Quality Assurance Project Plan

Water Quality Monitoring for Fecal Coliform Bacteria in Pierre Creek and Burns Creek

August 2007

Publication Number 07-10-036

Quality Assurance Project Plan

Water Quality Monitoring for Fecal Coliform Bacteria in Pierre Creek and Burns Creek

Prepared by:

Betsy Dickes
Washington State Department of Ecology
Water Quality Program
Olympia Washington 98504-7775

303(d) Listings Addressed in this Study

Pierre Creek WA-14-1190 fecal coliform bacteria
Burns Creek WA-14-1195 fecal coliform bacteria

August 2007
Publication Number 07-10-036

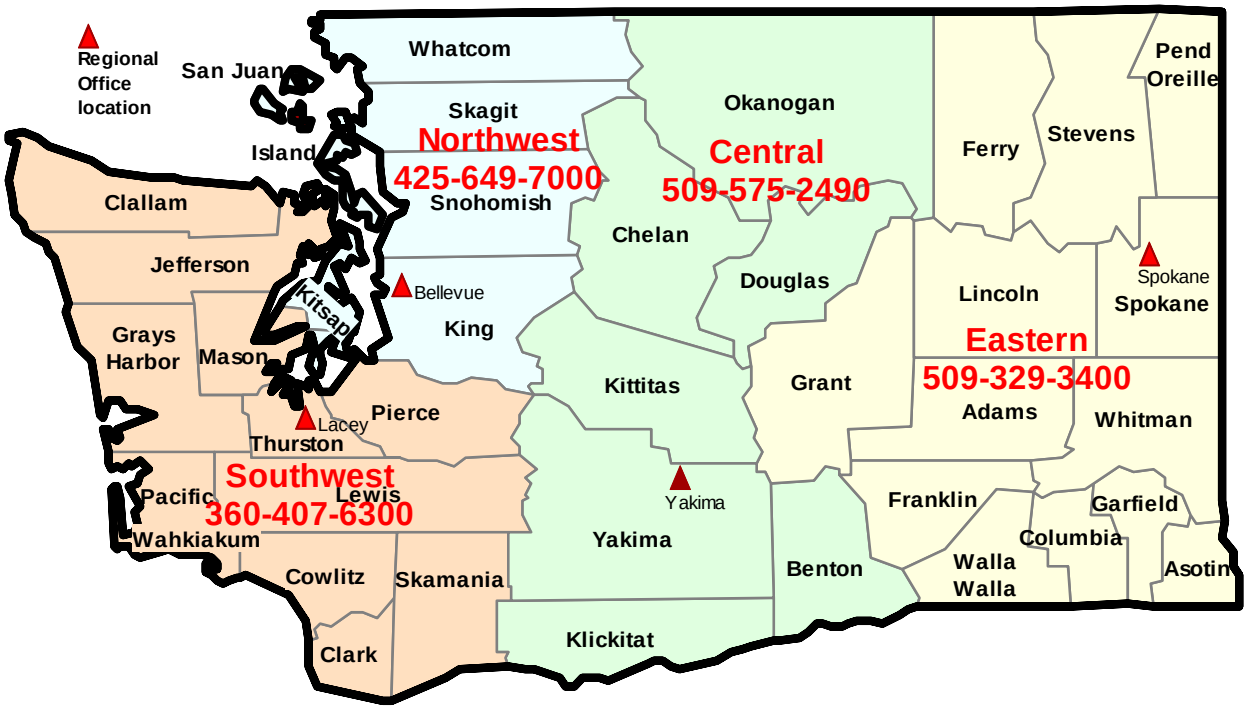
You can print or download this document from our website at:
http://www.ecy.wa.gov/biblio/0710036.html

For more information contact:

Department of Ecology
Water Quality Program
Southwest Regional Office
P.O. Box 47775
Olympia, WA 98504-7775

Telephone: 360-407-6270

Headquarters (Lacey) 360-407-6000



Persons with a hearing loss can call 711 for Washington Relay Service.
Persons with a speech disability can call 877-833-6341.

If you need this publication in an alternate format, please call the Water Quality Program at 360-407-6270. Persons with hearing loss can call 711 for Washington Relay Service. Persons with a speech disability can call 877-833-6341.

Approvals:

Accepted by: Betsy Dickes, Project Manager, Water Cleanup and Technical Assistance Unit, Water Quality Program, Southwest Regional Office	May 15, 2007
Accepted by: Christine Hempleman, TMDL Lead for Eastern Olympic WQMA, Water Quality Program, Southwest Regional Office.	June 4, 2007
Accepted by: Anise Ahmed, Environmental Assessment Program, Watershed Ecology Section	May 31, 2007
Accepted by: Kim McKee, Unit Supervisor, Water Cleanup /Technical Assistance Unit, Water Quality Program, Southwest Regional Office	June 4, 2007
Accepted by: Kelly Susewind, Section Manager, Southwest Regional Office	June 4, 2007
Accepted by: Bill Kammin, Ecology Quality Assurance Officer	May 31, 2007
Accepted by: Nancy Jensen, Manchester Laboratory, Microbiologist	May 31, 2007

Table of Contents

List of Figures

List of Tables

Abstract

Pierre Creek and Burns Creek are tributaries to Totten Inlet in Puget Sound, Thurston County, WA. There have been documented violations of water quality standards for fecal coliform bacteria (FC bacteria) since 1992. The creeks were placed on Ecology's 303(d) list of impaired water bodies for FC bacteria. A TMDL was conducted in 2006 using previously collected data. Best management practices have been implemented in the watershed. This monitoring study will collect water quality samples to determine current FC bacteria concentrations. Data will be used to determine compliance with state water quality standards and identify potential sources of FC bacteria. Samples will be collected at sites previously monitored by Washington Department of Ecology. These sites are at or near the point of discharge into Totten Inlet. Additional upstream sites have been added for this project.

Background

Pierre Creek and Burns Creek are tributaries to Totten Inlet, in WRIA 14 (Kennedy-Goldsborough Watershed), Thurston County (Figure 1). Washington State Department of Ecology (Ecology) monitored these two creeks for ten years (1992 through 2002) as part of the comprehensive National Monitoring Project in Totten and Eld Inlets (Batts and Seiders, 2003a and 2003b). Pierre and Burns Creeks violated water quality standards for fecal coliform bacteria (FC bacteria) every year of the study. As the result of the water quality violations, the creeks were placed on Ecology's list of impaired water bodies ((303(d) list) for FC bacteria. Both Pierre Creek and Burns Creek were on the 1996, 1998, and the 2004 303(d) list for FC bacteria.

Under the Federal Clean Water Act of 1972, a cleanup plan needed to be developed to determine the best means of bringing the waterbodies back into compliance with water quality standards. The cleanup plan is called a Total Maximum Daily Load (TMDL) study. A TMDL is the maximum pollutant loading a waterbody can tolerate and still meet Washington State's Water Quality Standards, Chapter 173-201A of the Washington Administrative Code. A TMDL was developed for tributaries to Totten and Eld Inlets (including Pierre Creek and Burns Creek), based on technical analyses of data previously collected by staff from Ecology, Thurston County, Squaxin Island Tribe, and Mason County (see Ahmed and Hempleman, 2006, for TMDL details).

Currently, the 2002/2004 303(d) list has Burns and Pierre Creeks classified as Category 5, i.e. needing a TMDL (Appendix 1). However, Category 5 is an incorrect classification. As mentioned in the above paragraph, Anise Ahmed (Ecology Environmental Assessment Program) performed a TMDL with previously collected data. The federal Environmental Protection Agency (EPA) approved this TMDL on 6/21/2006. Therefore, these creeks are actually Category 4A – "impaired but a TMDL has been conducted". This update will be proposed by Ecology when the next 303d list is submitted to EPA.

The current water quality standards classify the water of Pierre and Burns Creeks as Extraordinary Primary Contact Recreational waters (Appendix 2). The standard for this classification designates that FC bacteria levels must not exceed a geometric mean value of 50

colonies/100 mL, with not more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/100 mL.

Pierre and Burns Creeks drain into shellfish habitat in Totten Inlet. The Inlet is not on the 303(d) list for FC bacteria, however. Based on marine water quality monitoring by Washington State Department of Health Totten Inlet does not violate marine FC water quality standards. In 2005, it was classified as *Approved, Unclassified* for shellfish harvesting (Melvin, 2005).

Figure 1. General Area of Pierre Creek and Burns Creek

Project Description

The drainage areas for Burns and Pierre creeks are small at 0.26 and 0.16 square miles respectively (Ahmed and Hempleman, 2006). The creeks drain into the southern end of Totten Inlet. They are often dry from approximately May/June through August/September.

The watersheds are a mixture of rural residential, agricultural, and forested lands. Potential sources for bacterial pollution in the watersheds are failing on-site septic system, various types of domesticated animals (including cows, horses, sheep, chickens, dogs) and wildlife.

Best management practices (BMPs) have been implemented over the past several years in both watersheds. BMPs have been increasingly implemented in the Burns Creek watershed. For example, portions of Burns Creek are now fenced, livestock numbers are reduced during the wet season, and livestock are rotated in fields.

The project goal for Pierre and Burns Creeks water quality monitoring is to identify areas with elevated FC bacteria pollution.

Project objectives for Pierre and Burns Creeks Water Quality Monitoring are:

- Collect weekly water quality samples to be analyzed for FC bacteria.
- Assess compliance with Extraordinary Primary Contact Recreational water quality standards for FC bacteria.
- Identify sources of FC bacteria by dividing the reaches of the creek into segments.

Sampling Process Design

Pierre and Burns Creeks are in close proximity to each other – basically they are on either side of Oyster Bay Road near Burns cove, Totten Inlet. Therefore, both streams will be sampled for FC bacteria following a similar schedule. Water samples will be collected every Monday from March 12, 2007 through November 2007 and delivered to Ecology's Manchester Environmental Laboratory (MEL) by an Ecology courier on Tuesday mornings. Samples will be collected mid- to late- morning on Mondays to ensure the 24-hour analytical holding time is met. Flexibility on the collection time will also be determined by the span of daylight hours.

The sampling site at the mouth of each creek will be located as close as possible to those used in the National Monitoring Survey (Batts and Seiders, 2003a). Additional sites for this monitoring study were chosen to bracket segments of the creek and characterize sources flowing into the mainstem. The stream segments generally bracket potential sources, but they were also chosen for accessibility. As in the previous study, flow will be measured at the mouth sites. The TMDL is based on flow and bacteria concentrations at these downstream mouth sites.

Burns Creek will be sampled during a low tide, when possible. If the primary beach site (B1) cannot be accessed, Burns Creek will be sampled at the north culvert (B2N) or at the culvert on the south side of Oyster Bay Road (B2S) above the influence of the tide and roadside ditch (see Table 1 and Figure 2). The creek mainstem will be sampled from the lowest accessible downstream site to the uppermost site in the project. This will assist in preventing contamination from upstream sampling disturbance. The tributary ditches and culverts will be sampled in a manner and sequence that will not contaminate the mainstem waters and visa versa.

The lowermost site on Pierre Creek is not tidally influenced. The 'mouth' site is up in the forest about 80 meters due to the presence of a small dam at the beach. The creek will be sampled from downstream to upstream (see Table 1 and Figure 2) to prevent contamination from upstream sampling disturbance.

All samples will be placed immediately into a field cooler with ice. Staff will always have the field cooler in their possession. Whenever time allows, the samples will be transferred back to the larger ice-filled cooler in the van. The van will be locked whenever Ecology staff are not present. This is a protocol to secure chain of custody.

Permission to access the sampling locations on Burns and Pierre Creeks was provided by the land owners.

Sampling Procedures

Safety
Field personnel have the authority to ensure their safety. Personnel can refuse to proceed at any step if current or potential safety hazards are present.

Sampling
Standard Ecology Environmental Assessment Program protocols will be used for sample collection. Field sampling and measurement protocols will follow those described in *Field Sampling and Measurement Protocols for the Watershed Assessments Section* (Cusimano, 1993). Bacteria grab samples will be collected directly into pre-cleaned containers supplied by the laboratory and described in MEL (2005). Plastic poly bottles will be used to prevent sample loss through bottle breakage. Due to the small size of these streams, samples will be collected by reaching by hand into the stream thalweg (center of flow). Samples will be collected from below the surface of the water, with the sampling person standing downstream from the collection point. Caution will be exercised not to stir up sediment. Each bacteria sample will be labeled and immediately placed in a cooler with ice. Samples will be kept in conditions between 0°C and 4°C until the samples are processed by the laboratory. Samples will be received at the Manchester Laboratory within 24 hours of collection.

Table 1. Sampling Site Locations

CT*	INITIAL SITE NAME	SITE NAME RIVER MILE	WEEK #	LAB#	LATITUDE	LONGITUDE	DESCRIPTION (see Figure 2)
					BURNS CREEK		
1	**B1**		X	4130	N 47 ° 06' 22.2 "	W123° 02' 39.1"	Burns at mouth - on beach
2	**B2N**		X	4132	N 47 ° 06' 21.8 "	W123° 02' 39.5"	Burns just below culvert on north side (beach side) of Oyster Bay Road
3	**B2S**		X	4135	N 47 ° 06' 21.4 "	W123° 02' 40.8"	Burns culvert on south side (farm side) of Oyster Bay Road above influence of D1
4	**BCL**		X	4134	N 47 ° 06' 21.3 "	W123° 02' 38.6"	culvert east of B2N
5	**BPD**		X	4136	N 47 ° 06' 18.6 "	W123° 02' 43.4"	Burns at downstream end of pond
6	**BPU**		X	4137	N 47 ° 06' 17.8 "	W123° 02' 44.7"	Burns at upstream end of pond
7	**BTOP**		X	4138	N 47 ° 06' 11.0 "	W123° 02' 55.5"	Burns at southern property line of Oyster Bay farm
8	**D1**		X	4133	N 47 ° 06' 21.6 "	W123° 02' 41.1"	Ditch flowing east down Oyster Bay Road andnorth of Oyster Bay Road and above confluence with Burns.
9	*(site name)R*		X	4131	will match regular site		Replicate sample taken as close to another as posible in space and time
					PIERRE CREEK		
1	**P1**		X	4140	N 47 ° 06' 16.4 "	W123° 02' 33.1"	Pierre 80 m above mouth
2	**P2**		X	4141	N 47 ° 06' 13.1 "	W123° 02' 36.3"	North on creek on east side of intersection of Oyster Bay Road and 49th Ave
3	**P3**		X	4143	N 47 ° 06' 12.7 "	W123° 02' 37.5"	NW branch just west of Oyster Bay Road
4	**P4**		X	4144	N 47 ° 06' 11.1 "	W123° 02' 42.8"	NW branch west of Oyster Bay Road at forest line
5	**P5**		X	4145	N 47 ° 06' 12.5 "	W123° 02' 37.0"	SW branch just west of Oyster Bay Road
6	**P6**		X	4146	N 47 ° 06' 08.7 "	W123° 02' 39.7"	SW branch west of Oyster Bay Road below adjacent properties pond
7	**PT**		X	4142	N 47 ° 06' 14.1"	W123° 02' 33.0"	Tributary to Pierre coming in from the SE, sampled north of 49th Ave
8	**PTU**		X	4147	N 47 ° 06' 12.6 "	W123° 02' 33.1"	Tributary to Pierre south of 49th Ave above influence of PDT
9	**PDT**		X	4148	N 47 ° 06' 12.9 "	W123° 02' 32.9"	Ditch flowing west along 49th into PTU
10	*(site name)R*		X	4149	will match regular site		Replicate sample taken as close to another as posible in space and time

* CT = COUNT, NUMBER OF SAMPLES

** Latitude and Longitude were obtained using a hand held GPS unit - Garmon 76CSx

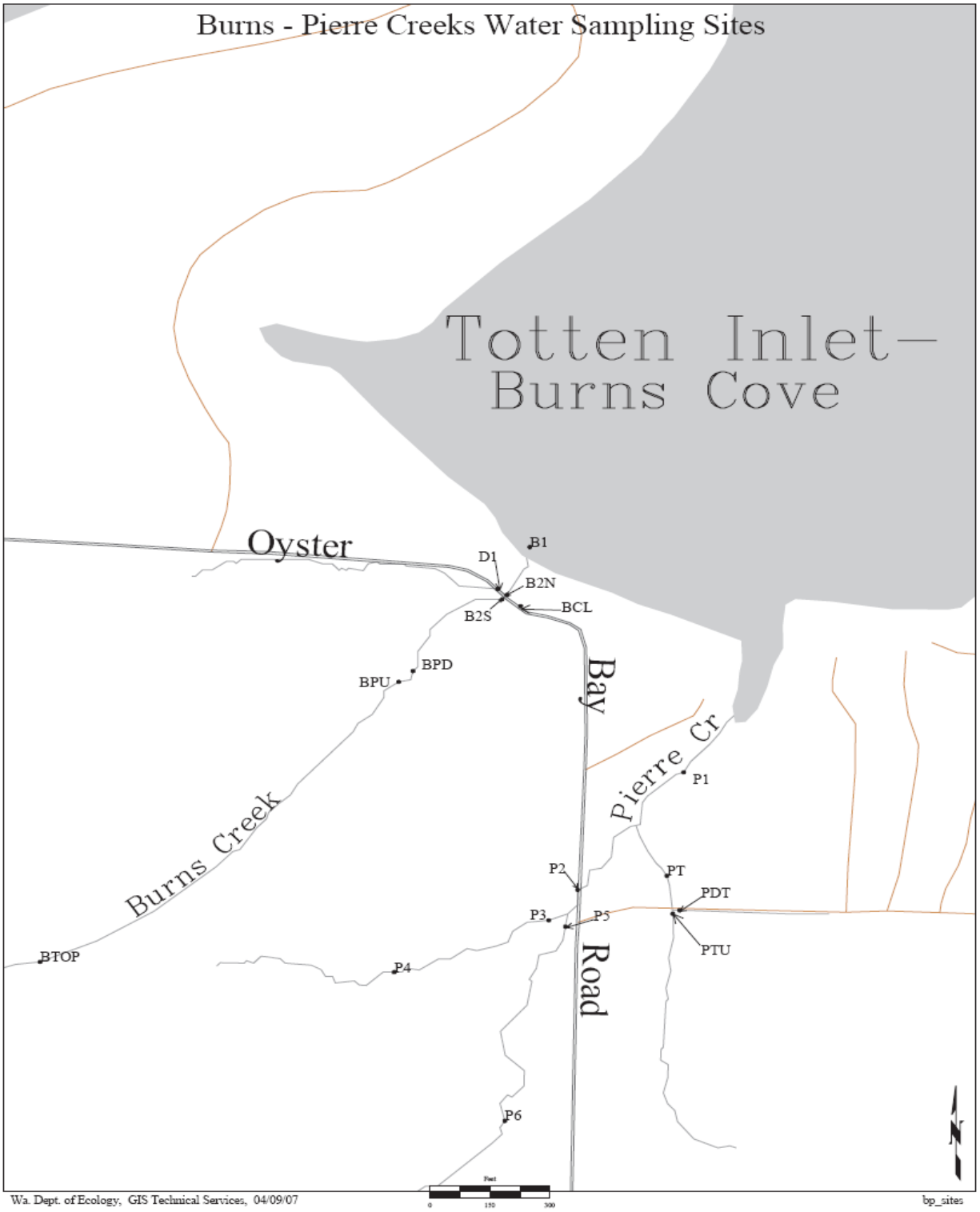


Figure 2. Pierre Creek and Burns Creek Sampling Sites

Sampling should be timed to avoid tidal influence at Burns Creek site – B1 which is the downstream site nearest to the mouth. If the tide is too high, water samples will be collected on the south side of Oyster Bay Road just above the culvert and outside of the influence of the roadside ditch. The sample bottles will be labeled with:

- Project name
- Date
- Site name
- Name of lead sampler
- Laboratory ID number
- Parameter (FC_MF)
- Sampling Time (written in field)

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

The lead staff will train all field assistants with field protocol associated with this study. This will include quality assurance and contamination prevention. All measurements taken and read by the lead staff, e.g. flow readings, will be repeated out loud by the assistant to provide documentation. The lead field staff will perform all water sample collection. Upon completion of sampling at each site, the notes will be reviewed to ensure all activities were performed and the records are legible.

Coordination for sampling dates, lab numbers, and methods, will be made with MEL using standard Ecology protocol. The samples and completed Manchester Laboratory Analyses Required form will be picked up on Tuesday morning at the Ecology Headquarters Chain of Custody Room by the formally assigned Manchester Courier. The sample cooler(s) will be transferred to the lab vehicle using chain of custody protocol.

Discharge will be measured at the downstream site on each creek using standard methods for estimating stream flow (Cusimano, 1993). At least one of the sites will be measured in replicate during each sampling event.

Low Flow
Pierre Creek and Burns Creek are intermittent streams and often are dry by the end of May. Professional judgment will be used to determine if a representative sample and flow measurement can be obtained as water depth decreases. These decisions will be documented in the field notebook. Sampling will resume as soon as there is enough water to collect a representative sample. This may be in September.

Storm Events
Most of the sampling will be conducted during the wet season (November through April). At least one storm event (>0.25 inches in the last 24 hours) will be targeted in the spring and one in the fall.

Measurement Procedures

Table 2. Summary of sampling and analysis procedures for field and laboratory procedures

Analysis	Method or Equipment	Estimated Range	Resolution	Holding Time	Preservation	Container	Estimated Samples
Water Velocity	Marsh-McBirney Flo-Mate 2000	0 - 6 ft/s	0.05 ft/s	N/A	N/A	N/A	2
Stream Gauge	Standard gauge plate	0 - 3 ft	0.1 unit	N/A	N/A	N/A	1
Fecal Coliform	Standard Methods Membrane Filter 9222D	0 - 1000 cfu/100mL	1cfu/100 mL	24 hours	Cool to 4ºC	250 ml autoclaved poly/glass bottle	20 during high flow

Quality Control Procedures

Total variation for field sampling and laboratory determination will be assessed by collecting replicate samples. Replicate results for bacteria samples tend to have a high relative percent difference (%RSD) compared to other water quality parameters. Bacteria sample precision will be assessed by collecting replicate samples. There will be at least 20% sample replication for each sample event. One out of the two flows taken at the downstream sites will be replicated. MEL will routinely analyze a duplicate sample from each sampling event to determine the presence of bias in analytical methods. The difference between field variability and laboratory variability is an estimate of the field sample variability.

All samples will be analyzed at MEL. Following standard quality control procedures (MEL, 2005). Field sampling and measurements will follow quality control protocols described in Ecology (1993). 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 analyses.

Data Quality Objectives

The measurement quality objectives are presented below in Table 3.

Table 3. Measurement Quality Objectives for Field and Laboratory Determinations

Analysis	**Accuracy** percent deviation from true value	**Precision** Relative Standard Deviation (RSD)	**Bias** percent deviation from true value due to systematic error	**Lower reporting Limits** Concentration Units
Water Velocity	±2% of reading +0.05 ft/s	0.1 ft/s	N/A	0.01 ft/s
Fecal Coliform (membrane filter (MF))	N/A	20 - 50% RSD*	N/A	1 cfu/ 100mL
*replicate results with a mean of less than or equal to 20cfu/100mL will be evaluated separately.				

Accuracy of measurements can be assessed by evaluating both precision and bias. Precision is a measure of data scatter due to random error, while bias is a measure of differences between a parameter value and the true value due to systematic errors. Precision will be quantified using relative standard deviation (%RSD). The target for precision of FC bacteria determinations is based on historical performances by MEL (Mathieu, 2006).

The laboratory's data quality objectives and quality control procedures are documented in the Manchester Environmental Laboratory (MEL) Lab Users Manual (MEL 2005) and the MEL Quality Assurance Manual (MEL, 2001).

Data Management Procedures

Data reduction, review, and reporting will follow the procedures outlined in MEL's Lab Users Manual (MEL, 2005). Laboratory staff will be responsible for internal quality control verification, and for proper data transfer and reporting data to the project manager via the Laboratory Information Management System (LIMS).

All water quality data will be entered from LIMS into Ecology's Environmental Information Management (EIM) system. Data will be verified and 25% of the data entries will be selected at random and reviewed for errors. If errors are detected, another 25% will be reviewed until no errors are detected.

The project manager will validate the quality of the data received from the laboratory and collected in the field in reference to the measurement quality objectives. The review will be performed within one month of data collection and adjustments to field or laboratory procedure or the measurement quality objectives will be made, as necessary. QA Project Plan signature

parties will be notified of major changes. Data that does not meet objectives may be approved for use by the project manager but this data will be qualified appropriately.

Elevated fecal coliform densities (>200 cfu/100mL) will be reported to the TMDL Lead. All other data will be made available for disbursement after quality control and EIM are completed. Data analysis will include evaluation of data distribution characteristics and, if necessary, appropriate data transformations. Estimation of univariate statistical parameters and graphical presentation of the data (box plots, time series, regressions) will be made using EXCEL (Microsoft, 200X) software. Any additional statistical analyses will be determined based on results and time available. This study is not a TMDL or formal effectiveness monitoring study.

Data Verification, Usability Determination, and Review

Data verification involves examining the data for errors, omissions, and compliance with quality control (QC) acceptance criteria. Once measurement results have been recorded, they are verified to ensure:

- Data are consistent, correct, and complete, with no errors or omissions.
- Results for QC samples accompany the sample results.
- Established criteria for QC results were met.
- Data qualifiers are properly assigned where necessary.
- Data specified in Sampling Process Design were obtained.
- Methods and protocols specified in the QA Project Plan were followed.

The field lead is responsible for verifying field data entries are complete and correct (e.g. decimal point missing from an entry or something doesn't look right based on experience).

Qualified and experienced laboratory staff will examine lab results for errors, omissions, and compliance with QC acceptance criteria. Findings will be documented in each case narrative. MEL is responsible for verifying their respective analytical results. Analytical data will be reviewed and verified by comparison with acceptance criteria according to the data review procedures outlined in the Lab User's Manual (MEL, 2005). Results that do not meet quality assurance requirements will be labeled with appropriate qualifiers, and an explanation will be provided in a quality assurance memorandum attached to the data package.

Data usability determination will follow verification. This determination is parameter-specific, and involves a detailed examination of the data package, using professional judgment to determine whether objectives have been met. The project lead will examine the complete data package in detail to determine whether the procedures in the methods and procedures specified in this QA Project Plan were followed. The usability determination will entail evaluation of field and laboratory results and relative percent differences between field replicates. Adherence with established protocols should eliminate most sources of bias (Lombard and Kirchmer, 2004). Laboratory duplicates help estimate laboratory precision. Field replicates should indicate overall

variability (environmental + sampling + laboratory) in the case of bacteria or (environment + instrumentation + sampling) in the case of flow and stream gauge.

Project Organization

The roles and responsibilities of Ecology staff involved in this project are provided below:

Betsy Dickes, *Project Manager, Water Quality Program, Southwest Regional Office (SWRO).* Responsible for overall project management. Defines final project objectives, scope, and study design. Responsible for writing the Quality Assurance Project Plan (QAPP), managing data collection, and preparing final report.
(360) 407-6296 bedi461@ecy.wa.gov

Christine Hempleman*, TMDL Lead, Eastern Olympic WQMA, Water Quality Program, SWRO.* Reviews and comments on QAPP and final report. Will coordinate with the TMDL technical advisory group and subsequent cleanup efforts.

Kim McKee, *Unit Supervisor, Water Quality Program, Southwest Regional Office (SWRO).* Responsible for review and signature approval of the QAPP and final report.

Kelly Susewind*, Section Manager, Water Quality Program, SWRO.* Responsible for review and approval of the QAPP and final report

Bill Kammin, *Ecology Quality Assurance Officer, Environmental Assessment Program.* Reviews the QAPP for technical merit and Agency consistency. Available for technical assistance on quality assurance issues.

Anise Ahmed*, Environmental Assessment Program.* Reviews the QAPP for technical merit. Available for technical assistance on quality assurance issues and problems during the implementation and assessment phases of the project.

Schedule

The following schedule may need to be updated periodically.

Completion of Final Approved QA Project Plan	**May 23, 2007**
Approval for Sampling Start/End	**March 12, 2007 – November 2007**
Draft Study Report	**March 17, 2008**
Final Study Report	**April 21, 2008**
Submit Data to the Environmental Information Management System (EIM)	**May 1, 2008**

References

Ahmed, A., 2004c. Quality Assurance Project Plan: Tributaries to Totten, Eld, and Little Skookum Inlets, Temperature and Fecal Coliform Bacteria Total Maximum Daily Load Study. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-106. www.ecy.wa.gov/pubs/0403106.pdf

Ahmed, A and Hempleman, C., 2006. Tributaries to Totten, Eld, and Little Skookum Inlets: Fecal Coliform Bacteria and Temperature Total Maximum Daily Load - Water Quality Improvement Report. Washington State Department of Ecology March 2006 Publication No. 06-03-007 Olympia, WA http://www.ecy.wa.gov/pubs/0603007.pdf

APHA, 1998. Standard Methods for the Examination of Water and Wastewater, 20th Edition. United Book Press, Inc. Baltimore, Maryland.

Batts, D. and K. Seiders, 2003a. Totten and Eld Inlets Clean Water Projects: Final Report. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-010. www.ecy.wa.gov/biblio/0303010.html

Batts, D. and K. Seiders, 2003b. Appendixes B, C, and D. Totten and Eld Inlets Clean Water Projects: Final Report. Washington State Department of Ecology, Olympia, WA. Publication No. 03-03-011. http://www.ecy.wa.gov/pubs/0303011.pdf

Cusimano, B. 1993. Field Sampling and Measurement Protocols for the Watershed Assessments Section. Publication Number 93-e04. Washington State Department of Ecology, Olympia, Washington. http://www.ecy.wa.gov/pubs/93e04.pdf

Lombard, S. and C. Kirchmer, 2004. Guidelines for Preparing Quality Assurance Project Plans for Environmental Studies. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-030. www.ecy.wa.gov/biblio/0403030.html.

Manchester Environmental Laboratory Quality Assurance Manual (MEL). 2001. The Quality Assurance manual for the Washington State Department of Ecology Manchester Environmental Laboratory. Washington Department of Ecology, Manchester, WA.

Manchester Environmental Laboratory (MEL). 2005. Manchester Environmental Laboratory Users Manual. 8th Edition. Washington Department of Ecology, Manchester, WA.

Mathieu, N., 2006. Replicate Precision for 12 TMDL Studies and Recommendations for Precision Measurement Quality Objectives for Water Quality Parameters. Washington State Department of Ecology, Olympia, Washington Publication No. 06-03-044.

Melvin, D., 2005. Annual Shellfish Growing Area Report for Totten Inlet. Washington State Department of Health. Division of Environmental Health, office of Shellfish and Water Protection. http://static.doh.wa.gov/ehp/sf/Pubs/gareports/05totten.pdf

Appendices

Appendix 1. The Water Quality Assessment Categories.

<table>
<tr><td>Category 1. Meets Tested Criteria</td><td rowspan="3">Not known to be impaired</td><td rowspan="4">EPA approval and TMDL not required</td></tr>
<tr><td>Category 2. Waters of Concern</td></tr>
<tr><td>Category 3. Lack of Sufficient Data</td></tr>
<tr><td>Category 4. Impaired But Does Not Require A TMDL because:</td><td rowspan="4">Impaired</td></tr>
<tr><td>4a. Already has a TMDL</td></tr>
<tr><td>4b. Has a Pollution Control Project</td></tr>
<tr><td>4c. Impaired but a TMDL is Inappropriate</td></tr>
<tr><td>Category 5. Polluted Waters that Require a TMDL (303(d) List)</td><td>EPA approval and TMDL required</td></tr>
</table>

Appendix 2. Water Quality Criteria for Fecal Coliform bacteria.

Water Contact Recreation Bacteria Criteria in Freshwater	
Category	Bacteria Indicator
Extraordinary Primary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 50 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 100 colonies/100 mL.
Primary Contact Recreation	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.
Secondary Contact Recreation	Fecal coliform organism levels must not exceed a geometric mean value of 200 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 400 colonies /100 mL.

Bacteria, Fresh Waters

Bacteria criteria are set to protect people who work and play in and on the water from waterborne illnesses. In the Washington State water quality standards, fecal coliform is used as an "indicator bacteria" for the state's freshwaters (e.g., lakes and streams). Fecal coliform in water "indicates" the presence of waste from humans and other warm-blooded animals. Waste from warm-blooded animals is more likely to contain pathogens that will cause illness in humans than waste from cold-blooded animals. The fecal coliform criteria are set at levels that have been shown to maintain low rates of serious intestinal illness (gastroenteritis) in people.

Use Categories

There are three use categories related to the freshwater bacteria criteria in Washington:

(1) The *Extraordinary Primary Contact* use is intended for waters capable of "providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas." To protect this use category: Fecal coliform organism levels must not exceed a geometric mean value of 50 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 100/colonies mL" [WAC 173-201A-200(2)(b), 2003 edition].

(2) The *Primary Contact* use is intended for waters "where a person would have direct contact with water to the point of complete submergence including, but not limited to, skin diving, swimming, and waterskiing." More to the point, however, the use is to be designated to any waters where human exposure is likely to include exposure of the eyes, ears, nose, and throat. Since children are also the most sensitive group for many of the waterborne pathogens of concern, even shallow waters may warrant primary contact protection. To protect this use category: "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 mL" [WAC 173-201A-200(2)(b), 2003 edition].

(3**)** The *Secondary Contact* use is intended for waters "where a person's water contact would be limited (e.g., wading or fishing) to the extent that bacterial infections of the eyes, ears, respiratory or digestive systems, or urogenital areas would be normally avoided." To protect this use category: "Fecal coliform organism levels must not exceed a geometric mean value of 200 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 400/colonies mL" [WAC 173-201A-200(2)(b), 2003 edition].

Compliance is based on meeting both the geometric mean criterion and the 10% of samples (or single sample if less than ten total samples) limit. These two measures used in combination ensure that bacterial pollution in a waterbody will be maintained at levels that will not cause a greater risk to human health than intended. While some discretion exists for selecting sample averaging periods, compliance will be evaluated for both monthly (if five or more samples exist) and seasonal (summer versus winter) data sets.