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Quality Assurance Project Plan

Bowman Creek Fecal Coliform Bacteria Characterization

July 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
https://fortress.wa.gov/ecy/publications/SummaryPages/1210021.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, BEDI0019.

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Quality Assurance Project Plan

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Characterization

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Approved by:

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Abstract

The Puyallup River Watershed is in Water Resource Inventory Area (WRIA) 10. The watershed includes the White River which enters the right bank of the Puyallup River at approximately river mile (RM) 10.4. Both rivers have been on the Washington State's 303(d) list of impaired water bodies for not meeting contact recreation water quality standards for fecal coliform (FC) bacteria. Ecology conducted a FC bacteria Total Maximum Daily Load (TMDL) study in the Puyallup River Watershed in October 2006 through September 2007 (Mathieu and James, 2011). Data collected during the TMDL identified that Bowman Creek, a tributary to the Lower White River, was not meeting water quality standards at its mouth during the dry season. This quality assurance project plan (QAPP) describes a water quality study to further characterize FC bacteria concentrations in the Bowman Creek tributary.

Background

The Puyallup and White rivers are in WRIA 10 (Figure 1). The White River enters the right bank of the Puyallup River at approximately RM 10.4 (Williams, et al., 1975). Both rivers have been on the Washington State's 303(d) list of impaired water bodies for not meeting contact recreation water quality standards for bacteria. The federal Clean Water Act of 1972 requires that Washington State develop a total maximum daily load study (TMDL) and implement activities that will bring the water bodies back into compliance with the standards.

Ecology conducted a fecal coliform (FC) bacteria TMDL in the Puyallup River Watershed in October 2006 through September 2007 (Mathieu and James, 2011). To comply with Washington State water quality standards, the fecal coliform organism levels in the watershed must meet the Primary Contact Recreation criterion:

- Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies/100mL, 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 values exceeding 200 colonies/100mL (Ecology, 2006).

The TMDL identified water bodies that did not meet water quality standards for FC bacteria. Ecology and the local community developed a plan of implementation activities that would improve water quality (Mathieu and James, 2011). Ecology was asked to conduct a more intensive characterization of FC bacteria concentrations in some of the impaired water bodies. Bowman Creek is one of those water bodies selected for further investigation. Bowman Creek is a tributary to the Lower White River entering on the left bank at approximately RM 7.65 (Williams, et al., 1975.). Based on data from the Puyallup TMDL, elevated concentrations in Bowman Creek were primarily in the dry season.

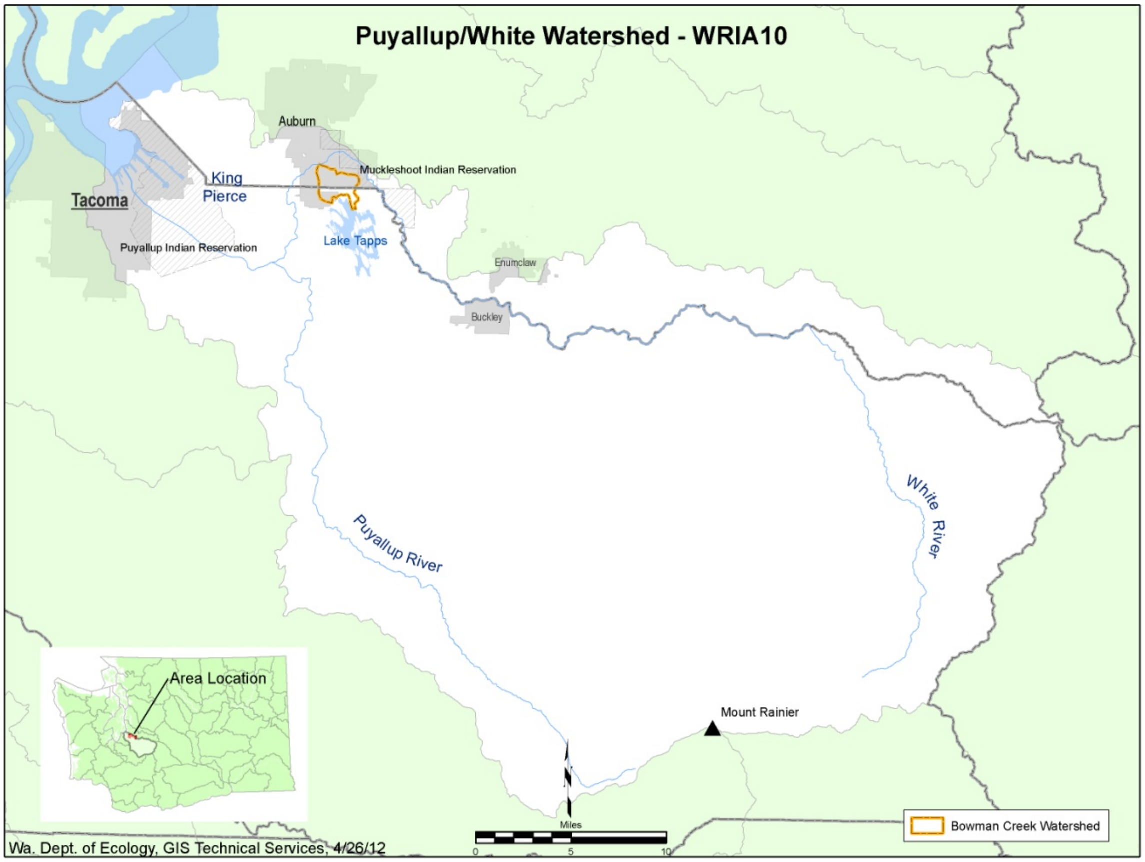

Figure 1. Puyallup River and White River Watershed, WRIA 10. *The Bowman Creek watershed is shown in the upper left of the watershed.*

Project Description

The goal of this study is to reduce FC contamination to the 303(d)-listed Lower White River.

The objectives of this study are to:

- Characterize FC concentrations in Bowman Creek.
- Compare results to the Primary Contact Recreation criterion.
- Use study results to guide implementation activities for cleaner water.

Eleven surface water monitoring sites have been selected in the Bowman Creek watershed (Figure 2 and Table 1). Sampling will occur twice a month during the dry season, July through October, and once a month during the wet season, November through June. In order to meet the project objective to characterize FC concentrations, additional samples and additional sample sites may be added during the course of the study. The project manager will review laboratory results for high or questionable results to determine the need for additional sampling.

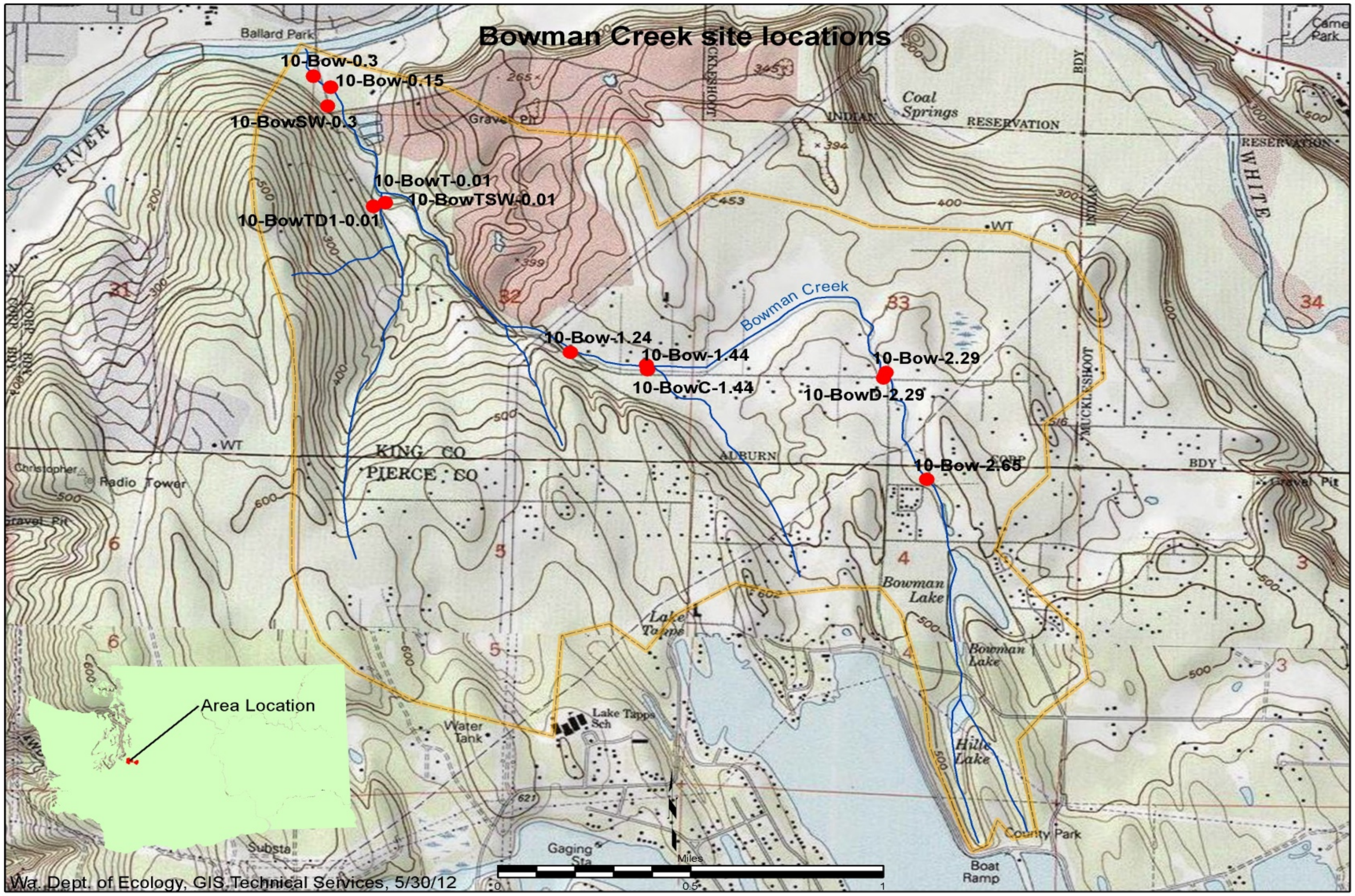

Figure 2. Sample locations in the Bowman Creek watershed.

Table 1. Sampling location ID and location descriptions.

Location_ID	Location Description	Latitude	Longitude
10-Bow-0.3	Bowman Creek mouth at the downstream site of Kersey Way, creek mile (CM) 0.08; the Puyallup TMDL sampling location. 10-Bow-0.15 will most likely be the primary site since characterization will be more accurate.	47.27345	-122.20822
10-BowSW-0.3	Stormwater from Oravetz Road that comes in on downstream side of road and intercepts with 10-Bow-0.3	47.27219	-122.20737
10-BowT-0.01	Bowman Creek Tributary 10.0043 at black fence, downstream side of Kersey Way. Tributary enters mainstem at CM 0.55.	47.268639	-122.204694
10-BowTSW-0.01	Beehive stormwater at black fence, downstream side of Kersey Way, collects water from Edgeview Housing development stormwater pond and from along Kersey Way.	47.268639	-122.204694
10-BOWTD1-0.01	Roadside ditch from the residence driveway up the hill. Enters the tributary on the left bank.	47.26794	-122.20471
10-Bow-1.24	Bowman Creek via driveway at 5202 Kersey Way	47.261861	-122.193667
10-Bow-1.44	Bowman Creek at CM 1.44 on 53rd St SE, E of Irene Ave. upstream of 3001 53rd Ave SE driveway at driveway culvert	47.26116	-122.189416
10-BowC-1.44	Ditch at Bowman Creek CM 1.44, crosses under the roadway and enters Bowman Creek from left bank.	47.26116	-122.189416
10-Bow-2.29	Corner of 53rd St SE and Randall Ave. SE, upstream side of road at culvert	47.26125	-122.176222
10-BowD-2.29	Roadside ditch. Flows under road just before reaching the corner of 53rd St SE and Randall Ave. SE. Enters on left bank of creek.	47.26101	-122.17634
10-Bow-2.65	Pierce County water quality sampling location at 1st St E., downstream side of road.	47.256716	-122.173839

Additional sites may be added as potential sources are identified.

Organization and Schedule

Table 2 lists the people involved in this project.

Table 2. Organization of project staff and responsibilities.

Staff	Title	Responsibilities
Cindy James Water Quality Program Southwest Region Phone: 360-407-6556 Cindy.James@ecy.wa.gov	South Puget Sound Water Quality Management Area Water Cleanup Coordinator, Client/Field Assistant	Clarifies project scope. Provides review and approval of the Quality Assurance Project Plan (QAPP) and technical report. Provides field assistance.
Betsy Dickes Water Quality Program Southwest Region Phone: 360-407-6296 Betsy.Dickes@ecy.wa.gov	Project Manager/ Principal Investigator	Writes the QAPP. Conducts sampling. Conducts QA review of data, analyzes and interprets data, and enters data into Ecology's Environmental Information Management database. Writes the technical report.
Kim McKee Water Quality Program Southwest Region Phone: 360-407-6407	Unit Supervisor for the Project Manager	Provides review and approval of the project scope and budget, tracks progress, and approves the QAPP and technical report.
Bob Bergquist Water Quality Program Southwest Region Phone: 360-407-6271	Section Manager for the Project Manager	Provides review and approval of the project scope and budget, and approves the QAPP and technical report.
Dean Momohara Environmental Assessment Program Phone: 360-871-8801	Interim Laboratory Director	Provides review and approval of the QAPP. Provides laboratory staff and resources.
Mike Herold Water Quality Program Phone: 360-407-6434	Quality Assurance Coordinator	Provides review and approval of the QAPP.

Table 3 presents the proposed schedule for field and laboratory work.

Table 3. Proposed schedule for completing the Bowman Creek field and laboratory work, data entry and reports.

Field and laboratory work	**Due date**	**Lead staff**
Field work initiated	August 2012	Betsy Dickes
Field work completed	July 2013	
Laboratory analyses completed	August 2013	
Environmental Information System (EIM) database		
EIM user study ID	BEDI0019	
Product	Due date	Lead staff
EIM data QA and loaded	Sept 2013	Betsy Dickes
Final report		
Author lead / Support staff	Betsy Dickes	
Schedule		
Draft due to supervisor	May 2014	
Draft due to client/peer reviewer	July 2014	
Draft due to external reviewer(s)	Sept 2014	
Final (all reviews done) due to publications coordinator	Nov 2014	
Final report due on web	Dec 2014	

Sampling schedule

The tentative sampling schedule is listed below. Some dates may change due to unexpected circumstances.

- August 8, 2012
- August 22, 2012
- September 5, 2012
- September 19, 2012
- October 10, 2012
- October 24, 2012
- November 7, 2012
- December 5, 2012
- January 9, 2013
- February 6, 2013
- March 6, 2013
- April 10, 2013
- May 8, 2013
- June 5, 2013
- July 10, 2013
- July 24, 2013

Quality Objectives

Quality objectives are statements of the precision, bias, and lower reporting limits necessary to address project objectives (Table 4). Precision and bias together express data accuracy. Other considerations of quality objectives include representativeness and completeness.

Precision

Precision is defined as the measure of variability in the results of replicate measurements due to random error. This random error includes error inherently associated with field sampling and laboratory analysis. Field and laboratory errors are minimized by following strict protocols for sampling and analysis. Precision for replicates will be expressed as percent relative standard deviation (RSD). RSD is the standard deviation of the replicates divided by the average of the replicates, expressed as a percentage. Precision quality will follow the guidelines established by Mathieu (2006). Twenty percent of FC samples will be duplicated in the field in a side-by-side manner to assess field and lab variability.

Table 4. Measurement quality objectives for field and laboratory work.

Analysis	**Accuracy** percent deviation from true value	**Precision** Relative Standard Deviation (RSD)	**Bias** deviation from true value due to systematic error	**Lower reporting Limits**
Fecal Coliform Bacteria	**N/A**	**20 - 50% RSD***	**N/A**	**1 cfu/ 100mL**
Water Velocity	**±0.05 ft/s**	**0.1 ft/s**	**N/A**	**0 ft/s**

*replicate results with a mean of less than or equal to 20cfu/100mL will be evaluated separately (Mathieu, 2006)

Bias

Bias is a measure of the systematic error between an estimated value for a parameter and the true value. Systemic errors can occur through poor technique in sampling, sample handling, or analysis. We will minimize the bias through strict adherence to standard operating protocols (SOPs). Field staff will follow the SOPs for FC (Ward and Mathieu, 2011) and streamflow (Sullivan, 2007). Sample contamination will be prevented through careful sample collection.

Representativeness

Representativeness will be assured through the use of standardized Ecology protocols (Ward, et al., 2011). However, fecal coliform values are known to be highly variable over space and time.

Completeness

Completeness is defined as a measure of the amount of valid data needed to be obtained from a measurement system. It will be assessed by examining: (1) the number of samples collected compared to the sampling plan, (2) the number of samples shipped and received at the Manchester Environmental Laboratory (MEL) in good condition, (3) the laboratory's ability to produce usable results for each sample, and (4) sample results accepted by the project manager.

The objective for sampling completeness is 100%. However, at times there may be practical constraints, such as staff availability, weather/road conditions, and safety concerns that may limit the ability of project staff to collect the number of samples or sample events expected. The other possibility is that a stream or ditch may be dry during any particular sampling event, particularly during summer.

Sampling Process Design (Experimental Design)

The assumption of this study is that enough samples will be collected to adequately characterize bacteria concentrations in the watershed and identify potential problem areas for implementation activities. The project manager will review laboratory results for high or questionable results to determine the need for additional sampling at an original location or a potential source identification site. The MEL will be notified one to two weeks prior to additional samples.

Due to the small watershed size, samples will be collected from downstream to upstream to prevent contamination.

Sample sites were selected based on: previous sample location; access to the sampling location; quality of sample location for representative water collection and discharge measurements; and potential sources. The sampling sites are shown in Figure 2 and described in Table 4. The original sample site used for the TMDL, 10-Bow-0.3 (CM 0.08), most likely will be dropped. The creek in this area is not confined and flows would be difficult to take. There is also the influence of the stormwater input at this site.

Laboratory Costs

The total laboratory cost for this project is approximately: $6232.50.

These costs were calculated using the MEL price list for 2012 for FC using membrane filtration at $24.93 per sample.

Characterization sampling including replicates (208 samples) =	$5,185.44
Source identification sampling (+20%) (42 samples) =	$1,047.06
Total laboratory costs =	$6,232.50

Sampling Procedures

Safety

Reviewing environmental conditions for safety will always be a priority before accessing a sampling site. Personnel can refuse to proceed if they believe safety hazards are present.

Sampling

Standard Ecology protocols will be used for sampling fecal coliform bacteria (FC) as described in Joy (2006) and Ward and Mathieu (2011). Samples will be collected from downstream to upstream to avoid contamination. Flow will be taken when site conditions allow; protocol will follow EAP024 by Sullivan (2007).

Staff will collect grab samples for FC directly into pre-cleaned 250-mL containers supplied by the MEL (MEL, 2008). Plastic bottles will be used to prevent bottle breakage and sample loss. Samples will be collected in a manner to prevent bottle contamination and to avoid contamination with sediment. Samples will be collected in the streams center of flow when possible. Each sample will be labeled and immediately placed in a dark thermal cooler with ice. Samples will be kept in conditions between 0˚C and <10˚C until they are processed by the laboratory. Samples will arrive and be processed at the MEL within 24 hours of collection.

A waterproof loose-leaf field notebook will be used to record typical field data and any unusual occurrence that may have impacts on sample results.

The project manager will provide training for anyone who is assisting with the fieldwork. This will include discussion of quality assurance and contamination prevention. Upon completion of sampling at each site, the project manager will review the field notes. This will ensure all activities are performed and that the records are legible.

The project manager will coordinate sampling dates, laboratory identification numbers and methods with MEL, using standard Ecology protocol. The samples and completed Laboratory Analysis Required form will be picked up at the Ecology Headquarters Chain of Custody room by the MEL courier. The courier will transport the samples to the MEL using chain of custody protocols.

Minimizing the spread of invasive species

Standard operating procedures to minimize the spread of invasive species will be followed (Parsons, et.al., 2012) between watersheds. Specifically, hydrogen peroxide will be used to clean off boots and any gear that is used in the water.

Measurement Procedures

Table 5 summarizes sampling and analysis procedures for field and laboratory.

Laboratory analyses will be performed in accordance with the MEL User's Manual (MEL, 2008). Samples will be analyzed using the membrane filtration method. The laboratory staff will consult with the project manager if there are any changes in procedures over the course of the project.

The project manager will communicate with the laboratory staff to ensure that laboratory resources are available. The project manager will follow MEL procedures for sample notification and scheduling. With adequate communication, sample quantities and processing should not overwhelm the laboratory capacity.

Standard Ecology protocols will be used for sampling fecal coliform bacteria (FC) as described in Joy (2006) and Ward and Mathieu (2011). Field staff will measure instantaneous flows with a Marsh McBirney Flo-mate meter (Sullivan, 2007). Table 6 describes what will be conducted at each site.

Table 5. Summary of sampling and analysis procedures for field and laboratory.

Analysis	Method	Estimated Range	Lower Reporting Limit	Holding Time	Preservation	Container
Fecal Coliform Bacteria	Standard Methods, Membrane Filter 9222D	0 - 1000 cfu/100mL	1cfu/100 mL	24 hours	Cool to 0ºC - <10ºC	250 ml autoclaved poly-bottle
Water Velocity	Marsh-McBirney Flo-mate 2000, SOP EAP024	0-10 ft/s	0 ft/s	N/A	N/A	N/A

Table 6. Locations where samples will be collected and discharge measurements taken.

Location ID	Sample	Discharge
10-Bow-0.15/10-Bow-0.3	X	X
10-BowSW-0.3	X	
10-BowT-0.01	X	
10-BowTSW-0.01	X	
10-BOWTD1-0.01	X	
10-Bow-1.24	X	X
10-Bow-1.44	X	
10-BowC-1.44	X	
10-Bow-2.29	X	X
10-BowD-2.29	X	
10-Bow-2.65	X	

Quality Control Procedures

Variability that comes from field sampling and from laboratory analyses will be assessed by collecting replicate samples and by performing replicate analyses in pre-cleaned bottles. Bacteria sample concentrations are inherently variable compared with other water quality parameters. Bacteria sample precision will be assessed through 20 percent replication. The MEL will analyze a duplicate sample from each sampling event to determine the presence of bias in analytical methods.

All water samples will be analyzed at MEL following standard quality control procedures (MEL, 2006). Field sampling will follow quality control protocols (Ward and Mathieu, 2011). If any of these quality control procedures are not met, the associated results will be qualified and used with caution. Professional judgment and peer review will determine if the data are used in analysis.

The Marsh-McBirney flow meter will be zeroed and adjusted according to factory specifications. Replicate discharge measurements will be taken once per sampling event. Discharge data will be used to interpret fecal coliform data.

Data Management Procedures

Data reduction, review, and reporting will follow the procedures outlined in MEL's Lab Users Manual (MEL, 2008). Laboratory staff will be responsible for internal quality control verification, proper data transfer, and reporting data to the project manager via the Laboratory Information Management System (LIMS).

The laboratory microbiologist will notify the project manager by e-mail when FC results are greater than 200 cfu/100 mL. Elevated FC concentrations will be reported to the South Puget Sound Water Quality Management Area Water Cleanup Plan Coordinator as soon as possible.

Water quality data will be electronically transferred from LIMS into an EXCEL® spreadsheet (Microsoft, 2007). Data will be verified and reviewed for errors. If any errors are found they will be corrected.

The project manager will upload the data into Ecology's Environmental Information Management (EIM) system after data verification and validation. An EIM user study identification number (BEDI0019) has been created for this study. All monitoring data will be available via the internet at www.ecy.wa.gov/eim/.

The project manager will assess the quality of the data received from the laboratory and collected in the field. The review of measurement quality objectives will be conducted and adjustments made to field or laboratory procedures as necessary. The South Puget Sound Water Quality Management Area Water Cleanup Plan Coordinator will be notified if major changes are made to the sampling plan.

Laboratory values below detection limit will be assumed to be the detection limit for analysis. Estimation of univariate statistical parameters and graphical presentation of the data will be made using EXCEL® software. Data will be looked at by dry season (July – September) and wet season (October – June).

Audits and Reports

The MEL will submit laboratory reports and chain-of-custody records to the project manager. Documentation from the lab should include any quality control results associated with the data in order to evaluate the accuracy of the data and to verify that the quality objectives are met.

The project manager is responsible for verifying data completeness. The project manager also is responsible for writing the final technical report. The final report will include analyses of results that form the basis of conclusions and recommendations. The final report will undergo the peer review process by staff with appropriate expertise.

Data Verification and Validation

Data verification

Data verification involves examining the data for errors or omissions as well as examining the results for compliance with quality control acceptance criteria.

Qualified and experienced laboratory staff will examine lab results for errors, omissions, and compliance with quality control criteria. Analytical data will be reviewed; it will be verified according to the data review procedures outlined in the MEL User's Manual (MEL, 2008). Results that do not meet quality assurance requirements will be labeled with appropriate qualifiers. Findings will be documented in each case narrative sent to the project manager.

Field data will be verified by the project manager. Staff will check field notebooks for missing or improbable measurements before leaving each site. Data entry will be checked against the field notebook data for errors and omissions.

Once measurement results have been recorded, they are verified to ensure that:

- Data are consistent, correct, and complete.
- Results for quality control sample accompany the sample results.
- Established criteria for quality control samples are met.
- Data qualifiers are assigned where appropriate.
- Data specified in the sampling design were obtained.
- Methods and protocols specified in the QAPP were followed.

Data validation

Data validation involves a detailed examination of the data package using professional judgment to determine it the MQOs for precision and bias have been met.

The project manager will examine the data for errors, omissions, and compliance with quality control criteria. Data will be checked to ensure that data entered into EXCEL® is consistent with field notebooks. Corrections will be made as needed. Validated data will be entered into EIM.

Data Quality (Usability) Assessment

The project manager will verify that all measurement and data quality objectives have been met for each monitoring station. If the objectives have not been met then consideration will be taken to qualify the data, how to use it in analysis, or whether it should be rejected. Decisions for data quality and usability will be documented.

Usability determination will entail evaluation of field and laboratory results and relative standard deviation between field replicates. Adherence to established protocols should eliminate most sources of bias (Lombard, et al., 2004). Laboratory duplicates estimate laboratory precision. Field replicates should indicate overall variability (environmental, sampling, and laboratory).

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