DEPARTMENT OF ECOLOGY
State of Washington

Quality Assurance Project Plan

White Salmon River Watershed Bacteria Assessment

January 2023

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Publication Information

Each study conducted by the Washington State Department of Ecology must have an approved Quality Assurance Project Plan (QAPP). 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.

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Cover photo: White Salmon River near Trout Lake, WA. Photo by Eiko Urmos-Berry.

Quality Assurance Project Plan

White Salmon River Watershed Bacteria Assessment

by Erik Hanson, Evan Newell, and Eiko Urmos-Berry

January 2023

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EAP: Environmental Assessment Program
EOS: Eastern Operations Section
WQP: Water Quality Program

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2.0 Abstract

In 1998, three segments of the White Salmon River and four tributaries were listed under Section 303(d) of the federal Clean Water Act for not meeting Washington State water quality standards for fecal coliform bacteria (FC). In the 2018 303(d) list, three segments of the White Salmon River, along with three tributaries and two ditches, were listed for FC.

In 2019, Washington revised the bacteria standards from FC to Escherichia coli bacteria *(E. coli*) (WAC 173-201A). Limited data for *E. coli* in the watershed is insufficient to determine if waters in the watershed meet the new *E. coli* standard.

This 2022-2024 study is designed to collect the necessary data. Nine sites will be monitored for *E. coli* and streamflow every other week for two years. Data collected from these sites will be used to identify stream segments with elevated bacteria levels, guide source identification monitoring studies, and provide data for future projects to achieve compliance with water quality standards.

3.0 Background

3.1 Introduction and problem statement

The White Salmon River Watershed has experienced long term issues with fecal coliform bacteria (FC). Currently, the White Salmon River and its tributaries, Rattlesnake Creek, Gilmer Creek, and Trout Lake Creek, along with Coate Ditch and an unnamed ditch, are listed under 2018 Section 303(d) of the federal Clean Water Act as not meeting Washington State water quality standards for FC. FC data collected by the Underwood Conservation District and the Washington State Department of Ecology (Ecology) from 1992 – 2015 were the basis for these listings.

In 2019, Ecology implemented a new Bacteria Water Quality Standard based on *E. coli*. Limited data exists for *E. coli* in the watershed. The current 303(d) listings for FC remain in effect until there is sufficient data to determine if stream reaches meet the new bacteria standard.

3.2 Study area and surroundings

The White Salmon River originates in the Gifford Pinchot National Forest in south-central Washington along the south slope of Mount Adams in Skamania and Yakima Counties. It flows south for 45 miles before entering the Columbia River. The White Salmon River is located in Water Resource Inventory Area (WRIA) 29 and drains about 386 square miles of Skamania, Yakima, and Klickitat Counties. Principal tributaries include Trout Lake and Buck, Mill, Dry, Gilmer, and Rattlesnake Creeks.

The major land uses within the White Salmon River Watershed include forest (93%), agriculture (4%), and residential (3%). The Gifford Pinchot National Forest makes up 78% of the forestlands within the watershed. Public and private timberlands make up the remainder (Ecology, 2010). Most agricultural activity is in the middle section of the watershed. Agricultural enterprises include cow-calf operations, hay and pasture (both irrigated and dryland), cereal grains, fruit

production, and irrigated agriculture (Haring, 2003). A complex network of irrigation ditches supplies water for these agricultural practices.

The towns of White Salmon, Bingen, and Underwood make up the largest urban areas in the watershed. Rural residents in the watershed live primarily in the vicinity of Husum/BZ Corner, and Trout Lake (Figure 1).

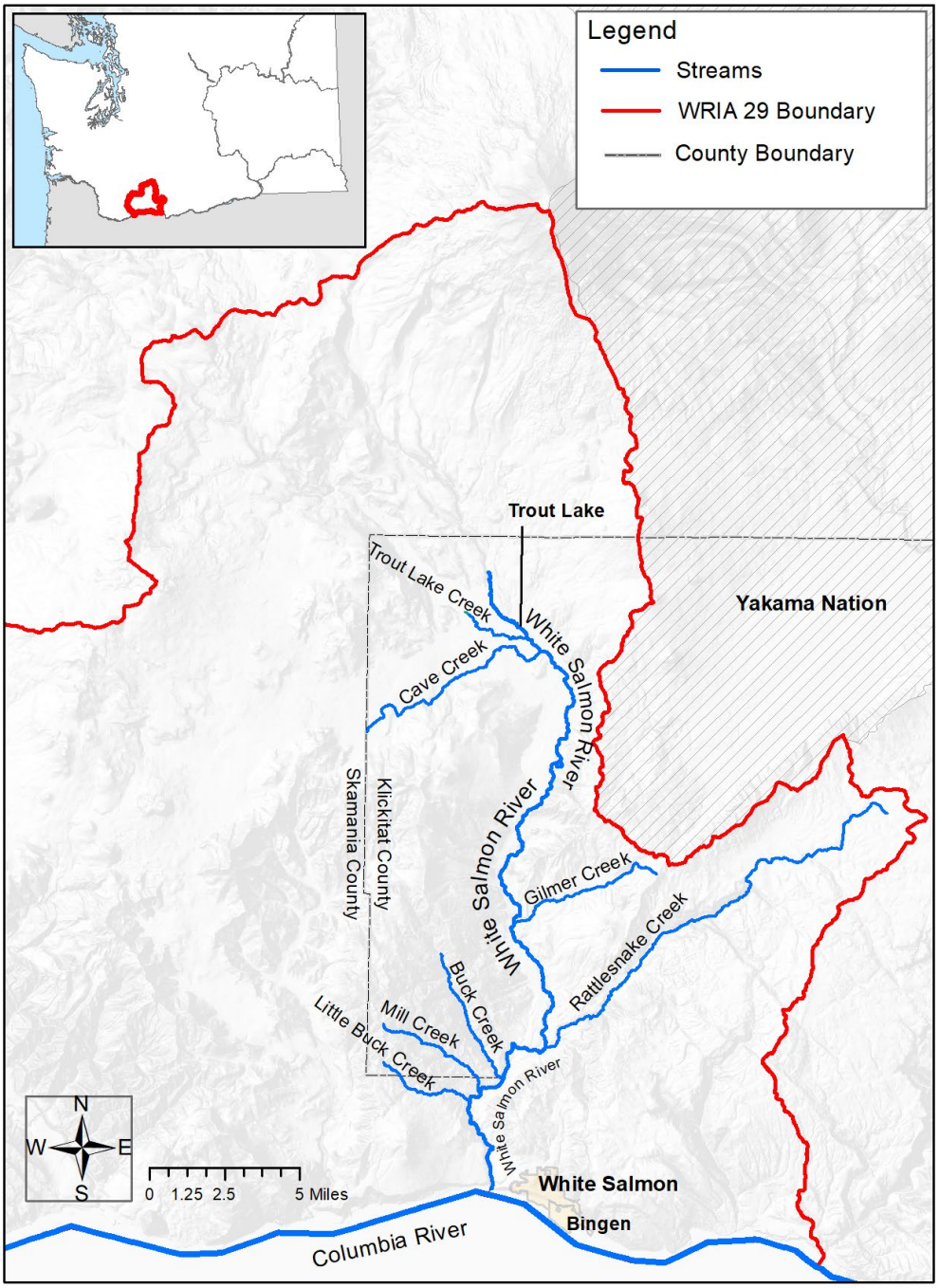

Figure 1. Map of study area for the White Salmon River Watershed Bacteria Assessment

3.2.1 History of study area

Historically, the White Salmon River supported significant steelhead, coho, and Chinook salmon populations. In 1913, the Condit Dam blocked anadromous fish passage on the White Salmon River at River Mile (RM) 3.3 and significantly impacted these fish populations. In 2011, the dam was removed and resulted in an additional 13 miles of the White Salmon River mainstem and several tributaries being accessible again to anadromous fish. Additional fish barriers include a falls near the town of Husum and a 20-foot falls at RM 16.

Husum was a historic Yakama Nation fishing village, and the Yakama Nation is highly involved in the protection and restoration of the river. In 2022, a disputed 121,465-acre parcel of land located 15 miles northwest of Goldendale, known as Tract D, was formally recognized as a part of the Yakama Nation Reservation. Tract D incorporates the upper watershed of Gilmer Creek.

3.2.2 Summary of previous studies and existing data

During 1992-2015, The Underwood Conservation District and Ecology collected FC data. This data led to the White Salmon River and its tributaries, Rattlesnake Creek, Gilmer Creek, and Trout Lake Ditch, being listed under Section 303(d) of the Federal Clean Water Act as exceeding water quality standards for FC.

In 2009, Ecology conducted a study to determine if the White Salmon River Watershed was in compliance with the FC standards (Collyard 2011). This study concluded that two of the three 303(d) listed segments of the White Salmon River, plus the tributaries, Trout Lake Ditch and Trout Lake Creek did not exceed FC standards. Three river segments of the White Salmon River, Rattlesnake Creek, Gilmer Creek, Trout Lake Creek, Coate Ditch, and a tributary of Trout Lake Ditch, exceeded standards. Source tracking identified possible sources of bacteria from irrigation ditches, manure management activities, livestock access to surface waters, and faulty onsite sewage systems.

In 2012, the Underwood Conservation District under an Ecology Water Quality Grant (#1300102) began the White Salmon River Fecal Implementation Project to target specific land uses and human activities identified by Collyard's 2011 report (Underwood Conservation District 2016). The conservation district assisted landowners with implementation of Best Management Practices (BMPs) that included two miles of livestock exclusion fencing, two off-site watering systems, three waste storage facilities, and riparian plantings. There was also an educational campaign addressing on-site septic system maintenance.

As part of the Ecology Water Quality Grant (#1300102), the Underwood Conservation District, under an approved quality assurance project plan, completed an Effectiveness Monitoring study on BMPs in 2015 (Underwood Conservation District 2016). The study collected and analyzed 186 FC samples.

- Using the 90-day rolling Geometric Mean target, Gilmer Creek at RM 0.2 exceeded State water criteria during the dry-season (April to October).
- Using the Single Threshold Value (STV), there were seven occasions where values exceeded 200 cfu/100 mL.

- During the wet season (November to March), Rattle Snake Creek (RM 0.1), Coate Ditch (at River Rd), and Hoake Ditch (at Stoller Rd) had STVs above 200 cfu. Gilmer Creek at RM 0.2 had a STV of 200 cfu.
- During the dry season, the White Salmon River (RM 22), Trout Lake Creek (RM 0.3), Rattle Snake Creek (RM 0.1), and Trout Lake Ditch (at Sunnyside Rd Return) had STVs above 200 cfu. Gilmer Creek at RM 0.2 had a STV of 200 cfu.

While the results of the Effectiveness Monitoring Study did reveal instances of exceedances, the benefit of the project can be seen in the overall reduction of very high levels of bacteria exceedances from the 2009 to 2010 data. However, the average geometric mean value increased. See Table 1 (Underwood Conservation District 2016).

Table 1. Comparison of results, 2010 to 2015

Location	2009-2010 Averages*	2014-2015 Averages*	2009-2010 High	2014-2015 High
White Salmon River mile 1.43	13.7	16.1	120	72
White Salmon River mile 12	13	31.1	640	190
White Salmon River mile 22.5	13	38.7	1300	150
Rattlesnake Creek mile 0.1	17.9	83.2	260	640
Gilmer Creek mile 0.2	52.4	78.6	24,000	200
Trout Lake Ditch mile 2.6	8.7	30.7	520	100
Trout Lake Creek mile 0.3	13.2	46.3	89	216

* geometric mean value
Units (cfu) = colonies/100 ml
Value does not exceed water quality standard
Value exceeds water quality standard

During 2019 and 2020, Ecology conducted limited sampling for *E. coli*, the new bacteria standard, on White Salmon River, Trout Lake Creek, and Buck Creek. The *E. coli* values in these samples were all below the 303(d)-listing threshold (>100 colonies/100 mL), except for one sample from Buck Creek. See Figure 2.

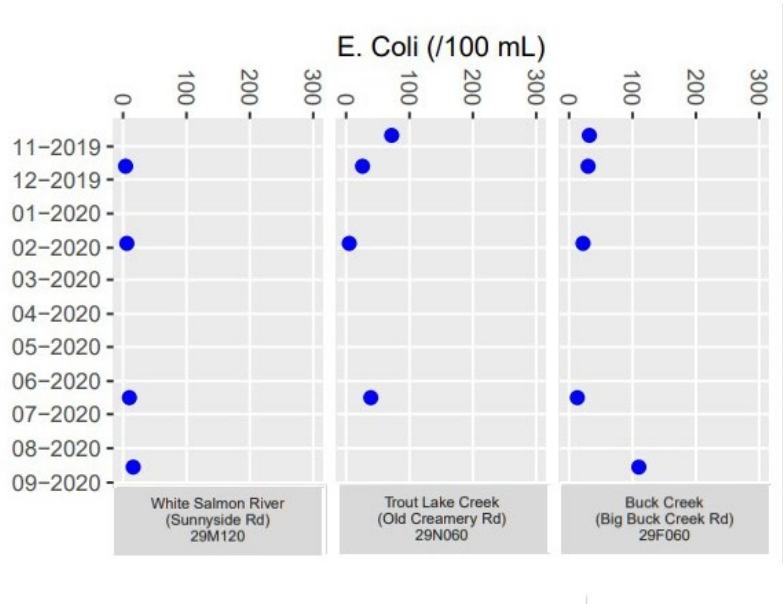

Figure 2. *E Coli* data from 2019 and 2020

3.2.3 Parameters of interest and potential sources

The study will collect and analyze E. *coli* in water samples and assess loading through measurement of streamflow.

E. coli primarily enter waterways from one or more of the following sources:

- Livestock with direct access to streams or operations with poor manure management.
- Failing or improperly constructed septic systems.
- Pet waste.
- Wildlife.
- Improperly treated sewage or other illicit discharges to the waterways.

3.2.4 Regulatory criteria or standards

Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A-200) establish beneficial uses of waters and incorporate specific numeric and narrative criteria for parameters such as bacteria.

Table 2 shows the bacteria criteria to protect water contact recreation in fresh waters. These criteria are based on *E. coli* and FC levels and are expressed as colony forming units (CFU) or most probable number (MPN). The use of FC levels to determine compliance expired December 31, 2020.

Table 2. Primary Contact Recreation bacteria criteria in fresh water

Bacterial Indicator	Criteria
E. coli	*E. coli* organism levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained within the averaging period exceeding 320 CFU or MPN per 100 mL.
Fecal coliform (expires 12/31/2020)	FC levels within an averaging period must not exceed a geometric mean value of 100 CFU or MPN per 100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained within an averaging period exceeding 200 CFU or MPN per 100 mL.

(i) A minimum of three samples is required to calculate a geometric mean for comparison to the geometric mean criteria. Sample collection dates shall be well distributed throughout the averaging period so as not to mask noncompliance periods.

(A) Effluent bacteria samples: When averaging effluent bacteria sample values for comparison to the geometric mean criteria, or for determining permit compliance, the averaging period shall be thirty days or less.

(B) Ambient water quality samples: When averaging bacteria sample values for comparison to the geometric mean criteria, it is preferable to average by season. The averaging period of bacteria sample data shall be ninety days or less.

(ii) When determining compliance with the bacteria criteria in or around small sensitive areas, such as swimming beaches, it is recommended that multiple samples are taken throughout the area during each visit. Such multiple samples should be arithmetically averaged together (to reduce concerns with low bias when the data is later used in calculating a geometric mean) to reduce sample variability and to create a single representative data point.

(iii) As determined necessary by the department, more stringent bacteria criteria may be established for rivers and streams that cause, or significantly contribute to, the decertification or conditional certification of commercial or recreational shellfish harvest areas, even when the preassigned bacteria criteria for the river or stream are being met.

(iv) Where information suggests that sample results are due primarily to sources other than warm-blooded animals (e.g., wood waste), alternative indicator criteria may be established on a site-specific basis as described in WAC **173-201A-430.**

4.0 Project Description

4.1 Project goals

- Determine if stream reaches in the watershed meet the new *E. coli* standard (WAC 173-201A).
- Identify sources of *E. coli*.

4.2 Project objectives

- Collect and analyze *E. coli* samples at primary locations every two weeks.
- When flow conditions permit, take streamflow measurements at each location.
- Conduct source identification monitoring for bacteria exceedances when indicated by results from primary locations.

4.3 Information needed and sources

Streamflow data from the mouth of the White Salmon River will be acquired from a United States Geological Survey (USGS) gage station that collects streamflow data.

4.4 Tasks required

Tasks required to meet the project goals are discussed below. Additional detail on the technical approach and field and lab tasks are described in Section 7.

The following tasks will be performed to support the goals and objectives of this study:

- Collect surface water samples every other week from primary locations on the White Salmon River, tributaries, and canals for bacteria analysis.
- Collect surface water samples from secondary locations for source identification monitoring at locations with possible bacteria standard exceedances.
- Collect streamflow measurements, whenever conditions allow, at each sampling location. Streamflow data will be used by Ecology's Water Quality Program staff for loading calculations.
- Install staff gages or collect reference point measurements at streamflow locations where higher flows may limit access and ability to take streamflow measurements. The stage information will be used to estimate streamflow.

4.5 Systematic planning process

This QAPP, along with the Programmatic QAPP (McCarthy and Mathieu, 2017), represent the systematic planning process.

5.0 Organization and Schedule

5.1 Key individuals and their responsibilities

Table 3 shows the responsibilities of those who will be involved in this project.

Table 3. Organization of project staff and responsibilities

Staff	Title	Responsibilities
Mark Peterschmidt WQP, CRO Phone: 509-731-7252	Unit Supervisor	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Damon Roberts WQP, CRO	Section Manager	Clarifies scope of the project. Provides internal review of the QAPP and approves the final QAPP.
Erik Hanson EOS. EAP Phone: 509-454-7664	Project Manager	Co-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.
Eiko Urmos-Berry EOS, EAP Phone: 509-429-0248	Principal Investigator	Co-writes the QAPP. Directs field activities. Leads field sampling and transportation of samples to the laboratory. Performs maintenance and calibration of field equipment. Conducts the EIM data entry QA.
Teo Fisher EOS, EAP Phone: 509-406-5944	Field Assistant	Helps collect samples and records field information.
Rachel Caron CRO, EOS, EAP 509-504-4056	Unit Supervisor	Provides internal review of the QAPP, draft report, approves the budget, and approves the final QAPP and final report.
George Onwumere EOS, EAP 509-454-4244	Section Manager	Reviews and approves the project scope and budget, tracks progress, reviews the draft QAPP, draft report, and approves the final QAPP and final report.
Alan Rue Manchester Environmental Laboratory, EAP Phone: 360-871-8801	Director	Reviews and approves the final QAPP.
Arati Kaza Phone: 360-407-6964	Ecology Quality Assurance Officer	Reviews and approves the draft QAPP and the final QAPP.

CRO: Central Regional Office
EAP: Environmental Assessment Program
EIM: Environmental Information Management database
EOS: Eastern Operations Section
QAPP: Quality Assurance Project Plan
WQP: Water Quality Program

5.2 Special training and certifications

Ecology field staff have relevant experience with the study's SOPs or will be trained by senior field staff. Field staff adhere to EAP's Field Operations and Safety Manual.

5.3 Organization chart

See Table 3, Section 5.1.

5.4 Proposed project schedule

Fieldwork will occur from December 2022 through December 2024.

Tables 4 – 6 list key activities, due dates, and lead staff for this project.

Table 4. Schedule for completing field and laboratory work

Task	Due date	Lead staff
Field work	December 2024	Erik Hanson/Eiko Urmos-Berry
Laboratory analyses	December 2024	Manchester Environmental Laboratory

Table 5. Schedule for data entry

Task	Due date	Lead staff
EIM data loaded* [1]	March 2025	Erik Hanson
EIM QA [2]	April 2025	Eiko Urmos-Berry
EIM complete [3]	May 2025	Erik Hanson

*EIM Project ID: ERHO0001
EIM: Environmental Information Management database
[1] All data entered into EIM by the lead person for this task.
[2] Data verified to be entered correctly by a different person; any data entry issues identified. Allow one month.
[3] All data entry issues identified in the previous step are fixed (usually by the original entry person); EIM Data Entry Review Form signed off and submitted to Melissa Peterson (who then enters the "EIM Completed" date into Activity Tracker). Allow one month for this step. Normally the final EIM completion date is no later than the final report publication date.

Table 6. Schedule for final report

Task	Due date	Lead staff
Draft to supervisor	October 2025	Erik Hanson/Eiko Urmos-Berry
Draft to client/ peer reviewer	November 2025	Erik Hanson/Eiko Urmos-Berry
Draft to external reviewers	December 2025	Erik Hanson/Eiko Urmos-Berry
Final draft to publications team	January 2026	Erik Hanson/Eiko Urmos-Berry
Final report due on web	April 2026	Publications staff

5.5 Budget and funding

In each sampling run, *E. coli* samples will be collected at nine primary sites, up to four source identification monitoring sites, and a quality assurance duplicate sample for every five samples collected. Costs of processing all samples collected by Ecology's Manchester Environmental Laboratory (MEL) have been included for each fiscal year (FY). The laboratory budget for this project is presented in Table 7.

Table 7. Laboratory budget for *E. coli* sample analysis

FY2023

Month	Samples	QA Samples	Total # of Samples	Cost/ sample	Total
December 2022	18	4	22	$42	$924
January 2023	30	6	36	$42	$1,512
February 2023	30	6	36	$42	$1,512
March 2023	30	6	36	$42	$1,512
April 2023	30	6	36	$42	$1,512
May 2023	45	9	54	$42	$2,268
June 2023	30	6	36	$42	$1,512
				Total	$10,752

FY2024

Month	Samples	QA Samples	Total # of Samples	Cost/ sample	Total
July 2023	30	6	36	$42	$1,512
August 2023	30	6	36	$42	$1,512
September 2023	30	6	36	$42	$1,512
October 2023	45	9	54	$42	$2,268
November 2023	30	6	36	$42	$1,512
December 2023	30	6	36	$42	$1,512
January 2024	30	6	36	$42	$1,512
February 2024	30	6	36	$42	$1,512
March 2024	30	6	36	$42	$1,512
April 2024	45	9	54	$42	$2,268
May 2024	30	6	36	$42	$1,512
June 2024	30	6	36	$42	$1,512
				Total	$19,656

FY2025

Month	Samples	QA Samples	Total # of Samples	Cost/ sample	Total
July 2024	30	6	36	$42	$1,512
August 2024	30	6	36	$42	$1,512
September 2024	45	9	54	$42	$2,268
October 2024	30	6	36	$42	$1,512
November 2024	30	6	36	$42	$1,512
December 2024	30	6	36	$42	$1,512
				Total	$9,828

6.0 Quality Objectives

6.1 Data quality objectives

The data quality objective for this study is to collect data of sufficient quantity and quality to assess whether stream segments in the White Salmon River Watershed meet water quality standards for bacteria. This objective will be met by using standard methods that meet the measurement quality objectives (MQOs) that are described below.

6.2 Measurement quality objectives

MQOs are performance or acceptance criteria for data quality indicators that include precision, bias, sensitivity, representativeness, comparability, and completeness. Field measurements and laboratory analyses have inherent data variability and both areas require MQOs. Table 8 lists the MQOs for the microbiology lab procedures.

Table 8. MQOs for microbiology lab procedures.

Analysis	Method	Method Lower Reporting Limit[a]	Lab Blank Limit	Precision Lab Duplicates (RPD)	Precision – Field Duplicates (median)[b]
E. Coli - MF	SM9222G1	1.0 cfu/100 mL, filtered	<RL	40%	50% of replicate pairs < 20% RSD 90% of replicate pairs <50% RSD[b]

MF: Membrane filtration; RL: Reporting limit; cfu = colony forming units; RPD = Relative percent difference
RSD = Relative standard difference

[a] reporting limit may vary depending on dilutions; detection limit in parentheses, no parentheses indicates MDL = lowest possible RL.

[b] field duplicate results with a mean of less than or equal to 5x the reporting limit will be evaluated separately.

6.2.1 Targets for precision, bias, and sensitivity

6.2.1.1 Precision

See Table 5 and Table 7 of the Programmatic QAPP (McCarthy and Mathieu, 2017) for field procedure and field sample collection MQO and Table 8 of this document for the microbiology lab precision.

Precision is a measure of the variability in the results of replicate measurements due to random error. Random error is due to variation in samples from the environment as well as other introduced sources (e.g., field and laboratory procedures). Ecology will collect one replicate sample for every five samples collected for *E. coli*, because this parameter inherently has large variability. MEL assesses precision through analytical duplicates.

6.2.1.2 Bias

Bias is the difference between the sample mean and the true value. Bias will be addressed by calibrating laboratory instruments, and by analyzing method blanks. Bias can originate from instrument sensor drift or improper calibration, sample instability during transportation or storage, sample or equipment contamination, or the inability of analytical methods to detect all forms of the parameter. Field bias will be assessed through following appropriate sample

collection procedures outlined in published SOPs. Lab bias will be assessed by MEL through the use of blanks.

6.2.1.3 Sensitivity

Sensitivity is a measure of the capability of a field instrument or lab method to detect a substance. It is commonly described as a detection limit. For lab data, the method reporting limit (RL) for *E. coli* is usually used to describe sensitivity. See Table 8 in this document for the reporting limit.

6.2.2 Targets for comparability, representativeness, and completeness

6.2.2.1 Comparability

See Section 6.2.2.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

The data in this study will not be compared to data from previous studies. The use of *E. coli* levels to determine compliance came into effect at the beginning of 2021. This study is establishing a baseline against which future studies will be compared specifically for *E. coli*. In order for the data collected to be comparable to future studies, field staff will strictly follow EAP protocols and adhere to data quality criteria.

6.2.2.2 Representativeness

See Section 6.2.2.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017)

Samples will be collected every other week at locations that are representative of the stream reach and at major inputs in a manner designed to meet study objectives. Sampling will be conducted throughout the year, capturing both dry and wet seasons to meet study objectives. Samples will be collected for two years, and when conditions allow, streamflows will be measured to provide a measure of loading.

6.2.2.3 Completeness

The goal is to correctly collect and analyze 100% of the water quality samples for this project. However, problems occasionally arise during sample collection, such as inclement weather, equipment malfunctions or sample container shortages, thus a completeness of 95% is acceptable.

In addition to collecting water samples, streamflow measurements will be taken. Due to the conditions at a few of the sampling locations, such as those in deep canyons, some sites are not accessible unless there is a bridge. While it may be possible to lower a small sampler off a bridge to collect a water sample, it is not safe for staff to lower streamflow measuring equipment into mostly fast-moving water. At those sites, staff will not be able to collect flow measurements. Also, high flows may make a site no longer wadeable, such as in the tributaries. A completeness of 70% for actual streamflow measurement would be acceptable.

Even though streamflow measurements may not be collected at each site, other measures will be in place to estimate a streamflow at those inaccessible sites, such as installing staff gages or reference measuring points in upstream or downstream locations.

7.0 Study Design

7.1 Study boundaries

The study area is within the White Salmon River Watershed located in Klickitat County, WA. It consists of the mainstem White Salmon River and its major tributaries located below the boundaries of the Gifford Pinchot National Forest down to the confluence with the Columbia River. See Figure 1 for a map of the study area.

The Water Resource Inventory Area (WRIA) and 8-digit Hydrologic Unit Code (HUC) number for the study area are:

- WRIA: 29 - Wind/White Salmon
- HUC number: 17070105 - Middle Columbia-Hood

7.2 Field data collection

7.2.1 Sampling locations and frequency

Fieldwork will be conducted every other week for two years, December 2022-Dec 2024.

Nine primary monitoring locations will be sampled during each sampling week:

- Three on the mainstem White Salmon River.
- Six on tributaries or irrigation ditches.

Ecology has identified 14 other potential locations for source identification monitoring. These locations either have listings for FC on the 303(d) list or were previously sampled during the 2009-2010 White Salmon River Fecal Coliform Bacteria Compliance Monitoring study (Collyard et al., 2009). While the parameter of concern for this study is *E. coli*, previous locations with elevated FC results may indicate areas with other bacteria issues. Other source identification sampling locations may be added in addition to the previously identified locations.

The project manager will review the laboratory results from the primary monitoring locations to determine whether source identification sampling is needed in certain reaches in the mainstem of the White Salmon River, in its tributaries, or at irrigation ditch outflows. The decision to add source identification sampling locations will be determined by downstream sampling station results. If *E. coli* samples routinely do not meet the water quality standards at a location, upstream source identification locations may be added. Source identification sampling will occur at specific location up to 4-5 consecutive samplings. Other locations, as indicated by laboratory results, will be cycled into the sampling schedules throughout the project term.

Figure 3 is a map of sampling locations, and Table 9 is a list of sampling locations.

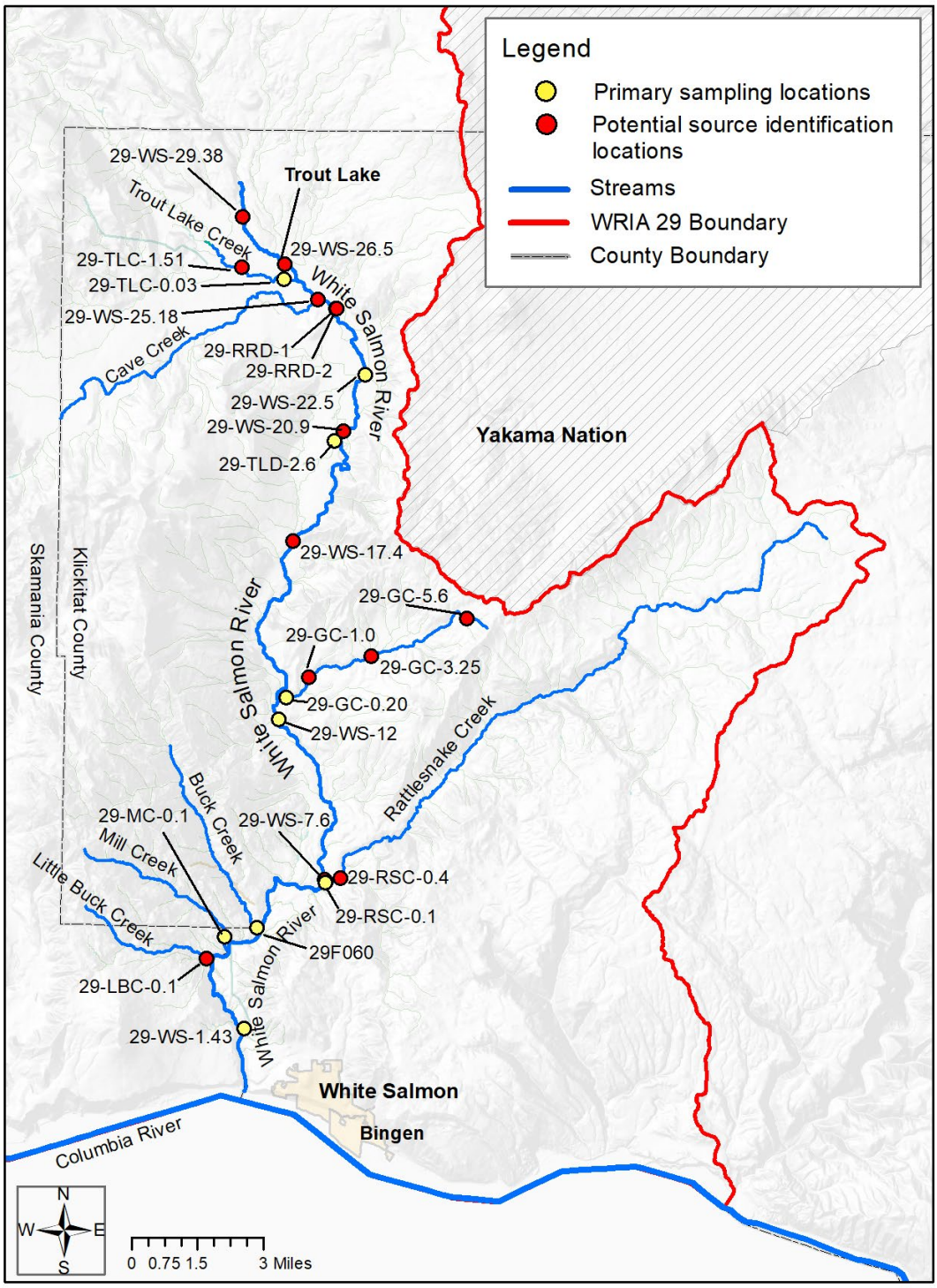

Figure 3. Map of sampling locations for the White Salmon River Watershed Bacteria Assessment

Table 9. List of proposed primary and source identification monitoring locations for the 2022-2024 study

Location ID	Type	Location Description	Latitude	Longitude
29-TLC-0.03	P	Trout Lake Creek Station @ River Mile 0.30 off Old Creamery Bridge	45.99512512	-121.50807882
29-WS-22.55	P	White Salmon River @ River Mile 22.5 bridge of Sunnyside Rd	45.96415503	-121.46937873
29-TLD-2.6	P	Trout Lake Ditch @ Sunnyside Rd culvert	45.94221449	-121.48346810
29-GC-0.20	P	Gilmer Creek @ River Mile 0.2 near mouth	45.85778459	-121.50439976
29-WS-12	P	White Salmon River @ River Mile 12 near boat launch	45.85060454	-121.50799985
29-RSC-0.1	P	Rattlesnake Creek @ River Mile 0.1 near mouth	45.79717434	-121.48505003
29-F060	P	Buck Creek at Big Buck Creek Rd	45.78204900	-121.51680100
29-WS-1.43	P	White Salmon River @ River Mile 1.43 below dam	45.74884408	-121.52220066
29-MC-0.1	P	Mill Creek at Lakeview Road	45.77898000	-121.53206000
29-TLC-1.51	ST	Trout Lake Creek at Mt. Adams Rd, bridge above Café	45.99886000	-121.52810000
29-WS-29.38	ST	White Salmon River, bridge on Mt. Adams Recreation Hwy	46.01553000	-121.52805200
29-WS-26.5	ST	White Salmon River @ N. Sunny Side Rd bridge	46.00018514	-121.50769877
29-WS-25.18	ST	White Salmon River @ River Rd. Bridge	45.98863513	-121.49206871
29-RRD-1	ST	White Salmon River irrigation ditch 1 at River Rd	45.98569412	-121.48341868
29-RRD-2	ST	White Salmon River irrigation ditch 2 at River Rd	45.98571312	-121.48302867
29-WS-20.9	ST	White Salmon River @ RM 20.9 bridge of Strong Rd	45.94559495	-121.47915893
29-WS-17.4	ST	White Salmon River @ RM 17.4 downstream of Winegartner Rd	45.90911480	-121.50228937
29-GC-5.6	ST	Gilmer Creek @ RM 5.6 off BZ Hwy	45.88458467	-121.42009890
29-GC-3.25	ST	Gilmer Creek @ RM 3.25 off Oak Ridge Rd culvert	45.87168464	-121.46494934
29-GC-1.0	ST	Gilmer Creek @ River Mile 1.0 off BZ HWY	45.86447463	-121.49408963
29-RSC-0.4	ST	Rattlesnake Creek @ River Mile 0.4 near Indian Creek Rd	45.79864434	-121.47813996
29-WS-7.6	ST	White Salmon River @ RM 7.6 Bridge of Main Street	45.79819435	-121.48559003
29-LBC-0.1	ST	Little Buck Creek near mouth (by Lakeside Drive)	45.77183000	-121.54026000

P = primary
ST = source identification tracking

7.2.2 Field parameters and laboratory analytes to be measured

Ecology will collect *E. coli* samples at each primary location and selected source identification monitoring locations. Ecology will take measurements of flow at each site as site conditions allow. See Table 10.

Table 10. List of parameters to be determined at each location.

Location ID	Location Description	Grab Sample	Inst. Flow
29-TLC-0.03	Trout Lake Creek Station @ River Mile 0.30 off Old Creamery Bridge	X	X
29-WS-22.55	White Salmon River @ River Mile 22.5 bridge of Sunnyside Rd	X	
29-TLD-2.6	Trout Lake Ditch @ Sunnyside Rd culvert	X	X
29-GC-0.20	Gilmer Creek @ River Mile 0.2 near mouth	X	X
29-WS-12	White Salmon River @ River Mile 12 near boat launch	X	
29-RSC-0.1	Rattlesnake Creek @ River Mile 0.1 near mouth	X	X
29-F060	Buck Creek at Big Buck Creek Rd	X	X
29-WS-1.43	White Salmon River @ River Mile 1.43 below dam	X	(1)
29-WS-25.18	White Salmon River @ River Rd. Bridge	(2)	(3)
29-WS-7.6	White Salmon River @ RM 7.6 Bridge of Main Street	(2)	(3)
various	Source identification locations	X	X

1) Data from the USGS gauge station will be used for streamflow information.
2) 29-WS-1.43 and 29-WS-25.18 are source identification locations. Grab samples will be collected when lab results from primary sampling locations indicate the need to add these locations for source identification tracking.
3) Streamflow measurements will be taken at 29-WS-1.43 and 29-WS-25.18 whenever conditions allow. The additional streamflow measurements at these locations will aid with estimating streamflow at other locations upstream and downstream where measurements may not be taken due to access.

Inst. = instantaneous

Sample and Field Measurements

Ecology will collect *E. coli* samples at each primary location. Samples will be sent to MEL for analysis.

Source Identification Sampling

If regular sampling at primary sampling locations confirms elevated levels of *E. coli*, staff may further investigate the area using source identification sampling to locate other stream reaches with potential pollution issues. The decision to add source identification sampling locations will be determined by downstream sampling station results. If *E. coli* samples routinely do not meet the water quality standards at a location, additional upstream source identification locations may be sampled.

Streamflow Measurements

Instantaneous streamflow measurements will be taken at every location as site conditions allow. Streamflow data from the mouth of the White Salmon River will be acquired from United States Geological Survey (USGS) gage station that collects continuous streamflow data (Table 11) in lieu of measuring streamflow at the location 29-WS-1.43.

Table 11, List of streamflow gages

Agency	Agency Location ID	Gage Name
USGS	14123500	White Salmon near Underwood, WA

At some sampling locations, the White Salmon River is in a deep, narrow canyon, which makes it impossible to collect streamflow measurements. In order to estimate the streamflow at these locations, other measures will be put into place. Ecology will install staff gages or establish reference points to track gage height. At times when a stream is inaccessible (e.g., flows are too high or impacted by snow and ice), the gage height measurements will be used to help establish a rating curve and estimate the streamflow.

Ecology's Stream Hydrology Unit may assist in collecting periodic streamflow measurements during periods of highest flow and in the post-processing of collected data.

Instantaneous *E. coli* loading data will be estimated at each site using the best available flow data.

7.4 Assumptions underlying design

Assumptions that underlie the project design include:

- The project design, including site selection and sample frequency, will adequately represent the watershed.
- The project design will sufficiently monitor bacteria levels in each stream segment and provide for source identification monitoring within and upstream of the stream segments.
- The study and field data collection are designed to follow the 2009-2010 White Salmon River Fecal Coliform Bacteria Compliance Monitoring study (Collyard et al, 2009). For this specific study, Ecology will be sampling for *E. coli* in order to monitor compliance with *E. coli* standard (WAC 173-201A-200).
- The collection of flow measurements will be used to calculate bacteria loading at specific sampling locations. The loading calculations will be useful for future compliance efforts.
- Results from the primary monitoring locations will be utilized to identify other locations with possible elevated levels of *E. coli* and for source identification tracking.

7.5 Possible challenges and contingencies

7.5.1 Logistical problems

Due to the year-round duration of this monitoring study, site accessibility could become a challenge. If a site becomes inaccessible due to weather, the addition of a new site will be considered based on the needs of the project objectives. In addition, steep topography and

canyon walls and high flows of some of the waterways could present challenges for sample and flow measurement collection. These events will be documented throughout the project. If equipment (e.g., flow meters) failure occurs during a sampling event, troubleshooting will be attempted in the field. If troubleshooting fails, any missed sites will be revisited at the next most convenient time dependent on staff priorities and lab availability.

See Section 7.5.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017) for a list of other potential logistical problems.

7.5.2 Practical constraints

See Section 7.5.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017) for a list of practical constraints.

7.5.3 Schedule limitations

See Section 7.5.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017) for a list of schedule limitations.

8.0 Field Procedures

8.1 Invasive species evaluation

See Section 8.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.2 Measurement and sampling procedures

See Section 8.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017). Table 9 in the Programmatic QAPP lists the field activities and their associated Standard Operating Procedures (SOPs) used to collect different types of data.

Additional Ecology SOPs can be found on Ecology's website.

8.3 Containers, preservation methods, holding times

See Table 12 for a list of the sample containers, preservation methods, or holding times needed for the collection of *E.coli.*

Table 12. Sample containers, preservation methods, and holding times (MEL 2016).

Parameter	Matrix	Recommended Quantity	Container	Holding Time	Preservative
E. coli	Water	250 mL, 500 mL for QC	250 mL (or 500 mL) polypropylene autoclaved bottle	24 hours	Fill the bottle to the shoulder; Cool to <10°C

8.4 Equipment decontamination

See Section 8.4 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.5 Sample ID

See Section 8.5 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.6 Chain of custody

See Section 8.6 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.7 Field log requirements

See Section 8.7 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

8.8 Other activities

See Section 8.8 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

9.0 Laboratory Procedures

9.1 Lab procedures table

See Table 13 for MEL's analysis method for *E. coli.*

Table 13. MEL's laboratory analysis method.

Analyte	Sample Matrix	Expected Range of Results	Method	Method Reporting Limit *
E. coli	Water	1 – 10,000 cfu/100 mL	MF – SM 9222G1	1.0 cfu/100 mL, filtered

*For microbiology, a method detection limit can vary based on sample dilutions. Instead, the method reporting limit is used.
MF: membrane filtration

9.2 Sample preparation method(s)

See Section 9.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

Collection and preservation of samples analyzed at the laboratory will be prepared according to MEL internal SOPs. Each SOP contains specific safety and Material Safety Data Sheet (MSDS) information.

9.3 Special method requirements

No special methods will be used for this study.

9.4 Laboratories accredited for methods

All chemical analysis will be performed at MEL, which is accredited for all methods.

10.0 Quality Control Procedures

See Section 10.0 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

10.1 Table of field and laboratory quality control

See Table 14 for quality control (QC) samples, types, and frequencies for the lab and field.

Table 14. Quality control samples, types, and frequencies for the laboratory and field.

Parameter	Laboratory				Field	
	Method Blank	Analytical Duplicates	Matrix Spikes	Lab Control Samples (LCS)	Field Blanks	Field Replicates
E. coli	1/batch*	1/batch*	n/a	n/a	n/a	1/5 samples

*For microbiology samples, a batch is represented by 10 samples.

See Section 10.1 (Table 14) in the Programmatic QAPP (McCarthy and Mathieu, 2017) for a list of the types and frequency of QC samples field measurements.

10.2 Corrective action processes

See Section 10.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017)

11.0 Data Management Procedures

11.1 Data recording and reporting requirements

See Section 11.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

11.2 Laboratory data package requirements

See Section 11.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

11.3 Electronic transfer requirements

See Section 11.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

11.4 EIM/STORET data upload procedures

See Section 11.4 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

12.0 Audits and Reports

12.1 Field, laboratory, and other audits

See Section 12.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

12.2 Responsible personnel

See Table 3 in Section 5.1 of this QAPP.

12.3 Frequency and distribution of reports

A peer-reviewed report will be completed and published to Ecology's website. The final report will also be distributed electronically to all managers, clients, tribes, municipalities, and other stakeholders involved or interested in the study.

See Section 12.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

12.4 Responsibility for reports

The project manager is responsible for the final report.

See Section 12.4 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

13.0 Data Verification

13.1 Field data verification, requirements, and responsibilities

See Section 13.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

13.2 Laboratory data verification

See Section 13.2 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

13.3 Validation requirements, if necessary

See Section 13.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

13.4 Model quality assessment

NA

14.0 Data Quality (Usability) Assessment

14.1 Process for determining project objectives were met

See Section 14.1 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

14.2 Treatment of non-detects

See Section 14.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

The lab reporting limit (RL) will be substituted for non-detects, in accordance with Ecology's Water Quality Program Policy 1-11 (Chapter 1 and 2, Ecology 2020 and 2021).

14.3 Data analysis and presentation methods

See Section 14.3 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

14.4 Sampling design evaluation

See Section 14.4 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

14.5 Documentation of assessment

See Section 14.5 in the Programmatic QAPP (McCarthy and Mathieu, 2017).

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WAC 173-201A-200. 2013. Washington State Administrative Code. Fresh water designated uses and criteria. http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A-200.

16.0 Appendix. Glossaries, Acronyms, and Abbreviations

Glossary of General Terms

Ambient: Background or away from point sources of contamination. Surrounding environmental condition.

Anadromous: Ascending rivers from the sea for breeding.

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 water body or segment, regardless of whether or not the uses are currently attained.

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.

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.

Reach: A specific portion or segment of a stream.

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

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.

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, requiring 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
E. coli	*Escherichia coli* bacteria
e.g.	For example
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management database
EPA	U.S. Environmental Protection Agency
et al.	And others
FC	Fecal coliform bacteria
i.e.	In other words
MEL	Manchester Environmental Laboratory
MQO	Measurement quality objective
QA	Quality assurance
QC	Quality control
RM	River mile
RPD	Relative percent difference
RSD	Relative standard deviation
SOP	Standard operating procedure
USGS	United States Geological Survey
WAC	Washington Administrative Code
WRIA	Water Resource Inventory Area

Units of Measurement

°C	degrees centigrade
cfs	cubic feet per second
cfu	colony forming units
m	meter
mL	milliliter
MPN	most probable number
STV	Single Threshold Value

Quality Assurance Glossary

Accreditation: A certification process for laboratories, designed to evaluate and document a lab's ability to perform analytical methods and produce acceptable data. For Ecology, it is "Formal recognition by (Ecology)…that an environmental laboratory is capable of producing accurate analytical data." [WAC 173-50-040] (Kammin, 2010).

Accuracy: The degree to which a measured value agrees with the true value of the measured property. USEPA recommends that this term not be used, and that the terms *precision* and *bias* be used to convey the information associated with the term *accuracy* (USGS, 1998).

Analyte: An element, ion, compound, or chemical moiety (pH, alkalinity) which is to be determined. The definition can be expanded to include organisms, e.g., fecal coliform, Klebsiella (Kammin, 2010).

Bias: The difference between the sample mean and the true value. Bias usually describes a systematic difference reproducible over time and is characteristic of both the measurement system and the analyte(s) being measured. Bias is a commonly used data quality indicator (DQI) (Kammin, 2010; Ecology, 2004).

Blank: A synthetic sample, free of the analyte(s) of interest. For example, in water analysis, pure water is used for the blank. In chemical analysis, a blank is used to estimate the analytical response to all factors other than the analyte in the sample. In general, blanks are used to assess possible contamination or inadvertent introduction of analyte during various stages of the sampling and analytical process (USGS, 1998).

Calibration: The process of establishing the relationship between the response of a measurement system and the concentration of the parameter being measured (Ecology, 2004).

Check standard: A substance or reference material obtained from a source independent from the source of the calibration standard; used to assess bias for an analytical method. This is an obsolete term, and its use is highly discouraged. See Calibration Verification Standards, Lab Control Samples (LCS), Certified Reference Materials (CRM), and/or spiked blanks. These are all check standards but should be referred to by their actual designator, e.g., CRM, LCS (Kammin, 2010; Ecology, 2004).

Comparability: The degree to which different methods, data sets and/or decisions agree or can be represented as similar; a data quality indicator (USEPA, 1997).

Completeness: The amount of valid data obtained from a project compared to the planned amount. Usually expressed as a percentage. A data quality indicator (USEPA, 1997).

Continuing Calibration Verification Standard (CCV): A quality control (QC) sample analyzed with samples to check for acceptable bias in the measurement system. The CCV is usually a midpoint calibration standard that is re-run at an established frequency during the course of an analytical run (Kammin, 2010).

Control chart: A graphical representation of quality control results demonstrating the performance of an aspect of a measurement system (Kammin, 2010; Ecology 2004).

Control limits: Statistical warning and action limits calculated based on control charts. Warning limits are generally set at +/- 2 standard deviations from the mean, action limits at +/- 3 standard deviations from the mean (Kammin, 2010).

Data integrity: A qualitative DQI that evaluates the extent to which a data set contains data that is misrepresented, falsified, or deliberately misleading (Kammin, 2010).

Data quality indicators (DQI): Commonly used measures of acceptability for environmental data. The principal DQIs are precision, bias, representativeness, comparability, completeness, sensitivity, and integrity (USEPA, 2006).

Data quality objectives (DQO): Qualitative and quantitative statements derived from systematic planning processes that clarify study objectives, define the appropriate type of data, and specify tolerable levels of potential decision errors that will be used as the basis for establishing the quality and quantity of data needed to support decisions (USEPA, 2006).

Data set: A grouping of samples organized by date, time, analyte, etc. (Kammin, 2010).

Data validation: An analyte-specific and sample-specific process that extends the evaluation of data beyond data verification to determine the usability of a specific data set. It involves a detailed examination of the data package, using both professional judgment and objective criteria, to determine whether the MQOs for precision, bias, and sensitivity have been met. It may also include an assessment of completeness, representativeness, comparability, and integrity, as these criteria relate to the usability of the data set. Ecology considers four key criteria to determine if data validation has actually occurred. These are:

- Use of raw or instrument data for evaluation.
- Use of third-party assessors.
- Data set is complex.
- Use of EPA Functional Guidelines or equivalent for review.

Examples of data types commonly validated would be:

- Gas Chromatography (GC).
- Gas Chromatography-Mass Spectrometry (GC-MS).
- Inductively Coupled Plasma (ICP).

The end result of a formal validation process is a determination of usability that assigns qualifiers to indicate usability status for every measurement result. These qualifiers include:

- No qualifier – data are usable for intended purposes.
- J (or a J variant) – data are estimated, may be usable, may be biased high or low.
- REJ – data are rejected, cannot be used for intended purposes.
  (Kammin, 2010; Ecology, 2004).

Data verification: Examination of a data set for errors or omissions, and assessment of the Data Quality Indicators related to that data set for compliance with acceptance criteria (MQOs). Verification is a detailed quality review of a data set (Ecology, 2004).

Detection limit (limit of detection)**:** The concentration or amount of an analyte which can be determined to a specified level of certainty to be greater than zero (Ecology, 2004).

Duplicate samples: Two samples taken from and representative of the same population, and carried through and steps of the sampling and analytical procedures in an identical manner. Duplicate samples are used to assess variability of all method activities including sampling and analysis (USEPA, 1997).

Field blank: A blank used to obtain information on contamination introduced during sample collection, storage, and transport (Ecology, 2004).

Initial Calibration Verification Standard (ICV): A QC sample prepared independently of calibration standards and analyzed along with the samples to check for acceptable bias in the measurement system. The ICV is analyzed prior to the analysis of any samples (Kammin, 2010).

Laboratory Control Sample (LCS): A sample of known composition prepared using contaminant-free water or an inert solid that is spiked with analytes of interest at the midpoint of the calibration curve or at the level of concern. It is prepared and analyzed in the same batch of regular samples using the same sample preparation method, reagents, and analytical methods employed for regular samples (USEPA, 1997).

Matrix spike: A QC sample prepared by adding a known amount of the target analyte(s) to an aliquot of a sample to check for bias due to interference or matrix effects (Ecology, 2004).

Measurement Quality Objectives (MQOs)**:** Performance or acceptance criteria for individual data quality indicators, usually including precision, bias, sensitivity, completeness, comparability, and representativeness (USEPA, 2006).

Measurement result: A value obtained by performing the procedure described in a method (Ecology, 2004).

Method: A formalized group of procedures and techniques for performing an activity (e.g., sampling, chemical analysis, data analysis), systematically presented in the order in which they are to be executed (EPA, 1997).

Method blank: A blank prepared to represent the sample matrix, prepared and analyzed with a batch of samples. A method blank will contain all reagents used in the preparation of a sample, and the same preparation process is used for the method blank and samples (Ecology, 2004; Kammin, 2010).

Method Detection Limit (MDL): This definition for detection was first formally advanced in 40CFR 136, October 26, 1984 edition. MDL is defined there as the minimum concentration of an analyte that, in a given matrix and with a specific method, has a 99% probability of being identified, and reported to be greater than zero (Federal Register, October 26, 1984).

Percent Relative Standard Deviation (%RSD): A statistic used to evaluate precision in environmental analysis. It is determined in the following manner:

$$\%RSD = (100 * s)/x$$

where s is the sample standard deviation and x is the mean of results from more than two replicate samples (Kammin, 2010).

Parameter: A specified characteristic of a population or sample. Also, an analyte or grouping of analytes. Benzene and nitrate + nitrite are all parameters (Kammin, 2010; Ecology, 2004).

Population: The hypothetical set of all possible observations of the type being investigated (Ecology, 2004).

Precision: The extent of random variability among replicate measurements of the same property; a data quality indicator (USGS, 1998).

Quality assurance (QA): A set of activities designed to establish and document the reliability and usability of measurement data (Kammin, 2010).

Quality Assurance Project Plan (QAPP): A document that describes the objectives of a project, and the processes and activities necessary to develop data that will support those objectives (Kammin, 2010; Ecology, 2004).

Quality control (QC): The routine application of measurement and statistical procedures to assess the accuracy of measurement data (Ecology, 2004).

Relative Percent Difference (RPD): RPD is commonly used to evaluate precision. The following formula is used:

[Abs(a-b)/((a + b)/2)] * 100

where "Abs()" is absolute value and a and b are results for the two replicate samples. RPD can be used only with 2 values. Percent Relative Standard Deviation is (%RSD) is used if there are results for more than 2 replicate samples (Ecology, 2004).

Replicate samples: Two or more samples taken from the environment at the same time and place, using the same protocols. Replicates are used to estimate the random variability of the material sampled (USGS, 1998).

Representativeness: The degree to which a sample reflects the population from which it is taken; a data quality indicator (USGS, 1998).

Sample (field): A portion of a population (environmental entity) that is measured and assumed to represent the entire population (USGS, 1998).

Sample (statistical): A finite part or subset of a statistical population (USEPA, 1997).

Sensitivity: In general, denotes the rate at which the analytical response (e.g., absorbance, volume, meter reading) varies with the concentration of the parameter being determined. In a specialized sense, it has the same meaning as the detection limit (Ecology, 2004).

Spiked blank: A specified amount of reagent blank fortified with a known mass of the target analyte(s); usually used to assess the recovery efficiency of the method (USEPA, 1997).

Spiked sample: A sample prepared by adding a known mass of target analyte(s) to a specified amount of matrix sample for which an independent estimate of target analyte(s) concentration is available. Spiked samples can be used to determine the effect of the matrix on a method's recovery efficiency (USEPA, 1997).

Split sample: A discrete sample subdivided into portions, usually duplicates (Kammin, 2010).

Standard Operating Procedure (SOP): A document which describes in detail a reproducible and repeatable organized activity (Kammin, 2010).

Surrogate: For environmental chemistry, a surrogate is a substance with properties similar to those of the target analyte(s). Surrogates are unlikely to be native to environmental samples. They are added to environmental samples for quality control purposes, to track extraction efficiency and/or measure analyte recovery. Deuterated organic compounds are examples of surrogates commonly used in organic compound analysis (Kammin, 2010).

Systematic planning: A step-wise process which develops a clear description of the goals and objectives of a project, and produces decisions on the type, quantity, and quality of data that will be needed to meet those goals and objectives. The DQO process is a specialized type of systematic planning (USEPA, 2006).

References for QA Glossary

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