# Willapa River
# Fecal Coliform Bacteria
# Total Maximum Daily Load

## Water Quality Improvement Report


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Cover photo: Green 35 navigation marker and light, located approximately midway between Potter Slough and the mouth of the Willapa River.

# Willapa River
# Fecal Coliform Bacteria
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## Water Quality Improvement Report

*by*
*Anise Ahmed and David Rountry*

Environmental Assessment Program
and
Water Quality Program
Washington State Department of Ecology
Olympia, Washington  98504-7710

| Waterbody | New Waterbody Number | Old Waterbody Number |
|---|---|---|
| Willapa River | YN05JR | WA-24-2010, WA-24-2020, WA-24-2030 |
| Riverdale Creek | IH25UI | -- |
| Wilson Creek | RX96AH | -- |
| Falls Creek | NA93NI | -- |
| Fern Creek | CO94AN | -- |
| Un-named Creek | AX11QJ | -- |
| Fork Creek | MO06ZS | WA-24-2037 |

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# Abstract

Segments of the Willapa River have been placed on the federal Clean Water Act section 303(d) list for failing to meet Washington State's water quality standard for fecal coliform bacteria. A previous draft Total Maximum Daily Load (TMDL) was based on data that were almost ten years old. During 2006, new data were collected by the Department of Ecology at various locations in the Willapa River watershed.

This report provides an evaluation of the 2006 data. It establishes target reductions, or numeric cleanup goals called load allocations, for nonpoint (diffuse) sources of bacteria pollution. This report also describes what it will take for the present and future permitted facilities to help the Willapa River meet state water quality standards. The target reductions were determined using the statistical roll-back method and are considered to be load allocations at the various river segments. The roll-back method compares monitoring data to standards, and the difference is the percent change needed to meet the standards. We found that the current permitted discharge limits for point sources will be adequate to help achieve this TMDL.

Load allocations are provided for all the river segments sampled. In some places, the river met standards, so the load allocation reflects that no reduction is needed. But target reductions are shown for 11 of the 24 stations sampled that did not meet standards.

Bacteria reductions are needed in six places of the upper watershed, and in three areas of the lower watershed. Data were too sparse to calculate statistically meaningful load allocations for four tributaries in the cities of Raymond and South Bend because these areas were only sampled during rain events in 2006. The cities and the Pacific Conservation District should continue to investigate and reduce pollution sources to manageable levels in these tributaries. Additional data from other studies were included in an analysis to calculate load allocations for two of the tributaries which are on the 303(d) list.

Ongoing tracking of cleanup activities as well as monitoring for water quality conditions in the impaired areas will be important. Monitoring will help focus ongoing cleanup into the highest priority locations and will help account for improvements.

# Acknowledgements

The authors of this report would like to thank the following people for their contribution to this study:

- Members of the North Pacific Infrastructure Action Team who participated in the development of the Quality Assurance Project Plan for the 2006 study and in the process towards completing this report.

- Mike Johnson of the Pacific Conservation District (CD) and Tom Salzer of the Washington Conservation Commission facilitated very positive discussions with the CD Board members and provided much of the report information about local agricultural pollution management programs and success. The CD Board should be especially commended for reaffirming in this TMDL their commitment to helping more landowners succeed with water quality and farm improvement practices.

- Steve Russell and Dean Parsons of the South Bend and Raymond Public Works Departments provided access to information about city stormwater management activities. They arranged the two cities' commitment to aid this TMDL with an ongoing focus on pollution source identification and controls.

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# Overview

This *Water Quality Improvement Report* describes the status of an ongoing bacteria pollution study and local water quality improvement work in the Willapa River watershed. It explains the nature of pollution sources and how sampling data from 2006 were used to determine numeric cleanup goals. It compares current and older water quality conditions and reviews progress already made to restore water quality.

This report recommends where more actions are needed to meet established beneficial uses of the river and estuary. A cleanup plan outline is included that describes how ongoing water quality monitoring and resources can be focused on cleanup of the most pressing problem areas. Baseline data were collected in 1998. Local water protection work since then has been very effective in lowering bacteria levels. However, more work is needed in certain areas of the watershed to meet water quality objectives.

This report helps meet a required part of the federal Clean Water Act. It addresses fifteen locations in the Willapa watershed that are named on the Clean Water Act section 303(d) list for bacteria reduction. In 1998, fecal coliform bacteria concentrations in these places were high enough to indicate a potential health risk to recreational users. Various swimming holes in the river are used by children and families in the summertime. Several rope swings, and fishing lures hanging from tree branches along the river mark favorite recreation spots. There is one commercial retreat center and a private group campground on the upper river shoreline.

The tributaries and the mainstem Willapa River drain to an estuary and Willapa Bay. The bay supports Tribal, commercial, and private shellfish harvest. Elevated bacteria concentrations indicate a potential health risk to people who eat shellfish, and can result in restrictions on shellfish harvest. The Washington State Department of Health (DOH) classifies areas for commercial harvest of shellfish. In Willapa Bay, DOH established a "sanitary line" separating the Approved area from the Prohibited area. A buffer area separates the shellfish harvest "sanitary line" from a point upstream at river mile 1.8 where the state marine water quality standards apply. Shellfish do occur in the buffer area and even upstream of where the marine water quality standards begin. DOH set the sanitary line at a calculated safe distance downstream of the Raymond and South Bend wastewater treatment plants to protect people from eating contaminated shellfish due to an upset, bypass, or loss of disinfection at either of these facilities.

Fortunately, no harvest restrictions have been needed in the mouth of the Willapa River for many years. However, the state marine water quality standard for shellfish protection is exceeded about one sample event each year at Johnson Slough near the river mouth. This TMDL is constructed to meet water quality standards at the mouth of the River near Johnson Slough.

The federal Clean Water Act requires that impaired waterbodies be restored to clean water standards through a total maximum daily load, or TMDL process. This process starts with a study and analysis of pollution levels and sources. Then it requires that actions be taken to restore healthy water quality, based on that analysis.

The first part of this report addresses the technical analysis and numeric cleanup goals determined from 2006 sampling data.  The second part of this document, the *Improvement Strategy*, describes the framework and local process for water quality restoration.

The report:

- Provides a comparison of baseline (1998) and newer water quality data.
- Calculates how much bacteria the creeks and river can tolerate and still be healthy for beneficial uses (called the 'loading capacity') using data primarily from the 2006 sampling study, and how much reduction is needed to reach healthy levels.
- Describes the framework for water quality improvement including participating organizations, primary funding sources, and the general approach to address primary pollution sources.
- Proposes a monitoring strategy framework to evaluate the effectiveness of improvement measures.

Bacteria reductions were calculated according to established scientific protocols and are provided for sampling locations that did not meet standards.  A "critical period" evaluation was also performed, to address the time of year when bacteria concentrations are highest.  There was not just one critical period identified for the collective locations in this project.  Bacteria levels violated standards at most sampling stations at least once during the sampling year.  Several stations violated standards during several consecutive months and multiple seasons of the year.

Bacteria reductions are needed in six places of the upper watershed, and at five areas of the lower watershed.  However, the area near Johnson Slough at the river mouth was identified as the most critical location.  It is closer to the shellfish areas where the marine water quality standard is the most protective of any location in the TMDL study.  While violations only occurred there about 10% of the time, they typically occurred during high precipitation conditions.

## Load allocations

Load allocations are the nonpoint source reductions needed at each station to meet water quality standards.  At some locations, no reduction is needed since the river segment and others immediately downstream already meet standards.  At other locations, water quality may meet standards but may still need a pollution load reduction in order to avoid more loading to a downstream segment that does not meet standards.  When a load reduction is needed, it is usually just to allow that particular segment to meet standards.

It should be noted, however, that the percent-reduction goals determined from this technical analysis are just that -- goals.  The final standard for achievement of the TMDL is to bring the river into compliance with water quality standards.

The 2006 data show that fecal coliform bacteria percent-reductions are needed at the rates and places given in the following table.

Table O-1. Target reductions necessary to achieve water quality standard at various locations in the Willapa River and its tributaries (2006)

| Station | Mainstem RM | Tributary RM | Location | Annual Target reductions % |
|---|---|---|---|---|
| WRSW | 37.1 | | Swiss Picnic Road | 81 |
| FERN | 36.2 | 0.4 | Elk Prairie Rd, Fern Creek | 70 |
| WRLE | 33.2 | | Lebam Road | 68 |
| FORK | 30.5 | 0.25 | Fork Creek | 41 |
| WRMN | 21.4 | | SR-6, near Menlo | 17 |
| WRC1 | 17.5 | | Camp One Road | 38 |
| WRWI | 13.7 | | Willapa Road | 46 |
| RAYSW-3 | 7.2 | 0.4 | Lions Club Park, Riverdale Creek | 78 |
| SBSW-2 | 3.1 | 0 | Central St. drain @ Coast Seafoods | 39 |
| WRSB3* | 1.5 | | Below Potter Slough | 49 |
| WRJS* | 0.4 | | Near Johnson Slough | 43 |

* seaward station where marine criteria apply

## Wasteload allocations

The TMDL process also requires an analysis of pollution discharges from facilities covered by National Pollutant Discharge Elimination System (NPDES) permits. Pollution reductions that might be identified for such facilities are called Wasteload Allocations. In this TMDL, NPDES permit limits for all of the facilities in the lower Willapa River are deemed protective of water quality standards and meet the intent of the TMDL.

## What to expect

Data generated by Pacific County Health Department, Pacific County, Ecology, and state Department of Health indicates that water quality has improved since 1998 throughout most of the watershed. They indicate that local restoration efforts underway since 1998 have resulted in substantial decreases in bacteria levels. However, a description of baseline conditions and a determination of load reductions (goals) are still required by the TMDL process, in order to measure progress towards water cleanup and to show that the TMDL has been achieved.

Based on bacteria reductions so far, this plan suggests that water quality standards for bacteria can be consistently met within the next five years, by 2012. Ongoing monitoring is essential to document the most current conditions and to help local organizations focus limited resources on fixing remaining priority areas.

# What is a Total Maximum Daily Load (TMDL)?

## Federal Clean Water Act requirements

The Clean Water Act established a process to identify and clean up polluted waters. Under the Clean Water Act, each state is required to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of designated uses for protection, such as cold water biota and drinking water supply, as well as numeric quality criteria required to achieve those uses.

Every two years, states are required to prepare a list of waterbodies – lakes, rivers, streams, or marine waters – that do not meet water quality standards. This list is called the 303(d) list. To develop the list, Ecology compiles its own water quality data along with data submitted by local state and federal governments, tribes, industries, and citizen monitoring groups. All data are reviewed before use in the 303(d) list, to ensure that they were collected using appropriate scientific methods. The 303(d) list is part of the larger Water Quality Assessment.

The Water Quality Assessment is a list that tells a more complete story about the condition of Washington's water. This list divides waterbodies into five categories:

Category 1 – Meets standards for parameter(s) for which it has been tested

Category 2 – Waters of concern

Category 3 – Waters with no data available

Category 4 – Polluted waters that do not require a TMDL because:
- 4a – Has a TMDL approved and it is being implemented
- 4b – Has a pollution control program in place that is expected to solve the problem
- 4c – Is impaired by a non-pollutant such as low water flow, dams, culverts

Category 5 – Polluted waters that require a TMDL – Category 5 sites make up the 303(d) list.

## TMDL process overview

The Clean Water Act requires that a Total Maximum Daily Load (TMDL) be developed for each of the waterbodies on the 303(d) list. The TMDL identifies pollution problems in the watershed and then specifies how much pollution needs to be reduced or eliminated to achieve clean water. Then Ecology works with the local community to develop an overall approach to control the pollution, called the Implementation Strategy, and a monitoring plan to assess effectiveness of the water quality improvement activities. Once the TMDL has been approved by EPA, a *Water Quality Implementation Plan* must be developed within one year. That plan identifies specific tasks, responsible parties, and timelines for achieving clean water.

## Elements required in a TMDL

The goal of a TMDL is to ensure the impaired water will attain water quality standards. A TMDL includes a written, quantitative assessment of water quality problems and of the pollutant sources that cause the problem. The TMDL determines the amount of a given pollutant that can be discharged to the waterbody and still meet standards (the loading capacity) and allocates that load among the various sources.

If the pollutant comes from an isolated source (referred to as a point source) such as a municipal or industrial facility's discharge pipe, that facility's share of the loading capacity is called a wasteload allocation. If it comes from a set of diffuse sources (referred to as a nonpoint source) such as general urban, residential, or farm runoff, the cumulative share is called a load allocation.

The TMDL must also consider seasonal variations and include a margin of safety that takes into account any lack of knowledge about the causes of the water quality problem or its loading capacity. A reserve capacity for future loads from growth pressures is sometimes included as well. The sum of the wasteload and load allocations, the margin of safety and any reserve capacity must be equal to or less than the loading capacity. Identification of the contaminant loading capacity for a waterbody is an important step in developing a TMDL. EPA defines the loading capacity as "the greatest amount of loading that a waterbody can receive without violating water quality standards" (EPA, 2001). The loading capacity provides a reference for calculating the amount of pollution reduction needed to bring a waterbody into compliance with standards. The portion of the receiving water's loading capacity assigned to a particular source is a load or wasteload allocation. By definition, a TMDL is the sum of the allocations, which must not exceed the loading capacity.

TMDL = Loading Capacity = sum of all Wasteload Allocations + sum of all Load Allocations + Margin of Safety

# What Part of the Process Are We In?

This document establishes the loading capacity and target reductions in fecal coliform bacteria at various segments of Willapa River, necessary to meet the water quality standards. It also describes a general framework of who is involved and what general actions are planned to restore water quality.

# Why is Ecology Conducting a TMDL Study in this Watershed?

## Overview

Ecology is conducting a TMDL study in this watershed because the federal Clean Water Act requires that impaired waterbodies be restored to meet water quality standards through a total maximum daily load, or TMDL, process. Ecology's Southwest Regional Office prioritized the watersheds needing TMDLs in southwest Washington. This TMDL stems from the 1996 priority setting process conducted with people who live in the Willapa area (Ecology, 1997).

## Study area

The Willapa River is located in southwest Washington State, in Water Resource Inventory Area (WRIA) 24, also known as the Willapa watershed, in Pacific County, Washington. Figure 1 shows Willapa River watershed. The lower river reach is from the mouth to below Mill Creek. This is the reach where tidal effects are observed. The upper river reach is upstream of this location.

## Pollutants addressed by this TMDL

This TMDL addresses exceedances of fecal coliform bacteria standards in the Willapa River and selected tributaries. Other 303(d) listings for this waterbody are temperature and dissolved oxygen. A TMDL for temperature was completed in 2004 (Stohr, 2004) and for dissolved oxygen in 2005 (Pickett, 2000; Cosmopolitan, 2005).

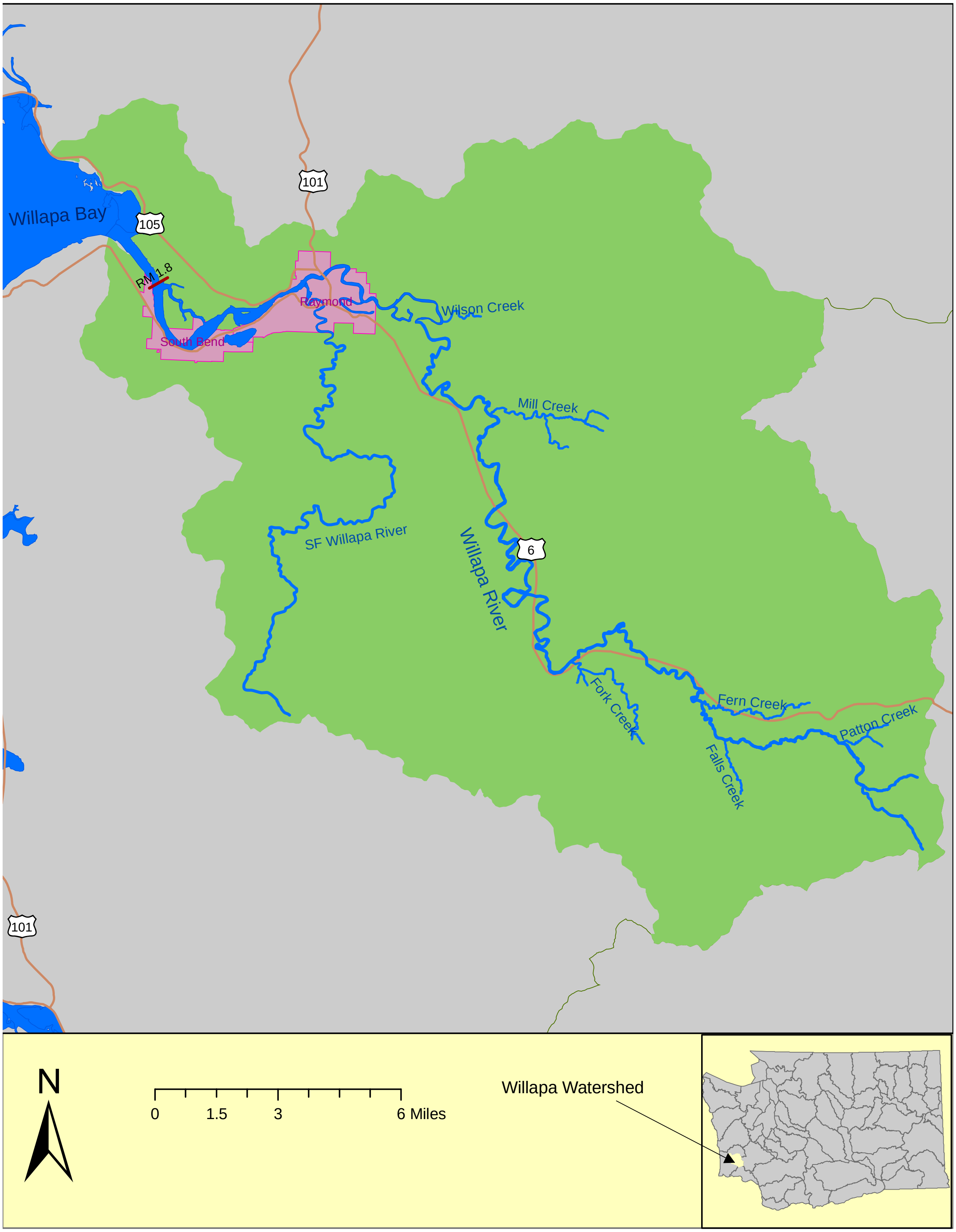


Figure 1. Map of Willapa River Watershed.

## Impaired beneficial uses and waterbodies on Ecology's 303(d) list of impaired waters

The main beneficial uses to be protected by this TMDL are primary contact recreation and shellfish protection. Table 1 shows the waterbody segments in the Willapa River on the 303(d) list for fecal coliform bacteria. In addition to waterbodies and locations listed in Table 1, other waterbodies and locations are also addressed in this report since they were monitored in 2006. At both the 303(d) and non-303(d) locations, where exceedance of the water quality criteria for fecal coliform was observed, load allocations were established. On the other hand, for both the 303(d) and non-303(d) locations where compliance with the water quality criteria was determined, load allocations were not established. Fork Creek, which is currently not 303(d) listed (therefore, not included in Table 1) is addressed in this report since it was determined to be water quality limited.

Table 1. Study area waterbodies on the 2004 303(d) list for fecal coliform bacteria

| Waterbody Name | Listing ID | Township | Range | Section |
|---|---|---|---|---|
| Willapa River | 10013 | 14N | 9W | 24 |
| | 6688 | 14N | 9W | 21 |
| | 9998 | 14N | 9W | 24 |
| | 10000 | 14N | 8W | 19 |
| | 10001 | 4N | 8W | 27 |
| | 10002 | 13N | 8W | 52 |
| | 10003 | 13N | 8W | 14 |
| | 10004 | 13N | 8W | 48 |
| | 10006 | 12N | 7W | 4 |
| | 10007 | 12N | 7W | 3 |
| Unnamed Creek (Central St drain @ Coast Seafoods) | 9995 | 14N | 9W | 28 |
| Riverdale Creek | 9989 | 14N | 9W | 24 |
| Wilson Creek | 10009 | 14N | 8W | 27 |
| Falls Creek | 9983 | 12N | 7W | 11 |
| Fern Creek | 9984 | 12N | 7W | 3 |

## Why are we doing this TMDL now?

A draft bacteria TMDL was previously completed by TetraTech (2004a and 2004b) based on data collected during 1998. Data collected since then by Pacific County, Department of Health (station No. 96 near Johnson Slough in Willapa Bay, 1999-2000) and Ecology (ambient monitoring station WPA003 near Johnson Slough in Willapa Bay, 1997-2004), reveals that bacterial water quality has improved since 1998.

The North Pacific County Infrastructure Action Team (NPCIAT) requested that the draft TMDL be revised using the more recent data set. Ecology collected monthly samples from key stations in the Willapa River over a period of one year in 2006. With a few exceptions, most of these stations had been previously monitored in 1998 (Pickett, 2000). This TMDL is based on data collected in 2006.

# Water Quality Standards and Beneficial Uses

In freshwaters, bacteria criteria are set to protect people who work and play in and on the water from waterborne illnesses. The Washington State water quality standards use fecal coliform 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 are shown to maintain low rates of serious intestinal illness (gastroenteritis) in people.

In marine waters, bacteria criteria are set to protect people who consume shellfish and who work and play in and on the water. The presence of these bacteria in the 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. Both shellfish protection and marine primary contact recreational uses have been designated for Willapa Bay seaward of a line bearing 70° true through Mailboat Slough light (Willapa River, river mile (RM) 1.8) per Washington Administrative Code (WAC) 173-201A-612. Upstream of RM 1.8, the river is designated for freshwater primary contact recreational use, based on specific use designations in WAC 173-201A-602 or by default in WAC 173-201A-600. The demarcation line between fresh and marine water quality standards is shown in Figure 2. This demarcation line at RM 1.8 is intended to be protective of commercial shellfish harvesting managed by DOH. The image on the left side in Figure 2 also has a line (sanitary line) separating areas designated as approved or prohibited for shellfish harvesting. This sanitary line is well to the west of the boundary between freshwater and marine standards, as shown in Figure 2.

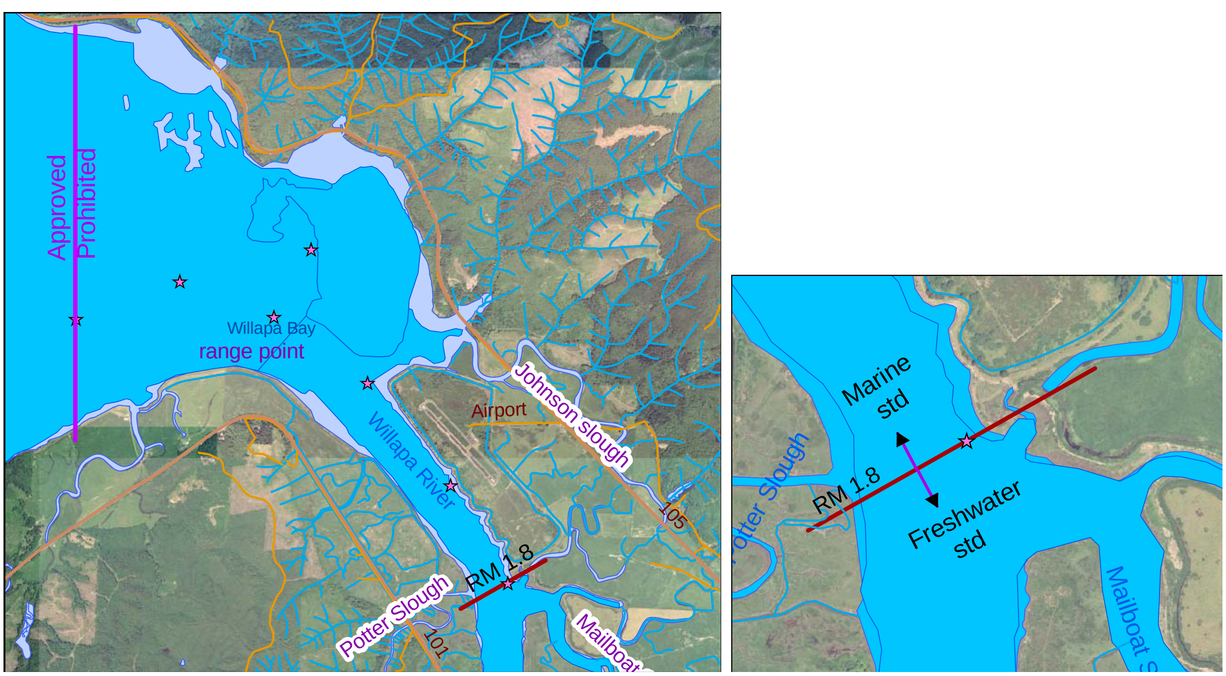


Figure 2. Demarcation of fresh and marine standards in Willapa River (RM 1.8) and sanitary line.

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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 designated to any waters where human exposure is likely to include exposure of the eyes, ears, nose, and throat. Since children are 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 in fresh water, bacteria in the water must meet the conditions of WAC 173-201A-200(2)(b), 2003 edition: "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". The criteria for fecal coliform are based on allowing no more than the pre-determined risk of illness to humans who work or play in a waterbody. The criteria used in the state standards are designed to allow seven or fewer illnesses out of every 1,000 people engaged in primary contact activities.

To protect either *Shellfish Harvesting* or *Primary Contact Recreation* (swimming or water play) in marine water, bacteria concentrations must meet the conditions of WAC 173-201A-210(3)(b), 2003 edition: "Fecal coliform organism levels must not exceed a geometric mean value of 14 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 43 colonies/100 mL". Federal recommendations for fecal coliform concentrations in our marine waters are the same for these two groups of activities. Thus, Ecology uses the same criterion to protect both "shellfish harvesting" and "primary contact" uses in the state standards.

Compliance is based on meeting both parts of the regulation. 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. While some discretion exists for selecting sample averaging periods, compliance will be evaluated for monthly data sets (five or more samples) and seasonal data sets (summer versus winter).

When fecal coliform concentration in the water reaches the numeric criterion, human activities that would increase the concentration above the criteria must stop. If the criterion is exceeded, the state will only allow human activities that will bring fecal coliform concentrations back into compliance with the standard.

If natural levels of fecal coliform (from wildlife) cause criteria to be exceeded, there is no allowance for human sources to measurably increase bacterial pollution.

While specific illness rates linked to human sources or animal sources has not been determined to date, warm-blooded animals managed by humans are exposed to human-derived pathogens and are a common source of serious waterborne illness for humans.

# Watershed Description

The Willapa River watershed, which includes the Willapa River and its tributaries, has a drainage area of about 262 square miles (Washington Conservation Commission, 1999) and is located in Pacific County in southwestern Washington. Major tributaries in the upper basin are Falls Creek, Fern Creek, Fork Creek, Trap Creek, Stringer Creek, and Mill Creek.

The lower Willapa River flows through the cities of Raymond and South Bend and empties into Willapa Bay. It is tidally-influenced from its mouth at Willapa Bay to approximately Camp One Road (about 14.5 miles). Major tributaries to lower Willapa River include South Fork Willapa River, Wilson Creek, and Ellis Creek. South Fork Willapa River joins the Willapa River at about river mile (RM) 7.1 and Wilson Creek enters the Willapa River at RM 12.1.

The Camp One Road bridge divides the river into its upper and lower reaches. The channel above Camp One Road is relatively narrow and winding and passes through agricultural areas.

The South Fork Willapa River enters the Willapa at RM 7.1. Tidal effects extend up the South Fork about 4.5 miles. The South Fork watershed represents about 20% of the total watershed area. However, summer base flows in the South Fork are actually slightly higher than in the mainstem Willapa River above the South Fork.

The mouth of the South Fork is in the industrial area of Raymond. The Weyerhaeuser lumber mill lies on the north bank, a Pacific Hardwoods mill (on Port property) on the south bank, the Port docks just downstream of the mouth, and the Raymond municipal wastewater treatment plant (WWTP) across the mainstem from the mouth.

From the South Fork to the Bay, the Willapa River is relatively wide, except for an area called “The Narrows” between Raymond and South Bend. Just below the narrows is a small industrial area with a Pacific Hardwoods mill and East Point Seafoods. The two other fish processors in South Bend are South Bend Packers near the center of town and Coast Seafoods at the west end of town. The South Bend WWTP sits between the river and Mailboat Slough across from the city. The Mailboat Slough area floods during high tides, which limits access to the South Bend WWTP. The mouth of the Willapa River is considered to be near the “Green 33” navigation aid and Johnson Slough.

The principal land uses in the Willapa River watershed are forest (80%), agriculture (8%), and other (12%). The “other” land use category includes non-forest, developed land, open water, and wetlands. In the upper, steeper part of the watershed, the dominant land use is commercial forest, managed by a mixture of private owners as well as state and federal agencies. Where the slope of the river decreases, a relatively wide valley floor develops, and the primary land cover changes to agriculture with dairy farms dominating the land use (Gove et al., 2001).

Annual precipitation ranges from 80 inches in the lower valley to 120 inches at the higher elevations with the heaviest rainfall between October and June (Stohr, 2001). According to the

2000 U.S. Census, the population of Pacific County was 20,984. The two major urban centers in the Willapa River watershed are the cities of Raymond and South Bend, both located on the lower Willapa River.

Willapa River flows have been monitored since 1947 (continuously since 1961) at USGS station 12013500 (at Camp One Road) which has a contributing area of about 130 square miles. Mean monthly flows are high in winter (highest in December) and low in summer (lowest in August) as shown in Figure 3. The mean annual flow at the USGS station is 639 cfs.

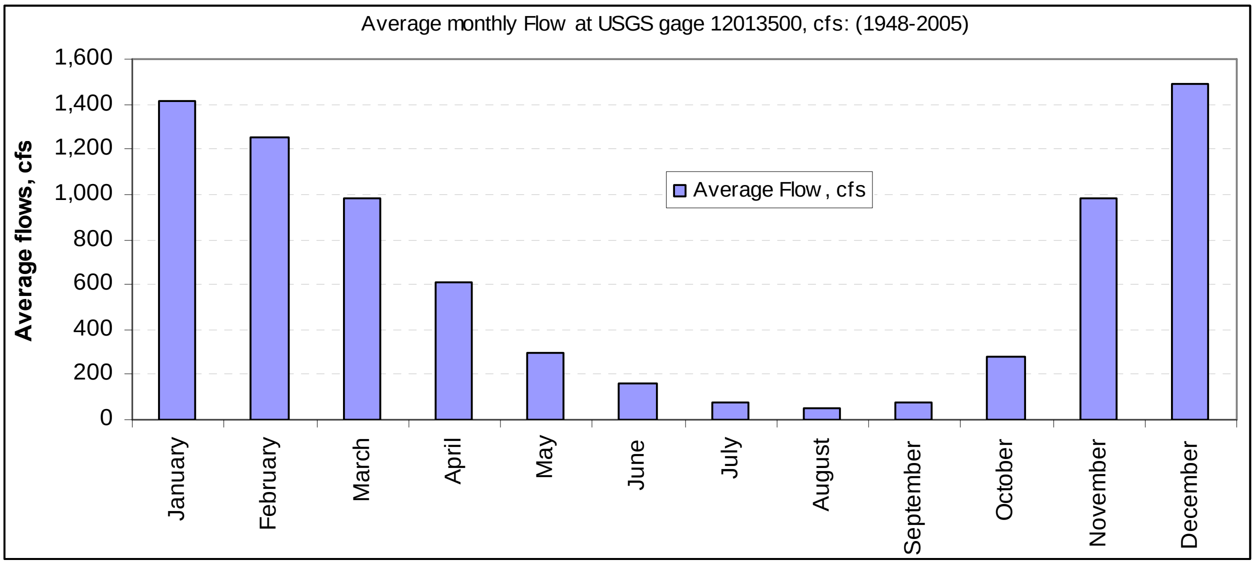


Figure 3. Mean monthly flows at USGS gage 12013500 (1948 - 2005).

# Sources of Pollution

Sources of fecal coliform bacteria in the watershed are both point and nonpoint in nature. Known point sources with permit effluent limits for coliform bacteria are City of Raymond wastewater treatment plant (WWTP) at RM 7.0, South Bend WWTP at RM 3.5, Coast Seafood at RM 3.1, East Point Seafood at RM 4.1, and South Bend Packers at RM 3.5. In general, nonpoint sources of fecal coliform bacteria are failing on-site sewage systems, livestock operations, hobby farms, urban areas, wildlife, and recreational uses.

The fecal coliform loading from point sources was previously determined to be an insignificant portion of the total bacteria loading to the Lower River (Tetra Tech 2004a).

In order to understand the sources of fecal coliform bacteria in the Upper Willapa River watershed, a microbial source tracking (MST) study was undertaken by Herrera Environmental Consultants (2005). Three stations along the Willapa River were monitored: an upstream station (WRPA) at RM 41.2, a midstream station (WRLE) at RM 33.2, and a downstream station (WRC1) at RM 17.5. The study concluded that the bacteria standards were exceeded at all stations during storm events year-round. During baseflow conditions, the standards were exceeded at only the midstream station.

The MST study concluded that the human fecal sources were not present at the upstream station but represented approximately 10% of all samples at midstream and downstream stations. Wildlife and avian sources were dominant in the upstream station and decreased in the downstream direction. Bovine fecal sources were dominant in the midstream and downstream stations. Other less significant sources were reported at all the stations.

The Willapa River basin is largely rural with the exception of the cities of Raymond and South Bend on the lower river. Both cities operate municipal wastewater treatment plants. There are several small towns, including Lebam, along the upper river. Residences on the upper river are not connected to municipal treatment facilities and rely on the use of onsite wastewater treatment facilities for the disposal of household sanitary waste. Agriculture, including dairy operations, is the primary land use in the upper river valley (Herrera Environmental Consultants, 2005).

# Goals and Objectives

## Project goals

The goals of this project were to establish load allocations for fecal coliform bacteria in the Willapa River watershed.

## Study objectives

The study objectives were to evaluate the fecal coliform bacteria data gathered in 2006 for both the upper and lower Willapa River, to determine where concentrations of fecal coliforms were the highest, and to establish load reduction targets to meet water quality standards.

# Field Data Collection: 2006

## Study methods

Ecology undertook a study in 2006 (Onwumere 2006) to monitor the Willapa River for fecal coliform bacteria. The study was meant to verify results from prior years that showed some improvement in bacteriological quality of the water. Since the data gave a current picture of water quality conditions, they were utilized in this project to set load allocations. Twenty four sites in the upper and lower Willapa River were sampled for fecal coliform bacteria on a monthly basis from January through December 2006. Ten monitoring sites were in the study area of the Upper Willapa River and its tributaries. The *Upper Willapa River* extends from RM 17.5 at Camp One Road (Station WRC1) through RM 41.2 at the confluence with Patton Creek (station WRPA) as shown in Figure 4. Six stations were in the mainstem Willapa River while the remaining four stations were in Mill, Fork, Fall, and Fern Creeks. Figure 4 also shows the locations of the monitoring stations in the Upper Willapa River.

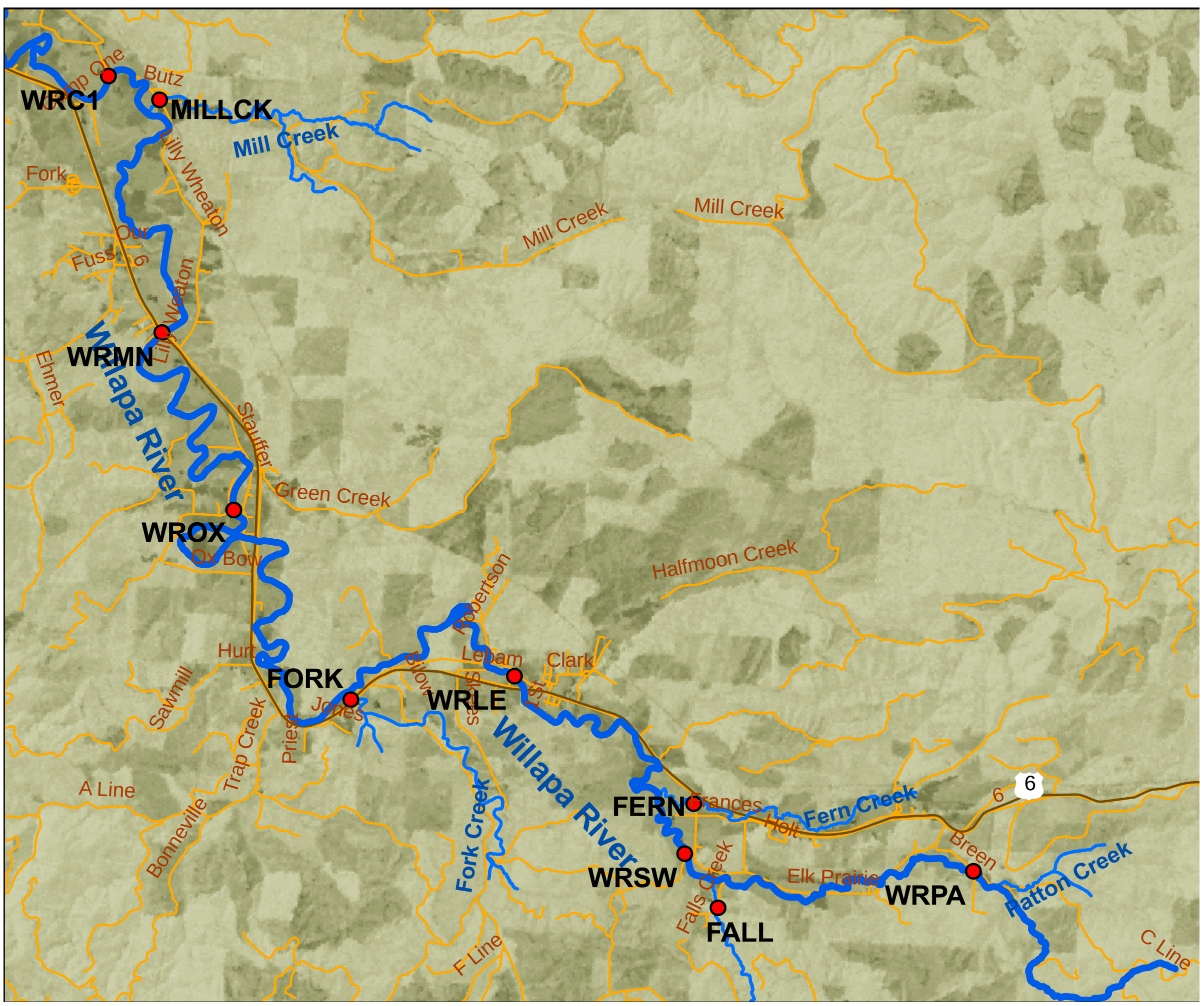


Figure 4. Upper Willapa River (RM 17.5 –RM 41.2) showing stations monitored in 2006.

Fourteen stations were monitored in the Lower Willapa River.  The *Lower Willapa River* study area can be divided into two sections.  The first section extends from station WRC1 (RM 17.5) to downstream of Mailboat Slough (RM 1.8).  In this section, the fresh water quality standards apply.  The second section extends from RM 1.8 to the mouth of the river (RM 0) beyond Johnson Slough and here the marine standards apply.  In 2006, ten mainstem stations and four tributaries were sampled in the Lower Willapa.  Two mainstem stations were seaward of RM 1.8.  Figure 5 shows the Lower Willapa River monitoring stations.

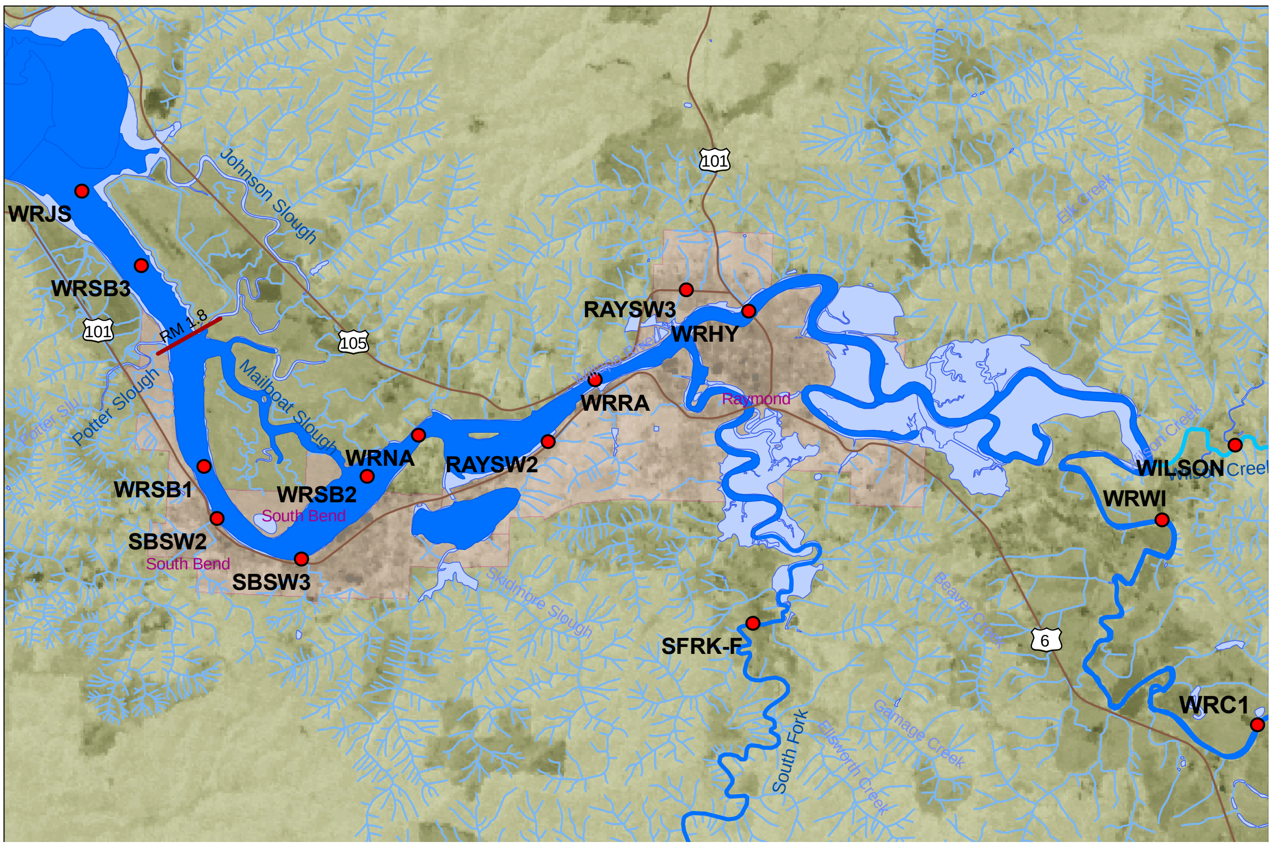


Figure 5.  Lower Willapa River 2006 monitoring stations.

## Study quality assurance evaluation

All samples collected in 2006 were analyzed using the Membrane Filter (MF) method, except one station where both the MF and the "most probable number" (MPN) method was used.  The bacterial concentration using the MF method was within the 95$^{th}$ percent confidence limits of the MPN method.  The measurement quality objective (MQO) used by Ecology's Manchester Laboratory for fecal coliforms in laboratory duplicates was met for this project.  The MQO used by Ecology's Environmental Assessment Program for field duplicates (Ecology, 2006) was also met for this project.  Detailed analysis for the MQO is presented in Appendix B of this report.

## Results and discussion

All FC data collected during the 2006 monitoring period are included in Appendix C. Conductivity data are in Appendix D. Station locations are described in Appendix E. Table 2 shows the geometric mean and 90$^{th}$ percentile of data collected at each station. The 90$^{th}$ percentiles for stations with less than 10 samples were not estimated. Mainstem FC concentrations were high in the upper reaches of the river, and in general, had a downward trend in the downstream direction.

Table 2. Summary of 2006 data collected in Willapa River by Ecology

| Station | n* | Minimum, cfu/100 mL | Geomean, cfu/100 mL | Maximum, cfu/100 mL | 90th percentile, cfu/100 mL |
|---|---|---|---|---|---|
| WRPA | 12 | 6 | 30 | 300 | 128 |
| FALLS | 12 | 3 | 20 | 190 | 156 |
| WRSW | 12 | 2 | 52 | 2000 | 1048 |
| FERN | 12 | 3 | 75 | 1200 | 664 |
| WRLE | 12 | 13 | 85 | 1550 | 432 |
| FORK | 12 | 3 | 44 | 490 | 338 |
| WROX | 12 | 6 | 32 | 430 | 171 |
| WRMN | 12 | 7 | 37 | 760 | 241 |
| MILLCK | 12 | 4 | 27 | 420 | 134 |
| WRC1 | 12 | 9 | 39 | 885 | 230 |
| WRWI | 12 | 6 | 49 | 930 | 367 |
| WILSON | 12 | 1 | 16 | 350 | 157 |
| WRHY | 12 | 1 | 19 | 900 | 179 |
| SFRK-F | 12 | 1 | 19 | 563 | 164 |
| WRRA | 12 | 2 | 13 | 360 | 93 |
| WRNA | 12 | 1 | 9 | 310 | 89 |
| WRSB-2 | 12 | 2 | 10 | 370 | 82 |
| WRSB-1 | 12 | 2 | 12 | 430 | 95 |
| WRSB-3** | 12 | 1 | 7 | 450 | 85 |
| WRJS** | 12 | 1 | 8 | 405 | 75 |
| RAYSW-3 | 6 | 10 | 24 | 224 | --- |
| RAYSW-2 | 6 | 1 | 8 | 61 | --- |
| SBSW-3 | 6 | 7 | 53 | 140 | --- |
| SBSW-2 | 6 | 6 | 42 | 330 | --- |

* n is the number of samples
** stations where marine standards apply
▢ indicates locations where freshwater water quality standards were not met.
▢ indicates locations where marine water quality standards were not met

Additional data for station RAYSW-3, Riverdale Creek at Lions Club Park, were collected by the City of Raymond (Appendix F) in 2006. Pooling the 2006 Ecology and City of Raymond data for the Lions Club Park station, the combined number of samples is 13 (January-September) with a geometric mean of 82 cfu/100 mL and a 90$^{th}$ percentile of 895 cfu/100 mL. The high 90$^{th}$

percentile is due to a high concentration (8800 cfu/100 mL) measured by the City of Raymond on June 5, 2006. The geometric mean and 90th percentile numbers *without* this data point are 56 cfu/100 mL and 287 cfu/100 mL, respectively.

## Rainfall and fecal coliform concentrations

To compare rainfall and fecal coliform concentrations in the Willapa River, the river data were evaluated separately for the upper and lower river. The lower reach is the tidally-influenced segment from the mouth to Camp One Road. The upper reach is above this location. Rainfall data were obtained from the Office of the State Climatologist (www.climate.washington.edu) for the Automated Weather Source (AWS) SchoolNet station in South Bend. The station is located at latitude 46.662°N and longitude 123.79°W (between Madison Street and Monroe Street off of 1st Street in South Bend).

Figure 6 shows the fecal coliform data at all mainstem stations in the upper and lower Willapa River. Overall, rainfall tends to produce higher concentrations in the upper reach. During dry or low rainfall periods, the upper reach also tends to be high in fecal coliforms.

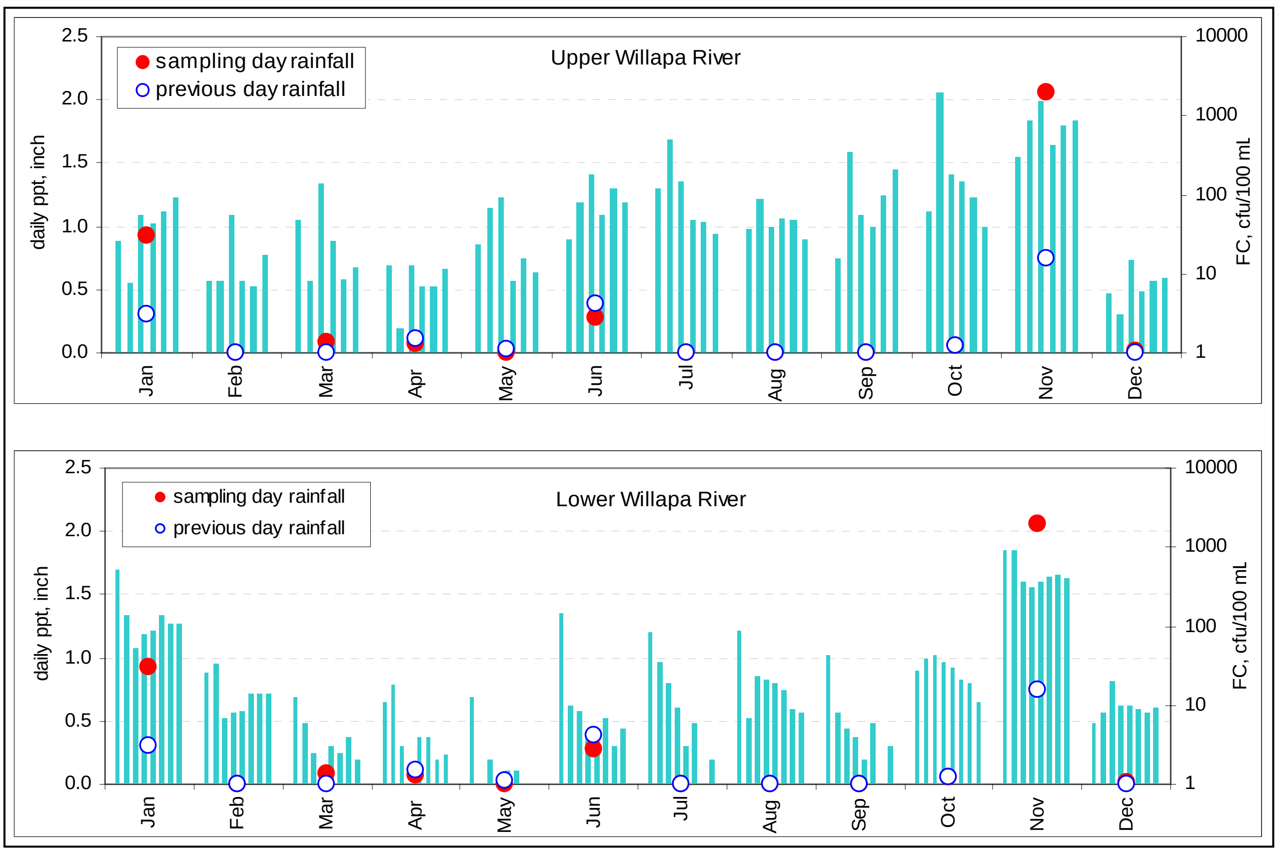


Figure 6. Fecal coliform concentrations at all stations in upper and lower Willapa River, compared to rainfall (2006)

## Conductivity and fecal coliform concentrations

Conductivity is a measure of salinity of the water and it is known that fecal coliform do not thrive in higher salinity environments (Mancini, 1978). Conductivity data from 2006 are presented in Appendix D. Figure 7 shows the conductivity values for each sampling station along the Willapa River during dry and wet weather conditions. The extent of saltwater is somewhere between the station at Willapa Road (WRWI) and station at Camp One Road (WRC1). During wet weather conditions, conductivity decreases due to dilution. Figure 8 shows that the associated bacterial concentrations are high during wet weather conditions.

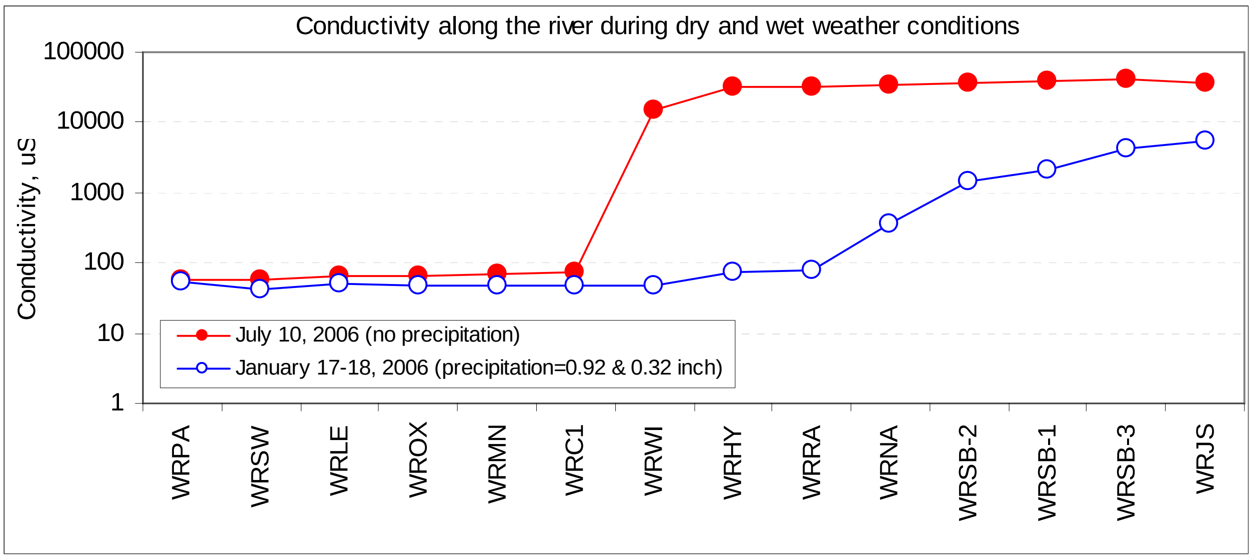


Figure 7. Conductivity measurements (2006)

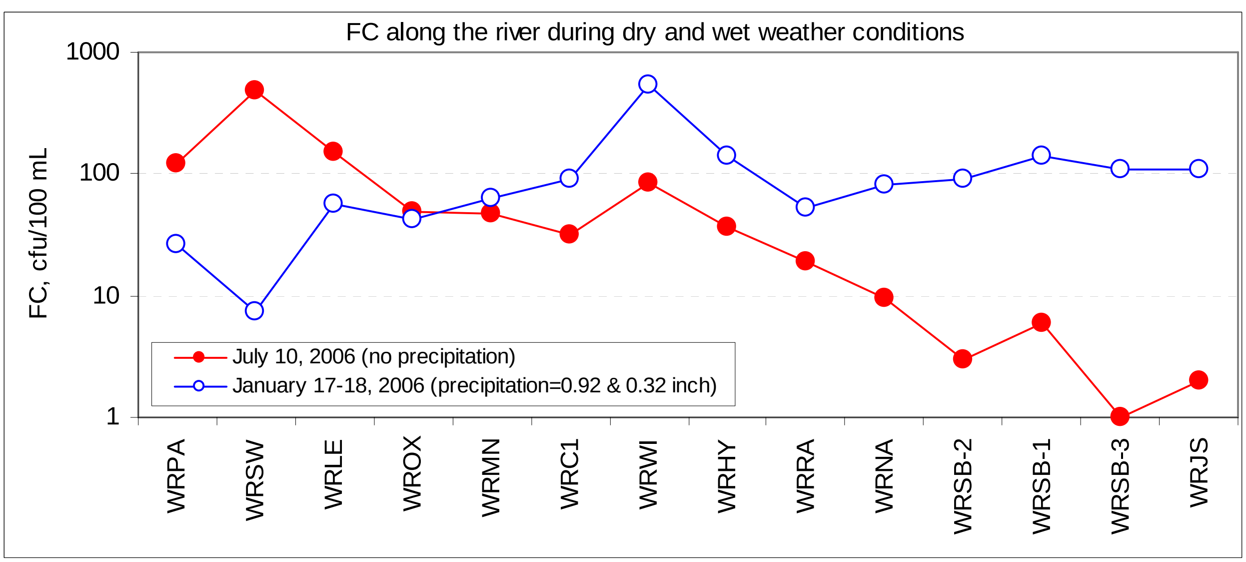


Figure 8. Bacteria measurements during dry and wet weather conditions (2006)

Also, considering the seaward station, WRSB-3, at RM 1.5, the conductivity and bacteria concentrations show that bacteria concentrations decrease with increasing conductivity (Figure 9). In November 2006, FC concentration at station WRSB-3 was 450 cfu/100 mL and the associated conductivity was relatively very low (see Appendix D). Since dry weather is associated with high conductivity, bacteria concentrations tend to be low in this season in the lower Willapa River. This would be an important consideration during the implementation phase of the TMDL.

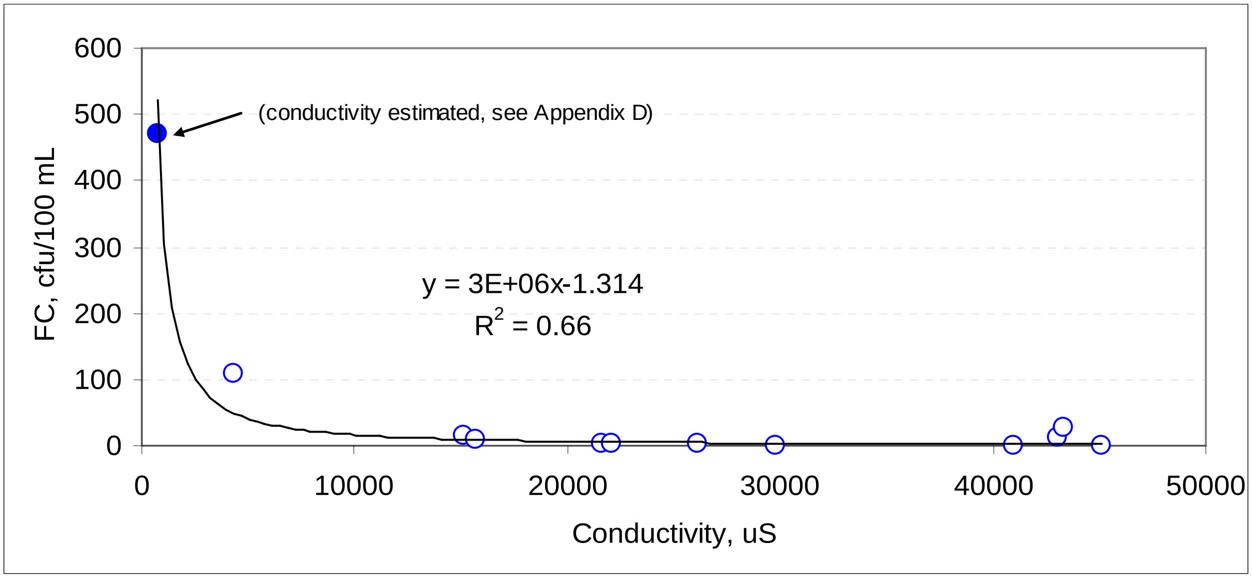


Figure 9. Fecal coliform concentrations and conductivity measured at station WRSB-3 in 2006

# Field Data from Other Recent Studies

Herrera Environmental Inc. performed a microbial source tracking (MST) study of the upper Willapa River in 2004 (Herrera 2005). This data is recent enough to pool with Ecology's data from 2006. Fecal coliforms were monitored at three stations: WRPA (below Patton Creek), WRLE (at Lebam), and WRC1 (at Camp One Road). Twenty samples were gathered between November 2003 and November 2004. Data from this study is presented in Appendix G.

Table 3 shows the 90$^{th}$ percentile and geometric mean of the pooled data. Annual trends were similar in the pooled data and the 2006 Ecology data (Table 2). For example, station WRPA met the standard, WRLE had higher FC concentrations, and WRC1 had lower FC concentrations in both datasets.

However, the pooled data were also different from the 2006 Ecology data. 90$^{th}$ percentile concentrations for these 3 stations were higher in the pooled data. FC concentrations at several stations between WRPA and WRLE were higher in the 2006 Ecology data than in the pooled data.

Table 3. Pooled data from the MST study and the 2006 Ecology field data

| Station | n* | Min, cfu/100 mL | Geomean, cfu/100 mL | Max, cfu/100 mL | 90th percentile, cfu/100 mL |
|---|---|---|---|---|---|
| WRPA | 32 | 4 | 33 | 360 | 169 |
| WRLE | 32 | 13 | 127 | 2100 | 624 |
| WRC1 | 32 | 5 | 53 | 1100 | 323 |

* n is the number of observations

In order to understand the monthly variability of FC concentrations, monthly geometric means were estimated from the pooled data for stations WRLE and WRC1 as shown in Figure 10. In the pooled data set, only the months of July and December were free of any rain on the day of sampling. The overall picture is that concentrations are low from December through April, but high from May through November.

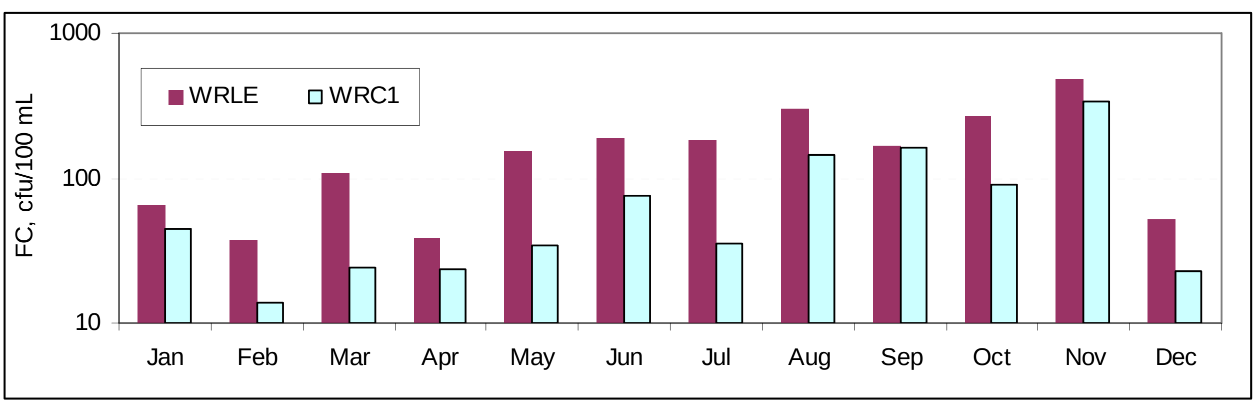


Figure 10. Monthly geometric mean of pooled 2004 MST study and 2006 Ecology data.

Microbial source tracking (MST) was conducted in 2004-05 at three locations in the upper watershed to assess sources of bacterial contamination (Herrera, 2005). The molecular ribotyping technique successfully matched 95 percent of the 552 E. coli isolates obtained from bacteria analyses described above to known sources. The results of the MST study are shown in Figure 11, and the conclusions are summarized below:

- Human fecal sources were not present at the upstream station, but represented approximately 10 percent of all sources observed at the midstream and downstream stations.
- Bovine fecal sources were not abundant at the upstream station, but were the predominant source observed at the midstream and downstream stations.
- Wildlife fecal sources generally decreased in percentage from upstream to downstream. Deer/elk were the predominant fecal sources observed at the upstream station. Avian fecal sources were also abundant at the upstream station and decreased downstream.
- Additional fecal sources commonly observed at all three stations included rodent/beaver and canine (includes both coyote and domestic dogs). Bear, raccoon and feline sources were negligible at all locations
- With few exceptions, fecal source matching percentages did not change substantially in relation to bacteria concentration (above or below standards), hydrologic condition (wet or dry) or season of the year.

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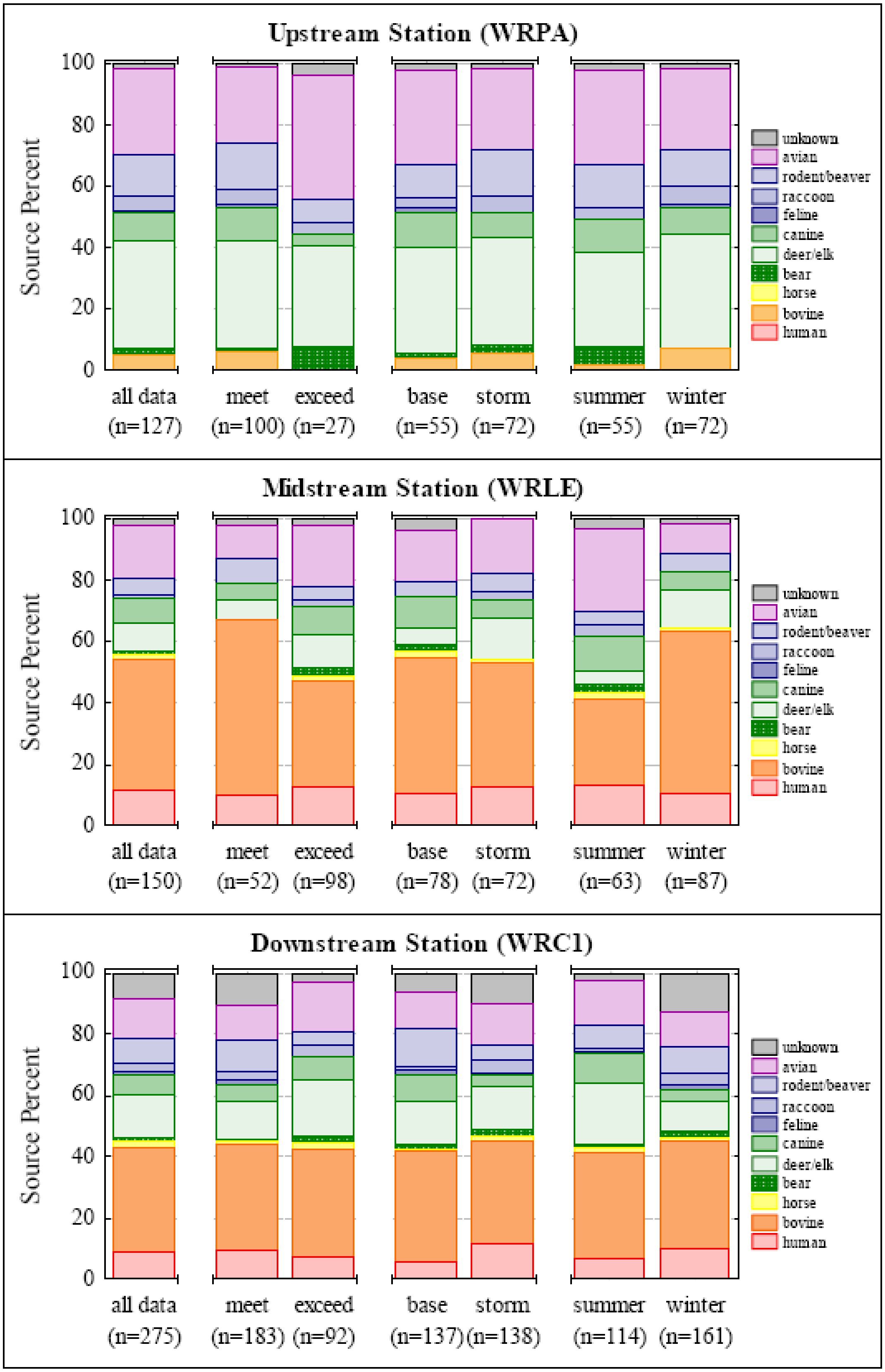


Figure 11. Fecal coliform bacteria sources observed at the three stations in the Upper Willapa River using molecular ribotyping technique (Herrera 2005).

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# TMDL Analyses for Fecal Coliform Bacteria

## Analytical framework

Development of allowable loads for fecal coliforms for the mainstem Willapa River and its tributaries is based upon an analysis of data collected in 2006. Fecal coliform data collected in 2004 during the MST study (Herrera, 2005) for three stations in the upper Willapa have also been considered.

Excel® spreadsheets were used to evaluate the data, including statistical analyses and plots.

The statistical roll-back method (Ott, 1995) was used to establish fecal coliform bacteria reduction targets for the mainstem segments, the tributaries, and sub-tributaries. The roll-back method simply compares monitoring data to standards, and the difference is the percent change needed to meet the standards. This method has been previously employed by Sargeant et al. (2005), Ahmed (2004a, 2004b, 2006), Roberts (2003), Joy (2000), and Pelletier and Seiders (2000).

The distribution of fecal coliform bacteria concentrations measured at a station over time is assumed to follow a log-normal distribution. Thus, log-normal distribution properties can be used to estimate the geometric mean and $90^{th}$ percentile bacterial concentrations. When these estimates are higher than the standards, the target reductions are simply estimated by rolling back the estimated geometric mean or $90^{th}$ percentile concentrations (whichever is most restrictive) to the respective water quality standards. Here is how the process works:

a) The data are first plotted on a log-scale against a linear cumulative probability function. A straight line signifies a log-normal distribution of the data.

b) The geometric mean of the data has a cumulative probability of 0.5. Alternately, the geometric mean can be estimated by the following formula:

$$\text{geometric mean} = 10^{\mu_{\log}}$$

where: $\mu_{\log}$ = mean of the log transformed data

c) The $90^{th}$ percentile of the data has a cumulative probability of 0.9. This is equivalent to the "no more than 10% samples exceeding …." criterion in the fecal coliform standard (WAC 173-201A). Alternately, the $90^{th}$ percentile can also be estimated by using the following statistical equation:

$$90^{th}\ \text{percentile} = 10^{(\mu_{\log} + 1.28\sigma_{\log})}$$

where: $\sigma_{\log}$ = standard deviation of the log transformed data

d) The target percent reduction required is the higher of the following two comparisons.

$$\left[\frac{\text{observed }90^{\text{th}}\text{ percentile} - 90^{\text{th}}\text{ percentile criterion}}{\text{observed 90th percentile}}\right] \text{x}\,100$$

or:

$$\left[\frac{\text{observed geometric mean} - \text{geometric mean criterion}}{\text{observed geometric mean}}\right] \text{x}\,100$$

e) As "best management practices" for nonpoint sources and treatment technologies for point sources are implemented and the target reductions are achieved, a new but similar distribution (same coefficient of variation) of the data is assumed to be realized with the previous mean and standard deviation reduced by the target percent reductions.

f) If the $90^{th}$ percentile is limiting, then the goal would be to meet the $90^{th}$ percentile fecal coliform standard, and no goals would be set for the geometric mean since, with the implementation of the target reductions, the already low geometric mean would only get better. Similarly, if the geometric mean is limiting, the goal would be to achieve the geometric mean standard with no goal for the already low $90^{th}$ percentile concentration.

# Loading capacity

"Loading capacity" means the maximum amount of pollution a waterbody can withstand and still fulfill beneficial uses (i.e., meet state water quality standards). The numeric loading capacity is based on the water quality criterion and the flow in the critical period.

## Fecal coliform concentrations

The lognormal characteristics of fecal coliform data have been well documented (Sargeant et al. 2005; Ahmed 2004a, 2004b, and 2006; Roberts 2003; Joy 2000; and, Pelletier and Seiders 2000). Data from station WRSW (Figure 4) is plotted here (Figure 12) to demonstrate that these data have similar characteristics.

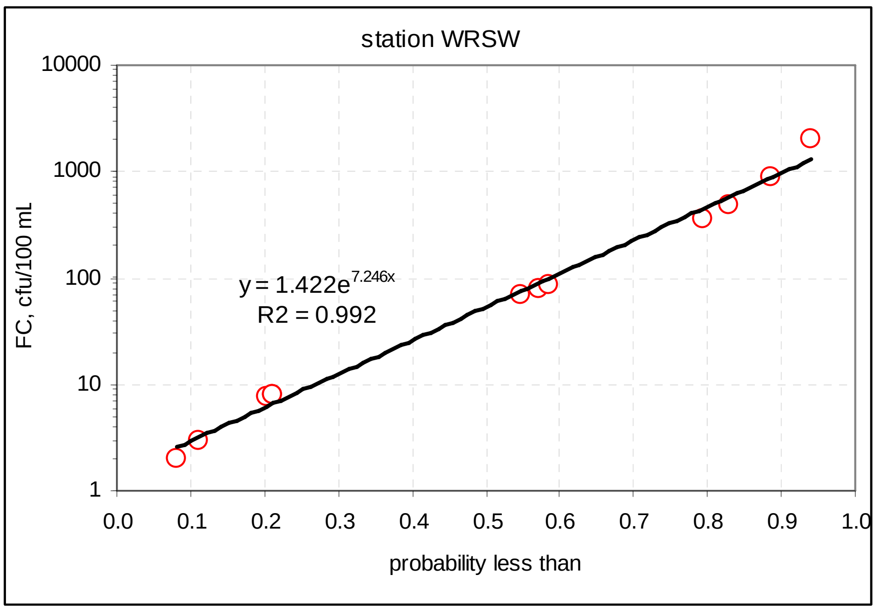


Figure 12. Cumulative probability distribution for fecal coliform at Upper Willapa station WRSW

Figure 13 shows the geometric mean and 90th percentile of data collected by Ecology (2006) at each station (n>10). Pooled data from the MST study (Herrera 2005) and the 2006 Ecology field monitoring were used for three stations, WRPA, WRLE, and WRC1. The geometric means of FC concentrations at most stations, on an annual basis, were within the water quality standards for fresh and marine waters. The only station that exceeded the geometric mean numeric criterion was at WRLE for the pooled data set. However, when only the 2006 Ecology data were used, the geometric mean criterion was not exceeded.

Of the eighteen freshwater stations (n>10) above RM 1.8, seven exceeded the 90th percentile freshwater quality standard. Of the two seaward stations (WRSB-3 and WRJS), both exceeded the 90th percentile marine water quality standard. Only one mainstem station (WRWI) in the lower Willapa River exceeded the freshwater criteria.

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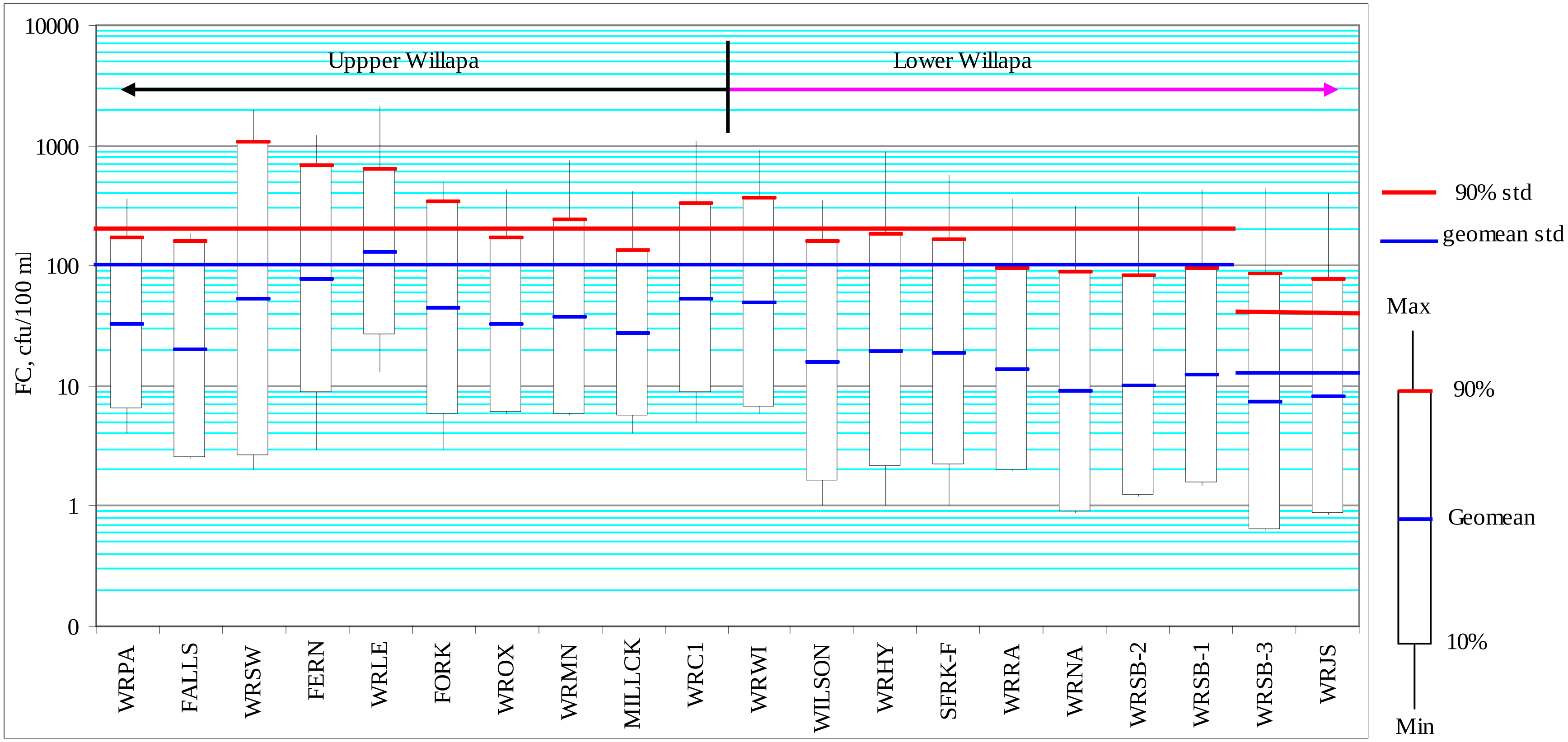


Figure 13. Fecal coliform distribution at various stations in the Willapa River (2006).

Additional data from sampling of Riverdale Creek by the City of Raymond during 2006 was also pooled for analysis. The pooled data (Ecology and City of Raymond) for Riverdale Creek station (RAYSW-3) suggest that between January and September, the geometric mean meets the water quality criterion of 100 cfu/100 mL while the 90th percentile exceeds the criterion of 200 cfu/100 mL, both with and without the high concentration (8800 cfu/100 mL) observed in June 2006 (Figure 14).

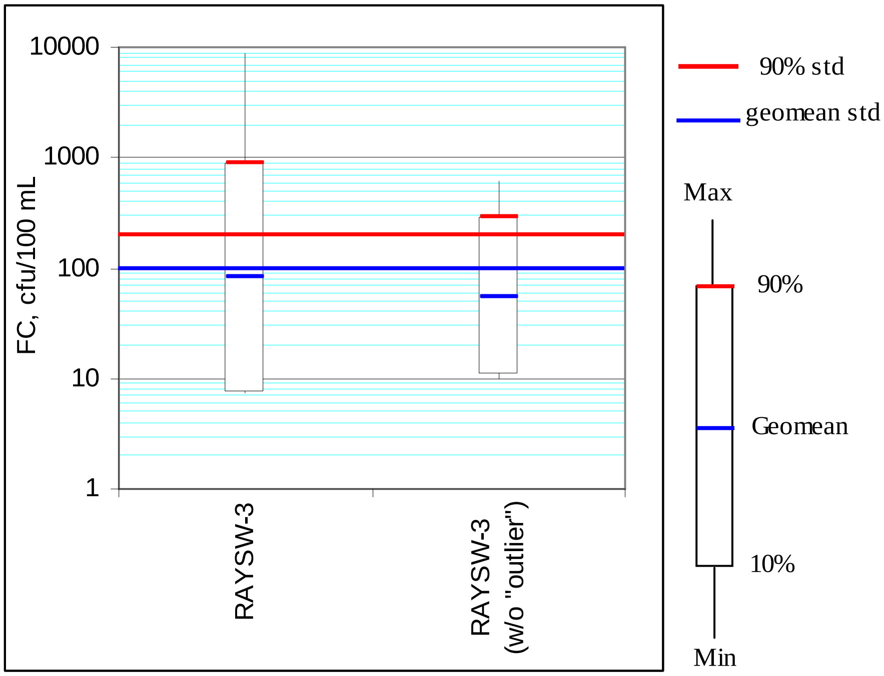


Figure 14. Fecal coliform distribution in Riverdale Creek, station RAYSW-3 (2006).

## Basis for fecal coliform loads

The loading capacity at all segments of the Willapa River, except at and downstream of River mile (RM) 1.8 (just downstream of Mailboat Slough, Figure 2 and Figure 5), is based upon a geometric mean concentration of 100 cfu/100 mL and a 90th percentile concentration of 200 cfu/100 mL under all flow conditions. Downstream of RM 1.8, the loading capacity is based upon a geometric mean of 14 cfu/100 mL and a 90th percentile concentration of 43 cfu/100 mL.

To estimate a daily loading capacity, annual average flow estimated at the various stations was multiplied by the water quality criterion of 200 cfu/100 mL. The 90th percentile criterion was used in the calculation because it was more limiting than the geometric mean criterion. Both the existing load and the loading capacity are presented in the next section.

For the upper Willapa, above Camp One Road, the flows at the various monitoring stations (Table 4) were estimated based upon a ratio of the drainage area of the monitoring station to the drainage area for the USGS gage at Camp One Road.

The drainage areas at the respective stations were estimated using *Streamstat* (Appendix H), a United States Geological Survey (USGS) integrated GIS application for Washington State (http://water.usgs.gov/osw/streamstats/Washington.html).

Table 4. Mean annual average flow at the various stations in Upper Willapa River

| Station | Drainage area, $mi^2$ | Mean annual average flow, cfs |
|---|---|---|
| WRSW | 17.9 | 88 |
| FERN | 12.9 | 63 |
| WRLE | 41.7 | 205 |
| FORK | 21.4 | 105 |
| WRMN | 101 | 496 |
| **WRC1** | **130** | **639** |

For Riverdale and the unnamed creek at Coast Seafood, the flows were estimated based on flow relationship developed by TetraTech (2004a) between flow in these creeks and that at the USGS gage at Camp One Road.

$$Q_{riverdale} = 0.018 * Q_{WRC1}$$
$$Q_{unnamed} = 0.018 * Q_{WRC1}$$

**Flow at station WRWI**

The freshwater component of flow at station WRWI at Willapa Road was estimated using the same method as other Upper Willapa stations, i.e., using a ratio of drainage area for WRWI to that for station WRC1. The mean annual average flow for station WRWI was thus estimated at 664 cfs. Station WRWI is also affected by tides as is evidenced from conductivity data (see Figure 7). The net flow was estimated from the freshwater flow, upstream salinity, and mean annual salinity of Willapa Bay (Fox 2007):

If $S_o$ = mean annual salinity of Willapa Bay
$S_s$ = mean annual salinity at station WRWI
$S_f$ = mean annual upstream freshwater salinity
$Q_f$ = mean annual freshwater flow at station WRWI
$Q_s$ = net flow at station WRWI
$Q_{salt}$ = tidal flow at WRWI = $Q_s - Q_f$

Salinity loading from tides + salinity loading from freshwater = salinity loading at WRWI

Or, $(Qs - Q_f)S_o + Q_f S_f = Q_s S_s$

Rearranging: $$Q_s = \frac{Q_f(S_o - S_f)}{(S_o - S_s)}$$

The upstream salinity $S_f$ , is pretty close to zero. Therefore, the above equation becomes:

$$Q_s = \frac{Q_f (S_o)}{(S_o - S_s)}$$

The Willapa Bay annual average salinity ($S_o$) was estimated from Ecology station LTM134 (latitude 46.705 and longitude -123.837) as 24 ppt (1973-2004 data)

The annual average salinity ($S_s$) at station WRWI was estimated using conductivity and temperature data collected in 2006 and conversion methods from APHA (2001). The mean annual salinity at station WRWI, based on 2006 data, is about 4 ppt. The net flow ($Q_s$) at WRWI is then equal to: 797 cfs. This flow was used at station WRWI to estimate the loading capacity.

**Basis for loading capacity at station WRSB-3**

For the seaward station WRSB-3 (RM 1.5), where the marine standards apply, the freshwater of flow was estimated as 1176 cfs. This is the flow at USGS gage at Camp One Road plus the flows in all the tributaries downstream of the gage (TetraTech, 2004a). However, a larger flow of water is present at this station due to tides. The loading capacity at this station was estimated by Tetra Tech (2004a) for April-October and November-December periods. The long term (1948-2005) flows at USGS gage 12013500 at Camp One Road suggests (see Figure 3) that the average monthly flow for January-March (1215 cfs) is similar to that of the average flow in Nov-Dec (1237 cfs). Therefore, the loading capacity in the months of January-March is assumed to be similar to the loading in Nov-Dec period. The annual average loading capacity at this station was estimated as follows:

$$\frac{7 * (loading\ capacity\ in\ Apr - Oct) + 5 * (loading\ capacity\ in\ Nov - Mar)}{12}$$

**Basis for loading capacity at station WRJS**

For the seaward station WRJS (RM0.4), where the marine standards also apply, the loading capacity was estimated based on a ratio of salinities at stations WRSB-3 and WRJS. A computer model developed and calibrated earlier for dissolved oxygen for the lower Willapa River (initially developed by Pickett (2001) and later modified by TetraTech (2004) and Fox (2005)), established salinities for river segments containing these stations. Station WRJS is in model segment 3, while station WRSB-3 is in model segment 6. The average salinities for segment 3 and segment 6 are 26.6 ppt and 26 ppt, respectively (Bill Fox 2007). Using the loading capacity for station WRSB-3, the loading capacity at station WRJS is estimated as follows:

$$\frac{salinity\ in\ segment\ 3}{salinity\ in\ segment\ 6}\ x\ loading\ capacity\ at\ segment\ 6$$

## Seasonal variability

Generally, target reductions should be set for a critical period when most historical exceedances of the fecal coliform standards have occurred (i.e., when bacteria levels were highest). However, where there is insufficient data to establish the geometric mean and/or the 90$^{th}$ percentile value, a broader time-period is used to lump sufficient data to estimate these values. The target reductions are then based upon the selected period. Periods of high exceedances or seasonality are still considered but in cases like this where the data are limited, it is more practical to use seasonality in the cleanup strategies.

A longitudinal bacteria profile (see Figure 8) shows that dry weather is associated with high bacteria counts in the upper Willapa River, but concentrations decrease in the lower river where there is increased salinity and tidal dilution. In wet weather, the bacteria concentrations rise in the lower Willapa River from reduced salinity due to a presence of a higher proportion of freshwater. Figure 7 shows the reduced conductivity in the lower river during wet weather conditions.

Wet weather is responsible for high fecal coliform bacteria in both the upper and lower reaches of the river. In the dry weather, bacterial concentrations are low in the lower Willapa River but the upper river still has high bacterial counts (see Figure 6).

In the lower river, exceedances were exclusively associated with wet weather conditions. Wet weather conditions should be the priority for controls needed to meet the cleanup goals in the lower river. However, if bacterial loads on adjacent terrestrial sites can be controlled during dry weather conditions, loading during rainfall events can be reduced.

The microbial source tracking study of the Upper Willapa River (Herrera 2005) concluded that the bacterial concentrations were substantially higher during storm events than in base flow conditions in both summer and winter. However, summer FC concentrations were higher than in winter for both storm events and baseflow conditions.

## Load and wasteload allocations

Target reductions may be either in terms of concentration, or load, or both. For Willapa River and its tributaries, the TMDL for fecal coliform is expressed in terms of fecal coliform concentration as allowed under Federal Regulations [40 CFR 130.2(I)] as “other appropriate measures”. The concentration measure is appropriate since the water quality standard can be directly compared to measured concentrations in the receiving water under all flow scenarios. The “target reductions” show what is necessary to achieve the water quality standard. However, loads at specific locations along the river and at the mouths of tributaries have been established to provide a relative comparison of contributions of fecal coliform.

## Load allocations

Load allocations are the nonpoint source reductions needed at each station. At some locations, no reduction is needed since the river segment and others immediately downstream already meet standards. At other locations, water quality may meet standards but a pollution reduction may still be needed in order to avoid adding loading to a downstream segment that does not meet standards. Most times when a load reduction is needed, it is just for that particular segment to meet standards. The actual assimilative capacity will vary daily as a function of the ambient river and estuary flow.

It should be noted, however, that the reduction goals determined from this technical analysis are just that -- goals. The final standard for achievement of the TMDL is for the river to be in compliance with water quality standards. The TMDL will be considered achieved when water quality standards are met throughout the Willapa watershed.

Typically, the loading capacity is based on the product of river flow times the pollutant concentration. Annual average flows were used to estimate both the existing load and the loading capacity. The difference between the two is the target reduction in bacteria necessary to achieve water quality standards, as shown in Table 5.

The target reductions for station WRLE and WRC1 were based on pooled data from the MST study (Herrera 2005) and the Ecology field data of 2006. Using only Ecology data the required reduction for station WRLE and WRC1 would be 54% and 13%, respectively. Each of the target reductions in Table 5 indicates how much reduction needs to take place upstream from the respective station locations to meet water quality standards at the station. The 49% reductions required at station WRSB3 will be achieved through the bacterial reductions required at station WRWI, at the mouths of tributaries RAYSW-3 and SBSW-2, and if necessary, additional reductions in the 13.7 mile stretch between WRSB3 and WRWI. It is presumed that the 49% reduction at WRSB3 would also help achieve the 43% reduction necessary at station WRJS.

Table 5. Target reductions necessary to achieve water quality standards at the various 303(d) listed and other impaired locations in the Willapa River and its tributaries (2006).

| Station | Mainstem RM | Tributary RM | Location | 303(d) listing | Mean Annual Flow, cfs | 90th percentile conc. cfu/100 | | Annual 90th percentile FC load, cfu/day | | Annual Target reductions, % |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | observed | criterion | Observed, | Capacity | |
| FALLS | 37.5 | 0.3 | Falls Creek | 9983 | | 156 | 200 | | | None |
| WRSW | 37.1 | | Swiss Picnic Rd | 10007 | 88 | 1048 | 200 | 2.3E+12 | 4.3E+11 | 81 |
| FERN | 36.2 | 0.4 | Fern Creek | 9984 | 63 | 664 | 200 | 1.0E+12 | 3.1E+11 | 70 |
| WRLE | 33.2 | | Lebam Rd | 10006 | 205 | 624 | 200 | 3.1E+12 | 1.0E+12 | 68 |
| FORK | 30.5 | 0.25 | Fork Creek | Not listed | 105 | 338 | 200 | 8.7E+11 | 5.1E+11 | 41 |
| WROX | 25.2 | | At Oxbow Rd | 10004 | | 171 | 200 | | | None |
| WRMN | 21.4 | | Mainstem at SR-6, | 10003 | 496 | 241 | 200 | 2.9E+12 | 2.4E+12 | 17 |
| WRC1 | 17.5 | | Camp One Rd | 10002 | 639 | 323 | 200 | 5.0E+12 | 3.1E+12 | 38 |
| WRWI | 13.7 | | Willapa Road | 10001 | 797 | 367 | 200 | 7.2E+12 | 3.9E+12 | 46 |
| WILSON | 12 | 1.45 | Wilson Creek | 10009 | | 157 | 200 | | | None |
| WRHY | 7.7 | | Highway 101 bridge | 10000 | | 179 | 200 | | | None |
| WRRA | 6.4 | | Near Port in Raymond | 9998 | | 93 | 200 | | | None |
| RAYSW-3 | 7.2 | 0.4 | Riverdale Creek | 9989 | 11.5 | 895 | 200 | 2.5E+11 | 5.6E+10 | 78** |
| SBSW-2 | 3.1 | 0.0 | Central Street drain at Coast Seafood | 9995 | 11.5 | Max = 330 | 200 | 9.3E+10 | 5.6E+10 | 39 |
| WRSB3* | 1.5 | | below Potter Slough | 6688 | --- | 85 | 43 | --- | 9.2E+14 | 49 |
| WRJS* | 0.4 | | Near Johnson Slough | 10013 | --- | 75 | 43 | --- | 9.4E+14 | 43 |

* Seaward station where marine criteria apply; loading capacity based on TetraTech (2004a) and Fox (2005)

** Without the "outlier," the target reduction would be 30%

## Wasteload allocations

Wasteload allocations describe the greatest amount of pollution that can be discharged from each point source, to meet the load capacity. Wasteload allocations are water quality-based effluent limits recommended for existing and future point sources, in order to meet water quality standards.

It should be noted that FC loading from the point sources are an insignificant portion of the total bacteria loading to the lower River (Tetra Tech 2004a).

Table 6 shows the current NPDES permit effluent limits for fecal coliform bacteria for the cities of Raymond and South Bend wastewater treatment plants (WWTPs). These effluent limits are technology based limits applied at the end-of-pipe. However, the existing permit allows a mixing zone with dilution factors of 1:77 and 1:167 for the cities of Raymond and South Bend WWTPs, respectively. These dilution factors are sufficient to meet the water quality standards at the edge of the applicable mixing zones. Therefore, the technology-based NPDES permit limits are protective of water quality and are adopted as the wasteload allocations. The associated bacterial loads are also shown in Table 6 and were estimated for the given flows and permit limits.

Table 6. Wasteload allocations for city wastewater treatment plants

| Point Source | Effluent limit, cfu/100 mL | | Maximum monthly average flow, MGD | Bacteria load*, based on weekly average limit, cfu/day |
|---|---|---|---|---|
| | Monthly average | Weekly average | | |
| Raymond WWTP | 200 | 400 | 1.5 | 2.27E+10 |
| South Bend WWTP | 200 | 400 | 0.69 | 1.04E+10 |

* Loads will vary with changes in flow. However, the concentration-based water quality standard will be met when the concentration-based effluent limit is met.

New point sources discharging to the Willapa River and its tributaries may be allowed, as long as they meet both the technology and water quality based effluent limit and the load is not significant enough to cause exceedances of water quality standard at any downstream locations beyond any applicable mixing zone.

Table 7 shows the current technology-based NPDES permit effluent limits for fecal coliform bacteria for the three seafood processors in the lower Willapa River. These effluent limits were initially included in the permit to be consistent with the technology based limits applied at the nearby municipal WWTPs. A mixing zone is not currently authorized in these NPDES permits. Studies are currently underway to update the permits and include an assessment of the technology-based limits. If these permits are revised, the water quality standards will be accounted for. The bacterial loads in Table 7 were estimated for the given flows and the technology-based effluent limits, and will be adjusted proportionally if the effluent limits are adjusted in the NPDES permits.

Table 7. Wasteload allocations for seafood processors

| Point Source | Effluent limit, cfu/100 mL | | Daily maximum flow, MGD | Bacteria load*, based on daily maximum limit, cfu/day |
|---|---|---|---|---|
| | Monthly average | Daily maximum | | |
| South Bend Packers | 200 | 400 | 0.025 | 3.79E+08 |
| East Point Seafoods** | 200 | 400 | 0.325 | 4.92E+09 |
| Coast Seafoods ** | 200 | 400 | 0.175 | 2.65E+09 |

*Mass loads will vary according to changes in flow.

**The current limits could change because studies are underway to find ways to reduce fecal coliform bacteria from their discharge.

A sensitivity analysis showed that the point source discharges have little impact on the bacteria load in the lower river (Tetra Tech, 2004). Efforts to reduce loading from the facilities are intended to decrease localized concentrations at the discharge outfall (near-field), and are not a deliberate or necessary outcome from this TMDL.

## Margin of safety

A margin of safety (MOS) is required in all TMDLs to ensure that the TMDL will protect water quality in cases when the data and other factors in the analysis are naturally variable or cannot be completely accounted for. The margin of safety for this fecal coliform TMDL is implicit through the use of conservative assumptions, summarized below.

The estimated targets do not account for any bacterial die-off in the water column or during travel from the source to the stream. As near-stream sources are removed or riparian buffer-strips established, bacterial travel time from the source to the stream during a storm event would increase. This would allow for greater exposure of the bacteria to the environment and potential die-off.

Target reductions were based on a $90^{th}$ percentile of fecal coliform pattern which takes into account the variability of the data. This is more conservative than the $10^{th}$ percentile water quality criterion which allows for 10% of the samples to exceed the criterion without considering the distribution of the data.

The maximum observed FC data was used to calculate the target reduction for the un-named tributary at Coast Seafoods (station SBSW-2) because there were less than ten observations. This conservative approach was taken since the $90^{th}$ percentile value would likely be lower if there were sufficient data available to estimate this value.

# Recommendations

In order to improve water quality of the Willapa River in a comprehensive manner, resources should be focused to first achieve the highest target reductions in the most upstream areas. This should help reduce fecal coliform concentrations downstream.

As best management practices (BMPs) are implemented, ongoing monitoring will be needed to show where water quality is improving and to indicate effectiveness of cleanup activities. Ongoing sampling should occur at stations that have been assigned load allocations.

The plan for additional investigations should also include the two tributaries, RAYSW-2 and SBSW-3 (where no load allocations were established), since only six samples were gathered at those locations in 2006.

Additional reductions in bacterial loads may be needed if compliance with the marine water quality standard (downstream of RM 1.8) is not achieved through compliance with the freshwater standards in the upper Willapa River. Source reductions in the lower river, including the cities of South Bend and Raymond, should target wet weather conditions. Also, if bacterial loads on adjacent terrestrial sites can be controlled during dry weather conditions, loading during rainfall events can be reduced.

# Implementation Strategy

## Introduction

This Implementation Strategy is intended to describe the framework for improvement of water quality in the Willapa River. It describes the roles and authorities of cleanup partners (i.e., those organizations with jurisdiction, authority, or direct responsibility for cleanup) and how they will address these water quality issues.

After U.S. Environmental Protection Agency (EPA) approves this TMDL, interested and responsible parties will work together to develop a *Water Quality Implementation Plan*. That plan will describe and prioritize specific actions planned to improve water quality and achieve water quality standards.

The main human-controlled sources of fecal coliform bacteria in this watershed are believed to be livestock waste, leaking or poorly maintained on-site septic systems, and possibly pet waste. Restoring water quality will depend on the actions of the people living in the watershed. For livestock sources, technical assistance is available and, in some cases, cost share incentives for installing best management practices. For septic systems, assistance may be available to help identify problems and low interest loans may be available to help with repairs or upgrades. Generally, participating organizations will work with landowners to build awareness and create solutions practical to each situation.

The TMDL goal is to continue implementing these water quality protection strategies on a voluntary scale. A voluntary approach must be more than general encouragement to take those actions which may improve water quality and to refrain from those that do not. To be effective, a voluntary approach should be active and should include at least the following general elements:

1. Assemble and publicize information on those locations where water quality is good.
2. Assess existing protections that these quality waters have, and understand how and why they support high quality waters.
3. Identify areas where existing protection programs are not likely to be effective.
4. Identify voluntary mechanisms and incentives that can improve protection where needed.
5. Obtain resources to implement voluntary approaches.
6. Provide technical assistance.
7. Publicize successful efforts and recognize successful individuals and organizations.
8. Monitor to assess success.
9. Apply adaptive management to make improvements where needed.

While voluntary compliance is the goal, enforcement options exist at the county and state level, if needed. When pollution problems are identified they must be prioritized and controlled. The responsible party can voluntarily choose the best methods appropriate to correct the situation. This plan establishes a goal of achieving bacteria reductions by 2012, five years following completion of the *Water Quality Improvement Plan.*

Ecology will submit this *Water Quality Improvement Report* to the Environmental Protection Agency (EPA) for approval. Following approval, local agencies and citizens will develop a detailed plan for clean up. That *Water Quality Implementation Plan (WQIP)* is anticipated to be complete by fall 2008.

The general approach for TMDL implementation will be to:

- Provide technical assistance and help each implementing partner find financing to make needed changes that will help improve water quality.
- Support the work of health department programs to help homeowners properly maintain their on-site septic systems, including local programs for education/outreach, financial assistance, or enforcement.
- Foster continued coordination among the farm service agencies, natural resource agencies, and agricultural landowners so that technical and financial assistance can continue to help expand implementation of BMPs for improving farm goals including water quality protection.
- Develop a coordinated monitoring program to track the implementation of activities and programs that will be called for in the *Water Quality Implementation Plan*.
- Assure that current data is available over the foreseeable future to show where water quality improvements have occurred and where our scarce cleanup resources should be focused next for the highest return-on-investment.

The approach is to complete and implement a realistic plan, monitor for success, and continuously adapt or refocus implementation where monitoring shows that changes are needed. Implementation will be contingent on available funding and the ability of the implementing parties to incorporate and prioritize the plan activities into their current programs and budgets. Financial assistance opportunities described later in this implementation strategy are available for implementing both point source and nonpoint source controls.

While government programs can help, it is the actions of individual landowners that primarily determine water quality. Implementation of this TMDL was actually started even before the TMDL field study was completed, and at least five years before TMDL load allocations were determined.

## What's already been done?

Local jurisdictions, the Pacific Conservation District (PCD) and Natural Resource Conservation Service (NRCS), landowners, and citizens groups have been working to protect and restore these areas for many years. For example, local natural resource planning groups produced a *Watershed*

*Analysis* (Weyerhaeuser, 1994) and *Salmon Recovery Strategies* (Willapa Bay Water Resources Coordinating Council, 2006) that have led to installation of best management practices (BMPs), education and outreach, riparian restoration, and water quality monitoring.

Many land improvements have helped prevent livestock manure and bacteria runoff to surface water. For example, a large tideland pasture located at Potter Slough in the lower river typically supported up to 300 cows until 2005 (personal communication, Pacific Conservation District Board, 2006). The land was sold for wetland conversion to restore it to natural river functions and the cattle were removed.

Actions of the Pacific County Community Department of Community Development (DCD) have helped guide a variety of water quality improvement actions such as availability of low-interest loans for septic system repair. Some actions, such as the Ecklund Park residential conversion to sanitary sewers in 1997, reduced bacteria loads in the lower Willapa River. This helped allow the state DOH Shellfish Protection Program to justify expanding the commercial shellfish harvest area closer to the river mouth. These bacteria reduction activities, implemented largely by landowners and the city, resulted in the upgrade of about 150 acres of growing area in 1998.

The Washington State Dairy Nutrient Management Program (DNMP) legislation was enacted and implemented in April 1998. All dairies in the Willapa watershed are now fully implementing farm management plans that have significantly reduced bacteria discharges to water. Major federal and state financial assistance programs have helped landowners improve their farm operations, economics and land conditions while helping to improve water quality. Direct benefits of the improved farm activities are described more fully below.

A Centennial Clean Water grant was awarded to the PCD in 2003 for farm management planning services and to help finance landowner projects that directly support this TMDL implementation. Livestock exclusion (fencing) and riparian planting have been applied to approximately 9300 feet of shoreline on three land parcels in important river segments of this TMDL.

The PCD also implements the federal Conservation Reserve Enhancement Program (CREP). Two Willapa Valley landowners have participated in this program since 1998. Landowners install fencing and riparian plantings on their shorelines and place that area in an easement in exchange for a multi-year lease payment. Those two agreements protect more than 6,000 feet of shoreline and provide a buffer of approximately 10 acres of land. Alternative livestock watering equipment is included since the cattle can no longer directly access the river.

These arrangements frequently allow or encourage more efficient and cost-effective grazing management opportunities. Producers have found that the different grazing rotations helps promote a more healthy plant cover, improves forage quantity and quality, and stabilizes the soils better than an uncontrolled animal access situation. Riparian planting further reduces soil loss from erosion and river washout.

Similar financial and conservation returns have been demonstrated with use of the federal Environmental Quality Incentive Program (EQIP) implemented in the Willapa basin by the

Natural Resource Conservation Service. EQIP provided grants helping dairy farmers with initial costs of implementing the Dairy Nutrient Management Act requirements. Grants paid for capital improvements like manure containment and dry-stacking that allows nutrients to be captured and used instead of wasted in runoff to surface water. Carefully-timed and controlled rates of livestock nutrient applications have improved forage quality and quantity, improved land /soil health and reduced the need for commercial fertilizer purchases. EQIP Program participants were initially very skeptical of the potential value of the activities brought by the DNMP, but many have effectively applied the program on their farms for financial and ecological profit.

While the water quality benefits of the increased investments in farm planning and improvements cannot be directly quantified, monitoring shows that water quality has certainly improved since 1998. However, more financial and technical support for the agriculture sector, as well as other implementing parties, would be especially helpful.

# What more needs to be done?

Cleanup activities should continue actions that reduce fecal coliform bacteria and should first target the most likely human-related sources of bacteria, and will focus on those areas shown to be the biggest sources of bacteria:

## Livestock waste management

Based on the microbial source tracking study (MST) by Pacific County in 2004, livestock waste is suspected to be the largest contributor of manageable bacteria to the Willapa River system. Management practices to reduce the amount of bacteria going into streams typically include:

- Restricting livestock access to creeks
- Containment and judicious usage of livestock manure products
- Riparian restoration
- Good pasture management
- Controlling roof runoff

An important action item is the evaluation of conservation improvements made since 1998 when the Willapa surface waters were first identified as violating bacteria standards. Are the improvements still in place? Are they still effective? Are they being maintained? Have land uses changed?

Technical assistance and cost-share incentives will be the primary approaches to reduce bacteria transport from livestock to the water. Education and outreach will also be important, to increase awareness of issues and involve more landowners in developing solutions. Where known sources exist and voluntary approaches are insufficient, enforcement is possible by both county and state jurisdictions.

## Failing septic systems

Failing and poorly maintained septic systems can leak bacteria and other pathogens into nearby waterbodies. Activities to reduce this source include:

- Conduct surveys of septic system maintenance records and on-site visits to follow-up on 2004 MST testing to identify likely locations of septic system problems (for example, the area that was sampled near Lebam).
- Conduct more in-depth septic system investigations. That might include dye testing, sampling seeps or stream segments, or other methods to identify problems.
- Apply or enforce local regulations to initiate corrections, possible action by state or county Health agencies to designate "area of special concern."
- Provide more septic system operation and maintenance education and outreach.
- Investigate possible actions that can be taken by the state or county health agencies to establish and provide documentation of "areas of special concern".

As funding allows, support may be available to help landowners take care of problems. Pacific County was instrumental in helping establish a low-interest loan program for homeowners to repair or replace failing septic systems in areas with potential to impact shellfish. That low-interest loan program might be expanded to serve homeowners in new priority areas or a similar program could be made available to accommodate repairs.

## Stormwater runoff

Water quality sampling of "tributaries" in Raymond and South Bend during 1998 and 2006 showed intermittent violations of bacteria standards. These places are identified in the technical analysis portion of this report as stations RASW2 and 3, SBSW2 and 3. Of these, Riverdale Creek and the underground Central Street drain at Coast Seafoods have shown the highest bacteria levels over time. Riverdale Creek at the Lions Park in Raymond and the South Bend Central St. drain are the only tributaries in the cities with numeric targets for cleanup (load allocation).

South Bend and Raymond have done and will continue to perform source identification work to assess how much of the sources are human related. Once found, preemptive strategies can be discussed and implemented. The cities have been implementing changes to the stormwater conveyance infrastructure which are expected to help decrease pollutant discharges. The city of South Bend plans to urge more homeowners with failing sewer pipe (side sewer lines) to repair their lines. The Public Works Departments of Raymond and South Bend are committed to help control human caused pollution. The cities could also apply for funding to locate sewer line leaks or illicit connections to the stormwater system which will help them make informed decisions about proper stormwater controls.

## Pet wastes

Pet waste can contribute significant amounts of bacteria, especially when left along a creek shoreline, a drainage ditch, storm drain, or watercourse where rainfall can wash it into surface water. A stream walk by DCD personnel several years ago identified and corrected problems at one site where pet waste was being dumped in Riverdale Creek in the city limits. But no specific evaluation of these sources has occurred recently. Some stormwater discharge sites in the cities have shown very high concentrations of fecal coliform bacteria. Large quantities of unmanaged waste, or intentional dumping could result in enforcement of local ordinances or state water quality regulations.

As more information on significant sources become available, targeted microbial source tracking (MST) may be conducted to assess the source of fecal coliform bacteria. MST may be conducted if there is no other information on the sources of bacteria in certain priority places. The need for these assessments will be evaluated as implementation proceeds.

Improving water quality will be an iterative process of evaluating and prioritizing potential sources, taking appropriate action, evaluating results and determining next steps. We may identify the need for additional actions during the detailed planning process, or as ongoing monitoring evaluates the effectiveness of actions taken. The entities described in the *Who Will Participate* section below, and possibly others, will work together to coordinate the process.

# Who will participate?

Water quality improvements can only be achieved with the active participation of individuals who live in and use the Willapa River watershed. The following agencies and groups will be working, in the various roles described below, to help landowners recognize and make needed changes.

## Cities of Raymond and South Bend

The cities will continue steps to review the integrity of the sewer lines to locate possible places of exfiltration or overflows, or other cross-connections that could add pollutants (especially fecal coliform bacteria) to the stormwater system. Raymond operates a vactor waste program to remove debris from stormwater catchments before the stormwater is discharged to the river system. The program will be assessed for its usefulness as a bacteria source control tool as implementation of the TMDL proceeds. Both cities could plan to continue analyzing stormwater sampling data to understand, locate, and correct sources of bacteria stormwater pollution, if funding is available.

This TMDL does not create new requirements for the cities to collect and treat stormwater in their treatment plants or separate facilities. Stormwater pollution sources may continue to be addressed according to local wastewater management plans and other local initiatives.

## Pacific Conservation District (PCD)

The Pacific Conservation District, under the authority of Chapter 89.08 RCW, develops farm plans to protect water quality by providing education and technical assistance to residents. PCD work is non-regulatory.

They work voluntarily with landowners to develop BMPs that maximize farm productivity while protecting the quality of both surface and underground water resources. The PCD is able to provide financial support for BMPs to some landowners through state and federal cost-share programs. When developing farm plans, the district uses guidance and specifications from the U.S. Natural Resource Conservation Service.

The PCD also receives grants from the Washington State Conservation Commission, Ecology, the Salmon Recovery Funding Board, and others. Landowners may receive a Notice of Correction from Ecology if management practices on their land (e.g., farm animal waste runoff into creeks) could potentially pollute waterbodies. Typically, the notice will refer the landowner to the PCD for assistance.

The Pacific CD conducted a farm inventory during spring of 2006 to improve their knowledge of types and amounts of farming activities in the county. The inventory results will enable the PCD to prioritize and plan their services more effectively. On-farm surveys conducted during the inventory helped to recruit additional willing landowners for ongoing voluntary implementation of conservation practices. The PCD will continue to work very hard to implement water quality protection programs, and convince their neighbors to implement farm plans. Because the PCD value clean water and have a good relationship with their neighbors, they can effectively influence implementation of water quality protection practices.

## Pacific County

The Pacific County Department of Community Development (DCD) regulates land use and development in compliance in compliance with Washington State's Growth Management Act, Chapter 36.70A RCW. The fish and wildlife habitat conservation chapter of the resource ordinance addresses buffers widths for streams, lakes, and saltwater shorelines. These regulations apply to development activities in Pacific County.

The DCD also administer local ordinances for on-site septic system management. The Pacific County Board of Health Ordinances 3A, B, C, and D describe elements of the county's program that help prevent and correct on-site septic pollution problems.

**Statewide, all county health departments have the specific requirement to:**

- "Identify failing septic tank drainfield systems in the normal manner and will use reasonable effort to determine new failures." (RCW 70.118.030). Ongoing water quality sampling/ monitoring by the Pacific Conservation District, Ecology and others will supplement information gathered by the DCD in order to better characterize probable locations of failing septic systems. This will help the DCD prioritize sub-basins or other locations for follow-up.

State regulations (246-272 WAC) also direct local health departments to assure that system operators:

- Are aware of the need for ongoing operation and maintenance.
- Know how to provide the needed operation and maintenance.
- Have access to professional services.

Health departments must also periodically monitor on-site septic systems to assure that owners are using appropriate operation and maintenance practices.

The DCD has an administrative plan to respond to on-site sewage system failures, including inspection of these systems, where appropriate. They could also pursue development of new financial assistance programs for homeowners, and work to expand the areas eligible for the State Shellfish Reserve Septic Loan Account Program already established in the county. They may specifically request Centennial Grant and State Revolving Fund loans to support local projects. The following outline suggests steps that the DCD could take to control on-site septic sources if funding is available.

**A. Identify Sources**

- Phased Approach
- Develop Complete and Accurate List of Septic Systems in Basin
- Oversee a Septic Maintenance Inspection Program (Statewide Requirement for Homeowners)
- Use Monitoring Results to Focus Efforts

**B. Identify Control Measures**

- Provide List of Certified/Licensed Inspection Contractors
- Provide List of Certified Septage Pumpers and Repair Contractors
- Provide Educational Materials
- Require Repairs or Replacements if Necessary

**C. Develop/Conduct Community Education, and Broker Financial Assistance Programs**

- Prioritize local “pre-emptive” audiences: public officials, banks/lenders, dealers of pre-manufactured homes, and real-estate industry.
- Provide bacteriological sampling and analysis for citizens or other partners to help identify pollution sources, or to assess septic systems condition.
- Prioritize system owners/neighborhoods according to monitoring program results.
- Hold educational meetings for communities in various priority subbasins of the Watershed.

Coordinate grant assistance to on-site system (OSS) operators, advise, and encourage local utility districts to develop financial support for effective local OSS protection programs.

## Natural Resources Conservation Service (NRCS)

The NRCS works with Conservation Districts to improve water quality and conservation. Water quality priorities are identified through watershed planning, DOH surveys, TMDLs, and other planning processes. The NRCS administers all of the programs in the 2002 Farm Bill, including:

- Conservation of Private Grazing Land Initiative
- Conservation Security Program
- Conservation Technical Assistance
- Environmental Quality Incentives Program
- Emergency Watershed Protection Program
- Farm and Ranch Lands Protection Program
- Grassland Reserve Program
- Plant Material Program
- Resource Conservation and Development Program
- Snow Survey and Water Supply Forecasts Program
- Soil Survey Programs
- Technical Service Providers
- Wetlands Reserve Program
- Wildlife Habitat Incentives Program

These programs, or variations of them based upon Congressional updates to the Farm Bill, are available to landowners in Pacific County. Several of the programs provide cost-share incentives to landowners who commit to implementing certain conservation practices. For more information on Farm Bill programs, go to www.wa.nrcs.usda.gov/programs/index.html

The NRCS also provides staff time and technical expertise to support restoration efforts.

## Puget Sound Action Team (PSAT), with Pacific County and Shorebank Enterprise Pacific Bank

The Puget Sound Action Team (PSAT), under authority of Washington State Chapter 273 Laws of 2001, works with governments and organizations in Pacific County to carry out the state Shellfish Reserve Account Septic Loan Program. Revenues from the sale of oysters and leases from state-owned tideland in Grays Harbor and Pacific Counties are available to help finance the repair of on-site sewage systems that could be contaminating shellfish growing areas. The account is administered by the Washington Department of Fish and Wildlife, which passes the septic system repair funding through to the PSAT for administration. Memorandums of Agreement between the PSAT and Pacific County, and Pacific County and Shorebank Pacific Bank describe how the program operates locally. The Loan Program was piloted in Pacific County during 2003 and revenues are expected to be available for the county to operate the program next biennium (2007-2009) as well.

## Washington State Department of Agriculture (WSDA)

Under RCW 90.64, Washington Department of Agriculture Livestock Nutrient Management Program is responsible for regulating nutrient management activities for all dairy and combined animal feeding operations (CAFOs) in Washington State. The goal of the Livestock Nutrient Management Program is to work with producers and stakeholders to protect water quality, promptly respond to complaints and concerns related to dairy and CAFO livestock operations, and promote a healthy dairy and livestock industry. The development of permits associated with livestock activities will be coordinated with TMDL implementation. Facilities under permit will be inspected on a routine basis to determine compliance with permit requirements which include no discharges to surface or groundwater.

When the WSDA confirms that poor farm management practices on dairies and CAFO livestock operations are likely to adversely affect surface waters, landowners are referred to local conservation districts for technical assistance. If necessary, the Nutrient Management Program can require specific actions under the Water Pollution Control Act (Ch. 90.48 RCW), such as implementation of an approved Nutrient Management Plan, updates to existing Nutrient Management Plans, Notices of Violation, Administrative Orders and Penalties to correct problems that impact water quality.

## Washington State Department of Health (DOH)

The Washington Department of Health (DOH), under authority of Ch. 43.70 RCW, regulates commercial shellfish harvest. As part of this program, they monitor marine water quality in commercial shellfish growing areas of the state including the Willapa and Bruceport areas. DOH is responsible for ensuring that the standards of the National Shellfish Sanitation Program are met in all commercial and public recreational shellfish growing areas in Washington State. They also advise and work jointly with the DCD on shellfish closures, pollution concerns, and shoreline conditions that could affect water quality in shellfish production areas of Willapa Bay.

DOH also administers minimum on-site sewage system requirements in Chapter 246-272A WAC. DOH has recently revised this regulation. Different parts of the regulations are scheduled to take effect at different times. The majority of the revised sections will be in effect by July 1, 2007.

## Washington State Department of Ecology (Ecology)

Washington Department of Ecology has been delegated responsibility under the federal Clean Water Act by the U.S. Environmental Protection Agency to establish water quality standards, coordinate water quality improvement projects (TMDLs) on waterbodies that fail to meet water quality standards, and enforce water quality regulations under the Water Pollution Control Act, Chapter 90.48 RCW. In addition to this regulatory role, Ecology provides financial assistance to local governments, tribes, conservation districts, and citizens groups for water quality projects. Projects that implement water cleanup plans for TMDLs are a high priority for funding.

For agricultural problems other than dairies or confined animal feeding operations, farmers may be referred to conservation districts for technical assistance if Ecology confirms that poor farm management practices are likely to be polluting surface waters. If necessary, Ecology can require specific actions under Ch. 90.48 RCW, such as implementation of an approved farm plan, to correct the problem.

### Environmental Protection Agency (EPA)

EPA is ultimately responsible for implementing the federal Clean Water Act, and restoring water quality. EPA contracted with a technical services firm, Tetra Tech, Inc. to produce the technical basis for this TMDL. They also provide funding to help implement many kinds of water quality protection actions.

## What is the schedule for achieving water quality standards?

The demonstrated pace of reducing bacteria concentrations in the Willapa river system in the past nine years suggests *that the water quality standard could be consistently achieved by 2012.* Local groups are on track to find and fix failing septic systems, livestock waste problems, and reduce bacteria pollution to stormwater. Their recent successes are documented in other sections of this report.

## Reasonable assurance

When establishing a TMDL, reductions of a particular pollutant are allocated among the pollutant sources (both point and nonpoint sources) in the waterbody. The Willapa fecal coliform bacteria TMDL has identified both point and nonpoint sources. TMDLs (and related Action Plans) must show "reasonable assurance" that these sources will be managed or reduced to their allocated amount. Education, outreach, technical and financial assistance, and permit administration are several of the actions which will be employed to ensure that the goals of this water clean up plan are met.

The technical analysis determined that the target wasteloads are equivalent to the facilities' current discharge permit limits and no further reductions are required of them in this TMDL. A sensitivity analysis showed that the point source discharges have little impact on the bacteria level in the lower river, so reducing their bacteria discharges below the permit limits will not contribute to compliance (Tetra Tech, 2004). Consequently, reasonable assurance of success depends on continuing performance of nonpoint source pollution controls.

Ecology believes that many local activities already support this TMDL, and add to the assurance that bacteria in the Willapa watershed will meet state water quality standards. This assumes that the adaptive management activities described below continue and are maintained.

It is the goal of all participants in the Willapa TMDL process to achieve clean water through voluntary control actions.

## Adaptive management

Continuing water quality improvements will involve an iterative process of evaluating information, taking action, evaluating results of those actions and deciding what comes next. The assessment tools that may be used include continued monitoring, increased priority on wet weather assessments, and targeted microbial source tracking. The involved organizations will work together to manage the cleanup. Water quality improvement actions have been evolving in the Willapa River system with considerable progress, for many years. The percent-reduction goals from the 2006 technical study reductions are just that -- goals. The final standard for achievement of the TMDL is for the river to be in compliance with water quality standards so that its designated uses can be maintained.

The adaptive management approach is to complete and implement a realistic plan, monitor for success, and continuously adapt or refocus implementation where monitoring shows that changes are needed. In order to assess progress effectively, activity implementation will be tracked periodically and water quality will be routinely monitored. The ongoing performance reviews will help show if any changes to the wasteload allocations are required or appropriate. The TMDL "rollback analysis" described earlier suggests that more pollution reductions throughout the upstream river areas will also correlate to greater improvements downstream. If monitoring shows that water quality standards cannot be met then the TMDL load allocations may be revised.

If the water quality standards are still not being met after all identified cleanup strategies to address human-related sources are fully implemented, then the exceedance may be due to natural conditions. In this case, the natural pollutant concentration would become the standard, and no human-caused pollution could exceed that natural condition. If a natural-condition situation becomes relevant in this project, it would be applied according to the terms of the anti-degradation requirements in the state water quality regulations at WAC 173-201A-310(3).

## Monitoring

The river was monitored at several locations. However, most tributaries were monitored only at their mouth. Therefore, the technical analysis for those creeks provides evaluation of water quality and pollution loads only at the creek mouths. That scale of analysis and source area prioritization is a common outcome of this phase for a TMDL project. At this stage of a "normal" TMDL project, many questions remain unanswered about specific sources and source areas. Identification and follow-up sampling of additional discrete sources is commonly addressed during the next phase of the TMDL (detailed implementation planning.)

In some cases, conclusions from the analysis cannot be easily explained by observed land use patterns. Other questions will arise during the course of the cleanup. Sampling, investigation, and evaluation will still be required. This might include water quality sampling, MST, land use surveys, creek walks, dye testing, or upstream/downstream sampling for on-site septic system effects or other methods chosen by local groups. Monitoring will likely occur through a combined effort involving the county, state, and could include volunteers and student groups if local partners want to arrange that.

Generally, monitoring should focus on the most polluted areas where source identification and cleanup work is occurring or needed. Over time, and as funding is available, all stations in the 2006 sampling plan should be monitored again. The monitoring is essential to document improvements, verify that the TMDL load allocations have been achieved, or indicate where the cleanup plan implementation might be adapted if necessary.

A detailed monitoring plan will be written and implemented during the next project phase (the Water Quality Improvement Plan). Our knowledge of the project needs at this time suggests several sampling priorities. Some of these priorities are already underway or planned by the project partners. For example, the City of South Bend and DCD personnel are exploring the possibility of conducting more sampling at site SBSW 2 and SBSW3. Upstream sampling is also occurring there to begin source identification analysis.

Ecology intends to continue sampling several places as part of the monthly "Ambient Monitoring Program", subject to future funding priorities. Sampling stations are presently located at Johnson Slough (river mile 0.5), near the Port of Willapa Harbor docks in Raymond (river mile 6.4), and at Willapa Road.

The DOH Office of Shellfish and Water Protection Program are adding a sample site seaward of the WRJS (river mouth) location that will help document compliance with the marine water quality standard. Ecology is also considering adding a sample station near the WRSB3 site to further document improvements in the lower river.

The stations named in Table 5 which have been assigned bacteria load reduction goals should continue to be sampled in order to help assess the effectiveness of, or the need to adapt, water quality improvement strategies. Ideally, more frequent sampling should be conducted in highest priority areas for cleanup action; to help with better accuracy in pollution source identification and to measure effectiveness of local actions.

The *Water Quality Implementation Plan* (next project phase) will describe details for the coordinated monitoring strategy.

## Potential funding sources

- *Centennial/State Revolving Fund (SRF)/319* – These three funding sources are managed by Ecology through one combined application program. Funds are available to public entities as grants or low-interest loans. Grants require a 25 percent match. They may be used to provide education/outreach, technical assistance for specific water quality projects, or as seed money to establish various kinds of water quality related programs or program components. Grant funds may not be used for capital improvements to private property. However, riparian fencing, riparian re-vegetation, and alternative stock watering are grant-eligible, if a landowner easement is given. Low-interest loans are available to public entities for all of the above uses, and have also been used as “pass-through” to provide low-interest loans to homeowners for septic system repair or agricultural best management practices. Loan money can be used for a wider range of improvements on private property.

- *Conservation Reserve Enhancement Program* (CREP) – This program provides incentives to restore and improve salmon and steelhead habitat on private land. This is a voluntary program to establish forested buffers along streams where streamside habitat is a significant limiting factor for salmonids. In addition to providing habitat, the buffers improve water quality and increase stream stability. Land enrolled in CREP is removed from production and grazing, under 10-15 year contracts. In return, landowners receive annual rental, incentive, maintenance and cost share payments. The annual payments can equal twice the weighted average soil rental rate (incentive is 110 percent in areas designated by Growth Management Act). CREP is administered by the Natural Resources Conservation Service.

- *Conservation Reserve Program (CRP)* – This is a voluntary program that offers annual rental payments, incentive payments for certain activities, and cost-share assistance to establish approved cover on eligible cropland. Assistance is available in an amount up to 50 percent of the participant's costs in establishing approved practices; contract duration between 10-15 years. The program is administered through the conservation district.

- *Environmental Protection Agency* – The EPA provides funding to apply to water quality improvement. There are also specific grants such as the Watershed Initiative Grant which can provide substantial funding.

- *Environmental Quality Incentives Program (EQIP)* - This federally funded program is also managed by Natural Resources Conservation Service:
  - Provides technical assistance, cost share payments and incentive payments to assist crop and livestock producers with environmental and conservation improvements on the farm.
  - $5.8 billon over next 6 years (nationally).
  - 75 percent cost sharing but allows 90 percent if producer is a limited resource or beginning farmer or rancher.
  - Program funding divided 60 percent for livestock-related practices, 40 percent for crop land.
  - Contracts are one to ten years.
  - No annual payment limitation, but sum not to exceed $450,000 per individual/entity.

- *Wetland Reserve Program (WRP)* - A voluntary program to restore and protect wetlands on private property (including farmland that has become a wetland as a result of flooding). Landowners can receive financial incentives to enhance wetlands in exchange for retiring marginal agricultural land. Landowner limits future use of the land, but retains ownership, controls access, and may lease the land for undeveloped recreational activities and possibly other compatible uses. This is a USDA program administered by the Natural Resources Conservation Service.

- *Salmon Recovery Funding Board (SRFB)* - This Board was set by the Washington State Legislature in 1999. It provides grants for fish habitat protection and restoration and related projects that produce sustainable and measurable benefits for fish and their habitat. Many habitat restoration projects in Pacific County have been funded by the SRFB lead entity. Streamside riparian planting is a common project element: an effective riparian cover often helps discourage livestock access to the stream and helps block runoff of manure. The local lead entity expects to continue using SRFB grants for these projects.

- *United States Department of Agriculture (USDA)* - Rural Housing Repair and Rehabilitation Loans are loans funded directly by the federal government. These loans are available to very low-income rural residents who own and occupy a dwelling in need of repairs. Funds are available for repairs to improve or modernize a home, or to remove health and safety hazards. This loan is a 1 percent loan that may be repaid over a 20 year period.

- *State Shellfish Reserve Land Account Loan Program* - Revenues from the sale of oysters and leases from state-owned tideland in Grays Harbor and Pacific Counties are available to help finance the repair of on-site sewage systems that are contaminating shellfish growing areas. The account is administered by the Washington Department of Fish and Wildlife, which passes the septic system repair funding through to the Puget Sound Action Team for administration. The Loan Program was piloted in Pacific County during 2003 and revenues are expected to be available again next biennium in both Grays Harbor and Pacific counties.

- *State Community Development Block Grants (CDBG*) - City of South Bend residents have access to a CDBG Grant for replacing failing side sewers. The city has helped many homeowners apply for and utilize the funds. Many more homes are known or presumed candidates for use of these grant funds.

- *Washington Wildlife and Recreation Program (WWRP)* - In 2005, the Washington State Legislature created grants to conserve vanishing farmland and to protect the state's rivers, lakes, streams, and saltwater areas. The law adds two new categories—Riparian Protection and Farmland Conservation—to the highly acclaimed WWRP.

  Under the new *Riparian Protection* category, local governments and lead entities for salmon recovery may apply for WWRP grants to protect and/or restore shorelines, rivers, streams, estuaries and other waterways. For more information see: www.iac.wa.gov/iac/grants/riparian_habitat.htm.

  WWRP *Farmland Conservation* grants are available to help cities and counties conserve working farms. In most Washington counties these grants will be the only funding source for farm conservation easements (other than a small share of the federal Farm and Ranchlands Protection Program). For more information see: www.iac.wa.gov/iac/grants/farmland.htm.

  Local governments are also eligible to apply for WWRP grants for the acquisition or development of local parks, trails, water access areas, and urban wildlife habitat. The WWRP is administered by the Washington State Interagency Committee for Outdoor Recreation (IAC)

# Summary of public involvement methods

This WQIR was written in two phases with separate public involvement processes: from 1998 through 2006, and from January through June 2007. Information follows about how individuals and groups were included in developing the project and WQIR.

## Phase 1: Public Involvement through 2006

Between 1998 and July 2006 there were approximately 30 public meetings in the Raymond and South Bend area where Ecology provided project status reports and received advice on development of the Willapa Bacteria TMDL. That participation led to the completion of a preliminary draft WQIR in March of 2006.

The Shoalwater Bay Indian Tribe was invited to participate in the local discussions and has been provided progress reports at key times during the study and project activities. The Tribe occupies land near Tokeland, about three miles seaward of the downstream boundary of the TMDL study area. The Tribe has not participated in project activities.

Many of the meetings through July 2006 occurred with the North Pacific County Infrastructure Action Team (NPCIAT). The NPCIAT group is comprised mostly of representatives from permitted facilities (point-source dischargers), and local government officials. Those meetings focused on a range of TMDL projects including dissolved oxygen, temperature, and to a lesser extent, bacteria. Discussion about the bacteria project became the primary agenda topic after the other two projects were completed in 2005.

Even though the technical studies suggested that the bacteria TMDL was a non-point source issue, NPCIAT discussions consciously tracked the bacteria TMDL project. The facility representatives were kept informed just in case the bacteria TMDL findings might later indicate the need for changes to their facilities. Some facility and local government officials were concerned throughout the project that the final TMDL might require costly repairs or upgrades to their facilities.

In June 2005, Ecology representatives met with Pacific County Commissioners to discuss their concerns about the project implications.

The Pacific Conservation District (CD) represents the largest group of people affected by the TMDL: citizens, landowners and especially agricultural, fisheries, and forestry business operators. The CD Board of Supervisors contributed to the WQIR, particularly during three meetings in 2006.

A group called the Willapa Bay Water Resources Coordinating Council also represents natural resource groups. They were provided project information at one meeting, and were regular recipients of updates by correspondence at key project stages.

Ecology also met with the Swiss Society of Lewis and Pacific Counties, to provide a status report and ask permission to access their recreational property on the upper Willapa River for water quality sampling during 2006.

In addition to group discussions described above, meetings were held at least twice with each of the following: an official from Pacific County Department of Community Development, with the South Bend Mayor and City Supervisor, with the Raymond Public Works Department Director and Assistant Director, with the Pacific CD manager and staff, and with the manager of the Port of Willapa Harbor. In a letter to the county in March, Ecology asked to conduct a workshop with the county Board of Health, to inform the Commissioners and Administrator about the draft WQIR and to request more information about the county role in on-site septic system management. The Board of Health hosted a meeting in June with many of the local project participants and Ecology. Local people were provided many opportunities to help write or comment on several draft versions of that report.

A display ad was published in the Willapa Harbor Herald announcing a public comment period for the report. The official Phase 1 comment period was open from May 8th through June 7th, 2006. Individual review-draft reports were hand delivered to key affected parties twice during the report development process, and to the Raymond public library for patron review on May 4.

In July 2006, the community requested that Ecology revise the TMDL study with newer water quality data that Ecology was collecting for 2006. Several of the primary interest group representatives were previously invited to comment on the Quality Assurance Project Plan (sampling plan) that defined the places, times and methods for the 2006 water quality sampling (Ecology, 2006).

## Phase 2: Public Involvement during 2007

Following a preliminary review of the 2006 data in January 2007, Ecology began work with the community to complete a new technical study and write a new WQIR. As requested by the participants, public involvement for this report differed from the 2006 process in that meetings were held almost exclusively in a workgroup forum rather than individually with the affected parties.

Three meetings were held to develop the current WQIR with the core NPCIAT members, their technical consultant, and other interested people. The City of Raymond provided new data to include for Riverdale Creek. Pacific County also provided data that they collected as part of a $200,000 grant that Ecology provided them during 2004 for their involvement in the TMDLs. Another grant element allowed the county to participate in the completion of the TMDL technical analysis. That effort (2004 through 2007) involved several meetings and phone work-sessions with the technical consultant representing Pacific County and other local entities.

A display ad was published in the Willapa Harbor Herald announcing a public comment period for the report. The official comment period was open from May 9 through June 6, 2007. An open-house and public meeting was held on May 24 to provide information and request written comments on the WQIR. Eleven area residents and county officials attended the meeting. The agency response to written comments received during the public comment period is presented below.

## Responsiveness Summary (Agency Response to Comments)

Only one commenter responded during the formal comment period. The upper Willapa River landowner complained about "sprays being used in the Willapa waterways." While the comments may be relevant to other projects that help stabilize riverbanks and increase shade along the waterways, it is not pertinent to this bacteria management TMDL. The comments do provide advice for other natural resource management. The commenter's letter and pictures will be forwarded to the local Conservation District who help manage the county Noxious Weed Program that the comment addresses most.

# Next steps

Once the TMDL has been approved by EPA, a *Water Quality Implementation Plan* must be developed within one year. Ecology will work with members of the NPCIAT and other interested local people to create that plan, choosing the combination of possible solutions they think will be most effective in their watershed. Elements of the plan should include: who will commit to do what, how will we figure out whether it worked, what if it doesn't work, and potential funding sources.

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# Appendices

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# Appendix A: Glossary and acronyms

**303(d) list:** Section 303(d) of the federal Clean Water Act requires Washington State periodically to 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.

**Best Management Practices (BMPs):** Physical, structural, and/or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

**Clean Water Act:** 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 waterbody 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 production of acid or gas from lactose in a suitable culture medium within twenty-four hours at 44.5 plus or minus 0.2 degrees Celsius. FC 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/100mL).

**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 concentrations may vary anywhere from ten to 10,000 fold over a given period. The calculation is performed by either: 1) taking the $n^{th}$ root of a product of n factors, or 2) taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

**Load Allocation (LA):** The portion of a receiving waters loading capacity attributed to one or more of its existing or future sources of nonpoint pollution or to natural background sources.

**Loading Capacity:** The greatest amount of a substance that a waterbody can receive and still meet water quality standards.

**Margin of Safety (MOS):** Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving waterbody.

**National Pollutant Discharge Elimination System (NPDES):** National program for issuing, modifying, revoking and reissuing, terminating, monitoring and enforcing permits, and imposing and enforcing pretreatment requirements under the Clean Water Act. The NPDES program regulates discharges from wastewater treatment plants, large factories, and other facilities that use, process, and discharge water back into lakes, streams, rivers, bays, and oceans.

**Nonpoint Source:** Pollution that enters any waters of the state from any dispersed land-based or water-based activities, including but not limited to atmospheric deposition, surface water runoff from agricultural lands, urban areas, or forest lands, subsurface or underground sources, or discharges from boats or marine vessels not otherwise regulated under the National Pollutant Discharge Elimination System Program. Generally, any unconfined and diffuse source of contamination. Legally, any source of water pollution that does not meet the legal definition of "point source" in section 502(14) of the Clean Water Act.

**Pathogen:** Disease-causing microorganisms such as bacteria, protozoa, viruses.

**Point Source:** Sources of pollution that discharge at a specific location from pipes, outfalls, and conveyance channels to a surface water. Examples of point source discharges include municipal wastewater treatment plants, municipal stormwater systems, industrial waste treatment facilities, and construction sites that clear more than 5 acres of land.

**Pollution:** Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state, including change in temperature, taste, color, turbidity, or odor of the waters, or such discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state as will or is likely to create a nuisance or render such waters harmful, detrimental, or injurious to the public health, safety, or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish, or other aquatic life.

**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.

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

**Surface waters of the state**: Lakes, rivers, ponds, streams, inland waters, salt waters, wetlands and all other surface waters and watercourses within the jurisdiction of Washington State.

**Total Maximum Daily Load (TMDL):** An allotment of a substance in a waterbody designed to protect it from exceeding water quality standards. A TMDL is equal to the sum of all of the following: (1) individual wasteload allocations (WLAs) for point sources, (2) the load allocations (LAs) for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

**Wasteload Allocation (WLA):** The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. WLAs constitute one type of water quality-based effluent limitation.

**Watershed:** A drainage area or basin in which all land and water areas drain or flow toward a central collector such as a stream, river, or lake at a lower elevation.

**Other acronyms:**

| | |
|---|---|
| **MQO** | measurement quality objective |
| **MST** | microbial source tracking |
| **QA** | quality assurance |
| **RM** | river mile |
| **RPD** | relative percent difference |
| **RSD** | relative standard deviation |
| **WAC** | Washington Administrative Code |
| **WWTP** | wastewater treatment plant |

# Appendix B: Evaluation of measurement quality objective for fecal coliform bacteria data gathered in 2006

## Laboratory duplicates

The measurement quality objective (MQO) used by Manchester Laboratory for fecal coliform laboratory duplicates is 40% relative percent difference (RPD), or the percent difference between the duplicate sample concentrations. Duplicates with concentrations of 20 cfu/100 mL or less are not considered in this evaluation. The laboratory analyzed 31 duplicate samples and found 23 samples with counts greater than 20 cfu/100 mL. All of these duplicates were within the 40% RPD required for meeting the MQO (8 samples exceeded 40% RPD, but the bacterial counts in these samples were less than 20 cfu/100 mL). The MQO established for the laboratory duplicates was met for this project.

## Quality assurance (QA) samples

The QA samples are blind field duplicates with no identification provided to the laboratory. There were 53 QA samples collected during the course of sample collection in 2006. Of the 53 samples, 32 had a mean FC concentration greater than 20 cfu/100 mL.

The recommended MQO for quality assurance samples (Ecology, 2006) is to have 50% of the QA samples below a 20% relative standard deviation (RSD) and 90% of the samples below a RSD of 50%. The RSD is defined as the percent standard deviation divided by the mean, or as the percent coefficient of variation for the duplicate QA samples. None of the samples used to assess the MQO should have a mean concentration of 20 cfu/100 mL or less.

Figure A1 shows the plot for the QA results for samples with a mean concentration of more than 20 cfu/100 mL. The samples met the MQO prescribed for the quality assurance samples.

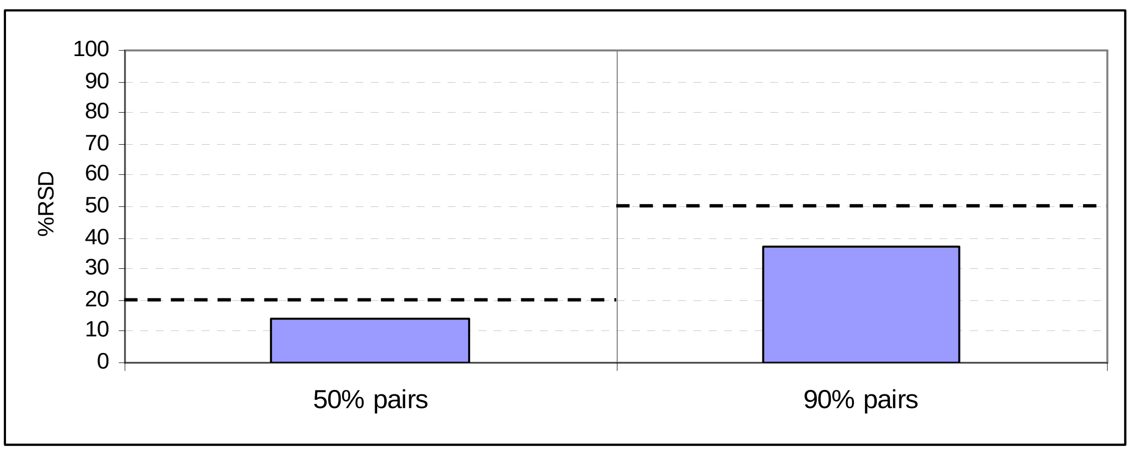



Figure A1. Percent RSD for QA samples (cfu/100 mL > 20) in Willapa River , (January-December, 2006).

# Appendix C: Fecal coliform data (cfu/100 mL) at all stations monitored by Ecology (Jan-Dec, 2006)

| Date | WRPA | FALLS | WRSW | FERN | WRLE | FORK | WROX | WRMN | MILLCK | WRC1 | WRWI | Wilson | WRHY | SFRK-F | WRRA | WRNA | WRSB-2 | WRSB-1 | WRSB-3 | WRJS | RAYSW-3 | RAYSW-2 | SBSW-3 | SBSW-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17-Jan | 27 | 4 | 8 | 160 | 57 | 10 | 43 | 63 | 16 | 92 | 535 | 3 | 140 | 12 | | | | | | | 19 | 61 | 7 | 42 |
| 18-Jan | | | | | | | | | | | | | | | 53 | 80 | 90 | 140 | 110 | 110 | | | | |
| 6-Feb | 8 | 3 | 8 | 160 | 57 | 8 | 8 | 7 | 8 | 18 | 26 | 6 | 34 | 7 | | | | | | | 224 | 1 | 28 | 6 |
| 7-Feb | | | | | | | | | | | | | | | 7 | 8 | 9 | 14 | 14 | 14 | | | | |
| 6-Mar | 48 | 7 | 8 | 240 | 140 | 68 | 26 | 9 | 25 | 12 | 13 | 3 | 6 | 6 | | | | | | | 11 | 2 | 120 | 19 |
| 7-Mar | | | | | | | | | | | | | | | 3 | 1 | 3 | 3 | 4 | 2 | | | | |
| 3-Apr | 13 | 5 | 2 | 10 | 13 | 230 | 7 | 7 | 4 | 11 | 11 | 1 | 18 | 9 | | | | | | | 10 | 48 | 140 | 330 |
| 4-Apr | | | | | | | | | | | | | | | 3 | 1 | 4 | 4 | 2 | 2 | | | | |
| 10-May | 24 | 11 | 69 | 92 | 93 | 3 | 8 | 16 | 23 | 11 | 13 | 16 | 1 | 1 | | | | | | | 13 | 5 | 120 | 37 |
| 9-May | | | | | | | | | | | | | | | 2 | 1 | 2 | 2 | 1 | 1 | | | | |
| 5-Jun | 27 | 50 | 80 | 530 | 180 | 50 | 56 | 120 | 88 | 80 | 150 | 28 | 10 | 51 | | | | | | | | | | |
| 6-Jun | | | | | | | | | | | | | | | 9 | 4 | 5 | 7 | 3 | 5 | | | | |
| 10-Jul | 120 | 180 | 490 | 40 | 150 | 59 | 49 | 47 | 32 | 32 | 84 | 64 | 36 | 51 | | | | | | | | | | |
| 11-Jul | | | | | | | | | | | | | | | 19 | 10 | 3 | 6 | 1 | 2 | | | | |
| 7-Aug | 37 | 23 | 86 | 48 | 40 | 140 | 51 | 47 | 28 | 27 | 88 | 40 | 7 | 53 | | | | | | | | | | |
| 8-Aug | | | | | | | | | | | | | | | 24 | 21 | 19 | 16 | 9 | 8 | | | | |
| 5-Sep | 16 | 75 | 355 | 3 | 57 | 92 | 40 | 100 | 23 | 210 | 43 | 350 | 8 | 28 | | | | | | | | | | |
| 6-Sep | | | | | | | | | | | | | | | 5 | 4 | 2 | 6 | 1 | 3 | | | | |
| 9-Oct | 62 | 100 | 2000 | 106 | 180 | 120 | 150 | 95 | 86 | 40 | 27 | 34 | 39 | 68 | | | | | | | | | | |
| 10-Oct | | | | | | | | | | | | | | | 44 | 36 | 30 | 21 | 19 | 11 | | | | |
| 6-Nov | 300 | 190 | 890 | 1200 | 1550 | 490 | 430 | 760 | 420 | 885 | 930 | 130 | 900 | 563 | | | | | | | | | | |
| 8-Nov | | | | | | | | | | | | | | | 360 | 310 | 370 | 430 | 450 | 405 | | | | |
| 4-Dec | 6 | 3 | 3 | 15 | 15 | 6 | 6 | 8 | 9 | 9 | 6 | 3 | 8 | 3 | | | | | | | 34 | 7 | 55 | 93 |
| 5-Dec | | | | | | | | | | | | | | | 20 | 10 | 10 | 9 | 8 | 9 | | | | |

The last four columns indicate sites where less than 10 stormwater samples per station were collected.

## Appendix D: Conductivity data (µS) at all stations monitored by Ecology (Jan-Dec, 2006)

| Date | \WRPA | FALLS | WRSW | FERN | WRLE | FORK | WROX | WRMN | MILLCK | WRC1 | WRWI | Wilson | WRHY | SFRK-F | WRRA | WRNA | WRSB-2 | WRSB-1 | WRSB-3 | WRJS | RAYSW-3 | RAYSW-2 | SBSW-3 | SBSW-2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17-Jan | 54 | 37 | 42 | 65 | 50 | 41 | 47 | 48 | 55 | 48 | 47 | 50 | 74 | 54 | | | | | | | 76 | 91 | 107 | 60 |
| 18-Jan | | | | | | | | | | | | | | | 78 | 357 | 1478 | 2050 | 4290 | 5460 | | | | |
| 6-Feb | 55 | 39 | 45 | 66 | 51 | 45 | 50 | 52 | 57 | 53 | 54 | 57 | 83 | 56 | | | | | | | 75 | 100 | 172 | 82 |
| 7-Feb | | | | | | | | | | | | | | | 4600 | 7690 | 13220 | 12830 | 15160 | 14670 | | | | |
| 6-Mar | 52 | 43 | 48 | 79 | 59 | 49 | 55 | 58 | 65 | 60 | 61 | 65 | 6720 | 68 | | | | | | | 87 | 166 | 640 | 251 |
| 7-Mar | | | | | | | | | | | | | | | 12880 | 19520 | 22100 | 22000 | 21600 | 21000 | | | | |
| 3-Apr | 54 | 43 | 48 | 77 | 56 | 48 | 53 | 55 | 65 | 57 | 59 | 66 | 2620 | 63 | | | | | | | 83 | 135 | 375 | 15080 |
| 4-Apr | | | | | | | | | | | | | | | 14900 | 19440 | 22200 | 21800 | 22100 | 21400 | | | | |
| 10-May | 57 | 50 | 53 | 98 | 62 | 55 | 60 | 63 | 65 | 73 | | 74 | 21100 | 74 | | | | | | | 86 | 200 | 188 | 31100 |
| 9-May | | | | | | | | | | | 66 | | | | 21600 | 24700 | 27800 | 27700 | 29800 | 29500 | | | | |
| 5-Jun | 53 | 50 | 51 | 102 | 62 | 49 | 56 | 58 | 74 | 60 | 62 | 73 | 12160 | 68 | | | | | | | | | | |
| 6-Jun | | | | | | | | | | | | | | | 17870 | 21300 | 21700 | 24000 | 26100 | 26400 | | | | |
| 10-Jul | 57 | 54 | 57 | 126 | 64 | 72 | 65 | 68 | 86 | 73 | 14550 | 88 | 31500 | 79 | 32900 | 35200 | 37300 | 39100 | 41000 | 37200 | | | | |
| 11-Jul | | | | | | | | | | | | | | | | | | | | | | | | |
| 7-Aug | 59 | 55 | 58 | 140 | 62 | 67 | 68 | 72 | 93 | 76 | 8980 | 93 | 35500 | 78 | | | | | | | | | | |
| 8-Aug | | | | | | | | | | | | | | | 36300 | 38500 | 39400 | 41000 | 43000 | 43200 | | | | |
| 5-Sep | 57 | 56 | 58 | 166 | 62 | 67 | 69 | 76 | 101 | 81 | 16390 | 94 | 38400 | 76 | | | | | | | | | | |
| 6-Sep | | | | | | | | | | | | | | | 41000 | 42400 | 43000 | 43600 | 45100 | 45800 | | | | |
| 9-Oct | 61 | 58 | 60 | 175 | 63 | 69 | 70 | 73 | 102 | 80 | 13280 | 100 | 40300 | 262 | | | | | | | | | | |
| 10-Oct | | | | | | | | | | | | | | | 34700 | 38900 | 40300 | 41900 | 43300 | 44400 | | | | |
| 6-Nov | 52 | 41 | 38 | 93 | 53 | 38 | 46 | 48 | 73 | 52 | 51 | 71 | 6960 | 52 | | | | | | | | | | |
| 8-Nov | | | | | | | | | | | | | | | 142* | 221* | 188* | 281* | 713* | 1100* | | | | |
| 4-Dec | 57 | 43 | 49 | 80 | 58 | 50 | 56 | 59 | 65 | 62 | 71 | 73 | 500 | 70 | | | | | | | 106 | 116 | 678 | 191 |
| 5-Dec | | | | | | | | | | | | | | | 3780 | 8120 | 9660 | 13690 | 15730 | 16840 | | | | |

* Conductivity was measured with Orion Model 130. This meter swings between µS and mS depending upon the range of salinity measured. The data were inadvertently recorded as mS because this is how most salinity data were recorded in this area of the Willapa River. Since there was excessive rainfall on November 7th and 8th, the meter was reading conductivity as µS and not mS. This is also reflected in the January 18th data during a lesser rainfall event and using the same meter as on November 8th.

# Appendix E: Locations for monitoring stations in 2006

| Station | Location | River RM | Tributary RM |
|---|---|---|---|
| WRPA | Below Patton Creek, off of Breen Rd | 41.2 | |
| FALLS | Falls Ck, Retreat Cntr, on Falls Ck Road | 37.5 | 0.3 |
| WRSW | Swiss picnic Road | 37.1 | |
| FERN | Fern Ck at Elk Prairie Road | 36.2 | 0.4 |
| WRLE | At Lebam | 33.2 | |
| FORK | Forks Ck at State Hatchery on Highway 6 | 30.5 | 0.2 |
| WROX | At Oxbow Road | 25.2 | |
| WRMN | At Highway 6 bridge near Menlo | 21.4 | |
| MILLCK | Mill Creek on Mill Ck Road bridge | 17.9 | 0.3 |
| WRC1 | On Camp One Road | 17.5 | |
| WRWI | At Willapa Rd | 13.7 | |
| Wilson | At Wilson Creek Road bridge | 12 | 1.45 |
| WRHY | At Highway 101 bridge | 7.7 | |
| SFRK-F | SF at Golf course (bridge on Fowler St) | 7.1 | 4.2 |
| WRRA | Near Port in Raymond | 6.4 | |
| WRNA | At Narrows | 5 | |
| WRSB-2 | In South Bend near inlet to Upper Mailboat Slough | 4.5 | |
| WRSB-1 | In South Bend, 1 mile upstream of Potter Slough | 3 | |
| WRSB-3 | In South Bend, downstream of Potter Slough | 1.5 | |
| WRJS | At Johnson Slough | 0.4 | |
| RAYSW-3 | Riverdale Ck at Lions Club Park | 7.2 | 0.4 |
| RAYSW-2 | Raymond drain, Off of Delaware St | 5.9 | |
| SBSW-3 | South Bend drain, at SB Packers | 3.75 | |
| SBSW-2 | Creek (Central St. drain) at Coast Seafood | 3.1 | |

RM = river mile

# Appendix F: Fecal coliform concentration in Riverdale Creek monitored by City of Raymond (2006)

| Station* | Date | Time | FC, cfu/100 mL |
|---|---|---|---|
| City limits | 4/3/2006 | 1135 | 59 |
| City limits | 5/1/2006 | 1320 | 40 |
| City limits | 6/5/2006 | 1005 | 175 |
| City limits | 7/3/2006 | 735 | 80 |
| City limits | 8/1/2006 | 1050 | 5 |
| City limits | 9/5/2006 | 1205 | 90 |
| Lions Club Park | 9/20/2005 | 1040 | 60 |
| Lions Club Park | 1/24/2006 | 1115 | 101 |
| Lions Club Park | 3/7/2006 | 1000 | 612 |
| Lions Club Park | 4/3/2006 | 1130 | 81 |
| Lions Club Park | 5/1/2006 | 1315 | 40 |
| Lions Club Park | 6/5/2006 | 1000 | 8800 |
| Lions Club Park | 7/3/2006 | 730 | 80 |
| Lions Club Park | 8/1/2006 | 1045 | 85 |
| Lions Club Park | 9/5/2006 | 1200 | 110 |

*The city limits station is at the end of Larch Street in Raymond.
The Lions Club Park station is the same station (**RAYSW-3)** monitored by Ecology in 2006.

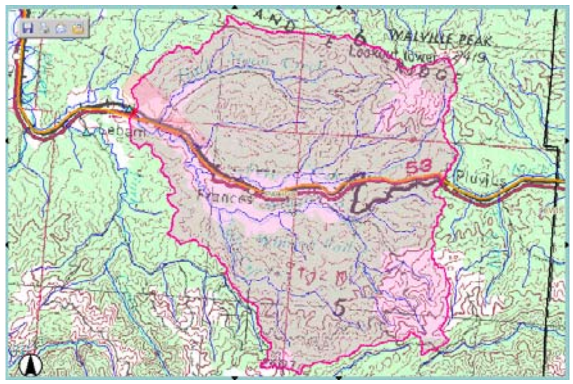
# Appendix G: Fecal coliform data gathered during the Microbial Source Tracking study of 2004 (Herrera 2005)

| Date | Station | | |
| --- | --- | --- | --- |
| | WRPA | WRC1 | WRLE |
| 18-Nov-03 | 240 | 960 | 1020 |
| 2-Dec-03 | 4 | 64 | 90 |
| 15-Dec-03 | 6 | 20 | 100 |
| 21-Jan-04 | 5 | 14 | 46 |
| 28-Jan-04 | 56 | 68 | 108 |
| 9-Feb-04 | 5 | 6 | 33 |
| 25-Feb-04 | 14 | 26 | 28 |
| 15-Mar-04 | 52 | 5 | 39 |
| 24-Mar-04 | 50 | 240 | 220 |
| 14-Apr-04 | 80 | 48 | 114 |
| 17-May-04 | 6 | 32 | 88 |
| 26-May-04 | 84 | 116 | 440 |
| 7-Jun-04 | 12 | 72 | 200 |
| 12-Jul-04 | 128 | 38 | 220 |
| 11-Aug-04 | 84 | 104 | 320 |
| 25-Aug-04 | 360 | 1100 | 2100 |
| 1-Sep-04 | 186 | 124 | 500 |
| 19-Oct-04 | 54 | 340 | 800 |
| 25-Oct-04 | 28 | 54 | 128 |
| 1-Nov-04 | 32 | 46 | 68 |

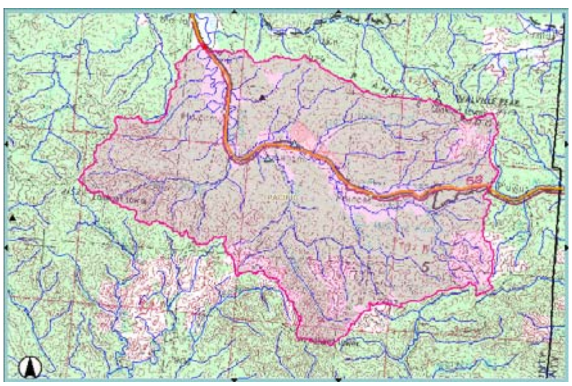
*This page is purposely left blank*

# Appendix H: Drainage area for stations in the Upper Willapa River

WRSW



WRLE



WRMN

WRWI