DEPARTMENT OF
ECOLOGY
State of Washington

Quality Assurance Project Plan

Deadman, Meadow, and Alpowa Creeks Fecal Coliform, Dissolved Oxygen, pH, and Temperature Straight-to-Implementation Monitoring

April 2012

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Publication 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 Ecology's website at www.ecy.wa.gov/biblio/1203102.html.

Data for this project will be available on Ecology's Environmental Information Management (EIM) website at www.ecy.wa.gov/eim/index.htm. Search User Study ID, tist0001.

Ecology's Activity Tracker Code for this study is 12-063.

Waterbody Numbers have not been assigned to the streams included in this project.

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Quality Assurance Project Plan

Deadman, Meadow, and Alpowa Creeks
Fecal Coliform, Dissolved Oxygen, pH, and Temperature
Straight-to-Implementation Monitoring

April 2012

Approved by:

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Signatures are not available on the Internet version.
ERO: Eastern Regional Office
EAP: Environmental Assessment Program
EIM: Environmental Information Management database

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Abstract

Deadman Creek, Meadow Creek, and Alpowa Creek do not meet Washington State water quality standards for low dissolved oxygen, high pH, excessive fecal coliform, and excessive stream temperatures. They are included on Washington State's 2008 303(d) list. The Washington State Department of Ecology intends to address these water quality listings through Straight-to-Implementation (STI).

To assist with this STI, data pertinent to these parameters will be collected to establish a baseline for future effectiveness monitoring (EM) and for comparison to past data. Parameters to be monitored include fecal coliform, total suspended solids, alkalinity, ammonia, nitrite-nitrate nitrogen, total persulfate nitrogen, ortho-phosphorus, and total phosphorus. Continuous temperature, pH, dissolved oxygen, and conductivity data will also be collected.

Background

Straight-to-Implementation

The Department of Ecology (Ecology) intends to address water quality impairments on Washington's 2008 303(d) list in the Deadman Creek, Meadow Creek, and Alpowa Creek watersheds through Straight-to-Implementation (STI) in lieu of a Total Maximum Daily Load **(**TMDL). The STI approach minimizes the need for extensive technical study where the causes of water quality problems are well-documented and the solutions already known. STI is typically used in watersheds where either the vast majority or all of the pollution is nonpoint, with few or no point source contributions. Ecology's Water Quality Program (WQP) staff in the Eastern Regional Office will develop an STI plan detailing what needs to be done in the watershed to meet water quality standards in parallel with this sampling effort.

Study Area Description

Deadman Creek, Meadow Creek, and Alpowa Creek are tributaries of the Snake River, located in WRIA 35 in southeastern Washington (Figure 1). Deadman Creek drains 135 mi^2 and Meadow Creek drains 69 mi^2 of an area located between Pomeroy and the Snake River. Both streams empty into the Snake River at Central Ferry. Alpowa Creek drains a 129 mi^2 area west of Clarkston, emptying into the Snake River near Chief Timothy State Park.

All three watersheds are located entirely within the Columbia Plateau ecoregion, and none of the watersheds has a significant amount of forested area. Land use within the three watersheds is dominated by agriculture and range. Most of the study area is privately owned. The largest manager of public lands is the Washington Department of Natural Resources, which owns approximately 2 mi^2 in each township (typically sections 16 and 36) throughout all three watersheds.

There are no major impoundments or NPDES point sources with direct discharges to any water body in the three watersheds. NU Chem LTD at Central Ferry has an industrial stormwater general permit on lower Deadman Creek (Permit #WAR001061).

A significant amount of riparian restoration and Best Management Practices (BMPs) have been implemented in the Deadman, Meadow, and Alpowa watersheds. However, much of the watershed remains without adequate riparian vegetation or BMPs (Atkins, personal communication).

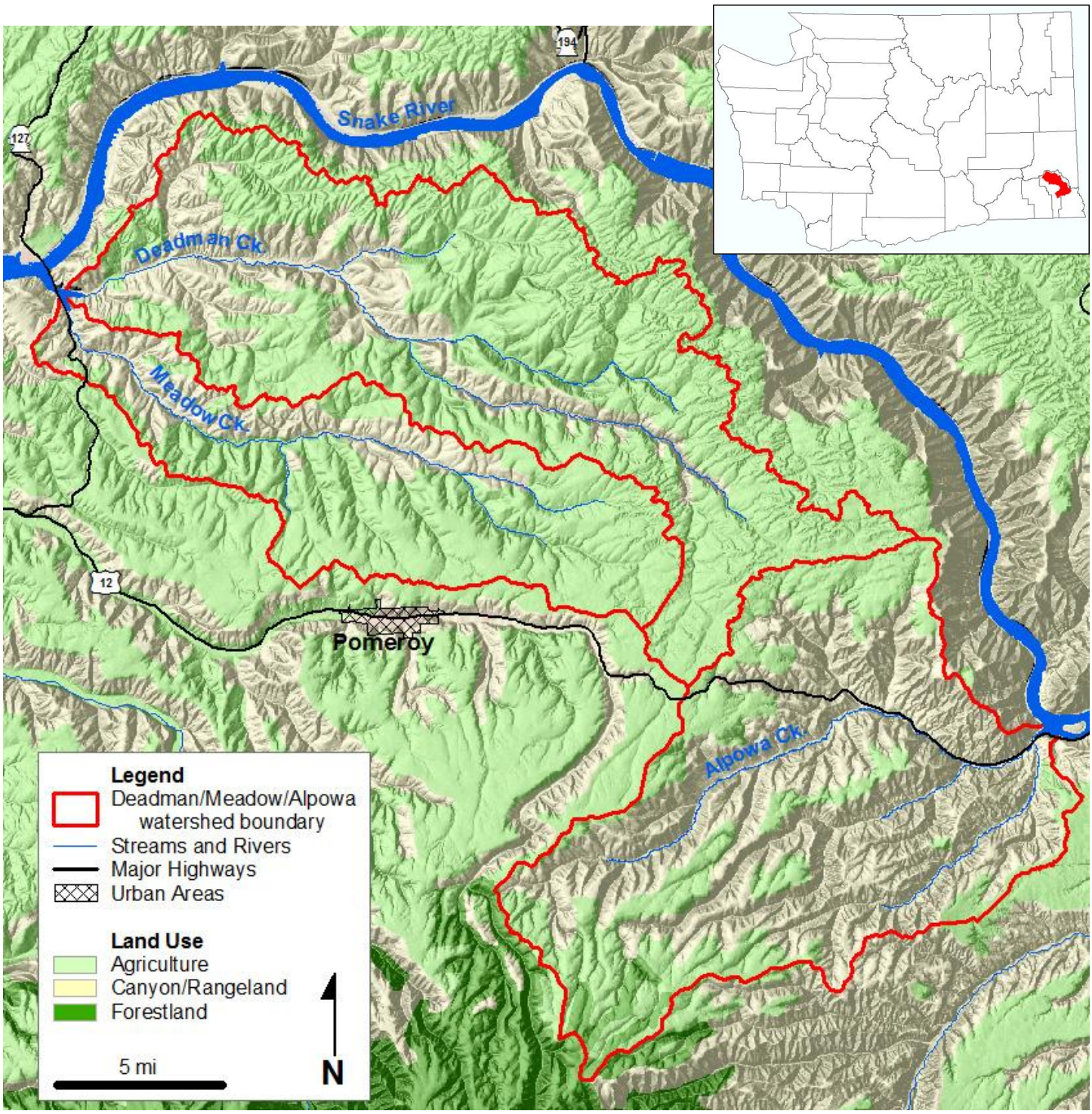

Figure 1. Location of the Deadman, Meadow, and Alpowa watersheds in southeastern Washington.

Land Use: USGS/GIRAS Land Use/Land Cover.

Water Quality Impairments

Monitoring conducted by Washington State University (WSU) and the Washington Department of Fish and Wildlife (WDFW) led to the listing of two segments of Deadman Creek, four segments of Meadow Creek, and one segment of Alpowa Creek for four parameters on the 303(d) list during the 2008 Water Quality Assessment. Table 1 presents 303(d) listings for all parameters in the Deadman, Meadow, and Alpowa watersheds.

Table 1. 303(d) listings in the Deadman, Meadow, and Alpowa watersheds.

Water Body	Listing ID	Parameter	Listing Category	Waterbody ID	Township	Range	Section
Deadman Creek	40553	Fecal Coliform	5	1178006466242	13N	40E	14
Deadman Creek	47174	Dissolved Oxygen	5	1178006466242	13N	40E	14
Deadman Creek	50475	pH	5	1178006466242	13N	40E	14
Deadman Creek	18829	Temperature	5	1178006466242	13N	40E	14
N. Deadman Ck.	50438	pH	5	1175832465906	13N	42E	19
N. Deadman Ck.	40535	Temperature	2	1175832465906	13N	42E	20
Meadow Creek	18830	Temperature	5	1177871466143	13N	40E	15
Meadow Creek	47172	Dissolved Oxygen	5	1177871466143	13N	40E	22
Meadow Creek	50473	pH	5	1177871466143	13N	40E	22
Meadow Creek	46000	Fecal Coliform	5	1177871466143	13N	40E	22
Meadow Creek	18831	Temperature	5	1177871466143	13N	40E	36
Meadow Creek	47173	Dissolved Oxygen	5	1177871466143	12N	42E	06
Meadow Creek	50474	pH	5	1177871466143	12N	42E	06
Meadow Creek	45999	Fecal Coliform	2	1177871466143	12N	42E	06
Alpowa Creek	47040	Dissolved Oxygen	5	1171999464202	11N	44E	25
Alpowa Creek	40556	Fecal Coliform	5	1171999464202	11N	44E	25
Alpowa Creek	40347	pH	5	1171999464202	11N	44E	25
Alpowa Creek	40538	Temperature	2	1171999464202	11N	43E	26
Alpowa Creek	40537	Temperature	2	1171999464202	11N	44E	17
Alpowa Creek	40536	Temperature	2	1171999464202	11N	44E	25

Existing Data

Pomeroy Conservation District and Washington State University have collaboratively collected water quality data from several sites in the Deadman, Meadow, and Alpowa watersheds from 1999-2006 (e.g. Baldwin, 2003). These data generally include fecal coliform and total suspended solids, as well as instantaneous measurements of water temperature, pH, dissolved oxygen, and streamflow. Additionally, Ecology's Freshwater Monitoring Unit (FMU) collected these same parameters as well as turbidity during four sampling runs in 2006-2007. Adequate fecal coliform and total suspended solids data may already exist up through 2007 at seven sites in the study area to provide a baseline. Existing instantaneous pH, dissolved oxygen, and temperature data are not usable for baseline comparison because these parameters exhibit a regular diel fluctuation. Continuous data are needed for these parameters.

Ecology's Stream Hydrology Unit (SHU) operates one continuous flow gaging station on Deadman Creek and one on Alpowa Creek. These units have been in operation since 2003. Continuous stream and air temperature are also collected at these stations. SHU also operated an

additional continuous gaging station on Deadman Creek from 2003-2010 and a staff gage station on Meadow Creek from 2003-2010.

Water Quality Standards and Beneficial Uses

The 2006 Water Quality Standards for Surface Waters of the State of Washington Chapter 173-201A WAC (Ecology, 2006a) designates all streams in the Deadman, Meadow, and Alpowa watersheds for the beneficial use, *Salmonid spawning, rearing, and migration.* This use protects salmon or trout spawning and emergence that only occur outside of the summer season (September 16 – June 14). Other uses include rearing and migration by salmonids. All streams in the three watersheds also have a designated recreational use, *Primary contact recreation*. This use protects humans during 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. Each beneficial use has associated water quality criteria. Table 2 lists the water quality criteria that are applicable in the Deadman, Meadow, and Alpowa watersheds.

Table 2. Water quality criteria applicable to the Deadman, Meadow, and Alpowa watersheds.

Parameter	Criteria
Fecal Coliform	Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies /100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies /100 mL.
Dissolved Oxygen	Dissolved oxygen concentration will not fall below 8.0 mg/L more than once every ten years on average. When a water body's DO is lower than 8.0 mg/L (or within 0.2 mg/L) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the DO of that water body to decrease more than 0.2 mg/L
pH	pH shall be within the range of 6.5 to 8.5 with a human-caused variation within above range of less than 0.5 units.
Temperature	7-day average of the daily maximum temperature (7-DADMax) will not exceed 17.5°C more than once every ten years on average. When a water body's temperature is warmer than 17.5°C (or within 0.3°C) and that condition is due to natural conditions, then human actions considered cumulatively may not cause the 7-DADMax temperature of that water body to increase more than 0.3°C.

In addition, supplemental temperature criteria have been established for two stream reaches in the study area to protect salmonid spawning and incubation. Table 3 summarizes these supplemental criteria.

Table 3. Supplemental temperature criteria for parts of Deadman and Alpowa Creeks.

Description of Stream Reach	Criteria
Deadman Creek from a point ~1 mile upstream of Breakdown Rd. to the mouth	Maximum 7-DADMax temperature of 13°C between Feb 15 – Jun 1
Alpowa Creek from a point 0.1 mile upstream of the point of Darland Ridge (T11N R43E s 34) to a point ~1 mile upstream of the intersection of Hwy 12 and Alpowa Creek Rd.	

Project Description and Sampling Design

Goals and Objectives

Because much riparian restoration and BMP implementation work has already been completed but more is needed, this project has two goals:

- Establish a data baseline for comparison to future effectiveness monitoring (EM) data.
- Where possible, assess the effectiveness of riparian restoration work done thus far.

These goals will be accomplished by meeting the following objectives:

- Establish a baseline dataset for dissolved oxygen and pH by collecting nutrient and alkalinity data as well as continuous dissolved oxygen, pH, and conductivity near the mouth of each of the three watersheds.
- Update and augment existing fecal coliform, total suspended solids, and continuous temperature data by sampling in locations that will be best suited to assess the effectiveness of riparian restoration work. Use past sampling locations where possible to allow comparison to existing datasets in order to assess effectiveness of riparian restoration and BMPs implemented thus far.
- Collect datasets that are compatible with the statistical tools and guidance that have been developed by Cadmus for effectiveness monitoring (Cadmus, 2011a; Cadmus, 2011b; Cadmus, 2011c).

Sampling Design

The sampling design for this project is intended to function as a before/after study with upstream/downstream study elements in certain locations (Cadmus, 2011a). All of the data collected during this project will be usable as a "before" dataset. However some of the fecal coliform and total suspended solids data may also be usable as an "after" dataset in locations where enough previous data are available to make a comparison, particularly where significant riparian improvements have been implemented in recent years. Six of the proposed sampling locations for this project have extensive amounts of data on fecal coliform and total suspended solids collected over several years up through 2007. (A seventh site in the study area which has extensive past data is not being included in this project.)

Continuous dissolved oxygen, pH, and conductivity data as well as nutrient and alkalinity data will be collected using a pour point sampling design (Cadmus, 2011a). These parameters will be collected at three sites, one each near the mouth of Deadman, Meadow, and Alpowa Creeks.

Fecal coliform, total suspended solids, and continuous temperature data, which are less resource-intensive, will be collected using a distributed sampling design. These parameters will be collected at a few sites in each watershed. The sites chosen include sites where past data is available for comparison, sites that capture a subwatershed of interest, and sites that bracket particular land uses or anticipated implementation of BMPs. Site pairs which bracket particular

areas on the North Fork of Deadman Creek and on Alpowa Creek can be used for upstream/downstream as well as before/after comparison.

In addition to the sampling locations proposed, laboratory budget is set aside for up to two additional fecal coliform/total suspended solids sampling locations which may be added during the project for source tracking. Typically this would occur when preliminary data indicate a large pollutant load entering the stream between two sampling locations. The additional source tracking site would then be added between the two sampling locations in order to determine more specifically which stream reach the load was coming from. Because these sites, if they are used, will be added opportunistically during the project, continuous temperature will not be collected at these locations. The decision to add a source tracking site will be made in coordination with the Water Quality Program project lead, taking into account land uses, ongoing BMP implementation projects, site access, and other considerations.

Nutrient, fecal coliform, and TSS samples will be collected once per month from April 2012 to March 2013. Alkalinity samples will be collected once per month from May-September 2012. Instantaneous field measurements of flow, temperature, pH, DO, and conductivity will be taken concurrently with sample collection. Continuous temperature, pH, DO, and conductivity data will be collected by Hydrolab® Minisondes® which will be deployed continuously from May-September 2012. Continuous temperature data will be collected using Onset® Hobos® which will also be deployed from May-September 2012. Air temperature loggers will be co-located with selected water temperature loggers for quality assurance purposes. Table 4 presents the sampling locations that will be used in this project, and the data that will be collected at each location. Figure 2 shows a map of these sampling locations.

Table 4. Stream sampling locations.

Station ID	Station ID Alias[1]	Station Description	Latitude	Longitude	Nutrients / Alkalinity	Continuous Hydrolab	FC/TSS	Flow	Continuous Temperature	
									Water	Air
35DEA-02.6	35M060	Deadman Ck. near mouth	46.6186	-117.7606	X	X	X	X	[2]	X
35NFD-00.3	35NFDEADMAN	NF Deadman Ck. near mouth	46.5898	-117.5788			X	X	X	
35NFD-04.7	(none)	NF Deadman Ck. below DNR sec.	46.5747	-117.5029			X	X	X	
35NFD-09.5	35BELLPLAIN	NF Deadman Ck. at Bell Plain Rd.	46.5622	-117.4232			X	X	X	
35SFD-00.1	35SFDeadman	SF Deadman Ck. at mouth	46.5898	-117.5822			X	X	X	X
35MEA-00.9	35N050	Meadow Ck. at mouth	46.6030	-117.7837	X	X	X	X	[2]	X
35MEA-12.2	MEADOW CR 2	Meadow Ck. at Ben Day Gulch Rd.	46.5492	-117.6094			X	X	X	
35ALP-00.9	35K050	Alpowa Ck. at mouth	46.4122	-117.2133	X	X	X	[3]	[3]	[3]
35ALP-03.5	W35ALPC-1	Alpowa Ck. at Pow Wah Kee Gulch	46.4049	-117.2556			X	X	X	
35ALP-08.4	ALPOWA CR 2A	Alpowa Ck. at Knotgrass Grade Jct.	46.4236	-117.3347			X	X	X	X
(up to 2 additional sites for source tracking which may be added opportunistically during study)							X	X		

[1]The Station ID aliases are station IDs in EIM that were created during various earlier projects and do not follow a unified naming convention.
[2]Continuous water temperature is collected by the Hydrolab so an additional datalogger is not needed.
[3]Continuous flow, water temperature, and air temperature are collected by Ecology's Stream Hydrology Unit (SHU) at this site.

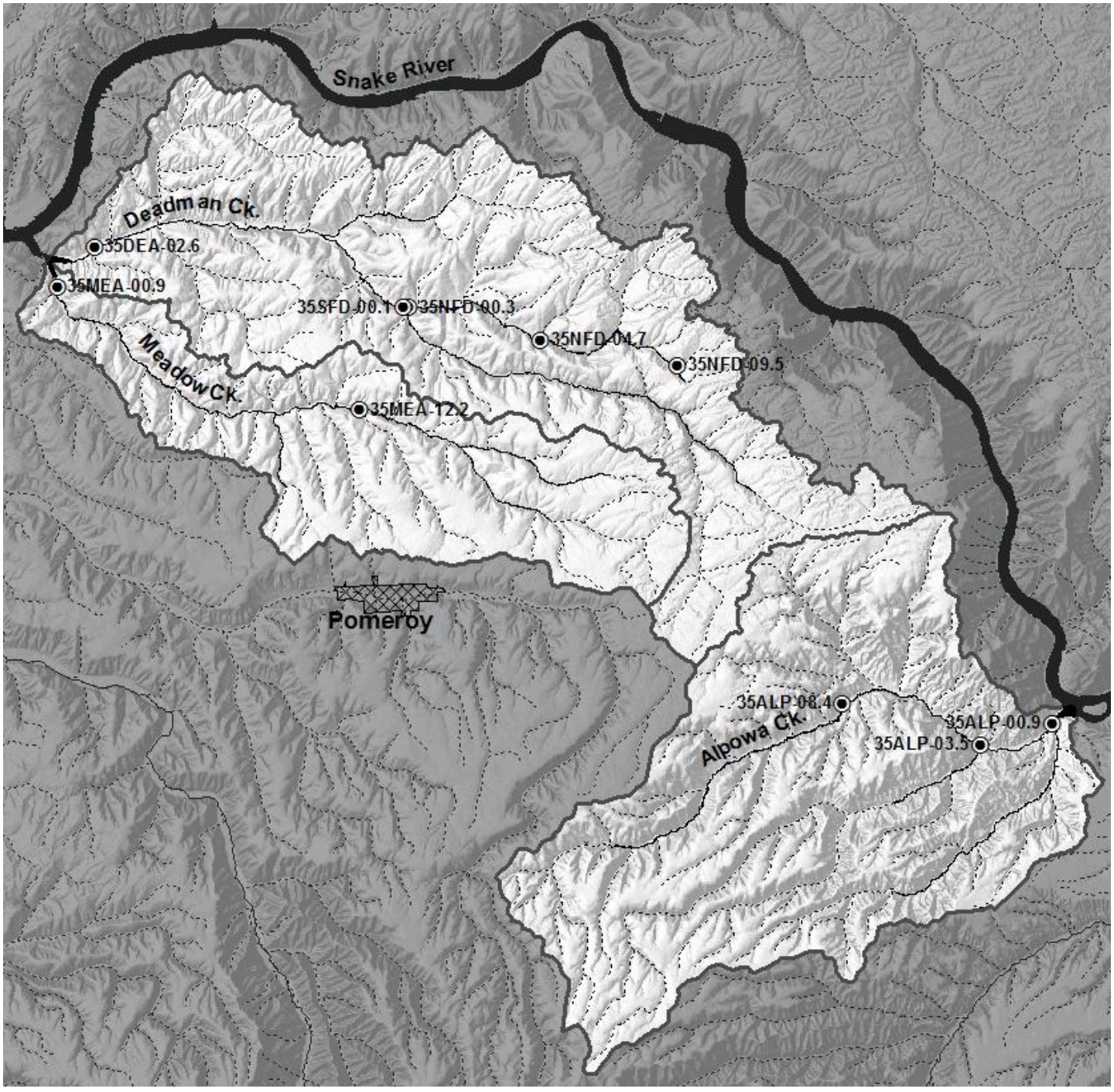

Figure 2. Map of stream sampling locations.

Organization and Schedule

Table 5 lists the people involved in this project. All are employees of the Washington State Department of Ecology. Table 6 presents the proposed schedule for this project. Table 7 gives the laboratory costs for this project.

Table 5. Organization of project staff and responsibilities.

Staff (all are EAP except client)	Title	Responsibilities
Chad Atkins Water Quality Program Eastern Regional Office Phone: 509-329-3499	EAP Client	Clarifies scopes of the project. Provides internal review of the QAPP and approves the final QAPP.
Tighe Stuart Eastern Regional Office Phone: 509-329-3476	Project Manager/ Principal Investigator/ EIM Engineer	Writes the QAPP. Oversees field sampling and transportation of samples to the laboratory. Writes the draft report and final report. Conducts QA review of data, analyzes and interprets data, and enters data into EIM.
Administrative Intern Eastern Regional Office Phone: TBD	Field Assistant	Helps collect samples and records field information. Assists with entry of data into EIM.
Gary Arnold Central Regional Office Phone: 509-454-4244	Section Manager	Reviews the project scope and budget, tracks progress, reviews the draft QAPP, and approves the final QAPP.
Dean Momohara Manchester Environmental Laboratory Phone: 360-871-8801	Interim 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
QAPP: Quality Assurance Project Plan

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

Field and laboratory work	Due date	Lead staff
Field work completed	3/2013	Tighe Stuart
Laboratory analyses completed	4/2013	
Environmental Information System (EIM) database		
EIM user study ID	ID number	
Product	Due date	Lead staff
EIM data loaded	10/2013	Tighe Stuart or intern
EIM quality assurance	11/2013	TBD
EIM complete	12/2013	Tighe Stuart
Final memo to client		
Author lead	Tighe Stuart	
Schedule		
Memo due to client	2/2014	

Table 7. Laboratory cost estimate.

Sample Type	Parameter	Sites	QA	Visits	Analytical cost per sample[1]	Subtotal
Surface Water	Nutrients[2]	3	1	12	$85	$4080
	Alkalinity	3	1	5	$19	$380
	Fecal Coliform	12[3]	2[4]	12	$26	$4368
	Total Suspended Solids	12[3]	2[4]	12	$13	$2184
					Total Laboratory Cost Estimate:	$11012

[1]Costs include 50% discount for Manchester Environmental Laboratory.
[2]Includes ammonia, nitrite-nitrate, total persulfate nitrogen, orthophosphate, and total phosphorus.
[3]Includes two hypothetical source tracking sites.
[4]This project has ten proposed sites. As long as only these ten sites are used, then only one QA per run will be necessary. If any additional sites are added for source tracking, then an additional QA site will be necessary as well.

Quality Objectives

By properly following laboratory and field standard operating procedures (SOPs), the quality objectives outlined in Table 8 should be met.

Table 8. Measurement quality objectives.

Analysis	Method	Accuracy	Precision RSD[1]	Bias	Reporting Limits
Field Measurements					
Streamflow	SOP EAP024	20%	20%	NA	
pH	SOP EAP033	0.2 s.u.[2]	0.2 s.u[2]	NA	1-14 s.u.
Temperature	SOP EAP033	0.2°C[2]	0.1°C[2]	NA	-5°C to 50°C
Temperature (Hobo®)	SOP EAP080	0.2°C[2]	0.1°C[2]	NA	-40°C to 70°C
Conductivity	SOP EAP033	10%	10%	NA	0.1 uS/cm
Dissolved Oxygen	SOP EAP033	4%	4%	NA	0.2 mg/L
Laboratory Analyses					
Total Persulfate Nitrogen	SM[3] 4500-N B	20%	<20%	+20%	25 ug/L
Ammonia Nitrogen	SM 4500-NH3 H	20%	<20%	+20%	10 ug/L
Nitrate & Nitrite Nitrogen	SM 4500-NO3 I	20%	<20%	+20%	10 ug/L
Orthophosphate (OP)	SM 4500-P G	20%	<20%	+20%	3 ug/L
Total Phosphorus (TP)	SM 4500-P F	20%	<20%	+20%	5 ug/L
Total Suspended Solids	SM 2540 D	20%	<20%	+20%	1 mg/L
Alkalinity	SM 2320 B	20%	<20%	+20%	20 mg/L
Fecal Coliform	MF 9222 D	35%	<40%	N/A	1 cfu/100 mL

[1] RSD: Relative Standard Deviation
[2] As units of measurement, not percentages.
[3] SM: Standard Methods for the Examination of Water and Wastewater, 20th Edition (APHA et al., 1998).

Sampling and Measurement Procedures

Field sampling and measurement protocols will follow those listed in an Environmental Assessment Program protocols manual (Ecology, 1993). Safety procedures detailed in the Environmental Assessment Program's Safety Manual (Ecology, 2006b) will be followed for all sampling.

Field measurements will follow approved Environmental Assessment Program SOPs (Ecology, 2012):

- EAP034 Collection, Processing, and Analysis of Stream Samples
- EAP013 Determining Global Positioning System Coordinates
- EAP011 Instantaneous Measurement of Temperature in Water
- EAP023 Winkler Determination of Dissolved Oxygen
- EAP033 Hydrolab® DataSonde and MiniSonde Multiprobes
- EAP015 Manually Obtaining Surface Water Samples
- EAP024 Estimating Streamflow
- EAP030 Fecal Coliform Sampling
- EAP071 Minimizing the Spread of Aquatic Invasive Species from areas of Moderate Concern
- EAP080 Continuous Temperature Monitoring of Fresh Water Rivers and Streams

Table 9 lists the sample size, containers, preservation, and holding time for each parameter in this study. Sample containers will be provided by Manchester Environmental Laboratory (MEL). Sample containers will be filled, tagged, and put on ice.

Table 9. Sample containers, preservation, and holding times.

Parameter	Sample Matrix	Container	Preservative	Holding Time
Alkalinity	Surface water	500 mL poly – no headspace	Cool to 4°C; Fill bottle *completely*; Don't agitate sample	14 days
Ammonia	Surface water	125 mL clear poly	H_2SO_4 to pH<2; Cool to 4ºC	28 days
Nitrate/Nitrite	Surface water	125 mL clear poly	H_2SO_4 to pH<2; Cool to 4ºC	28 days
Total Persulfate Nitrogen	Surface water	125 mL clear poly	H_2SO_4 to pH<2; Cool to 4ºC	28 days
Orthophosphate	Surface water	125 mL amber poly with Whatman Puradisc™ 25PP 0.45um filters	Filter in field with 0.45um pore size filter; Cool to 4°C	48 hours
Total Phosphorous	Surface water	125 mL clear poly	1:1 HCl to pH<2; Cool to 4°C	28 days
Fecal Coliform	Surface water	250 mL autoclaved clear poly	Cool to 4ºC	24 hours
Total Suspended Solids	Surface water	1000 mL clear poly	Cool to 4ºC	7 days

Quality Control Procedures

Continuous and instantaneous Hydrolab® meter measurements will conform to the quality control parameters in Table 10. Meter dissolved oxygen measurements will be compared to Winkler samples. Enough Winkler analyses will be performed during each sampling event or continuous Hydrolab® deployment to assess dissolved oxygen meter accuracy or correct results. A Winkler sample will be taken at each visit to a site with a continuously deployed Hydrolab®.

Conductivity and pH data will be verified using pre- and post-deployment calibration checks, which will be recorded and kept with field data. For continuously deployed Hydrolabs, conductivity and pH calibration will be checked and recalibrated each month throughout the deployment. Probe cleaning and maintenance will be performed after conductivity and pH post-checks but before recalibration. Dissolved oxygen will *not* ever be recalibrated mid-deployment, because only one Winkler sample will be taken each month, and multiple Winkler samples are needed to adequately check and/or correct the dissolved oxygen data. The Luminescent Dissolved Oxygen (LDO) probes are not expected to experience significant drift during deployment.

Table 10. Hydrolab® equipment individual probe quality control requirements.

Parameter	Replicate Samples	Field Calibration Check Standards	Calibration Drift End Check
Dissolved Oxygen	RPD[1] ≤ 20%	N/A	± 4%
Temperature	± 0.3 °C	N/A	N/A
Conductivity	RPD ≤ 10%	± 10 %	± 10%
pH	± 0.2 s.u.	± 0.2 s.u.	± 0.2 s.u.

[1]Relative Percent Difference

Total variability for laboratory analysis will be assessed by collecting replicate samples. Quality control measurements will be taken at intervals summarized in Table 11. MEL routinely duplicates sample analyses in the laboratory (lab duplicate) to determine laboratory precision. The difference between field variability and lab variability is an estimate of the sample field variability.

Field blanks and filter blanks will be submitted four times (quarterly) during the project to assess some areas of bias. Field and filter blanks will be made by sampling deionized water following exactly the same procedures used to take regular stream samples.

MEL will inform the project manager or principle investigator as soon as possible if any sample is lost, damaged, has a lost tag, or gives an unusual result.

Onset® Hobo datalogger calibrations will be checked before and after deployment using ice and warm temperature baths. In addition, continuous temperature data will be checked against monthly instantaneous temperatures measured with Hydrolabs.

Table 11. Field and laboratory quality control samples and intervals.

Analysis	Field Replicates	Check Standard	Method Blank	Duplicate	Matrix Spikes
Field Measurements					
Water Temperature	1/10 samples	N/A	N/A	N/A	N/A
Dissolved Oxygen	1/10 samples	N/A	N/A	N/A	N/A
Specific Conductivity	1/10 samples	1/run	N/A	N/A	N/A
pH	1/10 samples	1/10 samples	N/A	N/A	N/A
Laboratory Analyses					
Dissolved Oxygen (Winkler)	1/10 samples	N/A	N/A	N/A	N/A
Alkalinity	1/10 samples	1/batch	1/batch	1/20 samples	N/A
Total Nitrogen	1/10 samples	1/batch	1/batch	1/20 samples	1/20 samples
Ammonia Nitrogen	1/10 samples	1/batch	1/batch	1/20 samples	1/20 samples
Nitrate + Nitrite Nitrogen	1/10 samples	1/batch	1/batch	1/20 samples	1/20 samples
Orthophosphate	1/10 samples	1/batch	1/batch	1/20 samples	1/20 samples
Total Phosphorus	1/10 samples	1/batch	1/batch	1/20 samples	1/20 samples
Total Suspended Solids	1/10 samples	1/batch	1/batch	1/20 samples	1/20 samples
Fecal Coliform	1/10 samples	N/A	1/batch	1/20 samples	N/A

Data Management Procedures

Field measurement data will be entered into a field book with waterproof paper in the field and then entered into EXCEL® spreadsheets as soon as practical after returning from the field. This database will be used for preliminary analysis and to create a table to upload data into Ecology's EIM system.

Sample result data received from MEL by Ecology's Laboratory Information Management System (LIMS) will be added to a spreadsheet for laboratory results. This spreadsheet will be used to informally review and analyze data during the course of the project.

All monitoring data will be available in EIM, via the Internet, once the project data have been validated. The URL address for this geospatial database is www.ecy.wa.gov/eim/index.htm. All data will be uploaded to EIM by the EIM data engineer after the data have been reviewed for quality assurance and finalized.

All spreadsheet files, paper field notes, and Global Information System (GIS) device products created as part of the data analysis will be kept with the project data files.

Audits and Reports

A memo will be written by the project lead and given to the client. This memo will summarize data collected. For locations where previous fecal coliform and total suspended solids datasets exists, the memo will provide a brief analysis comparing results from this project with previous data.

Data Verification

Laboratory-generated data reduction, review, and reporting will follow the procedures outlined in the MEL *Lab Users Manual* (MEL, 2008). Lab results will be checked for missing and improbable data. Variability in lab duplicates also will be quantified using the procedures outlined in the *Lab Users Manual*. Any estimated results will be qualified and their use restricted as appropriate. MEL will send a standard case narrative of laboratory quality assurance/quality control results for each set of samples to the project manager.

Field staff will check field notebooks for missing or improbable measurements before leaving each site. The EXCEL® (Microsoft, 2007) Workbook file containing field data will be labeled DRAFT until data verification 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 project manager for consultation. Valid data will be moved to a separate file labeled FINAL.

The project manager will check data received from LIMS for omissions against the Request for Analysis forms. Field replicate sample results will be compared to quality objectives in Table 4. The project manager will review data requiring additional qualifiers.

Continuous temperature data will be subjected to a QA review similar to that used for temperature TMDLs. Water temperature datasets will be compared to air temperature datasets to ensure that the water datalogger was not exposed to air during deployment.

After data verification and data entry tasks are completed, all field and laboratory data will be entered into a file labeled FINAL and then into the EIM system. Another field assistant will independently review EIM data for errors at an initial 10% frequency. If significant entry errors are discovered, a more intensive review will be undertaken.

Data Quality (Usability) Assessment

After the project data have been reviewed and verified, the project lead will determine if the data are of sufficient quality to meet the study objectives. The project memo from the project lead to the client will discuss data quality and whether project objectives were met.

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Appendix. 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.

Conductivity: A measure of water's ability to conduct an electrical current. Conductivity is related to the concentration and charge of dissolved ions in water.

Dissolved oxygen (DO): A measure of the amount of oxygen dissolved in water.

Fecal coliform: 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 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.

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. This includes, but is 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.

Nutrient: Substance such as carbon, nitrogen, and phosphorus used by organisms to live and grow. Too many nutrients in the water can promote algal blooms and rob the water of oxygen vital to aquatic organisms.

Parameter: A physical chemical or biological property whose values determine environmental characteristics or behavior.

pH: A measure of the acidity or alkalinity of water. A low pH value (0 to 7) indicates that an acidic condition is present, while a high pH (7 to 14) indicates a basic or alkaline condition. A pH of 7 is considered to be neutral. Since the pH scale is logarithmic, a water sample with a pH of 8 is ten times more basic than one with a pH of 7.

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.

Reach: A specific portion or segment of a stream.

Riparian: Relating to the banks along a natural course of water.

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

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

Streamflow: Discharge of water in a surface stream (river or creek).

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.

Total Maximum Daily Load (TMDL): 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): Portion of solids retained by a filter.

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 standard, and are not expected to improve within the next two years.

Acronyms and Abbreviations

DO	(See Glossary above)
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EM	Effectiveness Monitoring
EPA	U.S. Environmental Protection Agency
et al.	And others
FMU	Ecology's Freshwater Monitoring Unit
GIRAS	Geographic Information and Analysis System
GIS	Geographic Information System software
i.e.	In other words
LIMS	Laboratory Information Management System
MEL	Manchester Environmental Laboratory
NPDES	(See Glossary above)
QA	Quality assurance
RPD	Relative percent difference
SOP	Standard operating procedures
SHU	Ecology's Stream Hydrology Unit
STI	Straight to Implementation
TMDL	(See Glossary above)
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife
WRIA	Water Resource Inventory Area
WSU	Washington State University

Units of Measurement

°C	degrees centigrade
cfu	colony forming units
mg/L	milligrams per liter (parts per million)
mL	milliliters
s.u.	standard units
um	micrometer
uS/cm	microsiemens per centimeter, a unit of conductivity