Mason County Public Health

Hood Canal Pollution Identification and Correction Project
Final Report
December 2008

Prepared for Washington State Department of Ecology

Centennial Clean Water Fund Grant Number: **G0600378**
Federal ID Number: **91-6001354**
Project Duration: **July 2005 to August 2008**

Prepared by: Amy Georgeson, Wendy Mathews and Penny Orth
Reviewed by: Arlene Hyatt
Mason County Public Health

Table of Contents — Page

List of Figures

List of Maps

Hood Canal Pollution Identification and Correction Project
Deliverables Summary – Required Performance

Centennial Clean Water Fund Grant Number: G0600378
Federal ID Number 91-6001354
Project Duration: July, 2005 to August, 2008

Task 1 – Project Administration/Management

Required Performance:

1. Effective administration and management of this grant project.
2. Maintenance of all project records.

   All Project records have been maintained in excel spread sheets and word documents. The databases that currently exist include:
   - Fecal coliform analysis spreadsheet, which includes both fecal coliform and nutrient data for all sites that have been sampled along Hood Canal
   - Hood Canal Onsite Septic System Survey Tracker, which includes all of the information that is collected during the sanitary survey
   - All the parcel numbers that existed within 1100' of Hood Canal as of May 14th, 2007.
   - All GPS points were downloaded into Mapsource, saved as Excel files and then converted into a shapefile in Arcmap.
   - Community presentations spreadsheet
   - Result Letter spreadsheet

   Word Documents include:
   - QAPP
   - All Quarterly Reports
   - 2007 Summary Report
   - All letters for residents in response to results, sanitary surveys, dye test or general information
   - Flyers for advertising community meetings
   - Handout for basic information about our project for residents
   - Mason County Pollution Identification and Correction Survey Form

3. Submittal of all required performance items, post project assessment plan, progress reports, financial vouchers, and maintenance of all project records.

   All written progress reports, were turned in by the 20th day of the month following the end of the quarter.

4. Submittal of final project completion report to the DEPARTMENT no later than November 15, 2007.

Task 2 - Shoreline Survey
Required Performance:

1. Submit Quality Assurance Project Plan for DEPARTMENT approval.

   QAPP originally submitted February 2007, accepted on May 2, 2007.

2. Perform sampling following the approved Quality Assurance Project Plan.

   All sampling was performed in accordance to the QAPP, except the following deviations:
   - Sampling occurred from 7/11/05 to 7/31/08. Sampling that was funded by this grant occurred between 5/8/07 to 7/31/08.
   - Only sections A to V were sampled. They were sampled during either wet or dry weather (not both) except for section I, which was sampled during both wet and dry weather.
   - No field replicates were taken for nutrient samples because TWISS did not require them and due to budgetary restraints.
   - Geometric Mean Calculations have not been included as there were not enough samples take at each site to make a geometric mean viable.

3. Input all monitoring data into EIM.

   All fecal coliform and nutrient data will be incorporated into the EIM database. Even data collected prior to the inception of the grant, but under the same project, will be included.

4. Conduct shoreline survey along Hood Canal in Mason County.

   At least 1416 independent sites have been sampled, from Triton Head on the northwest shore to Belfair. This includes the monitoring sites from Annas Bay.

5. Input data into RECIPIENT's Carmody database and provide copy of data to the DEPARTMENT, DOH, and the PSAT.

   Through e-mail discussion with Tammi Riddel of DOE on 10/16/2007 we clarified that we do not enter sampling data into the Carmody database. All sampling data is recorded in Excel spreadsheets. Carmody is parcel specific and only includes information about septic systems. All sampling data will be sent to DOE, DOH and PSP in the Excel spreadsheet format or be available via EIM.

Task 3 – Septic System Surveys
C. Required Performance:

1. RECIPIENT will conduct septic system surveys and work with homeowners to repair OSS.

   27 Sites were identified for Sanitary Surveys. 8 Failures were identified and 5 failures have been repaired.

2. RECIPIENT will work with homeowners to help secure funding to help with repairs.

MCPH Water Quality provides Shorebank loan information to all residences where a failure has been identified. At least 1 homeowner used Shorebank for their repair.

3. RECIPIENT will input survey data into their existing Carmody database.

   All data was provided to our Onsite program, which completes the download into the Carmody database.

Task 4 – Public Outreach
Required Performance:

1. Conduct two (2) pre-project meetings and four (4) workshops on proper operation and maintenance of OSS.

   4/13/06 and 3/15/07 pre-project meetings
   4/23/07, 6/4/07, 9/24/07, and 10/15/07 OSS Operation and Maintenance workshops.

2. RECIPIENT will modify existing newsletter quarterly to residents in the project area as well as other interested parties and maintain current information on the RECIPIENT's web site.

   Provided information for the WRIA 16 newsletters. The Hood Canal Water Educators Network (HCWEN) produced the "existing newsletter" at the time the contract was agreed upon. However, Mason County Public Health was unable to submit information for dissemination as HCWEN experienced some changes during the past year, and did not produce the newsletter. Summaries of activities have been provided for HCDOP monthly and quarterly updates and are available on their website. Summaries have also been provided for the Mason Conservation District updates.

3. The RECIPIENT will conduct two (2) post-project meetings informing residents about the results of the project.

   Meetings will be completed after the grant work is completed.

4. The RECIPIENT shall provide the DEPARTMENT with two copies of any tangible educational products developed under this grant.

   All public outreach information was previously submitted by November 2007.

Task 5 – Database Enhancement
Required Performance:

1. Enhance existing Carmody data base to meet identified up-to-date needs.

   Carmody was enhanced with new fields that include performing a query within the study area only

2. Update, enhance, and populate Operation and Maintenance database.
   Inventory and add OSS data into database.

   Twenty-nine records were added to Carmody based on parcel research performed under the HCPIC project.

1 Introduction and Background

Hood Canal is a deep fjord-like body of water, its length bounded by a high mountain range to the west and steep slopes all the way around. It is a valuable recreational and commercial resource to three Washington Counties, Jefferson and Kitsap to the north and Mason to the south. The canal receives glacier and snowmelt via many rivers and streams. An underlayment of impermeable basalt, along with a sloped and developed shoreline prevents significant infiltration. As a result, western Washington rains contribute huge volumes of water that carry surface contaminants to the canal. This large volume of freshwater contributes to the highly stratified temperature and salinity – as well as the to the pollution load - of the canal. The shallow entrance to the canal is just 150 feet deep giving way to depths of up to 600 feet. "The 'sill' tends to retain the water (reduces the exchange) in the canal and estimates of complete water exchange rates are in the magnitude of years" (HCDOP, 2005, "The Dissolved Oxygen Issue"). The slow exchange rate plus the temperature and salinity gradients limit mixing, causing oxygen to diminish with depth.

Olympics Reflecting in Hood Canal

In 2005, the Hood Canal Dissolved Oxygen Program (HCDOP), through the University of Washington, began a 3-year Integrated Assessment and Modeling (IAM) study to better understand the dynamics of Hood Canal and its persistent problem with low dissolved oxygen. "Confirmed records of fish kills date back to the early 1960s and anecdotal records exist for the 1920s. Recent oxygen levels are among the lowest in recorded history, prompting increasing concerns about the long term health of the canal" (Kitsap County Health District, 2005, "Shoreline Discharges"). Although fish kills have been a historic event, fish kills in 2002, 2003 and 2006 represented an increase in the frequency of these events. In addition, "the area of low dissolved oxygen is getting larger, spreading northwards. The periods of low dissolved oxygen last longer" (HCDOP, 2008, "Key Messages"). The current understanding reported in the IAM Study Preliminary Results is that the annual late-summer intrusion of new bottom waters forces low oxygen waters toward the surface. Favorable wind conditions can then bring these low oxygen waters rapidly to the surface, resulting in the high-mortality events in southern Hood Canal (Newton, 2008).

The factors contributing to the low Dissolved Oxygen (DO) conditions in Hood Canal are complex and dominated by natural processes that favor low DO. "The seawater stratification is strong, the natural organic productivity is high, and the circulation or flushing of the seawater is slow" (Newton, 2005, "Science Primer"). However, one of the seven hypotheses on possible causes for the lower oxygen concentrations in Hood Canal is, "changes in production or input of organic matter, due to human-caused loading of nutrients or organic material" (Newton, 2008, "Preliminary Results").

Looking West near the End of Lynch Cove

Although not quantitatively known, there is a demonstrated direct loading of organic material and nutrients to the Hood Canal from human activity via stormwater, agriculture, fertilized lawns, sewers, septic tanks, animals, etc., and carbon loading from fish carcasses, yard wastes, and failing septic systems. "Once all this extra organic material sinks and decomposes, that means that the naturally low oxygen concentration in the deep water will go even lower. Sometimes low enough to kill fish. Maybe humans could be tipping the balance in this sensitive ecosystem. We don't yet know...it is plausible, but it also may not be on a significant scale." (Newton, 2005, "Science Primer").

Many agencies have joined the effort to locate and limit sources of pollution to the canal. Much of the freshwater (stormwater, groundwater, rivers, etc) entering Hood Canal carries metals, pharmaceuticals, toxins, and pathogens, among other pollutants. In partnership with federal, state and other agencies, Mason County is attempting to address the pollutants found in stormwater through Low Impact Development and Stormwater Management Plans. Meanwhile, Mason County Public Health addresses the impacts of fecal pollution on public health, and on organic materials and nutrient loading through grant-funded projects. State standards set out in Chapter 173-201A WAC (for shellfish harvest and water recreation contact) and Chapter 246-272A WAC (Onsite Sewage Systems) provide the overall water quality attainment goals. Additional standards guiding County activities around fecal pollution are the county sanitary code, the 2007 Revised Onsite Sewage System Management Plan, and Washington State's Recommended Standards & Guidelines for Wastewater Systems.

Specifically addressing nutrient pollution has been a more complex task. Sources and remedies of nutrient pollution have not been well understood. In 2005, the Kitsap County Health District approached the issue by posing questions around the nitrogen contribution of functioning, as well as non-functioning Onsite Septic Systems (OSS). Though not typically designed to treat for nutrients, OSS were determined to have nitrogen treatment capabilities of around 90% in the anaerobic conditions of the septic tank and the aerobic conditions of the drainfield, as well as uptake by vegetation. Assumptions underlying the project design were stated in the Preliminary

Assessment and Corrective Action (PACA) Plan released by the Puget Sound Action Team and the Hood Canal Coordinating Council in May 2004. The report stated "Ecology staff has established through experimentation that nitrogen limits algal growth in Hood Canal (Newton *et al.* 1995). Therefore, the emphasis for this plan is primarily focused on nitrogen loading" and, "Overall, from the available data, we calculate that nitrogen leached from onsite sewage systems is clearly the largest source entering Hood Canal. Although not precise, we estimate that sewage contributes between 33% and 84% of all anthropogenic nitrogen entering Hood Canal." The nitrogen loading estimates were based on census data, and calculations using estimates of wastewater generated and "literature values of treatment efficiency" of OSS ("Shoreline Discharges", 2005). Since estimates were not based on empirical data, several studies are currently under way to determine under what conditions functioning septic systems contribute nitrogen to the canal, and to what degree.

Rainbow over Hood Canal – Looking towards Tahuya

However, there is no doubt that human sewage is a factor in the health of the canal, and it may yet be significantly connected to increased nutrients via both functioning AND non-functioning septic systems. The Kitsap County Health District Water Quality Program (Kitsap) staff have collected samples of freshwater discharges to Hood Canal in Kitsap County, and evaluated data in an attempt to correlate the presence of fecal coliform with nutrients from septic systems ("Shoreline Discharges", 2005). Mason County's Pollution Identification and Correction (PIC) project was modeled after Kitsap's PIC projects. Please see section 4. Project Design and Methods.

Previous water quality data and shoreline assessments have demonstrated known or potential fecal coliform pollution problems in the Mason County Hood Canal region. Fecal Coliform (FC) pollution has been identified by several agencies, including the Washington State Department of Health (WSDOH) at marine water monitoring stations (Scott Berbells and Don Melvin, DOH Shoreline Surveys of the Hood Canal Shellfish Growing Areas 5 through 9, 1996-2005), and Mason County, which monitored shoreline drainages (including water exiting the beach from underground flows (seeps), storm water runoff and bulkhead drains).

WSDOH also performs shoreline surveys to identify potential fecal pollution sources in order to classify commercial shellfish beds. In surveys of the Mason County Hood Canal shoreline (Hood Canal Growing Areas 4 through 9) from 1996 to 2005, WSDOH identified approximately 826 "potential sources" of fecal pollution based upon their staff field observations.

Hamma Hamma River – Elk Heard

In addition, Hood Canal has been recognized by several agencies as a significant resource deserving of protection. Mason County's Board of Health has identified Hood Canal as a Marine Recovery Area due, in part, to the existence of fecal coliform pollution. The Washington State Legislature defined Hood Canal as Aquatic Rehabilitation Zone #1 (ARZ #1). There are nine 303(d) listings for fecal coliform in the marine water of Hood Canal in Mason County, as well as shellfish growing areas that have been classified as prohibited or threatened. There are 496 acres of tidelands classified as "prohibited" for commercial shellfish harvest by WSDOH.

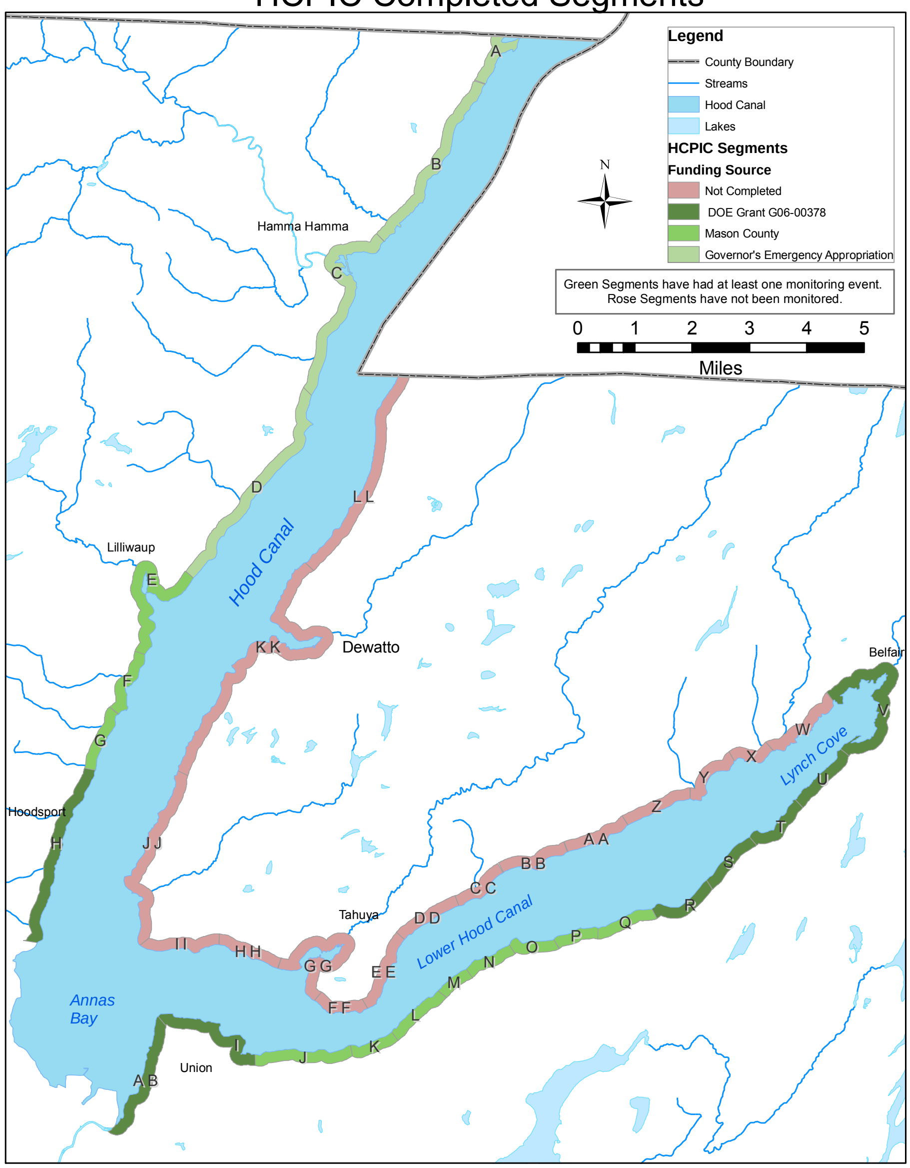
In April 2005, Mason County received $40,000 from the Governor's emergency fund to start sanitary survey work in response to mounting concerns over the health of Hood Canal, a critical commercial and recreational aquatic resource. Mason County was to identify and correct non-functioning onsite septic systems that allowed fecal pollution to enter Hood Canal. The Hood Canal Pollution Identification and Correction (HCPIC) project was continued with funding from Mason County for water monitoring and analysis (2005-2006), and from the Department of Ecology (DOE) through the Septic System Survey and Database Enhancement Grant #G0600378 (2007-2008). As in the Kitsap PIC project, Mason County would also try to locate inputs of organic material and nutrients that can promote algal growth (thereby contributing to decreasing levels of dissolved oxygen as proposed in PACA report). The HCPIC project ultimately performed three years of data collection and pollution source corrections from Triton's Head (at the Jefferson County border on the West Coast of Hood Canal) to Belfair (at the southeastern tip of the Canal).

2 Project Area Description

For the purposes of this report, Mason County Public Health (MPCH) is reporting on all of the work that has been performed within the Hood Canal Study Area since July 2005. However, funding under this grant only includes work that has been performed since May 2007. Work performed under this grant includes all nutrient monitoring and fecal coliform monitoring in the following Segments H, AB, I, R, S, T, U and V (see Map 1. HCPIC Completed Segments). Prior to this grant, MCPH completed 27.3 miles, monitoring along the Hood Canal Shoreline. Under this grant, MCPH complete 17.1 miles of monitoring along the Hood Canal Shoreline, including 8.3 miles of monitoring for fecal coliform and nutrients (Ammonia-Nitrogen [NH3], Nitrite/Nitrate-Nitrogen [NO2/NO3] and Orthophosphate [OP]). Nutrient monitoring occurred in segments H, AB and I.

Map 1.

HCPIC Completed Segments



Created December 1, 2008 by A. Georgeson

3 Project Goals and Objectives

The Hood Canal Pollution Identification and Correction (HCPIC) project (July 2005 through November 2008), modeled after the PIC projects conducted in Kitsap County, was designed to survey the entire Hood Canal shoreline in Mason County. Analyzing for Fecal Coliform (FC) pollution in freshwater inputs along the shoreline, the team proposed to identify sources of pollution and correct the problems, if possible. The primary focus would be on the identification of failing Onsite Septic Systems (OSS) followed by repair or replacement.

Sampling Location, Segment H

In addition, the Septic System Survey and Database Enhancement Grant required that the Carmody OSS Operation and Maintenance database be enhanced and populated with OSS in Mason County, allowing for monitoring and OSS-owner education about operation and maintenance of their septic systems.

The HCPIC project also included a nutrient component comprised of analyzing surface water samples for nutrient inputs at high FC sites (see 4.5 Project Design and Methods, Nutrient Study) and conducting an *intensive nutrient study* in selected areas. The nutrient study would supply data to test the hypothesis that there is a relationship between FC and nutrients, as stated in the 2004 PACA Report.

Public education regarding other pollution sources of FC (e.g. pet waste) and nutrients (e.g. yard waste) was addressed during surveys (see Section 4.4. Sanitary Surveys), and at 14 public meetings held over the course of this project.

Mason County established five goals to achieve improved water quality in freshwater inputs to Hood Canal and to collect data to look at FC in relation to nutrients:

- Reduce FC pollution in Hood Canal from a variety of sources, including failing Onsite Septic Systems (OSS) and inadequate animal waste management, along the entire developed Hood Canal shoreline within Mason County.
- Analyze water quality data from a limited study area to determine if there is a relationship between FC levels and nutrients in discharges to the marine shoreline.
- Analyze water quality data to determine if correction of FC sources leads to a reduction in nutrients.
- Provide water quality data that establish a baseline of the cumulative inputs of freshwater nutrients into the marine water surrounding the Annas Bay/Great Bend areas.

- Educate residents of the Hood Canal watershed about the FC and nutrient impacts on the Canal, and actions they can take to limit their affect.

To accomplish these goals, the following objectives were developed:

- Reduce fecal coliform pollution entering into Hood Canal from the northern Mason County borders to Lynch Cove (see Map 1. HCPIC Completed Segment) by identifying and correcting FC pollution sources.
- Attempt to reduce nutrient pollution entering into Hood Canal in the *intensive nutrient study area* by identifying and correcting nutrient pollution sources.
- Measure FC and nutrient concentrations in discharges to the marine shoreline in a limited study area.
- Where elevated FC pollution sources are identified, determine FC and nutrient concentrations in discharges before and after FC source correction.
- Educate residents of the Hood Canal watershed about the FC and nutrient impacts on the Canal, and actions they can take to limit their affect.

Wendy Mathews Collecting a Sample

4 Project Design and Methods

4.1 Project Design Introduction

Analyzing shoreline discharges for FC bacteria can identify sources of pollution from human and animal waste. The Kitsap County Health District developed and utilizes the “Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction Projects – Version 9” (2003), as a standardized method of evaluating discharges and identifying and correcting FC sources such as failing onsite sewage systems and inadequate animal waste management.

Sampling Location, Segment D

The Mason County Water Quality Program conducted a Pollution Identification and Correction (PIC) project on Hood Canal from July 2005 to August 2008 in the Mason County WRIA 16 watershed (including WRIA 14B), from the Jefferson-Mason County line around the Great Bend to Belfair. Originally, the survey area was to include the north shore of the Great Bend/Lynch Cove area, but due to budget, time and tide constraints, monitoring and survey work was halted at Belfair.

Work performed prior to May 2007 was conducted pursuant to “Mason County Surface Water Monitoring Standard Operating Procedures and Analysis Methods” (2003), which contains water sampling and sanitary survey protocols. The Kitsap County “Manual of Protocol” (2003) was consulted for guidance. Mason County Public Health adapted and adopted Kitsap’s PIC protocols as found in the Mason County Water Quality Standard Operating Procedures, Chapter 4.0 (SOPs) (2007). The “Mason County Septic System Surveys and Database Enhancement Quality Assurance Project Plan” (QAPP) was not completed and approved by DOE until May 2007. Staff followed all DOE-approved QAPP guidelines (which include Mason County’s Water Quality SOPs, 2007 update) for all work, including work completed before QAPP approval. All data will be submitted to DOE’s Environmental Information Management database (EIM) with a qualifier regarding the QAPP.

4.2 Selection of Laboratory for Sample Analysis

Mason County Water Quality staff initially selected the University of Washington’s Marine Chemistry Lab (UWMCL) for nutrient analysis. Not only were the costs up to 80% less than other local labs, but also the UWMCL is the lab used for sample analysis for the Hood Canal Dissolved Oxygen Program’s Integrated Assessment and Modeling Study. DOE informed Mason County in September 2006 that a QAPP would be required, since the project would be funded for 2006-2008 through the Department of Ecology’s (DOE) Centennial Clean Water Fund. Upon submitting the QAPP in December 2006, DOE’s Environmental Assessment Program (EAP) required that Mason County use Twiss Analytical Lab in Poulsbo, Washington, instead of the UWMCL.

Twiss Lab was preferred by EAP because both Kitsap and Jefferson Counties utilized Twiss for their PIC nutrient samples, and because EAP believed the UWMCL was using seawater methods for nutrient analysis. Mason County Water Quality staff had consulted with several DOE staff members in choosing the UWMCL. It was understood that UWMCL's DOE-accredited methods were more sensitive than would be required for PIC purposes and would therefore be comparable to Kitsap and Jefferson County's data (Will Kendra, EAP and Dennis Julvezon, DOE Lab Accreditation, May 2006). In December 2006, EAP's Bill Kammin said that the UWMCL analysis "would be ok" but that staff should run it by DOE's Lab Accreditation and get a written statement. The DOE Lab Accreditation Unit Supervisor, Stew Lombard, provided that written (e-mailed) statement on 12/11/2006. In addition, the UWMCL's methods (JGOFS methods) were adapted for freshwater and were accredited by DOE as equivalent to UNESCO 1994 freshwater methods (Clay Keown, DOE EIM, November 2006). Ultimately, EAP preferred Twiss methods and Mason County Water Quality made arrangements with them for nutrient analysis.

4.3 Shoreline Survey (Shoreline Evaluation Methods)

Before beginning fieldwork in July 2005, staff reviewed Kitsap's "Manual of Protocol" (2003) and Mason County's "Sanitary Survey Procedures" (2003). Staff acquired equipment and supplies, checked tides for the months ahead and developed monitoring plans that allowed for maximum monitoring time, and made arrangements with the Mason County Water lab for Fecal Coliform (FC) analysis. Maps were created separating the shoreline of Hood Canal into segments of approximately one to three miles in order to evaluate development density, manage data and to make comparisons.

Sampling a Seep out in the Mudflats

Water Quality staff began collecting samples for FC analysis in July of 2005. Staff accessed the shoreline from private properties after requesting permission from property owners on the monitoring day. Once on the beach, staff walked the exposed tidelands. When shoreline discharges were sighted, staff collected 100mL samples of water, observing all procedures from the above-mentioned QAPP and SOPs (see 4.1. Project Design and Methods, Project Design Introduction). After discussions with the UWMCL in 2005, measurements of salinity were added to the Mason County protocols and salinity readings began in March 2006 using a Vista A366ATC Refractometer (see section 4.3.1.Salinity for discussion of salinity issues.)

During the surveys, field data was collected in write-in-the-rain notebooks where the following data were recorded: date, weather observations, site identification, sample number, salinity, photo numbers and site descriptions. GPS waypoints were also acquired. Staff traveled on the beach side of the residences and therefore had no way to identify them using addresses. The combination of the address of the property by which the beach was accessed, the site description, GPS coordinates, and photos allowed staff to reliably re-locate the sites for confirmation sampling. Proper handling and transport of samples was carried out according to Mason County Water Quality SOPs.

Samples were analyzed for FC at the DOE-accredited Mason County Water Lab using DOE-accredited methods. High FC sample results (≥200 Most Probable Number (MPN) FC/100-mL water) triggered confirmation sampling. Sample results of ≥900 MPN FC/100-mL also triggered nutrient sampling (see 4.5. Project Design and Methods, Nutrient Study). If confirmation sample results were below 200 MPN FC, a follow-up sample was scheduled, preferably during wet weather. However, due to the seasonal nature of many Hood Canal residents, and the typical inaccessibility of the winter shoreline due to high tides during daylight hours, staff tended to take follow-up samples whenever it was feasible and safe. High confirmation results triggered Mason County Sanitary Surveys as delineated in the SOPs. Properties adjacent to the shoreline were prioritized for surveys and investigations extended no more than 1000 feet from the shoreline.

4.3.1 Salinity

Prior to QAPP development, no salinity readings were taken (as in Kitsap PIC protocols). However, fecal coliform bacteria have reduced life expectancy in water with higher salinity, as reflected in the different state standards for fresh and marine water. Many drainages, including bulkhead drains during outgoing tides, can exceed 20 parts per thousand (ppt). Kathy Krogslund, the University of Washington Marine Chemistry Lab (UWMCL) Manager, uses a range of salinity from 0-25ppt for freshwater, 25-30ppt as transitional, and 30+ppt as marine concentrations. Initially, Mason County Water Quality staff accepted the 0-25 ppt values for freshwater. Staff began taking salinity readings in March 2006 using a Vista A366ATC Refractometer. Early readings were likely skewed to higher levels due to a faulty calibration knob; a new refractometer was purchased and the older instrument was reconditioned by Seattle (Davis) Calibration lab in December 2006. Therefore, salinity readings were absent from July 2005-March 2006, were unreliable from March 2006-December 2006, and were taken regularly with a calibrated Vista A366ATC Refractometer beginning in January 2007.

Using a Refractometer to Determine Salinity

During the project, staff found that samples with high salinity readings had typically low levels of FC, therefore samples were (generally) no longer collected at sites with salinity readings above 20 ppt.

4.4 Sanitary Survey (Parcel Evaluation Methods)

Mason County Sanitary Survey procedures are described in the Mason County Water Quality SOPs. Sanitary Surveys included a parcel file OSS-record review (a copy was made for the homeowner), a Carmody Operation & Maintenance database search, and an interview with the homeowner or resident. The property was surveyed to identify the location of OSS components and their condition. System components were evaluated from surface observations only. Staff inspected for obvious signs of failure such as surfacing sewage or sewage odors. Staff also inspected for signs of poor system location or physical damage such as evidence that the drainfield was being driven upon, gutter downspouts directed toward system components, or cracked tank lids. Dye tests were performed when indicated (with permission of the system owner) to identify any outbreaks from the system, incomplete treatment, greywater discharges, etc.

The sanitary survey provided the opportunity to educate the resident about the proper operation and maintenance of a septic system in order to prolong its life and ways to protect it from unintentional damage. The survey also provided the opportunity to identify and educate the property owners regarding non-OSS fecal sources (such as pet waste) and nutrient pollution sources (such as yard waste near or thrown over the bulkhead). Non-OSS sources were addressed by recommending best practices such as picking up pet waste, composting of yard waste, and surface water runoff management.

Staff then requested that a dye test be performed; all requested dye tests were permitted. If more than one system in the same vicinity were to be dye tested, different dyes would be used. Similarly, if an OSS was repaired or replaced, a different dye would be used in the follow-up dye test. Fluorescein is a commonly used indicator dye, therefore when dye was found in background charcoal packets, Ozark Underground Laboratory (used for dye analysis) recommended that subsequent results be 10x background to be considered “significant”.

Dye Introduction into an OSS

According to Mason County’s “Water Quality Policies and Procedures” (2001), the definition of a “failing” septic system is “obvious signs of system failure (i.e. surfacing sewage, greywater discharges, etc.); presence of dye and bacterial counts in excess of 14fc/100-mL for marine water or 50fc/100-mL in freshwater; or failure to meet design requirements.” If dye was detected at the location of a high FC result, the owner would be instructed to pump the septic tanks and cap the tank outlet, and to contact a designer or Operation & Maintenance (O&M) Specialist. The property owner would be put into contact with the Mason County Onsite Septic System (Onsite) Program to approve and permit the repair, replacement or mitigation. Contact information for ShoreBank was provided to the system owner in regards to funding OSS repairs.

All data collected from surveys was recorded onto survey forms including the following: Property Information (parcel, address, owner, etc.), Septic System Information (System type, alterations or repairs, O&M status, records available, and information on household water usage), Field Inspection Information (OSS condition, surface water management, pet or livestock, etc.), and Final Rating OSS (No Apparent Problem, No Records, Non-Conforming, Suspect, or Failure). Data collected was then entered into HCPIC's OSS Tracker (Excel database) where calculations were made (see section 5. Results and Discussion). The Carmody database was updated with the operation and maintenance status of the 29 surveyed OSS.

4.5 Nutrient Study (Pilot Nutrient Study Methods)

The oxygen consumed during the growth, and primarily the decomposition, of large algal blooms has been identified as a contributing factor in Hood Canal's low dissolved oxygen issues. Nitrogen is the limiting nutrient in the growth of algae in the canal; therefore, nutrient sources have been closely examined. Jan Newton, lead scientist of the HCDOP IAM Study, said that the phytoplankton in Hood Canal is more sensitive to the effects of additional nutrients than any of the other sites studied, and three to four times more sensitive than the population in the Main Basin of Puget Sound (2005, "Science Primer").

Jorsted Creek

In the 2004 "Preliminary Assessment and Corrective Action (PACA) Plan", the Puget Sound Action Team and Hood Canal Coordinating Council postulated that the nutrient output of Onsite Septic Systems (OSS) provided a significant share of the nitrogen needed to promote large algae blooms. OSS designs and installations are based on the fate and transport of wastewater pollutants through soil, but in general are not specifically intended to treat for nutrients. Although it is currently accepted that the values for OSS nutrient output to Hood Canal stated in the PACA Plan are over-estimated, the actual values have not yet been determined. Current studies are looking at the variety of conditions that can affect OSS nutrient output that, among other factors, include system type and location, soil type and even the presence and type of vegetation.

In 2005, the Kitsap County Health District staff produced a technical report ("Shoreline Discharges") that reviewed available literature to evaluate the fate of nutrients in OSS effluent. Kitsap staff reported that, "Wastewater from toilets delivers about 75% of the nitrogen source to the OSS in the form of inorganic ammonia-nitrogen and organic nitrogen. Other nitrogen sources include food wastes and laundry water." Kitsap staff added a nutrient study portion to their Pollution Identification and Correction project in 2005, selecting three compounds for analysis: Ammonia-Nitrogen [NH3], Nitrite+Nitrate -Nitrogen [NO2/NO3] and Orthophosphate [OP]. These are compounds likely to be found after effluent has passed through the septic system.

As quoted in the technical report, "The soil and the biomat that forms at the drainfield's interface with the soil are critical in treating pathogens and nutrients. A significant portion of nutrient treatment occurs in the drainfield soil. Anaerobic conditions in the septic tank convert most of the nitrogen in raw sewage to ammonia. When the septic tank effluent is sent to the drainfield, aerobic conditions at the soil interface converts the ammonia to nitrite and then nitrate; this process is called nitrification (USEPA, 2002)."

The nutrient monitoring portion of Mason County's Pollution Identification and Correction (PIC) project design was based on this rationale. Kitsap County Health District's Water Quality PIC projects, in particular Kitsap's 2005 "Upper Hood Canal Restoration Project Final Report" provided Mason County with the methods for looking at the possible connection between Fecal Coliform (FC) and nutrients. The Kitsap PICs are applied to focused areas of concern of limited size. These PIC methods were adapted to apply to the 78 miles of Hood Canal shoreline in Mason County that precluded taking flow measurements and therefore the statistical evaluation of the data regarding loads.

Hill Creek

Staff walked the shoreline looking for flowing water from bulkhead drains, culverts, seeps (water exiting the beach from underground flows), and other drainages for FC analysis to be performed by Mason County Water Lab. When results showed FC values of ≥200 MPN FC/100-mL water, a confirmation sample was scheduled. Re-sampling a site with high FC values allowed staff to confirm that a FC source was persistent, rather than transitory as it might be from the presence of birds, for instance. When analysis showed FC values of ≥900 MPN FC/100-mL water, samples were collected for both FC and nutrient analysis. Twiss Analytical Labs performed nutrient analysis for Ammonia-Nitrogen, Nitrite+Nitrate-Nitrogen and Orthophosphate. The time was recorded in order to assure that analysis occurred according to the approved methods. Monitoring days were shortened when necessary to ensure timely transport of nutrient samples to Twiss Labs (or alternatively, to Belfair Water District or Twiss personnel for transfer to Twiss Labs). All methods for monitoring, recording and quality assurance followed those prescribed in the HCPIC QAPP.

Sampling at a Seep near Hoodsport

Confirmation samples with high FC (≥200 MPN FC/100-mL) triggered Sanitary Surveys. Sanitary Surveys provided the opportunity to evaluate homeowners' or residents' management of FC sources, as well as the management of nutrient sources. Education regarding nutrient management on the shoreline was provided, and corrections were encouraged (such as not throwing grass clippings over the bulkhead).

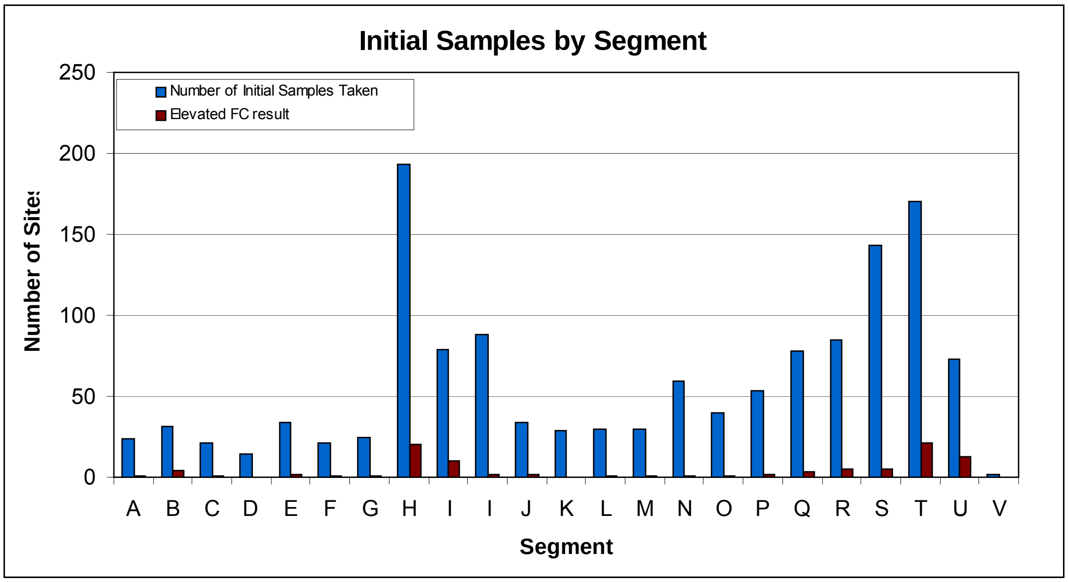
If the survey led to a dye test and then the repair or replacement of an OSS, additional FC and nutrient samples were collected when the correction was completed. This provided staff with data to compare FC and nutrients to determine if nutrient levels decreased when FC levels decreased. Nutrient sample results are presented in Section 5. Results and Discussion.

5 Results and Discussion

5.1 Shoreline Survey Results (Monitoring)

Since July 2005, Mason County Public Health (MCPH) has surveyed 44.4 miles along Hood Canal (HC) for shoreline discharges. MCPH collected over 1800 water samples, which were analyzed for Fecal Coliform bacteria (FC), from 1416 individual shoreline sites spanning a period of 107 days (see Map 2. Overview of Monitoring Locations and Figure 1. Initial Sites and Elevated Fecal Coliform Results). The discharges range from small seeps that surface out on tidal mud flats to major rivers that flow into Hood Canal.

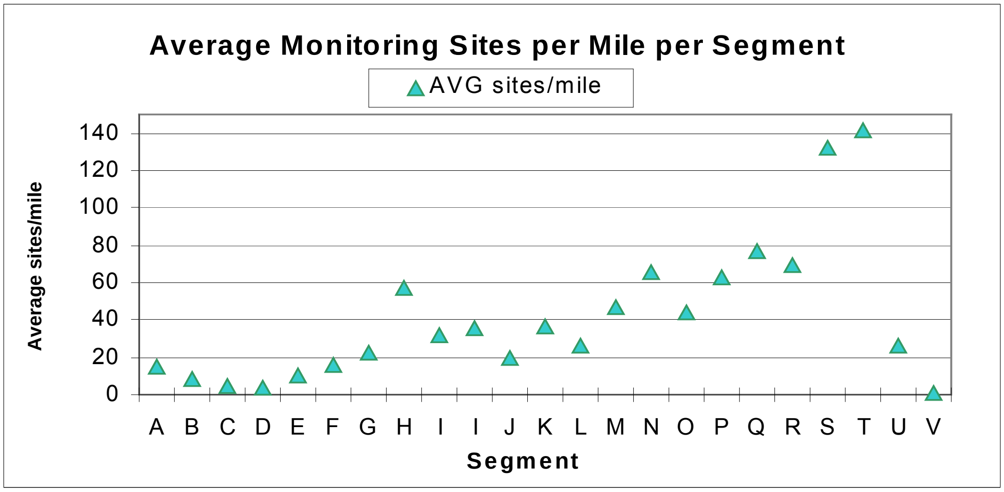
Figure 1. Initial Sites and Elevated Fecal Coliform Results



MCPH determined the average monitoring locations per mile, by segment, within the project area (see Figure 2. Average Monitoring Location per Mile). The average sites per mile is useful in determining which segments had the most run-off during the time that MCPH performed the water quality monitoring. Segments with more water are of more concern because of the potential inundation of onsite septic systems (OSS), which can stress or cause failure of the systems. This is especially evident in segment T, which had the highest average elevated fecal coliform sites/mile, and also has the highest amount of identified OSS failures. Since the primary method that MCPH uses to identify an OSS failure requires elevated FC results and a positive dye test, MCPH may not identify an OSS that is failing into the groundwater.

Of the 1356 sites, 97 (7.15%) of the initial samples were above the 200fc/100-mL threshold. As per MCPH Standard Operating Procedure (2007), MCPH took confirmation samples at 86 sites. See Figure 4, below, for the sites that did not receive a confirmation sample and the justification. Of the 88 confirmation samples, only 29 were above the 200fc/100-mL threshold (see Figure 3. for the Sanitary Survey Priority).

Figure 2. Average Monitoring Locations per Mile



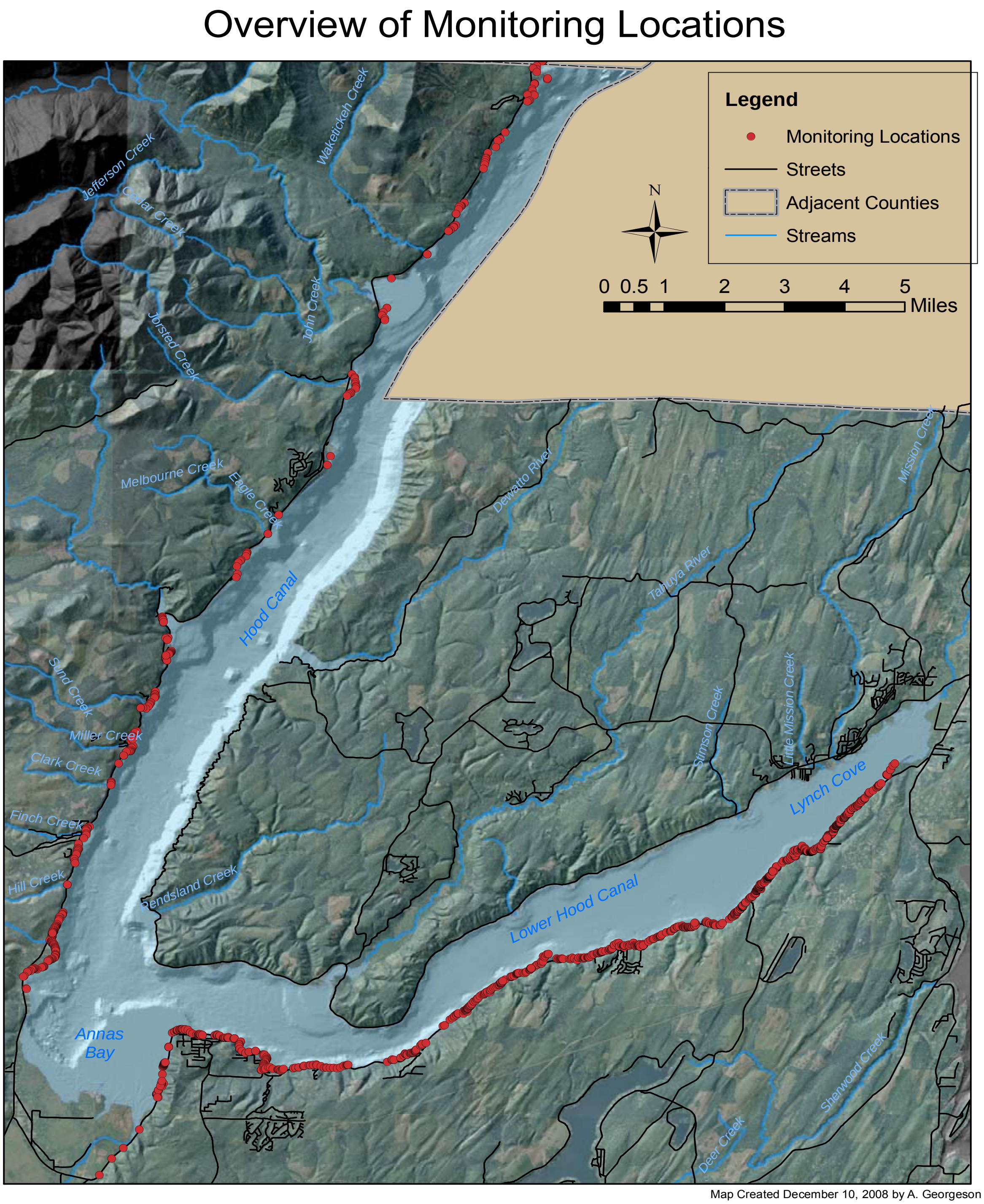
When an initial sample result is elevated followed by a confirmation sample result below the level of concern, MCPH's standard procedure is to re-sample that site. Generally, MCPH attempts to re-sample during wet weather, when an OSS is more likely stressed. This may be due to problems such as high ground water levels and increased surface water runoff resulting in inundation of the OSS thereby preventing proper treatment of OSS waste. However, in certain circumstances, it is necessary for MCPH to perform the re-sampling during the same season. This was especially true along Hood Canal mainly because many of the residents are seasonal. Additionally, some sites could not be re-sampled during wet weather, because they could not be accessed during daylight hours due to the tidal restrictions.

Figure 3. Sanitary Survey Priority

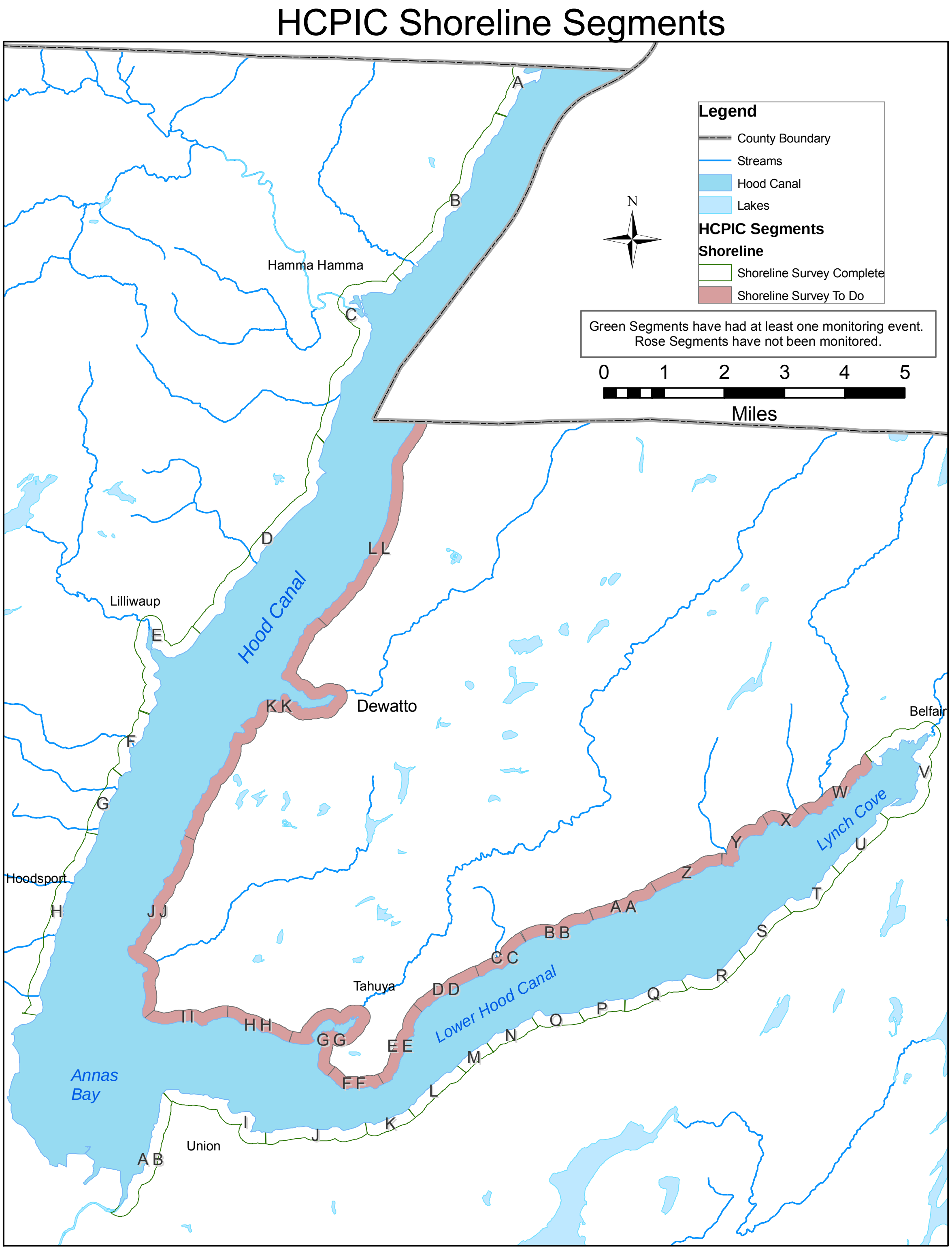
Number of samples	Priority	Range of fc/100-mL
12	Medium	200 – 499 fc/100-mL
17	High	≥ 500 fc/100-mL

MCPH identified 59 sites to re-sample (after the confirmation sample), only 19 of those sites were re-sampled. Of the 19 sites that were re-sampled, none had elevated fecal coliform levels greater than the 200FC/100-mL threshold. Twelve (12) sites that did not receive re-sampling were located in segment H. These sites have a low priority for re-sampling under the assumption that the Hoodsport & Potlatch areas will be sewered. Fifteen (15) sites were initially sampled at the end of the grant and there was not enough time and/or funding to complete the additional monitoring. Thirteen (13) sites were not re-sampled due to tides, access or timing.

Map 2. Overview of Monitoring Locations



Map 3. HCPIC Shoreline Segments



Created December 1, 2008 by A. Georgeson

Figure 4. Sites that did not receive confirmation samples

Site Number	Type of Discharge	Justification for not performing a confirmation sample:
C-01	Hamma Hamma River	Ambient monitoring did not support an ongoing problem, a large herd of elk frequent the area and there is little development along the shoreline
H-182	Small unnamed creek	This site was determined to be on Skokomish Nation Land
L-01	Direct Roof Discharge, from downspout	Although this sample result was 900fc/100-mL, it was determined that birds were the pollution source as the sample was taken directly from a roof downspout that was discharging onto the beach
O-01	Twanoh Creek	Twanoh State Park was in the process of repairing their L.O.S.S.*
S-130	Seep off of Holyoke Creek	The original sample was taken during an extremely low tide event and MCPH has not been able to access the site since
T-115	Seep	Sample location was dry each time MCPH attempted to perform a confirmation sample.
T-145	BH drain	Sample location was dry each time MCPH attempted to perform a confirmation sample.
T-147	BH drain	Sample location was dry each time MCPH attempted to perform a confirmation sample.
T-155	BH drain	Sample location was dry each time MCPH attempted to perform a confirmation sample.
U-20	Drain	Sample location was dry each time MCPH attempted to perform a confirmation sample.
U-25	BH Drain	Sample location was dry each time MCPH attempted to perform a confirmation sample.

*L.O.S.S. – Large Onsite Septic System

MCPH has identified segments of concern based on those that had elevated levels above the 90th percentile (See Figure 5. Summary of Initial Samples by Segment). Based on this information, MCPH determined that Segments H, S, T and U are of the greatest concern, of the segments that have been sampled, for potential impacts to Hood Canal. Generally, these segments have dense development along the shoreline, OSSs located near the bulkheads, poor soils and are areas prone to excess surface and groundwater run-off. These segments may also have more full-time residences.

Using GPS to Mark a Monitoring Location

Figure 5. Summary of Initial Samples by Segment

Segment	FC # of Sites	Initial Elevated FC**	LENGTH (Miles)	Avg. Elevated per mile	% Elevated/ per segment samples	% Elevated per total samples
A	24	1	1.61	0.62	4%	0.07%
B	31	4	3.63	1.10	13%	1.04%
C	21	1	4.30	0.23	5%	0.26%
D	14	0	4.10	0.00	0%	0.00%
E	34	2	3.26	0.61	6%	0.52%
F	21	1	1.33	0.75	5%	0.26%
G	25	1	1.11	0.90	4%	0.26%
H	193	20	3.39	5.90	10%	5.19%
I	79	10	2.47	4.04	13%	0.74%
I	88	2	2.47	0.81	2%	0.52%
J	34	2	1.76	1.14	6%	0.52%
K	29	0	0.78	0.00	0%	0.00%
L	30	1	1.14	0.87	3%	0.26%
M	30	1	0.64	1.57	3%	0.26%
N	59	1	0.90	1.11	2%	0.26%
O	40	1	0.91	1.09	3%	0.26%
P	53	2	0.84	2.39	4%	0.52%
Q	78	3	1.02	2.95	4%	0.78%
R	85	5	1.22	4.10	6%	1.299%
S	143	5	1.08	4.62	3%	1.299%
T	170	21	1.20	17.48	12%	1.55%
U	73	13	0.00	4.62	18%	0.96%
V	2	0	0.00	0.00	0%	0.00%
Totals	1356	97	39.17	2.47		

Highlighted cells are above the 90th percentile for that category
Segment I was included twice because it was monitored during wet and dry weather
Segment AB is not included in this data

Based on monitoring results, MCPH determined that 27 monitoring locations needed to have further investigations including sanitary surveys and dye tests.

5.2 Sanitary Survey Results

OSS surveys were conducted between August 2005 and August 2008. MCPH identified ~2090 parcels that are developed within 1000' of HC, within the completed segments (A-V). MCPH identified 29 properties (1% of total developed properties) of interest based on the 27 monitoring locations that had elevated confirmation results. MCPH also identified an additional property on the North Shore of HC, where a shellfish closure zone had been created that was centered on a property with a suspect OSS. MCPH performed sanitary surveys at 17 sites (41% of the 29 identified properties).

Figure 6. Summary of Pollution Identification and Correction Results

Properties Surveyed	Failing	Suspect	No Apparent Problems	No Records
17	8	3	6	1

MCPH was unable to survey twelve of the properties either because the property owners did not respond to County requests or the County was unable to contact the owner within the time allotted. Five of the properties were identified at the end of the project, leaving little time to attempt multiple contact the residents. See Figure 7, Properties that did not Receive Sanitary

Surveys (SS) and Section 8. Recommendations for further information on work that needs to be performed at these properties.

Figure 7. Properties that did not Receive Sanitary Surveys (SS)

Sites that need SS	Type of Discharge	Level of Concern	Reason SS has not been performed	Notes
T-102	Creek	High	No One Home (NOH)	Seepage pit <15' from surface water
U-33	BH Drain	High	NOH	Previous suspect - dye test positive, but low fecal coliform results
T-142	BH Drain	High	Seasonal Occupancy	Pervious suspect - dye test positive, but low fecal coliform results
M-25	BH seep	High	Seasonal occupancy	Unknown OSS, entire site is fill with BH out into tidally influenced area
T-102/T-106	Creek/BH drain	Medium	NOH	Seepage Pit is located on opposite side of the property from elevated fecal coliform result
T-89	BH drain	Medium	Seasonal Occupancy & NOH	Property had a >200' addition without upgrading the existing OSS, may have poured cement on top of OSS
Q-15	Creek/SW	Medium	NOH	Initial contact made with owner, but we have not been able to complete SS or DT. Multi-family OSS, df* is up on hill, potential wildlife influence
I-26	SW drain	Low	Seasonal Occupancy	Owner lives in the area, but is rarely at this property,
H-44	SW drain	Low	NOH	Only one house adjacent and undeveloped hill behind, potential wildlife influence
H-26	BH drain	Low	NOH	This property has not appeared to have any occupancy during our investigations and is in the proposed Hoodsport Sewer area.
U-71	creek	Low	NOH	There is a community df* pump located near this site that has had problems in the past (overflow), inspection of the pump station did not identify any signs of failure. There is a large wooded area between the mouth (sample location) and the next developed house, potential wildlife influence.

*df – drainfield

5.2.1 Dye Test Results

Dye tests are performed at sites to identify failing OSS or to rule out an OSS as a pollution source.

- MCPH performed eleven (11) dye tests within the study area, which accounts for 65% of the 17 properties that received sanitary surveys and 38% of the 29 properties that were identified for further investigation.
- Of the eleven (11) dye tests, MCPH identified seven (7) failing OSS
- One (1) additional failure was identified visually by a direct discharge from the bulkhead drains.
- Of the eleven (11) dye tests performed 64% (7) identified failing OSS.

Dye in the Marine Water from an OSS with a Broken Transport Line

Figure 8. Summary of Dye Test Results

Dye Tests Performed	Positive (Failure)	Surfacing Sewage Failure	Repairs
11 (65%)*	7 (64%)**	1 (6%)*	5 (63%)***

**Percent of the total number of sanitary surveys performed*
***Percent of the dye tests performed*
**** Percent of the identified OSS failures*

Dye in the Marine Water from an OSS with a Broken Transport Line

The maps on the following pages show the properties that received Sanitary Surveys or Dye tests. The purpose of the maps is to demonstrate what corrective actions have occurred and where there are areas that appear to have more failing OSS than others. Also, included on the map are the elevated FC and nutrient results. The maps are not intended to show these results in detail. The markers on the map represent FC and nutrient results. The following figures describe what each of these symbols represents:

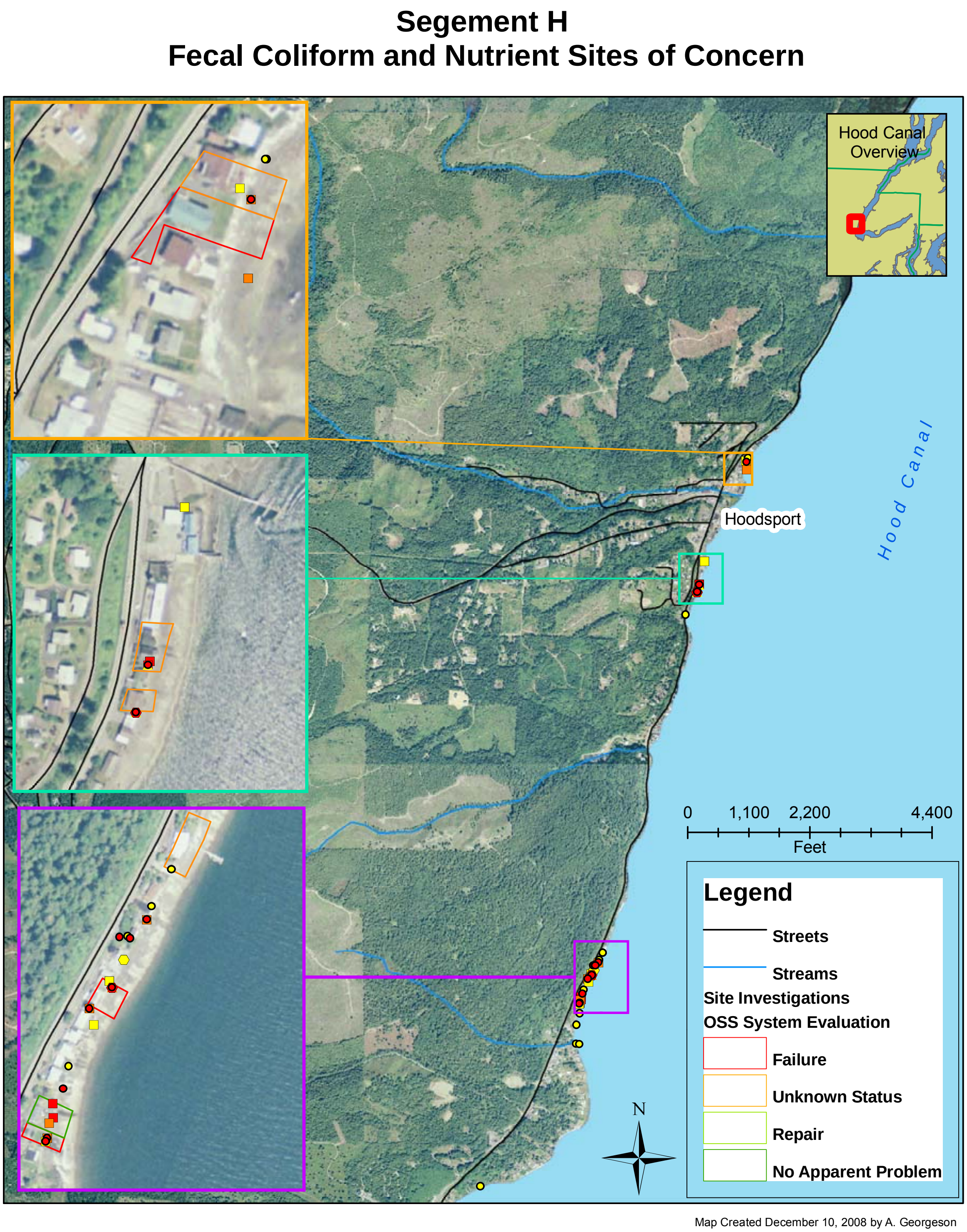
Figure 9. Map Symbols

Symbol	Represents
Little Circle	FC
Big Circle	NH3
Triangle	NO2/NO3
Square	OP

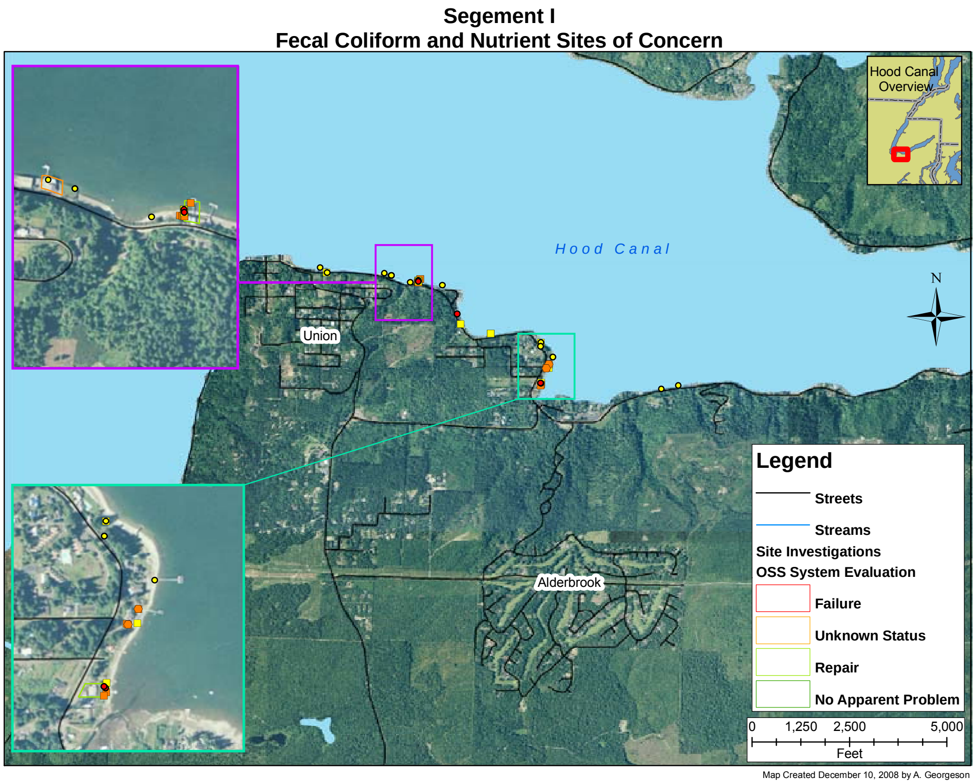
Figure 10. Map Colors

Symbol Color	Range Nutrient Result mg/L	Range Fecal Coliform Result /100-mL
Yellow	1.00 – 1.50	200 - 500
Orange	1.51 – 5.00	501 – 900
Red	>5.00	901 - ≥1600

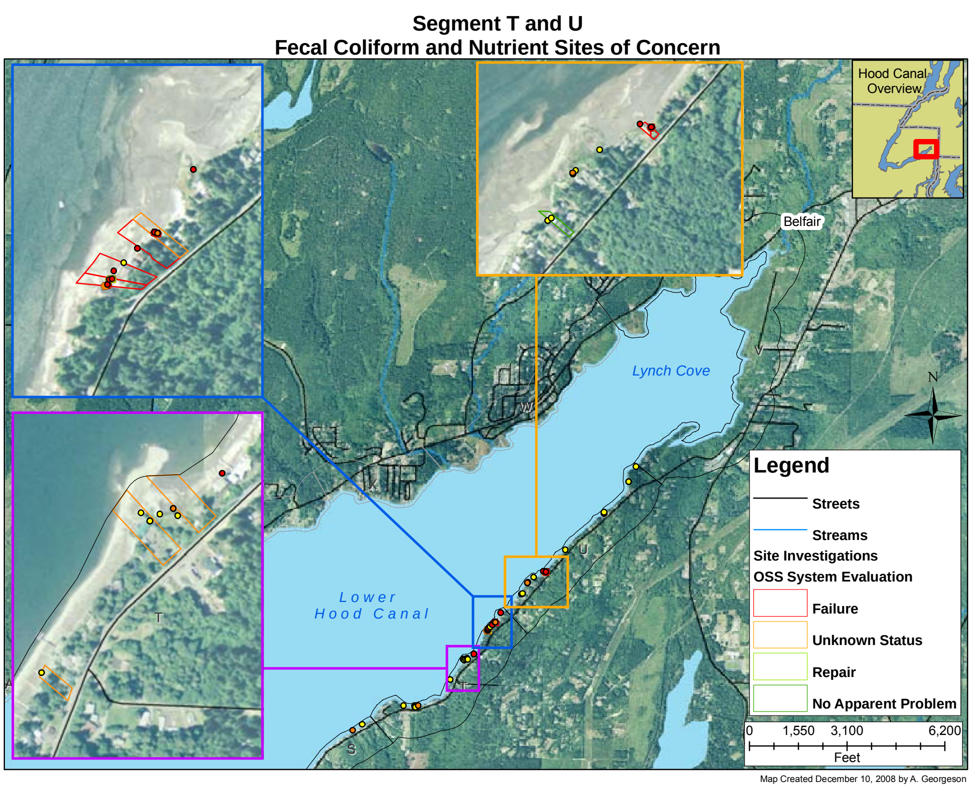
Map 4. Segment H, Properties of Concern



Map 5. Segment I, Properties of Concern



Map 6. Segment T and U, Properties of Concern



5.3 Analysis of Failures

The following factors are related to OSS failure (*Kitsap County Health District; Upper Hood Canal Restoration Project, 2005*):

- Age of the OSS
- Close proximity of the OSS to surface water
- Poor soil types and shallow depth to water table/impervious layer
- Inadequate maintenance of the OSS
- Number of previous repairs
- Direct grey water discharge

Figure 11. Analysis of Failing OSS

OSS Condition	Identified	Percent of Total Failures (8)
>20 Years Old	3 (3 unknown installation date*)	38% (75%)
Previously Repaired	4	50%
<100' from surface water	8	100%

**The three (3) OSS with unknown installation dates are assumed to have been installed prior to 1988.*

Of the eight (8) properties with identified OSS failures, at least six (6) were <20 feet from the surface water, with most of those OSS located directly behind the bulkhead. Also, all eight (8) properties experience excess storm, surface or groundwater that most likely contributed to the OSS's failure. Based on MCPH results, distance from surface water is the most common factor contributing to identification of OSS failure, followed by age of system (if you include the unknown installation dates) followed by properties that have had previous repairs. MCPH determined that 75% of the systems that were identified as failures were traditional gravity systems.

Figure 12. OSS Failures as Identified by System Type

Type of OSS	Number identified as failing	Percent of Failures (8)
Traditional Gravity	6	75%
Alternative Treatment	2	25%

Figure 13. Installation Dates of OSS that were identified as failures

>20 year Old	<20 Years Old	Unknown
3	2	3

Sampling Location, Segment U

5.3.1 Status of OSS repairs

- Five (5) of the failing OSS have had repairs completed.
- At one (1) of the properties with a failing OSS, the owner has been in contact with a designer and is working on the repair.
- At one (1) of the properties with a failing OSS, the owner has not yet been notified due to the potential intersection of a storm drain with the drainfield. MCPH plans to do further investigative work to help determine where the failure is occurring.
- One (1) OSS failure was visually identified as having a direct discharge out of bulkhead drains combined with elevated fecal coliform results of ≥1600 fecal coliform/100-mL of water and elevated nutrient levels of 14.5 mg/L ammonia and 1.34 mg/L of orthophosphate. After attempting to make contact at the property several times, MCPH notified the owner of the failure by mail. The property was a vacation rental that has been vacant since identification of the failure. The owner is trying to sell the property. MCPH has “tagged’ the parcel in Tidemark (MC’s Permit tracking database) as having a failing OSS, so that potential buyers can be aware of the current status of the OSS.

OSS effluent flowing out of a Bulkhead Drain into Hood Canal

5.3.2 Types of OSS repairs

Of the five (5) properties that have had OSS repairs, four (4) OSS appeared to be failing from the drainfield area and one (1) OSS appeared to be failing from the tank area. Three (3) properties had new OSS installed. Two (2) of those OSS were replaced with alternative OSSs and one (1) was replaced with a pressure distribution system to an open-bottom sand filter drainfield. One (1) OSS had corrections made to the system’s control settings and UV light added to the tank, and one (1) OSS had a repair done on an elbow joint that was not connected. Of the five (5) OSSs that were repaired/replaced, one (1) OSS is in a new location, across State Route 106 (approximately 250’ from the marine shoreline) from its previous location, which was directly behind the bulkhead. The property that had a UV light added to the tank will need additional assessment as follow up samples taken from the monitoring location still have elevated levels of fecal coliform and nutrients, possibly from a storm drain bisecting the drainfield.

Figure 14. Types of OSS Repairs

Replace OSS	Added Treatment	Repair performed
3	1	1

5.4 Nutrient Study Results

Since July 2007, MCPH has surveyed 8.3 miles of Hood Canal Shoreline for freshwater discharges, which were analyzed for nutrients, in addition to fecal coliform. The water samples were analyzed for the following nutrients: ammonia-nitrogen (NH_3), nitrite+nitrate-nitrogen (NO_2/NO_3) and ortho-phosphate (OP). MCPH collected over 580 shoreline samples from 514 individual monitoring locations. These samples were collected over a period of 36 days (See Map 2. Overview of Monitoring Locations). The discharges range from small seeps to rivers.

Segments H, AB and I were identified as shorelines of concern for nutrient inputs. These segments reach from the northern border of Hoodsport, along the eastern side of Annas Bay and then east to Alderbrook, excluding the Skokomish Nation Reservation (See Map 2. Overview of Monitoring Locations). At the time that this project was created, MCPH focused on these segments due to their proximity to the area normally affected by fish kills. By assessing the nutrient concentrations in this area, MCPH intended to help determine if anthropogenic sources of nutrients from the Hood Canal shoreline were playing a significant role in the lowering dissolved oxygen and causing fish kills.

During this project, the Hood Canal Dissolved Oxygen Program (HCDOP) determined that there is a chronic low dissolved oxygen problem or a “dead zone” in much of Lower Hood Canal (the area located east of the “Great Bend”). Furthermore, this dead zone may play a significant role in the episodic fish kills that occur near Annas Bay. MCPH recommends that future nutrient monitoring be focused in the Lower Hood Canal Area, identified as having a chronic dead zone by the HCDOP study, specifically on the South Shore due to the higher population densities.

Starfish on the Shoreline of Hood Canal

5.4.1 Kitsap County Health District (KCHD) and MCPH Nutrient Data comparisons

Kitsap County Health District determined that:

> No relevant dataset was found for comparison of the nitrate +nitrite nitrogen concentrations in this study. Hood Canal stream samples for nitrogen concentrations were collected by the Hood Canal Dissolved Oxygen Program freshwater sampling program during the same sampling period of January through April 2005 (http://www.prism.washington.edu/hcdop/index.html,2005). The average concentration of nitrate + nitrite nitrogen in Hood Canal streams is relatively low at 0.25 mg/L. These

larger streams represent flows influenced by larger basin areas. The optimum comparable data would be shoreline discharges from an undeveloped shoreline area ("Shoreline Discharges", 2005).

Kitsap County Health District collected nutrient data from 55 drainages in Hood Canal in 2005. Their NO2/NO3 results ranged from 0.01 to 9.80 mg/L. KCHD determined the 90th percentile for NO2/NO3 concentrations was 2.95 mg/L. ("Shoreline Discharges", 2005).

MCPH in comparison collected nutrient data from 514 Hood Canal drainages during 2007 & 2008. The NO2/NO3 results range from <0.01 to 21.8 mg/L. MCPH determined the 90th percentile for NO2/NO3 concentrations was 0.89 mg/L.

MCPH's samples were all collected from developed shorelines. MCPH agrees that an undeveloped Hood Canal shoreline would provide the optimum comparable data.

Figure 15. Comparison of KCHD and MCPH Data

	KCHD	MCPH
Total Drainages Monitored	55	514
90th Percentile NO2/NO3	2.95 mg/L	0.89 mg/L
Maximum NO2/NO3 result	9.80 mg/L	21.8 mg/L

5.4.2 MCPH Nutrient and Fecal Coliform Analysis

MCPH found that of the 593 total nutrient samples that were taken, 50 (8.4%) were associated with properties with identified failing septic systems, while 465 (78%) were associated with fecal coliform levels below the state freshwater standard (50FC/100-mL).

Waketickeh Creek

MCPH compared the FC and nutrient data by looking at all of the original data and three subsets of that data. The original set (Figure 16) of data includes all of the nutrient data that MCPH collected, which includes the samples that were taken before and after OSS correction and taken in both wet and dry weather.

The first subset of data is based on the nutrient monitoring locations that were associated with a failing OSS (Figure 17. Subset 1). Some of these failing OSS have not been confirmed, but based on previous positive dye test results and current FC and nutrient results, the properties are assumed to be associated with failing OSS for the analysis of this data only. The second subset of data includes all nutrient monitoring locations that are not associated with a failing OSS (Figure 18. Subset 2). The third subset of data is only those monitoring locations that meet the state freshwater quality standard for fecal coliform (<50FC/100-mL) (Figure 19. Subset 3).

MCPH performed basic descriptive statistical analysis of this data to determine mean, standard deviations, correlation values and the strength of those values etc. All FC results are in FC/100-mL and all nutrient results are in mg/L in the following data sets.

Figure 16. Original Data
All Monitoring Locations

Red numbers indicated the highest value of the 4 data sets.
Green numbers indicate the lowest of the 4 data sets.

	FC	NH3	NO2/NO3	OP
Maximum	160010	52.90	21.8	7.06
Minimum	2	0.01	0.01	0.01
Mean	448	0.36	0.49	0.23
Median	7	0.02	0.21	0.06
90^{th} percentile	240	0.12	0.88	0.65
Standard Deviation	6689.60	3.15	1.31	0.61
Sample set	593	593	593	593

Figure 17. Data Subset 1
Monitoring Locations Associated with Failing OSS

	FC	NH3	NO2/NO3	OP
Maximum	160010	52.90	21.8	7.06
Minimum	2	0.01	0.05	0.02
Mean	4413	3.52	2.00	0.24
Median	80	0.05	1.3	0.08
90^{th} percentile	1601	14.5	3.76	2.91
Standard Deviation	22854.16	10.36	3.44	1.68
Sample set	50	50	50	50

Figure 18. Data Subset 2
Monitoring Locations not associated with Known Failing OSS

	FC	NH3	NO2/NO3	OP
Maximum	1601	7.55	11.00	3.03
Minimum	2	0.01	0.01	0.01
Mean	82.54	0.07	0.34	0.18
Median	4.0	0.02	0.18	0.06
90^{th} percentile	130	0.10	0.65	0.62
Standard Deviation	273.56	0.35	0.74	0.35
Sample set	542	542	542	542

Figure 19. Data Subset 3
Monitoring Location Results that meet the Freshwater Quality Standard for FC (50FC/100-mL)

	FC	NH3	NO2/NO3	OP
Maximum	47	2.22	11.00	3.03
Minimum	2	0.01	0.01	0.01
Mean	8	0.06	0.40	0.17
Median	2	0.02	0.21	0.06
90^{th} percentile	23	0.10	0.79	0.61
Standard Deviation	8.93	0.21	0.06	0.01
Sample set	465	465	465	465

Figure 20. Fecal Coliform and Nutrient Correlation (C) and the Strength of the Relationship of the Correlation (R)

	All Data		Subset 1		Subset 2		Subset 3	
	C	**R**	**C**	**R**	**C**	**R**	**C**	**R**
FC & NH3	0.69	47.5%	0.68	46.7%	0.28	7.8%	0.11	1.2%
FC & NO2/NO3	0.38	14.3%	0.42	17.9%	0.01	0.0%	0.15	2.2%
FC & OP	0.41	16.6%	0.46	21.2%	0.06	0.3%	0.17	2.8%
NH3& NO2/NO3	0.21	8.5%	0.25	6.4%	0.00	0.0%	0.13	1.6%
NH3 & OP	0.80	63.9%	0.94	88.5%	0.21	4.4%	0.15	2.1%
NO2/NO3 & OP	0.23	5.3%	0.27	7.5%	-0.09	0.7%	-0.09	0.9%

A correlation value of 1 (or –1) equals an exact correlation, while a correlation value of 0 equals no correlation.

Based on the correlation and the strength of the relationships, it appears that the sets of data that include monitoring locations associated with failing OSS demonstrate a significant relationship between both fecal coliform and ammonia and between ammonia and orthophosphate. Whereas those sets of data that are not associated with failing OSS, do not demonstrate a significant relationship between any of the variables that were compared.

This data suggests that while failing OSS do increase nutrient inputs into Hood Canal, most functioning OSS do not appear to significantly increase nutrient inputs to Hood Canal surface water.

MCPH can not determine loading of these nutrients, as flow data was not collected, nor can MCPH determine nutrient input levels entering via groundwater into Hood Canal, based on the data that was collected.

From the data above, you can see that there is slight correlation between ammonia and FC, and a little stronger correlation between ammonia and othro-phosphate. This is most likely due to proximity to the shoreline of the failing OSS. The closer the failure is to the shoreline, the less time there is for OP to be adsorbed by the soil and NH3 does not convert to NO2/NO3.

It makes sense that the strength of the relationship between NH3 and OP is stronger than NO2/NO3 and OP. This is based on the fate and transport of both nitrogen and phosphate in the environment. Monitoring locations that are nearer to failing OSS appear to be more likely to have elevated NH3 levels. This is probably due to the fact that the NH3 would not have time to convert to NO2/NO3 before entering surface water. Further, the OP does not have the opportunity (spatial distance) to adsorb to the soil.

Conversely, at sites with some distance between the monitoring location and the OSS, it was more likely to find elevated levels of NO2/NO3. This would imply that the nitrogen compound had time to convert from ammonia to nitrite/nitrate and the ortho-phosphate had adsorbed to the soil. If funding becomes available, MCPH recommends that the distance from the OSS to the monitoring locations be determined.

5.4.3 Nutrient Results above the "Level of Concern"

MCPH could not find comparable data to determine the level at which nutrients become harmful to aquatic life or cause eutrophication. Due to this lack of data, MCPH used the 90th percentile value of all 593 samples for each analyte as the "level of concern". This data was collected from a developed shoreline; a better comparable set of data would include an undeveloped shoreline.

Figure 21. Nutrient "Levels of Concern"

	NH3	NO2/NO3	OP
90th Percentile	0.12	0.89	0.70

All units are mg/L.

None of the samples that had nutrient results above the "level of concern" had follow up actions, unless they were associated with elevated FC results. MCPH's original intention was to use the result of 1mg/L as the corrective action threshold for each analyte. Once all of the data was compiled, MCPH was able to determine 90th percentiles for each nutrient analyte, which, because of the sample size (just less than 600 samples), seems more accurate than the arbitrary 1mg/L value. There would not be any follow-up work performed at a monitoring location where the nutrient result is between the 90th percentile level and 1mg/L, unless there were elevated fecal coliform results as well. MCPH recommends that, as funding becomes available, the monitoring locations with nutrient results above the "level of concern" be investigated further.

Not including samples taken from the Annas Bay segment, MCPH identified 82 (14%) of the 593 samples that had at least one nutrient analyte above the "level of concern".

The Annas Bay samples were not included in this part of the analysis (except to determine the 90th percentiles) due to uncertainties about the outcome of the related properties.

Annas Bay accounts for an additional 50 (8%) samples of the 593 that had at least one nutrient analyte above the "level of concern". Of the Annas Bay sample results, the following analytes (or combination of analytes when more than one was above the "level of concern" at a monitoring location) had results above the "level of concern":

- OP (only) – 27 samples (54%)
- NH3 & OP – 14 samples (28%)
- NH3 (only) – 8 samples (16%)
- NO2/NO3 (only) - 1 sample (2%)

To better understand the relationship of the nutrient "levels of concern" and fecal coliform pollution for the 82 samples, MCPH compared nutrient results above the "levels of concern" to fecal coliform results and to the properties that had known failing septic systems (see Figure 22. Analysis of Nutrient Monitoring Results above the "Levels of Concern" below). MCPH categorized each sample based on the three nutrient results.

The data was categorized in a manner to help understand what role each of these nutrients or combination of nutrients has with failing onsite septic systems and fecal coliform levels. The nutrient combinations represent 82 different samples. Each of those 82 samples was analyzed for all three nutrients (NH3, NO2/NO3 & OP). This creates seven different possible combinations of nutrient results above the "level of concern," either each individual analyte, two of the analytes or all three analytes that had results equal to or greater than the 90th percentile. The figure below represents nutrient results that were greater than or equal to their respective 90th percentile. In the figure, the 43 failing OSS sample results are associated with 8 properties with known failing OSS (this can be due to a combination of multiple samples per monitoring location or multiple monitoring locations associated with one property).

Figure 22. Analysis of Nutrient Monitoring Results above the "Levels of Concern"

Nutrients "Levels of Concern" (≥ 90th percentile)	Total Samples of Concern*		Samples from Properties with Failing OSS**		FC ≥ 50 FC/100-mL**		≥ 200 FC/100-mL**	
NH3, NO2/NO3 & OP	4	5%	3	75%	4	100%	3	75%
NH3 & NO2/NO3	5	6%	2	40%	1	20%	0	0%
NH3 & OP	5	6%	4	80%	5	100%	5	100%
NO2/NO3 & OP	1	1%	0	0%	0	0%	0	0%
NH3	17	21%	7	41%	7	41%	5	29%
NO2/NO3	49	60%	27	55%	14	29%	9	18%
OP	1	1%	0	0%	1	100%	1	100%
Total Number of results for all Nutrient Combinations	82	14%***	43	52%	32	39%	23	28%

These numbers reflect all monitoring events at each monitoring site, which may include multiple samples per monitoring site.
* Percentage of the 82 samples of concern (except ***)
** Percentage of total samples of concern for each category
***This is the percentage of all 593 nutrient samples taken

In the Figure, MCPH shows both 50 FC/100-mL and 200 FC/100-mL thresholds. This is because 50 FC/100-mL is the state standard for freshwater, while 200 FC/100-mL was the threshold for further action under this project.

5.4.3.1 Nutrient Results above the "Level of Concern", OSS Failures and Fecal Coliform Results

From the data in Figure 22, MCPH determined that of the four (4) monitoring locations that have all three nutrient analytes (NH3, NO2/NO3 & OP) above the "level of concern", three (3) (75%) correspond with known failing OSS. The other property that does not have a known failing OSS is presumed to have a failing OSS. This is because of the elevated nutrient levels (NH3 = 0.63, NO2/NO3 = 21.80, & OP = 1.56) coupled with a FC result of 1600. Only one sample was taken at this monitoring location (due to no flow upon return visits). Neighboring monitoring locations also show either elevated FC levels and/or nutrient results above the "levels of concern" suggesting that further investigations should be performed at the adjacent properties.

For the analyte combinations of NH3 & OP, where both monitoring results were above the "level of concern", four (4) of the five (5) samples are associated with a failing OSS. The one (1) property that is not associated with a known failing OSS had two sample events, both of which had fecal coliform results of ≥1600. MCPH did attempt to make contact at this property, but no one was home. MCPH recommends that this property as well as the neighboring property (that is discussed above) both have further investigations conducted including, at a minimum, sanitary surveys.

For the analyte combinations of NH3 & NO2/NO3, 2 of the 5 sample results correspond with a failing OSS; the additional 3 sample results correspond with one monitoring location that had elevated nutrients but not fecal coliform. MCPH recommends that this property receive further investigation as well as the Blue Heron Condos (which are located across the SR 106 from the monitoring locations where the samples were taken).

In addition, 41% of the single analyte NH3 and 55% of the single analyte NO2/NO3 corresponded with known failing OSSs.

From the Eastern Shoreline of Annas Bay

5.4.3.2 Known Nutrient Origins versus Unknown Nutrient Origins

Based on the sample results, 14% (82 of the 593 samples) of the total water samples analyzed for nutrients had at least one nutrient analyte that was greater than or equal to the 90th percentile. Of the 82 samples that have results above the "level of concern", 52% (43 samples) were associated with failing septic systems and 4% (3 samples) were associated with fertilizer application.

This leaves 36 (44% of the samples) sample results where the nutrient amount is above the "level of concern" that have "unknown origin". These 36 samples are associated with 19 properties (meaning that either multiple samples were taken or there are several monitoring locations that appear to originate from the same property). Of these 36 samples, 23 samples have fecal coliform levels ≥200 FC/100-mL. These samples may be associated with unidentified failing septic systems.

One concern for Hood Canal, is that functioning OSS are contributing excess nutrients to Hood Canal. In the worse case scenario, from the collected data, if all 36 samples are associated with excess nutrients coming from functioning septic systems, it would only account for 6% of the total (593) samples that were taken. Would this data support a regulatory requirement for additional OSS treatment for nutrients along the shoreline of Hood Canal?

Because of the variability of the site conditions coupled with individual usage, OSS type and nutrient fate and transport, these samples may not be representative of what is happening in Lower Hood Canal. To better understand shoreline inputs of nutrients to Lower Hood Canal, MCPH recommends that additional nutrient monitoring be completed along the shoreline of Lower Hood Canal, including flow measurement.

Of the samples with nutrient results above the “level of concern” that have an unknown origin, 23 (64%) had corresponding fecal coliform levels of less than 50FC/100-mL. MCPH speculates that the source(s) of these elevated nutrient levels may be fertilizer, grass clippings, yard debris, unidentified failing OSSs or functioning OSSs. MCPH did not have the opportunity to investigate any of these properties. The additional 13 sample results with unknown nutrient origin are more likely to be associated with failing septic systems since they have both nutrient results above the “levels of concern” and elevated fecal coliform levels, especially the nine (9) samples that had corresponding FC results ≥ 200/100-mL. MCPH recommends that, if additional funding becomes available, sanitary surveys be performed at these properties to see if the source of the excess nutrients can be determined.

As the Figure 22 shows, there are some monitoring locations that are associated with a property with a failing septic system that do not have fecal coliform levels above either the 50 FC/100-mL or the 200 FC/100-mL thresholds. This data may reflect monitoring that occurred post OSS repair or multiple monitoring locations that are associated with one property. This demonstrates that nutrient monitoring could provide additional insight on where and how an OSS is failing. MCPH recommends that when funding is available, nutrient samples be taken in conjunction with fecal coliform samples to better identify and assess failing OSS. Please see section 5.4.4 for further information regarding nutrients and failing OSS.

Annas Bay

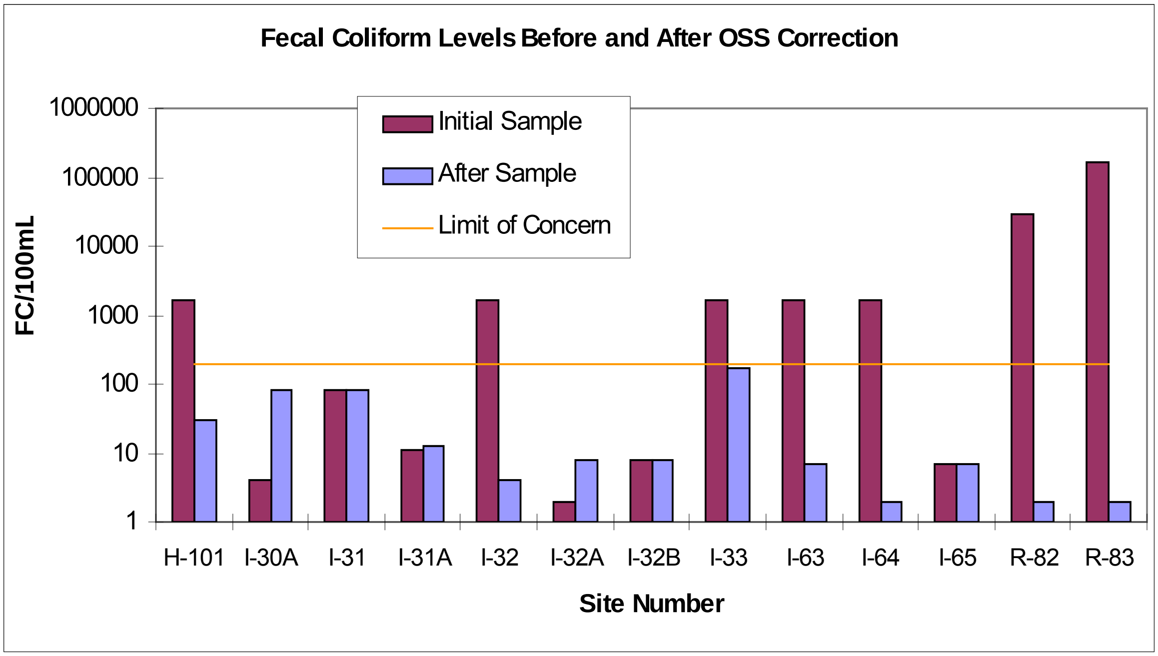
5.5 Nutrient Results at Properties with OSS Failures

MCPH has identified 8 failing OSSs. Of the eight (8) systems, 100% were found to have nutrient “levels of concern” associated with the property. Four (4) of the failing OSS were found to have elevated levels of ammonia and ortho-phosphate. The other four (4) properties were found to have elevated levels of NO2/NO3. MCPH found that at some properties the monitoring locations with nutrient results above the “level of concern” did not necessarily correspond with the monitoring location with an elevated FC level, but was found in an adjacent monitoring location associated with the same property.

Five of the OSS have been repaired or replaced (see section 5.3). One repair needs additional work performed, as the pollution source has not been abated. Work needs to be initiated at the two remaining properties.

Fecal coliform levels decreased at four (4) properties that had post-correction monitoring performed at them as shown in figure 23, below. Some of the sites did not see reductions in fecal coliform levels, but the FC results are below the action level. All of the results that were originally above the 200 FC/100-mL threshold decreased below that level in the post correction monitoring.

Figure 23. Fecal Coliform Levels Before and After OSS Correction

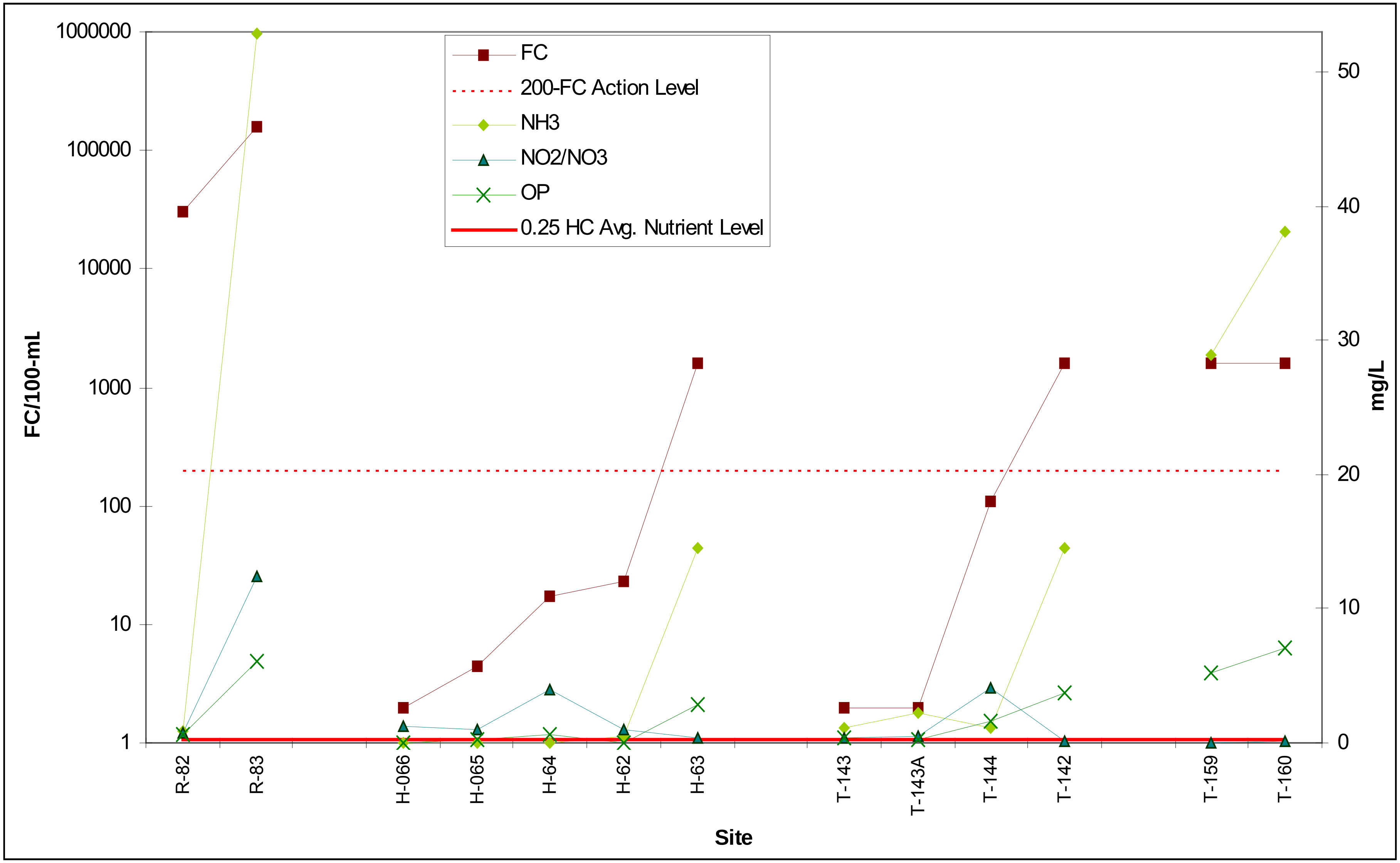


Note: Logarithmic Scale

Algal Growth, Segment R

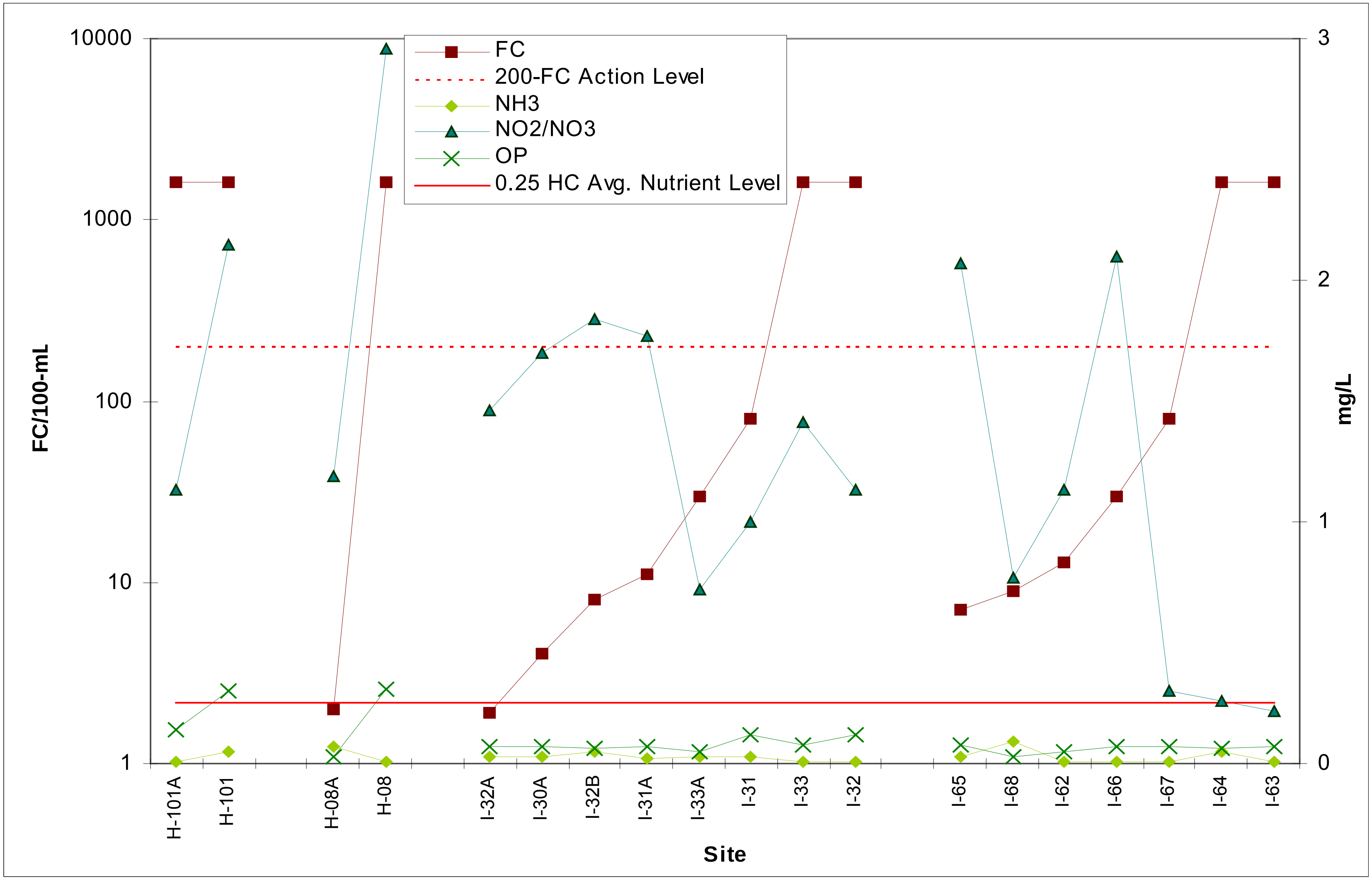
Initial results from properties associated with failing OSS were grouped into two categories (to better see the associated results in the following figures). The first group includes those nutrient results (from any one of the three analytes) that are greater than 3 mg/L (see figure 24). The second group includes those nutrient result that are less than 3 mg/L (see figure 25). The monitoring locations are grouped as they relate to each property that was identified as having a failing septic system. A connected line means that the sample results are associated with the same property, while a break in the line means a transition from one property to another. A different color and marker represent each nutrient or fecal coliform result. **Note that the left Y-axis is labeled FC/100-mL and the right Y-axis is labeled for nutrients in mg/L.**

Figure 24. Nutrients (Results >3mg/L) and Fecal Coliform Levels Associated with OSS Failure



Note: FC sale is logarithmic

Figure 25. Nutrients (Results with <3mg/L) and Fecal Coliform Levels Associated with OSS Failure



Note: FC sale is logarithmic

When these figures were created, 3 mg/L was arbitrarily chosen to optimize the detail of the scale for each sample set. What this accidentally demonstrated in Figure 24, monitoring locations with nutrient results greater that 3mg/L, is that the results for NH3 and OP are the predominately elevated values. While in Figure 25, monitoring locations with nutrient results less than 3 mg/L, the predominately elevated nutrient results are NO2/NO3. MCPH hypothesizes that these results correlate to the distance the failure is from the monitoring location. MCPH recommends that additional analysis be performed to determine the distance from each OSS to the monitoring locations.

Collecting Charcoal Samplers at a Dye Test Location

These figures also show the relationship between the nutrients and fecal coliform results. At some monitoring locations, the nutrients and the fecal coliform levels are proportionate, while at others they are inversely proportionate. For example, the fecal coliform results appear to be almost directly proportionate to the ammonia results. There are several monitoring locations that indicate an inversely proportionate relationship between NO2/NO3 and NH3, which would be expected as the ammonia breaks down and converts to NO2/NO3 in the environment.

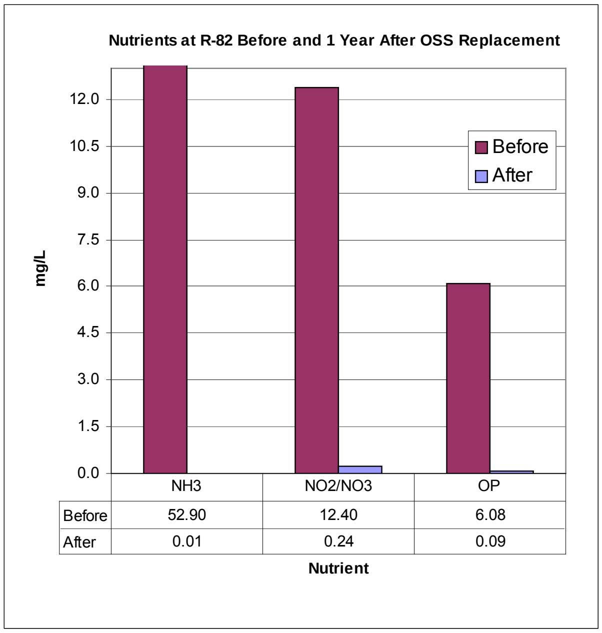
South Shore of Hood Canal

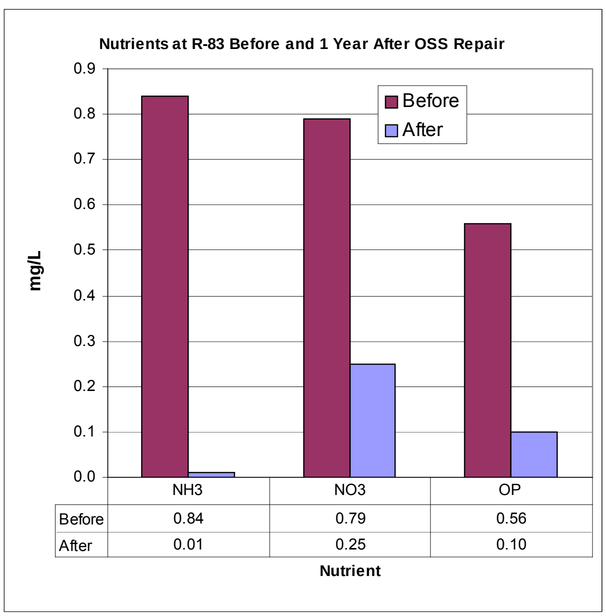
5.6 Nutrient Results at Specific Properties:

5.6.1 Property Associated with Monitoring Locations R-82 and R-83

Monitoring locations R-82 and R-83 are the only sites that had a year span between the original monitoring event and the post-correction monitoring event.

Figures 25 and 26 – Nutrient Results at R-82 and R-83





This property had a gross failure. The OSS was located within 15' of the bulkhead. The OSS was a gravity system. In the photo there are monitoring locations R-82 and R-83, and the approximate location of the OSS (~15' behind the bulkhead). The owner stated that sometimes the marine water would come up over his deck (located above the OSS), meaning that the OSS was most likely directly discharging to Hood Canal.

The initial confirmation fecal coliform results at the monitoring location were 30,000 (R-82) and ≥160,000 (R-83) per 100-mL of water. At these monitoring locations, all of the nutrient results were above the 90th percentile prior to the OSS repair. The nutrient results were significantly more elevated in the R-82 sample than in the R-83 sample. Although both of these monitoring locations had very low flows, the nutrient levels at R-82 may, in part, be due to the nutrient concentrations, as the flow was lower at R-82 than R-83.

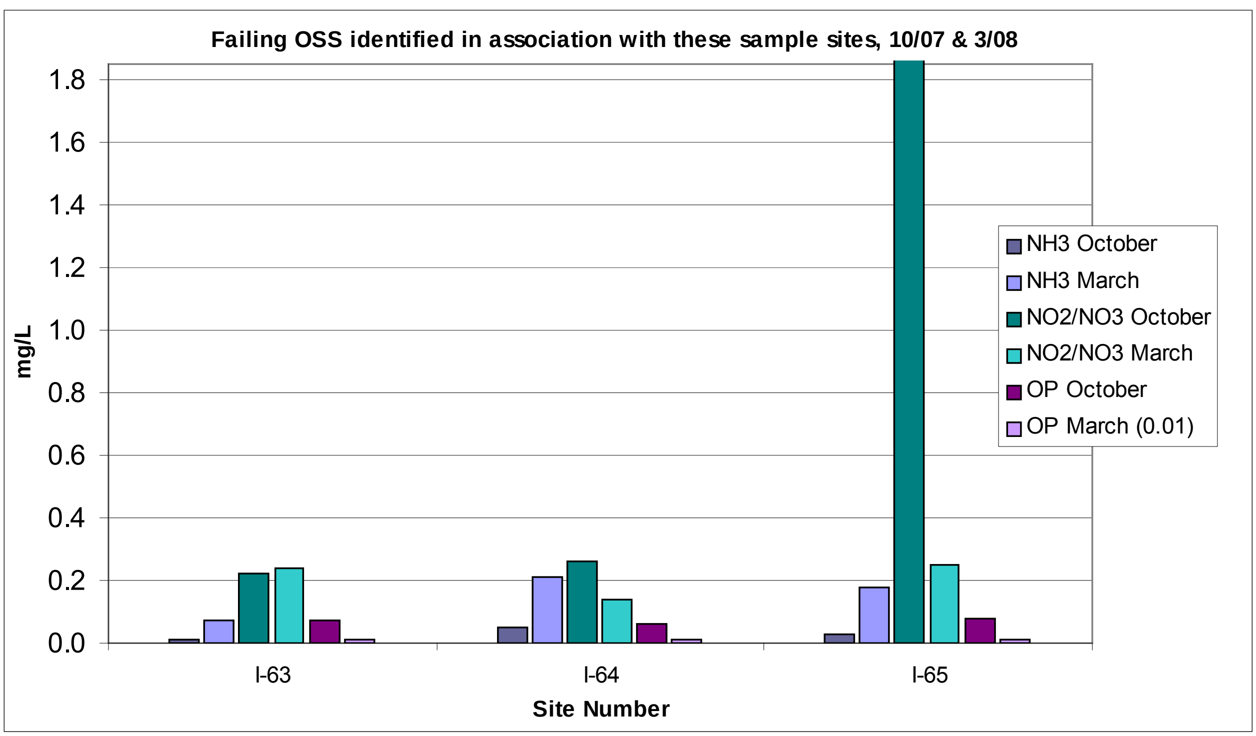
The OSS at this property was relocated behind their house and across State Route 106 (~250' from Hood Canal). A year after the initial confirmation sample, and about six months after the OSS repair was completed, post-repair samples were taken from these monitoring locations. Post-repair samples demonstrate that all of the nutrient analytes were all below the 90th percentile. Post-repair fecal coliform results were <2 FC (R-82) and 2 FC (R-83) per 100-mL of water.

This property demonstrates that when this OSS was repaired, both the nutrient and fecal coliform results were reduced to below the "levels of concern". Compared with other properties that had repairs, this one had the longest amount of time pass between the repair and the post-repair monitoring event. Nutrient levels may not decrease immediately following an OSS repair. MCPH recommends that future nutrient monitoring that occurs post-OSS-failure should include several samples that occur over a span of time (ie, directly after repair, 3 months after repair, 6 months after repair). This information would help in understanding if, and for how long, the various nutrients stay in the environment. MCPH hypothesizes that nutrients may remain in the environment longer than fecal coliform. This is because, although the source has been removed, the nutrients do not break down in the environment like fecal coliform does. Additionally, the nutrients may not leave the environment until they are "flushed" out by a rain event or other method of transport.

5.6.2 Property Associated with Monitoring Locations I-63 to I-65

This property has not had post-repair monitoring. An OSS repair has been completed at this property, but MCPH has not been able to perform post-repair monitoring due to daylight and tidal conditions. MCPH recommends that post-repair monitoring for fecal coliform and nutrients occur at monitoring locations I-63, I-64 and I-65.

Figure 27. Nutrient Results from Monitoring Locations I-63, I-64 and I-65



MCPH has sampled at this property three (3) times, October and November 2007 and March 2008. Figure 27 only includes the results from the October and March monitoring events. The results of the monitoring that occurred in November 2007 were similar to the October monitoring event. The November monitoring event was the confirmation sample taken prior to the sanitary survey. Between the October/November and March monitoring events, there were reductions in NO2/NO3 (except at I-63), OP and fecal coliform results. While at the same time, there were slight increases in NH3. These changes may be due to an elevated water table or anoxic conditions in the soil coupled with decreased use by the owner.

Area of the Drainfield – The Camille Tree Roots were in the Drainfield Laterals
The tree was removed when the new OSS was installed.

MCPH does not know if the variance was due to owner usage or weather conditions. The October 2007 monitoring event occurred in heavy wet weather. There were 4.64" of precipitation that occurred in the week prior to the monitoring event. The March 2008 monitoring event occurred in moderate wet weather. There had been 0.62" of precipitation in the week preceding the monitoring event.

Figure 28. I-63 to I-65 Fecal Coliform Results Prior to Repair

	I-63	I-64	I-65
October 2007	≥1600	1600	7
March 2008	7	2	7

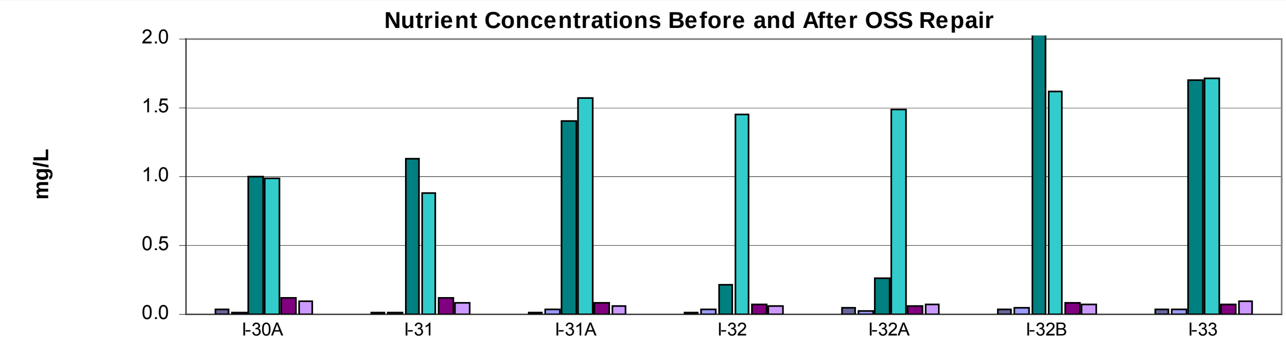
Results are FC/100-mL

Fecal coliform results also dropped significantly between the two monitoring events. Fecal coliform data suggests that the owner was not using the system. Notice that the highest NO2/NO3 results correspond with I-65, which originally had the lowest FC results. The variable fecal coliform levels demonstrate how a property that has a failing OSS may not be discovered during MCPH's limited one sampling event per monitoring location investigations. MCPH recommends reducing sample areas in order to facilitate multiple monitoring events at each site rather than large sample areas, which allow for limited monitoring events per site.

5.6.3 Property Associated with Sites I-30A to I-33

This property had an alternative treatment unit, which was installed in 1999 and was supposed to be connected to the existing drainfield. Once the system was diagnosed as failing, the cause of failure was determined to be that the tank was not connected to the drainfield. After the tank and drainfield were connected, post-repair monitoring demonstrates a spike of NO2/NO3 at several of the monitoring locations. MCPH is unsure of the reason for these nutrient level increases.

Figure 29. Nutrient Results from Monitoring Locations I-30A to I-33



	I-30A	I-31	I-31A	I-32	I-32A	I-32B	I-33
NH3 Before	0.03	0.01	0.01	0.01	0.05	0.03	0.03
NH3 After	0.01	0.01	0.04	0.03	0.02	0.05	0.04
NO2/NO3 Before	1.00	1.13	1.41	0.22	0.26	2.07	1.70
NO2/NO3 After	0.99	0.88	1.57	1.45	1.49	1.62	1.72
OP Before	0.12	0.12	0.08	0.07	0.06	0.08	0.07
OP After	0.09	0.08	0.06	0.06	0.07	0.07	0.09

Site

Monitoring occurred on four different dates at the three (3) original sampling sites. The first monitoring event was in September 2007, followed by a confirmation sample December 2007. Post-repair monitoring was performed in February and July 2008. MCPH performed a sanitary survey at the site in December 2007. At that time, the owner informed us that the septic tank had been pumped in November 2007. This may help explain the reduction in fecal coliform results between the September 2007 and December 2007 monitoring events.

Monitoring Locations I-30A to I-33 are at the Bottom of the Bulkhead

However, the results from the December monitoring show further elevated levels of NO2/NO3. All subsequent monitoring results were also elevated for NO2/NO3, even the monitoring that was performed six (6) months after the repair was complete. FC results have remained below the level of action. MCPH recommends that further investigation be completed at this site including FC and nutrient monitoring and, depending on those results, an additional dye test. If it is determined that the OSS at this site is not failing, MCPH recommends further investigation at this site to determine the cause of the elevated levels of nutrients.

5.6.4 Property Associated with Site H-101

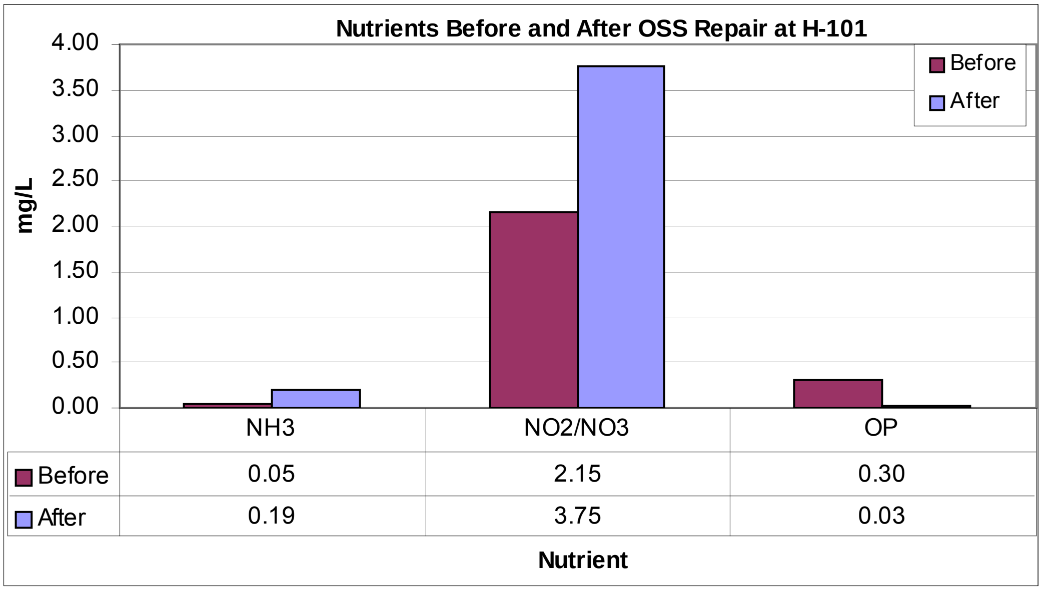
This property had an old gravity OSS that was located in fill on the waterfront side of the house. The install date of this OSS was unknown. The property is surrounded by water on three sides (two small creeks and Hood Canal) and is backed by US Highway 101, leaving little room to install an OSS that meets current OSS treatment standards. The drainfield was located less than 20' from the bulkhead. MCPH did not find any questionable sample results from either of the streams. The sample location of concern was at about the mid-point of the property out on the beach.

Property Associated with Site H-101 – Drainfield Located between the House and the Bulkhead

The owner had a pressurized system with an open-bottom sand filter drainfield that replaced the previous OSS at this site. Unfortunately, due to the limited size of the property, the drainfield was relocated in the same area on the waterfront side of the house behind the bulkhead. Post-repair monitoring at this location showed elevated levels of nutrients and fecal coliform. The post-repair monitoring shows that the NO2/NO3 levels actually increased. This may be related to the short amount of time that passed between the OSS replacement and the post-repair monitoring event.

MCPH dye-tested this system, post OSS repair, to see if it was still contributing to the pollution coming from this property. MCPH determined that the newly installed system is suspect. Dye was found surfacing at site H-101, however that was not the location with elevated fecal coliform results. The elevated levels of fecal coliform were found at site H-101A. In order for an OSS to be identified as a failure, a positive dye result and 50 FC/100-mL of water must be found at the same monitoring location.

Figure 30. Nutrient Results from Monitoring Location H-101



Shortly after the replacement OSS was installed, a spring emerged through the pavement of US Highway 101 near this residence. Washington State Department of Transportation repaired the highway and diverted the surfacing water. This excess water may have played a role in the poor performance of the replacement OSS. MCPH recommends follow-up monitoring to verify this hypothesis.

5.6.5 Other Properties:

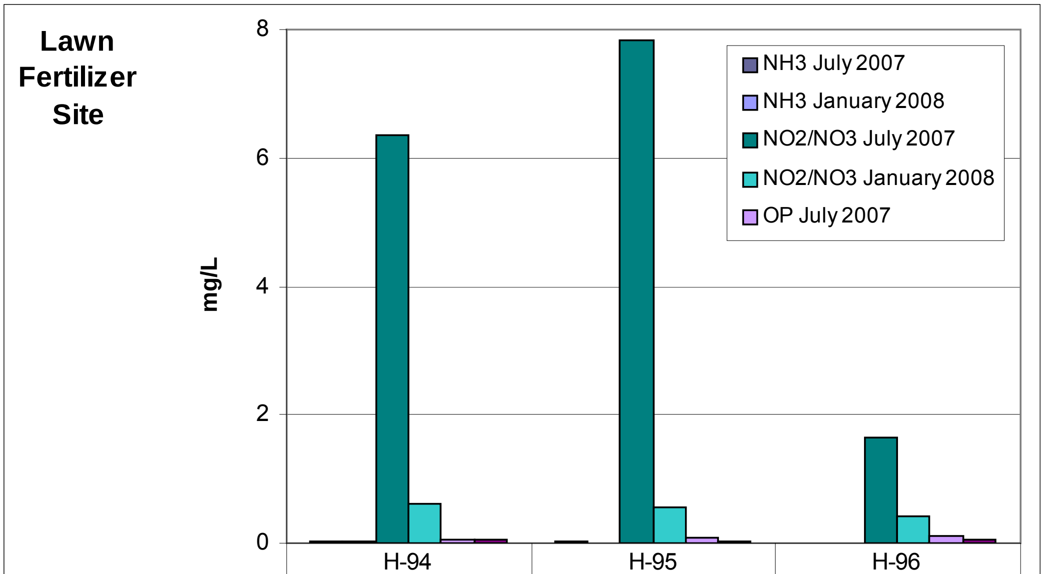
The additional properties that had failing OSS identified either have not completed the repair/replacement of their OSS or have not had post-repair monitoring. These properties are associated with the following monitoring sites: H-05, T-143, T-159 and T-160.

The Lawn is just barely Visible below the Deck Post

There is one additional property with elevated nutrient levels, but not elevated fecal coliform levels. This property is associated with monitoring locations H-94 to H-96. MCPH has not performed a sanitary survey at the site to identify the cause of the elevated nutrients.

However, the site had a healthy green lawn that extends to the edge of the bulkhead. Lawn fertilizer may be the culprit for the elevated nutrient levels at this site. The original sample was taken in July 2007 and the levels were elevated, while a confirmation sample that was taken in January 2008 shows a decrease in the nutrient results. MCPH recommends that a sanitary survey and additional monitoring be performed at this property.

Figure 31. Nutrient Results at Monitoring Locations H-94 to H-96



	H-94	H-95	H-96
NH3 July 2007	0.02	0.04	0.01
NH3 January 2008	0.02	0.01	0.01
NO2/NO3 July 2007	6.36	7.84	1.65
NO2/NO3 January 2008	0.62	0.56	0.42
OP July 2007	0.05	0.07	0.12
OP January 2008	0.06	0.02	0.06

Site

6 Public Education and Outreach

Mason County Water Quality staff conducted fourteen public meetings, workshops and water quality-related events to inform the communities around Hood Canal about the HCPIC project. Meetings included presentations intended to educate the public about the issues surrounding fecal coliform and nutrient pollution in Hood Canal. Presentations included information on the proper operation and maintenance of OSS to increase the lifetime of the system, as well as best practices for homeowners to reduce fecal and nutrient pollution - actions they could take to help restore the quality of water in Hood Canal. In addition, the Mason County Onsite Program performed an additional 10 OSS workshops. Other partners who attended and were available to answer questions at meetings and workshops were the Mason Conservation District and Mason and Jefferson WSU Extension offices.

MCPH Display Board

Information regarding the content of meetings, workshops, presentations, and products was provided to Tammy Riddell, the Department of Ecology Grant Administrator for this project, in November 2007.

MCPH HCPIC PowerPoint Presentation

7 OSS Operation and Maintenance Database Enhancement

The current Mason County Operation & Maintenance (O&M) program began with a Department of Ecology Centennial Clean Water grant in 2003. Carmody was selected as the internet-based data management software system. Initially, septic system records from previous sanitary survey databases were added to the O&M database. These databases were created in the 1990's for the Lower Hood Canal and Totten Little Skookum clean water districts.

Beginning in January 2004, all pumpers and O&M specialists were required to submit copies of service reports to Mason County Public Health. Reports are used to create service records for systems in the database. In addition, they aid in identifying systems not currently in the database or systems that require follow-up action.

Early in 2005, all permitted septic system installations were downloaded from Mason County's permitting software, TideMark. TideMark permit tracking was initiated in 1992. New septic installations are downloaded from Tidemark annually and added to the O&M database.

In 2006, a download from the County Assessor's database was edited to remove undeveloped parcels and parcels served by sewer systems. The remaining 8,455 records were added to the O&M database. Because no septic system data is available in the Assessor's data, several assumptions were made: Over 75% of identified septic systems in the county are conventional gravity. The percentage is much higher for systems installed prior to 1992. All records from the Assessor's database were assigned "conventional gravity" as the system type. Installation dates for these parcels were set at 12/31/1991 because they were installed prior to permit tracking in Tidemark.

Subsequently, properties for which there are maintenance records indicating that less than 1,000 gallons were pumped were updated with installation dates of 5/30/1974. The septic code changed on this date to a minimum septic tank size of 1,000 gallons. Neither of these dates reflects an actual installation date.

Projects such as water quality studies, building permit reviews, and responding to septic record requests from the public require review of parcel files and septic records. This provides an opportunity to update installation dates in the O&M database to the actual date and to correct system type if necessary. Accurate system data improves the usefulness of the O&M data system for staff and eventually for the public. To date, over 25,000 systems are being tracked in the Mason County O&M database.

Carmody was contracted to add a data field in the O&M database for Study Area. Parcels identified for special water quality studies can be assigned a Study Area code. During the first quarter of 2007, 3,340 parcels within 1,100 feet of the Hood Canal Shoreline were identified in the O&M database. Developed parcels not previously included in the database were added.

During the second quarter of 2007, Carmody developed a special report for the O&M database to generate reports for Study Areas as well as Watershed, River/Stream study areas, and for a user-defined set of parcel numbers. User-defined parcel numbers are copied into a section of the report filter criteria. The new report allows for a very flexible setup to generate information for ongoing target areas and customized reporting needs. Data available to the report are *Parcel Number, Site Address, Date Installed, Watershed, Component Type, River/Stream, Tracking Status*[*] *and Last Service Date.*

*Note: In the Mason County O&M database Tracking Status indicates if septic system has been serviced within the tracking schedule for the system-type. The maintenance-tracking schedule used in the Mason County O&M database for generating maintenance reminder mailings is as follows:

- Conventional systems – Every 5 years
- Proprietary systems – Annually
- Mounds & Sandfilters – Every three years.

Staffing levels and financial resources limit the number of reminder mailings that can be done.

The Mason County O&M program identifies septic systems that have not had maintenance within the tracking schedule assigned to each type of septic system. Reminders are sent annually to homeowners for whom maintenance reports have not been received. Over 2,000 reminders were sent to homeowners in the Hood Canal Shoreline target area since grant activities were initiated. To date, 1,934 maintenance reports have been received for Hood Canal Shoreline systems since 2004. This represents 58% of the systems on the Hood Canal Shoreline. 657 maintenance reports have been received for systems in the Hood Canal Shoreline target area since the beginning of the grant. Maintenance reports are submitted to Public Health on an ongoing basis. This number does not count reports we have received that have not been entered into the O&M database.

Looking North up the Main Stem of Hood Canal

8 Recommendations

Performing any of these recommendations is subject to management approval, funding and time.

8.1 Site Specific Recommendations

These recommendations should be addressed as funding becomes available:

- MCPH recommends that post-repair monitoring for fecal coliform and nutrients occur at sites **I-63, I-64 and I-65**.
- Ensure that all necessary repairs are performed at sites **T-144, T-159/T-160** and **H-08**. These sites have been verified to be associated with failing OSS.
- MCPH recommends that further investigation be completed at the property associated with sampling sites **I-30A to I-33**, including FC and nutrient monitoring, and, depending on those results, an additional dye test. If it is determined that the OSS at this site is not failing, MCPH recommends further investigation at this site to determine the cause of the elevated levels of nutrients.
- MCPH recommends that the property associated with sites **I-45, I-53** and **I-54** receive further investigation, as well as, the Blue Heron Condos (which are located across the SR 106 from the site where the samples were taken).
- MCPH recommends that additional analyses be performed to determine the distance each OSS failure is from the monitoring location(s).
- Perform sanitary surveys and dye tests (where needed) at the following sites:
    - **H-26, H-44, I-26, M-25, Q-15, T-89, T-102**, **T-106, T –115, T-142, T-145, T-147, T-155, U-20, U-25, U-33 and U-71**
- Perform post-repair monitoring at all sites that have OSS repairs or replacement.
- Perform confirmation nutrient monitoring at all sites that had initial sample results above the “level of concern.
- Perform sanitary surveys to identify the sources of nutrient pollution.
- Perform additional monitoring at those sites that had an elevated FC result followed by a confirmation FC result of <200FC/100-mL.
- To better understand shoreline inputs of nutrients to Lower Hood Canal, MCPH recommends that additional nutrient samples and flow measurements be taken along the shoreline of Lower Hood Canal.
- Explore funding to conduct pollution identification and correction projects (including nutrient monitoring) on North Shore and segments of concern: Segments H, S, T and U.

8.2 Project Recommendations

These recommendations are intended to help MCPH better perform this type of work in the future.

- MCPH recommends that when funding is available, nutrient samples be taken in conjunction with fecal coliform samples to better identify and assess failing OSS. At a minimum, whenever a suspected failing OSS is investigated, nutrient analyses should be performed in addition to fecal coliform analyses.

- MCPH recommends that flow measurements be taken in conjunction with all future nutrient monitoring to enable the calculation of nutrient loading entering the marine water, and facilitate statistical evaluation of the data.
- MCPH recommends that Mason County identify the distance between each OSS and surface water.
- MCPH recommends that future nutrient sampling that occurs post-OSS-failure should include several samples that occur over a span of time (ie, directly after repair, 3 months after repair, 6 months after repair). This information would help us understand if, and for how long, the various nutrients remain in the environment.
- Select smaller areas of study so as to complete a full series of wet and dry samples, confirmation samples, sanitary surveys, and corrections in a reasonable/practical/logical amount of time.
- Explore funding to conduct a pollution identification and correction project in Lower Hood Canal as an *intensive nutrient study area.* Studies have determined that there is a persistent low DO problem in the Hood Canal zone from Lynch Cove to Great Bend. Jan Newton, lead scientist for the HCDOP IAM Study, specifically suggested to Mason County Water Quality staff that a nutrient study be conducted in that area.

Shoreline - Segment P

References

Fagergren, Duane, Anne Criss, and Dave Christensen. "Hood Canal Dissolved Oxygen: Preliminary Assessment and Corrective Action Plan. Version 1". Puget Sound Action Team and Hood Canal Coordinating Council. 6 May 2004. Publication #PSAT04-06. Web. <http://www.psparchives.com/publications/our_work/hood_canal/hood_canal/HC_PACA.pdf>

Hood Canal Dissolved Oxygen Program. "The Dissolved Oxygen Issue". 2005. Web. 9 October 2008. <http://www.hoodcanal.washington.edu/aboutHC/brochure.html>

---. "Key Messages". 2008. Web. 9 October 2008. http://www.hoodcanal.washington.edu/aboutHCDOP/keymessages.html

Kitsap County Health District. "Hood Canal Shoreline Survey Quality Assurance Project Plan". Bremerton: Kitsap County Health District, 2005.

---. "Kitsap County Health District Water Quality Analysis of Hood Canal Shoreline Discharges Part 1". 2005. Web. 20 October 2008. http://www.kitsapcountyhealth.com/environmenta_health/water_quality/docs/shoreline_discharge_technical_report.pdf

---. "Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction Projects, Version Nine." Bremerton: Kitsap County Health District, 2003.

---. "Upper Hood Canal Restoration Project Final Report". 2005. Kitsap County Health District. Web. 9 October 2008. http://www.kitsapcountyhealth.com/environmenta_health/water_quality/docs/upper_hood_canal_final_report.pdf

Georgeson, Amy and Wendy Mathews. "Mason County Septic System Surveys and Database Enhancement Quality Assurance Project Plan". 2007.

Georgeson, Amy, Wendy Mathews, Stephanie Kenny, and Seth Book. "Mason County Water Quality Standard Operating Procedures". Mason County Public Health. 2007.

Mason County Department of Health Services. "Water Quality Policies and Procedures". 2001.

---. "Sanitary Survey Procedure". 2003.

Newton, Jan. "Science of Hood Canal Hypoxia: Science Primer". 2005. HCDOP. Web. 14 October 2008. <http://www.hoodcanal.washington.edu/aboutHC/scienceprimer.jsp)>

---. "HCDOP IAM Study Preliminary Results". 2008. Web. 15 October 2008. http://www.hoodcanal.washington.edu/documents/document.jsp?id=2204

Washington State Department of Health. "2004 Shoreline Survey of the Hood Canal 4 Shellfish Growing Area". 2005.

Washington State Department of Health. "DOH Shoreline Surveys of the Hood Canal Shellfish Growing Areas 5 through 9". 1996-2005