Wilson Creek Sub-Basin
Fecal Coliform Bacteria
Effectiveness Monitoring

Water Quality Study Design
(Quality Assurance Project Plan)

October 2012

Publication No. 12-03-120

DEPARTMENT OF
ECOLOGY
State of Washington

Publication and Contact Information

Each study conducted by the Washington State Department of 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/1203120.html

Author: Jenna Durkee
Communication Consultant: phone 360-407-6834.

Washington State Department of Ecology - www.ecy.wa.gov/

- Headquarters, Olympia 360-407-6000
- Northwest Regional Office, Bellevue 425-649-7000
- Southwest Regional Office, Olympia 360-407-6300
- Central Regional Office, Yakima 509-575-2490
- Eastern Regional Office, Spokane 509-329-3400

Study Codes

Data for this project are available at Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search User Study ID is JDURK0001.

Ecology's Activity Tracker Code for this study is 11-043.

Federal Clean Water Act 2004 303(d) Listings Addressed in this Study

Wilson Creek	WA-39-1020: LLID: 1204996469292: Fecal Coliform
Mercer Creek	LLID: 1205541469864: Fecal Coliform
Naneum Creek	WA-39-1025: LLID: 1205030469443: Fecal Coliform
Cooke Creek	WA-39-1034: LLID: 1204591469539: Fecal Coliform
Coleman Creek	LLID: 1204991469477: Fecal Coliform
Cascade Irrigation Canal	LLID: 12038882469702: Fecal Coliform
Ellensburg Water Company Canal	LLID: 1204659469835: Fecal Coliform
Caribou Creek	LLID: 1204591469529: Fecal Coliform
Cherry Creek	WA-39-1032 LLID: 1205084469164: Fecal Coliform
Wipple Wasteway (Badger Creek)	LLID: 1204966469272: Fecal Coliform

Cover photo: Cascade Irrigation Canal at Thrall Road (photo by Jenna Durkee)

Quality Assurance Project Plan

Wilson Creek Sub-Basin Fecal Coliform Bacteria Effectiveness Monitoring

October 2012

Approved by:

Signature: Date: October 2012
Jane Creech, Client, Water Quality Program, CRO

Signature: Date: October 2012
Jonathan Merz, Client's Unit Supervisor, Water Quality Program, CRO

Signature: Date: October 2012
Charles McKinney, Client's Section Manager, Water Quality Program, CRO

Signature: Date: October 2012
Jenna Durkee, Author / Project Manager, EIM Data Engineer, EAP

Signature: Date: October 2012
Jenifer Parsons, Author's Acting Section Manager, EAP

Signature: Date: October 2012
Joel Bird, Director, Manchester Environmental Laboratory

Signature: Date: October 2012
Bill Kammin, Ecology Quality Assurance Officer

Signatures are not available on the Internet version.
CRO: Central Regional Office
EAP: Environmental Assessment Program
EIM: Environmental Information Management system

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Abstract

The Washington State Department of Ecology (Ecology) compiled fecal coliform data collected from 1999-2002 by Kittitas County Conservation District, Kittitas Reclamation District, and Ecology. This data was used to create the fecal coliform Total Maximum Daily Load (TMDL) for the Wilson Creek Sub-Basin technical assessment, Water Cleanup Plan (2005), and Detailed Implementation Plan (2006).

Based on the 2005 TMDL, Wilson Creek sub-basin exceeded Washington State Class A Water Quality Standards for fecal coliform. The highest fecal coliform densities were reported from June through August, which correlated with the irrigation season as well as the onset of higher temperatures.

The purpose of the study outlined in this Quality Assurance Project Plan is to evaluate current fecal coliform levels in the Wilson Creek sub-basin. Data will be compared to the initial TMDL study to determine if fecal coliform levels have changed.

What is TMDL Effectiveness Monitoring?

TMDL Process

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

1. Scientific study to (1) characterize the pollution parameters identified in the Section 303(d) list of impaired water bodies, and (2) identify pollutant sources.
2. Modeling of 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 an 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 feasible 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 target-correlated with baseline conditions or desired future conditions.

The benefits of TMDL effectiveness evaluation include:

- A measure of progress toward implementation of recommendations. In other words, how much the watershed has been restored and how much more effort is required.
- More efficient allocation of funding and optimization in planning and decision-making. In other words, identifying 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.

Project Background

Study Area

The Wilson Creek Sub-basin is located in Central Washington, east of the Cascade Mountains in Watershed Inventory Resources Area (WRIA) 39, Upper Yakima (Figure 1). It is bordered by the Wenatchee Mountains, the Yakima River, Manastash Ridge, Colockum Mountains, and Boylston Mountains. The sub-basin encompasses 244,500 acres of land. Elevation ranges from 1,425 feet at Thrall Road (the confluence of Wilson Creek and the Yakima River) to 6,359 feet near the headwaters of Wilson Creek near Lion Rock.

The cities of Ellensburg and Kittitas and their surrounding areas make up the majority of the land mass in the sub-basin. There is Washington Department of Fish and Wildlife land as well as US Bureau of Reclamation land along the borders of the sub-basin. Ellensburg, with a population of 17,141 in 2008, is the largest city in Kittitas County. Ellensburg is home to Central Washington University which adds around 11,000 students to the population of Ellensburg during the school year (September through June.) Kittitas, a smaller town in the Wilson Creek sub-basin has a population of around 1,100 people.

Most of the land in the Wilson Creek sub-basin is used for agriculture with additional land used for residential, urban, evergreen forest and shrub steppe. The average annual rainfall is 8.9 inches, mostly accumulating in October through March. The average snowfall is 31.4 inches, mostly accumulating in November through February.

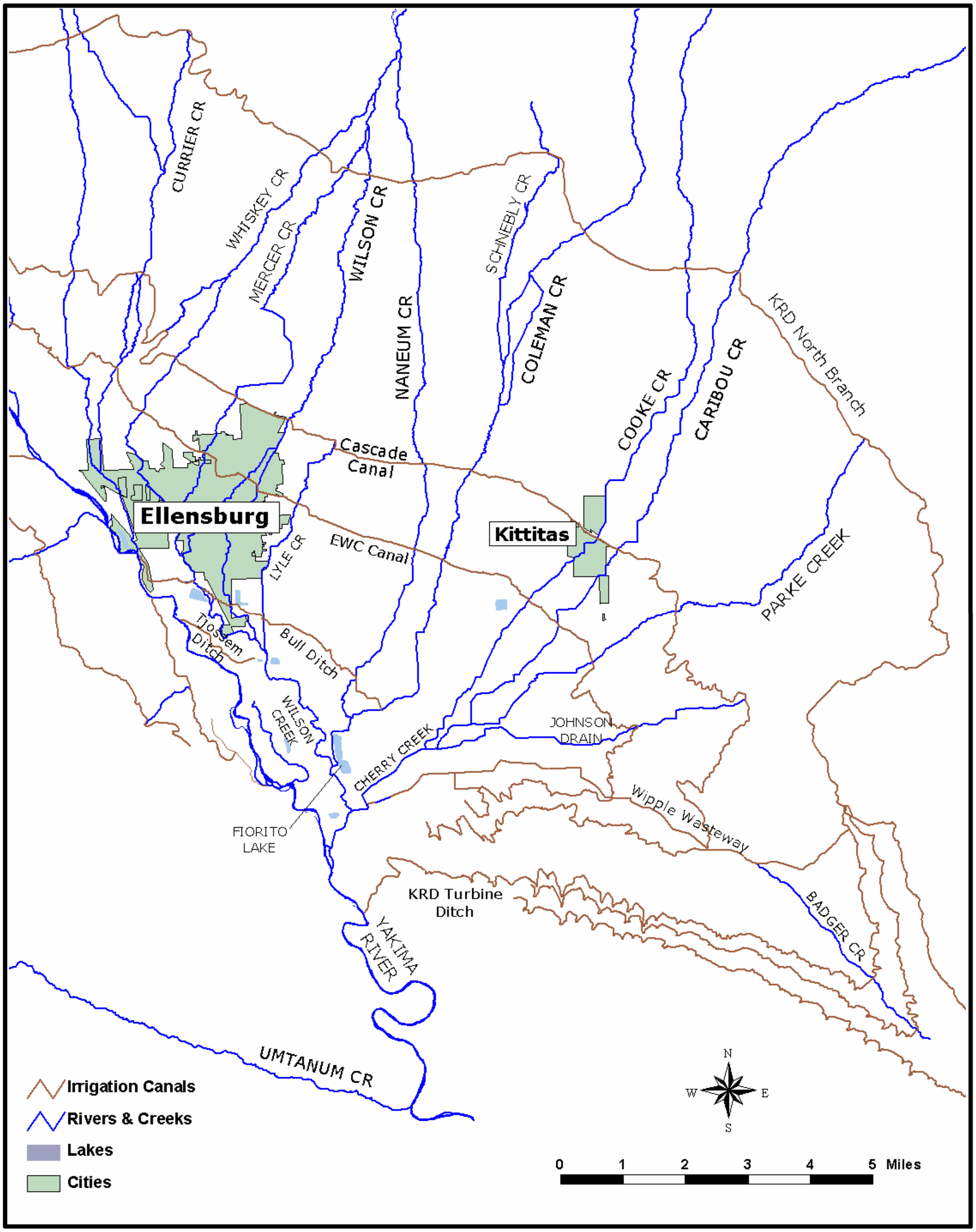

Figure 1. Wilson Creek sub-basin (map courtesy of Kittitas Reclamation District).

Impairment and Historical Data Review

Water quality impairments are documented in Washington's Water Quality Assessment Mapping Tool. (See www.ecy.wa.gov/programs/wq/303d/index.html for the most recent Water Quality Assessment information.)

This study will focus on the fecal coliform exceedances in the Wilson Creek sub-basin. Fecal coliform is bacteria found in the feces and the intestines of warm-blooded animals as well as in plant material. Fecal coliform can be an indication of disease carrying organisms and poor water quality.

Table 1 presents a list of all stream segments within the Wilson Creek sub-basin identified as having fecal coliform impairments. A complete table of listed parameters and stream segments is presented in Appendix B, Table B-1.

Sampling for the Wilson Creek TMDL was conducted by Kittitas Reclamation District, Kittitas County Conservation District, and Ecology from 1999-2002. Before the Wilson Creek TMDL, additional fecal coliform samples were collected under three statewide Ecology ambient monitoring projects (EIM User Study IDs AMS001B, AMS001D, and AMS001E). Also, two Water Quality Grants G0000116 include data from 1999-2002. Data and location information for most TMDL assessment stations are presented in table 2.

Complete information for these studies can be viewed in EIM by searching for the User Study ID at http://apps.ecy.wa.gov/eimreporting/Search.asp.

Table 1. Wilson Creek sub-basin 303(d) fecal coliform listings (Ecology, 2005a) (Ecology, 2008b).

Water Body Name	Listing Detail	Category
CARIBOU CREEK	10052	4A
CASCADE IRRIGATION DISTRICT CANAL	45673	4A
CASCADE IRRIGATION DISTRICT CANAL	45931	2
CHERRY CREEK	10035	4A
COLEMAN CREEK	6925	4A
COOKE CREEK	6721	4A
	6722	4A
	6923	4A
	10038	4A
	10039	4A
	45806	4A
	46830	4A
	46831	4A
	46833	4A
	46870	4A
	46871	4A
	46872	4A
CRYSTAL CREEK	6720	4A
ELLENSBURG WATER COMPANY CANAL	45674	4A
JOHNSON DRAIN	10040	4A
MERCER CREEK	6930	4A
NANEUM	10041	4A
	45241	4A
PARKE CREEK	35360	2
TURBINE DITCH	45683	4A
UNNAMED DITCH (TRIB TO COOKE CREEK)	45944	2
WHISKEY CREEK	6931	4A
WILSON CREEK	6719	4A
	6929	4A
	10047	4A
	10048	4A
	16814	4A
WILSON CREEK, WEST	45822	4A
WIPPLE WASTEWAY	6922	4A
	6932	4A
	6933	4A
	45186	4A

Table 2. Environmental Information Management (EIM) sample locations.

EIM User Location ID	Location Description
22-WLSN	Wilson Creek at Sanders Rd.
YAV191	Upper Naneum Creek at Naneum Rd.
30-CK	Cooke Creek Upper Basin (at Coleman Rd.)
29-CL	Coleman Creek Upper Basin (at Coleman Rd.)
31-CK81	Cooke Creek on number 81 Rd. (sample above irrigation input)
35-JNFR	Johnson Drain at Ferguson Rd.
TS15	Cooke Creek at South Ferguson Rd.
39COLO4.2	Coleman Creek at Moe Rd.
36-CHMO	Cherry Creek at Moe Rd.
37-WPMO	Wipple Wasteway at Moe Rd.
YAV146	Wilson Creek at Thrall Rd.
YAV192	Naneum Creek at Fiorito pond off Number 6 Rd.
39NAN10.1	Naneum Creek at Radar Rd.
39NAN06.7	Naneum Creek at Game Farm Rd.
39NAN05.6	Naneum Creek at Vantage Hwy.
23-WLUM	Wilson Creek at Umtanum Rd.

TMDL Overview

The objective of the Wilson Creek Sub-basin Bacteria Total Maximum Daily Load (TMDL) was to comply with Washington State's Class A Water Quality Standard: a geometric mean of 100 cfu/100 mL and a 90% value of 200 cfu/100 mL (Creech and Bohn, 2005). This TMDL was implemented using data collected from 1999-2002 by Kittitas Reclamation District (KRD), Kittitas County Conservation District (KCCD), and Ecology from 1999-2002.

Nonpoint fecal coliform sources affecting water bodies in the Wilson Creek sub-basin include wildlife, livestock, pets, and humans.

Two municipal Stormwater Phase II permits are issued in the Wilson Creek basin:
- Central Washington University (WAR046205)
- City of Ellensburg (WAR046205)

The wasteload allocations for these permits are required to be less than or equal to the class A fecal coliform standards of 100 cfu/100 mL geometric mean and 200 cfu/100 mL for a 90% value.

The City of Kittitas' wastewater treatment plant discharges to Cooke Creek under NPDES permit (WA0021253) and must comply with the monthly geometric mean of 100 cfu/100 mL and a daily maximum of 200 cfu/100 mL (Ecology 2005b).

The TMDL's critical period runs from approximately April 10 (when irrigation season begins) through the end of October (when irrigation water is turned off). We will take two samples before and two samples after irrigation season.

Cleanup and Implementation

The Wilson Creek Sub-basin Bacteria TMDL Detailed Implementation plan is divided into three categories:

- implementing best management practices where possible to reduce fecal coliform counts
- education/outreach
- monitoring

Nonpoint source discharges and overland transport are the main contributors to water body fecal coliform loading. Effectiveness monitoring will be conducted every five years until 2020 to determine if fecal counts are improving and where additional work is needed.

A Detailed Implementation Plan (DIP) (Creech, 2006) outlined Best Management Practices (BMPs) to decrease fecal coliform densities. The DIP focused on addressing failing and improperly connected septic systems, proper pet waste disposal, livestock waste disposal, irrigation practices, revegetation, wildlife management, responsible recreation practices, and public education.

Since the DIP was completed, significant progress has been made through BMPs including:

- changing from flood to sprinkler irrigation
- changing from open ditch to piped ditch systems
- using polyacrylamide for erosion and pollution control
- revegetation of riparian habitat
- upgrading livestock facilities and practices
- educating public on irrigation, livestock, farming, and pet waste disposal

Appendix B, Table B-2 shows Wilson Creek Sub-Basin Detailed Implementation Plan Summary.

Project Goal and Study Objectives

Goal

The goals of this effectiveness monitoring project are to determine attainment of water quality standard TMDL targets and to support the systematic review and improvement of water quality in the Wilson Creek sub-basin.

Objectives

The objectives of this proposed study are as follows:

- Determine if fecal coliform targets set by the 2005 TMDL study have been met.
- Determine if Washington State water quality standards for fecal coliform are being met.

Study Design

Overview

Sampling for fecal coliform will begin March 21, 2011, before the start of irrigation season, at the target stations identified in Table 3. Sampling will be conducted between April and November after irrigation has been shut off. The objectives for this project will be met by gathering fecal coliform data from previously sampled sites and comparing them to TMDL target limits.

There are 18 fixed network sample sites that will be sampled on a bi-weekly basis. Three of these sites (Upper Naneum Creek at Naneum Road, Cooke Creek at Cooke Canyon Road, and Coleman Creek at Coleman Road) are good representations of background conditions.

These sites, near the base of the Colockum and Quilomene Wildlife areas, are affected by wildlife, recreation, and cattle grazing. However, these sites are upstream of homes, crop land, and grazing activity. These three background sample locations were the only sites identified within the TMDL as having a geometric mean below the Class A Water Quality Standards of 100 cfu/100 mL or below (Creech and Bohn, 2005).

Samples for total suspended solids (TSS) and turbidity (TURB) will be collected and split with Kittitas County Water Purveyors. The split samples will be collected once per month, from April through October, at Upper Naneum Creek at Naneum Road and Wilson Creek at Thrall Road. This data will be used as followup to the Upper Yakima River Basin Suspended Sediment, Turbidity and Organochlorine Pesticide TMDL.

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. Missed sampling events will be rescheduled to maintain integrity of the characterization effort. Field monitoring data may be lost due to equipment failure; backup equipment will be available to minimize this problem. Apart from weather, unforeseen occurrences are random relative to water quality conditions. These occurrences will not affect long-term data analyses, except for effects from potential reduction in sample size.

Sampling Locations

Table 3 below lists the fixed network sampling sites by field ID, location description, and lat/long coordinates. Station locations are also present in Figure 1 and Figures C-1 through C-4.

The upstream sites – Upper Naneum Creek at Naneum Road, Cooke Creek at Cooke Canyon Road, and Coleman Creek at Coleman Road – are considered representative background sites. These sites are just at the downstream border of the Colockum Wildlife Area. Therefore wildlife could be a contributing factor to the fecal coliform load at these locations. These sites are upstream of homes, livestock operations, and croplands. These sites had the lowest fecal coliform density and the majority of the collected samples met Washington Class A Water Quality Standards.

Sampling sites at Mercer Creek at Kiwanis Park are located within the City of Ellensburg, and Wilson Creek at Sanders Road is outside city limits. Both sites are located downstream from Kittitas Reclamation District North Branch Canal, Cascade Canal, and Ellensburg Water Company Canal as well as farm land where cattle grazing and hay production takes place. Cooke Creek at Number 81 Road is located in the town of Kittitas also downstream from all three irrigation canals, farm fields, and grazing land.

The remaining sample sites are located south of I-90 downstream of the irrigation canals, wildlife areas, and cities of Ellensburg and Kittitas. Potential fecal coliform sources at these downstream sites include wildlife, human, livestock, and domestic pets.

Table 3. Sampling locations.

Field ID	Location Description	Latitude	Longitude
MC-1	Mercer Creek at Kiwanis Park	47.00542265	-120.5488525
WC-2	Wilson Creek at Sanders Rd.	47.01733	-120.51694
NC-3	Upper Naneum Creek at Naneum Rd.	47.01733433	-120.5169441
CKC-4	Cooke Creek Upper Basin (at Cooke Canyon Rd.)	47.08231169	-120.382076
CLC-5	Coleman Creek Upper Basin (at Coleman Rd.)	47.08469018	-120.3987994
CKC-6	Cooke Creek on number 81 Rd. (sample above irrigation input)	46.99330839	-120.4125213
EWC-7	Ellensburg Water Company Canal at Thrall Rd.	46.92672619	-120.4134625
CIC-8	Cascade Irrigation at Thrall Rd.	46.92706323	-120.3892261
JD-9	Johnson Drain at Ferguson Rd.	46.94427004	-120.4504495
PC-10	Park Creek at Ferguson Rd.	46.94630789	-120.4500371
CRC-11	Caribou Creek at South Ferguson Rd.	46.9524527	-120.452258
CKC-12	Cooke Creek at South Ferguson Rd.	46.95326	-120.45985
CLC-13	Coleman Creek at Moe Rd.	46.96296	-120.47723
CHC-14	Cherry Creek at Moe Rd.	46.93957621	-120.4765627
WWW-15	Wipple Wasteway at Moe Rd.	46.93367317	-120.4763895
WC-16	Wilson Creek at Thrall Rd.	46.92633	-120.50166
NC-17	Naneum Creek at Fiorito pond off Number 6 Rd.	46.93685	-120.50537
KRD-18	Kittitas Reclamation District Canal at Cooke Canyon Rd.	47.04915802	-120.3859645
WC-20	Wilson Creek East of Helen McCabe State Park	46.92390256	-120.50364062

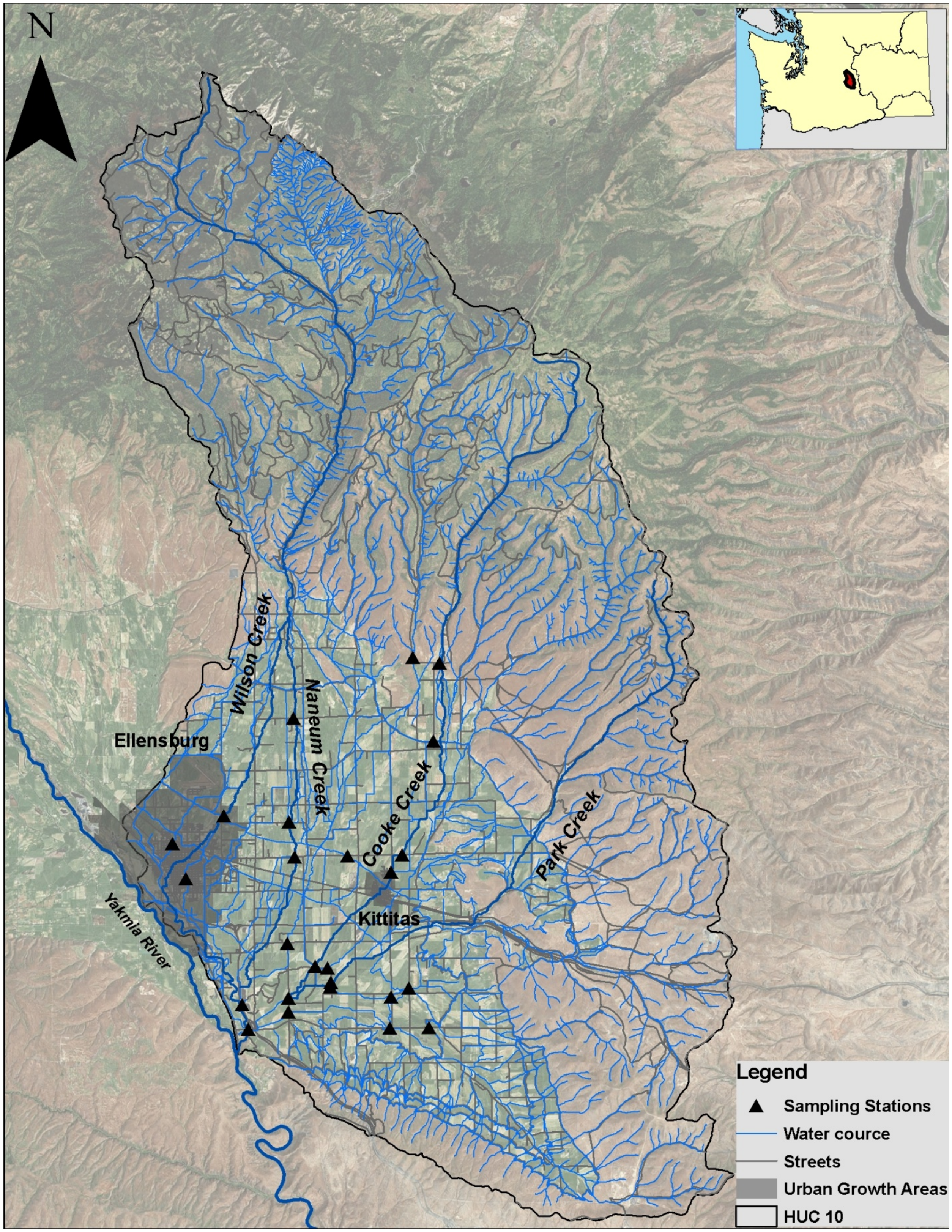

Figure 2. Wilson Creek sub-basin 2011 monitoring locations.

Verification Sampling

During the project, additional sites and/or samples will be added or sampled at the project manager's discretion if these will provide information to help meet the goals and objectives of the project. The addition of verification samples will largely be determined by data currently being collected. This will allow the project manager to immediately verify unexpected laboratory results or provide source identification and resolution.

Table 4. Verification sampling locations.

Field ID	Location Description	Latitude	Longitude
VCIC-1	Cascade Irrigation Canal at Vantage Hwy.	47.00013447	-120.4396838
VCC-2	Cooke Creek at Vantage Hwy.	47.0006613	-120.4056519
VJD-3	Johnson Drain at Badger Pocket Rd.	46.94382045	-120.4016957
VJD-4	Johnson Drain at Sorenson Rd.	46.94013044	-120.4126257
VNC-5	Naneum Creek at Radar Rd.	47.0589	-120.4733
VNC-6	Naneum Creek at Game Farm Rd.	47.0147	-120.4761
VNC-7	Naneum Creek at Vantage Hwy.	46.9996	-120.4727
VWC-8	Wilson Creek across from Lincoln School near Washington and Sampson St.	46.99035625	-120.540323
VWC-9	Wilson Creek at Umtanum Rd.	46.98110	-120.55158

Monitoring Partnerships

Split samples for total suspended solids (TSS) and turbidity (TURB) will be collected with Kittitas County Water Purveyors to gain information on the Upper Yakima River Basin Suspended Sediment, Turbidity and Organochlorine Pesticide TMDL.

TMDL Station Targets

Table 5 below outlines the percent reduction from each sampling site that is needed to meet Washington Class A Water Quality Standards for fecal coliform.

Table 5. Nonpoint source allocation targets.

Station Locations		TMDL Assessment (1999-2002)		Percent reduction needed to meet standards
Water Body Name	Station Description	GM	90th %tile	
Badger Creek[3]	above confluence with Wipple Wasteway	292	1,400	66.0%
Caribou Creek	at South Ferguson Rd.	428	3,000	78.50%
Cascade Irrigation District Canal	at Thrall Rd.	570	2,300	83.30%
Cherry Creek	at Moe Rd.	402	1,200	75.90%
Coleman Creek	at Moe Rd.	378	1,400	74.80%
Coleman Creek[2]	at Coleman Creek Rd.	22	91	0%
Cooke Creek	at #81 Rd.	492	5,900	81.40%
Cooke Creek	at South Ferguson Rd.	300	1,140	68.20%
Cooke Creek[2]	at Cooke Canyon Rd.	90	300	Bring 90% value up to standard
Ellensburg Water Company Canal	at Thrall Rd.	499	3,000	81.30%
Johnson Drain	at S. Ferguson Rd.	616	1,800	84.30%
Mercer Creek[1]	at Kittitas Reclamation District Canal	319	2,640	71.00%
Naneum Creek	at Fiorito Pond	265	620	62.80%
Naneum Creek[2]	at Naneum Rd.	9	42	0%
Parke Creek	at S. Ferguson Rd.	328	5,940	72.20%
Wipple Wasteway	at Moe Rd.	235	720	58.90%
Wilson Creek	at Sanders Rd.	552	1,000	81.70%
Wilson Creek	at Thrall Rd.	248	720	81.70%

[1] Site just upstream of 2011 monitoring site
[2] Background site
[3] Site downstream of 2011 monitoring site

Experimental Design

Bi-weekly sampling for fecal coliform, water temperature measurements, and any scheduled QA will be conducted from March through November at each of the 18 sample locations. The sample sites are included above in Table 3. Split samples for TSS and TURB will be collected with Kittitas County Water Purveyors every other sampling run as indicated by (Split Sample) at Naneum Creek at Naneum Road and Wilson Creek at Thrall Road.

Sampling Dates

March 21
April 5
April 20 (split samples)
May 2
May 17 (split samples)
June 1
June 14 (split samples)
June 29
July 12 (split samples)
July 27
August 9 (split samples)
August 22
September 7
September 20 (split samples)
October 3
October 18 (split samples)
November 1
November 15

Project Schedule

Table 6. Proposed schedule for completing field and laboratory work, entering data into EIM, and writing reports.

Field and laboratory work	Due date	Lead staff
Field work completed	December 2011	Kristin Carmack/Jenna Durkee
Laboratory analyses completed	December 2011	
Environmental Information System (EIM) database		
EIM user study ID	JDURK0001	
Product	Due date	Lead staff
EIM data loaded	February 2012	Jenna Durkee
EIM quality assurance	March 2012	Eiko Urmos-Berry
EIM complete	April 2012	Jenna Durkee
Final report		
Author lead / Support staff	Jenna Durkee	
Schedule		
Draft due to supervisor	September 2012	
Draft due to client/peer reviewer	November 2012	
Draft due to external reviewer(s)	December 2012	
Final (all reviews done) due to publications coordinator	December 2012	
Final report due on web	February 2013	

Project Costs

Table 7. Project costs.

Parameter	Cost per Sample	# Samples	Lab Verification Costs	Total Cost
Fecal Coliform	$23.88	426	$1200.00	$11,372.00
TSS	$11.42	16	$20.00	$202.72
TURB	$11.42	16	$20.00	$202.72
Travel				$500.00
				$12,277.44

Quality Objectives

Measurement Quality Objectives

Table 8. Measurement quality objectives.

Parameter	Check standard (LCS) % recovery limits	Duplicate Samples RPD	Lowest concentration of interest
Fecal Coliform	N/A	40	1 cfu/100 mL
TSS	80-120	20	1 mg/L
TURB	95-105	20	1 NTU

Sampling Procedures

Measurements

Water temperature will be measured at each site using alcohol thermometers following Ecology's Environmental Assessment Program's Standard Operating Procedure EAP-011 Instantaneous Measurement of Temperature in Water.

Samples will be processed by Manchester Environmental Lab using method SM9222D for fecal coliform, SM2540D for TSS, and SM2130 for turbidity (MEL, 2008).

Sampling

Sampling procedures for fecal coliform will follow the Environmental Assessment Program's Standard Operating Procedure (SOP) EAP-030 for the Collection of Fecal Coliform Bacteria Samples in Surface water. Duplicate fecal coliform samples will be collected for 10% of the samples using side-by-side collection following EAP-030 SOP.

Starting on April 20, 2011 and continuing monthly until October 18, side-by-side total suspended solids (TSS) and turbidity (TURB) samples will be collected with Kittitas County Water Purveyors, following EAP-015.

After collection, the samples will be placed on ice to cool. Just before shipping, the samples will be placed in a cooler with 8-10 blue ice and packing material to decrease damage while in transport. The samples will be shipped via Horizon Air from Yakima to Seattle where a Manchester Laboratory courier will transport the samples to Manchester Laboratory. See Manchester Laboratory's Users Manual Ninth Edition for other shipping specifics.

Table 9. Sample containers.

Parameter	Container	Sample Size	Preservation	Holding time
Fecal coliform	250 mL glass/polypropylene autoclaved bottle	Fill to bottle shoulder	Cool to ≤ 10°	24 hours
TSS	1000 mL w/m poly bottle	Fill to bottle shoulder	Cool to ≤ 6°	7 days
TURB	500 mL w/m poly bottle	Fill to bottle shoulder	Cool to ≤ 6°	48 hours

The Wilson Creek Sub-basin is an area of moderate concern for the spread of invasive species. Sampling staff will follow the Environmental Assessment Program Standard Operating Procedure EAP071 for minimizing the spread of aquatic invasive species.

Quality Control Procedures

Manchester Laboratory will be required to conduct one fecal coliform method blank per batch and one lab replicate per ten samples collected. A field replicate of the water temperature will be taken once per sampling event.

Table 10. Quality control.

Parameter	Field Replicates	Lab Method Blanks	Lab Replicates*
Fecal coliform (MF)	1/10 samples	1/batch	1/20 samples
Water Temperature	1/event	NA	NA
TSS	1/10 samples	1/batch	1/20 samples
TURB	1/10 samples	1/batch	1/20 samples

*1/20 samples for samples from this project. Note each batch must have a lab replicate performed regardless of batch size, so frequency could be greater than 1/20.

Corrective Actions

If quality control problems occur with the fecal coliform samples, the field lead and Manchester Laboratory will be in contact as soon as possible to discuss the causes of the issue and a solution. If problems are occurring with the field equipment, the accuracy of the equipment will be checked using a side-by-side comparison and appropriate measures will be taken. If data is in question it will be qualified.

Data Management Procedures

Laboratory Data

Manchester Environmental Laboratory will provide analytical data in the form of a Laboratory Information Management System (LIMS) batch in EIM. The field lead will enter corresponding location data and other information necessary to complete an EIM submittal. The LIMS batch will then be loaded into EIM. A field assistant will also check the analytical data, comparing a final report sent by the lab to the data in EIM by first checking 10% of the data and then an additional 10% if errors are found.

Laboratory Reports

Manchester Laboratory will provide fecal coliform data in the form of a final report emailed to the project manager as well as a LIMS batch to be entered into EIM.

Field Data

Field data will be recorded into an EIM Excel spreadsheet as soon as possible after each sample run. The data will be checked for accuracy throughout sampling. At the end of sampling, the data will be loaded into EIM by the field lead and checked for accuracy by a field assistant. 10 % of the data will be checked. If any errors exist, an additional 10% will be checked until no errors are found.

Audits and Reports

Manchester Environmental Laboratory conducts performance and system audits on procedures. Audit records are available by request.

After sampling is done, a final report will be completed by February 2013.

Data Verification and Usability Assessment

Data Verification

Staff will check field data for completeness and accuracy before leaving each site. Field data will be logged in EIM format and checked for accuracy as soon as possible upon return from the field.

Data Verification and Usability will follow the guidelines in Manchester Laboratory's Users Manual, Ninth Edition. Data review will be performed by the unit supervisor or an experienced analyst. Lab replicates and lab method blanks will be considered and data will be qualified accordingly. Data will be checked for errors in units, calculations, dilutions, dates, and transcription errors. If there are any problems with the data corrections, reanalysis will be made, if possible. If not, data will be qualified.

Upon completion of sampling, the field lead will enter lab and field data into EIM. A field assistant will then check data, following EIM guidelines. 10% of the data will be initially checked followed by an additional 10% if any errors are found.

Data Usability Assessment

Lab-assigned data qualifiers and field replicate data will be considered in data analysis. Fecal coliform counts will be compared to previous data, to look for improvement or deterioration of conditions. Water temperatures will be graphed in Excel to show temperature fluctuation over time. The field lead will be responsible for data analysis.

Project Organization

Ecology employees who will contribute to this project are listed in Table 13. All persons listed on the signature approval page are responsible for reviewing and approving the final Quality Assurance Project Plan.

Table 11. Organization of project staff and responsibilities.

Staff (EAP unless noted otherwise)	Title	Responsibilities
Jane Creech Water Quality Program Central Regional Office Phone (509) 454-7860	EAP Client	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Charles McKinney Water Quality Program Central Regional Office Phone (509) 457-7107	Client's Section Manager	Approves the QAPP.
Jenna Durkee Eastern Section Phone (509) 454-7865	Project Manager/ Principal Investigator/Field Lead	Collects data, conducts QA review of data, analyzes and interprets data, and prepares data for upload to EIM. Writes the QAPP, draft report, and final report.
Kristin Carmack Eastern Section Phone (509) 454-4243	Field Lead	Collects data, conducts QA review of data.
Jenna Durkee Eastern Section Phone (509) 454-7865	EIM Data Engineer	Uploads data into EIM.
Jenifer Parsons Eastern Section Phone (509) 457-7136	Project Manager's Section Manager	Reviews the QAPP and draft technical memo. Approves the QAPP, project budget, and technical memo.
Joel Bird Manchester Environmental Laboratory Phone (360) 871-8801	Director	Approves the final QAPP.
William R. Kammin Phone (360) 407-6964	Ecology Quality Assurance Officer	Reviews the draft QAPP and approves the final QAPP.

EAP: Environmental Assessment Program
EIM: Environmental Information Management database
QA: Quality Assurance
QAPP: Quality Assurance Project Plan

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Appendices

Appendix A. Glossary, Acronyms, and Abbreviations

Glossary

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.

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 waters' 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 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. 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).

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.

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.

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.

Total Maximum Daily Load (TMDL): A water cleanup plan. A distribution of a substance in a water body 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.

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 practices
Ecology	Washington State Department of Ecology
EPA	U.S. Environmental Protection Agency
NPDES	(See Glossary above)

NTU	Turbidity, Nephelometric Turbidity Units
TMDL	Total Maximum Daily Load
TSS	Total Suspended Solids
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resources Inventory Area

Units of Measurement

cfu	Colony Forming Units per 100 milliliters
mL	milliliters
mg/L	milligrams per liter (parts per million)

Appendix B. Supplementary Tables

Table B-1. Wilson Creek sub-basin 303(d) listed parameters and stream segments.

Water Body Name	Parameter	Listing Detail	Category
BADGER CREEK	Fecal Coliform	6934	4A
	pH	50691	2
BULL DITCH DIVERSION	pH	50700	5
CARIBOU CREEK	Fecal Coliform	10052	4A
	Temperature	35354	2
	Temperature	48433	5
	pH	50673	2
CASCADE IRRIGATION DISTRICT CANAL	Temperature	35355	2
	Temperature	35356	2
	Fecal Coliform	45673	4A
	Fecal Coliform	45931	2
	pH	50662	2
CHERRY CREEK	DDT	8934	4A
	4,4'-DDE	8935	4A
	Dieldrin	8936	4A
	Temperature	9616	2
	Fecal Coliform	10035	4A
	pH	16115	2
COLEMAN CREEK	Fecal Coliform	6925	4A
	Temperature	48437	5
	pH	50692	2
COOKE CREEK	Fecal Coliform	6721	4A
	Fecal Coliform	6722	4A
	Fecal Coliform	6923	4A
	Dissolved Oxygen	8348	2
	Temperature	8349	5
	Dissolved Oxygen	8350	5
	Temperature	8351	2
	Fecal Coliform	10038	4A
	Fecal Coliform	10039	4A
	Temperature	11852	5
	Temperature	35358	5
	Fecal Coliform	45806	4A
	Fecal Coliform	46830	4A
	Fecal Coliform	46831	4A
	Fecal Coliform	46833	4A
	Fecal Coliform	46870	4A
	Fecal Coliform	46871	4A
	Fecal Coliform	46872	4A
	Dissolved Oxygen	47362	2
	pH	50674	2
CRYSTAL CREEK	Fecal Coliform	6720	4A
	Dissolved Oxygen	8353	2
	Chlorine	8937	4A
	Ammonia-N	8938	4A
ELLENSBURG WATER COMPANY CANAL	Fecal Coliform	10045	4A
MERCER CREEK	Fecal Coliform	10046	4A

Water Body Name	Parameter	Listing Detail	Category
	Temperature	15058	2
	Temperature	15063	2
	Temperature	35361	2
	Temperature	35362	2
	Fecal Coliform	45674	4A
	pH	50711	2
	Fecal Coliform	6930	4A
NANEUM CREEK	Temperature	7315	5
	Temperature	9632	2
	Fecal Coliform	10041	4A
	Fecal Coliform	45241	4A
	Dissolved Oxygen	47382	2
	Temperature	48438	5
	Temperature	48439	5
	Temperature	48440	5
	pH	50694	5
	pH	50695	5
PARKE CREEK	Temperature	35360	2
UNNAMED DITCH (TRIB TO COOKE CREEK)	Fecal Coliform	45944	2
WEST SIDE CANAL	Fecal Coliform	45676	5
	Dissolved Oxygen	47391	2
	pH	50703	5
	pH	50719	5
WHISKEY CREEK	Fecal Coliform	6931	4A
WILSON CREEK	Fecal Coliform	6719	4A
	Fecal Coliform	6929	4A
	Temperature	8346	5
	Dieldrin	8919	2
	Fecal Coliform	10047	4A
	Fecal Coliform	10048	4A
	pH	11228	5
	Temperature	15060	2
	Temperature	15061	2
	Dissolved Oxygen	16110	2
	Fecal Coliform	16814	4A
WILSON CREEK, WEST	Fecal Coliform	45822	4A
WIPPLE WASTEWAY	Fecal Coliform	6922	4A
	Fecal Coliform	6932	4A
	Fecal Coliform	6933	4A
	Temperature	15056	2
	Temperature	35363	2
	4,4'-DDE	40718	4A
	Dieldrin	40719	4A
	Fecal Coliform	45186	4A
	pH	50664	5

Table B-2. Wilson Creek sub-basin Detailed Implementation Plan Summary.

Table 2: Primary Sources of FC in the Wilson Creek Sub-basin, Recommended Actions, Milestones, and Groups Responsible for Implementation.

Source Group	Specific Source	Explanation	Mode of transport[1]	Actions	Priority[2]	Milestone(s)	Group	Performance measures: What	Performance measures: When
Human waste	Failing on-site septic systems	Home septic system is failing or inadequate , and untreated sewage seeps into adjacent waterway	Both	Information and education program	H	Inform public about septic system maintenance	Ecology, KCPH	One informational mailing each year, one article in newspaper each year. Hold one public workshop each year re: failing septic systems	Annually
				Identify inadequate / failing systems	H	Locate faulty systems	Waterfront property owners, Ecology	Faulty systems identified and reported to KCPH	As found
				Address failing septic systems through technical assistance, recommend financial assistance programs	H	Address all known failing septic systems	KCPH	All requested technical assistance provided re: replacement of failing on-site septic systems	As needed
								All repairs to existing septic systems tracked & reported	Annually
				Financial assistance for septic system repair and replacement	M	Provide zero- and low-interest loans (and grants where possible) to landowners	KCPH, Ecology	All loans awarded for septic system repair or replacement tracked, alls numbers reported	Annually
				Property owners repair/replace faulty systems	H	Fix all known faulty systems	Waterfront property owners	All known faulty systems fixed each year	Annually

[1] Mode of transport indicates how FC is transported to water body – can be *direct* (animal deposits waste directly into water), *indirect* (waste deposited on land and washed into water), or *both*.
[2] Priority indicates which projects should be addressed first with limited resources. H = high, M = medium, L = low.

Source Group	Specific Source	Explanation	Mode of transport[1]	Actions	Priority[2]	Milestone(s)	Group	Performance measures	
								What	When
Human waste (cont.)	Direct connections ("Straight pipes")	Incorrect connection of sewer lines to natural water bodies, storm drains or irrigation waterways	Direct	Identify & replace inadequate/faulty systems; in cities, can use smoke and dye tests on storm drains	H	Locate and remove direct connections	Landowners, Ecology	All direct connections removed as they are found	Ongoing
	Sewer lines	Sewer lines can break or leak; sewage seeps into water body	Direct	Maintain municipal sewer lines	H	Monitor and repair any sewer line leaks or blockages	City of Ellensburg, City of Kittitas	City sewer lines flushed and inspected each year, per city's schedule	Annually
	Waste-water treatment plant	Operational failure could occur at Kittitas wastewater treatment plant (though not anticipated)	Both	Continue to monitor FC in effluent.	H	Meet requirements of NPDES permit	City of Kittitas	Discharge Monitoring Reports (DMRs) submitted as required	Monthly
				Report limit violations and report problems (if any)	H	Meet requirements of NPDES permit	City of Kittitas	All NPDES violations and their resolutions reported to Ecology	Ongoing

Source Group	Specific Source	Explanation	Mode of transport[1]	Actions	Priority[2]	Milestone(s)	Group	Performance measures	
								What	When
Domestic Animals	Pets	Animals deposit waste near waterways, waste is transported into water via overland flows	Indirect	Collect and properly dispose of any pet waste that can pollute a water body	M	Educate public re: pet waste	Ecology, City of Ellensburg, Kittitas County	1 set of educational materials re: pet waste management provided to all residents of Wilson Cr Sub-basin each year	Annually
						Provide way to properly dispose of pet waste	City of Ellensburg, WA State Parks	Pet waste collection bags are available at all parks in sub-basin	Ongoing
		Landowner dumps pet waste into water body	Direct	Dispose of waste properly	H	Educate public re: pet waste disposal and state WQ laws	Ecology, City of Ellensburg, Kittitas County	No pet waste is dumped in water bodies	Annually
						Pet waste properly disposed of	Pet owners	No pet waste is dumped in water bodies	Always
	Livestock	Provide education, technical and financial assistance to livestock managers	NA	Increase awareness among livestock managers	H	Educational mailings	Ecology, KCCD, WSU Extension	1 educational mailing each year	Annually
						Workshops and meetings	Ecology, KCCD, WSU Extension	1 workshop or meeting re: FC reduction	Annually
						Provide specific technical and financial assistance re: BMPs to livestock managers	KCCD, NRCS, WSU Extension, KCWP	All livestock managers who seek help are given financial and technical assistance	Annually

Source Group	Specific Source	Explanation	Mode of transport[1]	Actions	Priority [2]	Milestone(s)	Group	Performance measures	
								What	When
Domestic Animals (cont.)	Livestock (continued)	Livestock deposit waste in waterways	Direct	Limit access to streams and reduce time livestock spend in all waterways	H	Prevent livestock from lingering in water bodies, using fencing (**riparian grazing**[3] may be used in some situations)	Livestock managers	10% more livestock managers use some type of FC reduction BMPs each year	Annually
		Livestock deposit waste on land, overland flows transport FC into water body	Indirect	Protect and/or revegetate riparian areas[4]	M	Healthy riparian areas filter runoff	Livestock managers	10% more livestock managers use some type of FC reduction BMPs each year	Annually
				Minimize runoff	M	Irrigated runoff from pastures is reduced	Livestock managers	10% more livestock managers use some type of FC reduction BMPs each year	Annually
		Landowner dumps manure into water body (as disposal method)	Direct	Use appropriate manure disposal BMPs	H	All livestock manure is properly disposed of	Livestock managers	All livestock manure is properly disposed of	Always

Source Group	Specific Source	Explanation	Mode of transport[1]	Actions	Priority [2]	Milestone(s)	Group	Performance measures	
								What	When
Wildlife	On land	Wildlife FC transported into water body during run-off events	Indirect	Provide education and financial assistance to area residents re: BMPs that will help reduce impacts on water bodies of land-deposited wildlife FC. BMPs include protection and revegetation of riparian areas[5]	L	Public education and financial assistance re: riparian protection / revegetation is provided	Ecology, KCCD, WSU Extension, WDFW	Number of land owners requesting technical /and financial assistance with riparian restoration	Report annually
								Number of presentations re: riparian restoration made at workshops	Report annually
				Implement municipal stormwater BMPs	L	Wildlife FC input from cities is reduced	City of Ellensburg, City of Kittitas	Compliance with municipal stormwater permit	As required by permit
	In/on/over water	Waterfowl, muskrats, birds and other warm-blooded animals defecate directly into water	Direct	Revegetation of riparian areas with tree/bushes can discourage use of water body by waterfowl	L	Increased protection and revegetation of riparian areas	Shoreline landowners	Number of landowners participating in riparian restoration using trees/bushes	Ongoing
				Don't feed wild waterfowl[6]	L	Wild waterfowl not fed as pets	Everyone	Wild waterfowl remain wild	Always
		Large game animals (e.g., elk) deposit manure into water bodies (canals and streams)		Provide off stream water for large game animals	L	Less entry of large game animals into streams	Big Game Management Roundtable, WDFW	Fewer large game animals linger in waterways	Ongoing

[5] Healthy riparian areas filter runoff through non-compacted soils, grasses and forbs also help with some filtration.
[6] Feeding wild waterfowl encourages these animals to remain in area

Source Group	Specific Source	Explanation	Mode of transport[1]	Actions	Priority [2]	Milestone(s)	Group	Performance measures	
								What	When
All	All	Some actions are consistent with all types of FC sources and transport mechanism	Both	Inform recreational users about FC pollution	H	Educate recreational users of local water bodies re: FC pollution in streams	Ecology, KCPH	Two educational events and/or mailings each year	Annual
				Issue NPDES and state permits (including stormwater)	H	Issue permits for all discharging facilities with limits to protect water quality	Ecology	Where possible, all required permits are issued	As needed
				Conduct TMDL effectiveness monitoring	M	Demonstrate that FC reductions are occurring	Ecology and partners	All appropriate samples are collected and analyzed for FC and *E. coli*; implementation information collected.	2010, 2015, 2020
				Hold implementation progress meetings	M	Track implementation progress and coordinate efforts between organizations	Ecology	Implementation progress is documented on a regular basis	Annually or as needed

Source Group	Specific Source	Explanation	Mode of transport[1]	Actions	Priority [2]	Milestone(s)	Group	Performance measures	
								What	When
Unknown	Unknown	Not all sources of FC are clearly identified; also relative contribution of sources not known with precision	Both	Identify sources through microbial source tracking (MST), if necessary	M	Investigate MST labs and methods for identifying any remaining unknown sources	Ecology, other interested parties	Latest advances in MST are consistently researched and distributed to interested parties	When available
							Ecology	TMDL workgroup is reconvened as needed, to learn about MST methods	When available
						Conduct selected MST method	To be determined by step above	When approved by Ecology, MST research is conducted in areas of unknown sources	When needed
				Identify sources through water quality sampling	M	Monitor stream segments to narrow sources within 5 years	Ecology, other groups	FC densities monitored and findings reported, as required	By 2011

Table 3: Secondary Sources of FC in the Wilson Creek Sub-basin, Recommended Actions, Milestones, and Groups Responsible for Implementation.

Source Group	Specific Source	Mode of transport [1]	Explanation	Priority [2]	Actions	Milestone(s)	Group	Performance measures	
								What	When
Resuspension / Regrowth of Bacteria in Waterways	Domestic animals walking in water body	Direct	Stirs up sediment and disturbs bacteria in bottom sediments, transports bacteria	M	Limit access to streams and reduce time livestock spend in all waterways	Educate public re: benefits of keeping domestic animals out of water bodies	KCCD, KCPH, Ecology, KCWP, WSU Extension	Better public understanding of importance of livestock management BMPs	Ongoing
						Prevent livestock from lingering in water bodies, using fencing (riparian grazing[3] may be used in some situations). Limit domestic animal use of water bodies	Livestock owners, pet owners	10% more livestock managers use some type of FC reduction BMPs each year	Ongoing
	Wildlife walking in water body	Direct	Large game animals (e.g., elk) stir up sediment, transports bacteria	L	Provide off stream water for large game animals	Less entry of large game animals into streams	Big Game Management Roundtable, WDFW	Fewer large game animals linger in water bodies	Ongoing
	Water crossings (vehicles or livestock)	Direct	Stirs up sediment, transports bacteria	L	Limit water crossings with vehicles	Educate public re: avoiding driving vehicles in water bodies unless absolutely necessary	All	Public reduces water crossings with vehicles	Ongoing

[1] Mode of transport indicates how FC is transported to water body – can be *direct* (animal deposits waste directly into water), *indirect* (waste deposited on land and washed into water), or *both*.
[2] Priority indicates which projects should be addressed first with limited resources. H = high, M = medium, L = low.
[3] Information and guidelines on riparian grazing can be found in Appendix D.