Sinclair and Dyes Inlets Fecal Coliform Bacteria Total Maximum Daily Load

TMDL and Water Quality Implementation Plan

DEPARTMENT OF
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Cover photo: Gorst Creek at head of Sinclair Inlet (Ecology Shoreline Aerial photo, 2006)

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Fecal Coliform
Total Maximum Daily Load

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by

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Definitions, Acronyms and Abbreviations

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 drinking, recreation, aquatic habitat, and industrial use – are impaired by pollutants. These are water quality-limited water bodies (ocean waters, estuaries, lakes, and streams) that fall short of state surface water quality standards, and are not expected to improve within the next two years.

90th percentile: A statistical number obtained from a distribution of a data set, above which ten percent of the data exists and below which 90 percent of the data exists.

Best management practices (BMPs): Physical, structural, or operational practices that, when used singularly or in combination, prevent or reduce pollutant discharges.

Canary node: In the marine model used for this TMDL, a set of nine individual grid cells at selected locations around Sinclair and Dyes Inlets, where field monitoring was conducted and that were known to have higher inputs of fecal coliform bacteria, such as stream mouths, larger stormwater outfalls, and wastewater treatment facilities.

Clean Water Act: A federal act passed in 1972 and amended, that contains provisions to restore and maintain the quality of the nation's waters. Section 303(d) of the Clean Water Act establishes the TMDL program.

Designated uses: Those uses specified in Chapter 173-201A WAC (Water Quality Standards for Surface Waters of the State of Washington) for each water body or segment, regardless of whether or not the uses are currently attained.

Dilution factor: The relative proportion of effluent to stream (receiving water) flows occurring at the edge of a mixing zone during critical discharge conditions as authorized in accordance with the state's mixing zone regulations at WAC 173-201A-100.
http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A-020

Enterococci: A subgroup of the fecal streptococci that includes *Streptococcus faecalis*, *S. faecium*, *S. gallinarum*, and *S. avium*. The enterococci are differentiated from other streptococci by their ability to grow in 6.5 percent sodium chloride, at pH 9.6, and at 10 degrees C and 45 degrees C.

Existing uses: Those uses actually attained in fresh and marine waters on or after November 28, 1975, whether or not they are designated uses. Introduced species that are not native to Washington, and put-and-take fisheries comprised of non-self-replicating introduced native species, do not need to receive full support as an existing use.

Extraordinary primary contact: Waters providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas.

Fecal coliform (FC): That portion of the coliform group of bacteria which is present in intestinal tracts and feces of warm-blooded animals (mammals and birds) as detected by the product of acid or gas from lactose in a suitable culture medium within 24 hours at 44.5 plus or minus 0.2 degrees Celsius. Fecal coliform bacteria are "indicator" organisms that suggest the possible presence of disease-causing organisms. Concentrations are measured in colony forming units per 100 milliliters of water (cfu/100mL).

Geometric mean: A mathematical expression of the central tendency (average) of multiple sample values. A geometric mean, unlike an arithmetic mean, tends to dampen the effect of very high or low values, which might bias the mean if a straight average (arithmetic mean) were calculated. This is helpful when analyzing bacteria concentrations, because levels may vary anywhere from 10 to 10,000 fold over a given period. The calculation is performed by either:

(1) Taking the nth root of a product of n factors, or

(2) Taking the antilogarithm of the arithmetic mean of the logarithms of the individual values.

Load allocation: The portion of a receiving water's 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 water body can receive and still meet water quality standards.

Margin of safety: Required component of TMDLs that accounts for uncertainty about the relationship between pollutant loads and quality of the receiving water body.

Municipal separate storm sewer systems (MS4): A conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains): (1) owned or operated by a state, city, town, borough, county, parish, district, association, or other public body having jurisdiction over disposal of wastes, stormwater, or other wastes and (2) designed or used for collecting or conveying stormwater; (3) which is not a combined sewer; and (4) which is not part of a Publicly Owned Treatment Works (POTW) as defined in the Code of Federal Regulations at 40 CFR 122.2.

National Pollutant Discharge Elimination System (NPDES): National program for issuing and revising permits, as well as imposing and enforcing pretreatment requirements, under the Clean Water Act. The NPDES permit 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 pollution: 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, and viruses.

Phase I stormwater permit: The first phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to medium and large municipal separate storm sewer systems (MS4s) in municipalities with more than 100,000 residents and construction sites of five or more acres.

Phase II stormwater permit: The second phase of stormwater regulation required under the federal Clean Water Act. The permit is issued to smaller municipal separate storm sewer systems (MS4s) for municipalities generally between 10,000 and 100,000 residents and construction sites over one acre.

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 one acre of land.

Pollution: Such contamination, or other alteration of the physical, chemical, or biological properties, of any waters of the state. This includes change in temperature, taste, color, turbidity, or odor of the waters. It also includes discharge of any liquid, gaseous, solid, radioactive, or other substance into any waters of the state. This definition assumes that these changes will, or are likely to, create a nuisance or render such waters harmful, detrimental, or injurious to (1) public health, safety, or welfare, or (2) domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or (3) livestock, wild animals, birds, fish, or other aquatic life.

Pour point: In the Sinclair-Dyes model, a location where freshwater from streams, stormwater, wastewater discharge or surface runoff is discharged to marine waters.

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.

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

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

Stormwater: The portion of precipitation that does not naturally percolate into the ground or evaporate but instead runs off roads, pavement, and roofs during rainfall or snowmelt. 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.

Surrogate measures: To provide more meaningful and measurable pollutant loading targets, EPA regulations [40 CFR 131.2(i)] allow other appropriate measures, or surrogate measures in a

TMDL. The Report of the Federal Advisory Committee on the Total Maximum Daily load (TMDL) Program (EPA, 1998) includes the following guidance on the use of surrogate measures for TMDL development:

> *When the impairment is tied to a pollutant for which a numeric criterion is not possible, or where the impairment is identified but cannot be attributed to a single traditional "pollutant," the state should try to identify another (surrogate) environmental indicator that can be used to develop a quantified TMDL, using numeric analytical techniques where they are available, and best professional judgment (BPJ) where they are not.*

Total maximum daily load (TMDL): A distribution of a substance in a water body 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 for point sources, (2) the load allocations for nonpoint sources, (3) the contribution of natural sources, and (4) a Margin of Safety to allow for uncertainty in the wasteload determination. A reserve for future growth is also generally provided.

Wasteload allocation: The portion of a receiving water's loading capacity allocated to existing or future point sources of pollution. Wasteload allocations 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.

Water year (WY): The 365-day period continuous from October 1 to September 30. For example, October 1, 1990 to September 30, 1991 is WY 1991.

Acronyms and Abbreviations

Following are acronyms and abbreviations used frequently in this report.

90^{th} %ile	Ninetieth percentile value of a dataset
BMPs	Best management practices
CAFO	Combined animal feeding operation
cfs	Cubic feet per second
cfu	colony-forming units (of bacteria)
CF	Coniferous forest cover in watershed
CH3D	Curvilinear hydrodynamics in 3 dimensions – model used to simulate Sinclair and Dyes Inlets
CSO	Combined sewer overflow
CV	Coefficient of variation
DOH	Washington Department of Health
DSN	Data set number (used in HSPF model for each watershed represented in the model)
Ecology	Washington State Department of Ecology
ENVVEST	Environmental Investment

FC	Fecal coliform
EPA	US Environmental Protection Agency
ETF	Eastside Treatment Facility operated by City of Bremerton
GIS	Geographic Information System software
GM	Geometric mean
HSPF	Hydrologic Simulation Program Fortran- model used to simulate watershed runoff
IDDE	Illicit Discharge Detection and Elimination
KC	Kitsap County
KCD	Kitsap Conservation District
KCDCD	Kitsap County Department of Community Development
KCHD	Kitsap County Health District
KCSSWM	Kitsap County Storm and Surface Water Management
KPUD	Kitsap Public Utility District
LID	Low impact development
LULC	Land use and land cover
m	meter
MF	Membrane Filtration (laboratory procedure for processing and counting fecal coliform bacteria)
mL	milliliter; one one-thousandth of a liter
MOS	Margin of Safety
MPN	Most Probable Number (laboratory procedure for processing and counting fecal coliform bacteria)
MSGP	Multi-Sector General Permit
NBK	Naval Base Kitsap. This TMDL refers to NBK Bangor (Naval Base Kitsap at Bangor) and NBK Bremerton (Naval Base Kitsap at Bremerton)
NOI	Notice of Intent (to seek coverage under an NPDES permit
NPDES	National Pollutant Discharge Elimination System
NPS	Non point source
NRCS	Natural Resources Conservation Service
NSSP	National Shellfish Sanitation Program
OOS	Out of specification (Quality assurance for field samples)
PIC	Pollution Identification and Correction
PNNL	Pacific Northwest National Laboratory
POTW	Publicly owned treatment works
PSNS& IMF	Puget Sound Naval Shipyard and Intermediate Maintenance Facility
QA/QC	Quality assurance/Quality control
RM	River mile
RPD	Relative percent difference
SKWRF	South Kitsap Water Reclamation Facility
SPAWAR	Space and Naval Warfare Systems Center Pacific
SR	State Route
SWMP	Stormwater Management Plan
SWPPP	Stormwater Pollution Prevention Plan
TEC	The Environmental Company, Inc.
TIA	Total impervious area
TMDL	Total maximum daily load (water cleanup plan)

USACE	US Army Corps of Engineers
USFS	United States Forest Service
USGS	United States Geological Survey
UV	Ultraviolet
WASP	Water quality analysis simulation program
WDFW	Washington Department of Fish and Wildlife
WES	Waterways Experiment Station
WRIA	Water Resources Inventory Area
WQS	Water quality standard
WSDOT	Washington State Department of Transportation
WSUD	West Sound Utility District
WWTP	Wastewater treatment plant
WY	Water Year – October 1 through September 30

Executive Summary

Sinclair and Dyes Inlets are marine water bodies on the west side of Puget Sound in Washington State, located in Water Resource Inventory Area 15 (Figure ES-1). Fecal coliform (FC) bacteria pollution in the two inlets and in freshwater tributaries poses a risk to human health, and limits the marine waters where shellfish can be harvested safely. Under the Clean Water Act, the Washington State Department of Ecology (Ecology) has the authority to establish water quality standards for surface waters of the state and develop water quality improvement plans (total maximum daily load, or TMDL plans) for pollutants where the waters do not meet water quality standards.

To address the FC pollution, the Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF), U.S. Environmental Protection Agency (EPA), Ecology, and other stakeholders cooperated as part of Project ENVVEST (an acronym for Environmental Investment) to develop a TMDL for Sinclair and Dyes Inlets and freshwater tributaries. The TMDL defines water quality goals, and the implementation plan assigns responsibilities for actions and programs that will reduce fecal coliform (FC) and enable the watershed to meet standards by 2016.

Local governments have completed a number of successful projects to address the pollution. As a result, this TMDL is a progress report on water quality improvements, both in marine waters and streams. In 2003, Washington State Department of Health opened an area of Dyes Inlet to shellfish harvest that had been closed for decades, and an area of Chico Bay was opened in 2009. These achievements were made possible by Kitsap County Health District (KCHD)'s work in locating and correcting failing onsite sewage systems; by the city of Bainbridge Island's work to find and correct illicit discharges and on a sewer extension for residents of Lynwood Center; by the city of Bremerton's completion of a 16-year, $50-million infrastructure project to reduce combined sewer overflows; and other local government efforts.

Despite the improvements, recent water quality monitoring indicates that a number of streams and nearshore areas do not yet meet water quality standards. Thus, the TMDL assigns cleanup responsibilities (load and wasteload allocations) to the organizations with responsibility for the waters that drain to these problem areas.

This report starts with the water quality conditions determined through monitoring by local partners and PSNS&IMF in 2000-2003. At that time, PSNS&IMF led a technical study with water quality monitoring, characterization of land uses, and modeling to determine important sources of bacteria loading and the seasonal hydrological and precipitation conditions associated with high bacteria concentrations in streams, stormwater, and marine waters. Monitoring showed that FC levels were generally higher in more developed watersheds with greater population densities, in areas with a greater percentage of impervious area, and in areas with older sewer infrastructure or onsite sewage systems. Although creeks generally had higher FC concentrations in the dry season, FC levels in marine waters were more likely to exceed standards after major storm events or extended periods of rainfall.

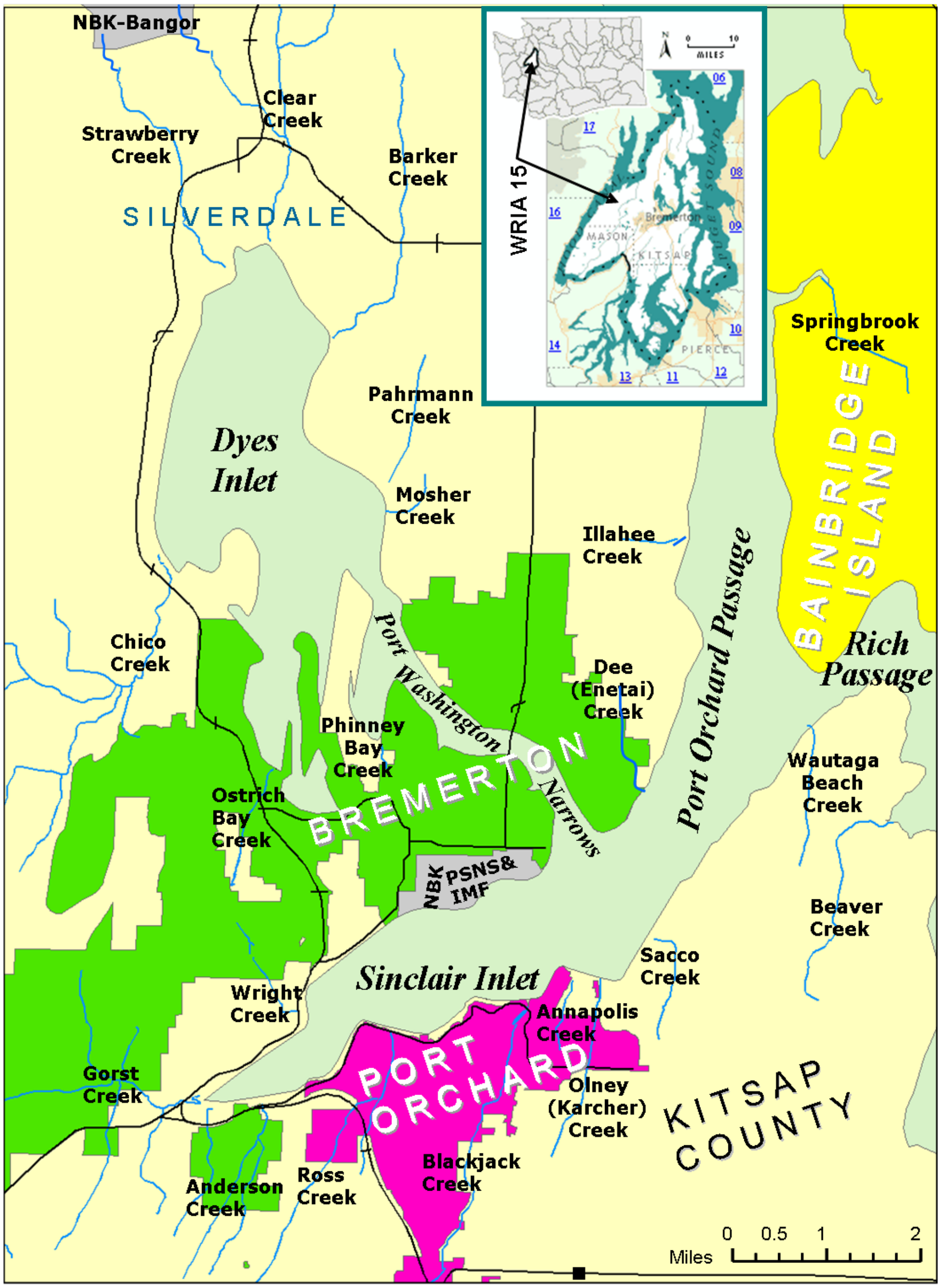

Figure ES-1. Sinclair and Dyes Inlets in WRIA 15 (Kitsap peninsula).

A watershed model (Hydrologic Simulation Program Fortran – HSPF) was used to simulate watershed flows, and a statistical model was developed to estimate FC concentrations as a function of upstream land use and land cover (LULC). A curvilinear hydrodynamics in three dimensions (CH3D) model was used to simulate the release, transport, and fate of FC loading (CH3D-FC) from watershed pour points corresponding to 39 streams, 58 stormwater outfalls, 44 shoreline drainage areas, and three wastewater treatment plants (WWTP). (Pour points are the model's simulated locations where freshwater from streams, stormwater, WWTP discharge or surface runoff is discharged to marine waters).

Model results for water year (WY) 2003 indicate that for marine waters to meet standards, FC targets more stringent than the freshwater quality standards are needed for Clear, Strawberry, Gorst, and Blackjack creeks. WY2009 and WY2010 data for marine and freshwater quality are used to determine the current percent reductions needed to meet standards. WY2010 was a significantly wetter year than either WY2003 or WY2009 and water quality was poorer. The percent reduction targets calculated and the load and wasteload allocations derived are based on the WY2010 results and are therefore more conservative than they would be, had the targets been based on WY2009 alone. However, because of the water quality improvements since WY2003, the percent reductions for most streams are not as large as those needed in WY2003.

Marine areas currently needing improvement include nearshore areas below Clear, Barker, Strawberry, Gorst, Blackjack, Karcher, Annapolis, and Sacco creeks; several sites in Port Washington Narrows and adjacent to Point Herron (southern tip of East Bremerton); two in Chico Bay; one in Oyster Bay; one off the Port Orchard waterfront, and one off Fletcher Bay, Bainbridge Island (Figure ES-2).

The TMDL requires monitoring at a number of freshwater and marine nearshore sites, including two nearshore areas that are not currently monitored -- the marine waters adjacent to PSNS &IMF and the nearshore below Lynwood Center, Bainbridge Island.

Of the freshwater tributaries monitored in 2000-2003, Anderson, Ross, Chico, and Mosher met and continue to meet freshwater water quality standards. In Dyes Inlet, Pahrmann, Barker, Clear, Kitsap Mall, Strawberry, and Ostrich Bay creeks exceed bacteria standards, as do Blackjack, Annapolis, Karcher, and Sacco creeks in Sinclair Inlet and Beaver Creek, which discharges to Clam Bay off Rich Passage. Phinney Creek and State Park Creek were not monitored in 2003, but monitoring of Phinney Creek since 2005 indicates serious bacteria pollution problems (Figure ES-3).

This TMDL includes water quality information for Gorst and Enetai creeks, designated Category 4B (has a pollution control program being implemented) on the state Water Quality Assessment. Although water quality has improved in both creeks, they do not yet meet standards and are assigned FC targets in the TMDL.

The NPDES permittees with responsibility for their contributions to water quality in their jurisdictions are assigned wasteload allocations (WLAs) (Table ES-1) where their MS4s discharge to streams and marine areas that need reductions in FC bacteria, based on current data). TMDL requirements become binding when they are incorporated into NPDES permits.

The existing permit limits for FC bacteria in the NPDES permits for three WWTPs that discharge to study area marine waters are adequate to protect marine waters. The three facilities are the city of Bremerton; South Kitsap Water Reclamation Facility in Port Orchard; and Kitsap No. 7 at Fort Ward, Bainbridge Island.

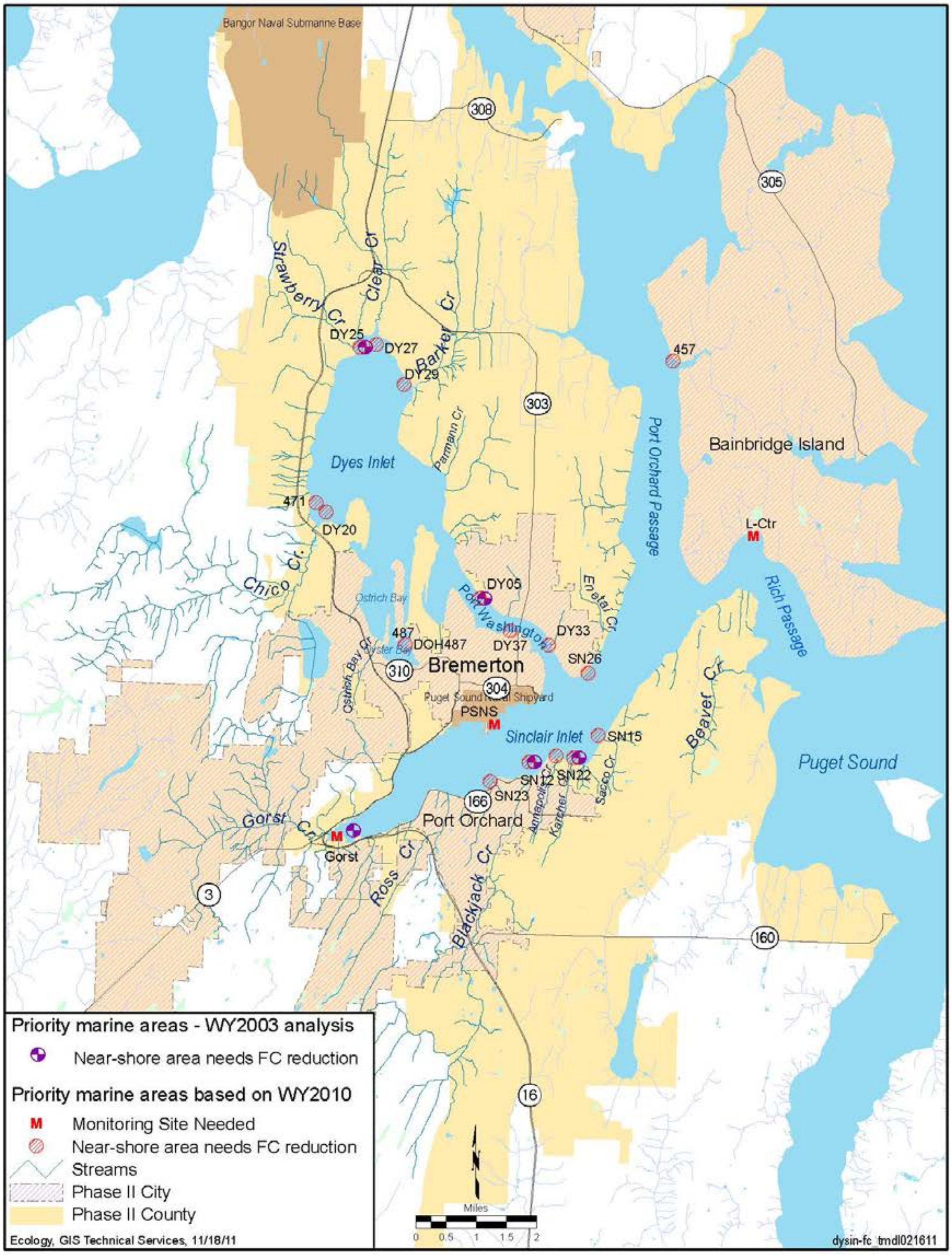

Figure ES-2. Marine nearshore areas needing reduction in fecal coliform bacteria.

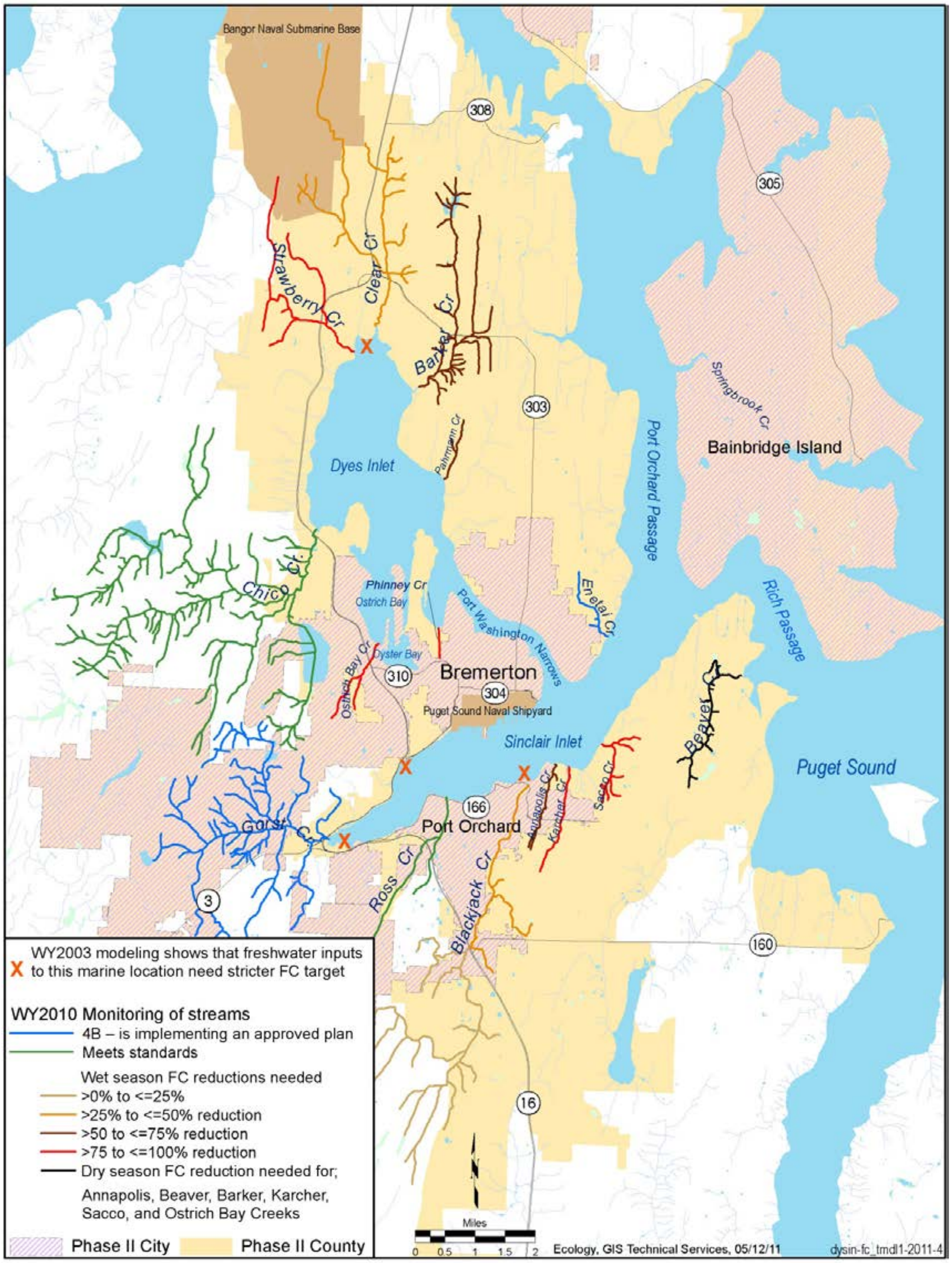

Figure ES-3. Fecal coliform wet season percent reductions needed for streams to meet standards.

However, as resources allow, the TMDL recommends the WWTP operators:

- Provide a geographic information system (GIS) data layer to local stormwater municipalities to assist in IDDE investigations.

- Review locations of sub-marine and sub-beach sewer pipelines, and when resources are more available look for opportunities to relocate to street utility corridors.

Table ES-1. NPDES permittees assigned wasteload allocations under the TMDL.

Ecology NPDES Phase II municipal stormwater permit	WLA Basis
City of Bainbridge Island	Stormwater discharge to nearshore below Lynwood Center.
City of Bremerton	Stormwater discharges to Phinney and Ostrich Bay creeks and seven nearshore sites.
City of Port Orchard	Stormwater discharges to Blackjack, Annapolis and Karcher creeks and one nearshore site.
Kitsap County	Stormwater discharges to Pahrmann, Barker, Clear, Strawberry, Ostrich Bay (creek), Phinney, Blackjack, Karcher, Sacco, and Beaver creeks and nine nearshore sites.
Municipal Stormwater NPDES General Permit	WLA Basis
Washington State Department of Transportation	Stormwater discharges from State Highways 3, 303, 304, 310, 16, 160 and 166 in Phase II municipalities.
Federal (EPA) NPDES stormwater discharges	WLA Basis
Puget Sound Naval Shipyard & Intermediate Maintenance Facility	Stormwater discharges with high concentrations of fecal coliform bacteria, to nearshore waters of Sinclair Inlet.
Naval Base Kitsap at PSNS; Naval Base Kitsap at Bangor	Stormwater discharges to Sinclair Inlet and to upper west fork of Clear Creek.
Ecology NPDES municipal wastewater permit	WLA Basis
Bremerton WWTP	Effluent discharge to Sinclair Inlet: Current permit limit for FC bacteria.
Kitsap WWTP No. 7 (Fort Ward, Bainbridge Island)	Effluent discharge to Rich Passage: Current permit limit for FC bacteria.
South Kitsap Water Reclamation Facility (Port Orchard)	Effluent discharge to Sinclair Inlet: Current permit limit for FC bacteria.

Meeting water quality standards by 2016 is expected through completion or continuation of programs already underway, including:

- Local advocacy for (with projects underway) incorporating Low Impact Development in urban redevelopment. Projects that infiltrate stormwater will reduce flow and FC in runoff.
- KCHD’s Sinclair Inlet Restoration Project (a Pollution Identification and Correction, or PIC project) started in 2007.
- KCHD grant project to assist Kitsap-area municipalities to develop Illicit Discharge Detection and Elimination (IDDE) programs, started in 2008.
- A city of Bremerton project to extend sanitary sewer collection to Gorst commercial and residential areas – an area plagued for years with failing onsite sewage systems.
- Programs to educate the public about ways to reduce the pollutants entering stormwater and properly dispose of pet waste. Both can be addressed under the Ecology Phase II municipal stormwater permit.

- WA State Department of Transportation (WSDOT) will implement the mapping and maintenance of its stormwater facilities in the Phase II jurisdictions in accordance with its NPDES municipal general stormwater permit. Additional actions for WSDOT are specified in the TMDL Implementation Plan under “Organizations – roles, programs, actions (Washington State Department of Transportation)”.
- Continued WA Department of Health (DOH) and KCHD marine monitoring of Dyes Inlet, Port Washington Narrows, Port Orchard Passage and Rich Passage. Continued KCHD monitoring of streams.

Additional actions will be needed to ensure meeting water quality standards by 2016, including:

- Phase II stormwater jurisdictions are required to focus two stormwater program elements - pollution investigations (IDDE programs) and Operations and Maintenance - on the streams and nearshore areas with assigned WLAs. They need to install and maintain pet waste education and collection stations at municipal parks and other permittee owned and operated lands adjacent to stream and marine shorelines.
- Kitsap County Surface and Stormwater Management (SSWM) and the city of Bremerton should assist Kitsap County Health District in obtaining funds for, and conducting a feasibility study to determine whether extending sewer service to neighborhoods with ongoing septic system failures would best address the serious fecal coliform pollution of Phinney and Ostrich Bay creeks.
- PSNS&IMF should monitor the nearshore below the shipyard to ensure stormwater or other source is not polluting these waters.
- The city of Bainbridge Island should continue monitoring Springbrook Creek and monitor the nearshore below Lynwood Center to ensure stormwater or other sources are not polluting these waters.
- KCHD should continue its progress in finding and correcting failing onsite sewage systems and pet and livestock pollution problems through PIC projects in priority Sinclair-Dyes watersheds.
- Enterprise Cascadia, a non-profit organization, is encouraged to secure funding so that it can continue its successful low-interest loan program for repairs and replacement of onsite sewage systems in Kitsap County.
- KCHD should continue its outreach to marinas and the boating community to ensure that more boat owners comply with marina pumpout requirements.

There is strong potential for future development to degrade water quality throughout the Sinclair and Dyes Inlets watershed. The TMDL uses a narrative approach to setting aside a reserve for growth; it calls for local governments starting in 2016 to incorporate Low Impact Development BMPs, where feasible, or use other stormwater management techniques, to minimize the discharge of bacteria to surface waters.

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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. The Clean Water Act requires each state to have its own water quality standards designed to protect, restore, and preserve water quality. Water quality standards consist of (1) designated uses for protection, such as cold water aquatic life and drinking water supply, and (2) criteria, usually numeric criteria, to achieve those uses.

Every two years, states are required to prepare a list of water bodies – lakes, rivers, streams, or marine waters -- that do not meet water quality standards. This list is called the 303(d) list and 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. The list assigns water bodies to one of 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 or insufficient data available to assign a category.

Category 4 – Polluted waters that do not require a TMDL because:

- 4A. – Have an approved TMDL being implemented.
- 4B. – Have a pollution control program being implemented.
- 4C. – Are impaired by a non-pollutant such as low water flow, dams, or culverts.

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

Further information is available at Ecology's Water Quality Assessment web site (www.ecy.wa.gov/programs/wq/303d).

TMDL process overview

The Clean Water Act requires that a total maximum daily load (TMDL), or water quality improvement plan) be developed for each of the water bodies 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. Ecology then works with local communities to develop an overall approach and a list of implementation activities that are expected to be effective in reducing the pollution to acceptable levels. The TMDL and its implementation strategy are sent to EPA for approval.

Once the TMDL is approved, Ecology continues to work with the local community to track implementation and review water quality monitoring results. Adaptive management is used to adjust elements of the TMDL plan to make sure pollutant reductions are achieved over time.

Elements the Clean Water Act requires in a TMDL

The goal of a TMDL is to ensure that impaired waters will meet water quality standards. A TMDL document includes a written, quantitative assessment of the water quality problems and of the pollutant sources that cause the problem, if known. The term TMDL also refers to the "loading capacity" – as defined by EPA, "the greatest amount of loading that a water body can receive without violating water quality standards" (EPA, 2001a, 2001b). The loading capacity provides a reference for calculating the amount of pollution reduction needed to bring a water body into compliance with the standards.

The portion of the receiving water's loading capacity assigned to a particular source is a wasteload or load allocation. If the pollutant comes from a discrete (point) source subject to a National Pollutant Discharge Elimination System (NPDES) permit, such as a municipal or industrial facility's discharge pipe, that facility's share of the loading capacity is called a *wasteload allocation*. If the pollutant comes from diffuse (non-point) sources not subject to an NPDES permit, such as general urban, residential, or farm runoff, the cumulative share is called a *load allocation*.

The TMDL development process must also consider *seasonal variation* 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 pollutant loads that may occur with population increase and changes in land use is sometimes included as well.

By definition, a TMDL is the sum of the allocations, which must not exceed the loading capacity. The sum of the wasteload and load allocations, any margin of safety, and any reserve capacity, must be equal to or less than the loading capacity.

$$\begin{aligned}\text{TMDL} &= \text{Loading Capacity} \\ &= \text{sum of all wasteload allocations} + \text{sum of all load allocations} + \\ &\quad \textit{margin of safety} + \textit{reserve capacity} \qquad \text{[EQU 1]}\end{aligned}$$

Why Ecology is Developing a TMDL in this Watershed

Parts of Sinclair and Dyes Inlets, adjacent marine waters, and the freshwater streams and stormwater that drain to the inlets are contaminated with fecal coliform (FC) bacteria (Figure 1). Safe human recreational uses of these water bodies are at risk, and the area of Sinclair and Dyes Inlets that can safely be harvested for shellfish is limited. Under the federal Clean Water Act a total maximum daily load (TMDL), or water quality improvement plan, must be developed when the state determines that a stream, river, lake or marine water body is polluted. This federal requirement is described in more detail on page 1.

A TMDL is the maximum amount of a pollutant that a water body can accept before there is a loss of beneficial uses (e.g., swimming, boating, shellfish harvesting). This document provides an estimate of the maximum amount of bacteria that Sinclair and Dyes Inlets can accept from watershed sources and still meet water quality standards. The TMDL also provides a plan for water quality improvement, with steps residents and local agencies can take to get to clean water. The goal of the plan is to protect beneficial uses so that the tributaries and marine waters in the study area meet state water quality standards for bacteria, and the maximum possible area of the two inlets is available for shellfish harvest.

This TMDL and water quality implementation plan includes a summary of current water quality conditions in Sinclair and Dyes Inlets and their freshwater tributaries. Although much work remains to be done, ongoing programs of the Kitsap County Health District (KCHD), local government stormwater programs, and other organizations have resulted in measurable improvements in water quality at many locations throughout the watershed.

Figure 1. Fecal coliform bacteria, microscopic view.

Health risk from harmful bacteria and viruses

Bacteria standards for Washington waters are set to protect people who work and play in and on the water from waterborne illnesses, as well as protecting those who consume shellfish from marine waters. FC bacteria are “indicator bacteria.” Their presence indicates that other pathogenic, or disease-causing bacteria and viruses may also be in the water. Ecology tracks indicator bacteria, rather than pathogenic bacteria and viruses, because the testing is easier and less expensive, and because extensive research has established a direct relationship between elevated FC and a higher incidence of disease. Feces from warm-blooded animals, as well as humans and birds, contain FC bacteria and may contain pathogens that make people sick. The state standards are maximum concentrations, or criteria, for FC bacteria in water. At concentrations below these criteria, the occurrence of pathogenic bacteria and viruses is typically lower.

Background

Sinclair and Dyes Inlets, and many streams and stormwater outfalls that drain into them, are polluted with FC bacteria. Project ENVVEST (an acronym for Environmental Investment) is an environmental partnership initiated by the United States Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF) with partners U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (Ecology). PSNS&IMF is part of the U.S. Navy’s operations in Bremerton. Located on the shores of Sinclair Inlet, the shipyard has been in operation since 1892. The goals of Project ENVVEST are:

- To better understand the ecological structure and function of Sinclair and Dyes Inlets.
- To define the extent of water quality impairments of the two inlets and quantify human-related stressors.
- To develop a toolbox of ecological (physical, biological, and chemical) metrics for long-term monitoring and adaptive management.
- To implement appropriate actions to protect, restore, and/or rehabilitate the ecosystem of Sinclair and Dyes Inlets.
- To educate and involve the public and stakeholders in watershed management.

Ecology worked with the PSNS&IMF and local stakeholders to conduct a TMDL study in this watershed because of a history of FC bacterial contamination from onsite sewage systems; combined sewer overflows (CSO); stormwater runoff from urban areas, inadequate management of human waste from boats and marinas, agricultural practices, and other pollution sources.

The history of water quality studies in this watershed and a detailed characterization of fecal coliform bacteria concentrations and loads are presented in the first technical report prepared for this TMDL, *An Analysis of Microbial Pollution in the Sinclair-Dyes Inlet Watershed* in support of the ENVVEST project (May et. al., 2005; www.ecy.wa.gov/biblio/0503043.html).

May et al. (2005) reported that two 1995 watershed action plans: the Sinclair Inlet Watershed Action Plan (KCDCD 1995a) and the Dyes Inlet–Clear Creek Watershed Action Plan (KCDCD 1995b) described then-current conditions in the watershed, identified existing and potential pollution problems, and included recommendations for correcting problems and improving the watersheds. One of the most significant recommendations in the two plans was that a long-term water quality monitoring program should be implemented in the watershed to identify and correct bacteria pollution problems (May et al. 2005).

The Kitsap County Surface and Stormwater Management (SSWM) program, formed in 1994 to protect and restore the waters of Kitsap County (KC), is a combined effort of KC Public Works Department, KC Department of Community Development (KCDCD), Kitsap Conservation District (KCD), and KC Health District (KCHD). KCHD, with funding from SSWM, has conducted water quality trend monitoring in Sinclair-Dyes watershed, as well as other parts of Kitsap County, since 1996. The KCHD Pollution Identification and Correction (PIC) program, funded in part by Ecology Centennial grants, uses community outreach, detailed monitoring along streams and shorelines, and enforcement to reduce pollution. SSWM program objectives were initially developed in response to recommendations in the two Watershed Action Plans (KCDCD 1995a,b) and are described in yearly executive plans (SSWM 2010).

Another development that led to significant water quality improvements in Sinclair and Dyes Inlets is the city of Bremerton's program to reduce Combined Sewer Overflows (CSOs). State and federal regulations limiting combined sewer overflows were put in place in 1989. Ecology approved the current CSO reduction plan in 2000. With the completion of the Pacific Avenue Basin Separation and Wastewater Treatment Plant Upgrade projects in 2010-2011, Bremerton completed its 16-year, $50+ million dollar CSO Reduction Program. The program accomplishments have been significant, as evidenced by CSO volume and frequency reductions greater than 99 percent (Figure 2, COB 2011).

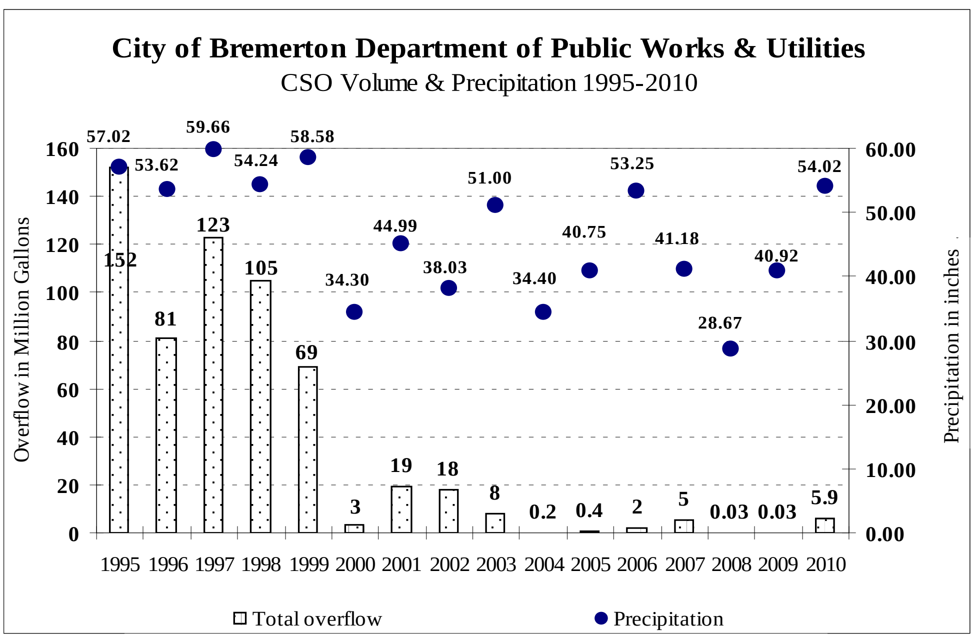

Figure 2. Annual Bremerton CSO volume and precipitation for 1995-2010.

The Department of Ecology develops and administers National Pollutant Discharge Elimination System (NPDES) permits for point sources of pollution in Washington State. EPA retains authority to issue NPDES permits to federal facilities and tribes. NPDES permittees in the watershed with potential to discharge fecal coliform bacteria include:

- Municipal wastewater treatment plants (WWTPs). In this watershed, facilities with individual permits for WWTPs are the city of Bremerton (Westside WWTP--discharges into Sinclair Inlet and Eastside Treatment Facility--discharges into the Port Washington Narrows), Kitsap County Sewer District No. 7 on Bainbridge Island (Fort Ward WWTP--discharges into Rich Passage), and the West Sound Utility District, which operates the South Kitsap Water Reclamation Facility in Port Orchard--discharges into Sinclair Inlet).

- Phase II municipal stormwater permit (2007). This permit covers smaller cities and counties with urban areas that collect stormwater runoff in municipal separate storm sewers and discharge it to surface water. In the Sinclair and Dyes Inlets watershed, the Phase II permit covers the urban portions of Kitsap County and the cities of Bainbridge Island, Bremerton, and Port Orchard.

- Washington State Department of Transportation (WSDOT) NPDES municipal stormwater permit (2009). WSDOT is authorized to discharge stormwater runoff to waters of the state from storm sewer systems along state highways (Routes 3, 16, 160, 166, 303, 304 and 310).

- Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF) is permitted to discharge stormwater and drydock discharge under an NPDES permit administered by EPA Region 10. The shipyard also has a state waste discharge permit for certain industrial wastewaters that are treated prior to discharge to the sanitary sewer through the city of Bremerton's Westside WWTP.

- Naval Base Kitsap Bangor is permitted to discharge stormwater under the (2008) EPA Multi-Sector General Permit for Stormwater Discharges from Industrial Activities.

Impairments addressed by this TMDL

The beneficial uses to be protected by this TMDL are primary contact recreation and shellfish protection. These uses will be protected by decreasing the load of FC bacteria to Sinclair-Dyes water bodies. This TMDL addresses a number of 303(d)-listed freshwater listings (Table 1) and marine listings (Table 2). Locations of these listings in the Sinclair and Dyes Inlet study area can be viewed at http://apps.ecy.wa.gov/wqawa2008/viewer.htm.

Table 1 includes a listing for waters of concern in the study area: Kitsap Mall Creek. Insufficient data were available to list it as impaired during the most recent water quality assessment. However, Kitsap Health monitored this creek as part of its Dyes Inlet Restoration (Pollution Identification and Correction) project during completion of the TMDL implementation plan, and the data indicate that the creek is impaired.

Appendix A lists pollutants other than FC on the 2008 Water Quality Assessment for Sinclair and Dyes Inlets and their freshwater tributaries. These will not be addressed by this TMDL. Ecology's strategy is to use this TMDL to continue the implementation actions needed to reduce fecal coliform bacteria in the watershed. The severity of some of these non-fecal coliform impairments may be reduced through these actions. Ongoing monitoring by Kitsap County Health District and other partner agencies will keep Ecology informed of water quality conditions and help determine whether additional TMDLs will be required.

Table 1. Study area water bodies on the 2008 303(d) list and waters of concern on the 2008 WQ assessment for fecal coliform in fresh waters (Ecology 2009).

Listing ID	Water body	Township	Range	Section
7604	ANNAPOLIS CREEK	24.0N	01.0E	36
7605	BARKER CREEK	25.0N	01.0E	22
7608	BARKER CREEK	25.0N	01.0E	15
7610	BEAVER CREEK	24.0N	02.0E	16
7611	BEAVER CREEK	24.0N	02.0E	20
7615	BLACKJACK CREEK	24.0N	01.0E	26
7616	BLACKJACK CREEK	24.0N	01.0E	35
7618	BLACKJACK CREEK	24.0N	01.0E	25
7623	CLEAR CREEK	25.0N	01.0E	16
7625	CLEAR CREEK	25.0N	01.0E	09
7627	CLEAR CREEK	25.0N	01.0E	04
7628	CLEAR CREEK	25.0N	01.0E	09
53103	STATE PARK CREEK	24.0N	02.0E	06
7632	UNNAMED TRIB TO BANGOR TRIDENT LAKE OUTLET CREEK	25.0N	01.0E	05
38405	ANNAPOLIS CREEK	24.0N	01.0E	25
38671	KITSAP CREEK	24.0N	01.0E	25
38887	STRAWBERRY CREEK	25.0N	01.0E	20
38923	OSTRICH BAY CREEK	24.0N	01.0E	16
38927	SACCO CREEK	24.0N	02.0E	19
38931	CLEAR CREEK, W.F.	25.0N	01.0E	08
38934	KARCHER CREEK	24.0N	01.0E	25
45154	KITSAP CREEK	24.0N	01.0E	20
7649	KITSAP LAKE	24.0N	01.0E	32
45704	SPRINGBROOK CREEK	25.0N	02.0E	20
45759	UNNAMED CREEK (TRIB TO KITSAP LAKE)	24.0N	01.0E	17
46483	UNNAMED CREEK (TRIB TO KITSAP LAKE)	24.0N	01.0E	17
53076	PHINNEY CREEK	24.0N	01.0E	10
53080	CHICO CREEK	24.0N	01.0W	02
53085	STRAWBERRY CREEK	25.0N	01.0E	17
53087	OSTRICH BAY CREEK, W.B.	24.0N	01.0E	16
53089	PAHRMANN CREEK	25.0N	01.0E	34
53107	BEAVER CREEK	24.0N	02.0E	29
Waters of Concern				
53086	KITSAP MALL CREEK	25.0N	01.0E	21

Table 2. Study area water bodies on the 2008 303(d) list for fecal coliform in marine waters.

Listing ID	Water body	Marine Grid Cell	Latitude	Longitude
38552	DYES INLET AND PORT WASHINGTON NARROWS	47122F6I4	47.585	122.645
38576	DYES INLET AND PORT WASHINGTON NARROWS	47122G6E9	47.645	122.695
38580	DYES INLET AND PORT WASHINGTON NARROWS	47122G6E8	47.645	122.685
38799	SINCLAIR INLET	47122F6E2	47.545	122.625
45321	PORT ORCHARD, AGATE PASSAGE, AND RICH PASSAGE	47122F5J3	47.595	122.535
45857	PORT ORCHARD, AGATE PASSAGE, AND RICH PASSAGE	47122G5A4	47.605	122.545
52892	PORT ORCHARD, AGATE PASSAGE, AND RICH PASSAGE	47122F5H9	47.575	122.595

There are other impaired waters in the study area that are being addressed through implementation of a pollution control program without a TMDL, through an Ecology- and EPA-approved process (Category 4B on the water quality assessment). Gorst Creek and Enetai Creek were designated Category 4B in 2005, based on data and commitments to cleanup by Kitsap County Health District. This TMDL provides updated water quality data and establishes target FC concentrations for the creeks based on the TMDL modeling, but does not set load or wasteload allocations. To maintain 4B status the responsible cleanup agency must submit new water quality data for each water quality assessment, and if progress is not made, the designation may return to impaired (Category 5, the 303[d] list).

Water Quality Standards and Beneficial Uses

Fecal coliform bacteria

When the state establishes water quality standards for pollutants, it also designates the level of protection for different water bodies. These designations come with specific numeric criteria for fresh and marine waters.

While most of the Sinclair-Dyes watershed is designated as Primary Contact waters by the state, three streams are considered Extraordinary Primary Contact since they drain into marine water east of the boundary line for Primary Contact marine waters. They are Beaver Creek, Karcher Creek, and Sacco Creek. The boundary line separating Sinclair and Dyes Inlets (Primary Contact designation) from the Extraordinary Primary Contact designation, for most of central Puget Sound, is at longitude 122 degrees 37 minutes. Refer to Water Quality Standards, designated uses for marine waters listed at:
http://apps.leg.wa.gov/WAC/default.aspx?cite=173-201A-612.

Numeric criteria for freshwaters

For freshwater, the *Primary Contact* designation is assigned 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 designation is for any waters where human exposure is likely to include exposure of the eyes, ears, nose, and throat. Since children are also the most sensitive group for many of the waterborne pathogens of concern, even shallow waters may warrant primary contact protection. To protect this use category: "*Fecal coliform organism levels must not exceed a geometric mean value of 100 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 200 colonies/mL*" [WAC 173-201A-200(2)(b), 2003 edition].

The *Extraordinary Primary Contact* use is intended for waters capable of "providing extraordinary protection against waterborne disease or that serve as tributaries to extraordinary quality shellfish harvesting areas." To protect this use category, FC organism levels must not exceed a geometric mean value of 50 colonies/100 mL, with not more than 10 percent of all samples (or any single sample when less than ten sample points exist) obtained for calculating the geometric mean value exceeding 100/colonies mL" [WAC 173-201A-200(2)(b), 2003 edition].

Compliance is based on meeting both the geometric mean criterion (referred to as Part I of the water quality standard) and the ten percent of samples (or single sample if less than ten total samples) limit (referred to as Part II of the standard). These freshwater criteria (Table 3) are designed to allow seven or fewer illnesses out of every 1,000 people engaged in primary contact activities. The persistence of bacterial sources for a given monitoring site may be suggested by exceedances of Part I vs. Part II of the standard. For example, exceedances of Part I may indicate a chronic pollution condition in the watershed, while locations that do not exceed Part I but have Part II exceedances may reflect more sporadic pollution from runoff related to storm events.

Once the concentration of FC in the water reaches the numeric criterion, human activities that would increase the concentration above the criteria are not allowed. If the criterion is exceeded, the state will require that human activities be conducted in a manner that will bring FC concentrations back into compliance with the standard. (Note that Ecology uses the 90th percentile value for a set of samples as a more accurate statistic to represent the second part of the standard – no more than 10 percent of samples may exceed a value of 200 cfu/100 mL.)

Table 3. Freshwater fecal coliform bacteria standards.

Freshwater Standard	PART I Geometric Mean (cfu/100 mL)	PART II 90th Percentile (cfu/100 mL)
Freshwater tributaries to Dyes Inlet and western Sinclair Inlet (Primary Contact)	100	200
Freshwater tributaries to eastern Sinclair Inlet & Rich Passage (Karcher, Sacco, and Beaver creeks) (Extraordinary Primary Contact)	50	100

If natural levels of FC (from wildlife) cause criteria to be exceeded, no allowance exists for human sources to measurably increase bacterial pollution further. While the specific level of illness rates caused by animal versus human sources has not been quantitatively determined, warm-blooded animals are a common source of serious waterborne illness for humans.

Numeric criteria for marine waters

In marine (salt) waters, bacteria criteria (Table 4) are set to protect shellfish consumption and people who work and play in and on the water. To protect both primary contact recreation and shellfish harvesting, FC bacteria are used as indicator bacteria to gauge the risk of waterborne diseases.

The presence of these bacteria in the water indicates the presence of waste from humans, other warm-blooded animals, or birds. Waste from warm-blooded animals is more likely to contain pathogens that will cause illness in humans than waste from cold-blooded animals.

To protect shellfish harvesting and primary contact recreation (swimming or water play):
"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/100mL" [WAC 173-201A-210(3)(b), 2003 edition].

Table 4. Marine fecal coliform bacteria standards.

Marine Standard	Part I Geometric Mean (cfu/100 mL)	Part II 90th Percentile (cfu/100 mL)
Sinclair and Dyes Inlets (shellfish harvesting & primary contact recreation)	14	43

The criterion to protect shellfish harvesting and primary contact recreation is consistent with federal shellfish sanitation rules. FC concentrations in Washington's marine waters that meet shellfish protection requirements also meet the federal recommendations for protecting people who engage in primary water contact activities. Thus, the same criterion is used to protect both "shellfish harvesting" and "primary contact" uses of marine waters in Washington State standards.

Compliance is based on meeting both the geometric mean criterion and the 10% of samples (or single sample if less than ten total samples) limit. These two measures must be used in combination to ensure that the bacterial pollution in a water body 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 both monthly (if five or more samples exist) and seasonal (summer versus winter) data sets.

Once the concentration of FC in the water reaches the numeric criterion, the state does not allow human activities that would increase the concentration above that criterion. If the criterion is exceeded, the state requires that human activities be conducted in a manner that will bring bacterial concentrations back into compliance with the standards.

If natural levels of bacteria (from wildlife) cause criteria to be exceeded, no allowance exists for human sources to measurably increase bacterial pollution. While the specific level of illness rates caused by animal versus human sources has not been quantitatively determined, warm-blooded animals are a common source of serious waterborne illness for humans.

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Watershed Description

Geographic setting

Located along the west side of central Puget Sound, Sinclair and Dyes Inlets are connected by the Port Washington Narrows and joined to the main basin of the Puget Sound by Port Orchard, Agate, and Rich Passages (Appendix L). The watershed drains about 62,348 acres (98 square miles) and includes portions of Kitsap County, the cities of Bremerton and Port Orchard, the unincorporated community of Silverdale, and the southwestern end of Bainbridge Island (an incorporated city). Land elevation ranges from sea level to the 1,689-ft Green Mountain to the west. The maximum depths of the inlets are 150 ft (Dyes) and 90 ft (Sinclair).

Major streams draining to Dyes Inlet include Chico and Clear creeks. Major streams draining to Sinclair Inlet include Blackjack and Gorst creeks. A number of smaller streams and stormwater conveyance systems are located within the developed areas of East and West Bremerton, Silverdale, Port Orchard, and Bainbridge Island.

The Kitsap Peninsula enjoys a cool, maritime climate that is mediated by the Cascade and Olympic mountain ranges, with average temperatures ranging from about 70°F in the summer to 40°F in the winter (NOAA 2007). Annual rainfall in Bremerton from water year (WY) 2000 to WY2006 ranged from 34 to 53 inches, with 42 inches during WY2003 (October 1, 2002 to September 30, 2003, COB 2007). (In WY2009 and WY2010 precipitation was 41 inches and 66 inches, respectively, at the Bremerton National Airport gauge). Most precipitation (85 percent) occurs between October and April. The marine waters of Sinclair and Dyes Inlets range from about 50°F in winter to about 66°F in summer. Salinity of both inlets is in a range of 28 to 30 parts per thousand salinity (Albertson et al., 1993).

Tides in the Puget Sound region are semi-diurnal and diurnal mixed modes with two high and two low tides every diurnal cycle (24.8 hours). Tides propagate from central Puget Sound and enter the inlets from the north (via Port Orchard and Agate passages) and from the southeast via Rich Passage. Once they reach the entrances to the two passages and the inlets, the tides are further modulated in a nonlinear fashion by a number of forcing mechanisms, including freshwater inflows, wind, water depth variations, and waterbody geometry. Tidal flows in the inlets are modulated both spatially and temporally, with a maximum tidal range of 5.5 meters during spring tides (Wang and Richter, 1999).

At present, native forests cover about half of the watershed but are mostly concentrated in a few undeveloped watersheds (e.g., Chico and Gorst watersheds). The remainder of the watershed is developed, with development more concentrated along the shorelines of the inlets. Most impervious surfaces are located in the urban centers of Bremerton (population 36,620); Silverdale, in unincorporated Kitsap County; the Naval Base Kitsap – Bremerton (NBK); Naval Base Kitsap - Bangor and Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF); and areas in and around Port Orchard (population 10,914).

The watershed includes commercial and industrial land uses and high-density residential land uses in the urban centers primarily surrounding Dyes Inlet and Port Washington Narrows (Figure 3, developed from 1999 Thematic Mapper image, Johnston et al., 2009a). Impervious surfaces that are not drained by streams are shoreline urban areas mostly located in West Bremerton, parts of East Bremerton, Port Orchard, and Silverdale (May et al., 2005).

Outside the urban centers is a broader range of land uses including medium and low-density residential, small non-commercial farms, and some forested areas and undeveloped public land. A few commercial farms are located south of Port Orchard in unincorporated Kitsap County. Bainbridge Island is predominantly low-density residential and rural with one commercial center.

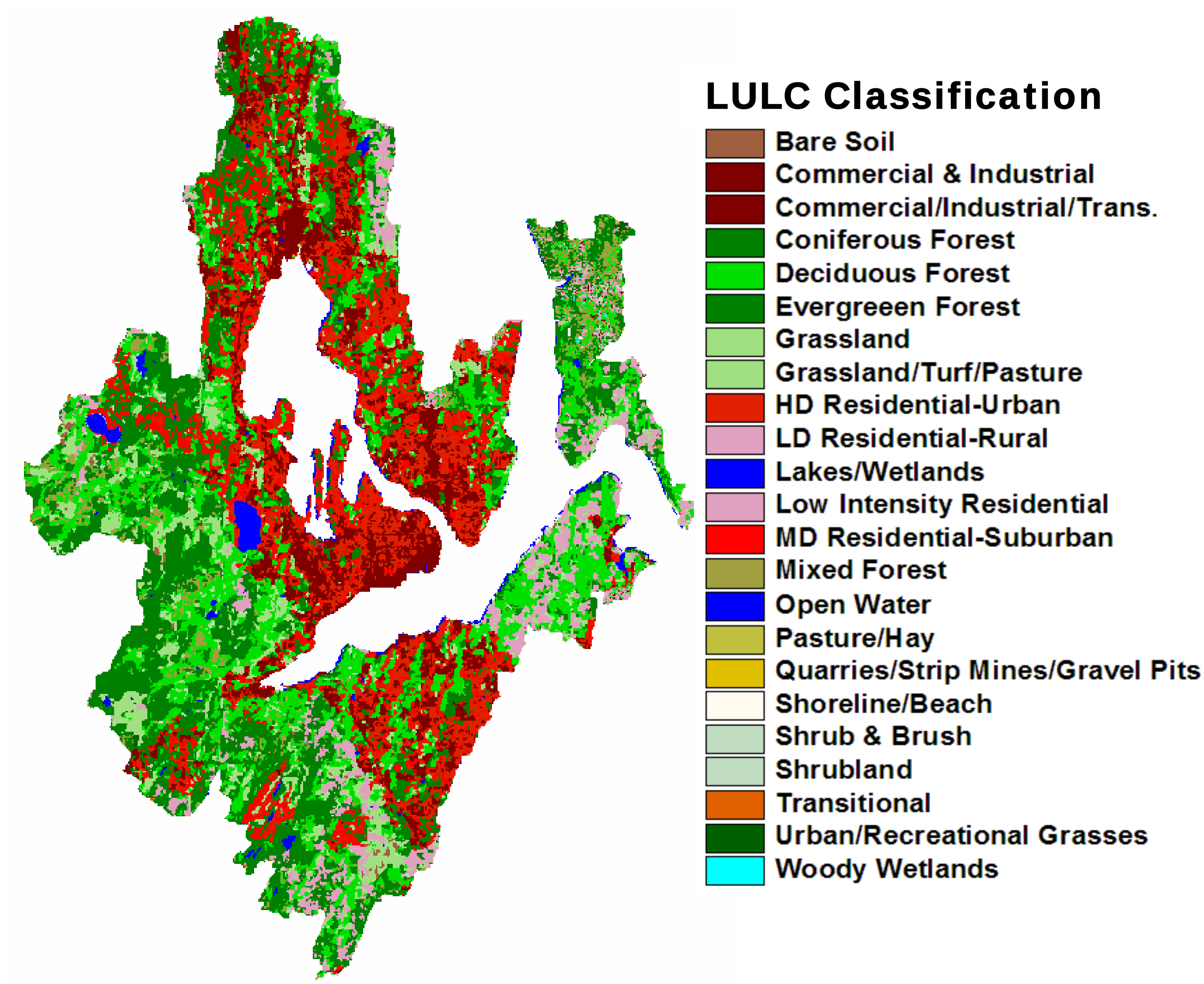

Figure 3. Land use and land cover classification, present day conditions (2000).

Tribes

The Suquamish Tribe is a self-governing, sovereign nation based on the Port Madison Indian Reservation, located east of Poulsbo on the Kitsap peninsula. Through its involvement in local planning and habitat protection and enhancement efforts, the tribe works to preserve natural resources that were guaranteed to the tribe for all time in 1955 with the Treaty of Point Elliott. Sinclair and Dyes Inlets are usual and accustomed fishing and shellfishing areas for the tribe. The tribe harvests shellfish commercially in Dyes Inlet and is an active participant and advocate for improving water quality and increasing the acreage of Dyes Inlet shellfish beds that are open to harvest.

Other entities

U.S. Navy Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF), Naval Base Kitsap – Bangor (NBK-Bangor) and Naval Base Kitsap – Bremerton (NBK-Bremerton). The Puget Sound Naval Shipyard was established in 1892 and occupies several hundred acres in downtown Bremerton on the northern shoreline of Sinclair Inlet. Although the shipyard has been engaged in the construction of vessels in the past, no construction of new vessels is performed at the yard now. The shipyard's main activities are repairing, refueling, and refitting vessels and the breaking up (recycling and disposal) of nuclear powered ships and submarines at the end of their service. PSNS&IMF is the Pacific Northwest's largest Naval shore facility and one of Washington State's largest industrial employers (NAVSEA 2010).

In 2004, the Naval Station at Bremerton and the Submarine Base at Bangor were joined to become one regional base known as Naval Base Kitsap. However, PSNS&IMF remains a separate command responsible for the industrial operations within the Controlled Industrial Area (CIA) of the base. NBK-Bremerton serves as homeport for aircraft carriers and submarines, and includes fleet support activities, a supply center, and mooring for many inactive ships (CNIC 2010).

NBK-Bangor, located on the eastern shore of Hood Canal near Silverdale, employs approximately 10,300 military and civilian personnel, provides housing for 4,200 on-base occupants, and serves as the base for ten Ohio Class Trident submarines and a modified Seawolf Class submarine. The site is characterized by flat-topped ridges, ranging in elevation from 300 to 500 feet above sea level. The 6,785-acre reserve includes 4,111 acres of evergreen forest, with some small meadows and a number of streams and lakes. Drainage to the Dyes Inlet watershed is via two small streams exiting the base to the southeast and discharging to the inlet via the west fork of Clear Creek. These discharges drain 1,928 acres, with land uses of about 556 acres impervious area and 1,300 acres undeveloped forest.

The Navy also owns property along the western shoreline of Ostrich Bay that includes Naval Hospital Bremerton and the Jackson Park Naval Housing and Camp Wesley Harris located in the Chico watershed.

State parks include Illahee State Park on Port Orchard Passage, Manchester State Park on Clam Bay and Rich Passage, and Fort Ward State Park on Rich Passage.

Pollution Sources

Human-caused and natural sources of microbial contamination can affect freshwater and marine systems, leading to the degradation or loss of ecosystem values and beneficial uses (Figure 4 from May et al., 2005). The following are potential sources of fecal coliform (FC) bacteria in the Sinclair/Dyes watershed.

Point sources/permit holders

FC bacteria sources can be present in a variety of municipal and industrial wastewater and stormwater sources. While sewage treatment plants (wastewater treatment plants, or WWTPs) are required, under their permits, to limit the amount of bacteria discharged, the permits for municipal stormwater systems do not have similar numeric effluent limits unless wasteload allocations (WLAs) are assigned through a TMDL. All municipal wastewater treatment plants, and some municipal stormwater systems, operate under individual or general NPDES permits issued by Ecology. Federal facilities are covered by NPDES permits administered by EPA.

Wastewater

The majority of homes in the watershed, as well as parts of some commercial areas (e.g., the west side of Silverdale) are served by onsite sewage systems, which are considered potential nonpoint sources of bacteria. Significant portions of the watershed are served by three centralized sewer collection and treatment systems:

- *Bremerton:* The city of Bremerton WWTP serves central and east Bremerton. The Westside plant is a secondary treatment system with activated sludge that operates year-round and treats wastewater from the city's entire service area. Its original design capacity was 10.1 million gallons per day (MGD). After a re-rating study, its NPDES permit limits for influent flows were increased to 15.5 MGD during wet weather months and up to 11 MGD during dry weather months. The plant needs the increased capacity to accommodate higher flows that result from the infrastructure improvements needed to reduce Combined Sewer Overflows (CSOs). The plant discharges to Sinclair Inlet.

  The city's Eastside Treatment Facility (ETF), a high-rate clarification system to treat combined sewage and stormwater, operates only in wet weather periods and discharges to Port Washington Narrows. This facility, and a number of other infrastructure improvements, is part of the city's compliance with WAC 173-245, which requires the reduction of CSOs. The infrastructure improvements were completed in 2010.

  In 2009, the city of Bremerton was awarded federal stimulus funds to extend a sewer collection line to the Gorst community at the head of Sinclair Inlet. This unincorporated area, with residential housing, commercial/industrial facilities, and the State Route 3 transportation corridor, has a history of failing onsite sewage systems. The new collection line and decommissioning of the existing onsite systems is expected to be complete in 2011 (COB 2009b, 2010a).

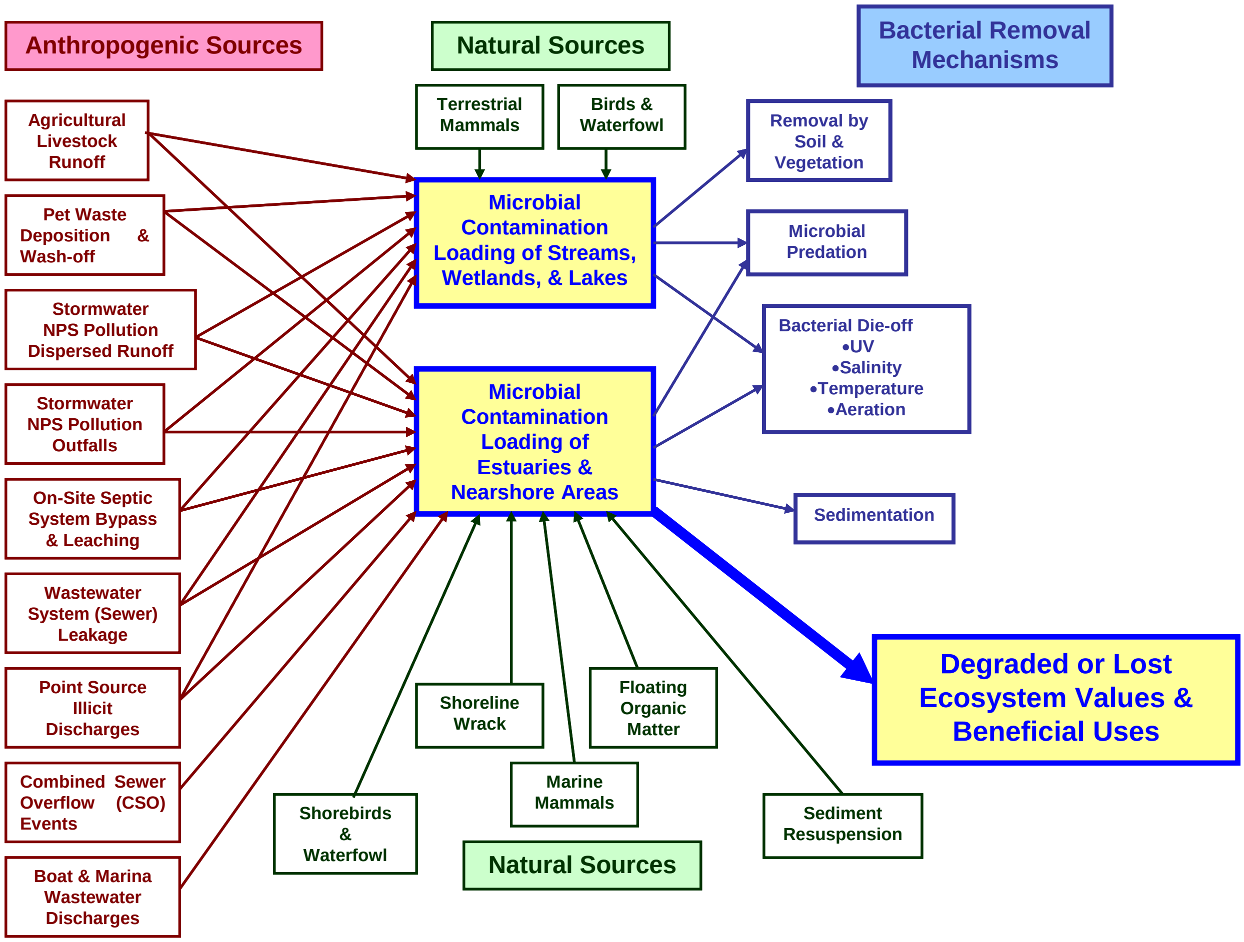

Figure 4. Conceptual model of sources and impacts of bacterial contamination in Sinclair and Dyes Inlets watershed.

- *Port Orchard:* The West Sound Utility District (WSUD) in Port Orchard was formed by the consolidation of Annapolis Water District and Karcher Creek Sewer District in November 2007. Currently, the district provides sanitary sewer in the service area that includes residential and commercial properties to the east and south of the city of Port Orchard. It operates the South Kitsap Water Reclamation Facility (SKWRF) owned by the district and the city of Port Orchard. This facility treats the wastewater in the district, city of Port Orchard, and McCormick Woods in Port Orchard's Urban Growth Area. This activated sludge facility was recently upgraded with a membrane bioreactor process. During wet periods the facility uses advanced primary treatment using a ballasted clarifier. It has a design capacity of 4.2 MGD and discharges to Sinclair Inlet.

- *Southwestern Bainbridge Island:* Kitsap County No. 7 near Fort Ward uses a secondary treatment system with extended aeration, activated sludge technology, and discharges to Rich Passage. This facility recently completed an expansion to a design capacity of 0.28 MGD.

- *Northern Dyes Inlet:* Parts of Silverdale are served by the Central Kitsap Wastewater Facility in Brownsville which discharges treated effluent to Port Orchard Passage at a location north of, and outside of the study area.

Stormwater

Urban areas that collect stormwater runoff in municipal separate storm sewers (MS4s) and discharge it to surface waters are required to have a permit under the federal Clean Water Act. The U.S. Environmental Protection Agency (EPA) stormwater regulations established two phases (Phase I and Phase II) for the municipal stormwater permit program (EPA 2004). The Department of Ecology develops and administers National Pollution Discharge Elimination System (NPDES) municipal stormwater permits in Washington State. None of the municipalities in the Sinclair-Dyes watershed is large enough for a Phase I permit. Three cities – Bremerton, Port Orchard, and Bainbridge Island – and the census-determined Urban Areas and Urban Growth Areas of Kitsap County are covered under the Phase II NPDES municipal stormwater permit (Figure 5).

Washington State Department of Transportation's (WSDOT)'s permit regulates stormwater discharge from MS4s owned or operated by WSDOT within the Phase I and II designated boundaries. WSDOT's permit also covers stormwater discharges to any water body in Washington State for which there is an EPA-approved TMDL with load allocations and associated implementation documents specifying actions for WSDOT stormwater discharges (applicable TMDLs listed in Appendix 3 of the WSDOT permit).

PSNS&IMF is permitted to discharge stormwater and drydock discharge to Sinclair Inlet under an NPDES permit administered by EPA Region 10. This permit also covers Naval Base Kitsap – Bremerton. Naval Base Kitsap – Bangor is covered under a separate MultiSector General Permit, an NPDES stormwater permit from EPA Region 10.

Agricultural point sources

The Sinclair-Dyes watershed does not have any permitted dairies or concentrated animal feeding operations (CAFOs).

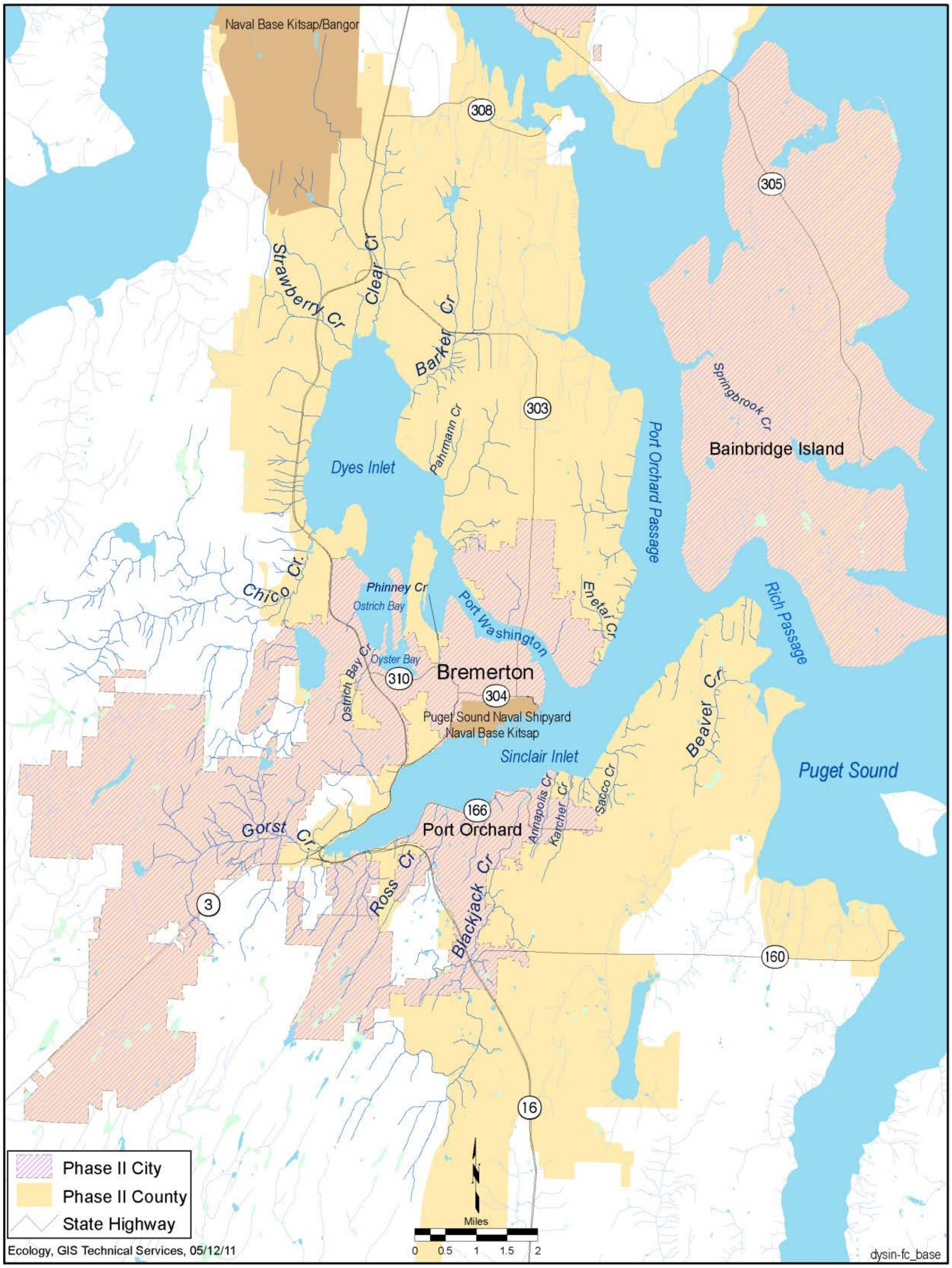

Figure 5. Phase II municipal stormwater jurisdictions in the Sinclair-Dyes watershed.

Nonpoint sources

Nonpoint (diffuse) sources of FC bacteria are not regulated by discharge permits. Ecology fecal coliform bacteria TMDLs are focused on human-caused pollution. Potential nonpoint sources in the study area that relate to human activities include:

- Poorly constructed or operated onsite sewage systems.
- Commercial parking lots with dumpsters. Kitchen waste from restaurants and food waste overflowing from dumpsters can attract rodents, birds and other urban wildlife that deposit feces where precipitation can carry them to stormwater systems.
- Non-commercial (hobby) farms and nurseries. Farms that allow livestock access to streams or mis-manage animal manure to allow stream contamination.
- Property owners who spread or stockpile animal manure without ensuring that streams are protected from contaminated runoff, causing pollution of streams and ditches.
- Marinas, boatyards, and recreational boating. Recreational boating is a popular activity on the inlets, and a number of marinas and boatyards are located around the inlets, with some providing slips for "liveaboards." Kitsap County adopted marina sewage regulations in 1999. Under county ordinance, marinas with liveaboard boaters or those with larger numbers of boats are required to provide sewage pump-out stations. Even where pump-out stations are available, some boat owners may not use them.

  (http://www.kitsapcountyhealth/environmental_health/water_quality/marina_sewage.htm)
- Pet waste. Private residences and public parks that allow pets can be sources of FC pollution to streams or stormwater systems, if feces are not properly collected and disposed of.
- Utility pipelines carrying sewage to treatment facilities, if broken.
- Wildlife fed by humans. This activity encourages wildlife to congregate where they normally would not, in numbers atypical of wildlife populations, and can result in fecal pollution.
- Other unidentified sources.

Wildlife in natural habitats is usually associated with low concentrations of FC bacteria in surface waters. Ecology TMDL guidance directs individuals and organizations to work first and hardest on the bacterial sources that are under human control. If natural levels of FC (from birds and wildlife) cause bacteria standards to be exceeded, then no allowance will be available for human sources to measurably increase bacterial pollution.

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Goals and Objectives

Project goal

The goal of this plan (total maximum daily load, or TMDL) is for Sinclair-Dyes inlets and tributaries to meet state water quality standards for fecal coliform (FC) bacteria. The *total maximum daily load* is the maximum amount of a pollutant that a water body can accept before there is a loss of beneficial uses (e.g., swimming, boating, shellfish harvest). This document estimates the maximum amount of FC bacteria the inlets and their tributary streams can accept and still meet standards. It also provides a water quality implementation plan with steps for local organizations to take to reduce bacteria enough to meet state standards.

As more of the marine waters begin to meet standards, additional parts of Dyes Inlet will be open to shellfish harvest. At present, the area of Dyes Inlet that is safe for shellfish harvest is limited, and safe human recreational uses of the inlets and their freshwater tributaries are at risk from bacteria. In Sinclair Inlet, contaminants other than bacteria, including PCBs in sediment, are also associated with risk to human health from shellfish consumption.

Study objectives

In 2000, the Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS&IMF), the U.S. Environmental Protection Agency, and Ecology entered into partnership in Project ENVVEST to develop and demonstrate alternative strategies for protecting and improving the environment of Sinclair and Dyes Inlets and their surrounding watershed (Navy, EPA and Ecology, 2000). The partners agreed to conduct a study to provide the technical basis for fecal coliform bacteria TMDL for the inlets and tributaries (ENVVEST 2002, Johnston et al., 2004).

The field study/modeling project was initiated in 2000 to establish the capacity of the inlets to accept bacteria loading from streams, municipal stormwater, wastewater treatment plants, and surface runoff, and still meet water quality standards. Study objectives were:

- To characterize FC bacteria concentrations and loads from major tributaries, stormwater outfalls, wastewater treatment facilities, and shoreline runoff into Sinclair and Dyes Inlets under different seasonal hydrological and precipitation conditions. The FC data for the watershed serves as input to a combined watershed and marine model.
- To use the watershed model hydraulic simulation program FORTRAN (HSPF) to simulate hydrology across the watershed to predict runoff from all streams, shoreline areas, and stormwater outfalls that discharge to the inlets.
- To use the output of FC loading from the watershed model as input to a dynamic marine model (the Curvilinear Hydrodynamic model in 3 Dimensions with FC kinetics, or CH3D-FC) of the inlets.
- To use the combined model to predict when and where exceedances of the marine FC standards would occur in the inlets.

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Analytical Approach

Study area

Field data collection, analysis and modeling for the Sinclair-Dyes TMDL covers the drainage areas corresponding to stream, stormwater and shoreline drainage areas, as seen in Figure 6. The marine waters included in the study are Sinclair and Dyes Inlets, Port Washington Narrows, the southern portion of Port Orchard Passage, and Rich Passage.

The principal streams in the study (Appendix L) include:

- Mosher, Pahrmann, Barker, Clear, Strawberry, Chico and Oyster Bay creeks draining to Dyes Inlet.
- Wright, Gorst, Anderson, Ross, Blackjack, Annapolis, Karcher (also called Olney), and Sacco creeks draining to Sinclair Inlet.
- Enetai (also called Dee), Springbrook, Illahee and Wautaga creeks draining to Port Orchard Passage.
- Beaver Creek draining to Rich Passage (Clam Bay).
- Phinney Creek – not monitored in 2000-2003 but included in this TMDL following listing on the 2008 Water Quality Assessment.

Some creeks were monitored at upstream or tributary sites in addition to the stream mouth. A number of stormwater outfalls were sampled in the jurisdictions of Kitsap County, Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS & IMF), and the cities of Bainbridge Island, Bremerton, and Port Orchard. The sites monitored in the study are listed in Tables 5 and 6.

Partnership study approach

The study approach is described in Quality Assurance Project Plan (QAPP) developed by Project ENVVEST participants and approved by Ecology (ENVVEST, 2002; Johnston et al. 2004) A technical report (May et al., 2005) describes the level of FC contamination in the watershed, using historical as well as new (2002-2004) data collected during Project ENVVEST by the participating stakeholders. Ongoing monitoring is being conducted by Kitsap County Health District [KCHD], Washington Department of Health (DOH), Kitsap County Surface and Storm Water Management program (KCSSWM), PSNS&IMF, and other stakeholders. Some of the stream gages are maintained by Kitsap Public Utility District (KPUD), the city of Bremerton (Bremerton), the city of Bainbridge Island (COBI), and the Silverdale Water District.

The results of the ENVVEST wet and dry season and storm event bacteria monitoring and loading for streams and stormwater outfalls in the watershed are presented in May et al. (2005). The report also describes a statistical approach to relate FC concentrations in streams and stormwater to the land use and land cover (LULC) characteristics of their drainage basins. This statistical approach provides a way to estimate FC loading inputs to the combined model from unmonitored basins.

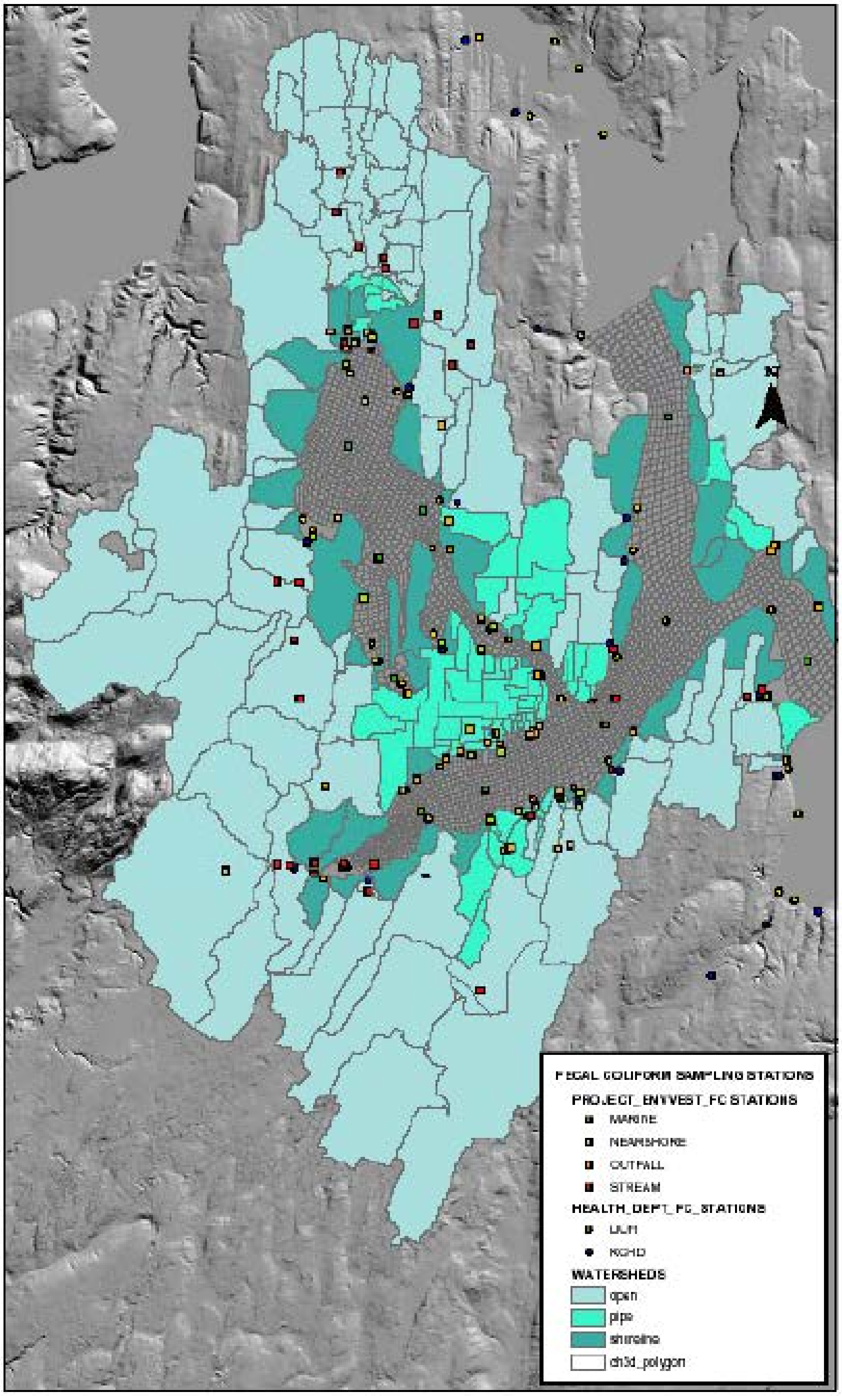

Figure 6. Watershed basins, extent of marine model grid, and locations of marine, nearshore, outfall and stream sample sites.

Table 5. Sample sites for fecal coliform TMDL study (from May et al., 2005).

Sampling Stations	Jurisdiction	FC Sample Station ID	Target Sampling Frequenc	Target Sample Type	Sample Site Location
City of Bremerton Stormwater Outfalls					
Callow Ave	City of Bremerton	SW1	3/Week	Storm Event	Outfall near Missouri Gate
Pacific Ave	City of Bremerton	SW2	3/Week	Storm Event	Outfall under PSNS Pier 7
Pine Rd	City of Bremerton	SW3	3/Week	Storm Event	Outfall at Lions Park Boat Ramp
Trenton Ave	City of Bremerton	SW4	3/Week	Storm Event	Outfall at bottom of Trenton Road near Gazebo
Stephenson Creek	City of Bremerton	SW5	3/Week	Storm Event	Outfall at Lendt Park Beach
Oyster Bay Ave	City of Bremerton	B-ST26	3/Week	Storm Event	Outfall at Oyster Bay Ave
Campbell Way	City of Bremerton	B-ST04	3/Week	Storm Event	Outfall at Campbell Way near Wheaton Ave
Evergreen Park	City of Bremerton	B-ST27	3/Week	Storm Event	Evergreen Park @ 14th St.
Kitsap Cty Stormwater Outfalls					
Silverdale at Sandpiper	Kitsap SSWM	LMK002	3/Week	Storm Event	Bucklin Hill Rd outfall next to Sandpipers
Silverdale West Bucklin Hill Road	Kitsap SSWM	LMK001	3/Week	Storm Event	Bucklin Hill Rd outfall next to Sandpipers
Silverdale at Bayshore	Kitsap SSWM	LMK004	3/Week	Storm Event	Old Silverdale
Phinney Bay Creek	Kitsap SSWM	LMK020	3/Week	Storm Event	Rocky Point residential area
Silverdale East Bucklin Hill Road	Kitsap SSWM	LMK026	3/Week	Storm Event	Located west of Clear Creek
Tracyton Boat Dock 055	Kitsap SSWM	LMK055	3/Week	Storm Event	Residential drainage ditch outfall
Tracyton 060	Kitsap SSWM	LMK060	3/Week	Storm Event	Residential drainage ditch outfall
Gorst Subaru	Kitsap SSWM	LMK128	3/Week	Storm Event	Located behind Subaru Auto Dealership
Port Orchard 155	Kitsap SSWM	LMK1 55	3/Week	Storm Event	Residential drainage ditch outfall
Gorst Navy City Metals	Kitsap SSWM	LMK122	3/Week	Storm Event	West of PSNS in residential Bremerton
DEE CREEK	Kitsap SSWM	DEECRK	3/Week	Periodic	End of Jacobson Rd
National Ave. 164	Kitsap SSWM	LMK1 64	3/Week	Storm Event	Residential drainage ditch outfall
Manchester 038	Kitsap SSWM	LMK038	3/Week	Storm Event	Just east of dock on E. Main in Manchester
PSNS Stormwater Outfalls					
PSNS CIA	PSNS	PSNS124	3/Week	Storm Event	CIA Indust. Waterfront - W of Dry Dock 3
PSNS Dry Dock	PSNS	PSNS115.1	3/Week	Storm Event	CIA Indust. Waterfront - W of Dry Dock 1
Upstream of 115.1 SW Bldg 856	PSNS	PSNS115.1A	3/Week	Storm Event	CIA Indust. Waterfront - Upstream of Dry Dock 1
Upstream of 115.1 Bldg 500 GUTTER	PSNS	PSNS115.1B	3/Week	Storm Event	CIA Indust. Waterfront - Upstream of Dry Dock 3
PSNS Motor Pool	PSNS	PSNS081.1	3/Week	Storm Event	CIA Indust. Waterfront Dry Dock 6/5 Bldg 455
Upstream of 081.1 DD6 CRANE	PSNS	PSNS081.1A	3/Week	Storm Event	CIA Indust. Waterfront Dry Dock 6 Crane
PSNS Industrial Nondrydock	PSNS	PSNS082.5	3/Week	Storm Event	CIA Industrial Non Dry Dock Bldg 480
Naval Station (Coml/Res/Rec)	PSNS	PSNS015	3/Week	Storm Event	Naval Station - McDonalds
Upstream of 015 MC MAIN LINE	PSNS	PSNS015A	3/Week	Storm Event	Naval Station - McDonalds
Upstream of 015 MC BALL FLD	PSNS	PSNS015B	3/Week	Storm Event	Naval Station - McDonalds
Naval Station Industrial	PSNS	PSNS008	3/Week	Storm Event	Naval Station Inactive Ships
PSNS Downstream of CSO 16	PSNS	PSNS126	3/Week	Storm Event	Outfall downstream of City CSO 16; Bldg 460
PSNS Industrial Nondrydock	PSNS	PSNS101	3/Week	Storm Event	CIA Bldg 431
Port Orchard Stormwater Outfalls					
Port Orchard Business District	Port Orchard	PO-BAYST	3/Week	Storm Event	Off Bay Street by City Hall
Port Orchard Urban	Port Orchard	PO-BETHAL	3/Week	Storm Event	Bethel Road
Port Orchard Mixed TBD	Port Orchard	PO-WILKENS	3/Week	Storm Event	Wilkens Road
Port Orchard Residential MD TBD	Port Orchard	PO-POBLVD	3/Week	Storm Event	Port Orchard Blvd
Bainbridge Island					
Springbrook Creek @ NE Fletcher Bay Rd	Bainbridge Island	BI-SBC	3/Week	Periodic	Culvert
Lynwood Center SW	Bainbridge Island	BI-LCSW	3/Week	Storm Event	Manhole in Harley Unruh's drive way
Fort Ward SW	Bainbridge Island	BI-FWSW	3/Week	Storm Event	No description available
Fletcher Bay Nearshore	Bainbridge Island	BI-FBNS	1/Week	Periodic	Mouth of Fletcher Bay
Lynwood Center Cove	Bainbridge Island	BI-LCNS	1/Week	Periodic	Off shore of Harley Unruh's Condo
Fort Ward Nearshore	Bainbridge Island	BI-FWNS	1/Week	Periodic	SE of salmon pens

Table 6. Additional sample sites for FC study (from May et al., 2005).

Sampling Stations	Jurisdiction	FC Sample Station ID	Target Sampling Frequency	Target Sample Type	Sample Site Location
Major Streams					
BARKER CREEK	KPUD	BA	3/Week	Periodic	At gauging site
BLACKJACK CREEK	KPUD	BL	3/Week	Periodic	At gauging site
CLEAR CREEK	KPUD	CC	3/Week	Periodic	At gaugingsite
CHICO CREEK (Main Stem)	KPUD	CH	3/Week	Periodic	At gauging site
PARISH CREEK	KPUD	PA	3/Week	Periodic	At gauging site
STRAWBERRY CREEK	KPUD	SC	3/Week	Periodic	At gauging site
ANDERSON CREEK - BREM.	KPUD	AC	3/Week	Periodic	At gauging site
OLNEY CREEK (KARCHER CREEK)	KPUD	OC	3/Week	Periodic	At gauging site
Tributary Streams					
Clear Creek East	PSNS	CE	3/Week	Periodic	At gauging site
Clear Creek West	PSNS	CW	3/Week	Periodic	At gauging site
Bangor Trident Lake	PSNS	BTL	3/Week	Periodic	Halfmile Rd
Bangor Storm Water Ponds	PSNS	BSWP	3/Week	Periodic	Melody Lane
BARKER CREEK Bulklin Hill Rd	ECOLOGY	BA-BHRD	3/Week	Periodic	Bucklin Hill Rd
BARKER CREEK Nels Nelson	ECOLOGY	BA-NN	3/Week	Periodic	Nels Nelson Rd
BLACKJACK CREEK (KFC)	ECOLOGY	BL-KFC	3/Week	Periodic	Behind KFC
GORST CREEK below Sam Christopherson	ECOLOGY	GC-1	3/Week	Periodic	Behind apartment
ANNAPOLIS CREEK	ECOLOGY	ANNAP	3/Week	Periodic	South of Bay St off Maple Ave
BEAVER CREEK Lower segment	ECOLOGY	BE-LOW	3/Week	Periodic	At culvert on road to Manchester Lab
GORST CREEK @ Jarsted Park	ECOLOGY	GC-JAR	3/Week	Periodic	Entrance to Jarsted Park
SACCO CR	ECOLOGY	SACCO	3/Week	Periodic	Stream Mouth south of Beach Drive
Chico @ Taylor Rd	Kitsap NR	CT	3/Week	Periodic	At gauging site
Dickerson	Kitsap NR	DI	3/Week	Periodic	At gauging site
Kitsap Creek	Kitsap NR	KC	3/Week	Periodic	At lake outfall
Kitsap Lake	Kitsap NR	KL	3/Week	Periodic	At lake inlet
Nearshore Stations					
Clam Bay	Nearshore	N1	Weekly	Periodic	head of Clam bay
Sinclair Inlet	Nearshore	N2	Weekly	Periodic	offshore of Karcher Creek STP
Sinclair Inlet	Nearshore	N3	Weekly	Periodic	mouth of Blackjack estuary
Sinclair Inlet	Nearshore	N4	Weekly	Periodic	Port Orchard Waterfront
Sinclair Inlet	Nearshore	N5	Weekly	Periodic	Port Orchard Marinas
Sinclair Inlet	Nearshore	N6	Weekly	Periodic	head of Sinclair Inlet
Sinclair Inlet	Nearshore	N7	Weekly	Periodic	Charleston Beach
Port Washington Narrows	Nearshore	N8	Weekly	Periodic	Evergreen Park
Port Washington Narrows	Nearshore	N9	Weekly	Periodic	Lions Park - North of Boat Ramp
Port Washington Narrows	Nearshore	N10	Weekly	Periodic	Anderson Cove
Phinney Bay	Nearshore	N11	Weekly	Periodic	Phinney Bay
Dye's Inlet - Ostrich	Nearshore	N12	Weekly	Periodic	Jackson Park Recreation Area
Dye's Inlet - Ostrich	Nearshore	N13	Weekly	Periodic	head of Ostrich Bay
Dyes Inlet - Chico Bay	Nearshore	N14	Weekly	Periodic	Chico Bay - mouth of estuary
Dyes Inlet - Silverdale Waterfront Park	Nearshore	N15	Weekly	Periodic	Sliverdale Waterfront Park
Dyes Inlet - North	Nearshore	N16	Weekly	Periodic	Silverdale West Coast Hotel
Dyes Inlet - North	Nearshore	N17	Weekly	Periodic	Clear Creek Estuary
Dyes Inlet - North	Nearshore	N18	Weekly	Periodic	Barker Creek Estuary
Marine Stations					
Port Orchard Passage	Marine	M1	Weekly	Periodic	
Rich Passage	Marine	M2	Weekly	Periodic	
Sinclair Outer	Marine	M3	Weekly	Periodic	
Sinclair Inner	Marine	M4	Weekly	Periodic	
Rocky Point	Marine	M5	Weekly	Periodic	
Erlands Point	Marine	M6	Weekly	Periodic	
Windy Point	Marine	M7	Weekly	Periodic	
Oyster Bay	Marine	M8	Weekly	Periodic	
Stream Storm-Event Stations					
BARKER CREEK	PSNS/TEC	BA	3	Storm Event	At gauging site
BLACKJACK CREEK	PSNS/TEC	BL	3	Storm Event	At gauging site
CLEAR CREEK	PSNS/TEC	CC	3	Storm Event	At gaugingsite
CHICO CREEK (Main Stem)	PSNS/TEC	CH	6	Storm Event	At gauging site
GORST CREEK (Above Jarsted Park)	PSNS/TEC	GC	3	Storm Event	At gauging site
STRAWBERRY CREEK	PSNS/TEC	SC	3	Storm Event	At gauging site
ANDERSON CREEK - BREM.	PSNS/TEC	AC	3	Storm Event	At gauging site
OLNEY CREEK (KARCHER CREEK)	PSNS/TEC	OC	3	Storm Event	At gauging site
Clear Creek East	PSNS/TEC	CE	3	Storm Event	At gauging site
Clear Creek West	PSNS/TEC	CW	3	Storm Event	At gauging site
CHICO @ Taylor Rd	PSNS/TEC	CT	3	Storm Event	At gauging site

The ENVVEST partners, including Ecology, determined that the hydrologic and precipitation conditions of WY2003 would be used for model runs in support of the TMDL. This is because the most data was available for that period and the models were calibrated for flow and transport using LULC and meteorological conditions present in the watershed during 2000-2004. Based on precipitation statistics for the watershed, the partners designated May to September as the five-month dry season and October to April as the seven-month wet season (May et al., 2005).

Modeling framework

To support TMDL analyses for the marine receiving waters, a modeling framework was developed to characterize FC loading from watershed sources, simulate the transport in the Inlets, and determine total loading capacity for FC in the receiving waters. The total loading capacity was then used to determine bacteria reductions needed for freshwater tributaries to meet standards, using the Statistical Rollback Method (Ott, 1995). Described fully in Johnston et al.(2009a), the modeling framework consists of:

- An HSPF model developed by EPA that uses the time history of rainfall, temperature and solar radiation; land surface characteristics such as land-use patterns; and land management practices to simulate watershed processes (EPA 2007). For the Sinclair and Dyes watershed, 15 HSPF submodels were developed to simulate watershed hydrology for streams (open channel flows), stormwater catchment areas (piped flows), and shoreline drainage areas (overland flows) (Skahill and LaHatte, 2007). The watershed model simulates hydrologic flows from 131 subbasins that drain to the inlets and passages (Figure 7 from Johnston et al., 2009a). The result of this simulation is a time history of the quantity of runoff from the watershed.

- Estimates of FC bacteria concentrations for all streams and stormwater outfalls in the watershed were developed using available monitoring data and were statistically related to upstream LULC (May et. al., 2005). Landscape features of each watershed sampled were clustered into statistically similar groups, and the sample distribution attributes of each cluster were used to “bound” (i.e., develop an interval estimate for) the FC concentration. The geometric means for each stream and shoreline watershed were estimated by regressing the mean FC concentration against the discriminate scores obtained from the cluster analysis.

  Stormwater outfalls were divided into statistically similar groups based on LULC, and the geometric means and prediction bounds were determined by available data (May et al., 2005). The predicted geomean FC concentrations were multiplied by the flow to obtain the FC load for each pour point discharging into Sinclair and Dyes Inlet (Table E-1, Appendix E.)

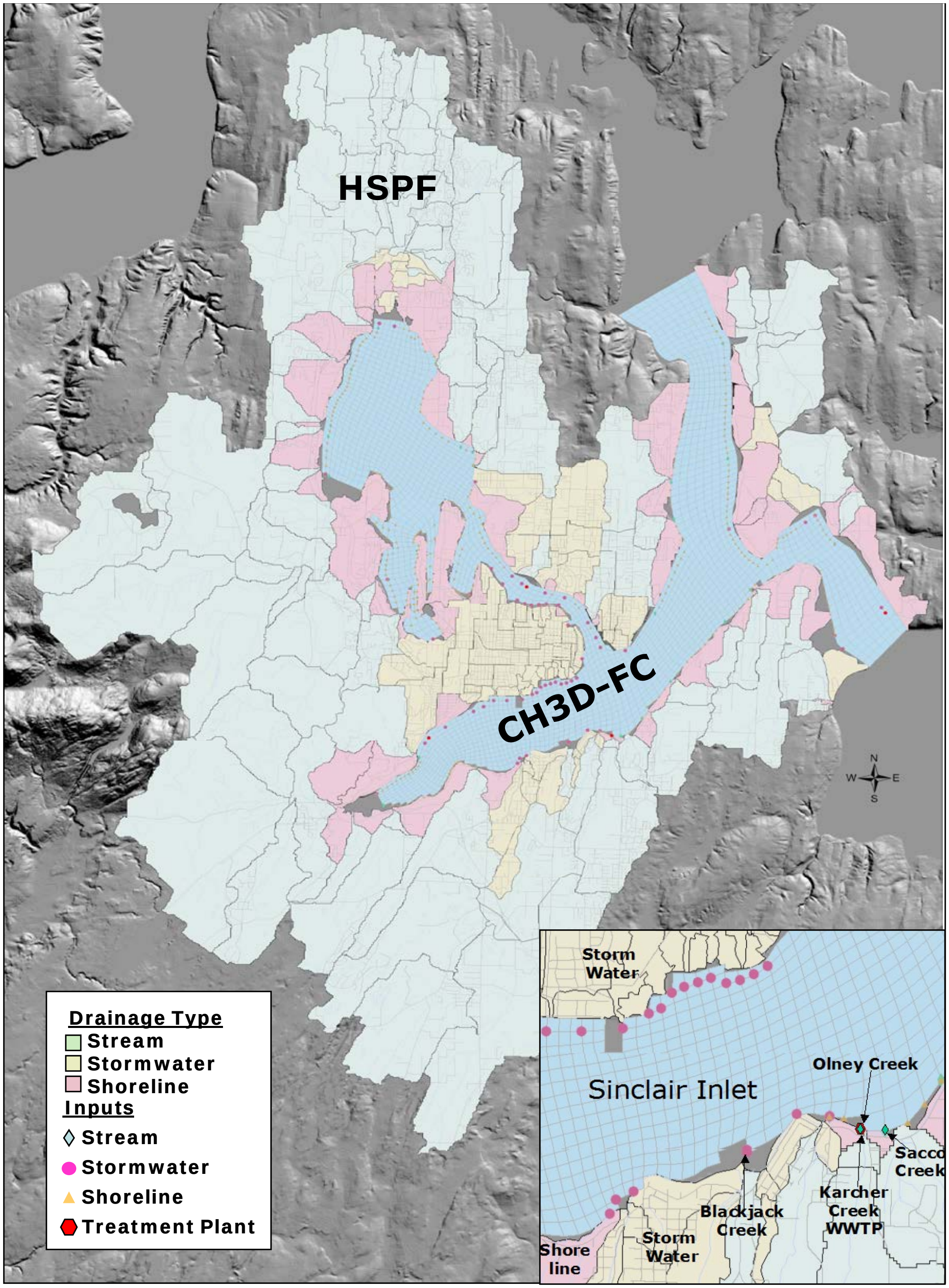

Figure 7. The integrated watershed and receiving water model for Sinclair and Dyes Inlets.

- For marine waters, the CH3D model, previously calibrated to match the hydrodynamics of the Inlets and modified to include FC kinetics (Wang and Richter 1999, Wang et al., 2005), was used to simulate the release, transport, and fate of FC loading from watershed pour points corresponding to 39 stream mouths, 58 stormwater outfalls, four WWTP[1] discharges, and 44 shoreline drainage areas (Figure 7). Data reported on monthly discharge monitoring reports (DMRs) submitted to Ecology were used to estimate flow and FC concentrations for discharges from the WWTPs which discharge only to marine waters.

- The output from HSPF was used as input to CH3D-FC (Figure 8 from Johnston et al., 2009a), and the time-varying flows were used to simulate freshwater discharge and FC loading from each of the stream, stormwater, WWTP, and shoreline pour points into CH3D-FC. The estuarine CH3D-FC model was run to simulate the tides, circulation conditions, freshwater, and FC inputs occurring during individual storm events (10 d) and over the course of Water Year 2003 (WY2003) from 1 October 2002 to 30 September 2003 (364 d).

Evaluation criteria were developed to assess model performance and its ability to simulate watershed hydrology, FC loading, and fate and transport of FC within the inlets (see Johnston et al., 2009a). The output of the combined models was compared to measured marine FC concentrations for the two inlets to verify model performance and identify limitations and uncertainties in the model's predictions. The evaluation showed that the integrated model performed well; the modeling framework was capable of simulating a wide range of dynamic loading within the inlets, from large-scale storm events with high flow conditions to dry, low-flow conditions during the summer months.

Based on the decision by the ENVVEST partners that WY2003 would be used for model runs, the marine model was run to simulate the tides, circulation conditions, fresh water, and FC inputs occurring over the course of WY2003 to calculate the critical conditions for the TMDL. Ecology convened a regulatory and tribal workgroup comprised of Suquamish Tribe, DOH, and KCHD to review modeling scenarios and agree on input and output specifications for the TMDL model runs. Among the modeling specifications agreed on by the workgroup:

- Model output would be evaluated for groups of nine individual grid cells ("canary nodes") located in areas known to have higher FC inputs, such as stream mouths, larger stormwater outfalls, and WWTP discharges, and for which monitoring data are available (Figure 9 from Johnston et al., 2009a). The model results for these nodes would be reviewed to determine if standards were exceeded. The model results reported would be individual grid cell FC results, as well as averages for each set of the highest two, three, four, six and nine cells.
- For comparison with the marine water quality standards, marine model output would include calculations of a moving 30-day geometric mean and 90th percentile bacteria concentrations for each marine grid cell for WY2003.

[1] Four WWTPs were included in the model but no discharge was simulated for the Eastside Treatment Facility (ETF).

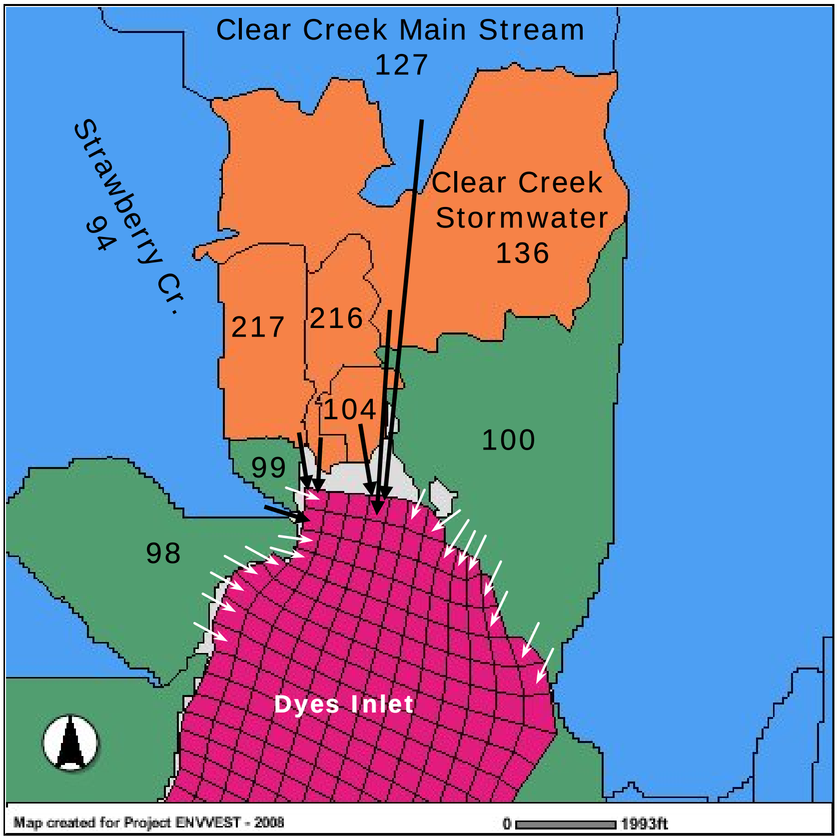

Figure 8. Linkage between flows from watershed and marine grid cells (red). *Flows from streams (blue watersheds) and stormwater outfalls (orange watersheds) shown by black arrows, and shoreline drainages (green watersheds) shown by white arrows. Numbers are the DSNs used n the model.*

- Scenarios to calculate wasteload and load allocations for streams, stormwater outfalls, and WWTPs would consist of WY2003 simulations where streams and stormwater outfalls would be set to the geometric mean (Part I, 100 cfu/100 mL) and 90th percentile (Part II, 200 cfu/100 mL) of the freshwater standard, and WWTPs would be set to the permitted maximum monthly average (Part I, 200 cfu/100 mL) and maximum weekly average (Part II, 400 cfu/100 mL). Therefore two scenarios were run. For Part I the streams and stormwater outfalls were set to 100 cfu/100 mL and the WWTPs were set to 200 cfu/100 mL. For Part II the streams and stormwater outfalls were set to 200 cfu/100 mL and WWTPs were set to 400 cfu/100 mL.

- Ecology reviewed the size of individual grid cells in the marine model (approximately 50 m by 50 m by 1 m deep) and compared these with the other minimum areas used for regulatory compliance in marine waters. Ecology determined the grid cells are smaller than the surface area corresponding to a default mixing zone for a point source discharge. (The default mixing zone represents the maximum area within which water quality may be out of compliance.) The area occupied by two grid cells corresponds approximately to the area for a default mixing zone. Based on this assessment, Ecology determined that for regulatory purposes, i.e., for comparison with the marine water quality standard, for any nine-cell canary node, the average FC concentration for the two grid cells with the highest concentrations in the canary node would represent the compliance area for determining exceedances of the marine water quality standard (see Appendix G).

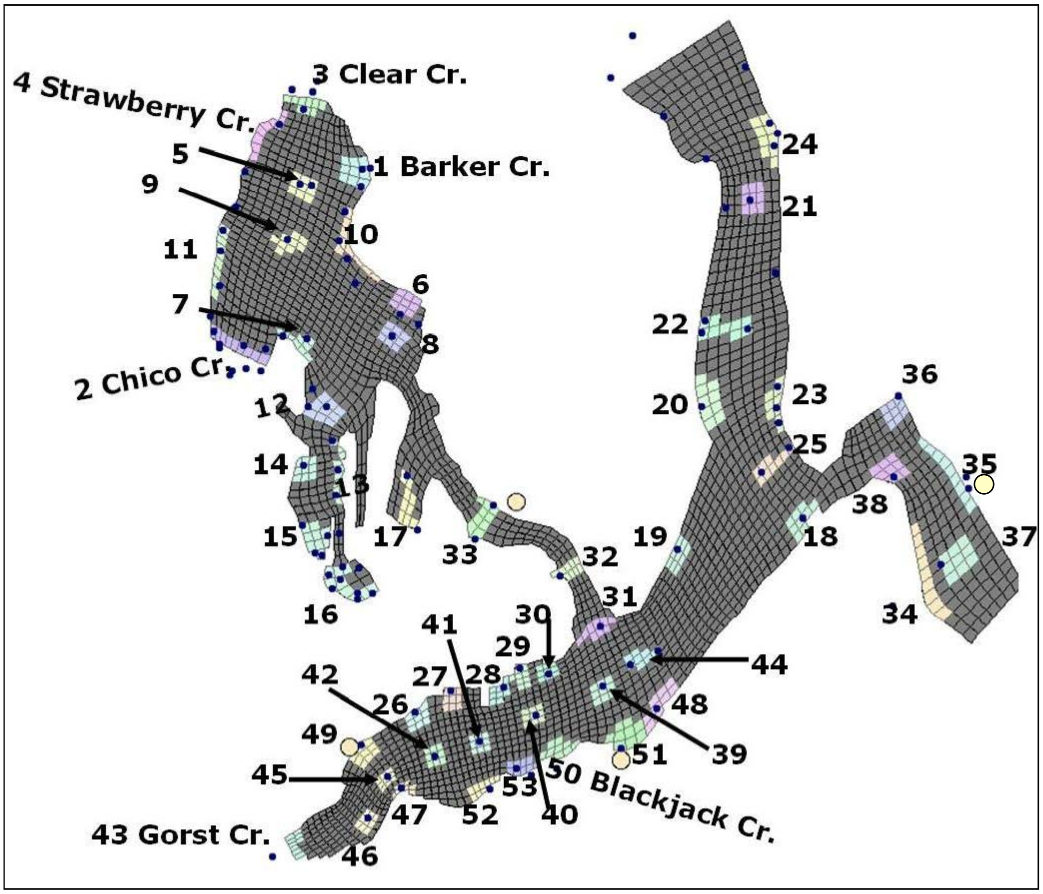

Figure 9. "Canary nodes" (numbered groups of nine marine grid cells) were selected based on proximity to known pollution sources. *Monitoring sites are blue dots and WWTP discharge locations are yellow circles.*

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Study Results and Discussion

Monitoring data sources

Fecal coliform (FC) monitoring data and other data used in this study are summarized in the technical study of microbial pollution of Sinclair and Dyes Inlets, *An Analysis of Microbial Pollution in the Sinclair-Dyes Inlet Watershed (*May et al., 2005).

Data used in the study are available in Appendix B of the May report, which can be downloaded from Ecology's Sinclair-Dyes TMDL website at: www.ecy.wa.gov/programs/wq/tmdl/sinclair-dyes_inlets/reports-documents.html.

The FC monitoring data for this project are also available on Ecology's Environmental Information Management (EIM) database under study names "ENVVEST"[2] for data collected under this partnership and "KITSAPWQ"[3] for ongoing water quality monitoring by KCHD.

KCHD also publishes annual reports summarizing its monitoring results for streams and marine waters in and around Kitsap County, available at: www.kitsapcountyhealth.com/environmenta_health/water_quality/docs/MonitoringReportDocs/Introduction.pdf. Data and annual reports from DOH's shellfish growing area classification program can be accessed from www.doh.wa.gov/ehp/sf/grow.htm.

Ambient monitoring and storm event data for the years 2001 to 2003 were used to characterize stream, stormwater and nearshore marine water quality. Additional stream, stormwater outfall and marine water quality data were collected during some storm events in 2004 and 2005.

Stream and stormwater discharge (flow) measurements are needed to calculate load. For the ENVVEST project, stream gages were added or already installed on Barker, Clear, Strawberry, Chico, Gorst, Anderson, Karcher, and Blackjack creeks. Flows during storm events were measured in a subset of storm conveyance systems; for example, continuous flow data were obtained upstream of 14 outfalls during storm events in April, May and October 2004 (TEC 2004).

Data Quality

Water sampling by participating agencies for the TMDL in 2001-2004 followed the procedures and quality assurance methods described in the Quality Assurance Project Plan (ENVVEST 2002, Johnston et al. 2004) and are described in May et al. (2005), Chapter 4. Water samples were analyzed for FC bacteria using the membrane filtration (MF) method by Manchester Environmental Laboratory or most probable number (MPN) by WDOH and KCHD.

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[2] Data from the FC TMDL study collected by Project ENVVEST can be accessed from http://apps.ecy.wa.gov/eimreporting/Detail.asp?Type=Study&ID=40986124&RecordsPerPage=100&RecordPage=1

[3] Data from the KCHD surface water quality monitoring program can be accessed from http://apps.ecy.wa.gov/eimreporting/Detail.asp?Type=Study&ID=56021866&RecordsPerPage=100&RecordPage=1

DOH conducts routine sampling for FC in Dyes Inlet, Port Washington Narrows, Port Orchard Passage and Rich Passage as part of their ongoing shellfish harvest classification program. Shellfish harvest classifications and monitoring data are reported annually (e.g., DOH, 2009).

A summary of the Quality Assurance/Quality Control (QA/QC) results from the ENVVEST study follows (May et al., 2005):

> QA activities were conducted to ensure that the collected data were of sufficient quality to support the goals of the project. Field duplicate QA samples were collected from each sampling station during the course of the sampling. These samples are very important in reducing sampling error and bias and ensuring the comparability among samples collected by the different stakeholder groups participating in the study. For the FC samples, one field duplicate for every nine samples (10%) was collected during the study period. The field duplicates were labeled and processed by the laboratory in the same manner as the other field samples. Electronic spreadsheets were used to document chain-of-custody information.
>
> Laboratory QA/QC procedures were conducted according to the laboratory-specific standard operating procedures in effect for the project. For each batch of 20 samples, the laboratory included one method blank and one laboratory duplicate analyzed along with the field samples. The laboratory's standard data quality acceptance criteria were used. Acceptance criteria focus on ensuring an appropriate level of data quality to meet the project objectives. Method blanks and laboratory duplicate samples were analyzed to evaluate and monitor analytical results. Throughout this study, acceptance criteria were periodically reviewed for appropriateness and adequacy in meeting the study goals and objectives.
>
> Targets for precision of bacterial analyses are inherently difficult to quantify. The coefficient of variation (CV) for replicate samples for FC has been found to increase as FC levels decrease. For low levels of FC (e.g., less than 10 FC/100 mL), the CV for replicates can approach 50%. For higher FC levels (e.g., greater than 100 FC/100 mL), the CV is typically around 20%. A relative percent difference (RPD) of 25% was established as the target for field duplicates, and an RPD of 40% (logarithmic scale) for laboratory duplicates. The actual values for the project were as follows:
>
> - Field Duplicate Average RPD = 10.5% (14 of 152 samples out of specification, or OOS)
> - Laboratory Duplicate Average RPD = 25.7% (12 of 53 samples OOS)
>
> These results are in accordance with the RPD values typically encountered in FC sampling and analysis studies (May et al., 2005).

Data collection

Kitsap County Health District (KCHD) has conducted ambient monitoring of many streams and a number of marine sites in the Sinclair-Dyes watershed since 1995, and has conducted two-to-three year detailed monitoring studies of streams with bacterial pollution problems. KCHD methods are detailed in *Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction (Version #9)* (KCHD 2003). Because available stream and marine bacteria data were collected by KCHD and DOH under regularly-scheduled sampling programs, the ENVVEST project used these data and collected additional stream, stormwater, nearshore, and marine samples (May et al., 2005).

No agency was routinely collecting samples from stormwater outfalls, so the project included routine and storm-event monitoring for a number of stormwater outfalls. The total number of stormwater outfalls discharging to the two inlets was estimated at more than 200 (for outfalls 24" and greater), too great a number for this project to monitor. Project ENVVEST selected stormwater outfalls for monitoring from each jurisdiction based on representative land use within the jurisdiction, the ability to obtain valid samples, and other logistical considerations. The stormwater outfalls monitored included eight stations in the city of Bremerton; four in the city of Port Orchard; two in the city of Bainbridge Island; 13 within the shipyard; and 13 in Kitsap County (Table 5).

Fecal coliform results for freshwater

In the microbial pollution report (May et. al., 2005), Chapter 6 summarizes stream, stormwater outfall, and WWTP FC monitoring data for the 2000-2003 study period. Summaries of the significant findings follow.

Streams

- For each stream, the percent total impervious area, percent forest for the drainage, number of samples, geometric mean, minimum, maximum, 25th, 75th, and 90th percentile FC concentrations, and comparisons with water quality standards are reported for the dry season, wet season, and the 2003 storm events. The number of FC measurements per stream per season ranged from 6 to 34 (May et al., 2005).
- There were more violations during the dry season than the wet season or storm events (May et. al., 2005[4], Figure 10).
- Streams were a major source of FC contamination to the nearshore environment of Sinclair and Dyes Inlets.
- Nearly all streams had higher dry season geometric means than their wet season geometric means, and two-thirds were higher in dry season than during storm events.

[4] Maps of FC concentrations and water quality violations can in the Sinclair/Dyes Inlet Watershed be viewed from www.ecy.wa.gov/programs/wq/tmdl/sinclair-dyes_inlets/fc_maps_final.pdf

- Ranked worst to best by their dry season FC geometric means, the principal streams in 2000-2003 were: Ostrich Bay (582 cfu/100 mL); Enetai (Dee) (403); Annapolis (317); Clear nearest the mouth at CC01 (255); Karcher (Olney) (232); Sacco (200); Beaver (190); Strawberry (139); Barker (138); Blackjack (123); Gorst (110); Ross (91); Pahrmann (86); and Chico (41 cfu/100 mL).

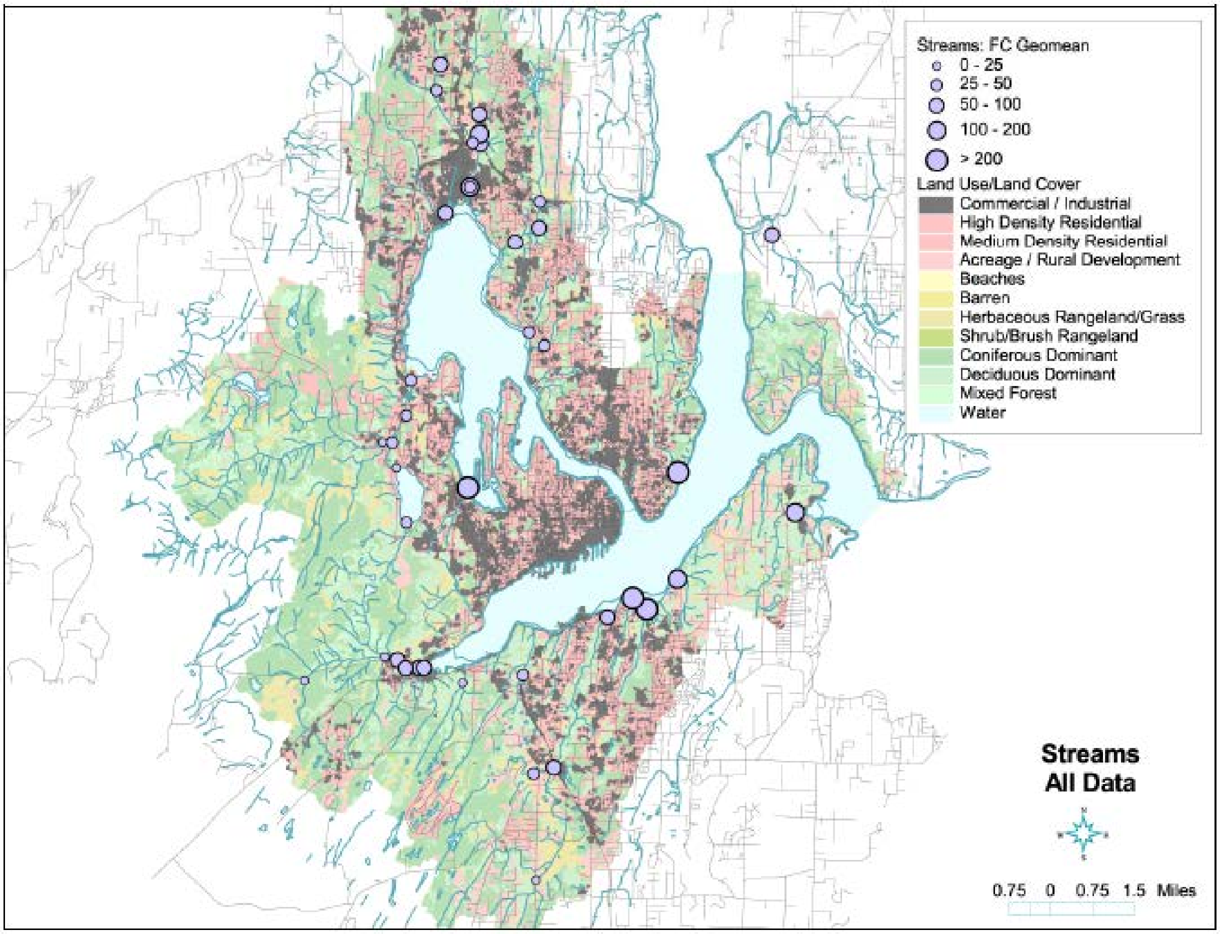


Figure 10. Fecal coliform geometric mean concentrations for freshwater tributaries to Sinclair and Dyes Inlets, all data 2000 to 2003.

Stormwater outfalls

For 33 stormwater outfalls, the drainage area in acres, percent total impervious area (TIA), percent forest cover, the number of FC samples and geometric mean, minimum, maximum, 25th, 75th and 90th percentile FC concentrations, and comparisons with water quality standards are reported in May et al., 2005. The number of FC measurements per outfall over two years of monitoring ranged from three to 20; however, more than 10 measurements were made for the majority of outfalls. The outfalls with fewer than five measurements were PSNS082.5 and two outfalls on Bainbridge Island, Fort Ward and Lynwood Center. Results include:

- Geometric mean FC concentrations for the outfalls, using all data for storms monitored in 2002 and 2003 are shown in Table 7. It is informative to scan the percent total impervious area and the percent forested cover for these stormwater drainages. In general, stormwater discharges with higher fecal coliform concentrations drain areas with high total impervious area and low forested coverage.
- Figure 11, reproduced here from May et al., 2005, shows locations around the two inlets of the monitored outfalls and the geometric mean FC concentration for each, using all measurements for storms monitored in 2002 and 2003.
- Stormwater outfalls were found to be important sources of fecal coliform contamination to the nearshore environment of Sinclair and Dyes Inlets during storms.
- Of the 33 outfalls, only five met part I of the freshwater standard (100 cfu/100 mL) (Table 7).
- Of the 33 outfalls, none met part II of the freshwater standard (more than 10% of samples may not exceed 200 cfu/100 mL) (Table 7).
- Table 8 ranks by concentration the 33 outfalls monitored for the 2002-2003 storm season. These outfalls are the responsibility of PSNS & IMF, Kitsap County, and the cities of Bremerton, Port Orchard, and Bainbridge Island (May et. al., 2005[5]).

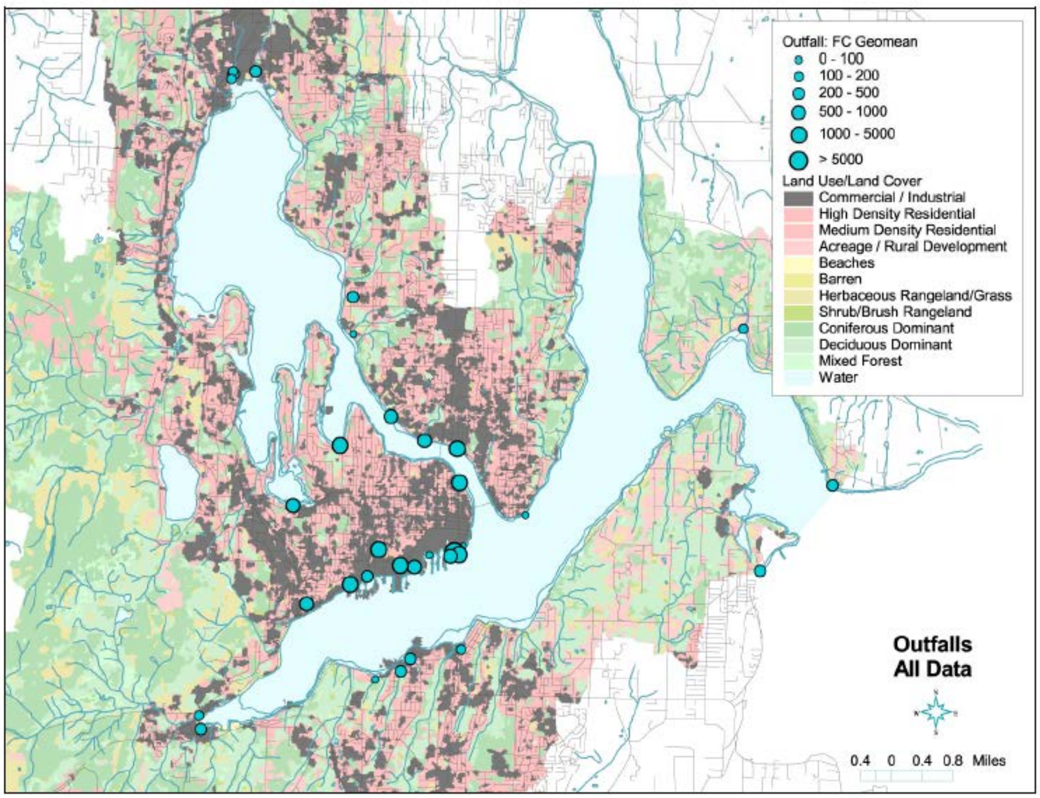


Figure 11. Fecal coliform bacteria concentrations in stormwater outfalls. Geometric means based on all data for 2000-2003.

[5] Maps of FC concentrations and water quality exceedances in the Sinclair/Dyes Inlet Watershed can be viewed from www.ecy.wa.gov/programs/wq/tmdl/sinclair-dyes_inlets/fc_maps_final.pdf

Table 7. Summary of stormwater outfall FC data for WYs 2002 and 2003 and comparison with freshwater bacteria criteria.

Location	Outfall ID#	Basin Area				FC/100 mL					
		acres	% TIA	% forest	n	min	max	25th %ile	75th %ile	Geomean[a]	90th %ile[a]
Shipyard	PSNS008	30	65	0	12	1	6100	130	2184	370	4354
Shipyard	PSNS015	103	60	1	18	54	13,175	839	5752	2007	11,824
Shipyard	PSNS082.5	22	61	0	3	170	6600	1135	4350	b	5700
Shipyard	PSNS115.1	14	65	0	14	1	35,500	385	5025	890	7999
Shipyard	PSNS101	17	63	0	13	1	90,000	1	250	16	4370
Shipyard	PSNS081.1	16	63	0	13	1200	99,000	3200	18,000	6800	32,000
Shipyard	PSNS124	9	65	0	12	1	1300	3	99	13	396
Shipyard	PSNS126	18	53	0	18	1	133,000	2225	14,000	2836	25,181
National Ave	LMK164	123	55	0	14	23	11,000	334	1538	663	4172
Evergreen	B-ST27	44	61	0	11	290	6150	975	2,975	1573	4752
Phinney Bay	LMK020	331	45	26	19	69	18,000	1268	3623	1718	5740
Oyster Bay	B-ST26	211	49	12	13	70	5050	80	2,000	953	3040
Callow	B-ST28 (SW1)	455	56	3	9	230	32,000	930	2600	2017	12,208
Stephenson	B-ST03 (SW5)	284	55	14	13	100	3800	250	1,200	599	2709
Pine Road	B-ST01 (SW3)	864	42	31	13	46	79,200	231	1714	701	2475
Campbell	B-ST07	222	58	3	11	290	5500	1012	3,254	1602	4700
Trenton	B-ST12 (SW4)	156	50	21	14	1	3600	3	502	32	748
Pacific Ave	SW2	140	63	0	8	520	2376	725	1,700	1158	2113
Silverdale (Bayshore)	LMK001	237	57	9	21	8	1300	57	746	193	1100
Silverdale	LMK004	33	61	0	17	7	2904	33	370	138	1033
Silverdale (Sandpiper)	LMK002	46	60	4	19	20	2500	74	616	222	1935
Silverdale	LMK026	534	46	14	17	15	2640	100	623	255	1160
Tracyton	LMK055	280	40	42	18	23	2000	77	468	173	963
Tracyton	LMK060	336	23	72	19	8	2850	13	200	75	1016
Port Orchard	PO-Bethel	33	55	0	11	10	1100	46	251	126	563
Port Orchard	PO-Bay	100	58	3	16	16	31,000	70	3,162	576	11,295
Port Orchard	PO-Blvd	87	48	17	20	25	17,500	183	1392	424	3160
Port Orchard	PO-Wilkens	143	24	76	16	8.5	640	21	200	64	442
Gorst Subaru	LMK128	174	27	81	19	49	2900	146	1128	334	1935
Gorst	LMK122	346	22	71	23	24	2100	48	498	156	1080
Manchester	LMK038	132	13	48	36	11	4000	161	656	325	3171
Lynwood Center stormwtr	BI-LCSW	92	6	67	4	31	820	45	572	b	721
Fort Ward stormwater	BI-FWSW	470	7	80	4	300	10,560	900	5808	b	8659

[a] Shaded cells indicate exceedance of either Part I (geomean<100) or Part II (90th percentile not to exceed 200) of the freshwater state water quality standard.
[b] For n<5, data are not sufficient to calculate geometric mean for comparison with Part I criterion.

Table 8. FC levels in stormwater WYs 2002-2003, from highest geometric mean to lowest.

Jurisdiction (NPDES permittee)	Location	Outfall ID	Rank	n	Fecal coliform bacteria, #/100 mL	
					Geomean	90th %ile
PSNS&IMF	Shipyard	PSNS081.1	1	13	6800	32,000
PSNS&IMF	Shipyard	PSNS126	2	18	2836	25,181
Bremerton	Callow Ave	B-ST28 (SW1)	3	9	2017	12,208
PSNS&IMF	Shipyard	PSNS015	4	18	2007	11,824
Bainbridge Isl	Fort Ward stormwater	BI-FWSW	5	4	**1963**[a]	8659
Bremerton	Campbell	B-ST07	6	11	1602	4700
Kitsap County	Phinney Bay[b]	LMK020	7	19	1718	5740
Bremerton	Evergreen	B-ST27	8	11	1573	4752
PSNS&IMF	Shipyard	PSNS082.5	9	3	**1331**[a]	5700
Bremerton	Pacific Ave	SW2	10	8	1158	2113
Bremerton	Oyster Bay	B-ST26	11	13	953	3040
PSNS&IMF	Shipyard	PSNS115.1	12	14	890	7999
Bremerton	Pine Road	B-ST01 (SW3)	13	13	701	2475
Kitsap County	National Ave	LMK164	14	14	663	4172
Bremerton	Stephenson	B-ST03 (SW5)	15	13	599	2709
Port Orchard	Port Orchard	PO-Bay	16	16	576	11,295
Port Orchard	Port Orchard	PO-Blvd	17	20	424	3160
PSNS&IMF	Shipyard	PSNS008	18	12	370	4354
Kitsap County	Gorst Subaru	LMK128	19	19	334	1935
Kitsap County	Manchester	LMK038	20	36	325	3171
Kitsap County	Silverdale	LMK026	21	17	255	1160
Kitsap County	Silverdale (Sandpiper)	LMK002	22	19	222	1935
Kitsap County	Silverdale (Bayshore)	LMK001	23	21	193	1100
Kitsap County	Tracyton	LMK055	24	18	173	963
Bainbridge Isl	Lynwood Center stormwater	BI-LCSW	25	4	**158**[a]	721
Kitsap County	Gorst	LMK122	27	23	156	1080
Kitsap County	Silverdale	LMK004	26	17	138	1033
Port Orchard	Port Orchard	PO-Bethel	28	11	126	563
Kitsap County	Tracyton	LMK060	29	19	75	1016
Port Orchard	Port Orchard	PO-Wilkens	30	16	64	442
Bremerton	Trenton	B-ST12 (SW4)	31	14	32	748
PSNS&IMF	Shipyard	PSNS101	32	13	16	4370
PSNS&IMF	Shipyard	PSNS124	33	12	13	396

[a]Geometric mean (bold) calculated for purpose of ranking, not for comparison with water quality criterion, because n<5.
[b]Same location as Phinney Creek, which is piped for part of its length.

Fecal coliform bacteria concentrations in WWTP treated discharge

Three municipal treatment facilities (WWTPs) discharge treated sewage effluent to marine waters in the Sinclair-Dyes study area: the city of Bremerton, Kitsap County No. 7 (southwestern Bainbridge Island), and South Kitsap Water Reclamation Facility (Port Orchard). No discharges occurred from Bremerton's ETF during any monitoring event during the study period. All the WWTPs operate under NPDES permits issued by Ecology and have FC permit limits:

- Maximum monthly geometric mean of 200 cfu/100 mL.
- Maximum weekly geometric mean of 400 cfu/100 mL.

Discharge concentrations of FC for the three wastewater treatment plants (WWTPs) are illustrated in May et al., 2005. However, the values used for Kitsap No. 7 discharge are incorrect; see next paragraph. Spikes of FC occurred occasionally; however, the three facilities were in compliance with their permit limits.

An error was made in Ecology's submission to PSNS&IMF of discharge data for Kitsap County No. 7 WWTP. Data from a different WWTP was submitted, resulting in overestimates of loading from this facility by about 10 times. This error results in additional conservatism in the model predictions for the area of Rich Passage near the Kitsap No. 7 discharge.

The error did not result in erroneous predictions of exceedances in canary nodes (marine grid cells) near the Kitsap No. 7 discharge because there were no model predictions of exceedances at any marine grid cells in Rich Passage, including those nearest this discharge and those nearest the stormwater outfalls below Fort Ward and Lynwood Center. The Lynwood Center nearshore location is identified as a priority area of concern in the TMDL, not because of model predictions, but because the geomean for five samples collected in the nearshore below Lynwood Center was 72 cfu/100 mL, more than five times the marine geomean criterion.

The watershed model simulated loads from all watershed sources into Sinclair and Dyes Inlets. The jurisdictions with stormwater outfalls that contributed to the discharges included Kitsap County, Washington Department of Transportation, PSNS&IMF, and the cities of Bremerton, Port Orchard, and Bainbridge Island (Figure 12 from Johnston et al., 2009a; see also Table 9). Based on the simulated loads, the top 30 FC discharges into Sinclair and Dyes Inlets were the major streams, especially Clear, Chico, Blackjack, Karcher, Barker, and Gorst creeks. The highest loads from the stormwater watersheds were obtained for Clear Creek (lower), Loxie Egans, East Bremerton Pine Road, BI Fort Ward, BI Lynwood Center, Tracyton Boat Dock, and PSNS015.

In Figure 12, BI-Pleasant Beach refers to shoreline segment for DSN 44 located along Pleasant Beach Dr NE between Lynwood Center and Fort Ward State Park. The loading was simulated as a shoreline discharge, i.e. the load was distributed into 7 shoreline grids. ENVVEST modelers classified this as a stormwater drainage system although a stormwater outfall was not located for this basin. The loading calculation for this pour point was based on the FC loading assigned to stormwater discharges for clusters with similar Land Use/Land Cover characteristics.

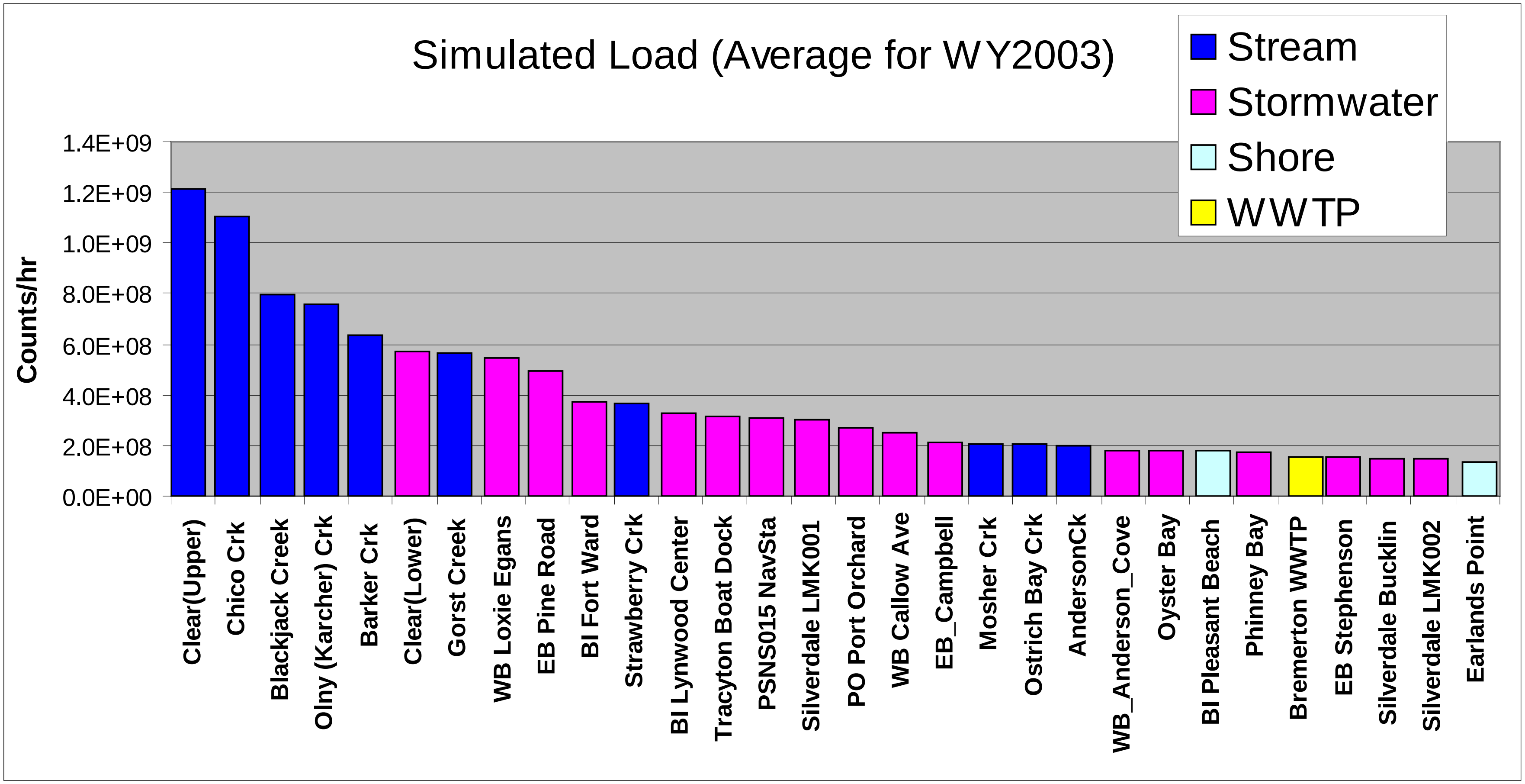


Figure 12. Simulated average yearly loads (counts/hr) for the top 30 sources of FC discharges into Sinclair and Dyes Inlets based on modeled hourly loads over the year.

Table 9. Summary of the average yearly loads (million counts/hr) for the top 30 sources of FC discharges into Sinclair and Dyes Inlets *based on modeled hourly loads over the year (with >0.9% of the average watershed load).*

Rank	Type	Name	Jurisdiction	Average load (million counts/hr)	% of Average Watershed load
1	Stream	Clear(Upper)	Kitsap County[1]	1215	7.98%
2	Stream	Chico Crk	Bremerton/Kitsap County[1]	1102	7.24%
3	Stream	Blackjack Creek	Port Orchard/Kitsap County[1]	799	5.25%
4	Stream	Karcher Crk	Port Orchard/Kitsap County[1]	760	4.99%
5	Stream	Barker Crk	Kitsap County[1]	634	4.18%
6	Stormwater	Clear(Lower)	Kitsap County[1]	572	3.76%
7	Stream	Gorst Creek	Bremerton/Kitsap County[1]	564	3.71%
8	Stormwater	WB Loxie Egans	Bremerton/Kitsap County[1]	543	3.56%
9	Stormwater	EB Pine Road	Bremerton/Kitsap County[1]	493	3.24%
10	Stormwater	BI Fort Ward	Bainbridge Island	371	2.44%
11	Stream	Strawberry Crk	Kitsap County[1]	366	2.41%
12	Stormwater	BI Lynwood Center	Bainbridge Island	327	2.15%
13	Stormwater	Tracyton Boat Dock	Kitsap County	313	2.05%
14	Stormwater	PSNS015 NavSta	PSNS&IMF	310	2.03%
15	Stormwater	Silverdale LMK001	Kitsap County[1]	301	1.98%
16	Stormwater	Port Orchard Blvd	Port Orchard[1]	267	1.76%
17	Stormwater	WB Callow Ave	Bremerton[1]	253	1.66%
18	Stormwater	EB Campbell	Bremerton[1]	212	1.40%
19	Stream	Mosher Crk	Kitsap County	208	1.36%
20	Stream	Ostrich Bay Crk	Bremerton/Kitsap County[1]	205	1.35%
21	Stream	Anderson Ck	Bremerton/Kitsap County[1]	197	1.29%
22	Stormwater	WB Anderson Cove	Bremerton	182	1.20%
23	Stormwater	Oyster Bay	Bremerton	180	1.18%
24	Shore	BI Pleasant Beach	Bainbridge Island	177	1.16%
25	Stormwater	Phinney Bay[2]	Bremerton/Kitsap County	175	1.15%
26	WWTP	Bremerton WWTP	Bremerton	156	1.02%
27	Stormwater	EB Cherry Ave	Bremerton	155	1.02%
28	Stormwater	Bucklin Hill	Kitsap County	150	0.98%
29	Stormwater	Silverdale LMK002	Kitsap County	146	0.96%
30	Shore	Erlands Point	Bremerton/Kitsap County/ PSNS&IMF[1]	137	0.90%

[1] Includes state highways under the jurisdiction of WSDOT.

[2]Since monitoring by KCHD began in 2005 and listed on state Water Quality Assessment, treated as stream.

Critical season for freshwater discharges to marine waters

The critical season is different for stream vs. stormwater discharges. The highest concentrations of fecal coliform bacteria in streams occur in the dry season when flows are lower. In contrast, by their nature, stormwater discharges occur largely during the winter wet season, unless part of their discharge is natural streamflow. As a result, both dry and wet season loading of bacteria from freshwater discharges to the inlets needs to be considered.

Fecal coliform results for marine water

Nearshore and marine FC monitoring data from KCHD, DOH, and Project ENVVEST for the study period 2000-2003 data were pooled and separated by season to calculate statistics for wet season, dry season, and storm events. These data are summarized in May et al. (2005). Data combined for all seasons (Figure 13 from May et al., 2005) indicate the nearshore areas where there were problems meeting water quality standards.

Locations and seasonality of fecal coliform exceedances in marine water

Two Dyes Inlet nearshore areas had fecal coliform problems in 2000-2003:

- Clear Creek estuary – exceeded Parts I and II water quality standards (WQS) in dry season and Part II in wet;
- Chico Bay – two stations exceeded Part II WQS (dry season) ; three exceeded Part II in wet.

The Clear Creek estuary is affected by highly developed commercial areas near the mouth, with suburban development upstream. Several stormwater outfalls and Strawberry Creek (highly developed in its lower reach) also discharge into northern Dyes Inlet. In early 2000s, DOH also imposed shellfish harvest restrictions at the mouth of Barker Creek on east side Dyes Inlet, due to FC levels in the stream and poorer marine water quality during flood tide (DOH 2010a,b).

Even though Chico Creek itself had good water quality, in 2000-2003 Chico Bay was affected by moderate-intensity shoreline development, surface runoff, and stormwater discharges from unincorporated Kitsap County in an area covered by the Phase II municipal stormwater permit. In the early 2000s, three DOH marine sampling stations in Chico Bay exceeded Part II of the marine WQS during wet season, so DOH classified this area as Restricted (Figure 14).

Sinclair Inlet nearshore areas with fecal coliform problems in 2000-2003 were:

- Estuary of Blackjack Creek – exceeded Part II WQS in wet season;
- Below Karcher (Olney) Creek– exceeded Part II WQS in wet season;
- Below Sacco Creek – exceeded Part II WQS in wet season;
- Near Port Orchard marina – exceeded Part II WQS in dry season.

(Note: DOH does not classify Sinclair Inlet for shellfish harvest, because WWTP discharges and presence of pollutants other than FC bacteria may make shellfish unsafe to eat.)

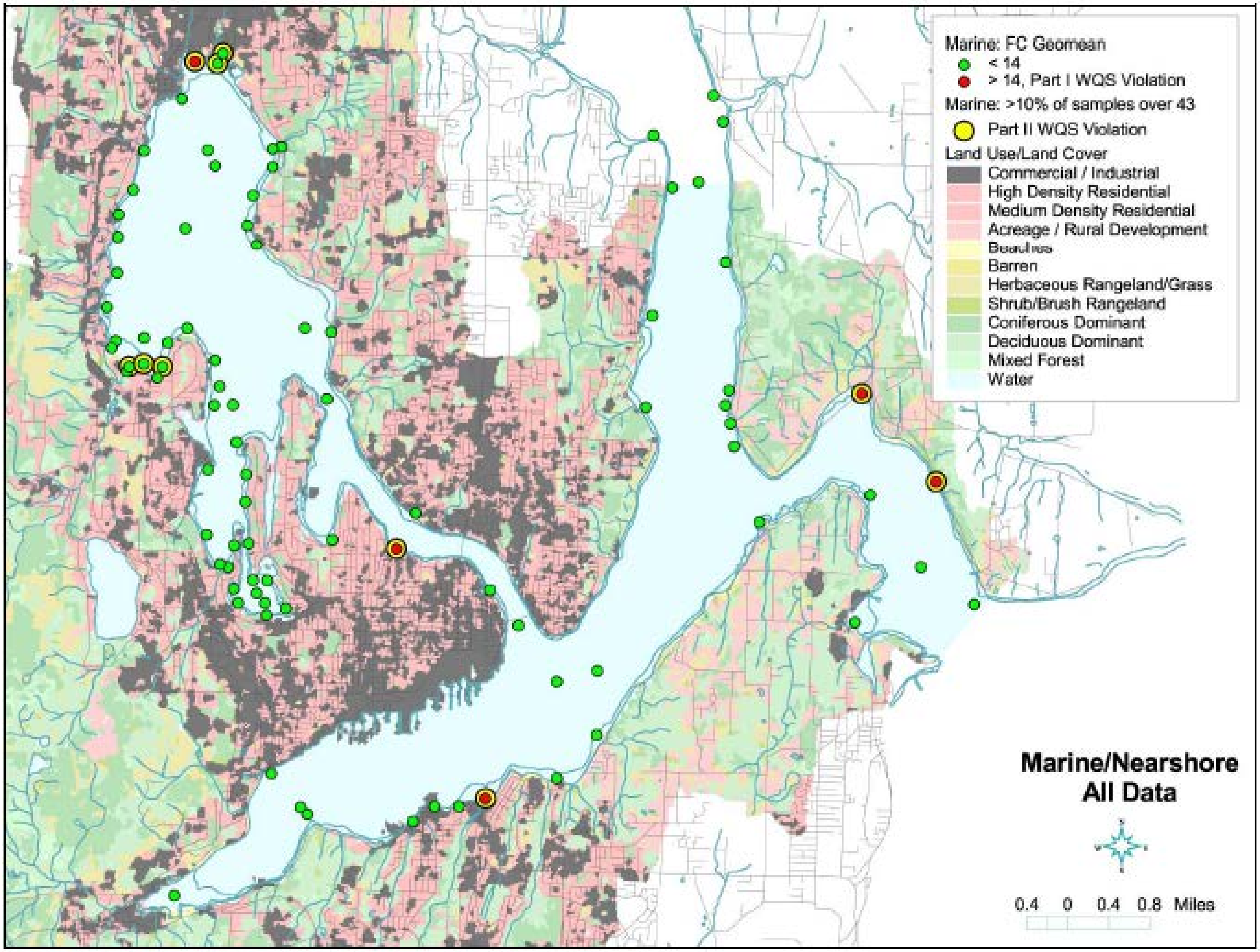


Figure 13. Fecal coliform bacteria concentrations and exceedances of marine water quality standards using all-season data for 2000-2003 from DOH, KCHD, and ENVVEST.

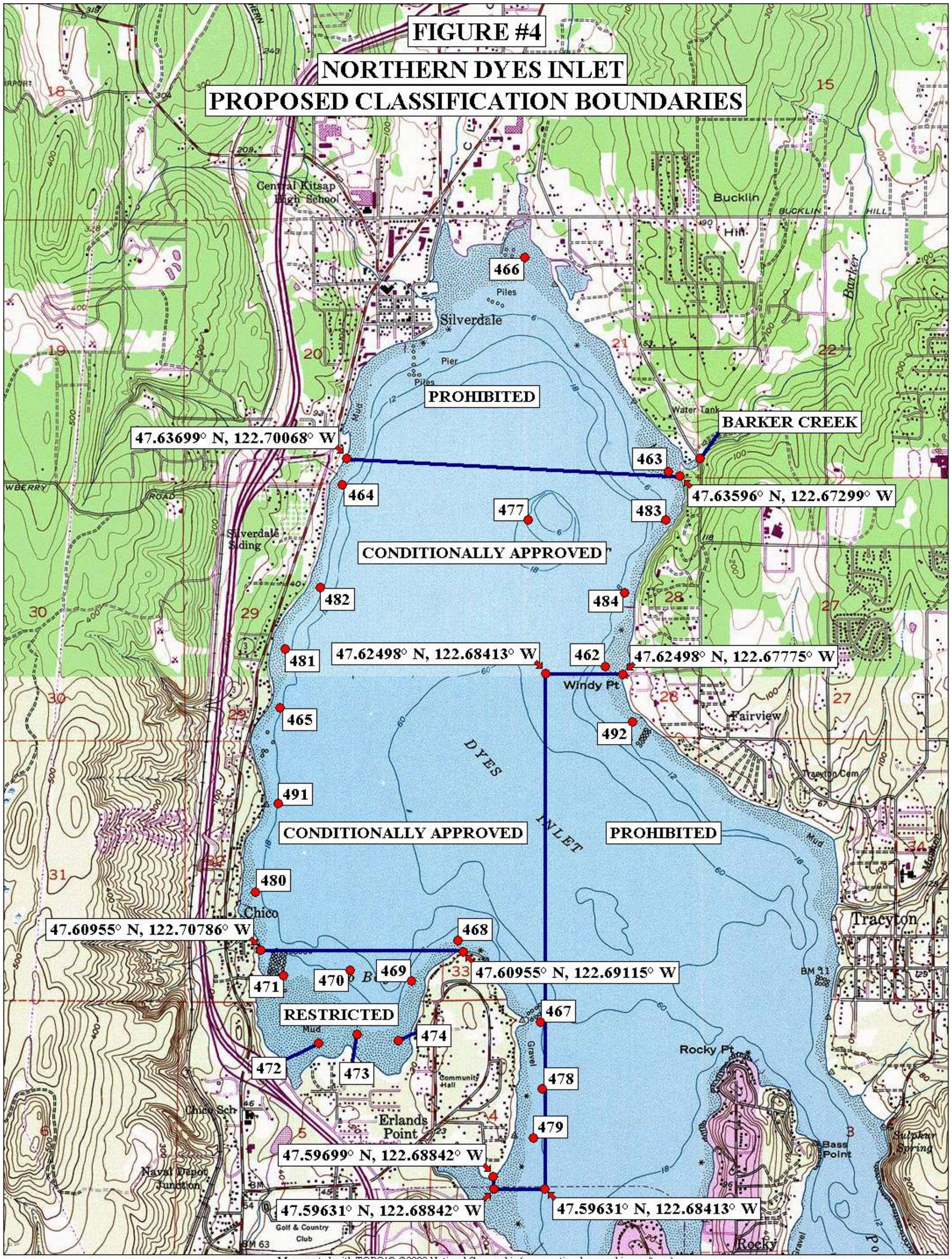


Figure 14. Dyes Inlet shellfish harvest classifications, 2003, showing reopened "Conditionally Approved" area (Washington State Department of Health.)

In addition, the nearshore area below Dee (Enetai) Creek, which discharges to Port Orchard Passage, did not meet Part II in dry season. The stream itself had the second-highest dry season geometric mean of all streams in the study.

During 2000-2003, about the same number of marine sites exceeded WQS during the wet season as in the dry season. Eight out of 83 monitored sites exceeded either Part I or Part II of the standards in the wet season, while 5 out of 83 exceeded one or both standards in the dry season. However, 10 percent of the wet season samples exceeded Part II of the standard, whereas only six percent of the dry season samples exceeded Part II of the standard. This suggests that more marine water quality problems occurred in the wet season than the dry season, “as might be expected for nearshore samples in developed areas where nonpoint runoff and other potential upland sources might be present,” (May et. al., 2005).

Samples collected by Project ENVVEST in nearshore marine waters during the 2002-2003 storm season (May et al., 2005) support these wet season observations. Because of the challenges of sampling storm events, the number of storm samples per site was only three to eight. Ecology policy requires a minimum of five sample values to calculate a geometric mean. Nine locations around the two inlets and adjacent waters exceeded Part I of the WQS, or Part II, or both:

- Anderson Cove on Port Washington Narrows – exceeded Part I and II.
- Rich Passage near Crystal Springs, Bainbridge Island – exceeded Part II.
- Rich Passage in nearshore near Fort Ward – exceeded Part II.
- Rich Passage below Lynwood Center – exceeded Part II.
- Blackjack estuary (Sinclair Inlet) – exceeded Part I and II.
- Nearshore Sinclair Inlet near mouth of Karcher (Olney) Creek – exceeded Part I and II.
- Nearshore Dyes Inlet at Silverdale Hotel site – exceeded Part II.
- Nearshore Dyes Inlet at Old Silverdale (DY24) – exceeded Part II.
- Dyes Inlet - Clear Creek estuary (DY27) – exceeded Part II.

TMDL Analysis

This section presents the modeling scenarios and simulation results for WY2003 used to determine the allowable loads to Sinclair-Dyes area receiving waters. In addition, it provides fecal coliform (FC) bacteria discharge targets for tributary streams derived using the statistical rollback method, and the analyses used to assess load reductions from stormwater and WWTP discharges. The major sources of uncertainty and conservatism used in the analysis are also reviewed and discussed.

The TMDL analysis consisted of model simulations conducted to support development of preliminary wasteload and load allocations for the marine waters of the inlets and determine the FC reductions needed to meet freshwater quality standards in the tributary streams.

The most important result of the marine modeling described in this section is the determination that, in order to be protective of shellfish harvesting in nearshore areas near the mouths of Clear, Strawberry, Gorst, and Blackjack creeks, FC targets for those drainages need to be more stringent than freshwater water quality standards (WQS).

Marine fecal coliform bacteria

Analytical framework

Three simulations using the marine model, and one assessment of monitoring data for marine nearshore areas ("observed data"), comprise this TMDL assessment of compliance with the standards in marine waters:

- First model run: The integrated watershed and receiving water model was used to simulate "actual conditions" for WY2003 to identify critical conditions and areas that exceeded water quality standards (*WY2003 "Actual Conditions" model simulation*).
- Second and third model runs. In accordance with the recommendations of the regulatory and Tribal steering group consisting of Ecology, Suquamish Tribe, DOH, and KCHD, two TMDL simulations of WY2003 were conducted. These simulations were run with specific input concentrations of FC bacteria for streams, stormwater outfalls, and WWTPs to determine whether and where exceedances of the marine WQS would occur in the two inlets.
    - To compare the predicted marine FC concentrations with Part I of the Standard, streams and stormwater outfalls were set at 100 cfu/100 mL, and WWTPs were set at 200 cfu/100 mL *(100/200 TMDL scenario model simulation).*
    - To compare predicted marine FC concentrations with Part II of the Standard, streams and stormwater outfalls were set at 200 cfu/100 mL, and WWTP discharges were set at 400 cfu/100 mL *(200/400 TMDL model scenario).*
- Observed data (monitoring results): Finally, for an additional check on WY2003 exceedances of standards, the geomean and 90th percentile of "observed data" (monitoring

results) were compared to Parts I and II of the standard. This review of "observed data" is not a model simulation.

The simulations were run using hydrology for WY2003 (Oct. 1, 2002 to Sept. 29, 2003). For the TMDL 100/200 scenario, the daily maximum FC concentration for each marine grid cell was used to calculate a 30-day moving geomean ($m30day_d$) for comparison with Part I of the marine standards (14 cfu/100 mL). For the 200/400 scenario, the daily maximum FC concentration for each marine grid cell was used to calculate a 30-day moving 90th percentile ($m30day90_d$) for comparison with Part II of the marine standard (43 cfu/100 mL).

If the standard was exceeded, the maximum concentration obtained from $m30day_d$ or *m30day90d* was used to calculate the target FC reduction needed as:

$Reduction_{P1}$	=	$(1 - 14/\max(m30day_d))\times 100$	Equation [1]
	=	% FC reduction needed to meet Part I of standard	
$Reduction_{P2}$	=	$(1 - 43/\max(m30day90_d))\times 100$	Equation [2]
	=	% FC reduction needed to meet Part II of standard	
and			
FC_Target_{P1}	=	$SimFC\times(1 - Reduction_{P1}/100)$	Equation [3]
FC_Target_{P2}	=	$SimFC\times(1 - Reduction_{P2}/100)$	Equation [4]
where			
$SimFC$	=	The simulated FC concentration for the stream, stormwater, shoreline, or WWTP discharging into the affected area	

Compliance with Standards

WY2003 "Actual Conditions." This first model scenario used the "best estimate" FC concentrations (geometric means based on "k-cluster regression"[6]) for stream, stormwater outfall, and shoreline discharges and point-to-point estimates of actual WWTP loading to the inlets. The average of the two highest grid cells exceeded Part I of the standards in the following areas (Table 10):

- Nearshore waters below mouth of Clear Creek, Dyes Inlet. Receives stream runoff from Clear and Strawberry creeks; stormwater discharges from lower Clear Creek, Silverdale Mall, and Bucklin Hill; and shoreline runoff from Tracyton Boulevard and Bayshore (Figure 15).
- Nearshore waters below mouth of Gorst Creek, Sinclair Inlet. Receives stream runoff from Gorst, Anderson, and Spring creeks; stormwater discharges from Navy City Metals and Gorst Subaru; and shoreline runoff from North Gorst and Elandan (Figure 16).

Thus, these model results tell us which areas of Sinclair and Dyes Inlets would exceed the marine WQS with estimated fecal coliform (FC) loading from freshwater sources at concentrations typical of those monitored in 2000-2003, given the hydrologic conditions of WY2003.

[6] "k-cluster regression" is the statistical method used to develop estimates of FC concentrations to be inputs in the Sinclair Dyes watershed model (see Appendix F, Model Development and Evaluation).

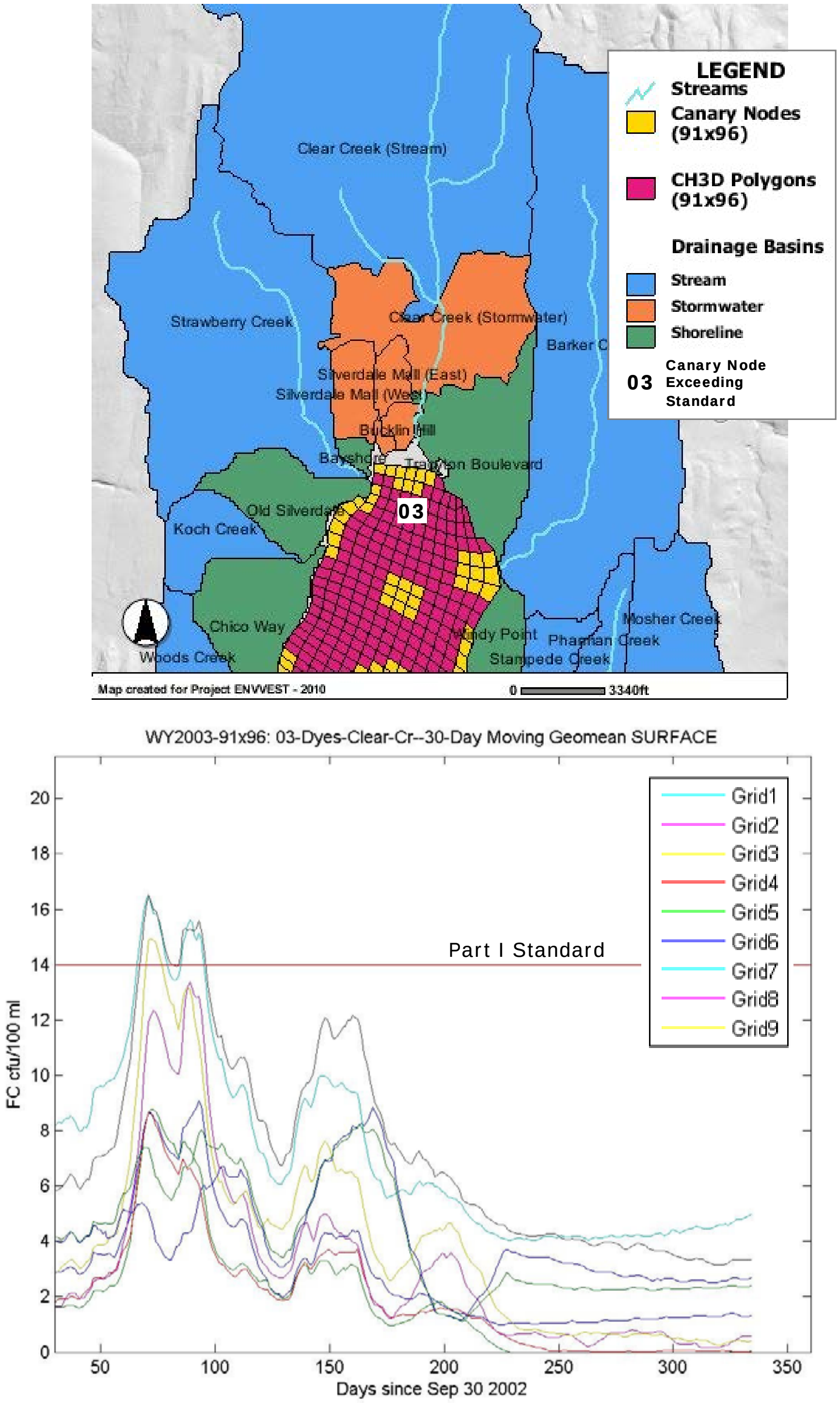


Figure 15. Canary node 03-Dyes-Clear-Cr at northern Dyes Inlet *(upper figure)* **and simulated 30-day moving geomean for the nine grid cells (lower) from "Actual Conditions" model run.**

It is somewhat surprising that there are only two marine areas with predicted exceedances. However, the "Actual Conditions" input FC concentrations for most streams were lower than the freshwater standards (tested in the two TMDL scenarios). In addition, the "Actual Conditions" input FC concentration for stormwater outfalls (947 cfu/100 mL; 321 cfu/100 mL; and 140 cfu/100 mL, depending on land use/land cover characteristics of the basin) in most cases represented higher stormwater loading of FC than was tested in the two TMDL scenarios, where all stormwater discharges were set to 200 or 400 cfu/100 mL.

Table 10. WY2003 "Actual Conditions"[a] model run results for canary nodes *where the two highest grid cells' average (AVG) of the 30-day moving geomean of daily max fecal coliform (FC) concentration (m30day$_d$) exceeded Part I of the marine standard (>14 cfu/100 mL). The required FC reduction is obtained by comparing AVG with the Part I standard.*

Water body	Canary Node Location	Max (30-day moving Geomean of Daily Max FC)			FC Reduction Needed
			cfu/100 mL		
		Grid cell	Surface	Depth-avg[b]	
Dyes	Nearshore below Clear Creek	AVG	16.5	16.5	**15%**
Sinclair	Nearshore below Gorst Creek	AVG	15.0	15.0	**4%**

(a) "Actual Conditions" model run used WY2003 hydrologic conditions and discharge volumes. FC inputs were estimated Geomeans based on statistical analysis of Land Use/Land Cover data.

(b) For nearshore areas with depth of only meter (one grid cell deep), surface and depth-average FC concentrations are the same.

WY2003 TMDL 100/200 model run. The purpose of this model run was to determine exceedances of marine WQS anywhere in the two inlets under the hydrologic conditions of WY2003, given the assumption that stream, shoreline and stormwater discharges met Part I of freshwater standards. This tells us whether or not the freshwater WQS are low enough given the size of the freshwater sources to allow the marine waters to meet standards throughout the inlets.

For this model scenario, all stream, shoreline, and stormwater discharges were set to 100 cfu/100 mL and all WWTP discharges to 200 cfu/100 mL. A 30-day moving geomean was calculated from the daily max FC concentration for each marine grid cell, then the average of the top two grid cells was compared with the Part I marine standard (14 cfu/100 mL). If the standard was exceeded, then a FC reduction was calculated using Equation [1].

The results of this simulation were used to identify FC sources that would need to be reduced in order to meet Part I of the standard in the Inlet receiving waters. The results (Table 11) indicate that, in order to meet the marine standards:

- FC concentrations in the nearshore area below Gorst (Figure 16) and Blackjack Creeks (Figure 20) would need to be reduced by 72% and 38%, respectively.
- FC concentrations in the marine area of Sinclair Inlet that receives both the Bremerton WWTP treated discharge and a stormwater discharge (Figures 17 and 18) would need to be reduced by 27%.

Table 11. WY2003 100/200[a] TMDL model run: results for canary nodes *where the 30-day moving geomean of the daily max FC concentration (m30dayd) for the average of the two highest grid cells (AVG) exceeded Part I of the standard (>14 cfu/100 mL). The FC reduction needed is obtained by comparing AVG with the Part I marine standard.*

Water body	Canary Node Location	Max (30-day moving Geomean of Daily Max FC)			FC Reduction Needed
		Grid cell	cfu/100 mL		
			Surface	Depth-avg[b]	
Sinclair	Nearshore below Gorst Cr	AVG	49.1	49.1	72%
Sinclair	Nearshore below Blackjack Cr	AVG	22.4	22.4	38%
Sinclair	Nearshore Bremerton WWTP	AVG	19.1	11.7	27%

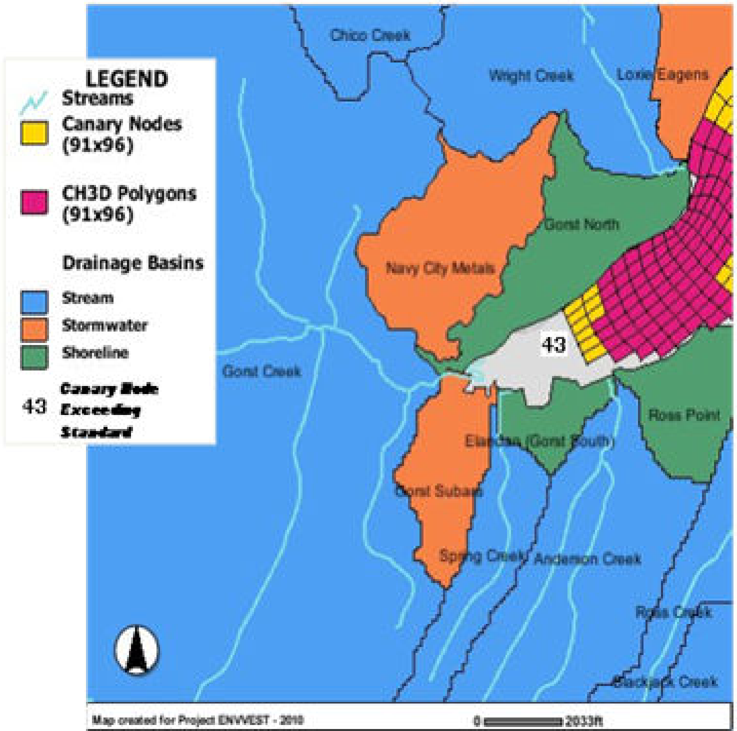
[a] 100/200 model run used WY2003 hydrologic conditions and discharge volumes. Stream, shoreline, and stormwater inputs set to 100 cfu/100 mL and WWTP discharges set to 200 cfu/100 mL.

[b] For nearshore areas with depth of only meter (one grid cell deep), surface and depth-average FC concentrations are the same.

WY2003 TMDL 200/400 model run. The purpose of this scenario was to determine whether, under the hydrologic conditions of WY 2003, with streams, shorelines and stormwater discharges at their 90th percentile values (corresponding to Part II of the freshwater standard), there would be any exceedances of Part II of the marine standard in the receiving waters (>43 cfu/100 mL). This would indicate whether the freshwater standards are low enough to protect marine waters, given the sizes of all the freshwater inputs.

For this scenario, all streams, shoreline, and stormwater discharges were set to 200 cfu/100 mL, and all WWTP discharges were set to 400 cfu/100 mL. The daily maximum FC concentration for each marine grid cell was used to calculate a 30-day moving 90th percentile for comparison with Part II of the standard (43 cfu/100 mL). Canary nodes in which at least one grid cell exceeded Part II of the standard (Table 12) were:

- Nearshore waters below Clear Creek, Dyes Inlet;
- Nearshore waters below Gorst Creek, Sinclair Inlet;
- Nearshore waters below Blackjack Creek, Sinclair Inlet (Figure 19); and
- Sinclair Inlet waters receiving Bremerton WWTP discharge and Loxie Eagens stormwater.



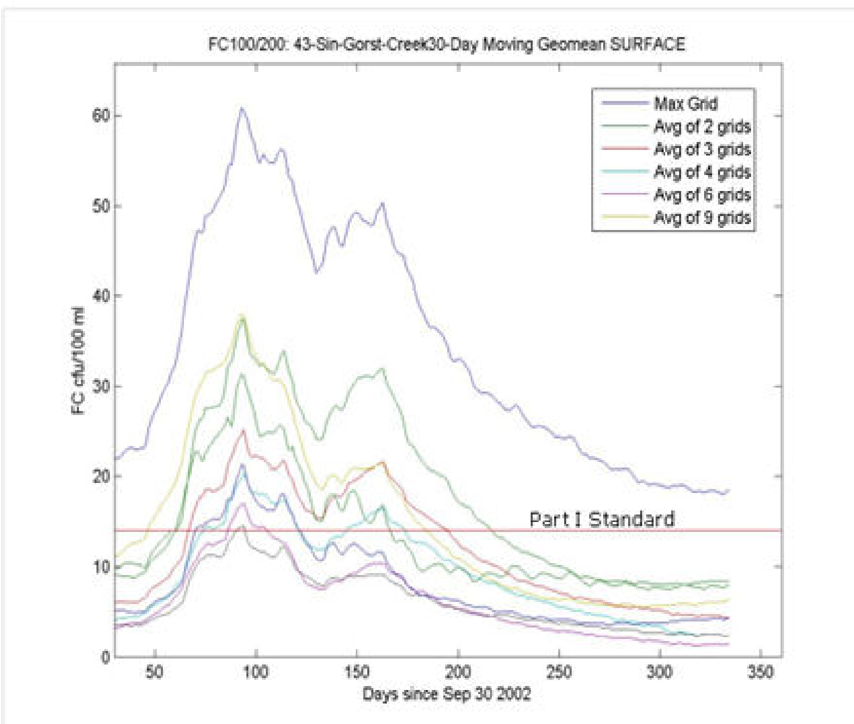


Figure 16. Location of canary node for receiving waters below Gorst *(upper figure)****.*** *Simulated 30-day moving geomean for surface grid cells of the Gorst canary node from WY2003 100/200 model run (lower figure).*

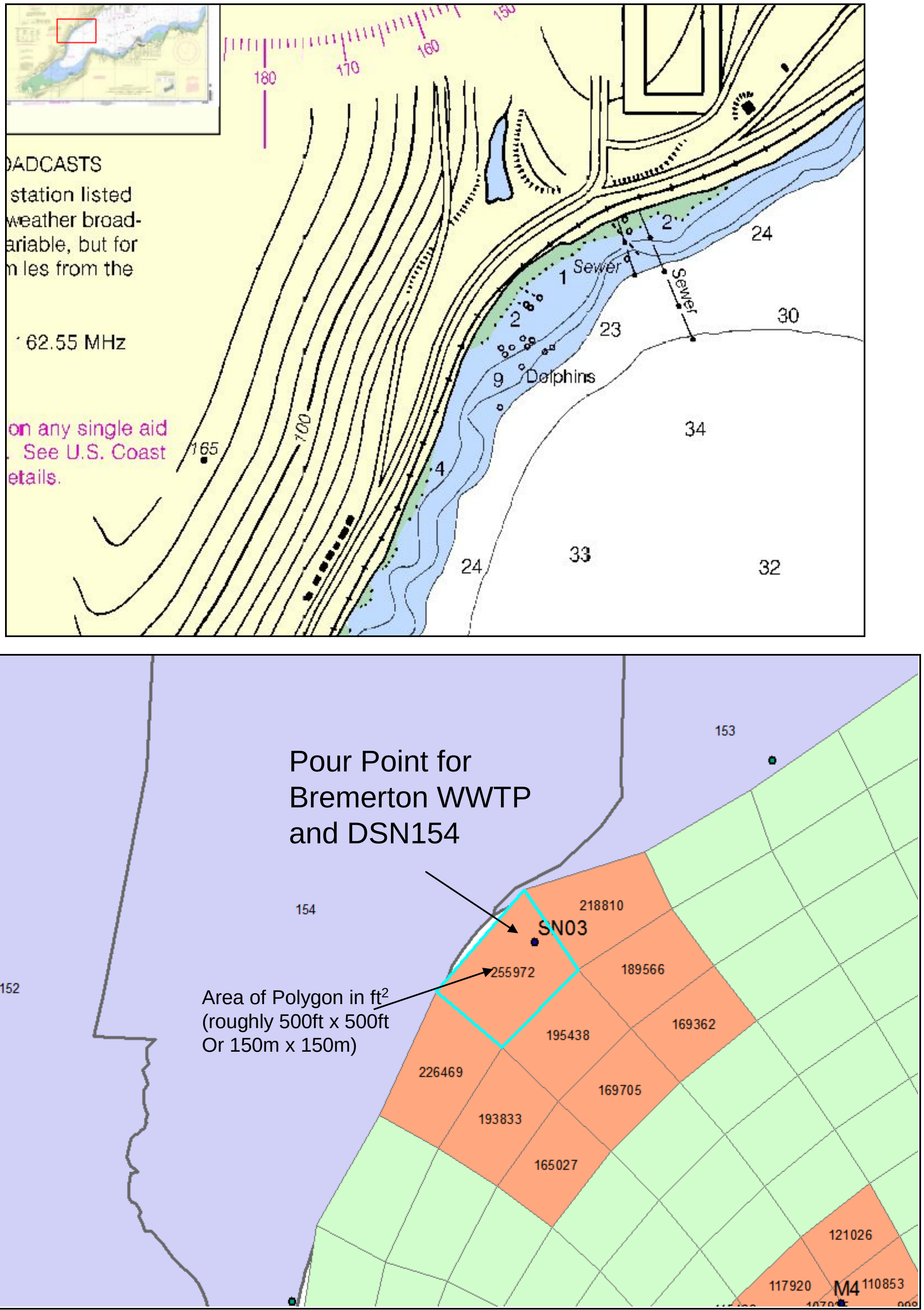


Figure 17. Location of Bremerton Westside WWTP outfall *(upper figure);* **canary node receiving the discharge and stormwater runoff from Loxie Eagens DSN 154** *(lower figure).*

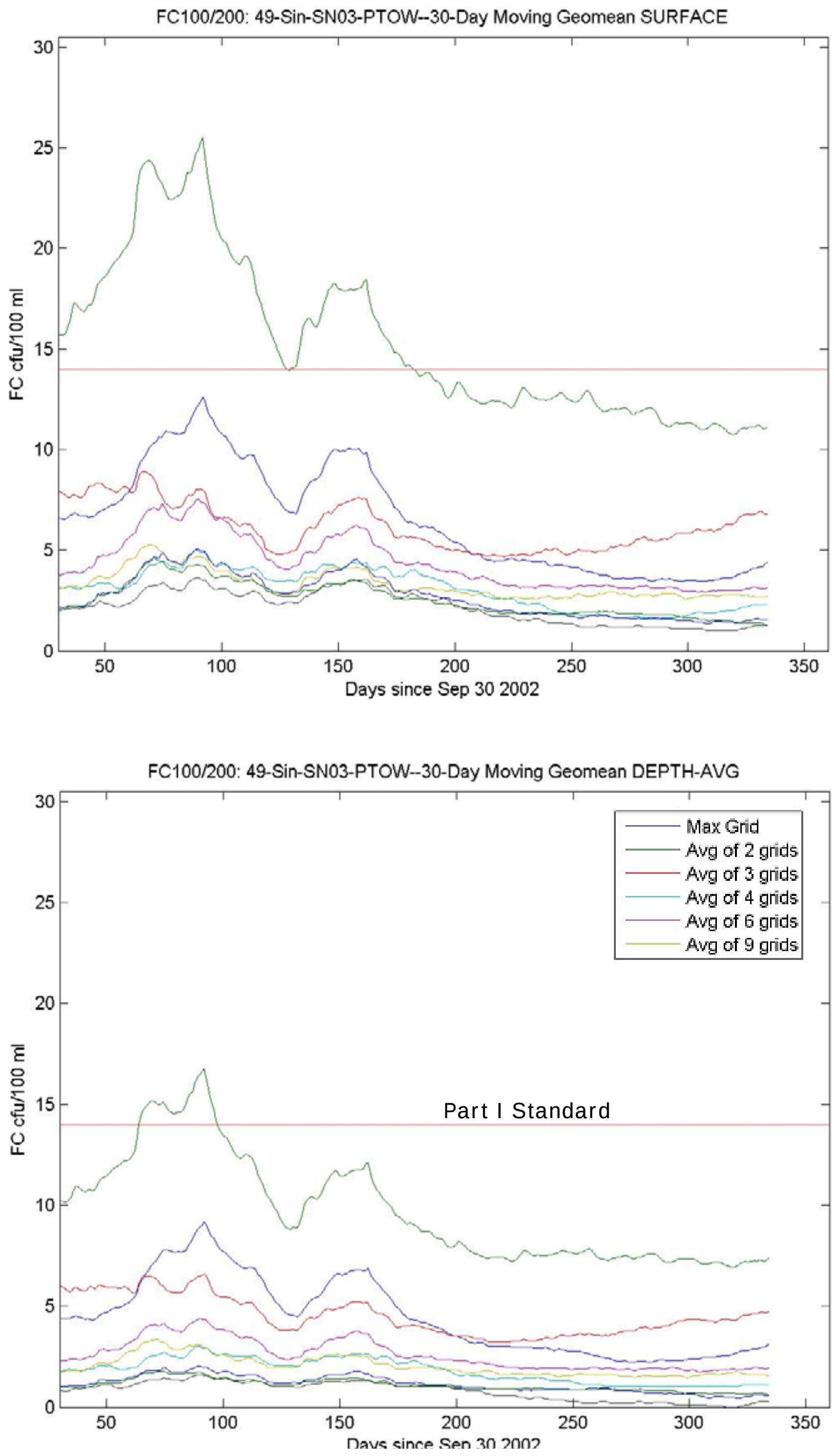


Figure 18. Simulated 30-day moving geomean for surface grid cells *(upper figure)* **and averaged over water column depths** *(lower figure)* **for cells that receive both Bremerton WWTP discharge and Loxie Eagens stormwater discharge (100/200 FC scenario).**

Table 12. WY2003 TMDL 200/400[a] model run results for four nearshore areas *where the average (AVG) of the two highest grid cells' 30-day moving 90th percentile of daily max FC concentration exceeded Part II of the marine standard (>43cfu/100 mL).*

Water body	Marine location	30-day moving 90th percentile of Daily Max FC			FC Reduction Needed
			cfu/100 mL		
		Grid cell	Surface	Depth-avg[b]	
Dyes	Nearshore below Clear Creek	AVG	58.9	58.9	**27%**
Sinclair	Nearshore below Gorst Creek	AVG	181.8	181.8	**76%**
Sinclair	Receiving waters for Bremerton WWTP treated discharge & stormwater	AVG	54.6	37.2	**21%**
Sinclair	Nearshore below Blackjack Creek	AVG	65.9	65.9	**35%**

[a] 100/200 model run used WY2003 hydrologic conditions and discharge volumes. Stream, shoreline, and stormwater inputs were set to 200 cfu/100 mL and WWTP discharges were set to 400 cfu/100 mL.

[b] For nearshore areas with depth of only meter (one grid cell deep), surface and depth-average FC concentrations are the same.

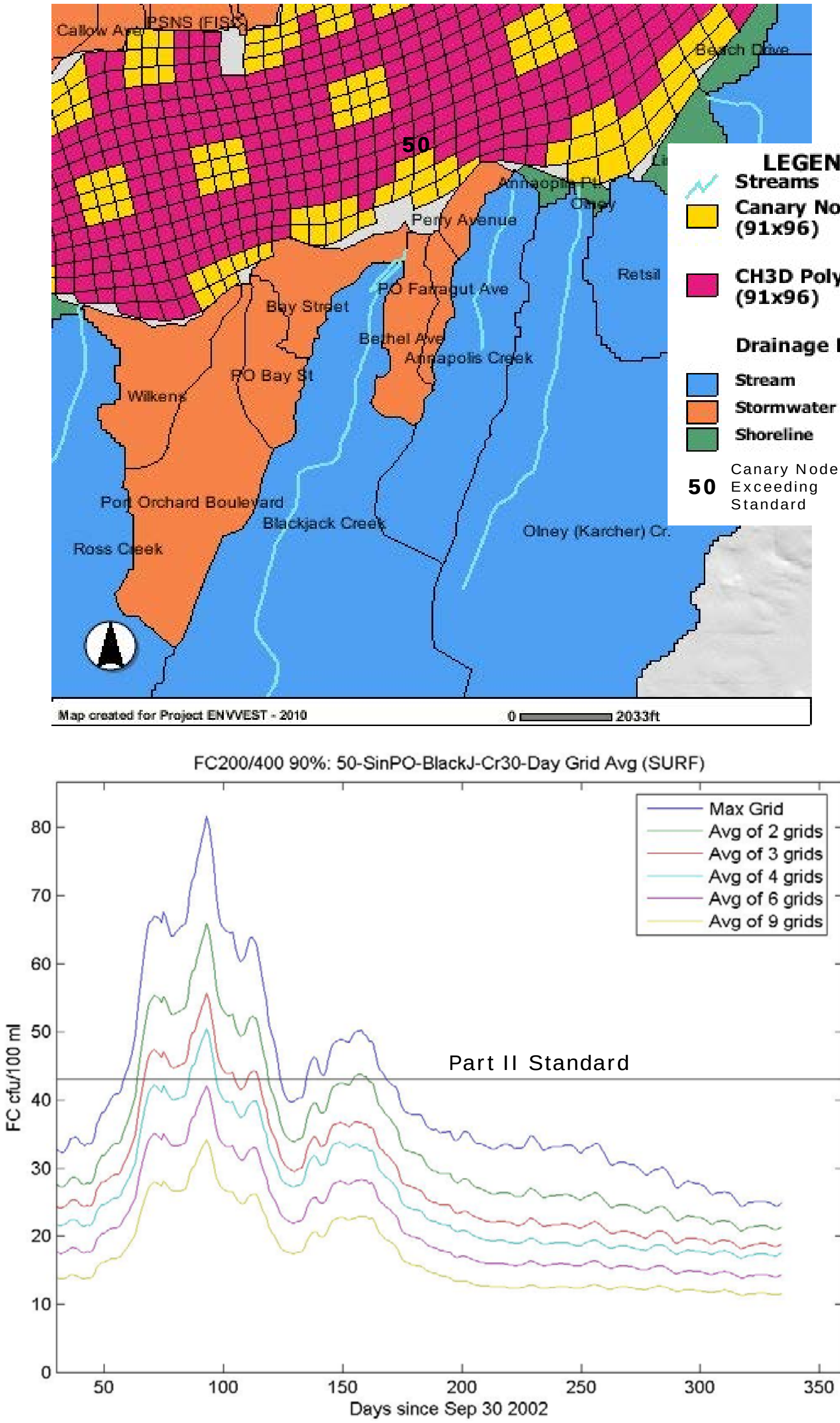


Figure 19. Marine grid cells below Blackjack Creek, Port Orchard *(upper figure).* **30-day moving averages for marine grid cells below Blackjack Creek (200/400 model run)** *(lower figure).*

Observed data. This is not a model run, but a set of monitoring results for WY2003 that can be compared with the results of the simulations. Tables 13 and 14 (from Johnston et al., 2009a) summarize WY2003 data for canary nodes for which there were FC measurements. Based on the observed data, water quality in one canary node (Blackjack Creek estuary in Port Orchard) exceeded both Parts I and II of the marine standard and five canary nodes exceeded Part II (Clear Creek, Anderson Cove/Pine Rd, Karcher Creek, Lynwood Center and Fort Ward nearshore).

Comparison of the observed data with results of the three model runs is instructive, but must be made with caution. If the model runs show an exceedance of the standards for a particular location, but the observed data do not, the model is not necessarily in error since the model provides a complete time series for WY 2003, whereas the number of actual measurements over the year (ranging from five to 60) is relatively small.

On the other hand, if the observed data show an exceedance not predicted by the model for a particular location, this suggests that additional monitoring and investigation of potential shoreline or watershed sources are warranted. The model uses an averaging process to estimate FC inputs for basins with particular land use/land cover (LULC) characteristics. Localized sources such as a failing onsite sewage system or transient sources such as broken pipes or livestock with direct access to a stream or ditch could result in high FC concentrations that happen to be collected in a sample. Such monitoring results may fall outside the model input values for FC estimated using LULC characteristics. In addition, data were missing for many canary nodes near the shipyard (#s 25-30) and central Sinclair Inlet (#s 39-41).

Of the six areas listed in Tables 13 and 14 (from Johnston et al., 2009a) not meeting the standards in WY 2003, the Clear Creek and Blackjack Creek nearshore areas were also predicted by the model to exceed standards. The remaining four locations – the Anderson Cove/Pine Rd area within Port Washington Narrows; the Fort Ward and Lynwood Center nearshore areas of Bainbridge Island; and the nearshore below Karcher Creek east of Port Orchard – may be associated either with large stormwater outfalls or failing shoreline residential septic systems.

In 2008, the Kitsap Health District and the city of Bainbridge Island completed and reported on shoreline surveys around the Lynwood Center cove area; no failing septic systems were identified (KCHD 2008; DOH 2009b). The 2008 survey confirmed that the Local Improvement District effort in 2006 by the city of Bainbridge Island to connect all shoreline properties around Lynwood Cove below Lynwood Center to sanitary sewer was successful in mitigating the elevated bacterial counts in shoreline drainages in 2003 ENVVEST sampling.

Table 13. “Observed data:” Fecal coliform statistics (WY2003 monitoring results) for sites in Dyes Inlet and other water bodies. *Observations for Dyes Inlet, Ostrich Bay, Phinney Bay, Port Orchard Passage, Rich Passage and Sinclair Inlet and comparison with marine water quality standards. Locations same as model canary nodes with same name. Shaded cells indicate exceedances.*

					Marine Water Quality Standard				
	Observed FC Data				Part I			Part II	
Group	n	Geomean	90th %		>=14	Reduction Needed		>=43	Reduction Needed
01-Dyes-Barker-Cr-	26	2	7		OK			OK	
02-Dyes-Chico-Cr--	60	4	17		OK			OK	
03-Dyes-Clear-Cr--	21	10	190		OK			YES	**77%**
04-Dyes-DY24-Straw	18	4	24		OK			OK	
05-Dyes-DY28-ClamI	16	2	3		OK			OK	
06-Dyes-DY32-Tracy	11	2	9		OK			OK	
07-Dyes-ErlandsPt-	13	2	7		OK			OK	
08-Dyes-M5-RockyPt	5	3	6		OK			OK	
09-Dyes-M7-MidWind	5	2	5		OK			OK	
10-Dyes-Windy-Pt	11	3	7		OK			OK	
11-Dyes-wShore	17	2	5		OK			OK	
12-Ostrich-Bay-M6	20	2	3		OK			OK	
13-Ostrich-eShore	15	2	4		OK			OK	
14-Ostrich-JackPar	5	2	4		OK			OK	
15-Ostrich-OBCreek	32	3	8		OK			OK	
16-OysterBay-all	46	3	15		OK			OK	
17-PhinnyBay-sEnd-	27	2	7		OK			OK	
18-POP-SN17-Waterm	11	2	8		OK			OK	
19-POP-Dee-Cr	11	6	38		OK			OK	
20-POP-IllaheeSPCr[a]	4	--	2		OK			OK	
21-POP-M1-MidChann	17	2	6		OK			OK	
22-POP-PO11	26	2	4		OK			OK	
23-POPASS-PO12	27	2	3		OK			OK	
24-POP-SpringBroCr	8	3	7		OK			OK	
25-30 Sinclair Inlet near shipyard			No data available						
31-PWN-DY01-mouth-	11	2	4		OK			OK	
32-PWN-EvrgnPark	6	10	17		OK			OK	
33-PWN-AnCov-PineR	21	6	50		OK			YES	14%
34-RPass-ClamBay	7	9	18		OK			OK	
35-RPass-FortWard[a]	4	--	938		--	Not known[a]		YES	95%
36-RPass-LynwoodC[a]	4	--	138		--	Not known[a]		YES	69%
37-RPass-M2-midChn	16	1	2		OK			OK	
38-RPas-SN18-Entra	11	2	4		OK			OK	
39-41 central Sinclair Inlet			No data available						
43-Sin-Gorst-Creek	17	3	10		OK			OK	
44-Sinclair-M3-mid	16	2	6		OK			OK	

[a]Only 4 measurements, so geometric mean not calculated.

Table 14. "Observed data:" Fecal coliform statistics for WY2003 monitoring for sites in Rich Passage and Sinclair Inlet *and comparison with marine water quality standards. Locations same as model canary nodes with same name. Shaded cells indicate exceedances.*

					Marine Water Quality Standard				
	Observed FC Data				Part I			Part II	
Group	n	Geomean	90th		>=14	Reduction Needed		>=43	Reduction Needed
45-Sinclair-M4-mid	7	7	14		OK			OK	
47-Sin-RossPt-SN08	11	2	7		OK			OK	
48-Sinclair-SaccoC	11	3	15		OK			OK	
49-Sin-SN03-POTW--	16	2	8		OK			OK	
50-SinPO-BlackJ-Cr	5	34	66		YES	58%		YES	35%
51-SinPO-KarcherCr	16	6	64		OK			YES	33%
52-SinPO-SN10-wfro	16	5	20		OK			OK	
53-Sin-SN11-12mari	27	4	21		OK			OK	

Summary of marine model results (Table 15): To protect shellfish harvest and recreation in the nearshore below Clear, Gorst, and Blackjack creeks, and near the Bremerton WWTP outfall, FC targets need to be more stringent than freshwater standards for those discharges. The limiting percent reductions and target concentrations are based on the model results in Tables 10, 11, 12.

Table 15. Percent reductions and target FC concentrations required to meet water quality standards as determined through the TMDL model simulations. *The FC target is applied to the freshwater source (Clear, Gorst, and Blackjack Creeks and the WWTP/stormwater discharges).*

Nearshore Area	Type	Limiting % Reduction	FC Target cfu/100 mL	
			Part I	Part II
03-Dyes-Clear-Cr	stream/shoreline/stormwater	27%	73	146
43-Sin-Gorst-Cr	stream/shoreline/stormwater	76%	24	47
50-SinPO-BlackJ-Cr	stream/shoreline/stormwater	38%	62	125
49-Sin-SN03-POTW	stream/shoreline/stormwater	27%	73	146
	WWTP	27%	147	293

Freshwater fecal coliform bacteria

The analyses conducted for the TMDL use historical and recent field and laboratory data, statistical analysis, and statistical modeling. Monitoring results and analysis of the FC bacteria data for Sinclair-Dyes watersheds are provided in *An Analysis of Microbial Pollution in the*

Sinclair-Dyes Inlets Watershed (May et al., 2005). The FC data evaluated in this study came from several sources:

- Kitsap County Health District
- Washington Department of Health
- Washington State Department of Ecology
- Puget Sound Naval Shipyard
- Kitsap County Surface and Stormwater Management
- City of Bremerton
- City of Bainbridge Island
- West Sound Utility District (Karcher Creek WWTP, now called South Kitsap Water Reclamation Facility)

Most of the data from the listed organizations was collected through regularly scheduled ambient monitoring. The quality assurance project plans for these data sources are referenced in May et al., 2005. Additional sampling by PSNS&IMF and other Project ENVVEST partner organizations was conducted to characterize dry weather flows from major stormwater outfalls and streams; base flows for streams; and storm event water quality in streams, marine nearshore areas, and stormwater outfalls. The sampling plans (ENVVEST, 2002; Johnston et al., 2004) were developed in coordination with Ecology and EPA and approved by Ecology.

Analytical framework

The modeling approach for FC bacteria in streams uses the statistical rollback method to determine the load reductions necessary to achieve the freshwater FC water quality standard. (The rollback method was also used as part of the marine modeling to calculate the stricter targets needed for some streams with larger impacts on marine FC concentrations.)

The statistical rollback method (Ott, 1995) has been used in a number of Ecology TMDLs to determine the necessary reduction for both the geometric mean value (geomean) and 90th percentile bacteria concentration (e.g., Joy, 2000) to meet water quality standards. Compliance with the more restrictive of the dual FC criteria determines the bacteria reduction needed. FC sample results for each site in this study were found to follow lognormal distributions, and the 90th percentile was calculated as the antilog of the mean of the log-transformed data plus 1.28 times the standard deviation of the log-transformed data.

The rollback method uses the statistical characteristics of a known data set to predict the characteristics of a sample population that would be collected after pollution controls have been implemented and maintained. In applying the rollback method, the reductions needed for the FC geomean and 90th percentile are determined by comparison with the water quality standard. The rollback factor is:

$$f_{rollback} = \text{minimum} \{ (100/\text{geomean}), (200/90^{th} \text{ percentile}) \} \qquad \text{Equation [5]}$$

and the percent reduction ($f_{reduction}$) needed is

$$f_{reduction} = (1 - f_{rollback}) \times 100\%, \qquad \text{Equation [6]}$$

which is the percent reduction that allows both geomean and 90th percentile target values to be met.

The result of statistical rollback is a target geomean that is usually lower (i.e., more restrictive) than the water quality criterion to allow for the 90th percentile of the sample population to meet water quality standards. The 90th percentile is used as an equivalent expression to the "no more than 10%" criterion found in the second part of the water quality standards for FC bacteria. The reduction factors for Sinclair-Dyes water bodies are included in a later section, load and wasteload allocations.

Seasonality and compliance with standards

Project ENVVEST FC data for streams were separated into wet season (October – April), dry season (May – September), and storm event data. Because there were seasonal differences in fecal coliform concentrations, compliance with standards was calculated separately for the two seasons, without the storm event data. The storm-event data for streams collected under the ENVVEST project are informative, but are not integrated with the dry and wet season data for calculating summary statistics and compliance with standards because:

- Storm event data represent a shorter period (WY2003 only) in contrast to ambient wet and dry season monitoring representing WY2001-2003.
- For most storm events, several samples were collected over time during the event. In contrast, the wet and dry season sampling was ambient monthly sampling with a single sample collected per sampling day.
- The wet and dry season data are not exclusive of storm events; some rain events occurred during ambient monthly sampling.
- Three streams (Pahrmann, Ostrich Bay creek, and Ross) were not monitored during storm events.

The required percent reductions for wet and dry seasons based on the 2000-2003 ENVVEST data are shown in Table 16. All the streams in the study needed reductions in FC concentrations in one or both seasons in order to meet standards, except for Chico Creek. Chico Creek did not need stricter freshwater targets in order to protect marine receiving waters. (The ENVVEST study also included Mosher and Anderson creeks, which met standards.) The FC percent reduction indicates the severity of the problem for each stream and the degree of improvement needed to meet the freshwater geometric mean and 90th percentile target capacity.

The five-month dry season (May through September) was the critical season for meeting freshwater standards in most streams. Geometric means and 90th percentile values for the dry season were usually higher than the corresponding FC statistics for wet season. For a minority (six) of the streams, water quality was poorer during storm events than during the dry season (Strawberry; Chico; Enetai; Gorst; Blackjack at SR-16; and Karcher).

For Dyes Inlet streams, the stream needing the most improvement in the dry season was Ostrich Bay Creek (93% reduction) followed by the Clear Creek system (64 to 90%); Barker Creek (56 to 86%); and Strawberry (68% to 90%). The higher reduction range for Strawberry Creek reflects its contribution to the Clear Creek estuary system where poor marine water quality requires a stricter target for polluted freshwater sources. (North Dyes Inlet where the Clear Creek estuary is located also receives direct discharges of stormwater.) Also in the dry season, Pahrmann Creek FC needed to be reduced by 64%. Chico Creek, the largest single stream discharging to either inlet, met the standards.

The Sinclair Inlet stream needing the most improvement in the dry season was Gorst (86 to 90% reduction required) followed by Sacco (88%); Karcher 86%; Annapolis 79%; Blackjack 48 to 68%; and Ross 64%. In Port Orchard Passage and Rich Passage/Clam Bay, Enetai (Dee) and Beaver creeks, respectively, needed 87 and 85% FC reductions, respectively, in the dry season.

The required FC percent reduction and Target Capacity for three streams (Clear/Strawberry, Gorst and Blackjack) were determined after review of the TMDL model simulations (see Section Marine FC Bacteria, Johnston et al., 2009a). The model results indicate that the FC load carried by these streams and other nearby discharges is large enough to result in exceedances of the marine water quality standards in marine waters near the stream mouths, even if these streams are meeting the 100/200 freshwater criteria.

Marine modeling for specific TMDL scenarios indicated that Clear, Gorst, and Blackjack creeks need 27%, 76% and 37.5% reduction, respectively, in FC bacteria in order to protect marine receiving waters (Tables 11 and 12). The proximity of the mouth of Strawberry Creek to Clear Creek requires that it be subject to the same marine protection as Clear Creek. These marine-protective percent reductions were applied to the freshwater criteria of 100 cfu/100 mL (geomean) and 200 cfu/100 mL (90^{th} percentile) to develop new freshwater target concentrations of 73 and 146 cfu/100 mL for Clear and Strawberry creeks; 24 and 47 cfu/100 mL for Gorst Creek; and 62 and 125 cfu/100 mL for Blackjack Creek (Table 15).

Table 16. Seasonal fecal coliform statistics for 2000 – 2003 ENVVEST data and required percent reductions.

Stream/site	WY 2003 Storm Events		2000-2003 Dry Season			2000-2003 Wet Season		
	Geomean	90th %ile	Geomean	90th %ile	Percent Reduction	Geomean	90th %ile	Percent Reduction
Dyes Inlet tributaries								
Pahrmann PA01	Not sampled		86	553	64	10	92	none
Barker BK01	109	422	138	450	56	53	352	43
Clear CC01	Not sampled		255	1411	90[a]	50	388	62[a]
Strawberry SR01	140	839	139	630	77[a]	33	178	18[a]
Chico CH01	71	224	41	141	none	8	61	none
Ostrich Bay OB01	Not sampled		582	2954	93	140	1568	87
Port Orchard Passage tributary								
Enetai DE01	423	3236	403	1585	87	231	1421	86
Rich Passage/Clam Bay tributary								
Beaver BV01	87	379	190	669	85	79	462	78
Sinclair Inlet tributaries								
Gorst at mouth	79	410	110	495	90[b]	45	247	81[b]
Gorst at Jarstad	107	351	83	369	46	40	346	42
Ross RS02	Not sampled		91	550	64	15	137	none
Blackjack at mouth	78	495	123	400	68[c]	39	138	9[c]
Blackjack SR16	114	524	76	252	21	26	141	none
Annapolis AP02	263	1551	317	953	79	216	1391	86
Karcher KA01	365	2847	232	705	86	125	958	90
Sacco SC04	109	544	200	845	88	107	877	89

[a] A 27% reduction in freshwater criteria for Clear Creek was determined by modeling the impacts of its discharge on marine waters (Dyes Inlet, see Section Marine FC bacteria). Statistical rollback was then applied to 2001-2003 data for Clear and Strawberry creeks to develop marine-protective freshwater targets.

[b] A 76% reduction in freshwater criteria for Gorst Creek was determined by modeling the impacts of its discharge on marine waters (Sinclair Inlet, see Section Marine FC bacteria). Statistical rollback was then applied to 2001-2003 data for Gorst Creek to develop marine-protective freshwater targets.

[c] A 38% reduction in freshwater criteria for Blackjack Creek was determined by modeling the impacts of its discharge on marine waters (Sinclair Inlet, see Section Marine FC bacteria). Statistical rollback was then applied to 2001-2003 data for Blackjack Creek to develop marine-protective freshwater targets.

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Current Water Quality

In this section, recent water quality data for the Sinclair-Dyes watershed are reviewed. The progress achieved "in the water" is compared with the percent reductions required as determined by the ENVVEST modeling results and the monitoring data for WY2003. For nearshore and stream sites where water quality has not changed, the percent reductions required to meet water quality standards will form the basis of load and wasteload allocations (see Loading Capacity section). For sites where water quality has improved or been degraded, new percent reductions are calculated to adjust load and wasteload allocations.

Current marine water quality

Marine water quality in many parts of Sinclair and Dyes Inlet and adjacent waters has improved since 2005. The 2010 shellfish harvest classifications (Figure 20) include most of Chico Bay approved in 2009 and a conditionally-approved area in the larger central portion of Dyes Inlet. Prohibited areas include northern Dyes Inlet near Silverdale, Clear Creek and Strawberry Creek; southeastern Dyes Inlet and Port Washington Narrows, and Ostrich, Oyster and Phinney bays. The increase in harvest area since 2003 can be seen by comparing Figures 14 and 20.

To assess current conditions, Ecology reviewed FC bacteria data from KCHD and DOH sites for WYs 2009 and 2010 (Table 17; Figures 21 and 22). The stations monitored by DOH and KCHD cover most of the marine nearshore sites monitored under Project ENVVEST; however a few Project ENVVEST mid-passage or mid-inlet stations are not monitored currently. Data for DOH sites that met both parts of the marine standard in WY2009 and 2010 are included in Appendix J.

During WY2009, most marine nearshore sites were in compliance with water quality criteria, with the exception of:

- DY27/DOH466, a site below Clear Creek likely affected by stormwater discharges in the nearshore area combined with creek discharge.
- DY25 in the nearshore below Strawberry Creek.
- DY34, a site on Port Washington Narrows likely affected by stormwater from one or more city of Bremerton stormwater outfalls.
- DOH471, off Chico Bay's western shore.
- DOH487, off Oyster Bay's eastern shore.
- SN12, Blackjack Creek estuary.
- Port Orchard Passage station DOH457 off Fletcher Bay, Bainbridge Island.

In WY2003, three of these sites had measured exceedances of water quality standards (DY25, DY34, and SN12; Tables 13 and 14). Also, the TMDL model simulation "Actual Conditions"

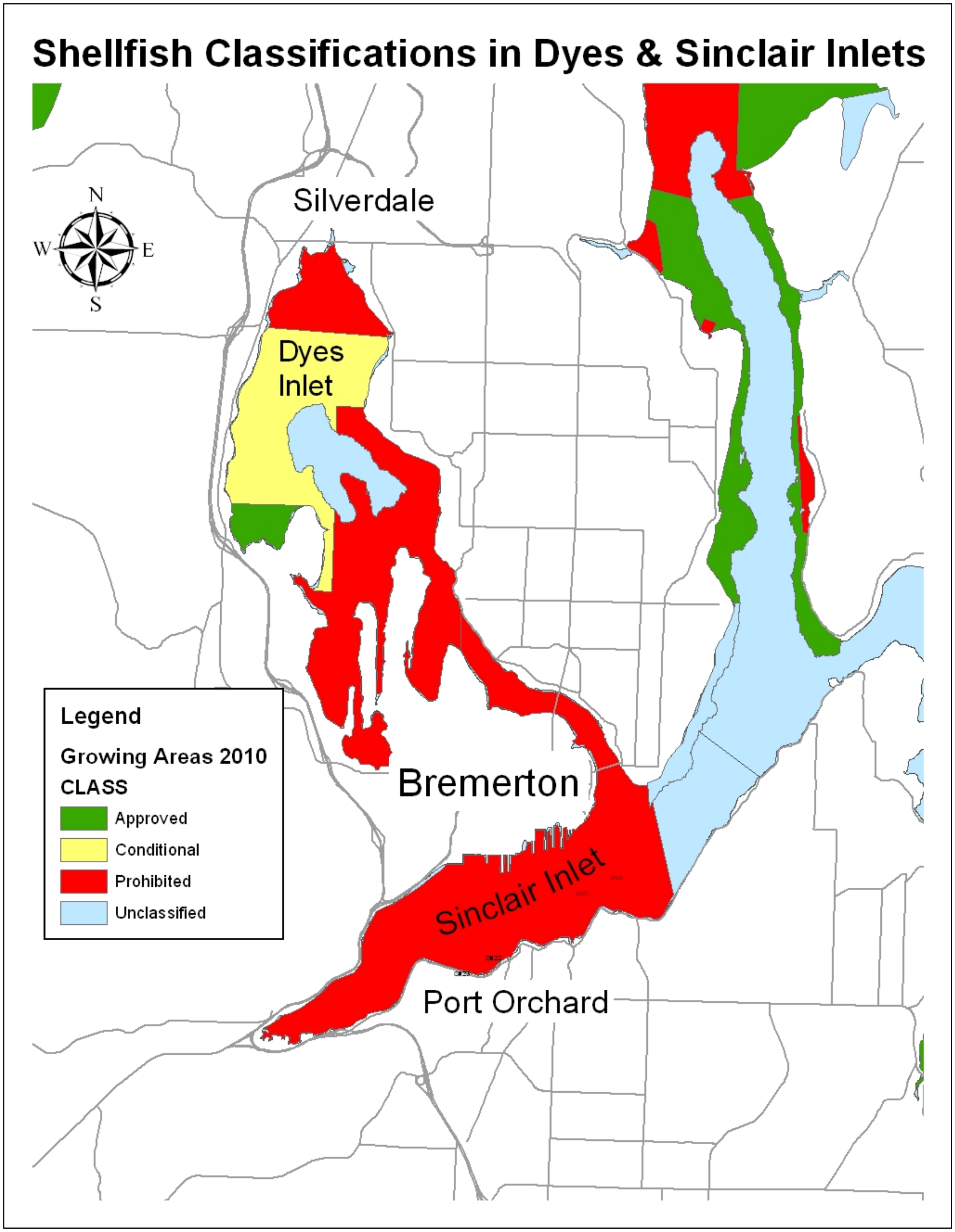

Figure 20. Washington Department of Health shellfish classifications for Sinclair and Dyes Inlets and adjacent marine waters, 2010

(Table 10) predicted an exceedance at DY25, the nearshore area below Strawberry and Clear creeks; the TMDL model simulation "100/200" (Table 11) predicted an exceedance at SN12, the

.

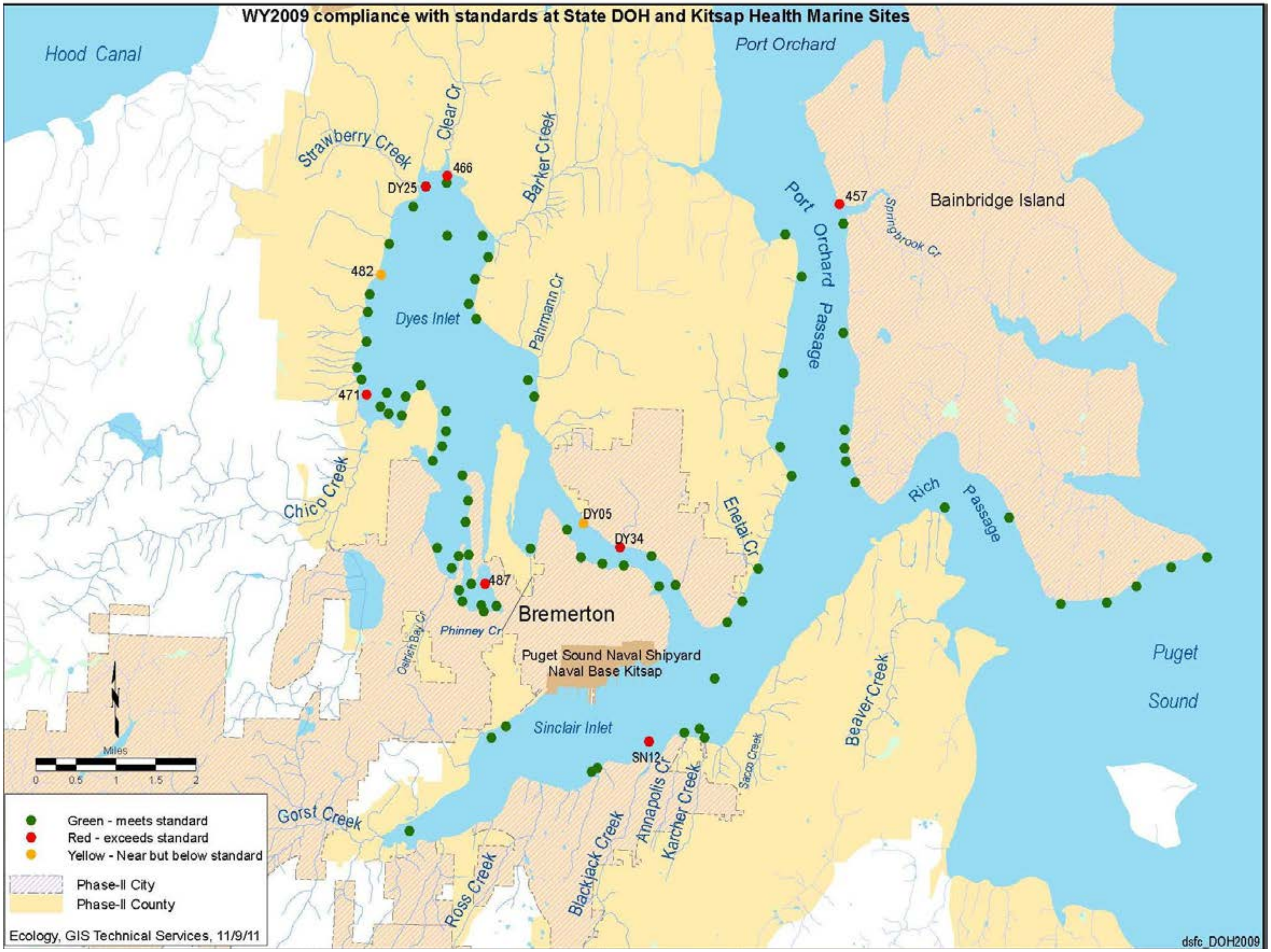

Figure 21. DOH and KCHD marine stations: Compliance with standards in WY2009.

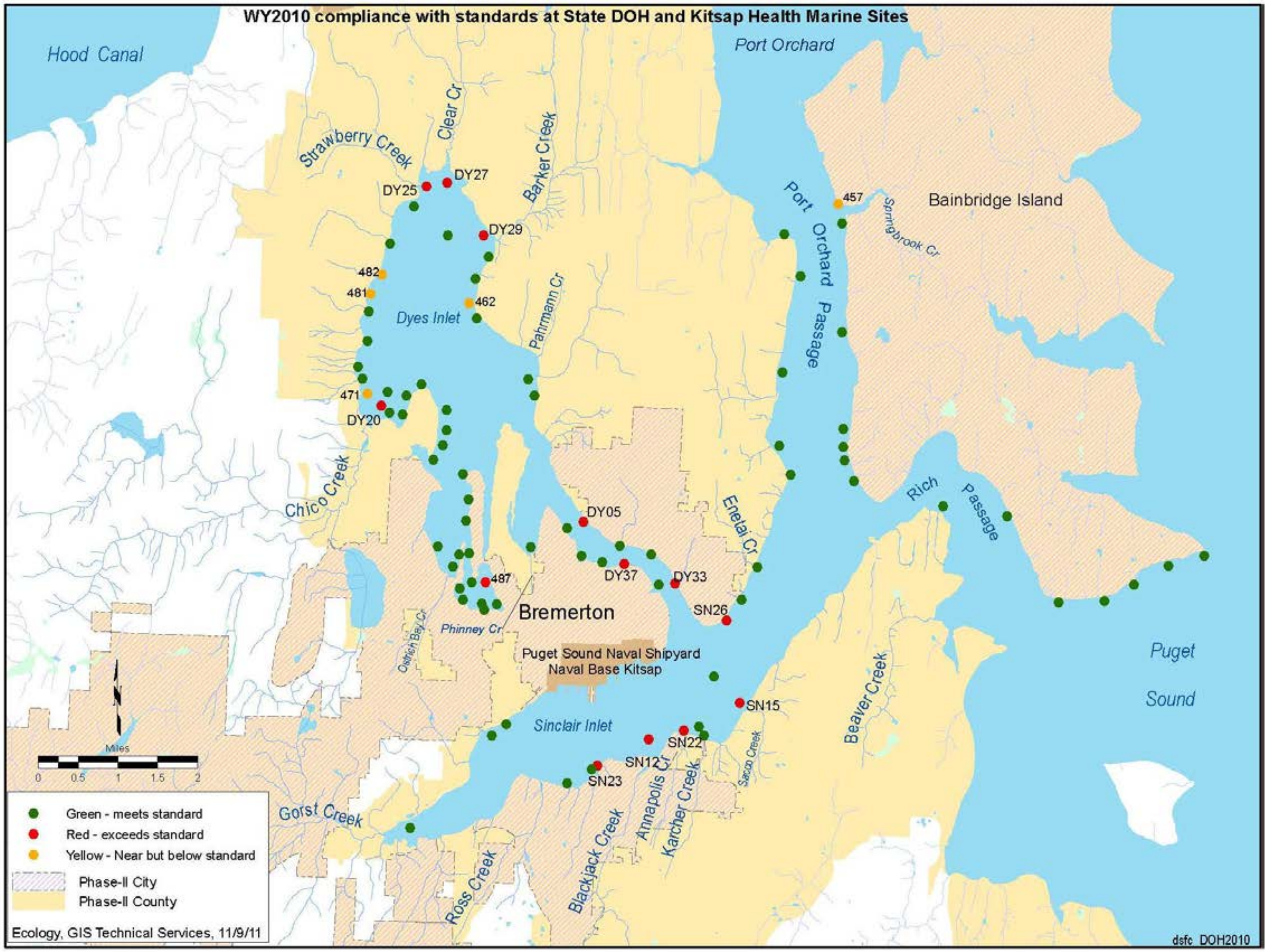

Figure 22. DOH and KCHD nearshore stations: Compliance with standards in WY2010.

Table 17. Sinclair-Dyes nearshore marine sites not meeting standards in WY2009 or 2010. *Values in shaded cells exceed either Part I or Part II of the marine water quality standard. Data for sites that met standards in both years listed in Appendix J.*

Site No.	WY2009		WY2010		Kitsap Health/DOH monitoring site
	GM	90th	GM	90th	
Dyes Inlet and bays					
DY29	3	8	5	122	Nearshore below Barker Creek
DY25	3	45	12	281	Nearshore below Strawberry Crk
DY27	3	8	23	818	Nearshore below Clear Creek
DY20	2	6	8	74	Chico Bay
DOH471	3	45	8	34	Chico Bay west shore
DOH487	6	105	13	47	Oyster Bay east shore
Port Washington Narrows					
DY05	6	34	9	68	Below Lions Park
DY33	1	2	8	75	Opposite Evergreen Park
DY37	2	12	4	46	Chester Ave. stormwater outfall
DY34	5	154	12	33	Nearshore Lent landing, SW of B-ST03 & CSO-OF11
Port Orchard and Rich Passages					
DOH457	5	104	5	39	Offshore Fletcher Bay
Sinclair Inlet					
SN26	1	2	5	75	Bachmann Park outfall
SN23	2	4	11	76	PO public boat ramp
SN22	4	22	6	61	below Annapolis Crk
SN15	*No data*		4	47	below Sacco Crk
SN12	6	101	10	77	below Blackjack Crk

nearshore area below Blackjack Creek; and the TMDL model simulation 200/400 (Table 12) predicted exceedances at both DY25 and SN12.

In WY2010, one site (DY34 in Port Washington Narrows) met standards but DY25 and SN12 continued to exceed marine water quality criteria. Other sites failing were (Table 17):

- Dyes Inlet stations below Barker Creek (DY29); and in the estuary of Clear/Strawberry creeks (DY25 and DY25/DOH466);
- Chico Bay station DY20;
- Oyster Bay eastern shore (DOH487);
- Port Washington Narrows near Lions Park (DY05); near the Chester Avenue stormwater outfall (DY37); and along the East Bremerton shoreline across from Evergreen Park (DY33).

- Sinclair Inlet stations SN12, SN15 and SN22 below Blackjack, Sacco and Annapolis creeks, respectively; SN23 near a stormwater outfall at Port Orchard public boat ramp; and SN26 below the Bachmann Park Gazebo, near a city of Bremerton stormwater outfall.

In WYs 2009 and 2010 total annual precipitation was 41 and 66 inches, respectively, at the Bremerton National Airport gauge. (For comparison, WY2003 total annual precipitation in Bremerton was 42 inches.) This 50 percent increase in rainfall in WY2010 compared with 2009 was likely an important factor in the poorer water quality in Dyes and Sinclair Inlets in WY2010 (Figures 21, 22).

Only one rain event in WY2010 was large enough to result in combined sewer overflows from city of Bremerton outfalls (pers. comunic., C. Berthiaume, city of Bremerton Utilities, 2010).

In Rich Passage below Fort Ward, Project ENVVEST storm-event FC data for a nearshore site near a stormwater outfall (Appendix F, BI-FWNS) suggest this area may have been subject to impacts from polluted stormwater or other sources such as the nearby salmon net pens that attract birds and marine mammals. No recent marine data are available for this site.

In Rich Passage below Lynwood Center, Project ENVVEST storm-event FC measurements were high for a nearshore site (Appendix F, BI-LCNS) and indicate this area may have been subject to impacts from failing onsite systems, polluted stormwater or other sources, including wildlife. Through the city of Bainbridge Island (COBI) efforts, a Local Improvement District (LID) was established and nearly all Lynwood Center shoreline residences were connected to sewer (Kitsap Sewer District No. 7) by 2006. The few that remained on septic installed new, state-of-the-art systems. In 2008 KCHD and COBI conducted shoreline surveys around Lynwood Cove and found no failing septic systems and healthy shoreline conditions (personal communication, C. Apfelbeck, city of Bainbridge Island, March 2011).

Since no recent marine data are available for this site, data will be collected by COBI as required under the Implementation Plan.

Current stream water quality

Kitsap County Health District (KCHD) conducts ambient monthly water quality monitoring on many of the Sinclair-Dyes streams evaluated in 2000-2003 under Project ENVVEST and publishes the results annually (KCHD 2010a; KCHD 2010b). KCHD data for WY2010 were separated by season for a comparison of stream geometric means and 90th percentile values with the WY 2001-2003 ENVVEST data (Table 18).

- Chico Creek met standards in WY2000-2003 and continues to meet standards.
- Several Dyes streams appear to show improvement, undoubtedly the result of the extensive work by Kitsap County Health District (KCHD) and local government partners in the Dyes Inlet Restoration Project (a PIC project), conducted from 2005 through 2009.
    - Pahrmann Creek now meets Part I and Part II in the dry season. In the wet season, this creek formerly met both parts of the standard but in WY2010 met only Part I.

- Barker and Ostrich Bay creeks do not show a change in compliance with Part I and Part II in WY2010 compared with 2000-2003.

Both Clear and Strawberry creeks in WY2010 dry season are in or near compliance, showing considerable progress. In 2007 a failing septic system was located and fixed in the drainage above CC01 (lower Clear Creek) and likely contributed to this improvement. In the wet season, both creeks meet Part I but not Part II.

- Enetai Creek on Port Orchard Passage now meets Part I in the wet season and has made considerable progress in the dry season as well. Enetai Creek has been assigned Category 4B in the state Water Quality Assessment – it has a pollution control program being implemented.
- Beaver Creek now meets both Parts I and II in wet season and has improved substantially in the dry season.
- In Sinclair Inlet, Gorst Creek has improved considerably but does not meet the stricter targets (24/47) set for the mouth due to its influence on nearshore marine waters. Gorst Creek has been assigned Category 4B – it has a pollution control program being implemented.
- Ross Creek met both parts of the standard in both seasons in WY2010.
- Blackjack Creek now meets the stricter 62/125 standards of this TMDL in the dry season. In the wet season of WY2010, it met the first part of the standard but not Part II.
- Annapolis Creek in WY2010 met both parts of the standard in the dry season and Part I in wet season.
- In WY2010, both Karcher and Sacco creeks, which need to meet the Extraordinary Primary Contact Recreation 50/100 standards, show measurable progress since 2000-2003 but do not meet the standards in either wet or dry season.

Current stormwater quality

Current measurements of FC bacteria in stormwater discharges to Sinclair and Dyes Inlets are not available. The monitoring plan (see section, *Performance measures and targets [Monitoring Plan])* under "Measuring Progress Toward Goals") does not require direct measurements of stormwater discharge. Instead, the TMDL requires that the stream and nearshore marine receiving waters continue to be monitored, and assigns to NPDES stormwater permittees the task of following up through their IDDE programs if the receiving waters show impairment.

Some monitoring of stormwater may also be conducted through these programs:

- The PSNS&IMF is currently updating the Shipyard's stormwater pollution prevention plan (SWPPP) (PSNS&IMF 2007) and is implementing a stormwater monitoring program (TAI 2009, TEC 2010) for the Shipyard and an ambient monitoring program for Sinclair and Dyes Inlets (Johnston et al., 2010a), including monthly monitoring of bacteria concentrations at a network of stations within the shipyard (Johnston et al., 2010b). The SWPPP's pollution prevention team is working to develop, implement, and maintain a pollution prevention plan for stormwater: reviewing, improving, and implementing stormwater BMPs, and improving industrial processes to reduce stormwater pollution. The stormwater monitoring program will monitor runoff from representative stormwater basins during qualifying stormwater events (>0.25 in of rainfall within a 24 hr period following a discernable period of no rainfall) (TEC 2010).

- Naval Base Kitsap (NBK) Bangor has a current SWPPP that meets the requirements of the most current (2008) EPA Multi-Sector General Permit (MSGP) for Stormwater Discharges from Industrial Activities (an NPDES permit). The MSGP requires annual sampling for outfalls that discharge to impaired waters. To meet permit requirements, NBK Bangor has conducted annual fecal coliform sampling at two Bangor stormwater systems that discharge to tributaries of Clear Creek (S. Jefferis, Naval Facilities Engineering Command NW, personal communication).

- The Puget Sound Partnership and Ecology Stormwater Working Group developed a scientific framework and recommendations for implementing a Puget Sound-wide stormwater monitoring network. As this report is written, Ecology has issued for public comment draft Phase I and Phase II NPDES municipal stormwater permits: www.ecy.wa.gov/programs/wq/stormwater/municipal/2012draftMUNIpermits.html

    - Locally, Kitsap County Surface and Stormwater Management is actively coordinating monitoring and assessment activities in Kitsap County (M. Fohn, Kitsap County SSWM, personal communication).

Table 18. Freshwater fecal coliform bacteria data for 2000-2003 (ENVVEST Project) and WY2010 (KCHD).

Stream/site	Target Concentration		2000-2003 Storm Events		2000-2003 Dry Season		2000-2003 Wet Season		WY 2010 Dry Season		WY 2010 Wet Season	
	Geomean cfu/100 ml	90th %ile cfu/100 ml	Geomean cfu/100 ml	90th %ile cfu/100 ml	Geomean cfu/100 ml	90th %ile cfu/100 ml	Geomean cfu/100 ml	90th %ile cfu/100 ml	Geomean cfu/100 ml	90th %ile cfu/100 ml	Geomean cfu/100 ml	90th %ile cfu/100 ml
Dyes Inlet tributaries												
Pahrmann PA01	100	200	Not sampled		86	553	10	92	56	110	48	490
Barker BK01	100	200	109	422	138	450	53	352	141	302	24	658
Clear CC01	73[a]	146[a]	Not sampled		255	1411	50	388	44	92	42	264
Strawberry SR01	73[a]	146[a]	140	839	139	630	33	178	45	142	49	940
Chico CH01	100	200	71	224	41	141	8	61	21	50	22	168
Ostrich Bay OB01	100	200	Not sampled		582	2954	140	1568	639	6044	135	1180
Port Orchard Passage tributary												
Enetai DE01	100	200	423	3236	403	1585	231	1421	165	334	80	826
Rich Passage/Clam Bay tributary												
Beaver BV01	50[b]	100[b]	87	379	190	669	79	462	94	202	13	62
Sinclair Inlet tributaries												
Gorst at mouth	24[a]	47[a]	79	410	110	495	45	247	72	150	15	138
Gorst at Jarstad	100	200	107	351	83	369	40	346	Not sampled		Not sampled	
Gorst at GMGC[c]	100	200	Not sampled		Not sampled		Not sampled		27	116	5	13
Ross RS02	100	200	Not sampled		91	550	15	137	20	62	6	122
Blackjack at mouth	62[a]	125[a]	78	495	123	400	39	138	42	94	17	218
Blackjack SR16	100	200	114	524	76	252	26	141	44	86	30	266
Annapolis AP02	100	200	263	1551	317	953	216	1391	151	240	61	814
Karcher KA01	50[b]	100[b]	365	2847	232	705	125	958	248	302	120	1462
Sacco SC04	50[b]	100[b]	109	544	200	845	107	877	127	1253	59	552

[a] Target reduced to meet marine standard in nearshore

[b] Extraordinary standard applies

[c] At Gold Mountain Golf Club

Exceeds standard

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Loading Capacity

This section explains the fecal coliform (FC) loading capacity for the marine waters and streams draining to Sinclair and Dyes Inlets and the contiguous portions of Port Orchard Passage and Rich Passage. The "loading capacity" of a water body is the maximum amount of pollutant it can receive from all inputs (both point and nonpoint sources) and still meet the state water quality standard.

The most comprehensive dataset available for this watershed, including water quality data for streams, stormwater, and marine nearshore areas and gauged flow for streams and stormwater, is for WY2003. Modeling of the TMDL scenarios used this dataset to determine the percent reductions in bacteria required for the marine water bodies and streams to meet water quality standards. These percent reductions, based on WY 2003 conditions, provide the baseline for assessing progress. Load and wasteload allocations assigned to organizations with responsibility for implementation take into account the most recent data for WY2009 and WY2010. A great deal of implementation has been accomplished since 2003.

Wasteload allocations are used to assign responsibility for implementation to organizations under permit; load allocations are for nonpoint sources and are addressed through a variety of actions. In this section, the TMDL analysis for WY2003 is used to establish preliminary load and wasteload allocations. Recent data for WY2009 and WY2010 are then used to set final load and wasteload allocations.

Because the state water quality standard for bacteria is based on statistical targets, the TMDL uses statistical targets to define loading capacities. The applicable statistics from the two-part FC bacteria standard for Sinclair-Dyes marine waters are:

- The loading capacity of marine waters (Sinclair and Dyes Inlets) is the marine water quality standards: 14 cfu/100 mL (geometric mean) and 43 cfu/100 mL (90^{th} percentile).

For Sinclair-Dyes freshwaters, the applicable statistics are:

- For streams discharging to marine waters designated Primary Contact, a geometric mean less than 100 cfu/100 mL and no more than 10 percent of samples to exceed 200 cfu/100 mL, unless a more restrictive target is needed to protect marine water quality. (Ecology uses the 90^{th} percentile statistic for a dataset as equivalent to the "no more than 10 percent" criterion.)
- For streams discharging to marine waters designated Extraordinary Primary Contact, a geometric mean less than 50 cfu/100 mL and no more than 10 percent of samples to exceed 100 cfu/100 mL, unless a more restrictive target is needed to protect marine water quality.
- For certain streams with relatively high flow and FC pollution (Clear/Strawberry, Gorst, and Blackjack), the loading capacity is reduced to the level that will allow marine receiving waters to meet WQS.

Preliminary load and wasteload allocations for marine waters

Sinclair and Dyes Inlets receive nonpoint discharges of FC bacteria from failing onsite sewage systems, animal waste, and stormwater discharges not covered by NPDES permit (such as those areas of Kitsap County outside NPDES Phase II jurisdiction).

FC concentrations in shoreline runoff to marine waters were estimated in the ENVVEST project based on the land use/land cover (LULC) characteristics of the different shoreline segments (May et al., 2005). Using the "best estimate" of FC loading conditions for WY2003 (Actual Conditions scenario, Johnston et al. 2009), the ENVVEST model predicted that nearshore areas below Clear/Strawberry and Gorst creeks would exceed standards due to FC loading from streams, stormwater, and shoreline discharges. (Averaging of grids resulted in the prediction that the estuary below Blackjack would meet marine standards.) Additionally, monitoring data also show nearshore areas that do not meet standards (see Current Marine Water Quality, in Current Water Quality section).

Load allocations (LAs) apply to all nonpoint sources contributing to receiving-waters impairments, including non-permitted (non-MS4) stormwater and shoreline sources, although they are not specifically broken out by source.

Point sources are facilities or municipalities with NPDES permits. If the TMDL determines a permittee has responsibility for the parameter of concern, it is assigned a wasteload allocation (WLA). The WLA must be expressed in numeric form in the TMDL. The stormwater permit may contain best management practices that will reduce the discharge of the parameter of concern instead of a numeric limit. Compliance with the action items/best management practices identified for a permittee's discharge constitutes compliance with the assigned WLA for that discharge.

The point sources that discharge to Sinclair-Dyes marine waters include:

- Municipalities and jurisdictions with NPDES Phase II permits that discharge stormwater from an MS4.
- Wastewater treatment plants (WWTPs) with individual NPDES permits.
- U.S. Navy. The Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS & IMF) has an NPDES permit issued by EPA Region 10 for drydock and stormwater discharge to Sinclair Inlet. Naval Base Kitsap Bangor has an NPDES Multi-Sector General Permit from EPA Region 10 for stormwater discharges.
- Washington State Department of Transportation (WSDOT), which has an Ecology NPDES stormwater permit for stormwater discharges from state highways and facilities.

Within the jurisdictions with NPDES stormwater permits, both point and nonpoint sources are assumed to contribute to bacteria loads in each drainage. (Nonpoint pollution can occur within an NPDES stormwater jurisdiction if there are direct discharges to creeks or marine shoreline, whether from onsite septic or animal waste, that are not transported by an MS4 conveyance system.) If data are not available to distinguish point source contributions from nonpoint source contributions, then the same percent reduction needed to meet FC target concentrations is assigned to both point and nonpoint sources.

This section explains the basis for the preliminary WLAs assigned to NPDES-permitted entities in the Sinclair-Dyes watershed. Tables 19, 20 and 21 list the jurisdictions and the preliminary decisions regarding the need for WLAs. Ecology assigned a preliminary WLA to point source dischargers to marine waters that met either of the following two conditions:

- Jurisdictions that may contribute bacteria to a nearshore area where WY 2003 "observed data" exceed the marine water quality standards (PSNS&IMF is included because of the high concentrations of bacteria in six of its outfalls, despite an absence of nearshore receiving water data. It is expected that PSNS&IMF will provide receiving water data to demonstrate whether or not its discharges are impairing nearshore waters). This condition applies to outfalls under the jurisdiction of (Table 19):
    - City of Bainbridge Island
    - City of Bremerton
    - City of Port Orchard
    - Kitsap County
    - PSNS & IMF
    - Washington State Department of Transportation (WSDOT)
- The facility or municipality discharges stormwater or wastewater to a nearshore marine area where the ENVVEST model predicts exceedances (Tables 11 and 12). This condition applies to (Table 20):
    - Bremerton WWTP

In Table 19, the preliminary WLAs assigned to the cities of Bainbridge Island, Bremerton and Port Orchard, Kitsap County, PSNS&IMF, and WSDOT are in a range of 27 to 77 percent. These percent reductions, based on the WY 2003 analysis, are the fecal coliform percent reductions needed for the marine receiving waters to meet standards.

Added support for the preliminary WLAs is provided in both high measured bacteria concentrations in stormwater and a high estimated bacteria load from at least one outfall associated with all the jurisdictions with the exception of WSDOT. Table 8 ranks the 33 stormwater outfalls monitored in WY 2003 by fecal coliform concentration. Except for WSDOT discharges, which were not monitored in the ENVVEST project, all the jurisdictions assigned a preliminary WLA in Table 19 had at least one outfall with geomean and 90^{th} percentile statistics well above the freshwater quality criteria, and these jurisdictions had at least one outfall with fecal coliform load modeled to be among the top 30 sources (Figure 12). Bremerton WWTP also ranks among the top 30 in estimated loading to the inlets.

Table 19. Preliminary marine wasteload allocations for Phase II municipal stormwater permittees, PSNS & IMF[a], and WSDOT based on the WY2003 analysis.

NPDES Stormwater Jurisdiction	Stormwater outfall(s)	Simulated FC load[b] (WY2003 avg) (million counts/hr)	Receiving waters FC target		Nearshore "observed" FC data for WY2003 (cfu/100 mL)		Preliminary WLA (Percent reduction)
			GM	90th ile	GM	90th %ile	
Kitsap County	Discharges to Lower Clear Creek	572	14	43	10	190	77[c]
City of Bremerton	Discharges to East Bremerton Pine Rd/Anderson Cove	493	14	43	6	50	14[d]
City of Bainbridge Island	Discharges to Fort Ward nearshore	371	14	43	n/a[e]	186	77[d]
City of Bainbridge Island	Discharges to Lynwood Center nearshore	327	14	43	67	138	79[d]
PSNS & IMF	PSNS015	310	14	43	No data available		To be determined[f]
City of Port Orchard	Discharges to nearshore below Blackjack Creek	No estimate available	14	43	34	66	58[c]
City of Port Orchard	Discharges to nearshore below Karcher Creek	No estimate available	14	43	6	64	33
WSDOT	Stormwater drainage from state highways to marine waters	WLA is percent reduction needed for marine waters to meet standards, for state highway drainages to impaired marine waters.[c]					

[a]NPDES permit for federal facilities administered by Region 10 EPA.
[b]From Table 9.
[c]Based on the percent reduction needed for the 90th percentile to meet standards (Table 13).
[d]Based on WY2003 "observed data" (Tables 13 and 14).
[e]Insufficient data to calculate a geometric mean for comparison with standards.
[f]PSNS & IMF will provide nearshore receiving water FC data to Ecology and EPA to determine need for WLA.

Table 20. Preliminary marine wasteload allocations for NPDES permittees that discharge to nearshore waters with exceedances of standards *predicted by ENVVEST model, based on WY2003 analysis.*

NPDES Permittee	Type of discharge and location	WY2003: 30-day moving average of daily maximum geomean FC concentration			FC % Reduction Needed	WLA
		Grid Cell	Surface	Depth-avg		
Bremerton WWTP	Treated effluent to Sinclair Inlet at SN03	Average of highest two grid cells	19	11.7	27%[a]	Current permit limits[b]

[a]Based on the percent reduction needed for the geomean (geometric mean) to meet standards (Table 11).
[b]Discussion below.

Potential for Bremerton WWTP treated discharge to result in exceedances of marine water quality standard. Under the 100/200 TMDL model scenario (Johnston et al, 2009), for the canary node that receives Bremerton WWTP discharge, the average of the top two grid cells in the surface layer was predicted to exceed the 14 cfu/100 mL marine geomean standard (Table 11). The predicted concentration of 19 cfu/100 mL for the average of the two highest surface grid cells would need to be reduced by 27 percent to meet the marine standard (Table 20).

While the ENVVEST model predicts an exceedance at the Bremerton WWTP outfall, the mixing zone model approved for use by Ecology to evaluate dilution and dispersion of effluent discharged from a diffuser does not predict similar exceedances (COB, 2002). The discrepancy between the two model results is explained by the fact that the mixing zone model takes into account the dispersion of the effluent plume as it rises from the 29-ft depth of Sinclair Inlet. The difference in density between the treated effluent (largely freshwater) and the receiving waters (28 – 30 salinity) causes the plume to rise rapidly, entraining seawater and becoming more dilute as it rises. The ENVVEST model is more conservative than the mixing zone model because it assumes that WWTP discharges enter marine waters at surface rather than at depth, so dilution and dispersion from the outfall diffuser are not simulated. In addition, the ENVVEST model includes discharges from the stormwater outfall in the area (see Figure 17). Because the mixing zone model better represents the outfall diffuser, and since ambient data from near the outfall (SN03) show that marine standards are being met (see Table J-1, Appendix J), the TMDL does not require reduced FC limits for Bremerton WWTP at this time.

Ecology recently approved Bremerton WWTP's request for re-rating of its design capacity to allow up to 50 percent increase in discharge during the winter wet season. A study of the re-rating request indicated that this change would not result in degradation of receiving waters. As a result, the permit limits for discharge (average flow for the maximum month) have been increased. The permit limits for FC (average weekly and maximum monthly concentration) are unchanged; however, a larger discharge at the same concentration could have greater potential to contribute to an exceedance of marine standards. To check on impacts from the larger discharge, Ecology requests that the current program of monthly ambient water quality monitoring at the station above the diffuser (SN03) be continued. Currently Kitsap County Health District (KCHD) monitors monthly at this site.

Potential for exceedances at South Kitsap Water Reclamation Facility (SKWRF) and Kitsap County No. 7 (Fort Ward) WWTP outfalls: In the Navy model, all three wastewater treatment plants (WWTPs) were simulated to discharge into the surface grid cells at the shoreline nearest to the outfall discharge points. This provides an additional level of conservatism for assessing impacts from the WWTPs, since in fact all three discharge at depth and considerable dilution is expected to take place before the discharge affects surface water bacteria concentrations. Neither the discharge from the SKWRF operated by West Sound Utility District, nor the Kitsap No. 7-Fort Ward WWTP discharge, was predicted by the ENVVEST model to result in exceedances of the marine standards in the surface waters that receive their discharges. As a result, none of the three WWTPs is assigned a reduction in the FC limit in its NPDES permit (Table 21).

Table 21. WY2003 analysis determined no change needed for FC limits for WWTPs.

Facility and permit number	Receiving water body	FC limits in current NPDES permit		FC limits for Sinclair Dyes TMDL	
		Monthly GM	Weekly GM	Monthly GM	Weekly GM
Bremerton WWTP WA0029289	Sinclair Inlet	200/100 mL	400/100 mL	200/100 mL	400/100 mL
Kitsap Cty Sewer District No. 7 (Fort Ward) WA0030317	Rich Passage	200/100 mL	400/100 mL	200/100 mL	400/100 mL
South Kitsap Water Reclamation Facility (Port Orchard) WA0020346	Sinclair Inlet	200/100 mL	400/100 mL	200/100 mL	400/100 mL

Washington Department of Transportation (WSDOT) stormwater discharges.
Several state highways in the watershed follow the shoreline and have potential to discharge contaminated stormwater to Sinclair or Dyes inlet. As seen in Figure 6, State Route (SR) 16 and 166 follow the southern shoreline and SRs 3 and 304 follow the northern shoreline of Sinclair Inlet. SR 3 on the north side of Bremerton is close to Ostrich Bay and Chico Bay off Dyes Inlet. SR 303 crosses the Port Washington Narrows via the Warren Avenue Bridge in Bremerton.

Where these state highways have drainages to the monitoring locations listed in Tables 13 and 14 that have exceedances of water quality standards, WLAs are assigned to WSDOT. The WLAs (Table 19) are the percent reductions from Tables 13 and 14 that are required for the impaired nearshore waters to meet standards.

The ENVVEST Project did not analyze WSDOT stormwater for fecal coliform bacteria directly, so this TMDL does not establish additional requirements under the WLA. However, as required under the WSDOT NPDES municipal stormwater permit, WSDOT must implement its permit for highway discharges within geographic areas covered under Ecology Phase II municipal stormwater permit (Figure 5).

Final marine load and wasteload allocations

Water quality data for WYs 2009 and 2010 (Table 17) were used to develop final marine LAs and WLAs. Data for nearshore sites that exceeded either the Part I or Part II marine standard (14 cfu/100 mL and 43 cfu/100 mL) are shown in Table 22. Because these sites receive either municipal stormwater or stream discharge draining jurisdictions with Phase II NPDES stormwater permits, the responsible jurisdictions are assigned WLAs. The WLA is equivalent to the percent reduction in fecal coliform needed for either the geometric mean or the 90^{th} percentile, whichever is greater, to meet standards.

Table 22. Final marine sites with load and wasteload allocations. *Shaded cell - standards exceeded during WY2009 and/or WR2010. "Monitoring" - monitoring needed to assess compliance with standards.*

Site No.	Monitoring Site Description	WY2003		WY2009		WY2010		LA/WLA[3]?
		Observed exceed-ances[1]	Modeled exceed-ances[2]	GM	90th	GM	90th	
Dyes Inlet and bays								
DY29	NEARSHORE BELOW BARKER CR			3	8	5	122	yes
DY25	NRSHORE BELOW STRAWBERRY CR			3	45	12	281	yes
DY27	HEAD OF DYES AT CLEAR CR ESTUARY	yes	yes	3	8	23	818	yes
DY20	CHICO BAY, MOUTH OF CHICO CRK			2	6	8	74	yes
DOH471	CHICO BAY, WEST SHORE			3	45	8	34	yes
DOH487	OYSTER BAY, EASTERN SHORE			6	105	13	47	yes
Port Washington Narrows								
DY04	NEARSHORE ANDERSON COVE - PORT WA MARINA CSO-OF9	yes		2	4	3	14	Monitoring
DY05	NEARSHORE LIONS PARK SOUTH OF BOAT LAUNCH B-ST01			6	34	9	68	yes
DY33	NEARSHORE OPPOSITE EVERGREEN Park B-SCHLEY CANYON			1	2	8	75	yes
DY37	City of Bremerton Chester Ave Storm water outfall			2	12	4	46	yes
DY34	NEARSHORE LENT LANDING, SW OF B-ST03 & CSO OF-2			5	154	12	33	yes
Port Orchard and Rich Passages								
DOH457	Off Fletcher Bay, Bainbridge Island			5	104	5	39	yes
	Lynwood Center	yes						Monitoring
	Fort Ward stormwater[4]	yes		3	9	2	4	No[4]
Sinclair Inlet								
	Nearshore at PSNS & IMF	no data						Monitoring
SN03	NEARSHORE HWY 3 MERGER NR PILINGS (BREM WWTP OUTFALL)		yes	1	4	2	4	Monitoring
SN05	Gorst estuary, head of Sinclair Inlet		yes	3	21	9	28	Monitoring
SN13	MOUTH OF KARCHER CREEK	yes		3	22	8	27	Monitoring
SN26	OUTFALL AT BACHMANN PARK GAZEBO B-ST12 & CSO OF-7,7A			1	2	5	75	yes
SN23	NEARSHORE OUTFALL RT SIDE OF PO PUBLIC BOAT RAMP			2	4	11	76	yes
SN22	NEARSHORE BELOW ANNAPOLIS CR			4	22	6	61	yes
SN15	NEARSHORE SACCO CR MOUTH			*No data*		4	47	yes
SN12	NEARSHORE BLACKJACK ESTUARY	yes	yes	6	101	10	77	yes

[1]From Tables 13-14.
[2] From Table 15.
[3] WLA assignments to permittees in Table 23.
[4] Data are for BI-FWNS (Appendix G). The only appropriate receiving water monitoring location for potential stormwater impacts is located in DOH Prohibited zone established around the Kitsap No. 7 WWTP outfall.

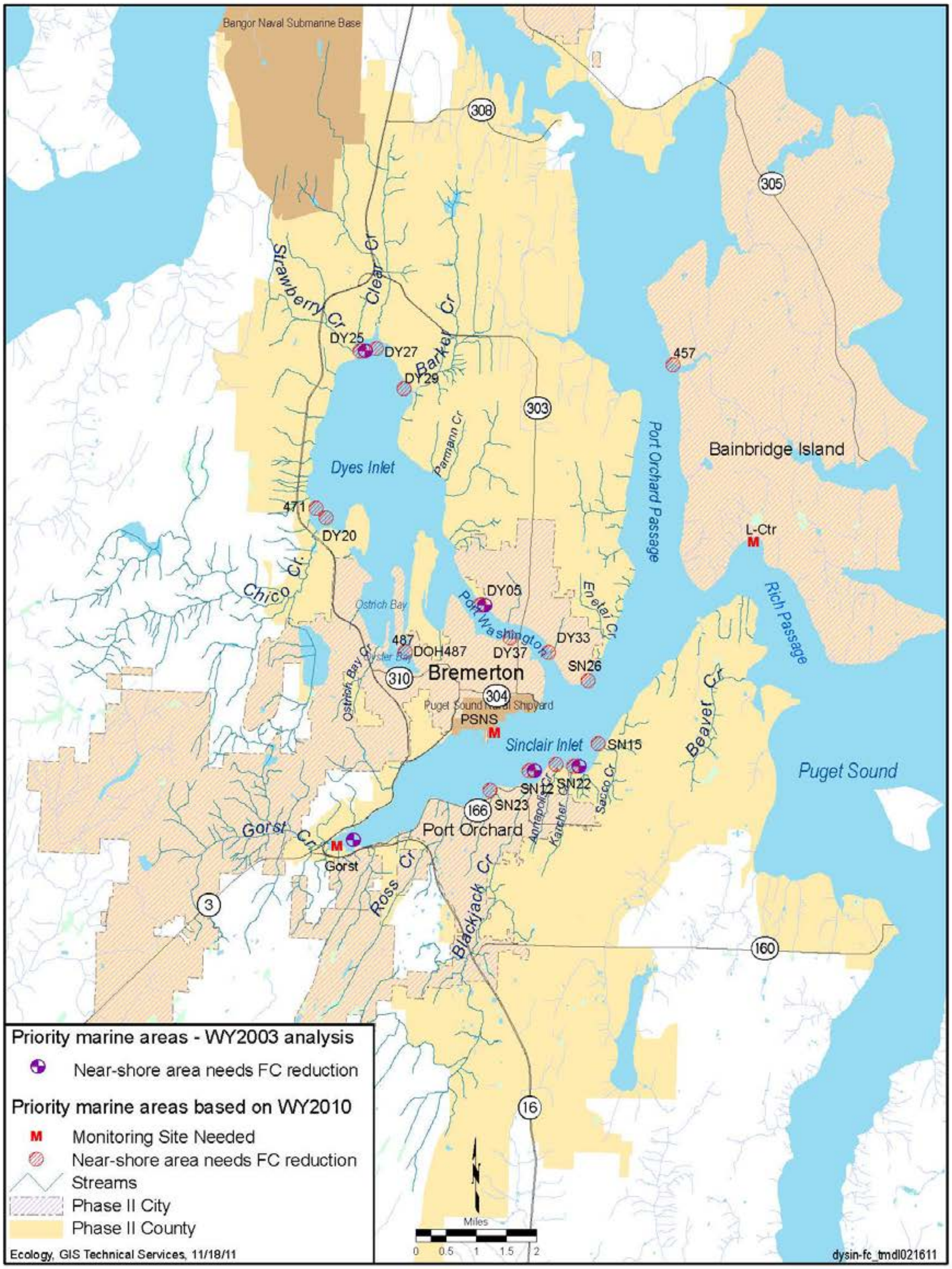

Figure 23. Nearshore marine priority areas for fecal coliform bacteria reduction.

Table 23. Final marine wasteload allocations (WLA) based on WY2009/WY2010. *(Shaded cells identify jurisdictions with primary responsibility. "Monitor"- monitoring needed to assess compliance.)*

	Site no./description	WLA[a]	NPDES Stormwater Permittees					
			City of Bainbridge Isl.	City of Bremerton	City of Port Orchard	Kitsap County	Navy	WSDOT
Dyes Inlet and bays	DY29 below Barker Creek	65%				Barker Cr		SR303
	DY25 below Strawberry Crk	85%				Strawberry Cr		SR3, SR303
	DY27 Head of Dyes below Clear Crk	95%				Clear Cr	NBK Bangor, WF Clear Creek	SR3, SR303
	DY20 Chico Bay	42%				Chico Bay-Erlands Pt		SR3
	DOH471 Chico Bay	4%				West shore		SR3
	DOH487 Oyster Bay east shore	8%		East shore				
Port Washington Narrows	DY04 Nearshore Anderson Cove	*Monitor*		Port WA Marina				
	DY05 below Lions Park	37%		E. Brem., Pine Rd., Cherry Ave.				SR303
	DY33 opp. Evergreen Park	43%		W. Bremerton				SR303
	DY37 Chester Ave stormwater outfall	7%		W. Bremerton				SR303
	DY34 Nearshore Lent Landing	72%		SW 0F BST-03 & CSO OF-2				
PO/Rich Passages	DOH457	59%	shoreline					
	Lynwood Center	*Monitor*	Lynwood Ctr, Schel-Chelb Cr					
Sinclair Inlet	Nearshore PSNS & IMF/NBK Bremerton outfalls	*Monitor*		Callow Ave Pacific Ave			PSNS/ IMF	SR304
	SN03 Bremerton WWTP Outfall	*Monitor*		Loxie Eagens		National Ave		SR3, SR304
	SN05 Gorst estuary	*Monitor*		Gorst Cr, Anderson		Gorst		SR3, SR16
	SN13 below Karcher Crk	*Monitor*			Beach Dr.	Karcher Crk		SR166
	SN26 Bachmann Prk outfall	43%		Trenton Ave.				
	SN23 PO public boat ramp	43%			Bay St., PO Boulevard			SR166
	SN22 below Annapolis Crk	30%			Annapolis Cr	Annapol. Cr		
	SN15 below Sacco Crk	9%				Sacco Creek		
	SN12 below Blackjack Crk	44%			Westbay Ctr	Blackjack Cr		SR166

[a] WLA= % reduction in fecal coliform required

Preliminary load and wasteload allocations for freshwater

Seasonal statistics were developed for each freshwater sampling site using the TMDL study data for years 2000-2003. The geometric mean and 90th percentile statistics for wet and dry seasons were compared to the water quality criteria, and, using the statistical rollback procedure, the percent reduction required to meet the criteria was calculated. The statistic that needed the larger percent reduction was chosen as the basis for compliance at each site. In this evaluation, the basis for compliance was usually the 90th percentile statistic.

Three streams with relatively high discharge (Clear, Gorst, Blackjack) were assigned lower (more restrictive) statistical targets because the integrated model showed the marine WQS would be exceeded in nearshore waters even when these streams met the freshwater standard. The more restrictive target for Clear Creek was also assigned to Strawberry because it discharges to the Clear Creek estuary and its FC contribution needs to meet similarly strict targets.

For WY2003, the target percent reduction values (Table 16) indicate the relative degree the streams were out of compliance with their respective statistical bacteria targets for wet and dry seasons. That is, the percent reduction values indicate how far over-capacity these stream bacteria loads were from being able to support Primary Contact and Extraordinary Primary Contact beneficial uses. Sites such as Ross Creek at RS02 and Pahrmann (PA01) that were meeting their loading capacity were assigned preliminary zero percent reduction values ("none").

In accordance with EPA reporting requirements, Table 24 summarizes stream loading capacities in million counts of FC bacteria per day. The load -- the amount of bacteria in the stream at a particular time -- is calculated by multiplying the average daily flow in cubic feet per second (cfs) by the concentration of bacteria in the stream. The stream flows are based on an 11-year record (October 1992 to October 2004) of monthly flows. The average daily flow for Dry Season is the average daily flow for the months May – September for the 11 years. The average daily flow for the Wet Season is the average daily flow for October – April for the 11 years. The target concentrations are the geometric mean targets from Table 18. The method for calculating daily bacteria load reductions is described in Appendix J.

Stream loading capacities are flow-dependent and change with flow. In wet years, streams generally discharge higher loads than in dry years. Compliance with the WQS and this TMDL will be assessed during implementation by comparing monitoring results with the concentration-based water quality criteria and not the loading capacity estimates. This is because the flow conditions during any particular monitoring event are unlikely to be the same as the average seasonal flows represented in the table.

Nonpoint contributions of a pollutant are evaluated by comparing the critical season concentrations at each monitoring site with the water quality standards. The load allocation is the percent reduction needed for the site to meet standards during the critical season. For the Sinclair-Dyes watershed, dry season stream concentrations of bacteria tend to be higher than wet season concentrations. However, higher wet season flows result in wet season loads that are generally higher than dry season loads. In this analysis, the percent reduction required for compliance during both seasons is reported.

Table 24. Loading capacities and preliminary load reductions for streams.

Stream	Site	Target Concentration		Observed 2000-2003		Average Daily Flow[a] (cubic feet/second)		Loading Capacity[b]		2000 – 2003 Load Reduction	
		cfu/100 mL		Dry	Wet			million counts/day		million counts/day	
		GM	90th %ile	GM	GM	Dry	Wet	Dry	Wet	Dry	Wet
Pahrmann	PA01	100	200	86	10	0.0	0.3	90	60	none	none
Barker	BK01	100	200	140	53	3.3	8.7	11,300	11,300	3100	none
Clear	CC01	73	146	260	50	5.7	13.4	35,600	16,300	25,400	none
Strawberry	SR01	73	146	140	30	1.3	7.3	4500	5900	2100	none
Ostrich	OB01	100	200	580	140	0.3	2.2	3800	7500	,100	2,100
Phinney	PH01/ LMK020	100	200	no data	1540	0.0	0.4	no data	13,200	no data	12,300
Beaver	BV01	50	100	190	80	0.1	1.1	260	2040	190	750
Ross	RS02	100	200	90	15	0.6	1.4	1400	500	none	none
Blackjack at Mouth	BJKFC	62	125	120	40	10.7	18.4	32,200	17,500	16,000	none
Annapolis	AP02	100	200	320	220	0.3	0.5	2060	2500	1400	1400
Karcher	KA01	50	100	230	130	3.5	5.6	19,900	17,200	15,600	10,300
Sacco	SC04	50	100	200	110	0.2	1.2	1050	3050	790	1600

[a] Dry season average daily flow based on monthly flows (May - September) for WY 1994 – 2004. Wet season average daily flow based on monthly flows (October – April) for WY 1994 – 2004.
[b] Stream loading capacity = seasonal average daily flow x target geomean concentration (Table 18) x 24.468 (conversion factor for units consistency)

The permitted entities that discharge to freshwater streams in the Sinclair-Dyes watershed are:

- Municipalities with NPDES Phase II permits for stormwater discharge (city of Bainbridge Island, city of Bremerton, city of Port Orchard and the urbanized areas of Kitsap County).
- Washington State Department of Transportation has an Ecology NPDES permit for stormwater discharge.
- Naval Base Kitsap at Bangor discharges stormwater to upper west fork of Clear Creek.

In 2000-2003, 12 streams in the Sinclair Dyes watershed did not meet state freshwater quality standards (Table 16). Listed in the table are the percent reductions needed for streams to comply with the statistical targets in dry and wet seasons. The statistic that needed the larger percent reduction (either the geometric mean or the 90th percentile value) was chosen as the basis for compliance at each site. In this evaluation, the basis of compliance was usually, but not always, the 90th percentile statistic. The percent reduction is applied to nonpoint sources as an LA and to point sources as a WLA.

Final load and wasteload allocations for freshwater

Table 25 provides updated (WY2010) water quality data for the streams evaluated for the TMDL. For streams that do not meet target concentrations, WLAs are assigned to entities with NPDES permits for stormwater discharge within each freshwater stream basin (Table 26). The

WLAs are expressed both as percent reductions in concentration needed to meet standards, and as the amount of fecal coliform load reduction on a daily basis that must occur, in units of counts of bacteria per day. The method for calculating daily bacteria load reductions is described in Appendix J.

Within the jurisdictions listed in Table 26, both point and nonpoint sources are assumed to contribute to bacteria loads. If data are not available to distinguish point source contributions from nonpoint contributions, then the same percent reduction needed to meet FC target concentrations is assigned to both nonpoint and point source discharges.

In the dry season (Table 25), five streams that did not meet targets in 2000-2003 met targets in WY 2010: Pahrmann, Clear, Strawberry, Ross and Blackjack creeks. (Chico Creek met targets both in 2000-2003 and in WY2010.) Two streams, Ostrich Bay Creek and Sacco Creek, had poorer water quality in WY2010 compared with 2000-2003. Because Gorst and Enetai Creeks have been designated Category 4B, a WLA is not required pending completion of other pollution control measures to achieve standards. A total of six streams require reductions in FC in order to meet water quality targets. Jurisdictions with stormwater discharges to these streams are assigned a WLA in Table 26.

In the wet season (Table 25), only two streams (besides Chico which met standards and Gorst and Enetai which have been designated Category 4B) improved enough to meet water quality targets in WY2010 – Ross and Beaver creeks. Clear, Ostrich Bay, Annapolis and Sacco improved since the 2000-2003 period, but not enough to meet target concentrations. Pahrmann, Barker, Strawberry, Blackjack and Karcher all have higher FC concentrations in WY2010 compared with the 2000-2003 period. Phinney was not monitored in 2003 but needs reductions. A total of 11 streams require reductions in FC in order to meet target concentrations. Entities with stormwater discharges to these streams are assigned a WLA in Table 26.

The designation of Gorst and Enetai creeks as Category 4B is discussed in section "Impairments addressed by this TMDL."

Figure 24 is a summary map showing how much fecal coliform reduction is needed for the Sinclair-Dyes tributaries for the wet season, based on WY 2010 data. (Fewer streams needed fecal coliform reductions in the dry season than in the wet season, so these are noted in the legend rather than illustrated.) The specific percentage reduction needed for each stream to meet standards is listed in Tables 25 (wet and dry seasons) and 26 (WLAs).

Table 25. Fecal coliform percent reductions needed in 2000-2003 and current percent reductions needed.

Stream/site	Target Concentration		Storm Events		2000-2003 Dry Season			2000-2003 Wet Season			WY 2010 Dry Season		WY 2010 Wet Season		Current Status: %Reduction Required to Achieve Limiting Target	
	Geomean cfu/100 ml	90th %ile cfu/100 ml	Geomean cfu/100 ml	90th %ile cfu/100 ml	Geomean cfu/100 ml	90th %ile cfu/100 ml	Reduction Needed	Geomean cfu/100 ml	90th %ile cfu/100 ml	Reduction Needed	Geomean cfu/100 ml	90th %ile cfu/100 ml	Geomean cfu/100 ml	90th %ile cfu/100 ml	Dry	Wet
Dyes Inlet tributaries																
Pahrmann PA01	100	200	Not sampled		86	**553**	64%	10	92	None	56	110	48	490	OK	59%
Barker BK01	100	200	109	422	138	**450**	56%	53	**352**	43%	141	302	24	658	34%	70%
Clear CC01	73 [a]	146 [a]	Not sampled		255	**1411**	90%	50	**388**	62%	44	92	42	264	OK	45%
Strawberry SR01	73 [a]	146 [a]	140	839	139	**630**	77%	33	**178**	18%	45	142	49	940	OK	84%
Chico CH01	100	200	Not sampled		41	141	None	8	61	None	21	50	22	168	OK	OK
Ostrich Bay OB01	100	200	Not sampled		582	**2954**	93%	140	**1568**	87%	639	6044	135	1180	97%	83%
Phinney PH01	100	200	Not sampled		Not sampled			Not sampled			818	1752	422	1601	89%	88%
Port Orchard Passage tributary																
Enetai DE01	100	200	423	3236	403	**1585**	87%	231	**1421**	86%	165	334	80	826	40%	76%
Rich Passage/Clam Bay tributary																
Beaver BV01	50 [b]	100 [b]	87	379	190	**669**	85%	79	**462**	78%	94	202	13	62	50%	OK
Sinclair Inlet tributaries																
Gorst at mouth	24 [a]	47 [a]	79	410	110	**495**	91%	45	**247**	81%	72	150	15	138	69%	66%
Gorst at Jarstad	100	200	107	351	83	**369**	46%	40	**346**	42%	Not sampled		Not sampled			
Ross RS02	100	200	Not sampled		91	**550**	64%	15	137	None	20	62	6	122	OK	OK
Blackjack at mouth	62 [a]	125 [a]	78	495	123	**400**	69%	39	**138**	9%	42	94	17	218	OK	43%
Blackjack SR16	100	200	114	524	76	**252**	21%	26	141	None	44	86	30	266	OK	25%
Annapolis AP02	100	200	263	1551	317	**953**	79%	216	**1391**	86%	151	240	61	814	34%	75%
Karcher KA01	50 [b]	100 [b]	365	2847	232	**705**	86%	125	**958**	90%	248	302	120	1462	80%	93%
Sacco SC04	50 [b]	100 [b]	109	544	200	**845**	88%	107	**877**	89%	127	1253	59	552	92%	82%

[a] Target reduced to meet marine standard in nearshore
[b] Extraordinary standard applies

Bold indicates which statistic (of geomean or 90th percentile needs the larger percent reduction in FC.

Percent of Improvement since 2000-2003	
(red)	<= 0%
(orange)	> 0 <=25%
(yellow)	>25<=50%
(light green)	>50%
OK	Meets Standard

Table 26. Final freshwater wasteload allocations (WLAs) expressed as daily load reductions for WY2010. *For jurisdictions with primary responsibility, creek drainage identified by shaded cell; secondary responsibility indicated by "x" or state highway no.*

Stream & Site	2000-2003 Loading Capacity (million counts/day)		WY2010 Load (million counts/day)		WLA (%FC reduction based on concentration[a])		WLA (FC load reduction) (million counts/day)[d]		NPDES Stormwater Permittees				
	DRY	WET	DRY	WET	DRY	WET	DRY	WET	City of Bremerton	City of Port Orchard	Kitsap County	Naval Base Kitsap/ Bremerton	WSDOT
Pahrmann PA01	90	60	80	370	-none-	83%[a]	-none-	304[a]					SR303
Barker BK01	11,300	11,280	14,630	6270	34%	70%	4980	4400					SR303
Clear[b] CC01	35,560	16,330	7830	16,790	-none-	45%	-none-	7600				x	SR3,SR303
Strawberry[b] SR01	4490	5880	1850	7480	-none-	84%	-none-	6300					SR3,SR303
Ostrich Bay OB01	3760	7460	5190	8880	97%	83%	5000	7400			x		SR3
Phinney PH01/LMK020	No data	13,200	920	4440	89%	88%	820	3900	x				SR310
Enetai	*Category 4B and must meet 100/200 freshwater criteria*												
Beaver[c] BV01	260	2040	160	410	50%	-none-	80	none					
Gorst[b] Creek	*Category 4B and must meet 24/47 targets set by the TMDL*												
Blackjack[b] at mouth BJKFC	32,200	17,540	14,050	9390	-none-	43%	-none-	4000			x		SR16,SR166
Blackjack at SR16	n/a	n/a	n/a	n/a	-none-	25%	-none-	n/a		x			SR16
Annapolis AP02	2060	2520	1250	870	34%	75%	400	660					
Karcher [c] KA01	19,900	17,220	26,920	20,320	80%	93%	21,500	18,900			x		
Sacco[c] SC04	1050	3050	840	2070	92%	82%	780	1700					
All other tributaries[e] must meet 50/100 or 100/200 criteria									*If permittee discharges stormwater to waterbody*				

[a]Except for Pahrmann Creek, the load reduction achieved using percent based on concentration is sufficient to meet the loading capacity. For Pahrmann in wet season, an 83% reduction (based on load) instead of 59% reduction (based on concentration) is needed to meet the loading capacity.
[b]Target reduced to meet marine standard in nearshore.
[c]Extraordinary standard applies.
[d]Calculations described in Appendix I.
n/a. Flow data for Blackjack at SR16 not available to calculate load.
[e]Other tributaries include Mosher, Anderson, Kitsap Mall, and State Park creeks, and Unnamed Tributary to Bangor Trident Lake outlet.

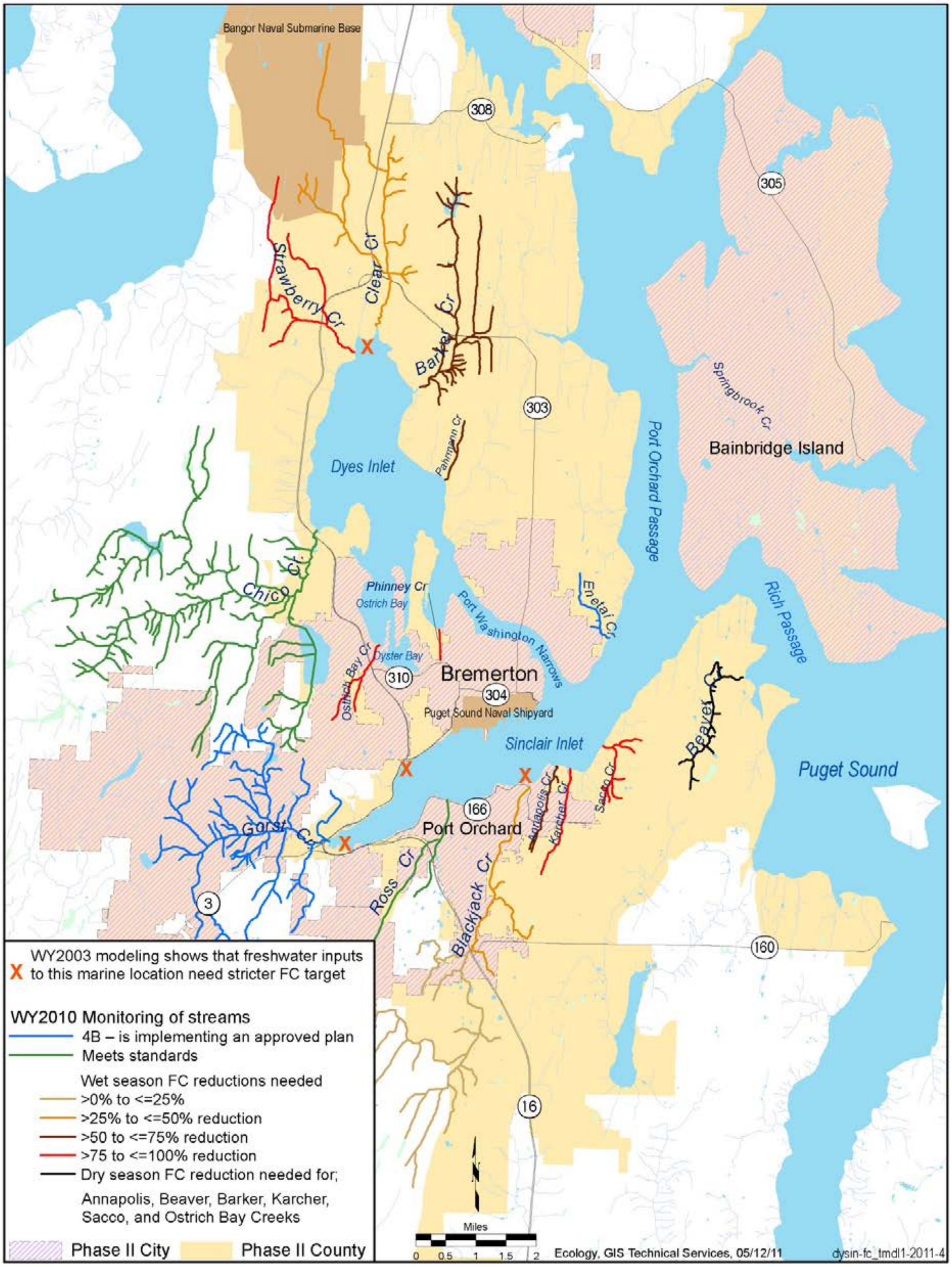

Figure 24. Fecal coliform wet season percent reductions needed for streams to meet standards.

Reserve capacity for future growth

An allocation for growth (that is, for development in the watershed) may be established in a TMDL to provide "space" for future discharges to a water body while still protecting its beneficial uses. In lieu of a numerical allocation for future growth, the TMDL uses a narrative approach to set aside reserve capacity. It calls for municipalities to implement low impact development (LID) where feasible, or to use other stormwater management techniques to minimize the discharge of bacteria into surface waters at applicable new development sites starting in 2016. LID incorporated at redevelopment sites will also assist in reducing the current load of fecal coliform bacteria to the targets established in the TMDL.

Future development that increases impervious area could put this at risk the progress made in the watershed over the past 20 years. Large areas of Dyes Inlet have been opened to commercial shellfish harvest, and the approaches that led to these gains are being applied to a greater extent of the watershed through Pollution Identification and Correction (PIC) projects and the phasing in of elements of NPDES municipal stormwater permits. In addition, it is expected that public understanding of the need to protect water quality through source control is increasing because of local stormwater-related education programs and wider attention to Puget Sound water quality.

Existing comprehensive plans and zoning designations will allow increases in housing density, numbers/sizes of commercial/industrial areas, and percent Total Impervious Area (%TIA) in the watershed. May et al. (2005) reported that the geometric mean FC concentration for individual streams was higher for streams in basins with a TIA $\geq$ 40% and lower for streams where more natural forest was retained, although neither relationship was statistically significant.

Future water quality conditions as development continues in Sinclair-Dyes Inlets were envisioned by using the ENVVEST model to simulate a "what if?" scenario. The effect of differences in future land uses and land cover (LULC) was modeled in coordination with the Kitsap County Northern Dyes Inlet Alternative Futures Planning Project (Folkerts 2007a, b). Under this planning process, citizens and planning staff worked to construct three future scenarios: (a) with growth following current land development policies; (b) with more conservation-oriented development policies; and (c) with less restrictive policies – the "future expansive buildout" scenario. Each scenario was characterized by differences in LULC.

The ENVVEST model was used to simulate FC loading to Dyes Inlet resulting from the "future expansive buildout" scenario (Johnston et al., 2009a). To run this simulation, the HSPF model was programmed to simulate flows under the future conditions, calculating the expected FC concentrations resulting from the changes in LULC, and simulating the effect of FC loading in northern Dyes Inlet during a typical storm event. In the model, the land area surrounding northern Dyes Inlet drains by way of 33 drainages - 12 streams, nine stormwater outfalls, and 12 shoreline segments, including the shoreline and watershed drainages from Erlands Point and Tracyton to Silverdale.

The result of the future "expansive build out" simulation was a 36 percent increase in TIA for northern Dyes Inlet watershed, compared with present day conditions. Some drainages increased in percent TIA by as little as four percent, but for less-developed areas, such as Woods Creek and Erlands Creek, the percent TIA more than doubled.

The future scenario simulation of a typical storm event (May 26-28, 2004; 1.8 inches rain in Silverdale, Johnston et al., 2009a) addressed the question: Under the projected conditions for "expansive build-out," how much would the FC bacteria load to Dyes Inlet increase?

For most of the creeks and shoreline segments, the "expansive build-out" scenario resulted in two to three times the present-day bacteria concentration during the simulated storm event. However, loading was increased by over ten times due to the predicted increase in runoff from the watershed. For the May 2004 storm event, the future geomean bacteria concentration near the mouth of Clear Creek was much higher than present day concentrations, with a marked increase in the frequency, magnitude, and duration of peaks exceeding the marine FC water quality standard. The modeling showed that future FC load was more influenced by increases in flow projected by HSPF than by the projected increases in FC concentrations. Manipulating the size and vegetation of streamside buffers had only a minor effect on the predicted FC concentration.

The futures analysis assumed that present-day relationships between LULC and modeled flow and between LULC and FC concentrations would hold true for the future. However, these relationships could change with increased implementation of LID, increases in the efficiency of on-site treatment, repairs and improvements to the sewer infrastructure, identification and control of ongoing pollution sources, improvements to the stormwater infrastructure, and other actions that could reduce FC pollution (Johnston et al., 2009a).

A positive outcome of the Alternative Futures Planning Project was a county decision to maintain current rural housing density requirements for the Barker Creek corridor. This will create a "buffer" for the creek with lower housing density and relatively low % impervious area, while allowing the Urban Growth Areas to the north and south to become more densely settled.

Overall, the fairly negative model prediction for a future scenario with expansive build-out needs to be considered in the light of the progress made in this watershed over the past 15 years. On one hand, increasing percent TIA in a watershed will reduce the land area available to infiltrate runoff that may be carrying bacteria. If results of the simulations for northern Dyes Inlet were extrapolated to the rest of the study area, then similar development would likely increase the extent and duration of FC exceedances. On the other hand, local programs in Kitsap have been effective in reducing FC through pollution prevention, education and enforcement. Thus, an increase in percent TIA may not be the single factor or even the most important factor affecting FC concentrations in marine waters.

A comparison of marine water quality in WY2009 and WY2010 (Figures 21 and 22) demonstrates that even with recent progress and other factors, water quality improvements are fragile and sensitive to changes in yearly precipitation. The current state of the landscape – including current human behaviors, percent impervious area, and stormwater infrastructure – is such that a much wetter year means poorer water quality and greater loss of beneficial uses. Overall, total loading to the watershed needs to be lower than occurred in WYs 2009-2010.

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Margin of Safety

A margin of safety to account for scientific uncertainty must be included in all TMDLs to ensure that targets will protect water quality in cases where the data or other factors in the analysis are naturally variable or unknown. The margin of safety in this TMDL is implicit through the use of conservative assumptions in project design and analysis.

Target reductions generally were based on the 90^{th} percentile of fecal coliform (FC) bacteria concentrations. The statistical rollback method assumes that the variance of the post-management data set will be equivalent to the variance of the pre-management data set. As pollution sources are managed, the frequency of high FC bacteria values is likely to decrease, which should reduce the variance and 90^{th} percentile of the post-management condition.

Conservative assumptions made in this TMDL analysis that contribute to a margin of safety include:

- The HSPF watershed model calibration was weighted to be less likely to under-predict flows from streams, shorelines, and stormwater drainage basins (see Skahill and LaHatte, 2006, 2007).
- The statistical cluster analysis used conservative assumptions for the loading concentration calculations (see May et al., 2005).
- Simulating WWTP FC discharges at the surface to the nearest shoreline grid cell is more conservative than simulating discharge at the actual location at depth, where additional dispersion and dilution takes place due to temperature and density differences between the effluent plume and the surrounding seawater. In the case of Bremerton WWTP, this approach was determined to be overly conservative and the results of the mixing zone model were found to be acceptable. The simulations for the other WWTPs did not predict exceedances of marine water quality standards, even for Kitsap No. 7 (Fort Ward) where an inadvertent error resulted in simulating discharges at more than 10 times the actual discharge.
- Discharges from multiple pour points were represented as entering the model at a single grid cell, where the bacteria counts are additive. This is more conservative than introducing them into adjacent grid cells, which would “disperse” the numbers of bacteria, and thus lower the predicted concentrations that are compared with the marine water quality standards.
- Conservative estimates were used for calculations based on land use/land cover, FC loading concentrations, and upper bound estimates of FC loading.
- Bacterial decay (die-off) was not considered in the calculations of statistical targets for freshwater, so this was conservative compared with the marine model simulations, which do include bacterial die-off.
- The wasteload allocations are based on water quality associated with the higher-precipitation WY2010, where a greater number of marine nearshore areas were affected and larger percent reductions were needed for streams to meet standards, compared with WY2009.

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Reasonable Assurance that Nonpoint Sources Will Be Reduced

When establishing a TMDL, reductions of a particular pollutant are allocated among the pollutant sources (both point and nonpoint sources) in the water body. For the Sinclair and Dyes Inlets Fecal Coliform Bacteria TMDL, both point and nonpoint sources exist. TMDLs (and related implementation plans) must show "reasonable assurance" that nonpoint sources will be reduced to their allocated amount, so it will not be necessary to put the entire burden on point sources. Education, outreach, technical and financial assistance, permit administration, and enforcement will all be used to ensure that the goals of this TMDL are met.

Ecology believes that the programs, activities, and authorities in the following list already implement this TMDL and add to the assurance that fecal coliform bacteria in the tributaries and marine waters of Sinclair and Dyes Inlets will meet the Washington State water quality standards by 2016. This assumes the activities described are continued and maintained.

- Washington State Department of Health (DOH) Office of Shellfish and Water Protection has authority to establish shellfish area classifications based on marine water quality. This office works with local governments and Tribes to inform them of changes in water quality and potential changes to shellfish area classifications. If marine water quality in commercial growing areas no longer meets classification criteria, DOH will downgrade these areas for harvesting. Such downgrades protect public health, call attention to pollution problems, and may lead to initiation of shellfish closure response plans and dedication of resources to address bacteria sources. DOH developed early alerts for local agencies and Tribes to locations where water quality may be trending worse by assigning "Threatened" status and informing these entities.
- Kitsap County Health District (KCHD) is authorized to require repair or replacement of failing onsite sewage systems in accordance with Kitsap County Board of Health Ordinance 2008-01 "Onsite Sewage System and General Sewage Sanitation Regulations," May 1, 2008.
- For livestock manure management problems, if landowners fail to work voluntarily with Kitsap Conservation District to eliminate impacts to surface waters, then KCHD can require compliance with Kitsap County Board of Health Ordinance 2004-02 "Solid Waste Regulations."
- KCHD is authorized to require compliance with Kitsap County Board of Health Ordinance 1999-13, "Marina Sewage Regulations," which prohibits discharge of sewage into marine waters from floating structures, and requires marina owners and operators to provide marina sewage disposal facilities or services.
- KCHD has been successful in obtaining funding for, and effectively completing several Pollution Identification and Correction (PIC) projects around Sinclair and Dyes Inlets, frequently with the assistance of local jurisdictions such as Bainbridge Island.
    - In the Dyes Inlet Restoration Project, KCHD located 82 failing sanitary sewage systems (OSS) out of a total 750 properties surveyed (14%). They also located 22 suspect, 90 non-conforming, and 126 systems with no records. This work resulted

in DOH change of shellfish harvest classification for Chico Bay from "Restricted" to "Approved."

    - Also for the Dyes Inlet project, KCHD and local governments conducted inspections of 207 commercial property stormwater facilities in the Silverdale area; sediment buildup in storm vaults and other neglected maintenance were the most common problems. The KCHD program of outreach and education to business owners, requiring owners to maintain systems and improve pollution prevention practices, resulted in reduced FC concentrations in parts of Clear Creek that receive significant stormwater inputs.

- Kitsap County, city of Bremerton, city of Port Orchard, and city of Bainbridge Island are in compliance with the Phase II municipal stormwater permit. This is a new permit with phased-in requirements, including actions such as implementation of an Illicit Discharge Detection and Elimination (IDDE) program that did not take effect until 2010. These municipalities established Interlocal Agreements with KCHD for IDDE program development and for cooperative, non-duplicative stormwater education programs.
- All municipal wastewater treatment facilities that discharge to Sinclair Inlet, Dyes Inlet and Rich Passage are in compliance with their NPDES permits, including limits for discharge of fecal coliform bacteria. The city of Bremerton is in compliance with its schedule for reducing Combined Sewer Overflows to marine waters.
- City of Bremerton completed its 16-year, $50 million CSO reduction program in 2010.
- In 2009, the city of Bremerton was successful in obtaining funding for extending a sewer collection line to the Gorst commercial/industrial and residential neighborhoods in unincorporated Kitsap County. This project, which is near completion as this document is published, includes providing hookups for and decommissioning approximately 100 onsite sewage systems in areas along Sinclair Inlet where the failure rate is notoriously high.
- Gorst and Enetai creeks were assigned "Category 4B" by Ecology in the 2008 Water Quality Assessment. This designation is for waters for which a local government agency or organization provides Ecology assurance that it is implementing a program that will result in compliance with water quality standards. Water quality standards for Gorst Creek are expected to be met through the combined effectiveness of two projects. A Kitsap County Health District (KCHD) Pollution Identification and Correction (PIC) project for Sinclair Inlet is underway, and new city of Bremerton sewage collection infrastructure, installed in 2010, replaced the frequently-failing individual onsite sewer systems in the Gorst neighborhood. KCHD also located and ensured corrections of failing onsite systems on Enetai Creek. Water quality in both creeks has improved since Category 4B designation.
- Both NBK Bangor and PSNS&IMF have stormwater pollution prevention plans (SWPPPs). PSNS&IMF is updating the Shipyard's stormwater pollution prevention plan (SWPPP, PSNS&IMF 2007), implementing a stormwater monitoring program for the Shipyard and an ambient monitoring program for Sinclair and Dyes Inlets (Johnston et al., 2010a,b). The SWPPP is supported by a pollution prevention team working to develop, implement, and maintain the plan. The team reviews, improves, and implements stormwater BMPs, and works to improve industrial processes at the shipyard to reduce stormwater pollution. The stormwater monitoring program will monitor runoff from representative stormwater basins

during qualifying stormwater events, where a qualifying event consists of >0.25 inches of rainfall within a 24 hr period following a discernable period of no rainfall (TEC 2011).

- KCHD's ambient stream and marine monitoring programs provide a tool for tracking water quality of the streams and marine waters in this TMDL. Additional sites needed for tracking progress are identified in the section, *Performance Measures and Targets (Monitoring Plan).*

While Ecology is authorized under Chapter 90.48 RCW to impose strict requirements or issue enforcement actions to achieve compliance with state water quality standards, it is the goal of all participants in the Sinclair Dyes TMDL process to achieve clean water through cooperative efforts.

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Implementation Plan

Introduction

This implementation plan describes what will be done to improve water quality in the Sinclair-Dyes watershed so that water quality standards will be met by 2016. It explains the roles and authorities of cleanup partners (organizations with jurisdiction, authority, or direct responsibility for cleanup), along with the programs or other means through which they will address these water quality issues.

For the Sinclair-Dyes watershed, this plan builds on effective existing local government programs. The purpose of the plan is to prioritize actions based on the TMDL analysis supplemented with recent water quality data. First it describes the types of programs that are effective in reducing fecal coliform bacteria. Then it reviews what programs are already in place to come up with a list of what remains to be done, in order for receiving waters to meet standards.

The plan identifies the water quality monitoring needed to track the effectiveness of current programs and of the additional actions recommended in this plan. Finally, it describes the adaptive management process that will be used to adjust priorities and actions during the next five years. It is intended to be a flexible plan that leaves some decision-making to local entities, and it recognizes the adaptive management and prioritization processes already working effectively in this watershed.

Improvements in marine water quality since 2000

In 2003, DOH upgraded a large central area of Dyes Inlet from Prohibited to Conditionally Approved for shellfish harvest (Figure 14). Nearly four miles of beach between Silverdale and Bremerton were opened to harvest for the first time since the mid-1960s (DOH 2001, 2003a, b). The marine water quality improvements resulted from years of work by the Kitsap County Health District (KCHD) to locate failing onsite sewage systems and the work of property owners to replace or repair the systems (KCHD 2009, 2010). The upgrade also resulted from the major infrastructure improvements by the city of Bremerton that reduced combined sewer overflows to Port Washington Narrows (COB 2009).

The CH3D dynamic marine model, developed by the PSNS&IMF under Project ENVVEST (and used for this TMDL), was used to support DOH's decision to upgrade the shellfish beds (DOH 2003b). The model was used to predict the transport, dilution, and die-off of fecal coliform (FC) bacteria from combined sewer overflows (CSOs) into Port Washington Narrows (Wang et al. 2005). The modeling demonstrated that some CSO effluent could reach the North Dyes Inlet shellfish beds; however, dilution and die-off would be sufficient to reduce bacteria concentrations below the marine water quality standard of 14 cfu/100 mL.

Priority locations and sources of fecal coliform pollution

Review of the streams and marine nearshore areas that have not improved significantly between 2003 and 2009 provides a set of priorities for local government programs and actions to reduce FC bacteria. These locations also are suggestive of the FC sources that are the most persistent and recalcitrant types of FC pollution sources in the Sinclair-Dyes watershed (Figures 22 and 24 and Tables 23 and 26):

- *Marine nearshore areas* with FC pollution problems identified either through ENVVEST monitoring (2000-2003) or TMDL model simulations were: nearshore areas below Clear/Strawberry, Blackjack and Karcher creeks; the Fort Ward and Lynwood Cove nearshore areas (Bainbridge Island); and the Anderson Cove/Pine Rd area of East Bremerton (Port Washington Narrows). Current nearshore data (Table 22) suggest that the Fort Ward nearshore area is meeting standards and that Port Washington Narrows still has some problem locations. One station in Chico Bay, one area of the Port Orchard waterfront, and the nearshore below Barker, Annapolis, Karcher and Sacco creeks did not meet standards in WY2010.

  Sources contributing to these areas are likely:

  - Failing shoreline-area onsite sewage systems
  - Recreational and live aboard boater waste
  - Bacteria-contaminated municipal stormwater from commercial or high density residential areas into marine waters. (Sources of bacteria to municipal stormwater are discussed in this section.)

- *Marine nearshore areas not currently monitored and that received high discharges of FC bacteria during the ENVVEST study, FY 2001-2003*:

  - Marine waters adjacent to PSNS & IMF where FC geomeans in discharges from eight outfalls were measured in a range of 10 to 7600 cfu/100 mL in FY 2001-2003. One of the outfalls, PSNS015, was estimated to be among the top 30 sources of FC loading to the watershed in WY2003. Sources of FC from the shipyard and the contiguous Naval Base Kitsap could be:
    - Illicit cross-connections between stormwater infrastructure and sanitary sewer collection lines. Aging infrastructure may be a factor.
    - FC bacteria from rodent and bird feces. Stringent oversight of trash containers, kitchen waste, etc, to remove food sources; more frequent and more efficient pavement sweeping; and vigilant maintenance of storm vaults and stormwater pipes may reduce this source.
  - Nearshore waters below Lynwood Center on Bainbridge Island. Kitsap Health, city of Bainbridge Island (2008), and DOH (2009) conducted shoreline and sanitary surveys as part of routine re-evaluation of shellfish growing areas after sewer service from Kitsap County No. 7 WWTP was extended to all of this neighborhood. The city acknowledged the need for this sewer service due to the high septic failure rate (at the time) and in response to a community petition. No onsite failing septic systems were

identified in these recent surveys. Monitoring is needed to determine whether these waters now meet standards.

- *Priority streams for cleanup based on potential for nearshore impacts as well as high FC concentrations and flows: Clear, Blackjack, Barker, Strawberry, Annapolis, Sacco and Karcher creeks*. Possible upstream sources include FC-contaminated stormwater from commercial areas; failing onsite systems; municipal sewer collection lines in need of repair; pet waste; and in more rural areas, livestock waste.
- *Other creeks with FC pollution problems based on WY2010 data*. (Sources same as those listed above):
    - Ostrich Bay Creek.
    - Beaver Creek.
- *"Watch list"* – Bremerton WWTP's Westside facility has a re-rated maximum capacity and daily discharge during the wet season that will increase over current discharge. Analysis suggests that this facility will not contribute to exceedances of water quality standards. Monthly water quality monitoring by KCHD at the outfall (SN03) will continue to be reviewed.

Programs and actions to address these fecal coliform sources

This section, organized by sources of FC bacteria, describes actions and programs that have been shown to be effective in addressing each type of source.

Onsite sewage systems

It is the responsibility of homeowners and businesses to ensure they properly operate and maintain onsite sewage systems. If these systems fail, they may pollute nearby surface waters. KCHD has authority under county ordinance to assess penalties on owners of failing onsite sewage systems, and has developed the Pollution Identification and Correction (PIC) program to monitor surface waters, inform the community, and locate and ensure correction of failing systems.

Finding failing onsite systems is critical, but the high cost of repair and replacement can be an obstacle. Having a low-cost local loan funding program for repair has made a difference in many counties in Washington State. For Kitsap County, Enterprise Cascadia, a nonprofit organization based in Shelton, Washington, has been instrumental in making low-interest loans to onsite system owners. Having disbursed most of its initial loan capital, this organization is researching funding models that will enable them to be self-sustaining and have sufficient funds to address Kitsap-area needs.

In some neighborhoods served for decades by onsite sewage systems, soil conditions in combination with increasing housing density may mean these individual systems do not, over the long term, provide sufficient treatment to protect surface waters from loading by nutrients and bacteria. Local experience by KCHD in Gorst demonstrated that an area with frequent septic failures required annual testing and monitoring of the systems to assure safe water quality. This propensity towards frequent septic failure demonstrated that sewering the area was the only permanent solution. The neighborhoods around Ostrich Bay Creek and Phinney Creek, the two creeks with the highest concentrations of fecal coliform bacteria in WY2010 (Table 25), are similar to Gorst in that the soils and high groundwater table combine to create areas which are marginal for onsite sewage system operation. Extending sewer service to these neighborhoods may be necessary to provide a permanent solution.

For the Ostrich Bay and Phinney Creek neighborhoods, this TMDL calls for the city of Bremerton to lead a technical and economic feasibility study of alternatives for sewering these two neighborhoods. The city of Bremerton, the likely provider of sewer service, agreed to assist with the study. The study should include a preferred alternative for addressing the pollution problems and information on ways to fund the solution. The study report with alternatives should be completed by 2016.

Recreational and live aboard boater waste

Kitsap County has an ordinance that requires boatyards, marinas, and yacht clubs to provide and maintain service for pumpout stations. Because of the challenge of enforcement, compliance is voluntary and depends on boater awareness and motivation to use the pumpout stations. To increase usage, KCHD is implementing a program to monitor usage at several pumpout stations at Kitsap-area marinas. Two Centennial Grant projects (Liberty Bay Pollution Identification and Correction and Sinclair Inlet Restoration) are funding the program, which will test the effectiveness of different methods to increase awareness and usage of pumpout stations.

KCHD and other local organizations with an interest in improving water quality are encouraged to consider a variety of ways to reach the boating community, such as:

- Working with Puget Sound-wide efforts, such as those supported by Puget Sound Partnership.
- Using marine weather reporting organizations to sponsor educational messages.
- Scheduling a floating, mobile pumpout service during a boating festival or other event, to draw attention to the importance of proper human waste management by boaters.

Recreational boating associations and other organizations – Power Squadron, Coast Guard auxiliary, the scuba diving community, People for Puget Sound, commercial and recreational fishing organizations – could also be important partners for reaching a larger segment of the boating community.

Municipal and industrial stormwater

Municipal and industrial stormwater systems are more appropriately considered “conveyors” of FC bacteria than sources. In commercial, industrial, and densely-settled residential areas the ultimate sources of FC may be:

- Human (failing onsite sewer systems or municipal sewer collection lines that are illicitly connected to the storm system or that leak).
- Pet waste (Figure 25).
- Waste from wildlife attracted to poorly-maintained kitchen dumpsters or areas littered with food waste.

Commercial, industrial, and densely-settled residential areas tend to have high percentages of total impervious area (TIA), which means there is less infiltration of stormwater by soils. Infiltration of stormwater by soils can be effective in reducing or eliminating FC. In addition, bacteria in water are generally associated with particulate matter, so storm sewers that receive street and parking lot sediments may temporarily "capture" bacteria and hold them in reserve only to release them again during high-flow events that may pick up and transport some of the sediment downstream.

The Phase II NPDES municipal stormwater permit covers the jurisdictions in this watershed: the cities of Bainbridge Island, Bremerton, and Port Orchard; and the urbanized areas of Kitsap County. The permit includes elements that, if implemented with some targeting of bacteria as a parameter of concern and with the geographic focus of this TMDL, can be effective in reducing FC concentrations in the watershed. Table 27 lists permit components that will assist in implementing this TMDL.

Figure 25. Is Oliver unintentionally tracking bacteria from backyard to stream?

Table 27. Major program components[1] of Stormwater Management Program (S5) in Phase II municipal stormwater permit issued in 2007.

S5 Program Component	Phase II permit requirement	To be completed under permit	Focused action
A. Stormwater Management Plan	Set up process & begin tracking costs, actions and activities. Establish coordination among permittees as possible.	August 2011 - Program fully implemented	
C.1 Public Education and Outreach	Implement education program. Begin to measure understanding, adoption.	Implement education and outreach program. Measure understanding and adoption of targeted behaviors in one targeted audience in one subject area. August 2011 - Distribute IDDE info to target audiences	Education program targeting specific source of FC bacteria
C.2 Public Involvement	Program begins. Stormwater Management Plan (SWMP) and annual reports are available to the public and posted on website.	Create ongoing opportunities for public input.	
C.3 Illicit Discharge Detection and Elimination (IDDE)	Establish public hotline to report spills and illicit discharges. Adopt IDDE codes & regulations to prohibit non-stormwater discharges, establish escalating enforcement. Develop enforcement strategy. Begin to map MS4, including outfalls to receiving waters. IDDE and general staff training. Maintain and improve recordkeeping if needed. Prioritize receiving waters for visual inspection.	February 2011 - Storm system map is complete and maps are kept updated. Dry weather screening of 3 high priority water bodies. August 2011 - Program fully implemented: field assessment (source screening), inspections, procedures to trace, correct illicit discharges, Distribute info on IDDE.	Target specific water bodies/segments in TMDL area to locate sources.
C.4 Control Runoff from New Development, Redevelopment Construction Sites (generally, disturbing at least 1 acre)	Make NOIs for construction, industrial stormwater permits available. Recordkeeping (inspections, maintenance, enforcement). Adopt regulations, implement program for runoff control, site plan review, inspection, enforcement, LID. Adopt/implement O&M regulations for post-construction BMPs & facilities. Staff training.	Implement program for runoff control, site plan review, inspection, enforcement, LID, etc. at applicable sites. 80% inspection rate.	
C.5 Municipal Pollution Prevention, Operation and Maintenance	Adopt and implement Stormwater Pollution Prevention Plan (SWPPP), inspection & maintenance schedule, procedures. Staff training.	August 2011 – Inspect 95% of MS4. Full implementation of policies, procedures, and practices to reduce stormwater runoff from permittee properties, including parks and rights-of-way.	As appropriate: special actions re: fertilizer application, trash management, system/conveyance maintenance/cleaning

[1] Other permit elements listed on next page. This is guidance only – see the permit for additional detail and related requirements.

Notes to Table 27: Other significant elements of the 2007 Western Washington Phase II Municipal Stormwater NPDES permit

This is guidance only: see the permit for additional detail and related requirements.

S1 Application for coverage

Operators of small MS4s designated by Ecology as “significant contributors” per S1.B.3 must submit NOI (Notice of Intent to seek coverage) within 120 days.

Jurisdictions submitting NOI to Ecology after January 17, 2007 need to conduct public notification.

Jurisdictions applying as Co-Permittees submit a joint NOI. Co-Permittees can end or amend agreements at any time.

S4.F Response to violations of water quality standards

Notification and possible corrective actions may occur at any time.

S7 Compliance with total maximum daily load (TMDL) requirements

Jurisdictions comply with applicable TMDL requirements listed in Appendix 2 with individual timelines.

S8 Monitoring

Report on all new stormwater monitoring studies and assessment of BMP appropriateness in each annual report.

By December 31, 2010 select sites for long-term discharge monitoring and questions/sites for SWMP effectiveness monitoring.

Beginning March 2011, annual reports include the status of preparing for the future, long-term monitoring program.

S9 Reporting

Keep all records related to permit and SWMP for at least five years. Beginning March 2008 submit report for previous calendar year using annual report forms in Appendix 3. Notify of changes in jurisdictional boundary with annual report.

(NEW 2010): Review planning codes, built-out status of neighborhoods; report barriers to implementing Low Impact Development .

G3 Notification of spill

Report to Ecology within 24 hours a spill into the MS4, which could constitute a threat to human health, welfare or the environment.

G18 Duty to reapply

Apply for permit renewal no later than August 16, 2011 (180 days before permit expiration).

G20 Non-compliance notification

Notify Ecology with 30 days of awareness of permit non-compliance.

How the Phase II municipal stormwater permit addresses bacteria

The Phase II stormwater permit as written does not specifically mention FC bacteria. However, some of its elements lend themselves well to reducing bacteria in stormwater if implemented with bacteria in mind:

- C.1 – Public education and outreach. The stormwater municipalities in the Sinclair-Dyes watersheds have worked together in the Kitsap Peninsula Clean Runoff Collaborative that has undertaken a public education program that includes messages on proper disposal of pet waste.
- C.3 – Illicit discharge detection and elimination (IDDE). This program can be used to investigate sources of FC in the stormwater system and eliminate them. A municipality can focus its IDDE program on high priority areas such as those water bodies identified in this TMDL as needing FC reduction.
- C.4 – Controlling runoff from new and redevelopment. This element includes a provision that municipalities must revise planning codes to ensure Low Impact Development (LID) approaches are allowed and/or encouraged. By reducing the stormwater that would leave a site, LID reduces the occurrence of high-flow, pollution-carrying storm events. Incorporating LID into new development is essentially "bacteria-neutral" in avoiding the addition of *new* sources of bacteria-carrying stormwater.
- C.5 – MS4 maintenance practices. A municipality can increase the frequency of storm vault cleaning, street sweeping, and other maintenance practices needed to reduce the occurrence of drain clogging and flooding that can disperse pollutants carried by stormwater into surface waters. Municipalities can also target additional resources to high-priority water bodies within their jurisdictions.

Figure 26. North end of Dyes Inlet receives both stormwater and creek discharges.

Effective approaches for reducing bacteria in stormwater

This information directed to Phase II NPDES municipal stormwater permittees also may be useful for U.S. Naval facilities and Washington Department of Transportation.

There are four main ways to reduce bacteria input to surface waters from stormwater systems:

- Infiltration
- Pollution prevention/source control (Figure 27)
- Improved operations and maintenance (Figure 27)
- Treatment

Infiltration. Since stormwater is mainly a transporter of bacteria to surface waters, approaches that infiltrate stormwater also decrease the input of bacteria. These approaches include LID retrofit projects to contain stormwater onsite; adding rain gardens and green roofs; and directing roof runoff to landscaped areas rather than street drains. Similarly, street runoff can be captured in bioswales rather than discharged to municipal separate storm sewer systems (MS4s).

Municipalities can encourage stormwater infiltration in a watershed by *(Note: as of this writing Ecology is asking for public comment on draft language for next issuance of the Phase I and II stormwater permits that would require implementation of LID)*:

- Adopting development policies to encourage reductions in impervious areas and wider use of LID in development. One approach, already adopted by Kitsap County Storm and Surface Water Management, assesses stormwater fees based on impervious area.
- Educating citizens and developers on the value of infiltrating stormwater and reducing impervious area.

Pollution prevention/source control. Both the public education and IDDE elements of the Phase II permit can help reduce the bacteria that enters the MS4, by addressing:

- Pet waste, through public education and providing pet waste bag stations in public parks.
- Wildlife waste from rodents and birds, by addressing food litter at poorly maintained garbage dumpsters at restaurants and food-handling facilities.
- Failing on-site systems or cross-connected sanitary sewers that discharge improperly to the MS4.
- Manure-composting facilities, stables, kennels, pet stores and other businesses with potential for animal waste sources of bacteria can be inventoried and targeted with specific education during inspections to ensure they do not contribute FC to stormwater.

Improved operations and maintenance. A municipality can reduce bacteria inputs to the MS4 by assessing and adjusting the frequency of storm system maintenance, and by optimizing the scheduling of street sweeping and conveyance/vault cleanout to limit resuspension of bacteria, sediment buildup, and prevent flooding.

Treatment. Ecology's Stormwater Manual (2005) Volume IV includes some stormwater treatment options but none specifically targeting bacteria.

Infiltration is actually a passive means of treatment using either existing soil on site or amended soils and substrate enhanced to ensure effective collection and treatment. Although costly and not appropriate for most locations, stormwater with bacteria can be treated using ozone or ultraviolet disinfection (e.g., Fowler and Rasmus, 2005).

Best Management Practices for Reducing FC in Stormwater

Dyes Inlet Restoration Project: Combining education, inspections & enforcement

Kitsap County Health District 2006-2008

http://www.kitsapcountyhealth.com/environmenta_health/water_quality/docs/Dyes_Inlet_FINAL_REPORT.pdf

The target location was impervious land development in Silverdale, adjacent to major streams and marine nearshore, where stormwater runoff contributes high levels of fecal coliform. Land development is predominately commercial businesses, high impervious area, with potential sources including restaurants, food facilities and urban wildlife. Receiving water quality was evaluated before and after the project. The strategy was to:

- Educate commercial property owners and managers about the link between pollution prevention on the site, storm system maintenance, and downstream water quality.
- Inspect private property storm systems that drain to the MS4. Set the target for vault and catch basin sediment depth at 60% of sump volume and maintenance of flow control and water quality facilities to original design standard and Ecology maintenance standards.
- Employ Health District ordinances for corrections of private commercial property storm systems identified to contribute sources including grease spills, leaking dumpsters and food waste or mop water dumped into storm drains.
- Send a follow-up "Thank You" letter with a sticker or window cling and educational information to property owners/managers who were compliant.
- Use enforcement tools such as Illicit Discharge ordinance (stormwater municipality) or Solid Waste regulations (Kitsap Health) regarding illegal dumping of industrial process waste (grease, food compactor liquid, etc) and need for leak proof dumpsters.

Basics:

- Kitsap County Storm and Surface Water Management (SSWM) had already mapped its MS4 infrastructure and conducted dry weather screening/illicit sampling.
- Knowledge of which businesses on septic systems, which on sewer.
- Ongoing public storm system maintenance performed by SSWM throughout the project before inspections and after.

Results:

- The Clear Creek reach dominated by stormwater had significantly reduced FC in dry weather.
- Marine stations in estuary of Clear Creek (DY24, DY27) showed improving trend over three years following inspection and compliance of 100% of commercial properties.

Lessons learned:

- SWMM changed the frequency and contact method for inspections of private commercial storm systems. Businesses that meet storm system maintenance goals are sent "Thank You" letter explaining the connection between a clean storm system and water quality.
- Non-compliant businesses receive technical assistance and followup inspections. The program strives for 100% compliance annually.
- All private commercial properties in the county are inspected annually.
- Working with the business owner is more effective than working with a non-owner property manager. Property owners are informed that they are responsible for the runoff from the property; then they have a greater vested interest in bringing tenants into compliance.

Figure 27. Dyes Inlet Restoration Project

Owners of wastewater treatment facilities (WWTPs)

The wastewater treatment facilities in the watershed (city of Bremerton; South Kitsap Water Reclamation Facility in Port Orchard; and Kitsap County No. 7 at Fort Ward, Bainbridge Island), operate under NPDES permits issued by Ecology. All are in compliance with their permits, which include limits for the discharge of fecal coliform bacteria.

The city of Bremerton operates a number of gravity and pressure beach sewers in its collection system. All beach sewers are constructed using water main-class pipe to ensure integrity of the system. The sewers are pressure-tested prior to being put in service and the system is inspected regularly as part of ongoing maintenance. System inspections generally consist of review of upstream and downstream pump station records to review flow data and identify any changes in quality or volume of flow, and review of pump station inflow to identify an increase in sand or chlorides, which would indicate infiltration to the system. In addition, staff prioritize physical inspection and cleaning of the sewers on an annual basis, based on issues including access and pipe age.

Pet waste

Under the current Phase II stormwater permit, Kitsap-area MS4s have conducted a coordinated survey of public awareness of appropriate disposal methods for pet waste and of the risk to surface waters from inappropriate disposal. The MS4s are encouraged to review effectiveness of their efforts by assessing public use of pet waste stations at public parks in the Sinclair Dyes watershed. They should continue to adjust the public education program as needed.

Livestock waste and manure management

Kitsap Conservation District (KCD) provides technical and financial assistance to livestock owners and operators of both commercial and non-commercial farms in Kitsap County. Besides providing farm planning and financial assistance programs that can increase production and conserve soil, the KCD educates landowners on ways to protect surface water (Figure 28). Recent Centennial Clean Water grants to Kitsap County Health District for Pollution Identification and Correction projects have included funding for KCD to develop inventories of agricultural properties near streams in the watershed, and to work with property owners with livestock that may pose a pollution risk to streams.

Figure 28. Sinclair and Dyes Inlet watersheds have a number of non-commercial farms.

Organizations – roles, programs, actions

This section describes the government agencies, tribes, non-profit organizations, and citizen groups that have regulatory authority, influence, information, resources, or other involvement in the Sinclair and Dyes Inlets TMDL. For each agency, current programs that address bacteria are listed, followed by the additional implementation activities that should be undertaken to address the load and wasteload allocations in Tables 23 and 26. All implementation activities are summarized in Table 28. The actions and a schedule are provided in Appendix B.

Native American Tribes

Tribes with interest in the natural resources of the Sinclair Dyes watershed should continue to advocate for reduced pollutant contributions to surface waters. The Suquamish Tribe, which has usual and accustomed fishing and shellfish harvest rights in the watershed, is encouraged to continue its efforts with other local partners to improve water quality.

The Suquamish Tribe has identified Ostrich and Oyster Bays in Dyes Inlet and Fletcher Bay on Bainbridge Island as priorities for potential future shellfish harvest. The two Dyes Inlet locations have not been opened to commercial shellfish harvest by DOH, even though most of the areas meet water quality standards. It is DOH precautionary policy to protect public health by prohibiting shellfish harvest where there are submarine or sub-beach sewage collection pipelines. At present, local sewer districts do not have sufficient resources to consider relocation of these pipelines.

Local and county planning agencies - consider TMDL during SEPA reviews

Planners need to consider TMDLs during state Environmental Policy Act (SEPA) and other local land use planning reviews. If the land use action under review is known to potentially increase discharges of fecal coliform bacteria to surface waters, then the project may have a significant adverse environmental impact. SEPA lead agencies and reviewers are required to look at potentially significant environmental impacts and alternatives and to document that the necessary environmental analyses have been done. Land use planners and project managers should consider findings and actions in this TMDL to help prevent new land uses from contributing to exceedances of water quality standards. Guidance for using TMDLs in SEPA impact analysis, threshold determinations, and mitigation is on Ecology's website at www.ecy.wa.gov/biblio/0806008.html. Additionally, the TMDL should be considered in the issuance of land use permits by local authorities.

Of interest to local planners is Ecology's proposed draft language for the Phase II municipal stormwater permit, which as of this writing is out for public comment related to including more low impact development as growth occurs. Although the final language is not yet determined, a version of it is likely to be included when the Phase I and Phase II NPDES municipal stormwater permits are reissued. The new regulations could affect local planning and permitting.

Independents and non-profit organizations

Most sources of FC bacteria could be more effectively reduced if the general public were more aware of the risks to human health, recreational uses, and shellfish harvest from behaviors that fail to prevent pollution of surface waters. Education and outreach that help change behaviors are needed to address proper management of pet waste, livestock manures, onsite sewage systems, and food waste left to attract wildlife.

Because the public is exposed to many messages from advertisers, schools, government, and other sources, innovative strategies may be needed to engage and persuade people to modify behaviors. Two possible approaches are provided here, and partners in the TMDL are encouraged to develop their own innovative ways to reach various audiences:

- Puget Sound Restoration Fund, a nonprofit organization, provides resources for "shellfish gardens" and projects to reestablish native shellfish in Puget Sound. Information at http://www.restorationfund.org/projects-shellfishgarden.php.
- Underwater video documenting trash disposal in marine waters may inspire recreational boaters and those on "liveaboards" to better protect the waters they use. The work of a Kitsap-area scuba diver and film producer can be viewed online at http://www.stillhopeproductions.com/.

Puget Sound Naval Shipyard & Intermediate Maintenance Facility and Naval Base Kitsap at Bangor

Puget Sound Naval Shipyard & Intermediate Maintenance Facility (PSNS&IMF) and Naval Base Kitsap at Bangor are authorized to discharge stormwater under federal NPDES permits issued by EPA Region X. Stormwater discharges from PSNS&IMF were determined to be a source of bacteria to Sinclair Inlet during Project ENVVEST monitoring.

PSNS&IMF works to reduce FC concentrations in its stormwater discharges through:

- Evaluating the integrity of sub-pavement storm piping throughout the shipyard.
- Updating PSNS&IMF stormwater pollution prevention plan (SWPPP), (PSNS&IMF 2007). The SWPPP is supported by an active pollution prevention team that is working to develop, implement, and maintain a pollution prevention plan for stormwater; reviewing, improving, and implementing stormwater BMPs, and working to improve industrial processes to reduce stormwater pollution.
- Implementing a stormwater monitoring program (TEC 2011) for the Shipyard. Runoff from representative stormwater basins will be monitored during qualifying stormwater events.
- Implementing an ambient monitoring program for Sinclair and Dyes Inlets (Johnston et al., 2010a,b).

NBK Bangor manages stormwater according to a SWPPP. The SWPPP (2009) is written to include all the requirements in the Multi Sector General Permit (MSGP) 2008. It includes:

- Training of staff to prevent pollution and locate and address illicit discharges.
- Quarterly dry and wet weather inspections to assure stormwater control measures are in place and correctives actions are being implemented.
- Wet weather stormwater visual and analytical sampling. The most recent visual monitoring was done in March 2011, and the most recent analytical sampling in January 2011. The parameters analyzed are aluminum, iron, lead, zinc, copper, fecal coliform, chemical oxygen demand, nitrate, and total suspended solids.

A base operating services contractor (BOSC) provides routine maintenance for the stormwater conveyance system, including cleaning catch basins and sweeping paved areas. It is contracted to clean all stormwater catch basins, associated piping, ditches and culverts annually, and is required to ensure there is free flow of storm water at all times through catch basins and other parts of the system, rather than having a maintenance requirement at percent full. They are contracted to inspect stormwater lift stations and stormwater ponds no less than once every 14 days and immediately after heavy rain fall or storm conditions.

Addressing the marine and freshwater WLAs (Tables 23 and 26)

To address the WLAs in Table 23, the PSNS&IMF will conduct ambient monitoring in the marine waters adjacent to Puget Sound Naval Shipyard and follow up with IDDE if the waters do not meet the marine standards.

To address the WLAs in Table 26, NBK Bangor will conduct dry weather screening of stormwater discharge from NBK Bangor to all locations where the facility discharges to West Fork Clear Creek, and follow up with IDDE if illicit discharges occur.

Kitsap County Health District

Kitsap County Health District (KCHD) takes an active role in monitoring water quality in Kitsap County and correcting pollution sources. KCHD has authority to enforce rules adopted by the state Board of Health, including rules to protect public drinking water sources and public health. KCHD routinely monitors water quality in county streams and along marine shorelines, and tracks water quality trends in surface water bodies throughout the county.

Besides the ongoing work in the following description, one of the most important tasks Kitsap County Health District can undertake to assure further reductions of bacteria in Dyes Inlet is to obtain resources for a technical and economic feasibility study for sewering neighborhoods draining to Ostrich Bay and Phinney creeks. City of Bremerton, the nearest sewer provider, and Kitsap County, the municipality in which these neighborhoods are located, need to collaborate and support this effort to ensure successful completion of a study with feasible recommendations.

KCHD implements several programs, funded at least partially by Kitsap County Storm and Surface Water Management (KCSSWM) that address fecal pollution sources:

- Septic system inspections of high-priority properties in Dyes and Sinclair Inlet watersheds. The Dyes Inlet Restoration Project was completed in 2009; 589 properties were inspected and 82 failing septic systems identified and repaired. The Sinclair Inlet Restoration Project, initiated in 2008 is scheduled to be completed in 2013. To date, 667 properties have been inspected, 52 failing septic systems identified, and 38 repaired. Potential sources of livestock manure waste in Blackjack, Karcher, Sacco, and Beaver Creek basins are being addressed through a partnership with the Kitsap Conservation District.
- Septic system monitoring and maintenance program. Alternative systems (those with mechanical elements and pumps) are required to have maintenance performed annually. The licensed professional maintenance provider reports maintenance activities via an online database.
- Marina boat waste control program. Marinas located in Dyes and Sinclair Inlet are inspected on a regular basis to ensure compliance with the Health District's "Marina Sewage Regulations".
- As part of the Kitsap Regional IDDE Project, commercial properties and associated storm water collection systems have been inspected in Bainbridge Island, Bremerton, Port Orchard, and unincorporated Kitsap County. To date, 163 properties have been investigated in Port Orchard, 50 illicit connections and 41 deficiencies (mostly sedimentation) have been identified. In Bremerton, 548 properties have been investigated and 18 illicit connections and 174 deficiencies have been documented. On Bainbridge Island, 207 properties have been investigated and 17 illicit connections and 99 deficiencies have been identified.
- Public complaints related to failing septic systems and general water quality issues are responded to, as needed.

NPDES municipal stormwater permittees

The cities of Port Orchard, Bainbridge Island, and Bremerton, and the urbanized areas of Kitsap County have NPDES municipal stormwater permit coverage under Ecology's Phase II municipal stormwater permit. The TMDL establishes numeric wasteload allocations (WLAs) for these jurisdictions (Tables 23 and 26) to ensure that their stormwater discharges are not contributing to exceedances of the fecal coliform standards in receiving waters.

Addressing the marine and freshwater WLAs in Tables 23 and 26

For Phase II permittees, implementing the Stormwater Management Program described in the permit will address most of the requirements of the TMDL. In addition, municipal stormwater permittees may be required, through the permit, to implement the following additional actions with focus on locations where they are assigned WLAs (Tables 23 and 26):

1. Illicit Discharge Investigation and Elimination: This permit element shall be implemented with priority for the geographic areas with WLAs.
2. Operations and Maintenance (O & M) – The frequency of O & M inspections of the MS4 infrastructure in the geographic areas of WLAs shall be reviewed and optimized to keep catch basin sediments at 60% of depth or less (Ecology 2005).
3. Bainbridge Island must ensure that monthly ambient monitoring, to confirm water quality improvements, is conducted in the nearshore area below Lynwood Center and to follow up with IDDE if the water is found to be impaired. Bainbridge Island must also conduct ambient fecal coliform monitoring of Springbrook Creek.

Municipal stormwater permittees are highly encouraged to do the following, but not required to:

1. For areas outside Phase II stormwater permit coverage – particularly in headwaters of Gorst and Chico creeks – Kitsap County Department of Community Development should require future developments to manage stormwater using Low Impact Development principles and practices as described in the Phase II permit expected to become effective in 2013.
2. Kitsap County Storm and Surface Water Management (KCSSWM) and city of Bremerton Utilities should assist KCHD in conducting a technical and economic feasibility study of providing sewer service to Phinney Bay and Ostrich Bay creek neighborhoods. A plan with preferred alternatives must be available by 2016.
3. Inventory businesses/land uses that have potential to discharge FC bacteria, including restaurants or facilities that dispose of food waste in outdoor trash containers. Include commercial animal handling facilities (kennels, stables, pet stores, etc.) and commercial composting facilities in the inventory.
4. Provide information to business owners about sources of FC bacteria, about their responsibility to prevent contamination of stormwater, and about impacts of stormwater on local marine waters.
5. Work with municipal sewer districts to obtain a geographic information system (GIS) datalayer with municipal sewer collection infrastructure, to assist in IDDE investigations.

Reserve capacity for growth

If not required to do so by the permit expected to become effective in 2013, then Phase II municipalities, starting in 2016, need new development projects[7] to implement Low Impact

[7] New development projects that trigger MS4 thresholds.

Development BMPs where feasible or to employ other stormwater management techniques to minimize the discharge of bacteria to surface waters.

Kitsap County Surface and Stormwater Management (KCSSWM)

KCSSWM protects people, property, and natural resources by addressing water quality and quantity. Four agencies carry out KCSSWM activities: Kitsap County Department of Public Works, Kitsap County Department of Community Development, Kitsap County Health District, and Kitsap Conservation District. These departments coordinate to ensure the county is in compliance with the Phase II municipal stormwater NPDES permit.

KCSSWM Public Works addresses fecal pollution sources through:

- Municipal Illicit Discharge Detection and Elimination (IDDE) Program Dry Weather Screening Program. Kitsap County has identified and mapped over 170 outfalls. KCSSWM sampled the flowing stormwater outfalls for pollutants, including fecal coliform. Sites with high bacteria levels are followed up with source identification methods.
- Kitsap County is the lead agency for establishing and maintaining the Water Pollution Hotline. Citizens can report water pollution and get rapid response (Figure 29).
- All municipal field staff are trained annually on how to identify and report water pollution problems. This training resulted in an increase in reporting and subsequent clean up or removal of illicit discharges and spills into the storm drainage system.
- KCSSWM is the lead agency for the implementation of the “Mutt Mitt” Program, where more than 120 pet waste pickup stations have been established and adopted by community groups. This program, established under Kitsap Clean Runoff Collaborative, makes picking up pet waste the “norm” in public places.
- KCSSWM is the lead agency for the implementation of the “Backyard Pet Waste Campaign” where property owners on lots smaller than 0.5 acres are mailed eye-catching materials encouraging pet waste pick up in their backyard.
- KCSSWM conducts annual inspections of approximately 250 commercial properties to assure they are maintaining clean systems that function as originally designed. This program resulted in documented fecal pollution reduction in Clear Creek in a 2008 study.
- KCSSWM is implementing a LID retrofit-planning project in the North Dyes Inlet Silverdale and Ridgetop basins. The project targets public and private commercial properties for retrofit actions that encourage infiltration and reduction of stormwater pollutants, including fecal coliform bacteria. The original planning phase is expected to be complete in late 2011.
- KCSSWM initiated a street sweeping program in fall 2010 using newly purchased high efficiency street sweepers. The sweepers (Figure 30) focus on urban areas as well as shoreline roads likely to contribute road sediment to nearshore water bodies.

Figure 29. Kitsap One, the hotline for reporting water pollution.

- KCSSWM manages stormwater solids from street sweeping, catch basin, and facility cleaning activities at the KC Decant Facility. These materials are tested and disposed of in accordance with local health district guidelines.
- KCSSWM implements a stormwater system retrofit program to construct water quality treatment facilities where current facilities are providing poor water quality treatment ,or where retrofits are concurrent with planned utility or road projects.

Figure 30. Kitsap County Storm and Surface Water Management high efficiency street sweeper.

- KCSSWM is encouraging LID in new development and LID retrofit:
  - In the Barker Creek drainage, the county fairgrounds are undergoing LID retrofit with $600,000 in improvements. The project, expected to be completed in 2012, is

modeled after the state fairgrounds LID project in Monroe and includes animal manure handling.

  - Kitsap County's "100 rain gardens" project. KCSSWM fees are being used for a residential rain garden project with a goal of establishing 100 gardens annually. The cost share is half the cost, up to $500 for each rain garden (retrofit only). The county's cost share addresses an identified barrier to installation of rain gardens. Availability of technical assistance, identified as a second barrier to installation, is addressed through technical assistance site visits from Washington State University Rain Garden Mentors and Kitsap Conservation District (KCD) staff. KCD implements the cost-share, since they administer cost share for agricultural best management practices (BMPs). As of September 2010, 47 rain gardens were established in the first seven months of the program.

City of Bainbridge Island Surface and Stormwater Management Program

Bainbridge Island's Surface and Stormwater Management Program (SWMP) is described at www.ci.bainbridge-isl.wa.us/water_quality_flow_monitoring_sswm_faqs.aspx. As part of its broader mission, the SWMP addresses requirements of the Phase II municipal NPDES stormwater permit. The program, based in the Department of Public Works, provides for city management of the installation, use, maintenance, and protection of a municipal stormwater drainage system. Under the program, the city determines the need for drainage systems and constructs and inspects them. The city also developed municipal code for low impact development (LID) approaches for new development and re-development to reduce stormwater runoff. Other elements of the SWMP include:

- Inspection of new development and re-development sites to ensure appropriate sediment and erosion control to prevent pollutant-laden runoff from the site before, during, and after construction, as well as long-term BMPs to control water quality and quantity after project completion.
- Development and implementation of a Stormwater Pollution Prevention Plan (SWPPP), that establishes best practices and procedures to prevent pollution generation from any Operation and Maintenance activity such as road maintenance, utility maintenance, automotive and equipment maintenance, and storage and materials handling and storage.
- Business inspections to identify any onsite pollutant-generating activities and correct any poor business or housekeeping practices that do, or have the potential to, result in an illicit discharge of pollutants to the stormwater drainage system or waters of the state.
- Water quality education, outreach, and technical assistance to citizens and business owners to eliminate and prevent any potential illicit discharges of pollutants to the drainage system or waters of the state.
- Put into city code the ordinance that prevents the discharge of pollutants to the stormwater drainage system, and controls runoff from new development, re-development, and construction sites.
- Investigation of reported water quality incidents through site visits, source identification monitoring, and corrective action.

- Prioritization of receiving water bodies based upon history of water quality incidents, land use, and water quality sampling and analysis.
- Field assessments of priority areas.
- Assessment of water quality of stormwater discharging to the waters of the state and the impact of said discharge to the receiving water body, to identify and eliminate pollutant sources, and to demonstrate regulatory compliance through Bainbridge Island's Water Quality and Flow Monitoring Program.
- Assessment of previous water quality problem history, land use, and receiving water quality to prioritize areas for pollutant source identification and elimination efforts.
- As a partner in Kitsap Clean Runoff Collaborative, the city participates in public outreach and educational activities related to improving stormwater quality.

Since 2005, the city has conducted water quality monitoring of streams including Springbrook Creek. Springbrook and other Bainbridge Island creeks in the study area are required to meet extraordinary primary contact freshwater quality standards (50 cfu/100 mL geomean and 100 cfu/100 mL 90^{th} percentile value). The TMDL requires the city (through the reissued NPDES permit) to conduct an investigation to ensure that stormwater polluted with fecal coliform bacteria is not causing exceedances of the marine standards at DOH site 457 offshore Fletcher Bay. The only creek monitored during the ENVVEST project was Springbrook Creek, monitored only during storm events (May et al., 2005). However, the city needs to continue ambient monitoring of this creek, which was assigned Category 5 on the 2008 Water Quality Assessment. The city must also ensure that monthly ambient monitoring is conducted in the nearshore below Lynwood Center and follow up with IDDE if the water is found to be impaired.

City of Bremerton

The city of Bremerton's Public Works and Utilities Department plans, constructs, operates, and maintains city water, sewer, storm, transportation systems, and other facilities. The city has implemented the required components of the Phase II NPDES municipal stormwater permit and participates in regional programs that address required elements of the NPDES permit.

- Bremerton developed a stormwater management plan (SWMP) and is tracking costs.
- As a partner in Kitsap Clean Runoff Collaborative, the city participates in public outreach and educational activities related to improving stormwater quality.
- Public involvement. Annual reports and SWMP are made available to public.
- Through an interlocal agreement with Kitsap Health District, city staff are trained in illicit discharge detection and elimination, and the city has adopted an ordinance providing authority to inspect private storm sewer systems.
- Bremerton adopted regulations to implement the program for runoff control, site plan review, inspection and other elements for new development and redevelopment of sites greater than one acre.
- The city adopted a stormwater pollution prevention plan for municipal facilities.

Outreach to businesses: The city of Bremerton developed an information package for commercial property owners and businesses about proper operation and maintenance of stormwater systems. The package also includes information about vehicle washing, leaks from vehicles, best housekeeping practices for supermarkets and groceries stores, and other information about ways to prevent discharge of pollutants to the city's MS4.

Low Impact Development: Bremerton's stormwater management plan emphasizes Low Impact Development (LID) and has a capital improvement budget item for implementing LID. The multiyear transportation improvement program includes a budget for creation of "green streets" – transportation features that implement LID measures for stormwater management, allow for bicyclists and pedestrians, and support land uses in tune with the concept of sustainable development.

Current Bremerton projects incorporating elements of LID include:

- The Manette Bridge replacement project, which includes a gravel infiltration bed to treat runoff from the bridge deck. City park projects (Blueberry and Lions Parks) funded in part by Ecology Centennial grants, incorporate LID elements. The Lions Park project along Port Washington Narrows (Figure 31) includes replacement of a paved parking lot on the shoreline with pervious parking lots away from shore, and a biofiltration basin with plantings to treat stormwater.
- Anderson Cove, on the west side of Port Washington Narrows. $800,000 of a larger grant will provide for the acquisition of property and construction of an infiltration facility for treating stormwater from nearly 60 acres of the contributing highly urban residential drainage basin. Stormwater will be infiltrated into the underlying glacial outwash soils through the construction of porous pavement and a stormwater infiltration facility.
- Manette Business Area, Pacific Avenue and 5th Street, are three areas of downtown Bremerton where existing streets will be retrofitted with "green" concepts to mitigate and treat stormwater using LID techniques. The purpose of this work is to develop methods for reconstructing Bremerton's street and stormwater infrastructure over time in a manner that reduces or eliminates street stormwater discharges in a manner that responds to changing visions of our urban neighborhoods. Street widths will be reduced and street surfaces will be reconstructed with pervious pavement and rain gardens with the proceeds of this funding.

Figure 31. City of Bremerton Parks Dept LID retrofit project at Lions Park: *Biofiltration cells will capture and treat stormwater that previously discharged to Port Washington Narrows.*

City of Port Orchard

The city of Port Orchard's Public Works Department manages the municipal separate storm sewer system and is responsible for addressing requirements of Port Orchard's Phase II NPDES municipal stormwater permit. The city implemented the necessary components of the permit and participates in regional programs that address some permit elements:

- Port Orchard has a stormwater management plan and is tracking costs.
- As a partner in Kitsap Clean Runoff Collaborative, the city participates in public outreach and educational activities related to improving stormwater quality.
- Public involvement. The city makes its annual reports and Stormwater Management Plan (SWMP) available to public.
- Through an interlocal agreement with the Kitsap Health District, city staff are trained in Illicit Discharge Detection and Elimination (IDDE), and the city adopted an ordinance providing authority to inspect private storm sewer systems. The city focused its initial work on GIS mapping of its storm sewer infrastructure, which is a necessary first step to fully implementing an IDDE program.
- Port Orchard adopted regulations to implement the program for runoff control, site plan review, inspection and other elements for new development and redevelopment of sites greater than one acre.
- The city adopted a stormwater pollution prevention plan for municipal facilities.

Washington State Department of Transportation

Discharge of stormwater runoff to waters of the state from state highway municipal storm systems is authorized by Ecology under the NPDES municipal general stormwater permit. The permit can be reviewed at: www.ecy.wa.gov/programs/wq/stormwater/municipal/wsdot.html.

WSDOT facilities with municipal separate storm sewer systems include highways, bridges, maintenance facilities, ferry terminals, weigh stations, and rest stops. As required by paragraph 402 (p) (3) of the Clean Water Act, the permit must effectively prohibit non-stormwater discharges into storm sewers that discharge to surface waters, and apply controls to reduce the discharge of pollutants to the maximum extent practicable (MEP). The permit does not directly regulate discharges from agricultural runoff, irrigation return flows, process and non-process wastewaters from industrial activities, and stormwater runoff from areas served by combined sewer systems. These types of discharges may be regulated by local and other state requirements if they discharge to municipal separate sewers.

The ENVVEST Project did not analyze WSDOT stormwater discharges for fecal coliform bacteria. The TMDL assigns WLAs to WSDOT where state highway stormwater discharges may introduce fecal coliform bacteria into impaired receiving waters adjacent to State Routes (SR) 3, 303, 304, 310, 16, 160, and 166 (Figure 5). As required under the WSDOT NPDES municipal stormwater permit, WSDOT will implement its stormwater program in areas covered under the Phase II municipal stormwater permits.

In addition to permit and Stormwater Management Program Plan (SMPP) implementation, which includes geographic positioning system (GPS) mapping of the MS4 and communication and coordination with local jurisdictions, WSDOT will:

- Identify maintenance needs during GPS mapping and conduct maintenance as soon as possible.
- Identify dry weather illicit discharges into WSDOT's right-of-way during GPS mapping (complete by March 1, 2015).

Through implementation of its SMPP, WSDOT has committed to coordinating with local governments (i.e., cities and counties) and tribes, and other local organizations in areas where highway and MS4 runoff commingle, and permit implementation responsibilities overlap in regard to maintenance, IDDE, mapping and reporting.

Through Ecology's annual meeting with WSDOT to review TMDLs, Ecology can raise concerns about implementation of the Sinclair and Dyes TMDL as needed.

Operators of wastewater treatment plants (WWTPs)

Three municipal wastewater treatment facilities discharge treated wastewater to the marine waters of Sinclair and Dyes Inlets and Rich Passage (city of Bremerton; South Kitsap Water Reclamation Facility in Port Orchard; and Kitsap County No. 7 [Fort Ward] on Bainbridge Island). Municipal sewer districts operate under NPDES permit from Department of Ecology, and have permit limits for fecal coliform (FC) bacteria in their discharge.

The city of Bremerton completed its extensive infrastructure improvement program in compliance with regulations requiring that combined sewer overflows be reduced to, on average, one per year.

The TMDL establishes WLAs equivalent to the current permit limits for FC. To address the requirements of the TMDL, the municipal sewer districts must continue to comply with the permit limits for FC. They must also continue to inspect and test the integrity of sewer infrastructure as required under their permits.

The TMDL recommends the operators:

- Provide to local municipal stormwater permittees a GIS layer with sewer collection line locations. This will assist the stormwater permittees and local health authorities, during IDDE investigations of FC contamination of streams, to distinguish between FC from a leaky sewer collection line and from failing septic systems or other sources.
- Review locations of any sewer collection infrastructure that run under marine water bodies or are buried under beaches. When resources become available, look for opportunities where street utilities are already being opened up during construction projects, to assess whether relocation of this infrastructure could be feasible.

Washington Department of Health

Washington State Department of Health (DOH) Office of Shellfish and Water Protection, under statutory authority of Chapter 43.70 RCW, monitors marine water quality in commercial shellfish growing areas and reports annually on status and changes in growing area classifications.

DOH plays an important role in communicating with state and local governments when changes in marine water quality indicate that more stringent freshwater quality protection is needed. The current cooperative relationship between DOH and Kitsap County Health District (KCHD) is a key element of the Adaptive Management process for this TMDL.

Kitsap Conservation District

The Kitsap Conservation District (KCD) (www.kitsapcd.org/) is a non-regulatory, legal subdivision of state government that administers programs to conserve natural resources. KCD works with agricultural and other private landowners to reduce soil erosion and impacts to water quality. Through voluntary work with landowners, the KCD promotes best management practices (BMPs) that protect water quality and prevent soil erosion.

KCD’s work with landowners includes:

- Livestock and manure management.
- Pasture management.
- Protection of stream banks from erosion.
- Stream bank restoration.
- Wildlife habitat enhancement.

- Woodland enhancement and maintenance.
- Conservation tree and shrub plantings.
- Provide educational presentations to schools and community groups.
- Furnish soils information.
- Provide Conservation Plans for farms and woodlands.
- Provide information to landowners on cost-share assistance for BMP implementation.
- Assisting landowners with emergency preparedness information and planning.

As of this writing KCD is a partner on KCHD's Pollution Identification and Correction (PIC) project for Sinclair Inlet, offering technical assistance to farms and animal hobbyists on BMPs to protect water quality. KCD is a partner with KCSSWM in a project to install 100 rain gardens per year on private property, to increase stormwater infiltration, and improve the quality of water discharged through storm drains. KCD offers technical assistance and cost share for rain garden installation.

Washington Department of Ecology

Ecology is responsible for overseeing and documenting implementation of the Sinclair and Dyes Inlets Fecal Coliform TMDL. Working with local organizations and reviewing water quality monitoring results will provide an opportunity for additional ideas to shape and direct this plan and make sure it is effective. Once EPA approves this TMDL, Ecology will be responsible for advocating implementation actions and periodically assessing progress in meeting water quality standards. Ecology will work with local organizations to develop projects and programs to meet the needs of the TMDL.

Ecology has regulatory oversight of the NPDES wastewater and stormwater permits cited in the TMDL, and will work to ensure that the WLAs are incorporated as appropriate into these permits so that required reductions in fecal coliform bacteria will occur. Ecology will communicate with EPA federal permit managers to ensure that requirements for federal facilities are carried out.

Ecology will periodically review results of local and state water quality monitoring to assess progress, and will work to adaptively manage the TMDL to assure its effective implementation. Ecology will continue to manage grant and loan programs that may assist in developing programs and projects to help reduce fecal coliform in the watershed. In addition, Ecology has the responsibility to ensure compliance with state water quality regulations under RCW 90.48.080.

EPA Region X

U.S. Environmental Protection Agency Region X (EPA) has oversight of Washington State's TMDLs. EPA will review this TMDL to ensure it meets the requirements of the Clean Water Act and that state water quality standards will be met by 2016.

EPA has regulatory oversight of federal facilities with NPDES permits. EPA permit managers have communicated with Ecology, and will continue to coordinate regarding requirements of the TMDL for the U.S. Navy facilities in the watershed.

Enterprise Cascadia

Enterprise Cascadia is a non-profit community development financial institution promoting economic opportunity and a healthy environment in urban and rural communities of Oregon and Washington. Formerly called Shorebank Enterprise Cascadia, the non-profit and non-bank organization continues one of its principal environmental programs: to provide loans for homeowners along Hood Canal, Kitsap County, and other parts of Puget Sound to repair and replace failing onsite sewage systems. In just over three years, more than two hundred owners have used these loans to pay for septic system improvements (Figure 32). A two-pronged effort is now underway to make loans available to additional Puget Sound onsite sewage system owners who need to do repairs or a replacement.

Enterprise Cascadia is committing $7.5 million in private funds and seeking an equal matching amount from public sources. The $15 million capital addition will permanently endow the Hood Canal Regional Septic Loan component of the program, which currently serves sewage system owners in Jefferson, Kitsap, and Mason Counties.

With Enterprise Cascadia's support, local public health agencies in three counties obtained commitments of state and federal funds to broaden the availability of septic repair loans. EPA grants of $400,000 each to Kitsap and Clallam counties will provide loan capital to property owners for repair or replacement of failing on-site septic systems. This new capital moves the Septic Loan Program a step closer to permanent sustainability.

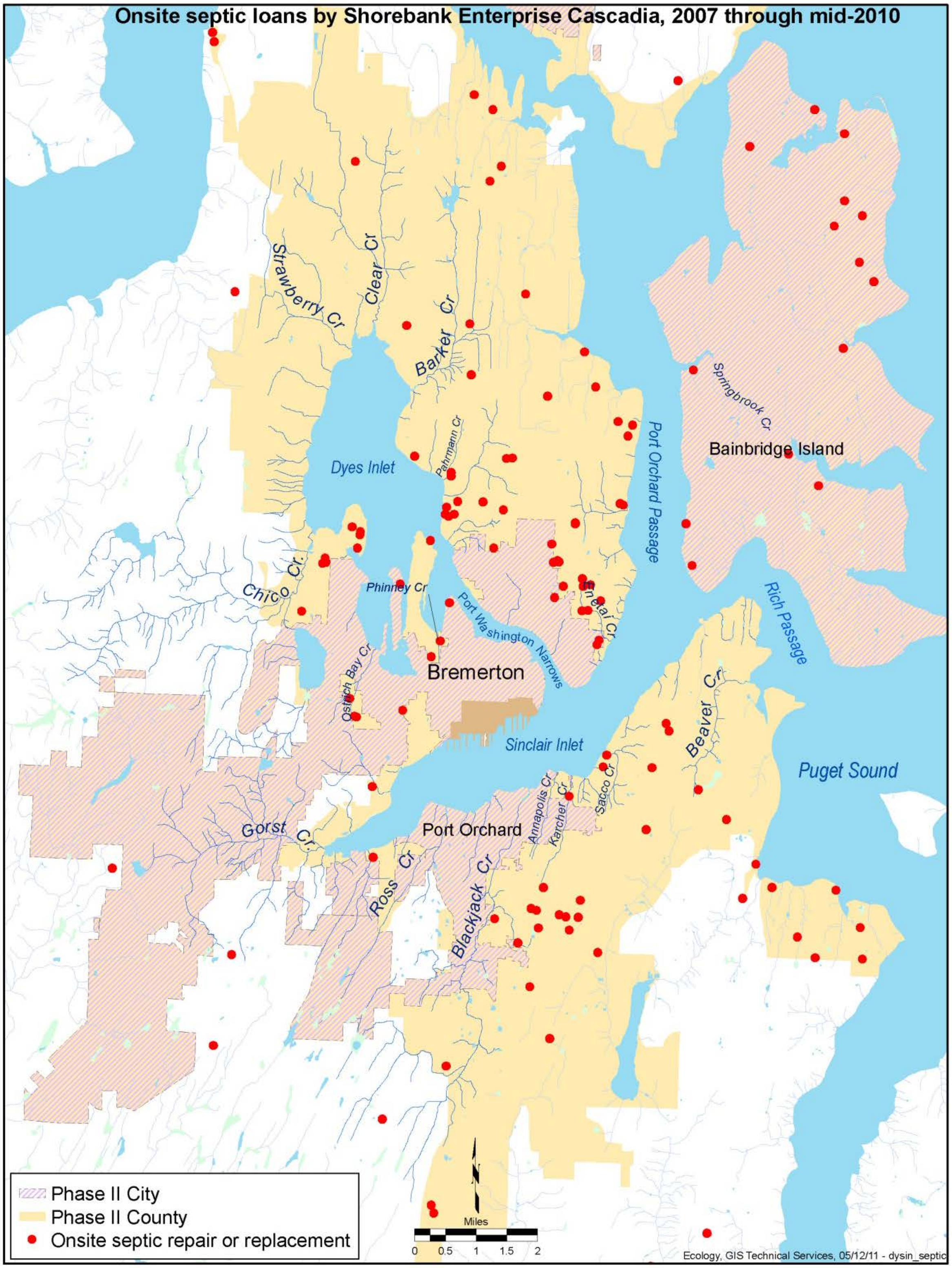

Figure 32. Locations of onsite septic repair or replacement projects with loan funding from Enterprise Cascadia.

Implementation Summary

Table 28 lists implementation actions assigned to Sinclair-Dyes watershed organizations.

Table 28. Implementation actions and programs, by source.

Onsite sewage systems that have failed or need repair

Organization	Action	Date
KCHD	Continue to obtain resources for, and conduct, Pollution Identification and Correction projects for creeks and shoreline areas that are not meeting water quality standards	Ongoing
KCSSWM/KCHD	Continue funding KCHD monitoring of streams draining to Sinclair-Dyes Inlets, Port Washington Narrows, Port Orchard and Rich Passages	Ongoing
Enterprise Cascadia	Develop secure funding to ensure sustainable loan program for repair and replacement of onsite sewage systems	Ongoing
KCHD (if funds avail.) with KC SSWM and City of Brem. Utilities	Conduct technical and economic feasibility study of alternatives for sewering Phinney Creek and Ostrich Bay Creek neighborhoods.	Plan with recommenda-tions by 2016

Recreational and live aboard boater waste

Organization	Action	Date
KCHD	Complete marina pumpout survey and education project in Sinclair and Dyes Inlets; evaluate voluntary compliance; develop recommendations for additional education, incentives or regulations as appropriate.	Grant completion date
KCHD and other implementing agcys	Develop alternative ways to increase boater awareness of need to use pumpout stations and protect water quality.	By 2013

Municipal stormwater polluted with fecal coliform bacteria

Organization	Action	Date
Phase II municipal permittees; PSNS & IMF; NBK-Bangor; and NBK-Bremerton	Require applicable new developments to incorporate low impact development BMPs or use other stormwater management techniques to minimize the discharge of bacteria to surface waters. Look for opportunities to incorporate LID in retrofit and redevelopmt[8] projects.	Starting in 2016
	Address locations with WLAs (Tables 23 and 26) by targeting implementation of NPDES stormwater management program. • Use WLA locations to prioritize implementation of IDDE program; • Use WLA locations to optimize frequency of O & M inspections of MS4 infrastructure.	Following TMDL approval
	Review the sites listed in Tables 29 and 30 for water quality monitoring and work together to ensure these are covered.	Following TMDL approval
Phase II municipal stormwater permittees	Recommended: Inventory businesses/land uses that could discharge FC bacteria, including facilities that dispose of food waste in outdoor trash containers. Include commercial animal handling facilities (kennels, stables, pet stores, etc.) and commercial composting facilities. Provide information about impacts of polluted stormwater to local waters.	Following TMDL approval
KCSSWM/KCHD	Continue funding KCHD monitoring of streams in watershed.	Ongoing

[8] If the use of LID BMPs in redevelopment projects is not otherwise addressed by the reissued Phase II permit.

Cont'd Municipal stormwater polluted with fecal coliform bacteria

Organization	Action	Date
KC SSWM and City of Bremerton	Assist Kitsap Health with feasibility study for sewering Phinney Creek and Ostrich Bay Creek neighborhoods	Plan with recommendations by 2016.
PSNS&IMF	Monitor marine receiving waters below shipyard for FC	Following TMDL approval
City of Bainbridge Island	Monitor marine receiving waters below Lynwood Center; continue monitoring of Springbrook Creek and follow up with IDDE as needed	Following TMDL approval
WSDOT	Implement WSDOT Municipal Stormwater Permit in the Phase II coverage areas of this watershed, for SR16, SR160, SR166, SR3, SR303, SR304, and SR310 with: • Identify maintenance needs during GPS mapping of infrastructure and conduct maintenance as soon as possible. • Identify dry weather illicit discharges into WSDOT's right of way during GPS mapping.	Following TMDL approval, by March 1, 2015

Municipal stormwater outside Phase II municipal permit coverage

Organization	Action	Date
Kitsap County Department of Community Development	For areas outside municipal stormwater Phase II permit coverage, KCDCD is encouraged to require applicable developments to manage stormwater in accordance with Low Impact Development principles and practices.	Ongoing

Municipal sewer districts

Organization	Action	Date
Municipal WWTP operators	Continue compliance with bacteria limits in NPDES permits	Ongoing
	Provide GIS layer with sewer collection line locations to MS4s	2016
Bremerton WWTP	Assist Kitsap County Health in feasibility study for sewering Phinney Creek and Ostrich Bay Creek neighborhoods	Plan with recommendations by 2016

Livestock waste

Organization	Action	Date
KCD	Provide KCHD a livestock inventory for Sinclair Dyes watershed	2013
	Assess need in Sinclair Dyes watershed for workshops, flyers or other education for landowners on best practices for animal waste management	2013

Schedule for meeting water quality standards

The TMDL and implementation plan are expected to result in Sinclair and Dyes Inlets and their tributaries meeting water quality standards in 2016.

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Measuring Progress toward Goals

The implementation plan is a list of actions and programs to be undertaken by residents and organizations within the Sinclair-Dyes watershed. It recommends that resources be allocated to ensure that marine waters and tributary creeks will meet water quality standards by 2016.

To track the progress of the TMDL, Ecology will assist local organizations in conducting a biennial review of water quality monitoring data and status reports from organizations responsible for achieving bacteria reductions. The biennial review will include an open meeting format to encourage information sharing and will, at a minimum, address three questions:

- Do water quality data indicate sufficient progress is being made toward meeting water quality standards in 2016?
- Is each implementing agency and jurisdiction fulfilling its commitment to implementation?
- If implementation is occurring as expected but water quality is not improving, what additional activities, changes in priority locations, or alternative approaches are needed?

This TMDL is expected to take approximately five years to reach water quality standards. Ecology will conduct a biennial review of water quality data in 2013. If fecal coliform reductions have not progressed 40 percent of the way to the TMDL targets at that time, then Ecology will work with local organizations to review the implementation plan and identify the additional activities, or different types of activities, to ensure progress (see the Adaptive Management section). Additional monitoring may be needed to increase the probability of identifying sources and meeting targets on schedule. It may also be helpful to assign local targets to specific sub-areas.

Performance measures and targets (Monitoring Plan)

The monitoring program described here assumes that ongoing monitoring programs will be allocated resources to continue:

- State Department of Health (DOH) Office of Shellfish Protection will continue the monitoring that supports shellfish harvest classifications in Dyes Inlet and nearby marine waters.
- Kitsap County Health District (KCHD) will continue its current ambient monitoring of freshwater tributaries and marine waters of Sinclair and Dyes Inlets (Figure 33).
- PSNS&IMF will conduct ambient monitoring of marine waters surrounding the Shipyard for FC, incorporate sampling for FC in stormwater monitoring, and based on the results of the monitoring, identify pollution identification and control projects as needed.
- Naval Base Kitsap – Bangor will continue monitoring stormwater discharges to the West Fork of Clear Creek to make sure they are not contributing to fecal coliform impairment.

- City of Bainbridge Island will continue monitoring Springbrook Creek with the goal of making corrections as needed to ensure compliance with standards.

The Sinclair and Dyes Inlets FC TMDL establishes fecal coliform bacteria targets for 11 streams (Table 29) and 15 nearshore marine sites (Table 30) in the watershed.

For both the freshwater and marine sites, the monthly monitoring is considered the basic, or "Level I" monitoring. Water quality data will be reviewed after two full years of monitoring (WY2012 and WY2013). If nearshore water quality is not meeting standards, then a Level II response is required.

- Level II response for Phase II municipal stormwater permittees, PSNS-IMF and Naval Base Kitsap (NBK) is follow-up through their Illicit Discharge Detection and Elimination (IDDE) programs. Through their investigations, if state highway discharges appear to have a role in the FC contamination, then the stormwater permittees will contact WSDOT to participate in the IDDE investigation.
- For Bremerton WWTP, documentation of impaired marine waters above the effluent diffuser requires a Level II response, which is the establishment of reduced permit limits for FC bacteria.

Progress will also be monitored by tracking implementation actions. Appendix B is a schedule and list of implementation activities for each organization listed in *Organizations - Roles, Programs, Actions* section of this report. Ecology will work with Kitsap jurisdictions and organizations in the Sinclair-Dyes watershed to schedule a biennial review of water quality to determine whether different approaches are needed.

Figure 33. Kitsap County Health District conducts monthly ambient monitoring on Sacco Creek (above) and other watershed creeks.

Table 29. FW monitoring sites & TMDL bacteria targets. *Minimum/ year ten ambient samples.*

Station Description	Responsible Organization	Station ID	Start Date[a]	TMDL Target	
				GM	90th %ile
Mosher	Kitsap County	MS01	2012	100	200
Pahrmann	Kitsap County	PA01	2012	100	200
Barker	Kitsap County	BK01	2012	100	200
Clear	Kitsap County	CC01	2012	73	146
Strawberry	Kitsap County	SR01	2012	73	146
Chico	Kitsap County	CH01	2012	100	200
Ostrich Bay Creek	Bremerton/Kitsap County	OB01	2012	100	200
Phinney	Kitsap County/City of Bremerton	PH02	2012	100	200
Enetai	Kitsap County	DE01	2012	50	100
Illahee	Kitsap County	IC01	2012	50	100
Wright	Bremerton	WR01	2012	100	200
Gorst	Kitsap County/City of Bremerton	GR01	2012	24	47
Anderson	City of Bremerton	AN01	2012	100	200
Ross	Port Orchard	RS02	2012	100	200
Blackjack	Port Orchard/Kitsap County	BJ01	2012	62	125
Annapolis	Port Orchard/Kitsap County	AP01	2012	100	200
Karcher	Port Orchard/Kitsap County	KA01	2012	50	100
Sacco	Kitsap County	SC01	2012	50	100
Beaver	Kitsap County	BV01	2012	50	100
Springbrook	City of Bainbridge Island	Current site	2012	50	100

[a]Water quality monitoring to begin following EPA approval of TMDL.

Table 30. Marine monitoring sites and TMDL FC targets. *Minimum per year: 10 ambient samples.*

Station Description	Responsible Organization	Station ID	Start Date	TMDL Target	
				GM	90th %ile
Nearshore below Barker Creek	Kitsap County	DY29	ongoing	14	43
Nearshore below Clear Creek	Kitsap County	DY27R	ongoing	14	43
Nearshore below Strawberry Creek	Kitsap County	DY25	ongoing	14	43
Chico Bay	Kitsap County	DY20	ongoing	14	43
Chico Bay	Kitsap County	DOH471	ongoing	14	43
Oyster Bay	Kitsap County	DOH487	ongoing	14	43
Port Washington Narrows - nearshore Anderson Cove	City of Bremerton	DY04	ongoing	14	43
Port Washington Narrows - Lions Park	City of Bremerton	DY05	ongoing	14	43
Port Washington Narrows – opp. Evergreen Park	City of Bremerton	DY33	ongoing	14	43
Port Washington Narrows/Chester Ave	City of Bremerton	DY37	ongoing	14	43
Port Washington Narrows – Lent landing	City of Bremerton	DY34	ongoing	14	43
Off Fletcher Bay, Bainbridge Isl	Department of Health	DOH457	ongoing	14	43
Nearshore below Lynwood Center	City of Bainbridge Island	new	2013	14	43
Nearshore at PSNS	PSNS & IMF	new	2013	14	43
Bremerton WWTP diffuser	City of Bremerton	SN03	ongoing	14	43
Nearshore below Gorst Creek	Kitsap County/City of Bremerton	SN05	ongoing	14	43
Nearshore below Karcher Crk	Kitsap County	SN13	ongoing	14	43
Near outfall below Bachmann Prk	City of Bremerton/Kitsap County	SN26	ongoing	14	43
Port Orchard below public boat ramp	City of Port Orchard/Kitsap County	SN23	ongoing	14	43
Nearshore below Annapolis Creek	Port Orchard/Kitsap County	SN22	ongoing	14	43
Nearshore below Sacco Creek	Kitsap County	SN15	ongoing	14	43
Nearshore below Blackjack Creek	City of Port Orchard/Kitsap County	SN12	ongoing	14	43

Effectiveness monitoring

Effectiveness monitoring determines whether the interim targets and water quality standards have been met after the water quality implementation plan is put into practice. Ecology's Environmental Assessment Program usually conducts effectiveness monitoring of TMDLs several years after a TMDL is approved by EPA. (Effectiveness monitoring is not intended to mean an evaluation of the effectiveness of individual BMPs in reducing pollution.)

Ecology's effectiveness monitoring studies include streamflow measurements in order to compare current loads with loads measured during monitoring for the TMDL. While the number of stream gages was reduced following the ENVVEST project, recently KPUD and KCSSWM worked to increase the number of operating gages. Ecology recommends that the following gages continue to be maintained, in order for good characterization of these water resources and to support effectiveness monitoring in the future.

- Currently gages are operating on Barker, Clear, Strawberry and Blackjack creeks, managed and maintained by Kitsap Public Utility District (KPUD) and Silverdale Water District (SWD).
- The city of Bainbridge Island maintains a stream gage on Springbrook Creek. Flow measurement and fecal coliform bacteria monitoring began in 2004.
- KCSSWM is in the process of purchasing flow gaging equipment and coordinating with KPUD and SWD for installing and collecting data for the next five years for Clear Creek main stem, West Fork Clear Creek, Barker Creek, Strawberry Creek, and Blackjack Creek.
- Gorst Creek flow gage was installed by Ecology in June 2007, and is currently operated and maintained by Ecology.
- Additional monitoring locations by Silverdale Water District, Kitsap Public Utilities District, and the city of Bremerton include Heinz Creek and Upper Gorst Creek. A network of precipitation stations is also maintained by various jurisdictions and citizen volunteers (CoCoRaHas 2010).

Ecology and participants that developed the TMDL will review data collected by local agencies to determine whether data are sufficient and the timing is appropriate for assessing effectiveness of the TMDL.

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Adaptive Management

Based on current implementation in the Sinclair-Dyes watershed and additional requirements of this TMDL, it is expected that fecal coliform reductions will be achieved and water quality standards met by 2016. This *water quality implementation plan* identifies water quality targets (Tables 29 and 30) and implementation actions.

An adaptive approach will be used to adjust the implementation plan in response to new water quality monitoring data. To track the progress of the TMDL, Ecology will assist local organizations in conducting a biennial review of water quality monitoring data and status reports from organizations responsible for achieving bacteria reductions. The biennial review will include an open meeting format to encourage information sharing. Ecology encourages local jurisdictions to assess progress in meeting wasteload allocations and provide data to Ecology (Appendix H) that indicate that the fecal coliform targets have been met at specific locations.

If water quality standards are achieved, but individual wasteload and load allocations have not been met, the TMDL will be considered satisfied.

Adaptive management is already incorporated into the work of two agencies with commitments to addressing fecal coliform pollution in this watershed:

- State Department of Health (DOH)'s Office of Shellfish and Water Protection conducts water quality monitoring in Rich and Port Orchard Passages and cooperatively with Kitsap County Health District (KCHD) in Dyes Inlet. DOH notifies local agencies when water quality is threatened or improves through its classification process. DOH reports annually on water quality for growing areas, and works informally with KCHD when water quality data indicate follow-up to find sources is needed.
- KCHD reports annually on stream and nearshore marine water quality. It also has a Pollution Identification and Correction (PIC) prioritization process that takes into consideration the Washington State Water Quality Assessment (303d listings); TMDLs; recent water quality data; and shellfish area classification information from DOH.

Ecology will consult periodically with DOH and KCHD to assess whether these biennial reviews, informal communications, and prioritization processes are effectively addressing changes in water quality and ensuring water quality standards will be met by 2016.

If the implementation actions outlined in Table 28 are completed, but water bodies still do not meet water quality standards, then revised implementation actions will be developed in consultation with appropriate local agencies and organizations. Consultation may include discussion of a number of topics and questions including:

- Effectiveness of current actions and programs.
- Effectiveness of existing enforcement capabilities.
- Are all sources of FC bacteria being addressed?
- Is additional funding required to make programs more effective?

- Is the geographic scope of current actions adequate to address all important sources?

Water quality monitoring (see *Performance Measures and Targets [Monitoring Plan]* section) is one of the tools that Ecology and implementing organizations will use to assess progress in achieving water quality standards.

It is ultimately Ecology's responsibility to ensure that cleanup is being actively pursued and water quality standards achieved.

Potential Funding Sources

Financial assistance for water quality improvement activities is available through Ecology's grant and loan programs, state salmon recovery and outdoor recreation grants, Kitsap Conservation District cost-share programs, Kitsap County programs and other sources (Table 31). Ecology will work with stakeholders to identify funding sources and prepare appropriate scopes of work to help implement this TMDL.

Table 31. Potential funding sources for TMDL implementation.

Sponsor	Fund	Uses
Department of Ecology, Water Quality Program	Centennial Clean Water Fund, Section 319, and State Revolving Fund www.ecy.wa.gov/programs/wq/funding/	Facilities and water pollution control-related activities; implementation, design, acquisition, construction, and improvement of water pollution control. Priorities include: implementing water quality implementation plans (TMDLs); keeping pollution out of streams and aquifers; modernizing aging wastewater treatment facilities; reclaiming and reusing waste water.
County Conservation District	Federal Conservation Reserve Enhancement Program (CREP) www.kitsapcd.org/	Conservation easements; cost-share for implementing agricultural/riparian best management practices (BMPs).
Enterprise Cascadia	Currently developing new funding strategy. www.sbpac.com	Non-profit organization makes low-interest loans in Kitsap, Mason and Jefferson counties for repair of individual onsite sewer systems.
Department of Ecology, SEA	Coastal Zone Protection Fund	Limited grants for on-the-ground projects funded by penalty monies collected by the Water Quality Program.
State Recreation and Conservation Funding Board	Recreation and Conservation Office www.rco.wa.gov/rcfb/grants.asp	Provides grants for habitat restoration, land acquisition and habitat assessment. Current grant programs include: • Aquatic Lands Enhancement Account • Land and Water Conservation Fund • Washington Wildlife Recreation Program
Natural Resources Conservation Service	Emergency Watershed Protection www.nrcs.usda.gov/programs/ewp/index.html	NRCS purchases land vulnerable to flooding to ease flooding impacts.

Sponsor	Fund	Uses
Natural Resources Conservation Service	Wetland Reserve Program www.wa.nrcs.usda.gov/programs/wrp/wrp.html	Landowners may receive incentives to enhance wetlands in exchange for retiring marginal agricultural land.
Natural Resources Conservation Service	EQIP (Environmental Quality Incentive Program) www.nrcs.usda.gov/programs/eqip/	Provides technical assistance, cost share, and incentive payments to assist crop and livestock producers with environmental and conservation improvements on the farm. Contracts last five to ten years.
Natural Resources Conservation Service	AWEP (Agriculture Water Enhancement Program) www.nrcs.usda.gov/programs/AWEP/	Offers financial and technical assistance to help farmers and ranchers carry out water enhancement activities that conserve ground and surface water and improve water quality on agricultural lands such as cropland, pasture, grassland and rangeland.
PSNS&IMF	Federal Dept of Defense budget process	Funding to meet environmental compliance requirements and fleet readiness

Summary of Public Involvement Methods

A number of methods were used to involve local and state agencies, Tribes, nonprofit organizations, and the general public in the Sinclair and Dyes Inlets Fecal Coliform TMDL.

A series of ENVVEST community meetings with Ecology participation was held from January 2005 through October 2008. These meetings were held in three different areas of the watershed: Silverdale, Bremerton, and Port Orchard. Attendance ranged from 20 to 40. In addition to updates on fecal coliform monitoring and modeling by PSNS & IMF Project ENVVEST, Ecology provided updates on the TMDL process. Organizations made presentations on programs that address fecal coliform pollution in the watershed, including:

- Suquamish Tribe shellfish and fisheries restoration programs.
- KCHD's Dyes Inlet Restoration Project.
- Kitsap County regulations covering pumpout stations at marinas.
- Kitsap County programs to reduce household hazardous waste.
- South Kitsap Water Reclamation Facility (SKWRF) in Port Orchard upgrade.
- State Department of Health reports on Dyes Inlet marine water quality and shellfish area classifications

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Ecology made presentations about the TMDL to the West Sound Watershed Council in 2007 and 2011, to TMDL 2007 (a national meeting on TMDLs sponsored by the Water Environment Federation), and to the Kitsap-area municipal stormwater managers group in 2009. In July 2010 and February 2011, Ecology held local meetings to update study results and acquaint Kitsap-area municipalities, tribes, and implementing organizations with the approach for developing load allocations and wasteload allocations.

In July 2011, two public meetings were held, the first in Port Orchard and the second in Silverdale. This provided opportunity for the public to hear the findings and requirements of the TMDL during the public comment period June 27 to August 1.

Local agency staff and other partners in Project ENVVEST were involved early in the TMDL. The PSNS&IMF coordinated an ambitious program of storm event monitoring in the creeks, nearshore areas, and 33 stormwater systems and outfalls, and pulled together staff from a number of agencies to assist with the sampling effort. The PSNS&IMF coordinated technical meetings involving local and state agencies, Tribes, and other organizations from early 2000 through 2008.

Reports and data from the studies were published as technical reports by Ecology and the Navy and are accessible on the World Wide Web. In addition, the PSNS&IMF and several Project ENVVEST partners reported on technical and scientific results of the project at scientific meetings such as Puget Sound and Georgia Basin conferences and Pacific Northwest chapter meetings of the Society for Environmental Toxicology and Chemistry.

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Conclusions and Recommendations

This total maximum daily load (TMDL) was initiated prior to 2002, when a draft TMDL study plan (ENVVEST, 2002) was published under a unique partnership of the PSNS&IMF, Ecology and EPA. Through the project, much has been learned about the land-based sources of fecal coliform bacteria, the fate and transport of bacteria from the land to receiving waters, and the importance of urban stormwater and failing shoreline onsite systems in contributing fecal coliform bacteria to marine waters.

Conclusions

Based on the TMDL analysis and review of recent water quality data, water quality has improved in several parts of the Sinclair-Dyes watershed. Improvements are still needed at a number of locations that have been assigned load allocations equivalent to the percent reduction needed in fecal coliform bacteria concentrations so that water quality standards will be met.

For locations where point sources, as well as nonpoint sources contribute to the impairment, and where data are not available to distinguish the relative importance of point and nonpoint sources, the percent reduction is assigned to both point and nonpoint sources.

Wasteload allocations for marine waters were assigned at 22 monitoring sites to six NPDES stormwater permittees, and range from seven to 95% reduction in fecal coliform concentration.

Wasteload allocations for freshwaters were assigned at 12 monitoring sites on 11 creeks to five NPDES stormwater permittees, and range from 25 to 97% reduction in fecal coliform concentration.

Progress in the watershed related to this project includes:

- Successful completion of an ambitious multi-agency monitoring and modeling program (ENVVEST) to understand fecal coliform pollution sources and impacts in the Sinclair-Dyes watershed. The PSNS&IMF served as technical lead. Two technical reports were published documenting the modeling and monitoring work, identifying pollution sources, and recommending source correction measures: May et al. (2005) and Johnston et al. (2009a). Data and supporting information are available on the internet.
- Early implementation of tools that are effective in finding pollution sources and ensuring correction, such as Kitsap County Health District (KCHD) Pollution Identification and Correction projects and the Dyes Inlet Restoration Project, which targeted stormwater discharge from commercial properties.
- The city of Bremerton's 16-year, $50 million Combined Sewer Overflow Reduction Program has dramatically reduced the volume and frequency of Bremerton's CSO discharges to the inlets since 1995. This work, and additional work by KCHD to find and correct failing onsite

systems led to state Department of Health decisions to open areas for shellfish harvest in Dyes Inlet in 2003 and Chico Bay in 2009.

- Cooperative efforts of the city of Bainbridge Island with KCHD reduced FC inputs along the shoreline of the island and increased water quality awareness among citizens.
- Cooperative work by Phase II stormwater municipalities led to Kitsap One (county-wide hotline for reporting water quality problems), pet waste education, and Centennial grant-funded training of commercial/business property inspectors by KCHD.
- Ecology's administration of NPDES municipal stormwater permits will help reduce pollution loading to the inlets from stormwater runoff as stormwater programs mature.
- Effective adaptive management processes led by state Department of Health and Kitsap County Health District are in place for quick response and investigation when monitoring data indicate a problem.

Over the course of the project, changes occurred in the regulatory landscape and in wider acceptance and implementation of development approaches that are more protective of downstream water quality:

- In 2007, Ecology issued the Phase II NPDES municipal stormwater permit, covering the cities of Bremerton, Bainbridge Island, Port Orchard, and Kitsap County.
- In 2009, Ecology issued the statewide NPDES municipal stormwater permit to Washington State Department of Transportation.
- In 2009, Kitsap Home Builders Foundation published a Low Impact Development Guidance Manual for Kitsap-area planners and developers.
- The city of Bremerton and other municipalities are successfully completing redevelopment projects with significant Low Impact Development/stormwater infiltration elements.

Usefulness of the ENVVEST model:

- A dynamic marine model did a very good job of simulating fecal coliform bacteria concentrations in relatively open marine waters, where water movement, mixing, and bacteria sources and survival are more predictable. The model was used successfully to track the dispersion and die-off of bacteria in Dyes Inlet from combined sewer overflows in Port Washington Narrows, enabling state Department of Health to open more of the inlet to commercial shellfish harvest.
- The model does a good job simulating bacteria concentrations at the mouths of streams in the nearshore area. The model accurately differentiated the impacts of smaller polluted streams from larger ones on nearshore marine waters.

Limitations of the ENVVEST model:

- Localized sources of fecal coliform bacteria, such as failing onsite sewer systems along the shoreline, are not well characterized using a modeling approach such as this one. Onsite failure can result from the vagaries of human management rather than consistent, predictable landscape characteristics. Because this watershed has a high density of older shoreline homes served by onsite systems, this category of fecal coliform source is particularly important in affecting nearshore water quality.

Impacts of wet vs. dry years on marine water quality:

- The poorer marine water quality in Dyes and Sinclair Inlets in WY2010, compared with WY2009, may be related to a higher frequency of failing onsite systems in a very wet year and more efficient transport of bacteria by stormwater infrastructure.

Recommendations

- Local governments should continue to fund programs such as Kitsap County Health District's Pollution Identification and Correction program.
- Local government planning agencies should develop education and incentives for permitted, but as yet-undeveloped projects that were approved prior to recent emphasis on LID. The objective would be for these projects to take a second look at incorporating LID design principles before construction begins.
- For two stream basins with areas outside municipal Phase II stormwater permit coverage – Gorst and Chico creeks – Kitsap County Department of Community Development should call for future developments to manage stormwater either in accordance with Low Impact Development principles and practices or use other stormwater management techniques to minimize discharge of bacteria to surface waters.
- Local government planning agencies should look for opportunities to protect stream water quality through riparian protections. An example is a recent Kitsap County decision to retain lower density zoning for the Barker Creek corridor, based on the Alternative Futures process.
- Local government planning agencies should look for opportunities to incorporate LID or other stormwater management techniques into retrofit and redevelopment[9] projects to minimize bacteria discharge to surface waters.
- Because of size differences, Kitsap-area local governments have variable experience with illicit discharge detection and elimination (IDDE) programs. Funding is needed to continue Kitsap Health's IDDE assistance to smaller cities to ensure their programs are effective.
- Local municipalities and utility districts should continue to operate and maintain flow gages on Barker, Clear, West Fork Clear, Strawberry, Chico, Blackjack, Heinz, Upper Gorst and Springbrook creeks.
- Municipal parks districts should provide these measures to protect and improve water quality:
    - Install and maintain animal waste education and collection stations at municipal parks where substantial domestic animal use (including use by dogs and horses) is expected.

[9] If the use of LID BMPs in redevelopment projects is not otherwise addressed by the reissued Phase II permit

    - Ensure that outdoor trash containers, dumpsters and other facilities that may contain food waste that attracts wildlife are properly maintained.

- Municipal wastewater treatment facility operators should provide a GIS layer with sewer collection line locations to local municipal stormwater permittees, to assist them in IDDE investigations of FC bacteria sources.

- For the neighborhoods draining to Phinney and Ostrich Bay creeks (two of the most polluted creeks in the watershed) KCHD is seeking funding for a technical and economic feasibility study of alternatives for sewering the Phinney Creek and Ostrich Bay Creek neighborhoods. Kitsap County and the city of Bremerton need to assist with the study. The study should aim to develop a preferred alternative for addressing the pollution problems and information on ways to fund the solution. The study report should be completed by 2016.

- For parts of the watershed where onsite sewer systems and municipal sewer collection lines co-occur, a diagnostic tool should be developed for determining which of the two may be polluting a surface water body.

  If the chemical and bacteriologic characteristics of onsite system leakage are not distinguishable from those of leakage from municipal sewer collection infrastructure, then a systematic, cooperative process should be developed to narrow down the sources that pollute streams or stormwater.

- As resources allow, municipal wastewater treatment facility owners should review any sewer infrastructure located in marine waters or in beaches, and look for opportunities for relocations to street utility corridors if these are to be opened up during construction projects.

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Appendices

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Appendix A. Sinclair-Dyes watershed listings for pollutants other than bacteria

Table A-1. Sinclair Dyes watershed Category 5 freshwater listings not covered by this TMDL (2008 Water Quality Assessment). All listings are in WRIA 15.

Listing ID	Water body	Parameter	Township	Range	Section
38404	ANNAPOLIS CREEK	Dissolved Oxygen	24.0n	01.03	25
38408	BARKER CREEK	Dissolved Oxygen	25.0N	01.0E	22
38424	BEAVER CREEK	Dissolved Oxygen	24.0N	02.0E	16
38451	BLACKJACK CREEK	Dissolved Oxygen	23.0N	01.0E	11
38455	BLACKJACK CREEK	Dissolved Oxygen	23.0N	01.0E	23
38483	CHICO CREEK	Dissolved Oxygen	24.0N	01.0E	05
38486	CHICO CREEK	Temperature	24.0N	01.0E	05
38491	CLEAR CREEK	Dissolved Oxygen	25.0N	01.0E	16
38495	CLEAR CREEK	Dissolved Oxygen	25.0N	01.0E	09
38607	GORST CREEK	Dissolved Oxygen	24.0N	01.0E	32
38670	KITSAP CREEK	Dissolved Oxygen	24.0N	01.0E	08
38673	KITSAP CREEK	Temperature	24.0N	01.0E	08
38858	ROSS CREEK	Dissolved Oxygen	24.0N	01.0E	34
38922	OSTRICH BAY CREEK	Dissolved Oxygen	24.0N	01.0E	16
38928	SACCO CREEK	pH	24.0N	02.0E	19
40750	CHICO CREEK	Temperature	24.0N	01.0E	08
6345	KITSAP LAKE	Phosphorus	24.0N	01.0W	32
42170	KITSAP LAKE	PCB	24.0N	01.0W	32
43033	ENETAI CREEK	Dissolved Oxygen	24.0N	02.0E	07
52957	OSTRICH BAY CREEK	Dissolved Oxygen	24.0N	01.0E	16
52964	CHICO CREEK	Dissolved Oxygen			
52968	KITSAP CREEK	Dissolved Oxygen	26.0N	02.0E	15

Table A-2. Sinclair Dyes watershed Category 5 marine listings not covered by this TMDL (2008 Water Quality Assessment). All listings are in WRIA 15.

Listing ID	Water body	Parameter	Marine Grid Cell	Latitude	Longitude
38547	PORT ORCHARD, AGATE PASSAGE, AND RICH PASSAGE	Dissolved Oxygen	47122F6G1	47.565	122.615
8699	DYES INLET AND PORT WASHINGTON NARROWS	Mercury	47122F6I8	47.585	122.685
38847	PORT ORCHARD, AGATE PASSAGE, AND RICH PASSAGE	Dissolved Oxygen	47122F5J4	47.595	122.545
48946	SINCLAIR INLET	Dissolved Oxygen	47122F6D7	47.535	122.675
52999	PORT ORCHARD, AGATE PASSAGE, AND RICH PASSAGE	Dissolved Oxygen	47122F5H9	47.575	122.595
53000	PORT ORCHARD, AGATE PASSAGE, AND RICH PASSAGE	Dissolved Oxygen	47122F5J7	47.595	122.575
53002	PORT ORCHARD, AGATE PASSAGE, AND RICH PASSAGE	Dissolved Oxygen	47122F6F0	47.555	122.605

Appendix B. Schedule of Sinclair Dyes TMDL implementation actions

Table B-1. Schedule of implementation activities

Source	Organization	Implementation Actions	Potential Concern	Performance Measure	
				What	When
Onsite Septic Systems	Kitsap County Health District	Continue to obtain resources for, and conduct, Pollution Identification and Correction projects for priority creeks and shoreline areas	Fecal coliform pollution from onsite system malfunction or failure	Grant application	Fall 2013
Onsite Septic Systems	Enterprise Cascadia	Develop secure funding for sustainable loan programs for onsite repair/replacement	Fecal coliform pollution from onsite system malfunction or failure	Funds obtained	Fall 2013
Onsite Septic Systems	Kitsap County Health District with Bremerton and Kitsap Cty SSWM	Conduct technical and economic feasibility study of alternatives for sewering Phinney and Ostrich Bay Creek neighborhoods	Fecal coliform pollution from onsite system malfunction or failure	Plan with preferred alternative	2016
Waste from boaters	Kitsap County Health District	Recommended: Complete marina pumpout survey and draft recommendations	Improper disposal of human waste	Draft report with recommendations	One year following TMDL approval
Waste from boaters	Kitsap County Health District	Recommended: Develop alternative ways to reach boating community	Improper disposal of human waste	Implement new educational or regulatory approaches	2016
Stormwater with fecal coliform pollution	Phase II NPDES municipal permittees	To address current WQ impairments, look for opportunities to incorporate LID into retrofit and redevelopment [10]projects. To prevent future degradation of water quality, require applicable new development to incorporate LID BMPs or other stormwater management techniques that minimize the discharge of bacteria to surface waters.	Piped stormwater systems from urban areas with high percent impervious surface typically have high fecal coliform concentrations in discharges.	Local development permits, as reported in Phase II NPDES stormwater annual report	Starting in 2016

[10] If the use of LID BMPs in redevelopment projects is not otherwise addressed by the reissued Phase II permit.

Source	Organization	Implementation Actions	Potential Concern	Performance Measure	
				What	When
		Address locations with WLAs (Tables 23 and 26) via geographic focus of IDDE and Operations & Maintenance programs	Fecal coliform bacteria conveyed by stormwater	Phase II NPDES stormwater annual report	Yearly following TMDL approval
		Work together to ensure monitoring continues at KCHD sites in Tables 29 and 30	Assess compliance with water quality standards	KCHD monitoring data available to Ecology	Yearly
	City of Bainbridge Island	Monitor nearshore below Lynwood Center	Assess compliance with water quality standards	Monitoring data available to Ecology	Yearly following TMDL approval
	City of Bainbridge Island	Monitor Springbrook Creek	Assess compliance with water quality standards	Monitoring data available to Ecology	Yearly following TMDL approval
	PSNS & IMF	Monitor marine receiving waters below shipyard	Assess compliance with water quality standards	Monitoring data available to Ecology	Yearly following TMDL approval
Stormwater with FC pollution outside Phase II permit coverage	KC Dept of Community Development	For areas of Gorst and Chico stream basins outside municipal Phase II permit coverage, call for new development to manage stormwater to minimize the discharge of bacteria to surface waters.	Fecal coliform bacteria conveyed by stormwater	Implementation review meeting with Ecology	Ongoing
Stormwater with fecal coliform pollution	WSDOT	Implement WSDOT Municipal Stormwater Permit in the Phase II coverage areas of this watershed, for SR16, SR160, SR166, SR3, SR303, SR304, and SR310 with: • Identify maintenance needs during GPS mapping & conduct maintenance as soon as possible • Identify dry weather illicit discharges into WSDOT's right of way during GPS mapping	Fecal coliform bacteria conveyed by stormwater	Implementation review meeting with Ecology	By March 1, 2015
WWTPs	Municipal WWTP operators	All: Continue compliance with bacteria limits in NPDES permits	Fecal coliform bacteria that reaches surface waters outside permitted mixing zone at concentrations exceeding water quality standards	Discharge monitoring reports	Monthly

Source	Organization	Implementation Actions	Potential Concern	Performance Measure What	Performance Measure When
		City of Bremerton: Assist KCHD with feasibility study for sewering Phinney and Ostrich Bay creek neighborhoods	Pollution of Phinney and Ostrich Bay creeks	Plan with preferred alternative	2016
Livestock and manure manage-ment	Kitsap Conservation District	Recommended: Provide KCHD inventory of parcels with livestock	Fecal coliform bacteria that reaches surface waters at concentrations exceeding water quality standards	Parcel inventory	2013
		Recommended: Assess need for property owner education on BMPs for livestock and manure management		Need for education reported to KCHD and Ecology	2013

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Appendix C. Record of public participation

List of public meetings

July 29, 2010 and February 17, 2011. Local review meetings were held in the Norm Dicks Government Center, Bremerton, to hear presentations on the Navy model results and review the preliminary draft TMDL document.

July 20 and 21, 2011. Public meetings on the Draft Fecal Coliform TMDL (in Port Orchard, July 20; in Silverdale July 21). The public comment period was June 27 to August 1, 2011.

March 14, 2012. City of Bremerton-hosted meeting with the cities of Bainbridge Island, Port Orchard, Poulsbo; with Kitsap County SSWM, Suquamish Tribe, EPA and Ecology, to discuss TMDL language to address the potential for future development to contribute bacteria to surface waters in the Sinclair and Dyes Inlets watersheds.

Other meetings

A series of ENVVEST community meetings with Ecology participation was held from January 2005 through October 2008. To better serve the public, these meetings were held in three different areas of the watershed: Silverdale, Bremerton, and Port Orchard. In addition to updates on fecal coliform monitoring and modeling by PSNS & IMF Project ENVVEST, Ecology provided periodic updates on the TMDL process. Local organizations provided updates on programs that addressed fecal coliform pollution, including:

- Suquamish Tribe shellfish and fisheries restoration programs
- KCHD's Dyes Inlet Restoration Project
- Kitsap County regulations covering pumpout stations at marinas
- Kitsap County programs to reduce household hazardous waste
- South Kitsap Water Reclamation Facility upgrade.

Newspaper articles

May 3, 2011 (Kitsap Sun): "State: Cleanup efforts for Sinclair, Dyes Inlets working," see http://www.kitsapsun.com/news/2011/may/03/state-cleanup-efforts-for-sinclair-dyes-inlets/

July 21st, 2011 (Kitsap Sun): "Kitsap study reveals much about stormwater," see http://www.kitsapsun.com/news/2011/jul/21/kitsap-study-reveals-much-about-stormwater/

Outreach and announcements

A 30-day public comment period for this report was held from June 27 through August 1, 2011.

A news release was sent to local media in the Sinclair Dyes watershed area, and the two public meetings were advertised in the Kitsap Sun on July 13th and 17th.

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Appendix D. Tables for model setup

Table D-1. Geometric mean fecal coliform (FC) loading concentrations and the cluster 25th and 75th percentile FC loading concentrations estimated for each pour point (DSN, or Data Set Number) discharging into Sinclair and Dyes Inlets (May et al., 2005, Table 8-43).

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_3	Stormwater	East Bremerton-Upper Pine Rd		1	210	947	1255	
DSN_4	Stormwater	East Bremerton-Middle Pine Rd		1	210	947	1255	
DSN_5	Stormwater	East Bremerton-Upper Stephenson		1	210	947	1255	
DSN_6	Stream	Dee Creek	DEE	4	12.3	179.22	705	
DSN_7	Stormwater	East Bremerton-Pine Rd	BST-001 (SW3)	1	210	947	1255	
DSN_8	Stormwater	East Bremerton-Sheridan		1	210	947	1255	
DSN_9	Stormwater	East Bremerton-Stephenson	BST-003 (SW6)	1	210	947	1255	
DSN_10	Stormwater	East Bremerton-East Park		1	210	947	1255	
DSN_11	Stormwater	East Bremerton-Campbell Ave	BST-07 (SW5)	1	210	947	1255	
DSN_12	Shore	East Bremerton-Reid Ave		4	12.3	179.65	705	
DSN_13	Shore	East Bremerton-Cherry St		4	12.3	141.53	705	
DSN_14	Stormwater	East Bremerton-Manette East		1	210	947	1255	
DSN_15	Stormwater	East Bremerton-Manette West		1	210	947	1255	
DSN_16	Stormwater	East Bremerton-Trenton Ave	BST-012 (SW4)	1	210	947	1255	
DSN_17	Stormwater	East Bremerton-Marlowe Ave		1	210	947	1255	
DSN_18	Shore	East Bremerton-Parkside Dr		4	12.3	179.84	705	

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_19	Stormwater	East Bremerton-Manette Bridge		1	210	947	1255	
DSN_20	Stormwater	East Bremerton-Upper Trenton		1	210	947	1255	
DSN_21	Shore	North Illahee Shore		5	11.1	119.26	294	
DSN_22	Shore	Jackson Park Shore		5	11.1	97.43	294	
DSN_23	Shore	Illahee (MESO-NW)		3	9.5	23.70	50	Predicted geometric mean was greater than the Cluster within stream 75th percentile, the overall 75th percentile was used
DSN_24	Shore	Illahee State Park Shore		5	11.1	82.87	294	
DSN_25	Shore	Earlands Point Shore		4	12.3	144.03	705	
DSN_26	Shore	Rocky Point Shore		5	11.1	116.03	294	
DSN_27	Stormwater	Gorst Commercial (Subaru)	LMK-128	3	62	140	263	
DSN_28	Shore	Gorst Elandan Gardens		5	11.1	82.15	294	
DSN_29	Stream	Spring Creek (Gorst)		1	11	36.29	138	
DSN_30	Shore	Ross Point Shore		5	11.1	65.50	294	
DSN_31	Stormwater	Port Orchard Downtown - Wilkens	PO-WILKENS	3	62	140	263	
DSN_32	Stormwater	Port Orchard Downtown - Bay St	PO-BAY	1	210	947	1255	
DSN_33	Shore	Port Orchard Annapolis Point		4	12.3	131.17	705	
DSN_34	Shore	Port Orchard Olney Ave		5	11.1	105.12	294	
DSN_35	Shore	Port Orchard Ahlstrom Rd		5	11.1	110.71	294	

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_36	Shore	Port Orchard Lindstrom Hill		2	23	48.60	263	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used
DSN_37	Shore	Port Orchard Beach Dr		1	11	29.91	138	
DSN_38	Shore	Port Orchard Hillcrest Dr		2	23	48.60	263	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used
DSN_39	Shore	Port Orchard Waterman Point		2	23	48.60	263	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used
DSN_40	Shore	BI-Hansen Rd		1	11	24.50	138	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used
DSN_41	Shore	BI-Crystal Springs		1	11	26.05	138	

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_42	Shore	BI-Point White		2	23	48.60	263	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used
DSN_43	Stream	Schel Chelb Creek (BI)	BI-SC	2	23	48.60	263	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used
DSN_44	Stormwater	BI-Pleasant Beach		2	158	321	459	
DSN_45	Stormwater	BI-Fort Ward	BI-FW	2	158	321	459	
DSN_46	Shore	Manchester Point Shore		2	23	31.16	263	
DSN_55	Stream	Gorst Creek @ Sam Christopherson	GC-SC	1	11	29.89	138	
DSN_57	Stream	Anderson Creek	AC	1	11	30.34	138	
DSN_58	Stream	Barker Creek	BA	2	23	84.34	263	
DSN_64	Stream	Olney (Karcher) Creek	OC	4	12.3	157.37	705	
DSN_65	Stream	Earlands Creek		3	9.5	23.70	50	Predicted geometric mean was greater than the Cluster within stream 75th percentile, the overall 75th percentile was used
DSN_66	Stream	Woods Creek		1	11	36.30	138	
DSN_67	Stream	Koch Creek	KOCH	4	12.3	145.21	705	
DSN_68	Stream	Crystal Creek		5	11.1	89.84	294	
DSN_71	Stormwater	Jackson Park Creek Stormwater		3	62	140	263	

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_72	Stream	Stampede Creek		4	12.3	153.75	705	
DSN_73	Stream	Pahrmann Creek	PHRM	4	12.3	153.42	705	
DSN_74	Stream	Illahee Creek	ILL	3	9.5	23.70	50	Predicted geometric mean was greater than the Cluster within stream 75th percentile, the overall 75th percentile was used
DSN_75	Stream	Illahee State Park Creek	ILL-SP	5	11.1	99.56	294	
DSN_76	Stream	Sacco Creek	SACCO	2	23	69.75	263	
DSN_77	Stream	Sullivan Creek		2	23	55.70	263	
DSN_79	Stream	Waterman Creek		2	23	26.45	263	
DSN_80	Stream	Rich Cove Creek		2	23	32.40	263	
DSN_81	Stream	Lower Beaver Creek	BE-LOW	2	23	54.41	263	
DSN_82	Shore	BI-Baker Hill West		1	11	24.50	138	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used
DSN_83	Stream	Gazzam Creek (BI)		1	11	44.94	138	
DSN_84	Stormwater	BI-Lynwood Center	BI-LWC	2	158	321	459	
DSN_85	Shore	BI-Baker Hill East		1	11	24.50	138	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_86	Stream	Islandwood Creek (BI)		2	23	48.60	263	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used
DSN_87	Stream	Chico Creek Lower	CH01	1	11	36.63	138	
DSN_92	Stream	Mosher Creek	MOSH	4	12.3	152.46	705	
DSN_93	Stream	Ross Creek	ROSS	5	11.1	91.03	294	
DSN_94	Stream	Strawberry Creek	SC	5	11.1	82.67	294	
DSN_95	Shore	Chico Bay Shore North		3	9.5	23.70	50	Predicted geometric mean was greater than the Cluster within stream 75th percentile, the overall 75th percentile was used
DSN_96	Shore	Chico Way Shore		5	11.1	126.33	294	
DSN_97	Shore	Chico Bay Shore South		4	12.3	132.44	705	
DSN_98	Shore	Old Silverdale Shore		4	12.3	129.77	705	
DSN_99	Stormwater	Silverdale Bayview Dr	LMK-004	1	210	947	1255	
DSN_100	Shore	Silverdale Tracyton Blvd		4	12.3	153.66	705	
DSN_101	Shore	Windy Point		5	11.1	105.91	294	
DSN_102	Shore	Tracyton Paxford Ln		5	11.1	85.13	294	
DSN_103	Shore	Tracyton Stampede Blvd		5	11.1	92.00	294	
DSN_104	Stormwater	Silverdale Bucklin Hill Rd	LMK-026	1	210	947	1255	
DSN_136	Stream	Clear Creek @ Bucklin Hill Rd	CC01	5	11.1	96.60	294	
DSN_137	Shore	West Dyes Inlet Cedar Terrace		4	12.3	142.46	705	
DSN_139	Shore	Phinney Bay East Shore		5	11.1	124.77	294	
DSN_140	Stormwater	West Bremerton Narrows Stevens Dr		1	210	947	1255	

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_141	Stormwater	West Bremerton Narrows Snyder Ave		1	210	947	1255	
DSN_142	Stormwater	West Bremerton Narrows Anderson Cove		1	210	947	1255	
DSN_143	Stormwater	Phinney Creek Stormwater	LMK102	1	210	947	1255	
DSN_144	Stormwater	West Bremerton Narrows Thompson Ave		1	210	947	1255	
DSN_145	Shore	Oyster Bay Marine Dr.		4	12.3	131.83	705	
DSN_146	Stormwater	West Bremerton Narrows Chester Ave		1	210	947	1255	
DSN_147	Stormwater	West Bremerton Narrows Park Ave		1	210	947	1255	
DSN_148	Stormwater	West Bremerton Narrows Ohio Ave		1	210	947	1255	
DSN_149	Stream	Ostrich Bay Creek	OBC	4	12.3	175.37	705	
DSN_150	Stormwater	West Bremerton Washington Ave		1	210	947	1255	
DSN_151	Stormwater	Oyster Bay	BST-026	1	210	947	1255	
DSN_152	Stream	Wright Creek	WRT	3	9.5	23.70	50	Predicted geometric mean was greater than the Cluster within stream 75th percentile, the overall 75th percentile was used
DSN_153	Stormwater	National Ave	LMK-164	1	210	947	1255	
DSN_154	Stormwater	West Bremerton Loxie Egans		1	210	947	1255	
DSN_155	Stormwater	West Bremerton Auto Center Way		1	210	947	1255	
DSN_156	Stormwater	West Bremerton 11th St		1	210	947	1255	
DSN_157	Stormwater	West Bremerton Upper Callow		1	210	947	1255	
DSN_158	Stormwater	West Bremerton Callow Ave	BST-028 (SW1)	1	210	947	1255	

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_160	Stormwater	West Bremerton High Ave		1	210	947	1255	
DSN_161	Stormwater	West Bremerton Narrows High Ave		1	210	947	1255	
DSN_162	Stormwater	West Bremerton Narrows Evergreen Park		1	210	947	1255	
DSN_165	Stormwater	West Bremerton Pacific Ave		1	210	947	1255	
DSN_166	Stormwater	PSNS008 Inactive Ships	PSNS008	1	210	947	1255	
DSN_167	Stormwater	PSNS015 McDonalds NavSta	PSNS015	1	210	947	1255	
DSN_168	Stormwater	PSNS FISC		1	210	947	1255	
DSN_169	Stormwater	PSNS081.1 Bldg 455 "R" St.	PSNS081	1	210	947	1255	
DSN_170	Stormwater	PSNS082.5 Bldg 480	PSNS082	1	210	947	1255	
DSN_171	Stormwater	PSNS DD5		1	210	947	1255	
DSN_172	Stormwater	PSNS Bldg 457		1	210	947	1255	
DSN_173	Stormwater	PSNS "N" St.		1	210	947	1255	
DSN_174	Stormwater	PSNS101 Pier 5		1	210	947	1255	
DSN_175	Stormwater	PSNS115.1 Dry Dock 1	PSNS115	1	210	947	1255	
DSN_176	Stormwater	PSNS124 Dry Dock 3	PSNS124	1	210	947	1255	
DSN_177	Stormwater	PSNS126 Bldg 460 Pier 8	PSNS126	1	210	947	1255	
DSN_178	Stormwater	PSNS Main Gate		1	210	947	1255	
DSN_182	Shore	Manchester Fuel Depot Shore		3	9.5	23.70	50	Predicted geometric mean was greater than the Cluster within stream 75th percentile, the overall 75th percentile was used
DSN_183	Stormwater	Port Orchard Boulevard	PO-POBLVD	1	210	947	1255	
DSN_185	Stormwater	Port Orchard Farragut Ave		1	210	947	1255	

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_186	Stormwater	Annapolis		1	210	947	1255	
DSN_187	Stream	Annapolis Creek	ANNP (LMK-136)	4	12.3	180.67	705	
DSN_188	Shore	Port Orchard East Shore		4	12.3	162.34	705	
DSN_189	Stormwater	Port Orchard Cline Ave		1	210	947	1255	
DSN_190	Stormwater	Port Orchard Cline Ave Upper		1	210	947	1255	
DSN_192	Stormwater	Port Orchard Tracy Ave		1	210	947	1255	
DSN_193	Stream	Blackjack Lower Mainstem	BL-KFC	1	11	48.16	138	
DSN_195	Stormwater	Tracyton Boat Dock	LMK-055 & 060	1	210	947	1255	
DSN_196	Stormwater	Manchester Fuel Depot Upland Area		2	158	321	459	
DSN_199	Shore	Tracyton Shore		5	11.1	90.16	294	
DSN_201	Shore	Madronna Point Shore		4	12.3	167.64	705	
DSN_202	Stormwater	Port Orchard Bethel Road	PO-BETH	1	210	947	1255	
DSN_203	Shore	BI Battle Point West		1	11	18.76	138	
DSN_204	Shore	BI Fletcher Shore South		1	11	24.50	138	Predicted geometric mean was less than the Cluster within stream 25th percentile, the overall 25th percentile was used
DSN_205	Stream	Isseii Creek (BI)		1	11	34.30	138	
DSN_206	Shore	BI Fletcher Bay		1	11	23.33	138	
DSN_207	Shore	BI Battle Point E		1	11	43.61	138	
DSN_208	Stream	Fletcher Bay Creek (BI)		1	11	50.47	138	
DSN_210	Stream	Lower Springbrook Creek (BI)		5	11.1	58.91	294	
DSN_211	Shore	Manchester South Shore		5	11.1	91.62	294	
DSN_212	Shore	Manchester North Shore		5	11.1	94.06	294	
DSN_213	Stormwater	Manchester	LMK-038	2	158	321	459	

DSN	Pour Point Type	Basin Description/Location	WQ ID	Cluster Assignment	Cluster 25th Percentile	Predicted Geometric Mean	Cluster 75th Percentile	Comment
DSN_214	Shore	Gorst North Shore		5	11.1	98.95	294	
DSN_215	Stormwater	Gorst Commercial (Navy City Metals)	LMK-122	2	158	321	459	
DSN_216	Stormwater	Silverdale Mall West	LMK-002	1	210	947	1255	
DSN_217	Stormwater	Silverdale Mall East	LMK-001	1	210	947	1255	
DSN_218	Stormwater	West Bremerton Burwell		1	210	947	1255	
DSN_219	Stormwater	West Bremerton Warren Ave S. of 11th		1	210	947	1255	
DSN_220	Stormwater	West Bremerton Park Ave	BST-CSO-16 (SW2)	1	210	947	1255	
DSN_221	Stormwater	West Bremerton Porter (Callow)		1	210	947	1255	
DSN_222	Stormwater	West Bremerton Chester Ave		1	210	947	1255	
DSN_223	Stormwater	West Bremerton Evergreen Park	BST-027	1	210	947	1255	
DSN_224	Stormwater	West Bremerton Cambrian Ave (Callow)		1	210	947	1255	

Appendix E: Model Development and Evaluation

The development, calibration, verification, and evaluation of the integrated watershed and receiving water model developed for the Sinclair/Dyes Inlet watershed is summarized in this Appendix. Model development is described in Johnston et al. (2009a). Information about the model development, application, and simulation results can be viewed by accessing the ENVVEST Spatial Viewer at http://kairos.spawar.navy.mil/Website/spatialviewer.

Calibration and verification of HSPF model

The watershed modeling process consisted of deploying 15 Hydrologic Simulation Program FORTRAN (HSPF) models to simulate the hydrology of 17 subwatersheds within the Sinclair and Dyes Inlet drainage basin (Figure E1). The process of watershed model calibration and verification is described in Skahill and LaHatte (2006, 2007) and Johnston et al. (2009a). This section is a short summary.

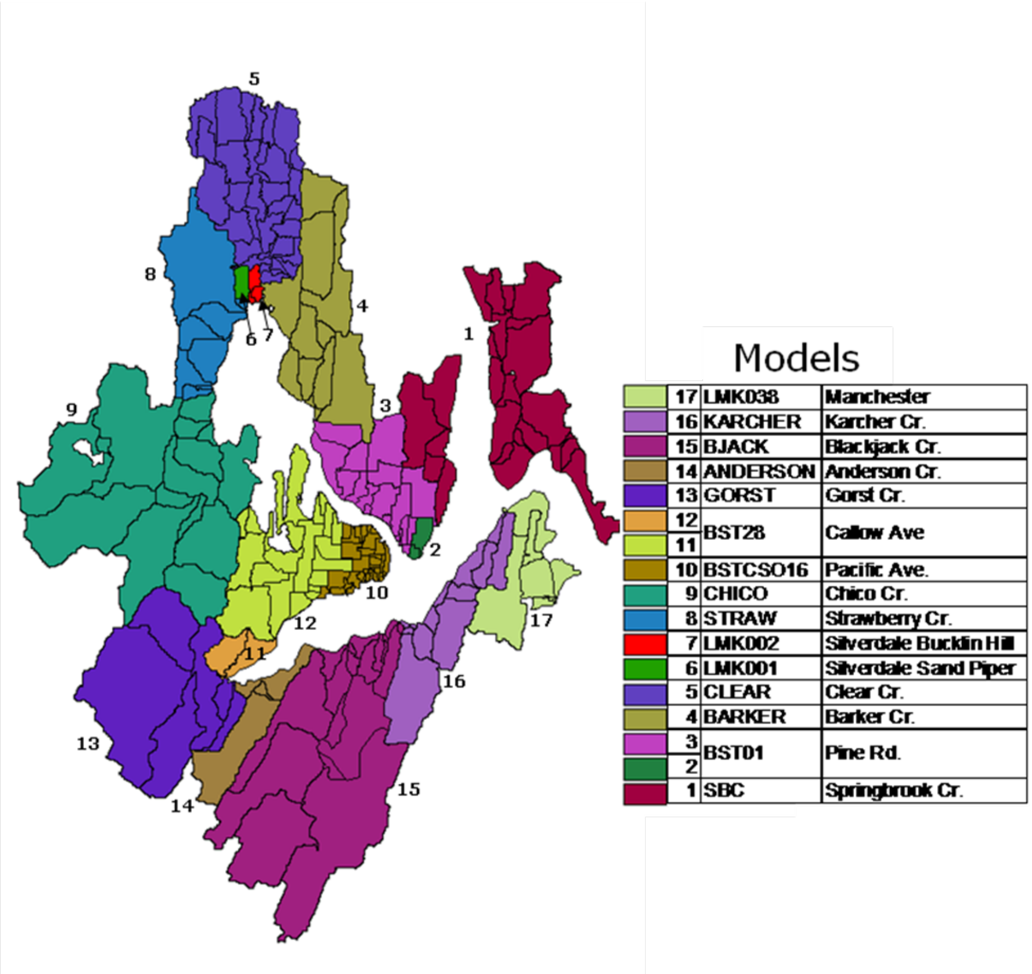

Figure E1. Delineated watersheds, landscape segments, and HSPF sub-basin models used to model hydrologic runoff from the Sinclair and Dyes Inlets watershed.

Model calibration consists of changing values of model input parameters in an attempt to match field conditions within some acceptable criteria. The watershed subbasin models were calibrated based on measured precipitation data by fitting stream flow stage-discharge data and matching pre-determined targets for average annual precipitation to partition into surface runoff, interflow runoff, baseflow runoff, total evapotranspiration, impervious surface runoff, and impervious surface total evapotranspiration for each type of LULC represented in the models (Skahill and LaHatte 2006, 2007).

The HSPF subbasin models were calibrated for an identified calibration period -- generally WY2001 and WY2002 based on the available observed data (Figure E2). Parameter estimation and optimization software was used in an iterative procedure (repeated runs of the model) to minimize the model-to-measurement misfit between observed data and mean annual precipitation targets and their simulated counterparts and fit model parameters to the observed data (Table E1). Parameters selected for estimation were those that were related to the LULC features and that would be most useful for applying model results from gauged streams to ungauged streams and stormwater basins.

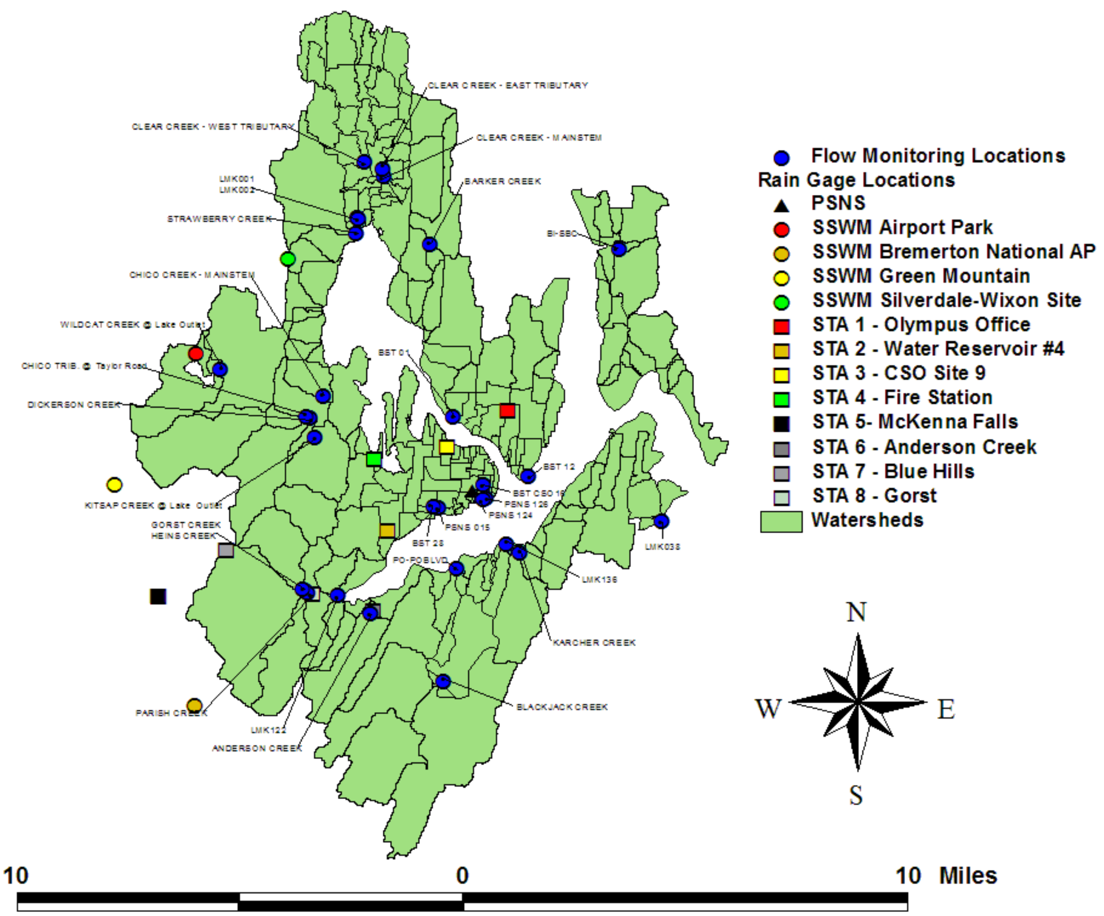

Figure E2. Watershed boundaries and locations of flow monitoring and rain gauging stations used to collect data to support hydrologic model deployment and calibration for the Sinclair and Dyes Inlets watershed.

The hydrology model was calibrated with consideration for:

- Including as much information as possible about engineered conveyance systems and other factors that would affect runoff.
- Not "over calibrating" any of the sub-basin models such that the predictions would not be applicable to nearby basins.
- Focusing the calibration on landscape-scale processes, which sacrificed some of the accuracy of the modeled stage-discharge relationships in favor of models that were more representative of the watershed as a whole.

The watershed model calibration and verification effort attempted, as much as possible, to incorporate conventional guidance for HSPF model calibration so as to not overly bias the models to individual storm events or isolated flow regimes.

Table E1. Parameters estimated during calibration of HSPF sub-basin models (Skahill and LaHatte 2006, 2007).

Parameter	Description	Bounds imposed during calibration[1]
IMP	percent effective impervious area	11% - 19% for medium density residential
		19% - 32% for high density residential
		51% - 98% for commercial/industrial development
		7% - 10% for acreage and rural residential
INSUR	Manning's n for the impervious overland flow plane	0.01 - 0.15
RETSC	retention (interception) storage capacity of the impervious surface	0.01 - 0.3
AGWETP	fraction of ET[2] taken from groundwater (after accounting for that taken from other sources)	0.01 - 0.2
AGWRC	groundwater recession parameter	0.833 - 0.999 day^{-1}
DEEPFR	fraction of groundwater inflow that goes to inactive groundwater	0.0 - 0.2
INFILT	related to infiltration capacity of the soil	0.001 - 1.0 in/hr
INTFW	interflow inflow parameter	1.0 - 10.0
IRC	interflow recession parameter	0.30 - 0.85 day^{-1}
NSUR	Manning's n for the overland flow plane	0.05 - 0.5
LZETP	lower zone ET parameter - an index of the density of deep-rooted vegetation	0.1 - 0.9
LZSN	lower zone nominal storage	2 - 15 in
UZSN	upper zone nominal storage	0.05 - 2 in

[1]Alley and Veenhuis 1983

[2]ET = evapotranspiration

Model verification is the process of determining that a computer model or simulation accurately represents the developer's conceptual description and specifications. The calibrated sub-basin models were used to predict flows during a different water year (WY2003). These predictions were then compared with observed flows from WY2003 (e.g., Chico Creek, Figure E3) and observed targets for the whole model and individual land use classes to verify that the model predictions could reproduce observed data with reasonable accuracy.

The performance of the sub-basin hydrology models were evaluated based on quantitative comparison of observed and predicted flows and professional judgment (Table E2). The performance of the individual sub-basin models was ranked at one of five levels, from exceptional to not useable. These ratings were based on comparison of modeled and observed flow for a sub-basin segment. For example, the CHICO sub-basin model was calibrated and verified at the Chico Creek main stem gauging station at Golf Club Hill Rd and about 2 km upstream of the pour point at the mouth of the stream. Thus, the exceptional rating for CHICO sub-basin model was assigned by extension to the remainder of the stream. It was also assigned to adjoining watersheds at Erlands Point and along Chico Bay because these watersheds did not have adequate flow measurements for verification and because they were part of the CHICO landscape segment. Although this assignment is not certain, there is some confidence based on their similarity in geography, LULC, and meteorological forcing.

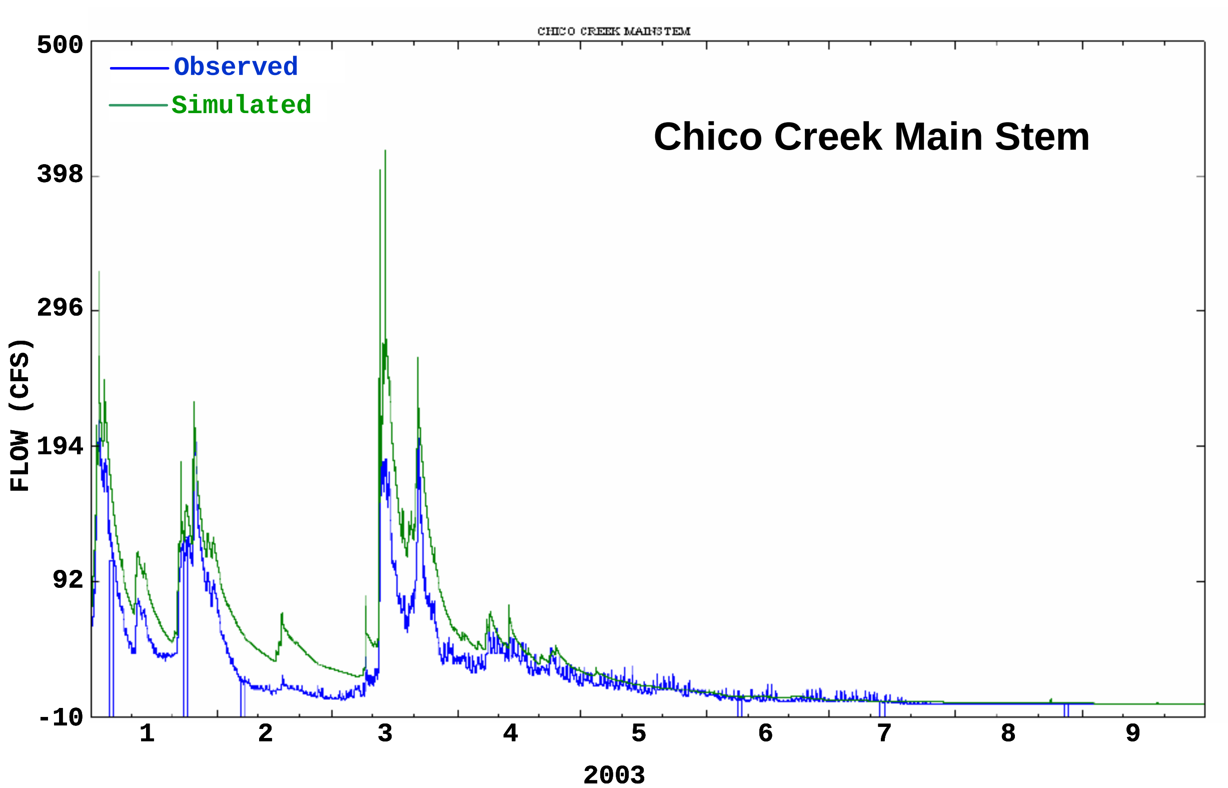

Figure E3. Results of HSPF model verification of Chico Creek main stem for observed (blue) and simulated (green) flow for 2003 (from Figure 2-7 in Johnston et al., 2009)

Table E2. Simplified performance evaluation for the HSPF sub-basin models (adapted from Johnston et al., 2009, Table 2-3).

Model	Basin	Evaluation
Anderson	Anderson Creek	Good
Barker	Barker Creek	Exceptional
Blackjack	Blackjack Creek	Good
BST01	Pine Rd	Good
BST28	Callow Ave	OK
BSTCSO16	Pacific Ave	Fair
Chico	Chico Creek	Exceptional
Clear	Clear Creek	Exceptional
Gorst	Gorst Creek	Good
Karcher	Karcher (Olney) Creek	Good
LMK001	Silverdale Mall (W)	Good
LMK002	Bucklin Hill Rd	Good
LMK038	Manchester Ave	Good
SBC	Springbrook Creek	Good
Strawberry	Strawberry Creek	Exceptional
Not used for watershed scale simulation		
PSNS015	Naval Station McDonalds	Fair (BSTCSO16 used)
PSNS126	CIA CSO16	Fair (BSTCSO16 used)
LMK136	Annapolis Creek	Not useable (Blackjack used)
PSNS124	CIA Building 438	Not useable (BSTCSO16 used)
POPOBLVD	Port Orchard Boulevard	Not useable (Blackjack used)

Although the sub-basin models for the streams generally performed well, the models for highly developed basins with limited data for calibration such as downtown Bremerton (Pacific Ave., BSTCSO16) and West Bremerton (Callow Ave., BST28) resulted in models that were less accurate but were deemed acceptable for simulating watershed scale runoff. For example, BST28 tended to over-predict surface runoff by about 25% on an annual basis, yet the model faithfully reproduced the timing and relative intensity of storm event peaks and discharge volume (Skahill and LaHatte 2006, 2007).

Three sub-basin models were judged as not acceptable for simulating runoff: LMK136 (Annapolis Creek); PSNS124 (CIA Building 438); and POPOBLVD (Port Orchard Boulevard). It is likely that limited data, tidal influences, malfunctioning gauging equipment, and/or problems with the geometry/layout of the monitoring site contributed to poor performance at these sites. Therefore the watershed scale simulation for these basins used the nearest calibrated model with similar landscape segments. That is, the Annapolis Creek and POPOBLVD basin were simulated by the Blackjack Creek model and the PSNS basins were simulated by the BSTCSO16 model (Table E2, Figure E1).

Each watershed is unique and there is uncertainty in transferring the model parameters to other basins. However, because the watersheds within each landscape segment are very similar with respect to geography, LULC, and meteorological forcing, deploying a range of subbasin models throughout the watershed greatly increases the confidence in the modeled results and is better than, for example, just applying the model developed for Chico Creek to the entire watershed. Any errors or biases introduced by a particular subbasin model would only affect the predictions within that landscape segment. The watershed model development was supported by a robust field monitoring program supported by a distributed network of flow and rain monitoring stations in streams and stormwater basins (Figure E2, Johnston et al., 2009).

Calibration and verification of watershed fecal coliform loading concentration

The empirical relationships between fecal coliform (FC) concentrations measured in streams and outfalls and upstream land-use/land-cover (LULC) were analyzed statistically to develop a predictive model for FC in drainages based on their LULC characteristics. The development of this statistical model is described fully in May et al. (2005). The statistical approach used cluster analysis, with landscape characteristics used as variables along with regression with cluster scores and FC concentration (i.e., “k-cluster regression”). This approach was selected after comparison with several other statistical approaches because:

- The combined approach achieved the lowest residual error between observed and predicted FC concentrations;
- Extrapolation to unmeasured systems was not required, because the LULC variables needed for cluster assignment were available for all the sub-basins and land segments in the watershed; and
- Concentration intervals were defined to represent uncertainty about the estimate.

Stream FC: To assess performance of this method, FC loading calculated from observed data for 2000-2003 and for WY 2003 alone, was compared with FC loading predictions for the same periods using the statistical model. The observed and predicted geomean FC concentrations for streams were determined to be in good agreement with each of the cluster assignments (Figure E4). When combined with the watershed flow the simulated loads tracked observed data well, particularly with respect to capturing peak events associated with storms and wet season flows, however the simulated loads did not track the observed loads as well during low flow conditions (Figure E5).

In general, simulated loads for most stream mouths tracked the observed loads quite well, notably for larger streams with higher discharges including Chico, Clear, Blackjack, Strawberry, and Barker creeks. All these simulated loads fell within or near the 95% prediction interval of the regression. Exceptions were underestimates of loading for Enetai (Dee); Karcher (Olney); Annapolis; Ostrich Bay; and Springbrook creeks. Loading was overestimated for Parman and Mosher creeks (Figure E5).

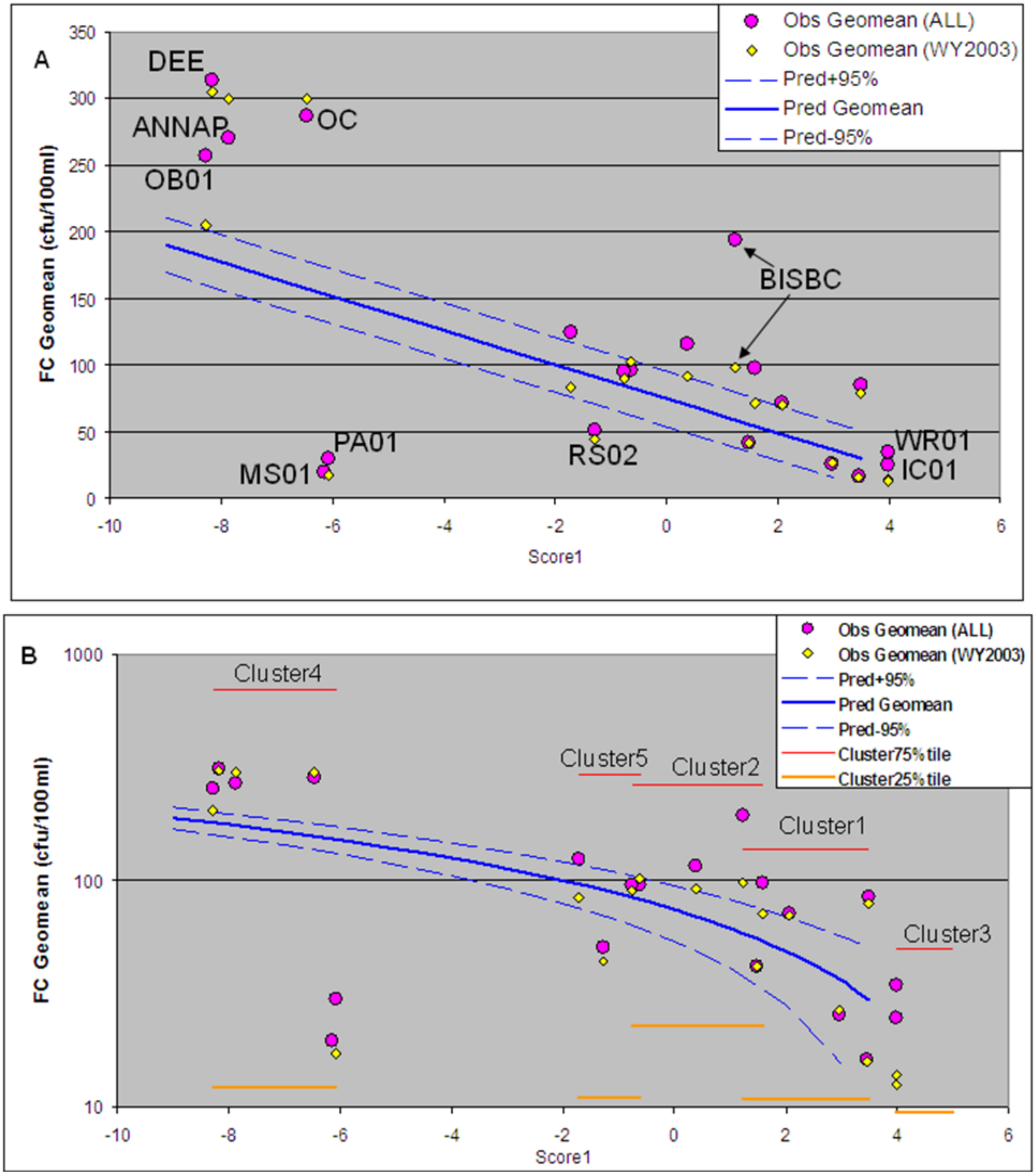

Figure E4. (A) Comparison of predicted geomean FC concentrations (blue regression line) to observed geomean at mouths of streams for all data from 2001-2003 (ALL – pink circles) and WY2003 (yellow diamonds) as a function of cluster score (Score1) obtained from upstream LULC . (B) Same data with 25th and 75th percentile bounds of each cluster on a log scale (from Figure 2-12 in Johnston et al., 2009).

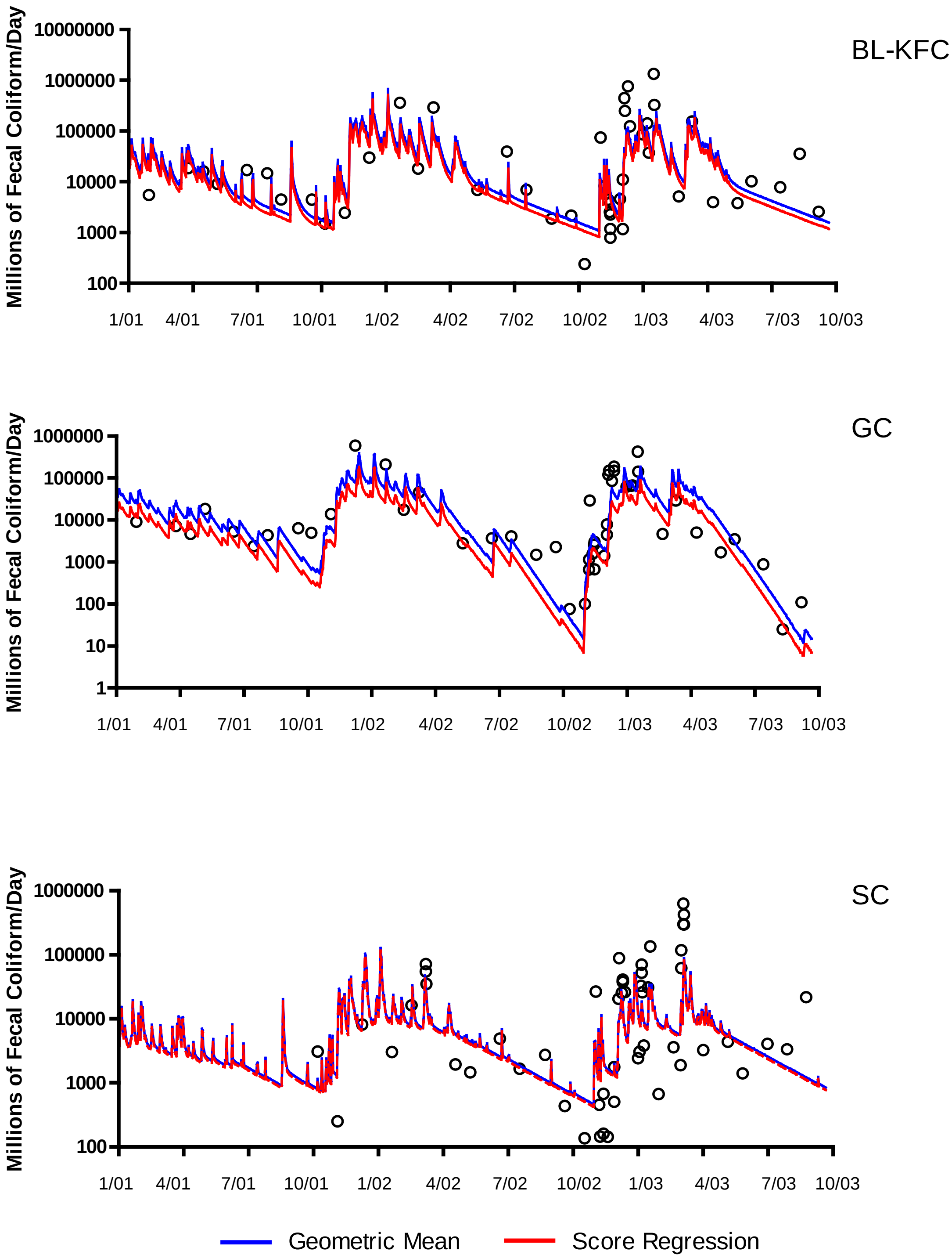

Figure E5. Observed fecal loads (circles) and simulated loadings using the geometric mean from the observed data (Geometric Mean–blue lines) and the predicted mean from the k-cluster (from Figure 2-11 In Johnston et el., 2009).

Stormwater FC: The predicted geomean FC concentration for industrial, urban, rural, and suburban stormwater outfalls showed good agreement with observed data (Figure E6). Although there was less data available for calculating the FC concentrations for stormwater outfalls than for streams, the statistical analysis for the outfalls followed the approach developed for streams to the extent possible, with the addition of professional judgment and practical experience (Johnston et al., 2009).

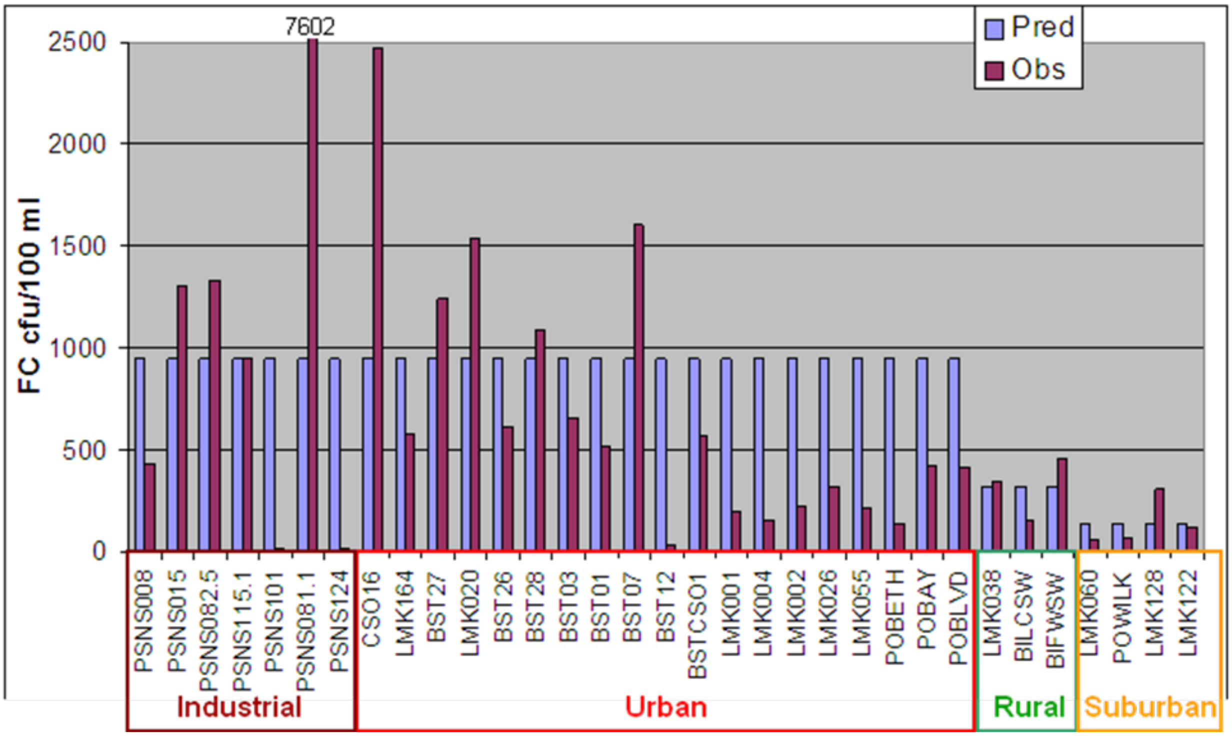

Figure E6. Predicted (Pred) and observed (Obs) FC geomean concentrations for industrial, urban, rural, and suburban stormwater outfalls in watershed (from Figure 2-13 in Johnston et al., 2009).

Shoreline discharge FC: FC concentrations in shoreline runoff to the inlets were not measured directly in this project, so an assumption was made that these were similar to concentrations in streams and related to the LULC characteristics. This was considered more appropriate than treating them as stormwater because, for the most part, they lack an engineered collection and conveyance system. It is possible that treating shoreline runoff areas the same as streams may underestimate the actual FC concentrations, especially for heavily developed shoreline areas of Bremerton, Port Orchard, and parts of Dyes Inlet (Johnston et al., 2009).

Waste Water Treatment Plant Loadings: Data from the discharge monitoring reports (DMRs) submitted from the three WWTPs that discharged into Sinclair and Dyes Inlets during WY2003 were used to calculate the loads by multiplying the daily flow (MGD) by the point estimates of FC concentration and obtaining a point-to-point interpolation of continuous loading from each of the plants. These data represent the best estimate of FC loads from the plants. Overall it appeared that the loading estimates for the WWTPs adequately captured the variation and magnitude of the discharges and provided a good estimate of FC loading from these sources (Johnston et al., 2009).

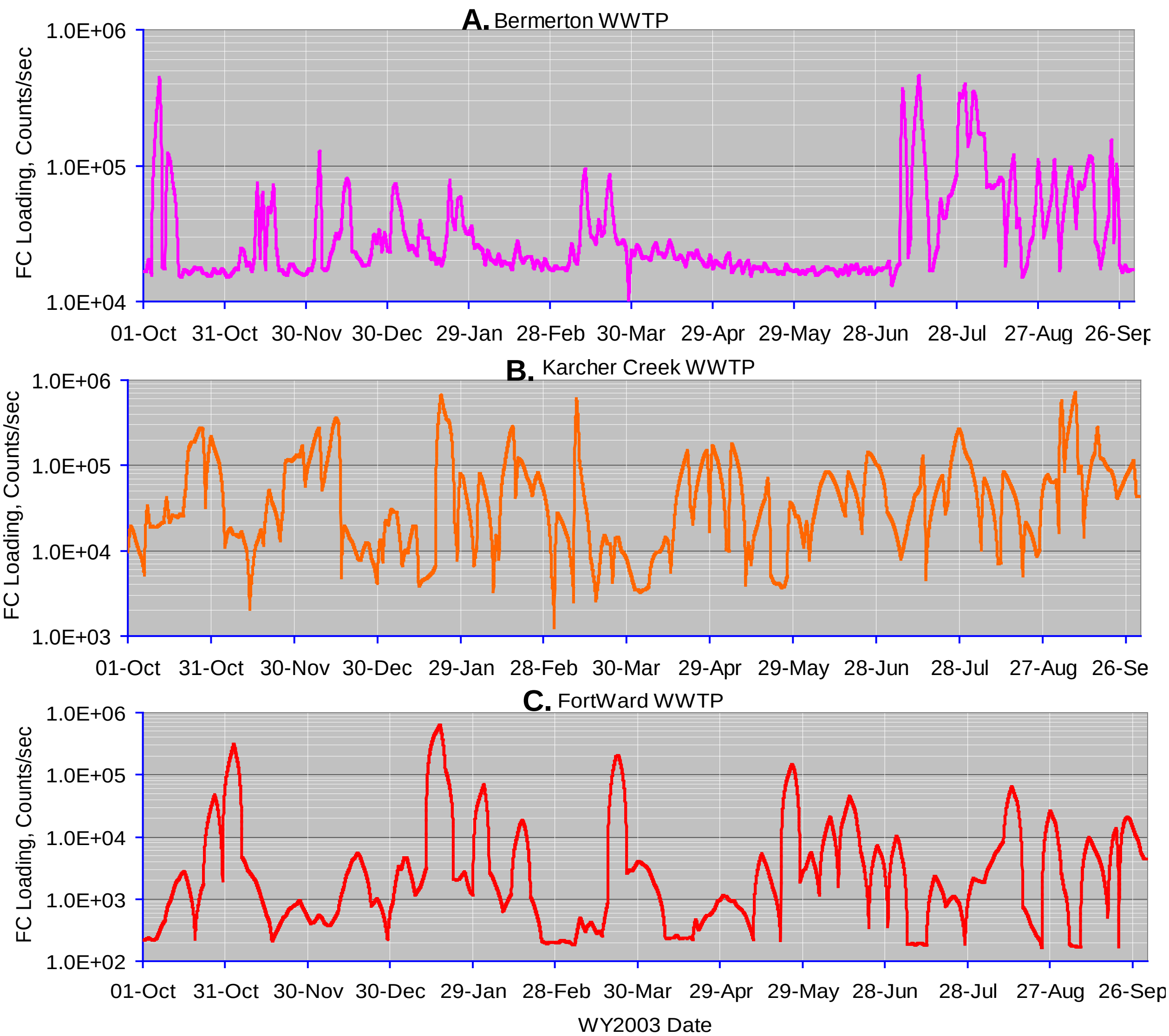

Figure E7. Simulated FC loads (counts/sec) from the Bremerton (A), Port Orchard/Karcher Creek (B), and Fort Ward (C) WWTPs for WY2003 (from Figure 2-15 in Johnston et al., 2009). Note Fort Ward loads are not correct, see text

An error was made in the submission by Ecology to PSNS & IMF of the daily discharge data for Kitsap County No. 7 (Fort Ward) wastewater treatment plant. Data from a different wastewater treatment plant was submitted, and use of the wrong data resulted in overestimated loading from this facility by about 10 times. This provides an unexpectedly large safety factor in the model predictions for the area of Rich Passage near the Fort Ward discharge. Even with the erroneous loading, the model did not predict any exceedances of standards either at the Fort Ward WWTP outfall canary node or in the shoreline canary nodes near the stormwater outfalls below Fort Ward or Lynwood Center.

Calibration and verification of the CH3D-FC model

Hydrodynamic Model: The dynamic marine model CH3D was developed and used to simulate the dynamics of water movement and FC dispersion and fate in the inlets. Model calibration and verification was performed using a number of data sets collected over different years and seasons:

- A set of USGS tide and current measurements in Sinclair Inlet during February to April and July to August 1994.
- A number of research cruises in 1997 and 1998 in Sinclair Inlet that measured water velocity at all depths from surface to bottom using acoustic Doppler current profilers (ADCP) (Katz et al., 2004).
- To address questions about fate of CSOs from the City of Bremerton, a drogue and current meter study was conducted during the fall of 2000 in Dyes Inlet and Port Washington Narrows to provide data for hydrodynamic model calibration and verification. Additionally, a dye release study was conducted in March 2002 to simulate a CSO discharge event in Port Washington Narrows during incoming tide (ENVVEST 2001, Wang et al., 2005).

Away from shore, CH3D predicted currents within 2 to 5 cm/hr of measured values for most of Sinclair Inlet. Based on the comparison between modeled and measured current speeds CH3D tended to over predict water speed at the mouth of the Port Washington Narrows and under predict water speed near the shore. Resolving nearshore currents are problematic due to wake aliasing from the boat collecting ADCP data. The predictions of current direction followed the expected pattern but deviated from measurements, probably because some of the measurements could have been aliased by the boat wake or reflect local wind and stream conditions. The predicted current speed and direction, without the impact of local weather or boat disturbances, may better represent mean current conditions in Sinclair Inlet (Richter 2004).

For Dyes Inlet, the calibrated model was able to reproduce the drogue trajectories and current velocity and direction with very good accuracy and the simulation of a dye release in the Port Washington Narrows showed good agreement with the observed dye plume (Wang et al., 2005).

In the model report (Johnston et al., 2009a), the authors state:

> "The model verification for CH3D was very rigorous. There were numerous observations of current velocity (> 600,000 vertical profiles) over the entire tidal range taken at a large variety of locations and depths throughout the inlets (mainly Sinclair Inlet), during different seasonal time periods, and over all phases of the spring-neap tide cycle. Critical locations within the inlets were intensely monitored, including the confluence of the Port Washington Narrows and Sinclair Inlet, the connection between the Port Washington Narrows and Dyes Inlet at Rocky Point, inner Ostrich Bay, the main basin of Sinclair Inlet, and numerous marine and nearshore locations throughout the inlets. Current data were also collected utilizing different methods, including underway ADCP surveys, bottom moored ADCPs, fixed current meters, drogue releases, and a dye study. Based on this enormous amount of data, there is a high degree of confidence that CH3D simulates currents and tides with very good accuracy for most of the inlets."

Integrated Watershed and Receiving Water Model: The integrated CH3D-FC model which includes the freshwater flows and FC loading was run to make sure the flows from the watershed model were represented properly. Salinity was matched with observed data by fixing the initial and boundary conditions obtained for short term simulations of storm events (10 d). CH3D uses a curvilinear grid that is represented by Cartesian rows and columns. The grid developed for Sinclair and Dyes Inlets contains 91 rows and 96 columns (91 x 96 grid) and a resolution of about 100 to 150 meters (300 to 450 feet). A higher resolution grid was developed to reduce "initial" dilution in areas of low flushing such as the mouths of Clear, Chico, and Karcher Creeks, and other areas, including Oyster Bay, Ostrich Bay, Phinney Bay, and near the Shipyard. This higher resolution grid has 94 rows and 105 columns (94 x 105 grid) and a resolution of about 30 to 50 meters (100 to 150 feet) in those areas. Simulations were conducted using both grids (Figure E8). Use of the higher resolution model was necessary to more accurately simulate nearshore areas because most of the observed data were from these nearshore areas where the shellfish beds are located.

The data from individual storm events sampled in April, May, and October 2004, and monitoring data from WY2003, were used for model verification (Figure E9). CH3D-FC was set up to simulate individual storm events that occurred on 19 to 20 April 2004, 26 to 27 May 2004, 18 to 19 October 2004, and all of WY2003. For the 2004 storm events, ambient marine and nearshore samples were collected 12 to 24 hours after the storm event (Johnston et al., 2004). The observed FC data from the inlets were compared to the CH3D-FC predictions to evaluate how well the model did in matching the observed data. No attempt was made to "fine-tune" the FC predictions because there was no way to know if the model was "wrong" or if additional sources were missing from the model. Under-prediction of FC concentrations where measured marine samples were higher may be due to intermittent sources such as failing onsite sewage systems, wildlife, waterfowl, agricultural waste, and/or leaking sewer infrastructure.

The simulation results of the 2004 storm events showed that the integrated model could produce plausible results with relatively high accuracy for major portions of the model domain (Figure E9). While there were mismatches between model predictions and observations at some locations, the integrated model appeared to be quite capable of simulating storm runoff and FC loading during storm events (Johnston et al., 2009).[11]

[11] Animations of the simulations can be viewed by accessing the ENVVEST Spatial Viewer at <http://kairos.spawar.navy.mil/Website/spatialviewer>

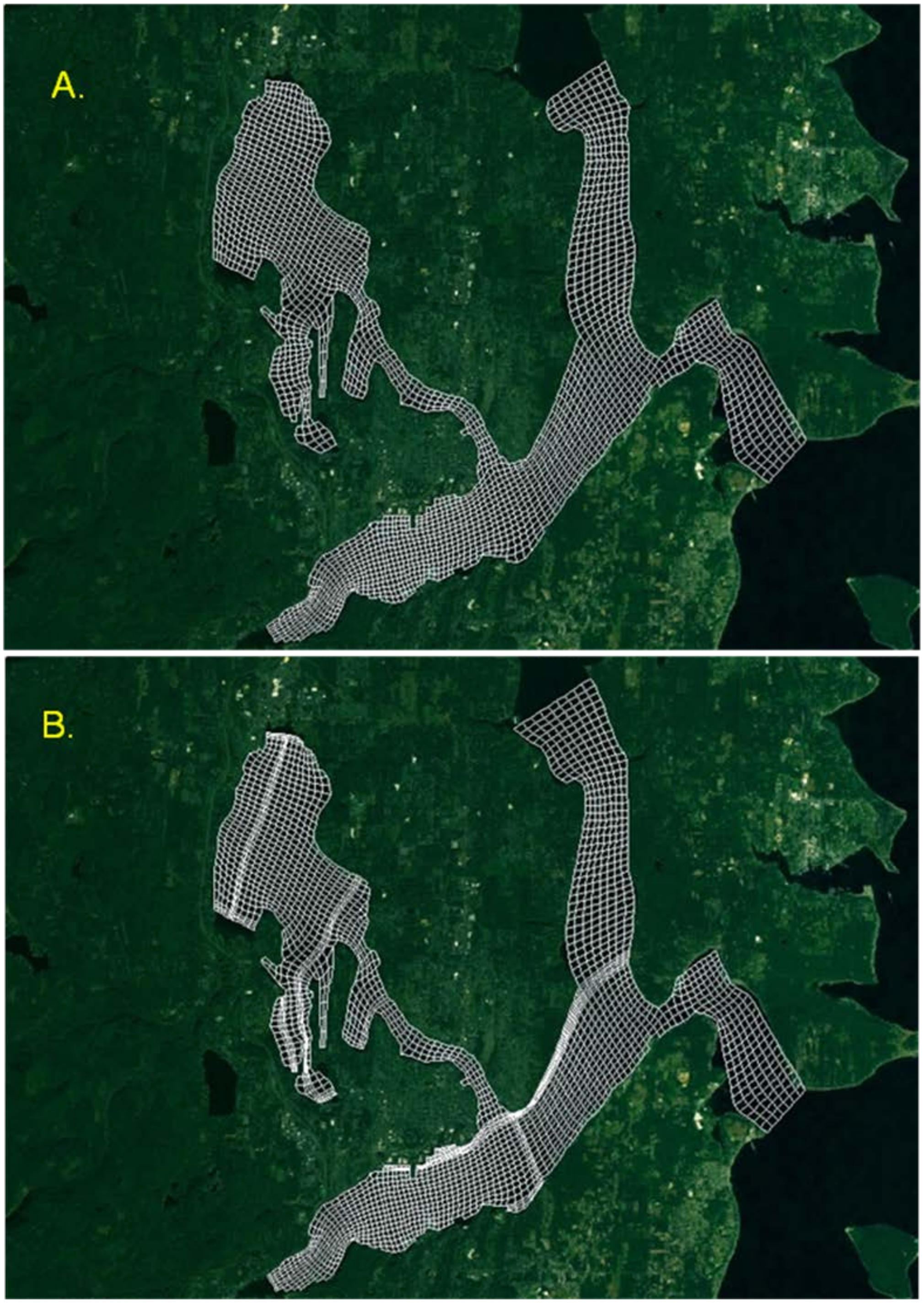

Figure E8. The computational grids used for CH3D-FC including the 91 x 96 grid (A) and the 94 x 105 grid (B) that has higher resolution in nearshore areas.

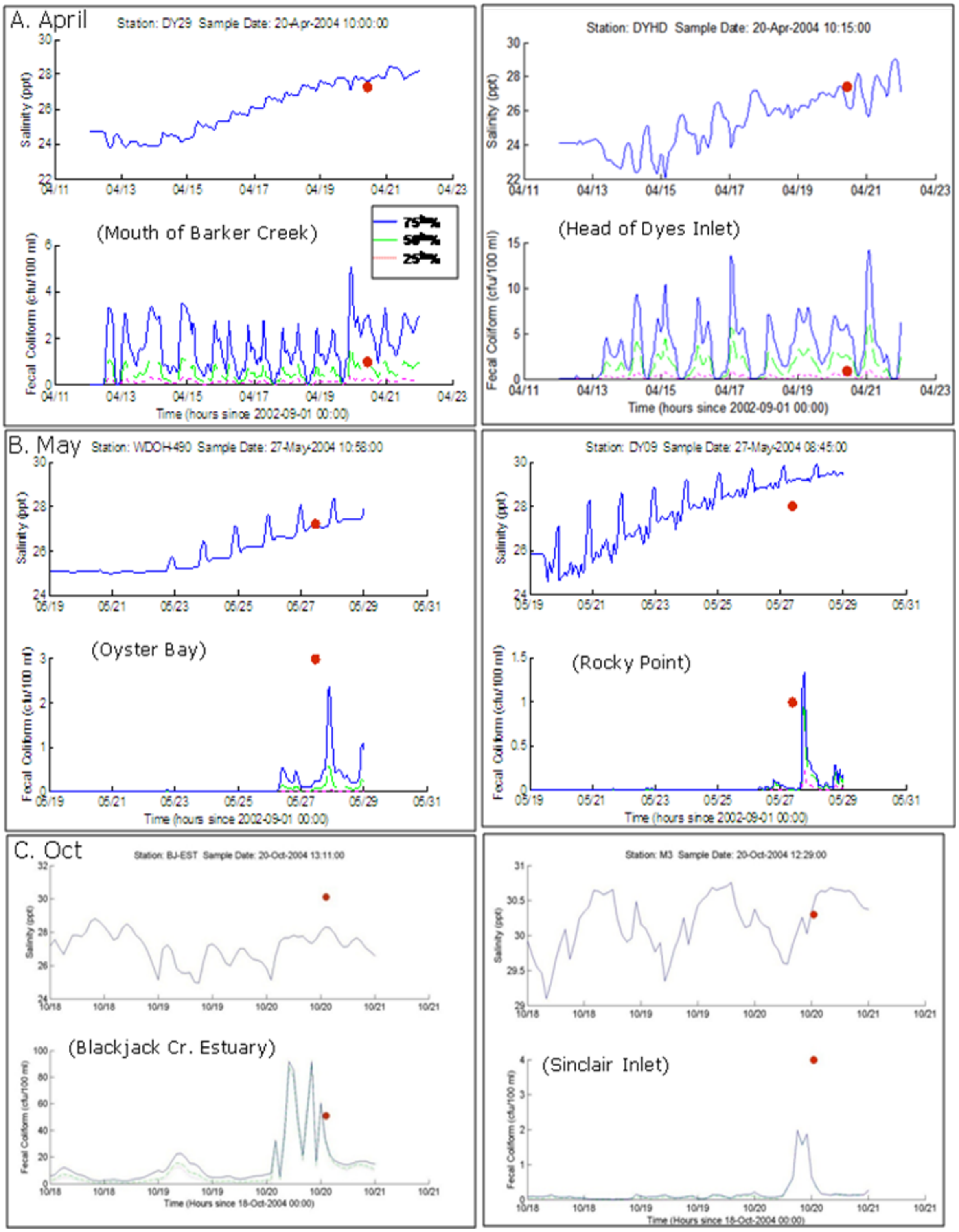

Figure E9. Example results from comparison between simulated (lines) and observed data (red points) for salinity and FC from the April (A), May (B), and October (C) 2004 storm events for nearshore (left panels) and marine (right panels) stations. Simulated results for the 25th-, 50th- (geomean), and 75th percentiles of the FC loading concentrations are shown in red, green, and blue, respectively (from Figure 4-40 in Johnston et al., 2009).

Model Evaluation, Sensitivity and Error Analysis

How well the watershed model predicted FC loading from the streams and stormwater outfalls was evaluated by comparing the observed load to the simulated load. The observed and simulated mean, median, and mode of the FC loads were calculated for each sub-watershed (identified by an individual Data Set Number, or DSN). The mean was used to evaluate the central tendency, the median evaluated the 50th percentile, and the mode represented the most frequent value of the observed and simulated data sets. The mean and median were compared by dividing the simulated mean and median by the observed statistic and scoring the result. Overall, the model appeared to be better at predicting loads from streams than from stormwater outfalls (Figure E10). Predicted loads from streams were dominated by the larger streams - Clear, Chico, Blackjack, Gorst, and Barker Creeks. The predicted loads from Olney (KA01), Strawberry (SC), Beaver (BE-LOW), Wright (WC01) Creeks were lower than the observed loads, while the load from Mosher Creek (MS01) was over predicted. All the simulated median FC loads from the streams were generally within an order of magnitude of the observed median FC loads (Figure E10A).

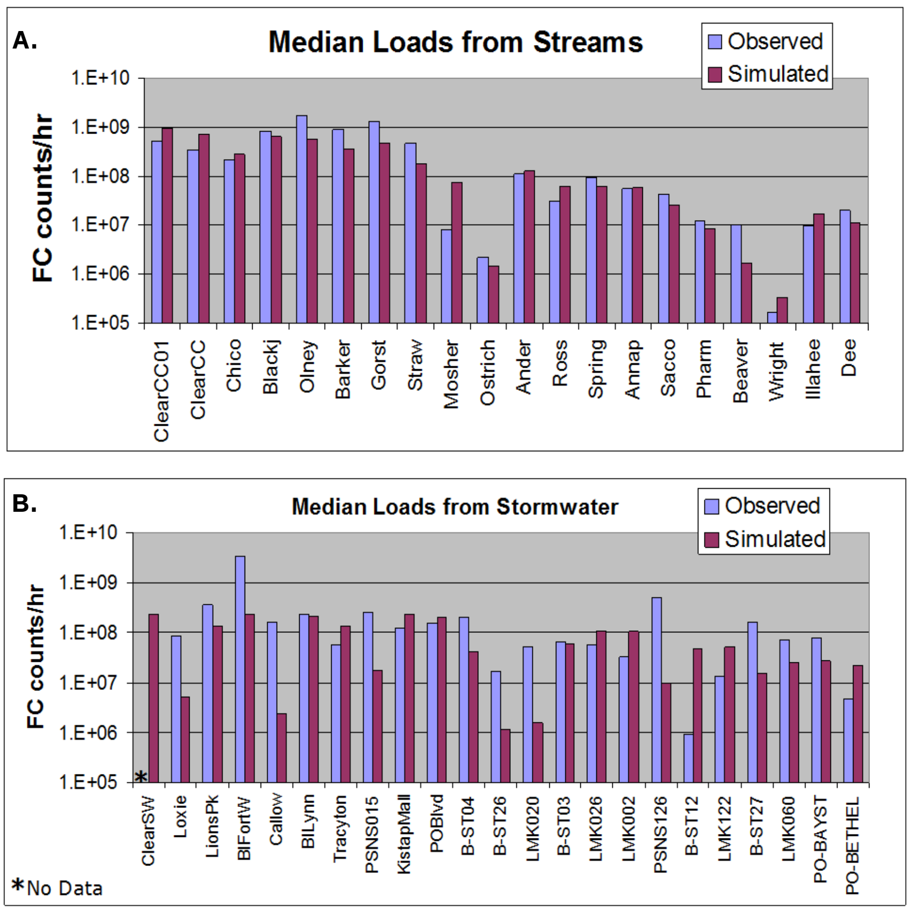

Figure E10. Comparison between observed and simulated median FC loads for WY2003 in streams (A) and stormwater outfalls (B). *The median was based on all available data for observed and the modeled hourly loads over the year for simulated FC.*

Of the 31 stormwater systems evaluated, the model tended to under predict the FC loads, except for outfall BST-12, which over predicted the median FC load by a factor of 50 (Figure E10B). The loads from the stormwater systems were not as well represented as the streams, possibly due to the scarcity of data, the flashiness of the stormwater flows, and the high variability inherent in the observed data from the stormwater systems.

The watershed loading evaluation appraised the accuracy of the simulated loading and assessed the confidence that could be placed on subsequent model predictions. Obviously, major flaws in estimates of loading from the sub-watershed would prevent CH3D-FC from producing useable results (Johnston et al., 2009). The evaluation showed that there was a high degree of confidence for simulating watershed-wide FC sources into the receiving waters of the inlets. There was good-to-excellent agreement with observed data for most sub-watersheds; however, there was a tendency to under-predict loads in nearshore areas with low flushing.

Evaluation of the CH3D-FC model consisted of comparing model predictions to observed data collected during WY2003. The WY2003 simulation was conducted to simulate FC loading over a yearly time cycle, determine the critical conditions for FC loading, compare to observed data collected over the year, and simulate scenarios required for the TMDL. Based on the comparison to observed data, there was good-to-excellent agreement between model predictions and observed data for marine waters; however, there was a tendency of the model to under-predict FC concentrations in certain nearshore areas, including the mouths of Clear and Strawberry Creeks (Figure E11), in Oyster Bay, near the mouth of Enetai Creek, along the Port Orchard waterfront (Figure E12), and along the southern shore of Bainbridge Island (Figure E13).

Sensitivity analysis was conducted to evaluate the sensitivity of model predictions to specific sets of input parameters, including FC loading concentration, stream and storm water flow, wind, and FC bacterial die-off. The May 2004 simulation was selected for the sensitivity analysis. The parameter being evaluated was changed to evaluate the difference from the base condition, while all other parameters were held constant. The base condition was the geomean FC loading for the May 2004 storm event (S5). The results were compared to the effect of varying FC concentrations to the 25th percentile (S4) and the 75th percentile (S6), increasing flow by 20% (S14), increasing flow by a factor of 2 (S15), applying a constant wind speed of 10 m/sec (22.6 mph) from the SW (S16), and eliminating bacterial decay to simulate FC inputs as a conservative tracer (S17).[12]

The 26 to 27 May 2004 storm event was assumed to represent a "typical" storm event. The storm generated about 1.3 to 2.6 inches of rain within the study area with the peak intensity occurring the morning of 27 May. The storm occurred following a relatively dry period of little to no rain, allowing the effects of the storm to be reasonably distinct from baseflow conditions.

[12] Animations of the simulations can be viewed by accessing the ENVVEST Spatial Viewer at <http://kairos.spawar.navy.mil/Website/spatialviewer>

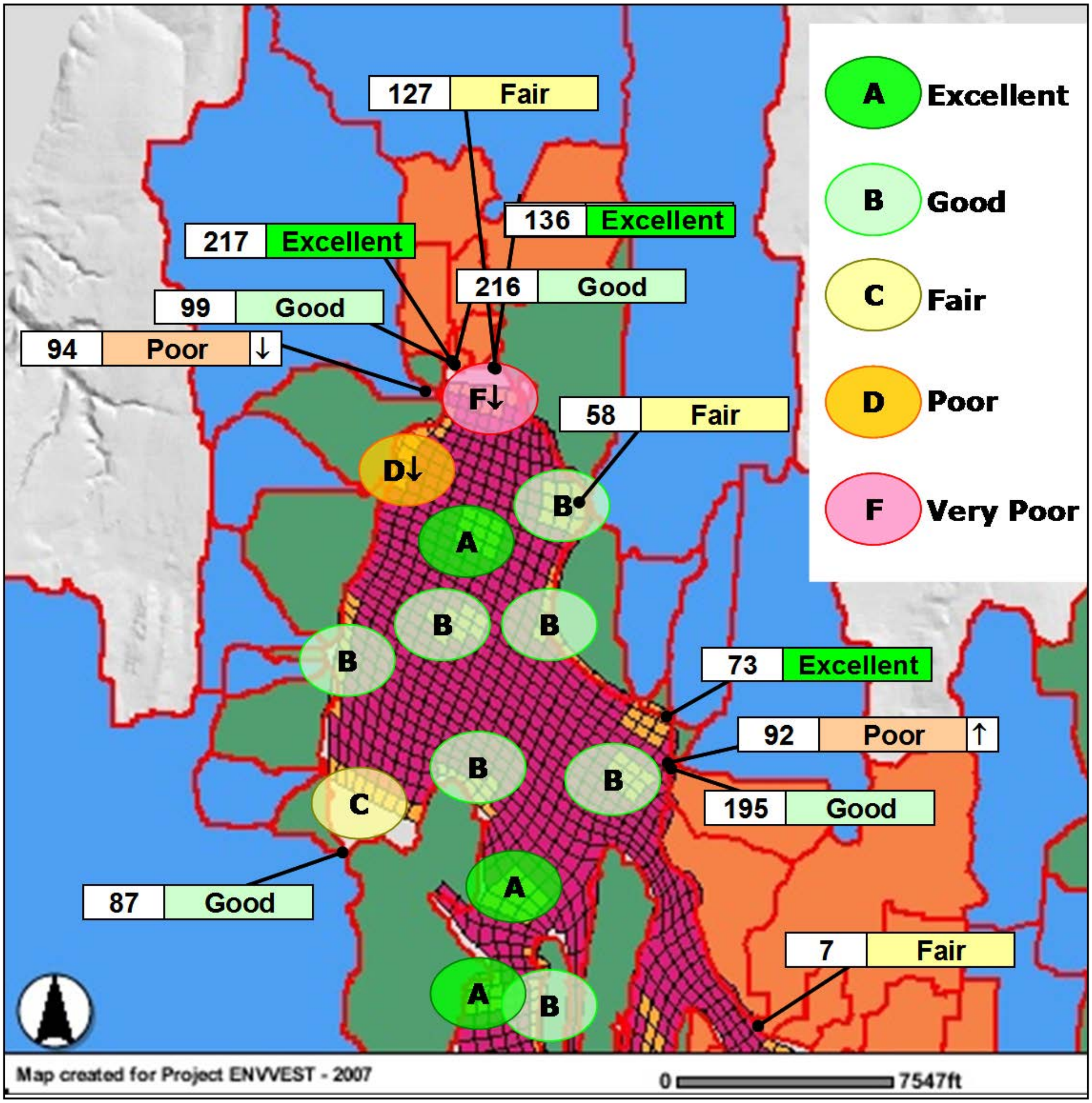

Figure E11. Model evaluation results for estimating FC loading from watershed DSNs (rectangles) and predicting FC concentrations at canary nodes (circles) in Dyes Inlets during WY2003 (from Figure 4-46 in Johnston et al., 2009) Arrow pointing up means over-prediction; arrow pointing down means underprediction of FC concentration.

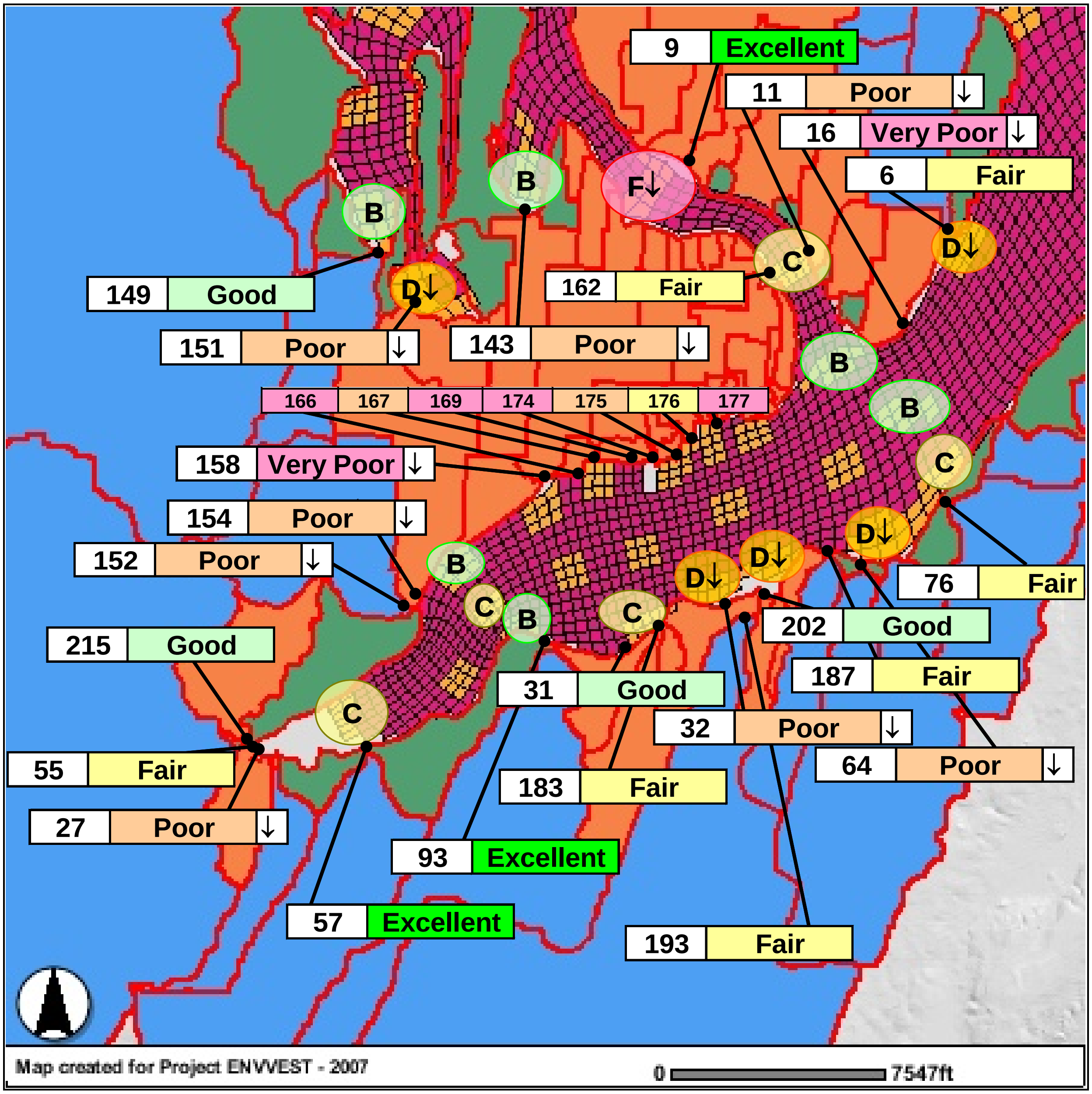

Figure E12. Model evaluation results for estimating FC loading from watershed DSNs (rectangles) and predicting FC concentrations at canary nodes (circles) in Sinclair Inlet, Port Washington Narrows, Phinney Bay, Ostrich Bay, and Oyster Bay (from Figure 4-47 in Johnston et al., 2009). (Arrow pointing up means over-prediction; arrow pointing down means underprediction of FC concentration. See Figure 11 for legend.)

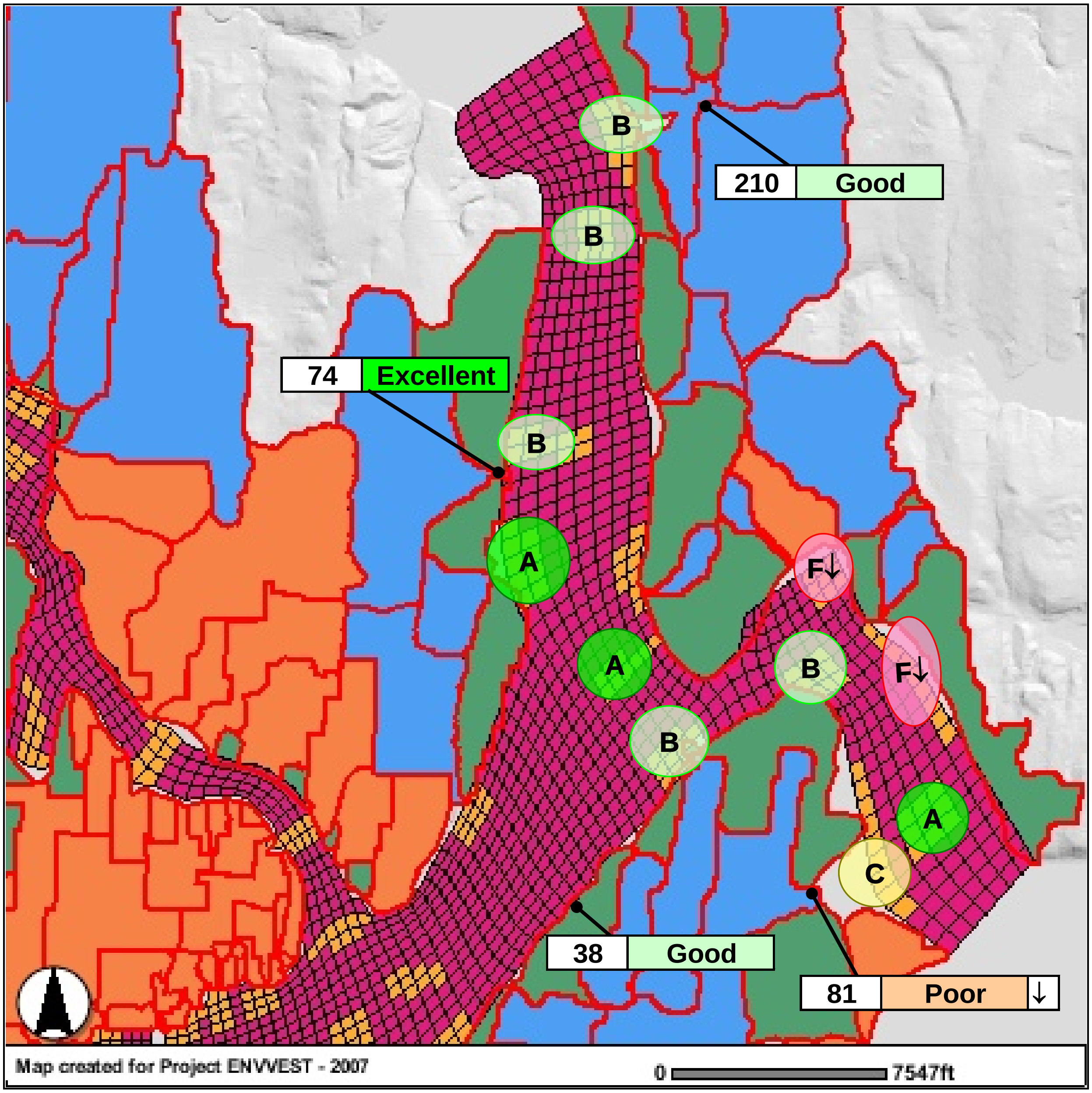

Figure E13. Model evaluation results for estimating FC loading from watershed DSNs (rectangles) and predicting FC concentrations at canary nodes (circles) in Port Orchard and Rich Passages (from Figure 4-48 in Johnston et al., 2009). (Arrow pointing up means over-prediction; arrow pointing down means underprediction of FC concentration. See Figure 11 for legend.)

The relative importance of each of the parameters evaluated in the sensitivity analysis is shown for a grid cell located in the middle of Northern Dyes Inlet (i = 91, j = 68, using the 94 x 105 grid) in Figure E14. The highest concentrations occurred when there was no bacterial die-off (S17), followed by the 75th percentile loading concentration (S6). The peaks for the no die-off and 75th percentile occurred very closely. The decay due to uV radiation during the daylight hours is apparent in the difference between the S17 and S6 time series. The effect of wind (S16) and increasing flow (S14 and S15) only had minor effects on the FC concentrations compared to the base simulation (S5). The sensitivity analysis showed that the most important factors affecting the distribution of FC in the inlets were the FC loading, which was controlled by the loading concentration and freshwater flows, physical mixing, and FC die-off. Wind and small changes to freshwater flows did not appear to have much effect on the FC distribution in the inlets.

There are uncertainties and limitations to what the model can simulate. The model indirectly accounts for sources from failed septic systems, leaking sewer infrastructure, and upland waterfowl and wildlife only to the extent that these sources contributed to the empirical data used to develop the FC loading concentration estimates. Potential sources of FC not explicitly simulated by the model included marinas, recreational and commercial boating, broken pipes, combined sewer overflow (CSO) events, sediment resuspension, regeneration of bacteria spores, nearshore waterfowl, marine mammals, and any other unknown sources.

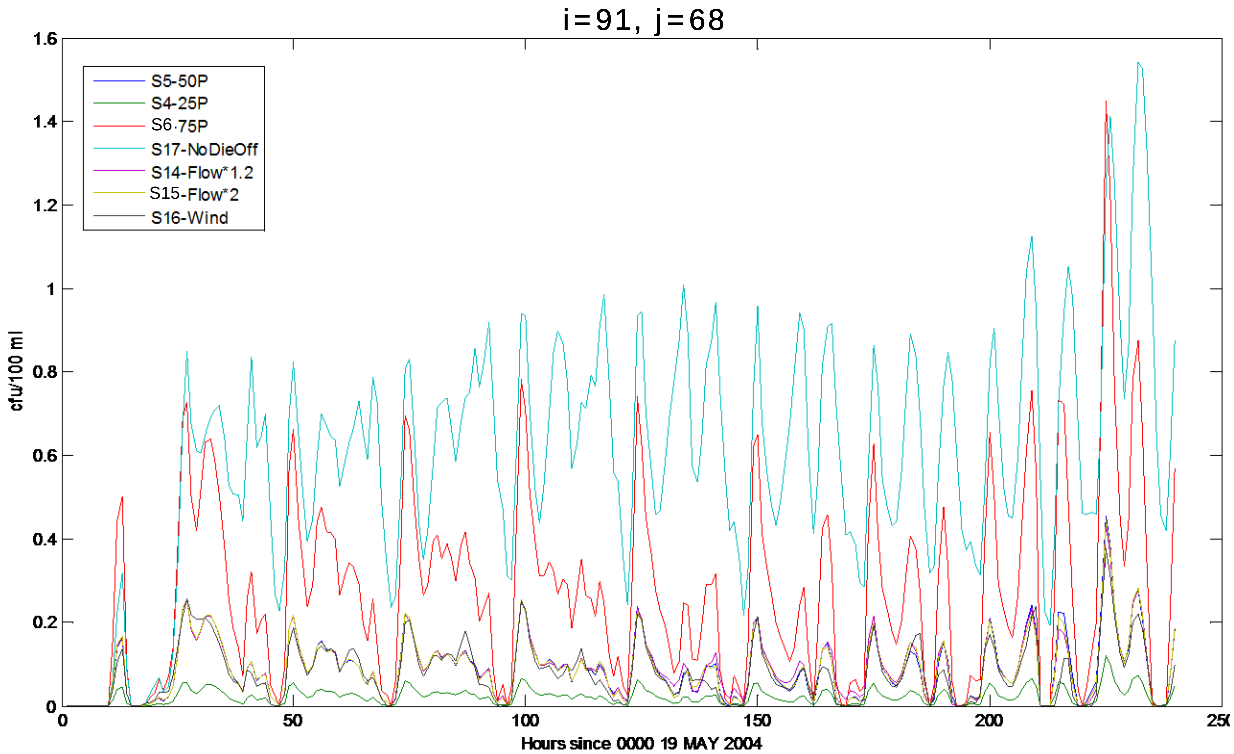

Figure E14. The FC levels simulated for a surface grid in the middle of northern Dyes Inlet for the geomean FC loading concentration (S5 -Base), the 25th (S4) and 75th percentiles (S6) FC loading concentration, no FC die-off (S17), flow increased by 1.2 (S14) and 2.0 (S15), and wind (S16) (from Figure 4-52 in Johnston et al., 2009).

Appendix F. ENVVEST data indicating problem marine nearshore areas

Marine areas in Sinclair and Dyes Inlets were designated as TMDL priorities for cleanup based either on ENVVEST model predictions of exceedances of the fecal coliform marine standards (Tables 11 and 12) or on fecal coliform data collected by Project ENVVEST in 2002-2003 (Table 32, below. Data are also summarized in "Observed data," Tables 13 and 14.

Table F-1. ENVVEST nearshore data indicating problems in some canary nodes.

Monitoring Site Name	Collector Organization	Sample Date	Fecal Coliform Bacteria Concentration (cfu/100 mL)	Notes
Canary Node 03 Nearshore below Clear Creek				
DY27	KCHD	10/17/2002	1	
DY27	PSNS-NS/M	11/14/2002	5	
DY27	KCHD	11/20/2002	4	
DY27	PSNS-NS/M	12/17/2002	49	Samples collected different times same day
DY27	KCHD	12/17/2002	17	
DY27	PSNS-NS/M	1/7/2003	2	
DY27	KCHD	1/14/2003	4	Samples collected by two agencies, same time
DY27	BKCHD	1/14/2003	2	
DY27	PSNS-NS/M	1/24/2003	190	Samples collected same time; field duplicates averaged
DY27	PSNS-NS/M	1/24/2003	190	
DY27	KCHD	3/20/2003	30	
DY27	KCHD	4/15/2003	23	
DY27	KCHD	5/21/2003	1	
DY27	KCHD	6/12/2003	17	
DY27	KCHD	7/21/2003	1	
DY27	KCHD	8/19/2003	1	
DY27	KCHD	9/17/2003	2	
SHOTEL	PSNS-NS/M	11/14/2002	69	
SHOTEL	PSNS-NS/M	12/17/2002	750	
SHOTEL	PSNS-NS/M	1/7/2003	1	
SHOTEL	PSNS-NS/M	1/24/2003	200	
WDOH-466	WDOH	11/5/2002	11	
WDOH-466	WDOH	2/20/2003	33	

Monitoring Site Name	Collector Organization	Sample Date	Fecal Coliform Bacteria Concentration (cfu/100 mL)	Notes
Canary Node 33 Port Washington Narrows near Pine Rd & Anderson Cove				
ANCOVE	PSNS-NS/M	11/14/02	2	
ANCOVE	PSNS-NS/M	12/17/02	2000	
ANCOVE	PSNS-NS/M	1/7/03	5	
ANCOVE	BKCHD	1/14/03	50	
ANCOVE	PSNS-NS/M	1/24/03	33	
DY05	KCHD	10/17/2002	1	
DY05	PSNS-NS/M	11/14/2002	8	
DY05	KCHD	11/20/2002	7	
DY05	PSNS-NS/M	12/17/2002	20	Samples collected different time of day
DY05	KCHD	12/17/2002	2	
DY05	PSNS-NS/M	1/7/2003	6	
DY05	KCHD	1/14/2003	13	Samples collected by two agencies; same time
DY05	BKCHD	1/14/2003	8	
DY05	PSNS-NS/M	1/24/2003	64	
DY05	KCHD	3/20/2003	1	
DY05	KCHD	4/15/2003	1	
DY05	KCHD	5/21/2003	2	
DY05	KCHD	6/12/2003	1	
DY05	KCHD	7/21/2003	1	
DY05	KCHD	8/19/2003	2	
DY05	KCHD	9/17/2003	2	
Canary Node 35 Nearshore below Fort Ward				
BI-CSNS	BI-SW	11/13/2002	22	
BI-CSNS	BI-SW	11/18/2002	140	
BI-CSNS	BI-SW	12/16/2002	191	Field duplicates; averaged.
BI-CSNS	BI-SW	12/16/2002	9	
BI-FWNS	BI-SW	11/7/2002	1330	
BI-FWNS	BI-SW	11/13/2002	9	
BI-FWNS	BI-SW	11/18/2002	25	
BI-FWNS	BI-SW	12/19/2002	13	
WDOH-461	WDOH	2/20/2003	1.7	
WDOH-461	WDOH	4/29/2003	1.7	
WDOH-461	WDOH	6/16/2003	11	
WDOH-461	WDOH	8/12/2003	4.5	

Monitoring Site Name	Collector Organization	Sample Date	Fecal Coliform Bacteria Concentration (cfu/100 mL)	Notes
Canary Node 36 Nearshore below Lynwood Center				
BI-LCNS	BI-SW	11/7/2002	134	
BI-LCNS	BI-SW	11/13/2002	77	Field duplicates; averaged.
BI-LCNS	BI-SW	11/13/2002	120	
BI-LCNS	BI-SW	11/18/2002	11	
BI-LCNS	BI-SW	12/16/2002	140	
Canary Node 50 Nearshore below Blackjack Creek				
BJ-EST	PSNS-NS/M	11/14/02	21	
BJ-EST	PSNS-NS/M	12/17/02	43	
BJ-EST	PSNS-NS/M	1/7/03	45	
BJ-EST	BKCHD	1/14/03	13	
BJ-EST	PSNS-NS/M	1/24/03	80	
Canary Node 51 Nearshore below Karcher Creek				
SN13	KCHD	10/17/2002	4	
SN13	PSNS-NS/M	11/14/2002	120	
SN13	KCHD	11/20/2002	4	
SN13	PSNS-NS/M	12/17/2002	40	Samples collected by two different agencies
SN13	KCHD	12/17/2002	17	
SN13	PSNS-NS/M	1/7/2003	88	
SN13	KCHD	1/14/2003	11	Samples collected by two different agencies
SN13	BKCHD	1/14/2003	9	
SN13	PSNS-NS/M	1/24/2003	32	
SN13	KCHD	3/20/2003	9	
SN13	KCHD	4/15/2003	2	
SN13	KCHD	5/21/2003	1	
SN13	KCHD	6/12/2003	1	
SN13	KCHD	7/21/2003	1	
SN13	KCHD	8/19/2003	1	
SN13	KCHD	9/17/2003	1	

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Appendix G. Ecology memorandum on model grid cell size for compliance

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From: Hicks, Mark (ECY)
Sent: Wednesday, February 07, 2007 12:29 PM
To: Roberts, Mindy (ECY)
Cc: Lawrence, Sally (ECY)
Subject: RE: Clarification on water quality standards applied to the Sinclair and Dyes Inlet Fecal Coliform TMDL

Your description matches my understanding as well.

From: Roberts, Mindy (ECY)
Sent: Thursday, January 25, 2007 4:54 PM
To: Hicks, Mark (ECY)
Cc: Lawrence, Sally (ECY)
Subject: Clarification on water quality standards applied to the Sinclair and Dyes Inlet Fecal Coliform TMDL

Mark--

I would like to verify that my interpretation of the changes to the water quality standards is correct. The Quality Assurance Project Plan for the Sinclair/Dyes Inlet was published by the Navy several years ago, and the field work for the project terminated in 2005, prior to the December 2006 revision to the water quality standards. The Navy, with Ecology's assistance, has been modeling the systems, and we will be drafting the TMDL report in 2007. The study will include load reduction targets for the tributaries to the two inlets as well as marine-based reductions.

According to your December 2006 document, *Implementation Plan for the Revisions to Chapter 173-201A WAC* (publication no. 06-10-072), page 4, item 2, TMDLs for which the field work is completed but the report has not been completed or submitted to EPA for approval, the TMDL submittal report will target the previous version of the water quality standards in setting load allocations and wasteload allocations. The Summary Implementation Strategy, however, will include monitoring plans that address the new criteria. The fecal coliform bacteria numeric criteria did not change.

Table 612, page 112, specifies that Sinclair and Dyes Inlets west of 129 degrees 37 minutes west should be protected for shellfish harvest, and all marine areas must meet the following fecal coliform standards: geometric mean < 14/100 mL and <10% of samples > 43/100 mL.

Table 602, pages 71 and 72, of the water quality standards identifies several specific tributaries as primary contact recreation. Because tributaries not specifically listed in Table 602 also default to primary contact recreation, all freshwater tributaries to Sinclair and Dyes Inlet must meet the following fecal coliform standards: geometric mean < 100/100 mL and <10% of samples > 200/100 mL.

Because several tributaries enter marine areas within or near shellfish harvesting zones, we are working with the modelers and the health entities to determine whether more stringent freshwater targets are needed to meet the marine fecal coliform standards. The marine model grid has a very fine resolution that may not be appropriate for characterizing public health or aquatic life threats. As we discussed October 2, 2006, while there is no defined mixing zone allotted to a stream entering a marine area, the closest analogy is the default mixing zone allowed for a point source discharge. The appropriate size is a 200-foot radial zone from the inlet point. The total surface area of the 200-ft radial semicircle is 5837 m2. Because the model uses grid cells of size 50 m by 50 m by 1 m deep, the compliance volume will be two 2500-m2 grid cells, or 5000 m2 surface area by 1 m deep.

We will be finalizing the models and setting load and wasteload allocations by June 2007, and now is the time to determine what the targets will be. If the targets change during the report development, then additional analyses will be necessary, requiring more time to develop. Also, mentioning different numerical targets in the TMDL submittal report to EPA and the Summary Implementation Strategy could cause confusion among the stakeholders.

Please advise.

Mindy Roberts

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Appendix H. Annual reporting for NPDES Phase II stormwater permittees

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DEPARTMENT OF ECOLOGY
NORTHWEST REGIONAL OFFICE
3190 - 160TH AVENUE S.E.
BELLEVUE, WA 98008-5452

Memorandum

DATE: November 2011 (revised)

TO: Phase II Municipal Stormwater Permittees

FROM: Sally Lawrence, TMDL Lead, Sinclair Dyes Fecal Coliform TMDL

SUBJECT: Reporting mechanism for Phase II municipal stormwater permittees with Wasteload Allocations in the Sinclair Dyes Fecal Coliform TMDL

The Sinclair Dyes TMDL in Tables 23 and 26 establishes Wasteload Allocations (WLAs) for three Phase II NPDES municipal stormwater permittees:

- City of Bremerton
- Kitsap County
- City of Port Orchard
- City of Bainbridge Island

The WLAs require permittees to implement certain elements of the permit at specified locations in the watershed that did not meet water quality standards in WY2009 and/or WY2010.

To inform Ecology that the WLAs are being addressed, the permittees will include in their NPDES annual report to Ecology (Permit Condition S7.A.) a brief description of the activities over the past year at each location.

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Appendix I. Approach for calculating daily bacteria loading

Estimates of daily load reductions that would be achieved by the freshwater load and wasteload allocations are required elements of TMDLs. Load calculations require both flow and bacteria concentration data. Unfortunately, many of the streams in this TMDL did not have flowgages in WY2010. To estimate flows of all streams from a single gaged stream (Gorst), Ecology and the Navy used an ENVVEST and KPUD spreadsheet of monthly flows for the period 1994 through 2004, which included these streams: Gorst, Barker, lower Chico, Clear, Enetai, Karcher, Ross, Strawberry, Ostrich Bay, Annapolis, Blackjack, Pahrmann, Sacco and Beaver.

Gorst streamflows were available both for the 1994-2004 period and for WY2010 at Ecology gage 15P070, at:
https://fortress.wa.gov/ecy/wrx/wrx/flows/stafiles/15P070/15P070_2010_DSG_MD.txt

The average daily flows by month and season were calculated for all the streams, where WET season was from Oct-Apr and DRY season was from May-Sept. We assumed that the flow from Gorst was proportional to the other flows for the streams (and stormwater) basins in the watershed during the same season. We calculated the proportionality between Gorst and the other streams for the modeled flow and then used the measured flow for Gorst from FY2010 to estimate the flows for each stream in FY2010.

Then, the current condition load in counts per day for each stream was calculated from wet and dry season geometric mean data from Table 25, multiplied by the estimated flows for 2010. The daily load reduction in counts per day was calculated by applying the percent reduction required for each stream and monitoring site (Table 26) to the estimated load.

The load calculations in Table 24 (using data for 2000 to 2003) were done in the same way.

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Appendix J. DOH and KCHD nearshore monitoring data for WYs 2009 and 2010

Fecal coliform statistics for WYs 2009 and 2010 for DOH and KCHD marine monitoring sites in Sinclair and Dyes Inlets and Port Orchard and Rich Passages (see Figures 22 and 23). These sites met bacteria standards in both years. Sites that did not meet standards in at least one year are listed in Table 17.

Table J-1. DOH and KCHD marine water quality data for WYs 2009 and 2010.

DOH site	WY2009		WY2010	
	GM	90th	GM	90th
444	2	3	2	2
445	2	6	2	3
448	2	3	2	2
450	2	8	2	3
452	2	5	2	3
453	2	2	2	5
454?	3	17	2	4
455	3	12	2	3
456	2	2	2	5
753	No data available		3	6
754	No data available		3	17.5
755	No data available		2	3
711	2	2	2	2
712	2	2	2	5
713	2	2	2	2
714	2	3	4	16
715	2	2	2	2
469	2	2	4	12
470	2	2	5	14
473	2	2	5	22
474	2	7	5	26
478	2	6	3	4
479	2	2	2	4
481	4	20	4	31
482	3	30	3	4
483	3	4	3	13
484	3	7	3	13
485	3	11	3	8
486	2	5	4	14
488	2	3	4	15
489	2	2	3	12
490	3	21	2	4

DOH site	WY2009 GM	90th	WY2010 GM	90th
492	2	3	3	10
546	2	2	4	21
576	2	4	4	23
578	3	7	4	14
604	2	8	2	4
605	3	11	4	14
606	2	5	5	12
462	3	10	4	31
464	3	7	3	4
465	3	8	4	8
467	2	4	2	4
468	2	4	3	4
491	2	2	4	4
655	2	4	5	23
661	2	2	3	13

KCHD monitoring sites					
Site no.	WY2009		WY2010		Site description
	GM	90th	GM	90th	
DY32	3	28	2	21	Nearshore Tracyton boat launch
DY31	1	2	4	22	Mouth of Mosher Creek
DY28	1	2	2	5	Mid channel N end Dyes Inlet over shoal
DY24	1	2	8	31	Nearshore dock at Silverdale Cty Park
DY21	2	13	3	25	Nearshore creek N of Chico boat ramp
DY15	2	7	5	22	Nearshore head of Ostrich Bay
DY14	1	2	5	29	Nearshore south side Oyster Bay
DY36	3	12	3	16	Pilings at end Snyder Ave. CSO 0F8
DY35	2	4	3	29	Nrshore below tank farm CSO-OF10 & CSO-OF11
DY04	2	4	3	14	Nearshore Anderson Cove – Port WA marina CSO-OF9
DY03	2	4	6	12	Nearshore NE corner Warren Ave Bridge CSO-OF3
DY02	2	8	3	6	Nearshore Evergreen Park boat launch B-ST27
SN27	3	25	5	30	South Kitsap Water Reclamation Facility outfall
SN03	1	4	2	4	Bremerton WWTP Outfall
SN05	3	21	9	28	Gorst estuary – mid channel, head of Sinclair Inlet
SN24	No data		3	17	Nearshore outfall west side base of pier, Wilkins Place
SN18	1	2	1	2	Nearshore Pt Glover (Green channel marker #9)
SN14	2	4	2	12	Midchannel betw Pt Heron & Annapolis
SN13	3	22	8	27	Mouth of Karcher Creek
SN10	2	4	No data		Nearshore dock near Tweetens Restaurant, PO Blvd outfall
SN25	2	2	3	28	Nearshore Navy Yard City SW Outfall LMK164

Appendix K. Response to Public Comments

Comments received on the Public Review Draft (June 2011) and Ecology's responses.

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Sinclair Dyes TMDL Appendix K Table. Response to Comments

No	Type	Comment	Response
1	General	Any requirement in the TMDL is binding only after it has been incorporated into a NPDES Permit.	Ecology TMDLs use the term ”requirement” for actions that will be required under NPDES permits. While NPDES permits have the necessary enforcement mechanism, it is the TMDL document that explains what will be required and why, based on TMDL modeling and monitoring results. TMDL requirements are intentionally specific, because permit managers may not have sufficient knowledge of the pollution sources and locations to develop TMDL-related permit requirements. Ecology will work with EPA to ensure the permit requirements for the Navy are appropriate given the results of the TMDL.
2	General	Ecology has pointed to the effectiveness of local government in making improvements in water quality in this watershed. Why is Ecology not establishing a Category 4B designation for this watershed?	Category 4B designation in the Water Quality Assessment is not an award for work well done, although that may be considered in the designation. Category 4B is appropriate for subbasins where point sources are not contributing to the WQ problem. Requirements that apply to point sources are enforced through permits; Category 4B does not include a regulatory process for modifying permits, whereas TMDLs assign load allocations to nonpoint sources and wasteload allocations to point sources (entities with NPDES or other discharge permits). In Sinclair Dyes watershed, stormwater is an important conveyor of fecal coliform pollution, and potentially, wastewater treatment plant effluent might need to be addressed as well; both are regulated with NPDES permits. Stormwater from Phase II entities is addressed when NPDES stormwater permits are reissued or through administrative order.
3	General	Some high FC measurements at marine locations are not correlated with upland or upstream sources and may indicate a wildlife input. Relying on load allocations for streams may not achieve adequate FC reductions in the marine areas.	Agreed. If freshwater sources (stream, stormwater outfalls and shoreline seeps) to the marine nearshore meet standards, then there could be a wildlife source. Local governments should first ensure that human-caused sources have been addressed before concluding that a wildlife source is causing a bacteria impairment.
4	General	TMDL requirements for Phase II municipalities need to take into account staffing levels and current permit requirements, as we have no additional budget to address these.	The TMDL requirements for Phase II municipalities have been designed to be addressed by current stormwater programs. The requirements are for geographically-focused actions and program elements that are already required under the Phase II stormwater permit.

No	Type	Comment	Response
5	General	The TMDL should establish an allocation for future growth, to cover anticipated future increases in pollution discharge that are a consequence of population increase and expansion of the built environment. The TMDL should offer a choice to local municipal stormwater jurisdictions to either meet the stricter targets (that would result from setting aside an allocation for growth) or requiring Low Impact Development standards where feasible to maximize infiltration and minimize runoff from all new development.	The TMDL sets aside a reserve capacity for growth using a narrative approach. If not required to do so by the permit expected to become effective in 2013, then Phase II municipalities, starting in 2016, need new development projects[13] to implement Low Impact Development BMPs where feasible or to employ other stormwater management techniques to minimize the discharge of bacteria to surface waters. Designing new development using Low Impact Development goals and principles to minimize stormwater discharge is currently considered the most effective known and reasonable approach to avoiding or reducing the increases in flow and contaminant concentrations that typically accompany increases in impervious area as populations increase and the built environment expands. The Phase II permit is the appropriate regulatory vehicle for requiring LID or other effective stormwater management techniques. To address areas of the Sinclair Dyes watershed outside Phase II stormwater permit coverage, Ecology has added the following language to the TMDL: For parts of Gorst and Chico stream basins that are outside municipal Phase II permit coverage, Kitsap County Department of Community Development should require future developments to manage stormwater in accordance with Low Impact Development principles and practices as described in the Phase II permit expected to become effective in 2013.
6	General	Ecology is within its authority to include a reserve capacity for growth and to require BMPS that will assure restoration of beneficial uses.	Ecology acknowledges it has authority to establish a reserve capacity for growth. With the language added to the TMDL in response to Comment (5), Ecology believes this TMDL identifies and requires the nonpoint BMPs and point source BMPs that the municipal stormwater jurisdictions need to implement to assure protection and enhancement of beneficial uses.

[13] New development projects that trigger MS4 thresholds.

No	Type	Comment	Response
7	General	Why is WSDOT stormwater assigned a WLA, given statements in the report that WSDOT discharges were not sampled during the TMDL study and are merely assumed to contain bacteria?	The TMDL assigns WLAs to all NPDES stormwater permittees with jurisdiction within the geographic area of the TMDL study, providing the permittee discharges to nearshore waters shown to be impacted by bacteria and can reasonably be assumed to convey bacteria. The WLAs are expressed in the form of Best Management Practices that are not only expected to be effective in reducing bacteria, but also are already-required elements of WSDOT's stormwater permit. Since WSDOT is required to implement its permit within the geographic areas of the Phase I and II stormwater permits statewide, the Sinclair Dyes WLA assigned to WSDOT reinforces this requirement and provides a geographic focus for WSDOT's required stormwater program elements.
8	General	Some Bainbridge Island locations were sampled only during storm events that were not representative of normal ambient conditions. Lastly, WY2009 and WY2010 data for the Crystal Springs nearshore and the Fort Ward nearshore area demonstrates standards attainment. Lastly, current data (2011) shows standards attainment in the Lynwood Center nearshore area.	Stormwater discharges were monitored during storm events because that is when flow occurs. To increase modeling accuracy, FC in receiving waters needed to be measured at the same time (during storm events). The latter data are not used to characterize "normal ambient conditions." Except for one NPDES permittee (the Navy), FC data for stormwater discharges alone were not used to establish a Wasteload Allocation. (Since receiving water data were not available for the Navy, the TMDL establishes a monitoring requirement.)
9	Page 27	Table 7. Regroup sites more logically.	No change. this table is from May et al., 2005
10	Page 30	Figure 8. Reclassify Bainbridge Island subbasins for in ENVVEST model.	No change. The ENVVEST model and monitoring were reviewed by technical workgroup including representatives of city of Bainbridge Isl in 2000-2003 prior to running the model. In addition, changing subbasin classification would not affect model results, which showed no exceedances in nearshore areas from BI stream, stormwater, shoreline or WWTP inputs.
11	Page 31	Bullet 1, Line 5. "Pour points" in Figure 8 are illegible. Lynwood Cove sites may be on the wrong site of the cove.	No change. This figure is from May et al., 2005.
12	Page 37	Para 2, Line 8. Table 7 on page 27 and Figure 12 on page 39 identify only two stormwater outfalls on Bainbridge Island.	Noted.

No	Type	Comment	Response
13	Page 42	Para 4, Lines 4-8 states that Fort Ward nearshore area was designated area of concern not due to model predictions but because samples collected in the nearshore during WY2003 had high bacteria concentrations(see Appendix F data for Canary Node 35 Nearshore below Fort Ward). Canary Node 35 on Figure 10, page 33 of draft TMDL, should not include data for BI-FWNS or BI-CSNS locations. BI-FWNS is located about 1.5 miles south of the Canary Node 35 location shown in Figure 10. BI-CSNS is located along the Crystal Springs shoreline near Canary Node 23 and should not be grouped with BI-FWNS or WDOH-461 data. WDOH-461 had only 4 samples for WY 2003 (1.7, 1.7, 11, and 4.5), so no geomean can be calculated and the highest single sample meets the 90th percentile standard.	Fort Ward nearshore area is an area of concern due to high individual FC measurements in receiving waters (see Appendix F) in the vicinity of stormwater discharge with high individual FC concentrations (BI-FWSW, Tables 7 and 8). Ecology agrees that BI-CSNS is in a completely different receiving water body. No BI-CSNS were considered in re-evaluating the requirement for monitoring in the nearshore below BI-FWSW. Ecology has dropped the monitoring requirement for nearshore Fort Ward due to the fact that the appropriate monitoring location would be within a DOH Prohibited zone.
14	Page 42	Monitoring results from different locations (e.g., Crystal Springs nearshore area and Fort Ward nearshore area, Bainbridge Island) were grouped together inappropriately during the assignment of data to marine model grid cells.	The ENVVEST modeling approach included aggregating data from somewhat different sampling points in order to characterize conditions in a nearshore area. The QAPP was reviewed and approved by Ecology & by the ENVVEST technical workgroup, which included representatives from COBI. Because of lack of specific Lat-Long information at the time, Crystal Springs data were grouped with Fort Ward. While this grouping could have been done differently, it did not result in any model predictions of exceedances of the marine water quality standard in any nearshore areas off Bainbridge Island.
15	Page 42	Para 5, Lines 6 - 8. Because loadings were simulated by the model and the TMDL acknowledges the concentration of bacteria in the Fort Ward Nearshore area was grossly over-estimated for that pour point, this ranking is suspect.	The overestimate of FC data for the Canary Node that receives effluent from Kitsap No. 7 WWTP does not affect any of the rankings cited in Para 5, lines 6 – 8.

No	Type	Comment	Response
16	Page 44	Figure 13. Please clarify the “BI Pleasant Beach Shore site.” The loading calculation for this pour point should not have been estimated using the Fort Ward nearshore data that was from a monitoring location at the south end of the island.	“BI Pleasant Beach” in Figure 12 refers to shoreline segment for DSN 44, located along Pleasant Beach Dr NE between Lynwood Center and Fort Ward State Park. The loading was simulated as a shoreline discharge, i.e. the load was distributed into 7 shoreline grids. ENVVEST modelers classified this as a stormwater drainage system although a stormwater outfall was not located for this basin. The loading calculation for this pour point was not based on Fort Ward data. It was based on the FC loading assigned to stormwater discharges for clusters with similar Land Use/Land Cover characteristics.
17	Page 45	Table 11. WY2003 100/200 TMDL model run. What about the streams with Extraordinary Primary Contact Standard (50/100) that discharge to eastern Sinclair Inlet?	A model run with these streams (Karcher, Sacco, and Beaver) meeting the stricter standard was not included, but they were included with the 100/200 model runs. These streams are relatively small, and the model did not predict impacts to the marine receiving waters under either “Actual Conditions” or “100/200” scenario. Impacts to receiving waters would be even less if they met 50/100, so a separate model run would not have provided any new information.
18	Page 46	Para 1.	No correction required.
19	Page 47	Figure 14. BI-FWNS is not correctly located on this map (see comment 53). Figure 12 on page 39 shows the correct location.	Noted.
20	Page 47	Figure 14. Only WDOH 461 is located in the area identified as Fort Ward Nearshore. This site showed no exceedances of the standard so the symbol should be a green dot.	Noted. The nearshore symbol at DOH 461 in the figure represents an aggregate of data from several nearshore locations; overall these did not meet part II of the standard.
21	Page 61	Para 1, Line 5. BI-LCNS (Lynwood Center Nearshore-Canary Node 36) and BI-FWNS (Fort Ward Nearshore, please correct location) have only 4 sampling values, so cannot be compared with Part I of the standard. WDOH-461 (Canary Node 35) showed NO EXCEEDENCES of either parts of the standard.	Data for BI-FWNS in Appendix F, Canary Node 35, exceed Part II of standard, as acknowledged in the City’s letter dated March 30, 2011.

No	Type	Comment	Response
22	Page 62	Table 15.	The ENVVEST approach of aggregating data from several nearby marine stations to develop a descriptive data sets for marine canary nodes was described in the QAPP, reviewed, and supported by the technical workgroup including local municipalities.
23	Page 70	Para 4. BI-FWNS is not co-located with site WDOH-461, but rather approximately 1.5 miles south adjacent to the Kitsap Sewer District No. 7 WWTP outfall. Marine waters there consistently met standard in WY2003, WY2009, and WY2010.	Comment noted.
24	Page 70	Para 5. Shoreline surveys and IDDE in this area showed that failing septic systems not polluted stormwater caused bacterial contamination in shoreline drainages in 2003. Sewering of this area by 2006 resulted in good shoreline conditions around Lynwood Cove, as confirmed by KCHD/COBI shoreline survey work in 2008.	The shoreline surveys do not replace the requirement for 12 months of ambient monitoring of receiving waters.
25	Page 70	Para 5 and 6. DELETE "No recent marine data are available for this site." At the request of the city of Bainbridge Island, KCHD began collecting monthly samples in the cove below the Lynwood Center outfall in May 2011, and results so far are below standards.	No change. Ecology will review the data once the minimum 10 samples have been collected and data submitted by COBI.

Appendix L: Sinclair and Dyes Inlets in WRIA 15 (Kitsap peninsula).

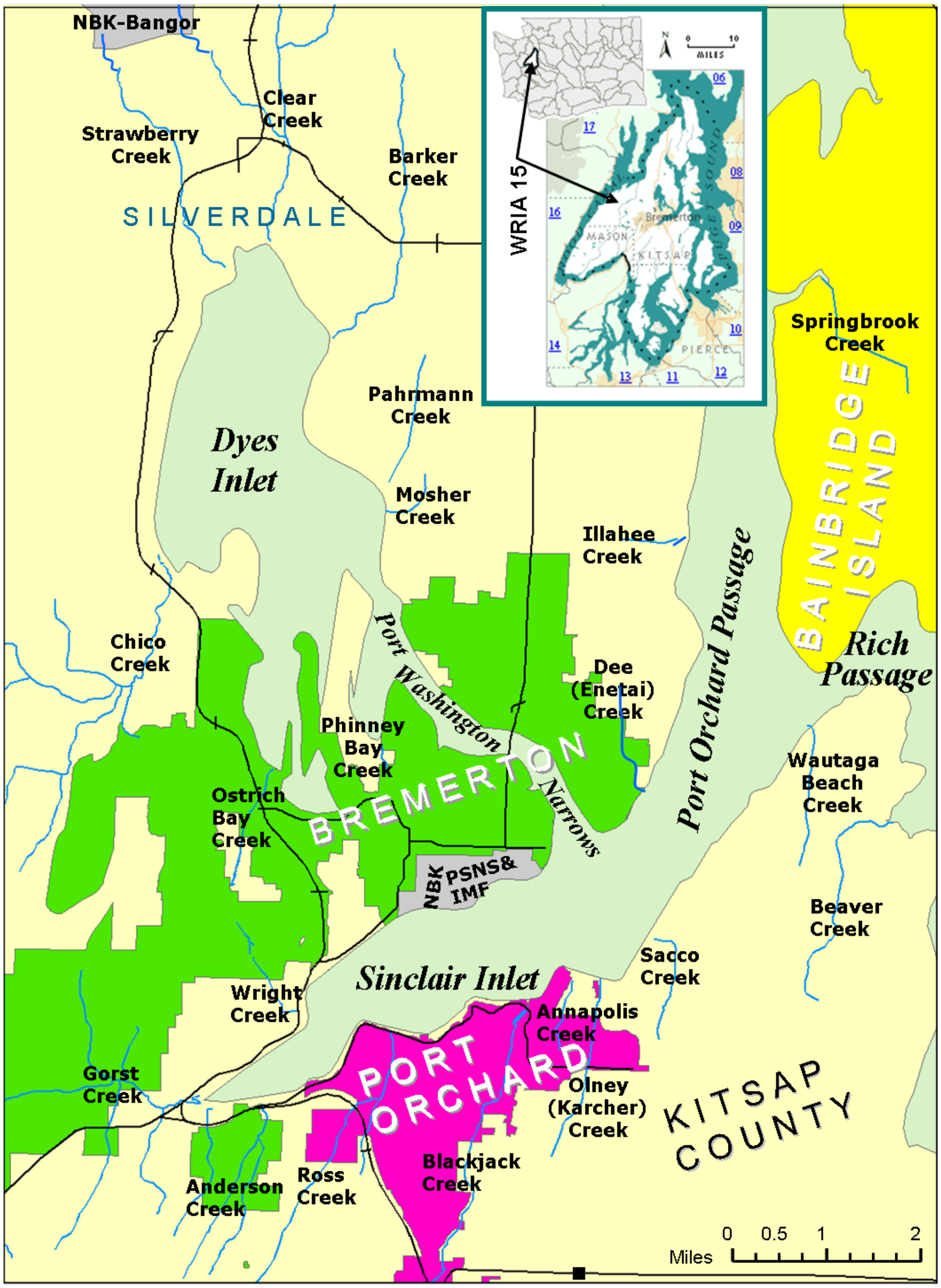

Figure L-1. Sinclair and Dyes Inlets in WRIA 15 (Kitsap peninsula).