thalweg: The deepest and fastest moving portion of a stream.

Total Maximum Daily Load (TMDL): A water cleanup plan. A distribution of a substance in a waterbody designed to protect it from not meeting (exceeding) water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations for point sources, (2) the load allocations 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.

Total suspended solids (TSS): The suspended particulate matter in a water sample as retained by a filter.

Wasteload allocation: The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. Wasteload allocations 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.

303(d) list: Section 303(d) of the federal Clean Water Act requires Washington State to periodically prepare a list of all surface waters in the state for which beneficial 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.

Acronyms and Abbreviations

BMP	Best management practice
DMR	Discharge Monitoring Report
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
GIS	Geographic Information System software
NPDES	(See Glossary above)
RM	River mile
RSD	Relative standard deviation
TMDL	(See Glossary above)
USFS	United States Forest Service
WAC	Washington Administrative Code

WDFW	Washington Department of Fish and Wildlife
WQA	Water Quality Assessment
WRIA	Water Resource Inventory Area
WWTP	Wastewater treatment plant

Units of Measurement

°C	degrees centigrade
cfu	colony forming units
dw	dry weight
mg/L	milligrams per liter (parts per million)
mL	milliliters
s.u.	standard units
ug/L	micrograms per liter (parts per billion)
uM	micromolar (a chemistry unit)
umho/cm	micromhos per centimeter
uS/cm	microsiemens per centimeter, a unit of conductivity