# North Shore Hood Canal
# Pollution Identification and Correction Project
# Final Report
# December 2011

Prepared for the Washington State Department of Ecology

Centennial Clean Water Fund Grant Number: **G10000122**
Federal ID Number: **91-6001354**
Total Cost of Project: **$180,135**
Grant Amount: **$135,101**
Project Duration: **October 2009 to December 2011**

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# Glossary

| | |
|---|---|
| **As-Built Records** | The final drawing record of an installed on-site septic system, required as part of the on-site septic system permit. |
| **Anoxic** | Lacking air. In the context of denitrification, less than 0.5 mg/L of dissolved oxygen are necessary for denitrification to occur, less than 0.2 mg/L are ideal. |
| **Aerobic** | In the presence of air. |
| **Carmody** | Mason County Public Health's On-site Septic System Operation and Maintenance on-line tracking database |
| **Cultural Eutrophication** | When human activity, such as the use of detergents or fertilizers, introduces increased amounts of nutrients, which "fertilize" plants and algae and eventually robs the water body of all of its oxygen. |
| **Denitrification** | The anoxic conversion of nitrites or nitrates into nitrogen gas that escapes to the atmosphere where it is relatively stable. |
| **Eutrophication** | Nutrient enrichment of a water body. It can be a natural process that normally occurs in aging lakes. It occurs naturally when nutrient production and consumption do not cancel each other out and the water body slowly becomes over-fertilized. |
| **Hypoxia** | A reduction in dissolved oxygen, to the point that it becomes detrimental to marine organism (1-30% dissolved oxygen saturation). Most fish cannot survive with less than 30% dissolved oxygen saturation. |
| **Nitrification** | The aerobic conversion of ammonia to nitrite and then from nitrite to nitrate. 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 |
| **Operation and Maintenance** | On-site Septic System inspection that assesses the use of the system, determines when and if a septic system needs to be pumped, or if it needs other maintenance, such as replacement of a UV light, or replacement of chorine tablets, adjustment of timers or pumps, etc. Helps to protect and prolong the life of an on-site septic system. |
| **Sanitary Survey** | Site specific interview conducted with residents regarding their on-site septic system and other potential sources of fecal and nutrient pollution. Purpose is to educate residents on how they can protect and prolong the life of their on-site septic system |
| **Shoreline Survey** | Water quality monitoring, typically of freshwater discharges that flow into marine water to identify sources of pollution, generally use to identify fecal coliform pollution. |

# Abbreviations

| | |
|---|---|
| **FC** | Fecal Coliform |
| **HCDOP** | Hood Canal Dissolved Oxygen Program |
| **HCPIC** | Hood Canal Pollution Identification and Correction |
| **HCSEG** | Hood Canal Salmon Enhancement Group |
| **IAM** | Integrated Assessment and Modeling |
| **KCHD** | Kitsap County Health District |
| **MCPH** | Mason County Public Health |
| **mg/L** | milligram/Liter |
| **mL** | milliliter |
| **$NH_3$-N** | Ammonia-Nitrogen |
| **$NO_3$+$NO_2$-N** | Nitrate+Nitrite-Nitrogen |
| **ORCA** | Oceanic Remote Chemical Analyzer |
| **OSS** | On-site Septic System |
| **O&M** | Operation and Maintenance |
| **$PO_4$-P** | Orthophosphate |
| **ppt** | Part per Thousand |
| **PIC** | Pollution Identification and Correction |
| **QAPP** | Quality Assurance Project Plan |
| **SOP** | Standard Operating Procedures |
| **USGS** | US Geological Survey |
| **DOE** | Washington State Department of Ecology |
| **WWTP** | Waste Water Treatment Plant |

## Northshore Hood Canal Pollution Identification and Correction Project Deliverables Summary

**Required Performance**
**Centennial Clean Water Fund Grant Number: G1000122**
**Federal ID Number 91-6001354**
**Project Duration: October, 2009 to December, 2011**

### Task 1 – Project Administration/Management (Total Cost: $13,559, Total Budgeted: $12,798)

Required Performance (contract language in italics):

1. *Effective administration and management of this grant project.*

This project was originally proposed to span a 24 month period, which included approximately two months for QAPP preparation and approval. When the grant application was submitted, the anticipated start date was proposed to be July 30, 2009 with an anticipated completion date of July 30, 2011. While the contract was being developed, the DEPARTMENT's Project Manager added 6 months to the end of the contract period (completion date of December, 2011) because of the anticipated time required for the contract to be approved (October, 2009) and the anticipated amount of that would be required for preparation and approval of the Quality Assurance Project Plan (QAPP).

Final Approval of the QAPP occurred June 24, 2010, leaving only 16 months to perform monitoring and sanitary surveys as opposed to the originally proposed 24 months.

This shortened time period in combination with the seasonal nature of many of the residents prevented Mason County Public Health (MCPH) from meeting all of the required performance deliverables for this grant.

2. *Maintenance of all project records.*

All Project records have been maintained. The following is a summary of the main records that have been maintained:

- Invoices from the contract lab (Twiss Analytical Lab) for nutrient analysis
- Nutrient and Fecal Coliform Analysis sheets provided by the labs
- QAPP
- All Quarterly Reports
- All letters to residents in response to results, sanitary surveys, dye test or general information
- Mason County Pollution Identification and Correction Survey Form

The following is a list of spreadsheets or databases that were created as part of this project:

- EIM formatted monitoring data entry and a separate analysis spreadsheets, which include fecal coliform, nutrient and salinity data for all sites that were monitored for those parameters along the Northshore of Hood Canal.
- Hood Canal On-site Septic System Survey Tracker, which includes the information that is collected during the sanitary survey.
- All the parcel numbers that existed within 1100' of Hood Canal as of October 15, 2010, which was used for the ranking and identification of sanitary survey locations based on fecal pollution potential.
- All the parcel numbers that existed within 1100' of Hood Canal as of November, 8 2011, which was used for the analysis in this final report.
- All GPS points were downloaded into GPS Pathfinder Office, saved as shapefiles and added to Arcmap. Then coordinates were generated that were added to the EIM formatted spreadsheet.

3. Timely submittal of all required performance items, progress reports, and financial vouchers.

All quarterly reports were submitted by the 15th of the month following the end of the quarter. Reports covered progress towards required performance and summaries of data collection and analysis.

4. *Submittal of draft project completion report to the DEPARTMENT's Project Manager no later than* ***November 15, 2011****.*

Draft submitted to the RECIPIENT on December 16, 2011. Staff underestimated the time it would take to complete the draft report in combination with staff's other commitments.

Task 2 – Shoreline Survey (Total Cost: $120,107, Total Budgeted: $165,405)
Required Performance (contract language in italics):

1. *Submit Quality Assurance Project Plan for DOE approval.*

The RECIPIENT submitted the draft QAPP on January 15, 2010 for review and after necessary edits the final QAPP was approved by the DEPARTMENT on June 24, 2010.

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

- All sampling was performed in accordance to the QAPP, except the following deviations: Dry weather monitoring was performed between June 28, 2010 and October 20, 2010 and between July 11, 2011 and August 2, 2011. Wet weather monitoring was performed between November, 3, 2010 and June 29, 2011 and October 4 & 5, 2011. This was based on actual precipitation.
- Only sections W to JJ were sampled. They were sampled during both wet and dry weather. The RECIPIENT could not identify any access locations north of Dewatto Bay in segments KK and LL. All of the roads that lead to the water are private gated roads. A boat could have assisted staff in accessing this section of shoreline.
- In the field, staff mislabeled sites in segments X, II, JJ, and KK. There were samples taken from segment X, but they were all labeled as segment W, so in the end segments X and W were combined. There were also samples taken in segment KK but they were all labeled as segment JJ. Samples that were taken from JJ were labeled as II.
- All final report numbers were based on the corrected final segment lines.

See maps in the final report for additional clarification.

3. *The RECIPIENT will input all sampling data into EIM at least yearly.*

The RECIPIENT entered data into EIM approximately yearly. The first data collection occurred in June, 2010. The first data download was performed in August, 2011. MCPH also performed a data download in November, 2011. MCPH did not receive any response to the data downloaded in August until November, 2011. In November, the new EIM Data Coordinator had several questions and clarifications regarding the data. MCPH will ensure that all data is accurately reflected in EIM.

Task 3 – Septic System Surveys (Total Cost: $43,755 Total Budgeted: $67,625)
Required Performance (contract language in italics):

1. *Conduct sanitary surveys at properties associated with high fecal coliform or nutrient sample results, conduct dye tests and work with the county On-site Program and the homeowner to correct the septic problem.*

The RECIPIENT had a difficult time making contact with residents during the study period. The RECIPIENT believes that this type of project would be best executed during the summer months due to the high level of seasonal occupants. MCPH intends to continue to attempt to perform follow-up work on all sites identified for sanitary surveys (either through elevated fecal coliform or nutrient results or prioritized

through parcel ranking for fecal pollution potential) under another grant (G1000278), which shares the same study area.

The RECIPIENT performed 51 sanitary surveys. The RECIPIENT did not identify any failing OSS as part of the sanitary survey process. However, the RECIPIENT identified 1 failing OSS from the shoreline, which has been posted for non-occupancy. In addition, 18 sites within the study area had their OSS either repaired or replaced and 6 sites had new OSS installed, between July, 2010 and December, 2011.

2. *Provide homeowners with information on best practices regarding OSS operation and maintenance, and keeping fecal coliform and nutrients from entering the Canal.*

The RECIPIENT provided educational information to 51 homeowners on how to minimize their pollution impact on Hood Canal and how to protect and prolong the life of the OSS during sanitary surveys. The RECIPIENT also left educational materials at 55 houses where contact could not be made.

3. *Update the Carmody database as needed.*

The RECIPIENT updated 388 OSS records in Carmody.

## Task 4 – Public Outreach (Total Cost: $3,475, Total Budgeted: $4,172)

Required Performance (contract language in italics):

1. *The RECIPIENT will participate in two events providing information to North Shore area residents on proper operation and maintenance of OSSs.*

The RECIPIENT provided updates on this project to the Lower Hood Canal Watershed Coalition during two meetings, on March 7, 2011 and December 5, 2011.

The RECIPIENT in collaboration with WSU-ext had an OSS presentation, with highlights of both Hood Canal grants at the North Mason Timberland Library in Belfair on February 3, 2011.

2. *The RECIPIENT will submit data and supporting material in the form of a summary report to the county Web site.*

The RECIPIENT posted reports and other grant related information onto Mason County's webpage.

http://www.co.mason.wa.us/health/environmental/water_quality/north_shore_pollution_identification.php

A quick link to the overarching Hood Canal page is: http://tiny.cc/hoodcanal

3. *The RECIPIENT will provide the DEPARTMENT with two copies of any tangible educational products developed under this grant.*

The RECIPIENT did not produce any educational products.

# 1. Introduction and Background

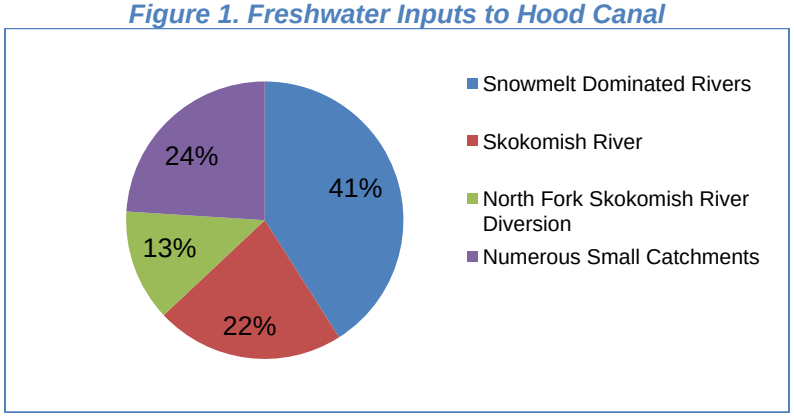
*Photo 1 Looking West across Hood Canal at the Olympic Mountain Foothills*

Hood Canal is located in Western Washington between the Olympic Peninsula and the Kitsap Peninsula. It is a valuable recreational and commercial resource to Jefferson, Kitsap and Mason Counties and two Tribal Nations, the Skokomish in the South and the Port Gamble S'Klallam in the North. During the past decade, Hood Canal has received national attention because of estuarine eutrophication, which has lead to the increase of large die-offs of marine organisms ("fish kills").

Hood Canal is a glacial fjord inlet in Puget Sound. The long narrow shape of Hood Canal results in a classic estuarine circulation pattern and a stratified water column throughout much of the year. Hood Canal has also been shown to be more susceptible to eutrophication than other areas of Puget Sound (Newton, Jan, et al, 1995). The entrance to Hood Canal is located off of the Straits of Juan de Fuca. Its length is bounded by the Olympic Mountains to the west and slopes of the Kitsap Peninsula to the east. Its 'L' shape extends from the Strait of Juan de Fuca southwest toward Annas Bay where it turns and continues northeast to Belfair.

The canal receives snowmelt and precipitation via many rivers and streams. Freshwater inputs to Hood Canal include snowmelt dominated rivers of the Olympic Peninsula, the Skokomish River and the North Fork Skokomish diversion and other numerous small catchments. On average, over 60% of Hood Canal precipitation occurs between November and January while <10% occurs between June and August.

***Figure 1. Freshwater Inputs to Hood Canal***




Western Washington rains contribute large volumes of water that flow into Hood Canal and most deep infiltration is prevented by an underlayment of till and basalt compounded by a sloped and developed shoreline. This large volume of freshwater carries untreated pollutants and contributes to the highly stratified temperature and salinity of Hood Canal. In addition, there is a shallow sill located at the entrance of Hood Canal. The sill tends to retain the water, reducing the water exchange in Hood Canal and estimates of complete water exchange rates are in the magnitude of years (Hannafious, 2005). The slow exchange rate plus the temperature and salinity gradients limit mixing, causing oxygen to diminish with depth.

Soils along the Mason County shoreline of Hood Canal are predominantly Alderwood gravelly sandy loam and Everett gravelly sandy loam. Alderwood gravelly sandy loam is characterized by good natural drainage and is moderately shallow to a layer of cemented till that limits infiltration and root penetration. Everett gravelly Sandy loam is characterized by somewhat excessively drained droughty soils also underlain by glacial till (A. 0. Ness, 1960).

*Photo 2 Starfish*

In addition, Hood Canal has been recognized by several agencies as a significant resource, deserving protection. Mason County's Board of Health has identified Hood Canal as a Marine Recovery Area. The Washington State Legislature defined Hood Canal as Aquatic Rehabilitation Zone #1 and Hood Canal is designated as a shoreline of Statewide Significance (RCW 90.58.030).

This project is a continuation of the Hood Canal Pollution Identification and Correction (HCPIC) Project. Prior monitoring occurred between 2005 and 2008 along the Western and Southern Shores of Hood Canal, located within Mason County. Similar PIC projects have been performed in the Hood Canal Watershed by both Kitsap and Jefferson Counties. This project assessed freshwater discharges in the intertidal area before it enters the marine water along the Eastern and Northern Shores of Hood Canal located within Mason County. The purpose of this project was to locate shoreline flows with fecal coliform and/or nutrient pollution, identify and correct anthropogenic pollution sources, provide individualized education to homeowners to prevent pollution from entering Hood Canal and update Mason County's On-site Septic System (OSS) Operation and Maintenance (O&M) Database, Carmody.

*Photo 3 View North from the Eastern Shore of Hood Canal*

## 1.1. Fecal Coliform Pollution

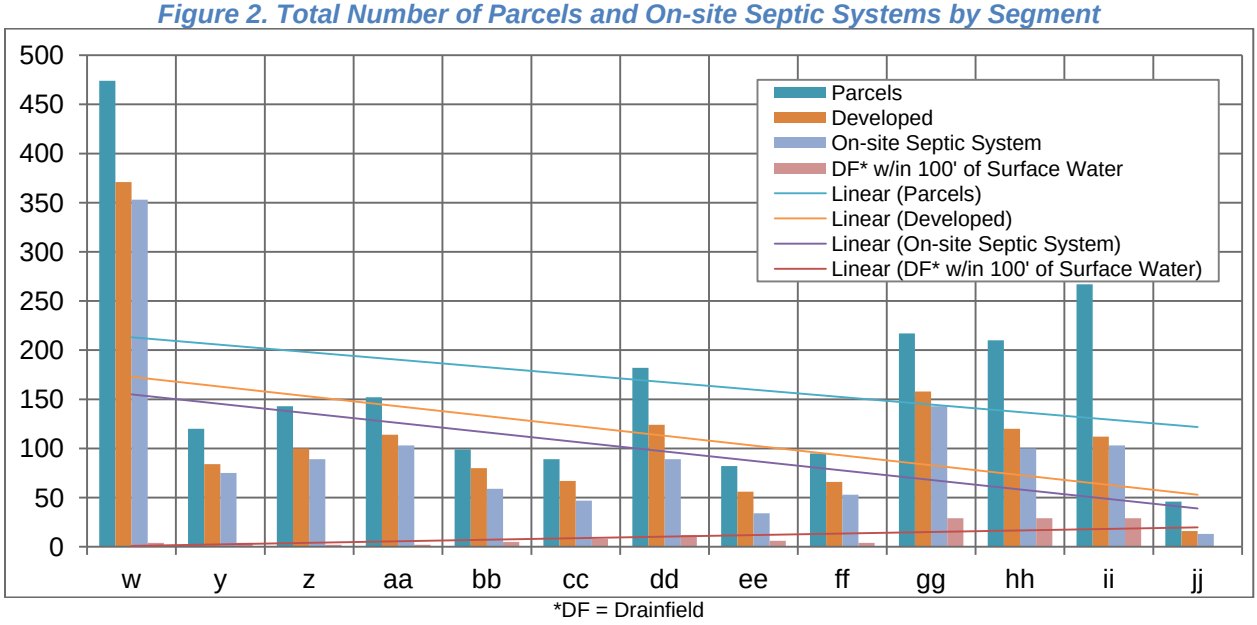
Fecal pollution is the result of untreated wastes. Fecal Coliform (FC) bacteria exist in the intestines of warm-blooded animals; including, humans, pets, livestock, birds, wildlife, etc. FC found in water samples can indicate the presence of untreated human and/or animal waste and the associated pathogens. Common sources of FC pollution include failing OSS, inadequate or improper pet or livestock waste management and wildlife. Mason County Public Health (MCPH) is most concerned with anthropogenic fecal pollution sources including failing OSS and improper pet or livestock waste management.

*Photo 4 Raccoon on Undeveloped Section of Eastern Shoreline*

OSSs are prevalently used around Hood Canal to treat human waste. In Mason County, there are a broad range of different OSS types and dates of installation associated with shoreline residences along Hood Canal. Different OSSs pose different levels of fecal pollution potential. In order, to better assess this potential from within the study area, MCPH performed some summary analysis on existing OSS records from within the study area.

MCPH identified ~2302 parcels within the Northshore Study Area, of those parcels, approximately 1509 (66%) are developed. Currently, there are ~1297 parcels[1] that have a known or assumed OSS on them.

***Figure 2. Total Number of Parcels and On-site Septic Systems by Segment***




*DF = Drainfield

There is an average density within the study area of 1 OSS per 0.42 acre. As-built (final installation) records exist for 509 sites (39%), while 151 sites (12%) do not have as-built records.[2] There are ~134 sites (10%) where the drainfield (df) is known to be within 100' of the shoreline, while 523 (40%) sites have a known drainfield location that is greater than 100' from the surface water or the OSS has a variance to have the df within 100' of surface water[3] (see **Figure 2. Total Number of Parcels and On-site Septic Systems by Segment**).[4]

[1] Previous data that MCPH had compiled showed more sites with OSS than sites that were developed. However when the Mason County Assessor changed their parcel database last year, there was added clarification about which properties were developed. MCPH has not updated their OSS information to reflect an assumed OSS on each developed property (as the data was originally populated), mainly because we are validating all records within this study area under G1000278.
[2] A remaining ~49% of the OSS records need verification, to determine if an as-built record exists.
[3] Surface water is defined as anywhere there is water, marine or fresh, for a significant period of time, including Dec. 1 to March 31.
[4] A remaining ~49% of the OSS records need verification, to determine the location of the df.

The data regarding if a drainfield is within 100' of surface water is useful in identifying those segments that pose the greatest pollution potential from failing OSS. The data may be slightly skewed, since we are continuing to verify OSS records, meaning we have not identified all of the sites with a drainfield within 100' of surface water.

***Figure 3. Summary of OSS System Types***

| # of Sites | % of Total OSS Parcels | Type of OSS |
|---|---|---|
| 30 | 2% | Aerobic Treatment Device |
| 10 | 0.77% | Community Systems |
| 1037 | 80% | Conventional OSS[5] |
| 146 | 11% | Pressurized DF[6] |
| 1 | 0.08% | Food Permit |
| 11 | 0.85% | Glendons |
| 2 | 0.15% | Holding Tanks |
| 2 | 0.15% | Nibblers |
| 11 | 0.85% | Sand Filters |
| 46 | 4% | Seepage Pits |
| 1 | 0.08% | Textile Filters |

MCPH compiled OSS data on both system type and the installation date (see **Figure 3. Summary of OSS System Types** and **Figure 4. Summary of OSS Installation Dates**).

***Figure 4. Summary of OSS Installation Dates***

| # of Sites | % of Total OSS Parcels | Known OSS Installation Date |
|---|---|---|
| 17 | 1% | 1930 - 1950 |
| 242 | 19% | 1950 - 1970 |
| 231 | 18% | 1970 - 1980 |
| 163 | 13% | 1980 - 1990 |
| 305 | 24% | 1990 - 2011 |
| 958 | 74% | Total OSS with a known Installation date |

In addition, there are 274 sites that have assumed OSS type and install date, but they are known to have some kind of existing OSS, because they have had O&M performed, but the OSS records have not yet been verified. There are 65 other sites that are assumed to have an OSS, but they have not had a service event, since the creation of Carmody, our electronic O&M tracking database, in 2003. This means for those 65 sites, their existence is based solely on the parcel being developed.

Currently, within the Hood Canal Watershed in Mason County, there is only one Waste-Water Treatment Plant (WWTP), located at Alderbrook Resort. However, Mason County is completing work on the Belfair WWTP and it should be on-line in the near future. There are ongoing discussions about WWTPs in the Potlatch and Hoodsport areas in Mason County.

*Photo 5 Bulkhead Drain Monitoring Location*

Previous water quality data and shoreline assessments have demonstrated known and potential FC pollution problems in the Hood Canal Watershed in Mason County. FC pollution has been identified by several agencies; including, the State of Washington Department of Health (DOH) and Department of Ecology (DOE), the Hood Canal Dissolved Oxygen Project (HCDOP), the Hood Canal Salmon Enhancement Group (HCSEG) and Mason County. These groups have monitored marine water and shoreline drainages; including, streams, seeps, stormwater runoff and bulkhead drains.

The Washington State Department of Health performs shoreline surveys to identify potential fecal pollution sources in order to classify commercial shellfish beds. During the Mason County Hood Canal shoreline surveys (Hood Canal Growing Areas 4 through 9) from 1996 to 2005, DOH identified approximately 407 "potential sources" of fecal pollution based upon

[5] includes ~339 assumed systems
[6] Does not include pump to gravity drainfield systems

their staff's field observations. These properties are spread along the entire shoreline of Hood Canal within Mason County.

Analyzing shoreline discharges for FC bacteria can help identify sources of human and animal waste. MCPH utilizes Pollution Identification and Correction (PIC) protocols, as described in the Mason County Water Quality 2007 Standard Operating Procedures (SOP)(Georgeson, Mathews, Book, & Kenny, 2007). These procedures outline a standardized method of evaluating discharges and identifying and correcting anthropogenic FC sources such as failing on-site sewage systems and inadequate animal waste management.

*Photo 6 View South towards Annas Bay from Eastern Shore of Hood Canal*

## 1.2. Eutrophication and Low Dissolved Oxygen in Hood Canal

Hood Canal has had a history of low dissolved oxygen levels, which have caused episodic fish kills, since most aquatic life utilizes dissolved oxygen to breathe. 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, Science of Hood Canal Hypoxia: Science Primer, 2005).

Eutrophication, or nutrient enrichment of a water body, is a natural process that normally occurs in aging lakes. It occurs naturally when nutrient production and consumption within the lake do not cancel each other out and the water body slowly becomes over-fertilized with nutrients. However, cultural eutrophication occurs when human activity, such as the use of detergents or fertilizers, introduces increased amounts of nutrients, which "fertilize" plants and algae and eventually robs the water body of all of its oxygen. While not rare in nature, eutrophication does not naturally happen frequently or quickly. However, artificial or human-caused eutrophication has become so common that the word eutrophication by itself has come to mean a harmful increase and acceleration of nutrients.

*Photo 7 Dripping Hillside Monitoring Location*

When additional nutrients are added to a body of water, the plants begin to grow explosively and algae "blooms." In the process, the increased amounts of plants and algae consume greater amounts of oxygen in the water. When algae die, oxygen is required by bacteria in order for them to decompose the dead algae. A cycle then begins in which more bacteria decompose more dead algae, consuming even more oxygen in the process. The bacteria then release more nutrients back into the water, which feed more algae. As levels of oxygen in the body of water become lower, species such as fish and mollusks literally suffocate to death (Science Clarified, 2011).

Hood Canal *is naturally susceptible* to eutrophication due to its physical shape. Hood Canal is a long narrow water body, with a pronounced hook near the end. It has a sill coupled with a floating bridge that minimize exchange

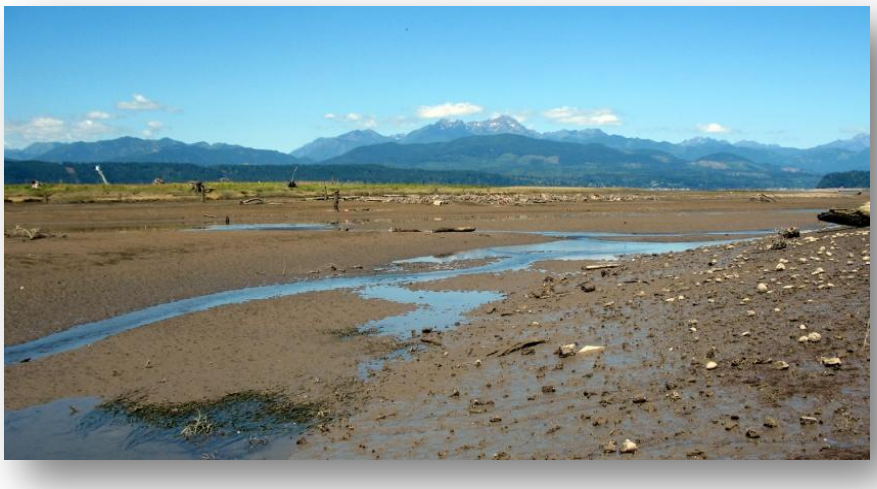
and reduce flow. Hood Canal extends for about 50 miles southwest from the entrance to Union, where it turns sharply to the northeast and continues for about 15 miles to Belfair. The entrance to Hood Canal contains a sill that is 150' deep, while the main stem reaches depths of 600'. In addition, the water in Hood Canal is highly stratified due to density, salinity and temperature. According to Jan Newton, lead scientist of the HCDOP Study, 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(Newton, Science of Hood Canal Hypoxia: Science Primer, 2005).

*Photo 8 Staff preparing to take a Nutrient Sample*

The current understanding regarding the mechanism that causes the fish kills, as reported in the Integrated Assessment and Modeling (IAM) Study Preliminary Results, is that the annual late-summer intrusion of new bottom waters forces existing low oxygen bottom 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, HCDOP IAM Study Preliminary Results, 2008). In winter, oxygen levels generally rebound with an exchange of water from the ocean coupled with increased mixing due to increased freshwater inputs (precipitation and river flows), less algae growth and wave action produced by winds. Fish kills generally originate in the Potlatch/Annas Bay area and then extended north. Much of Lower Hood Canal has been identified as an area with a chronic low dissolved oxygen problem (the area located east of the 'Great Bend"). This chronic low dissolved oxygen area may play a significant role in the episodic fish kills that occur near Annas Bay.

"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). Although fish kills have been a historic event, fish kills in 2002, 2003, 2006 and 2010 represented an increase in the frequency of these events. The increases in the frequency and geographic extent of fish kills combined with oxygen levels that were the lowest in recorded history, prompted increasing concerns about the long-term health of the canal. However, sediment samples have demonstrated that over the last 400 years, there have been hypoxia events during each century in Hood Canal. The Pacific Northwest National Laboratory discovered a cycle of low-oxygen events in the early 1700s, early 1800s, and early 1900s. The current trend shows that conditions conducive to low oxygen levels have returned to Hood Canal(Pacific Northwest National Laboratory, 2007).

*Photo 9 Looking Northwest at the Olympics from the Eastern Shore of Annas Bay*



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 On-site 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. The direct relationship of fecal pollution and nutrient pollution is not fully understood. It has been proposed that both functioning as well as failing on-site sewage systems may contribute to the nutrient load.

*Photo 10 Flower in the Forest*

Shoreline data collected by MCPH identified the highest nutrient results were associated with sites that had known failing OSS. Kitsap County, as part of their PIC, did not find a correlation between FC and nutrients. Current studies continue to look at the variety of conditions that can affect OSS nutrient output, including HCDOP's final report, Hood Canal-wide PIC projects, and a Jefferson County pilot project that analyzed nutrients in OSS tanks. OSS nutrient output is hypothesized to be affected by system type and location, soil type, distance to surface or groundwater and the presence and type of vegetation, in addition to individual household practices including water usages and what is allowed to go down the drain (such as food scraps).

In 2005, HCDOP, through the University of Washington, began the 3-year IAM study to better understand the dynamics of Hood Canal and its persistent problem with low dissolved oxygen. As part of the HCDOP study, three Oceanic Remote Chemical Analyzer (ORCA) Buoys, autonomous sensors, were installed in Hood Canal. These ORCAs collect continuous water column profile data. The ORCAs demonstrate that hypoxic conditions may persist year-round in Lower Hood Canal. Further, the monitoring station in the north (Bangor) shows that hypoxia may be spreading north with conditions of biological stress for up to six months of the year (Hood Canal Dissolved Oxygen Program, 2005).

In 2005, the Kitsap County Health District (KCHD) staff produced a technical report 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 to the OSS in the form of inorganic ammonia-nitrogen and organic nitrogen. Other nitrogen sources include food wastes and laundry water." Kitsap staff, based on concerns with the potential relationship between OSS and low DO in Hood Canal, added a nutrient study portion to their Pollution Identification and Correction project in 2005, selecting three compounds for analysis: Ammonia-Nitrogen ($NH_3$-N), Nitrate+Nitrite–Nitrogen ($NO_2$+$NO_3$-N), and Orthophosphate($PO_4$-P). These compounds were chosen because they are likely to be found after effluent has passed through the septic system (Kitsap County Health District , 2005).

*Photo 11 Looking West towards Hoodsport*

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)."

In addition, in 2005, KCHD conducted a FC bacteria and nitrate+nitrite-N correlation study, as reported in the *Kitsap County Health District Water Quality Analysis of Hood Canal Shoreline Discharges – Part I, November 2006.* The results of this study found no correlation between FC and nitrate+nitrite nitrogen. However, all sampling was completed during wet weather, when denitrification is more

likely to occur in the soils because of elevated groundwater levels (Cogger, 1988).

MCPH also collected $NH_3$-N, $NO_2$+$NO_3$-N and $PO_4$-P (collectively referred to as nutrients in this document) data as part of the previous HCPIC project. This data was collected to complement the work being performed by Kitsap County and HCDOP by increasing the sample size and providing additional data to better understand the relationship between FC and nutrients. The most elevated levels of FC and nutrients were associated with sites that had failing OSS(Georgeson, Mathews, Orth, & Hyatt, 2008).

*Photo 12 Looking Northeast down Lower Hood Canal from Potlatch*

In 2007 & 2008, under the previous HCPIC project, MCPH monitored 8.3 miles of Hood Canal Shoreline for nutrient inputs. MCPH collected over 580 shoreline samples from 514 individual monitoring locations, which were analyzed for fecal coliform, salinity, and nutrients. MCPH identified 82 samples with at least one nutrient analyte above the 90$^{th}$ percentile. In absence of a nutrient surface water standard in Washington, MCPH designated the nutrient 'level of concern' as any site that had a result above the 90$^{th}$ percentile, based on the previously collected data (see **Figure 18. HCPIC Nutrient 'Levels of Concern"**).

MCPH found that at locations where a failing OSS was identified there was at least one site with a nutrient result above the 'level of concern.' Nutrient results above the 'level of concern' did not always correspond directly to monitoring locations with elevated fecal coliform results; however, when they did not correspond directly, they were often found in adjacent monitoring locations, which gave a more complete idea of how the septic system may be malfunctioning. For example, at sites where the OSS failure was located within close proximity to the monitoring location, fecal coliform, $NH_3$-N and $PO_4$-P results were elevated, while if the location of the failure was further from the monitoring location, $NO_2$+$NO_3$-N and FC were elevated(Georgeson, Mathews, Orth, & Hyatt, 2008).

Post-OSS repair monitoring provided mixed information. Only one site had a year span between the original monitoring event and the post-correction monitoring event. This site showed a 99.9% reduction in ammonia-nitrogen, 98% reduction in Nitrate+Nitrite-nitrogen, 98.5% reduction in ortho-phosphate-phosphorus and a 99.9% reduction of fecal coliform. At the other sites, which had less time between OSS-correction and post-correction monitoring, the reductions were not as pronounced. MCPH proposes periodic additional FC and nutrient sampling over the course of a year after OSS correction.

*Photo 13 Cormorants on Pilings*

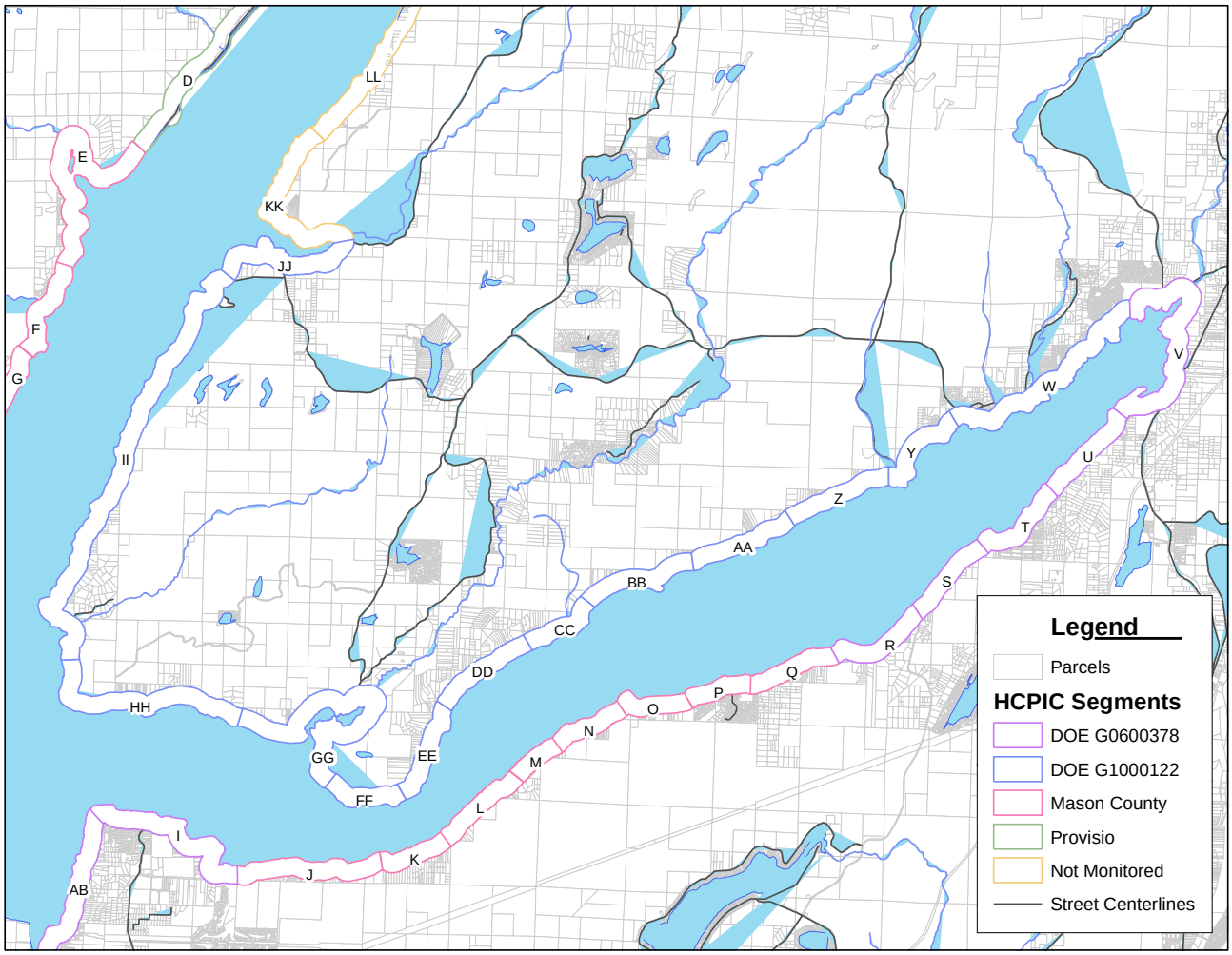
The NS-HCPIC project also included a nutrient component comprised of analyzing surface water samples within the *intensive nu-*

*trient study* areas. The nutrient study supplied data to test the hypothesis of whether there is a relationship between FC and nutrients, as stated in the 2004 PACA Report (Fagergren, Criss, & Christensen, 2004).

## 2. Project Area Description

The Mason County Northshore Hood Canal Pollution Identification and Correction (NS-HCPIC) project's study area included the northern and eastern shorelines of Hood Canal within Mason County (see **Map 1 Northshore HCPIC Final Project Boundaries).** The Northshore Segments were monitored under this DOE grant, number G1000122.

**Map 1 Northshore HCPIC Final Project Boundaries**




MCPH has divided the shoreline area into 17 segments, which are represented by the letters v – ll. These segments extend 1000' upland from the marine shoreline. The segments were divided into approximately 1-mile long sections. Some of the segments were longer and generally represent the less developed areas (see **Figure 7. Development and OSS by Segment)**

*Photo 14 Rainbow over Hood Canal*

*Figure 5. Approximate Lengths of each Segment*

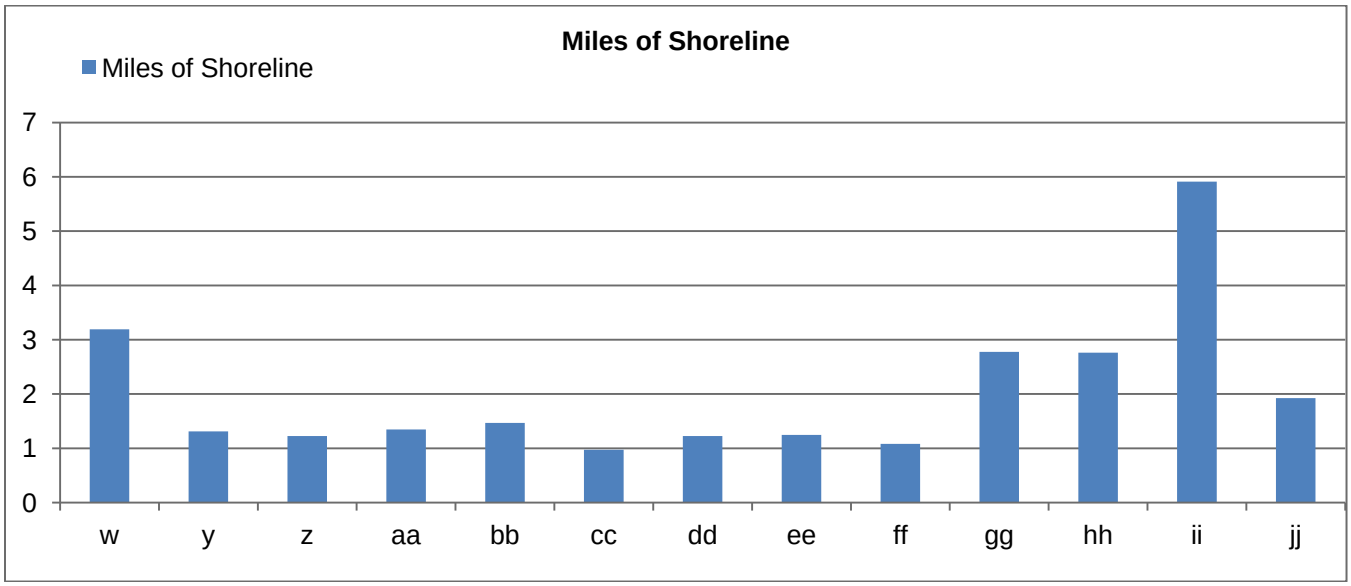
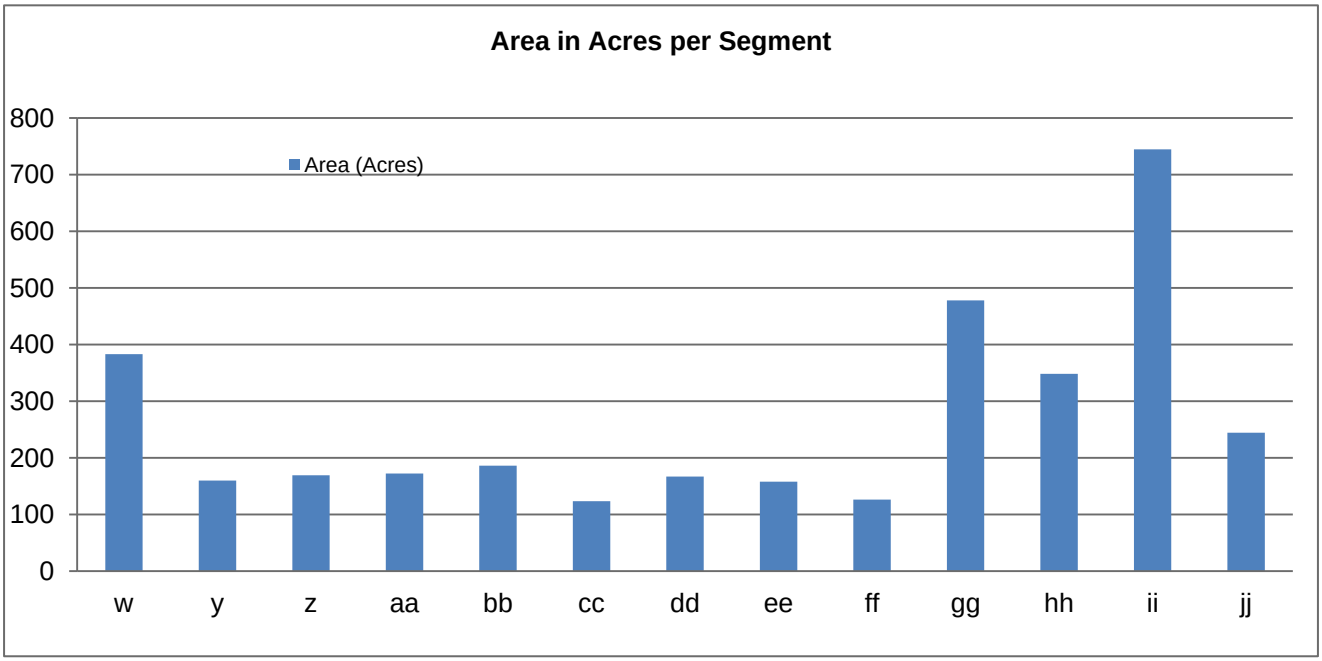


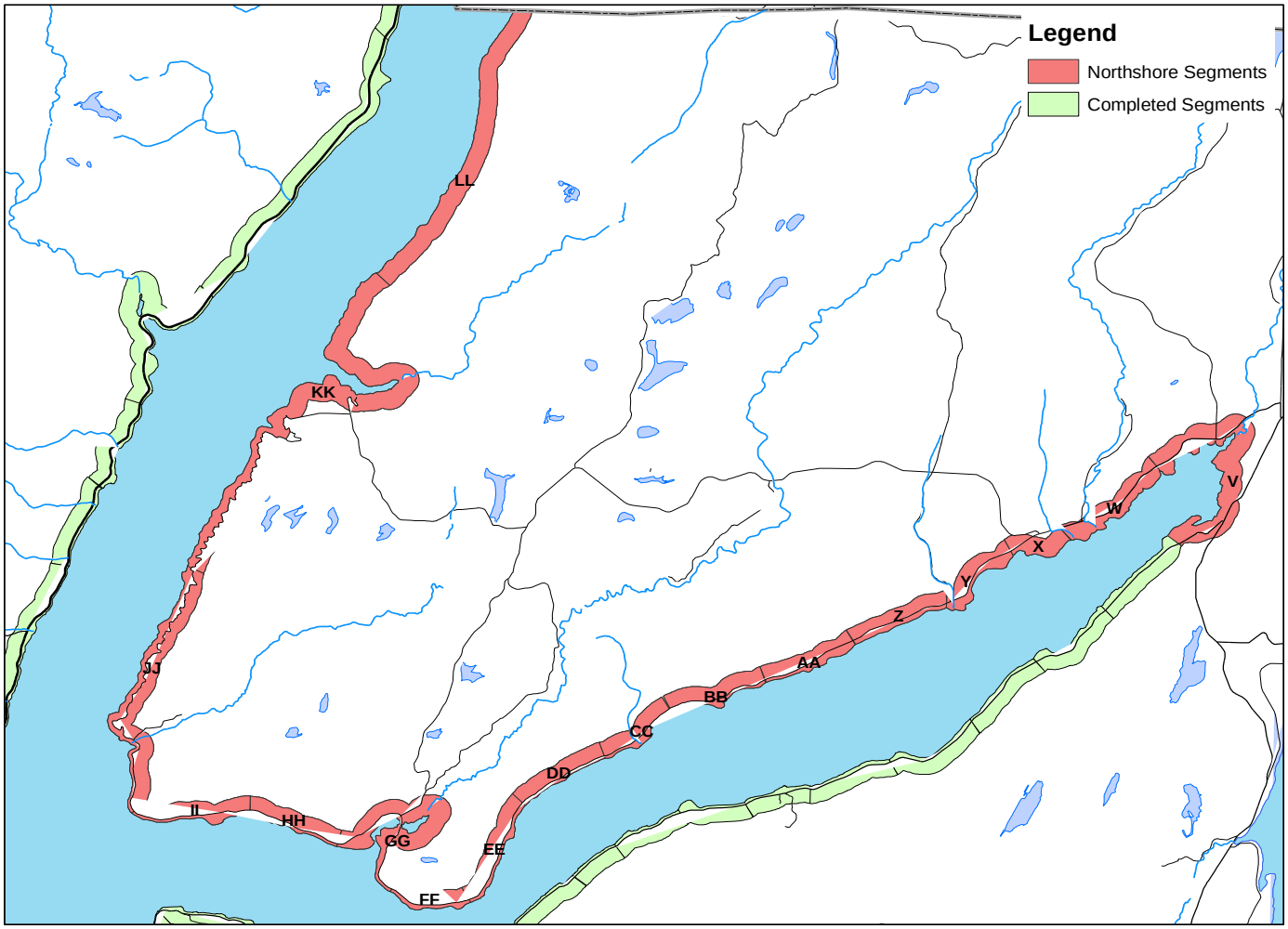

*Figure 6. Approximate Area of each Segment (Acres)*




The length of each segment is not directly proportional to the area (see **Figure 5. Approximate Lengths of each Segment** and **Figure 6. Approximate Area of each Segment (Acres)**). This is important to consider when looking at development and septic system densities from within each segment. The average area of a segment that is 1 mile long by 1000' wide is 121 acres; while 640 acres represents a square mile. Segment breaks were originally determined under the original HCPIC project. Due to some errors in the field, the original segments v and x are both represented within segment w. Segment ii includes areas of the original area of jj and jj now represents a portion of segment kk (see **Map 2 Original Segments** compared to **Map 1 Northshore HCPIC Final Project Boundaries**).

Some segments of shoreline were almost entirely undeveloped; including segment v, ii, jj, kk and ll, investigations in these areas was curtailed in order to focus on developed areas with a higher chance of achieving compliance and certain segments lacked shoreline access.

***Map 2 Original Segments***




MCPH determined the number of parcels, the number of developed parcels and the number of known and assumed OSS in each segment. MCPH then used both the area of the segments to determine the density of parcels and OSS in each segment. This information is useful in determining which segments pose the greatest pollution potential (see **Figure 7. Development and OSS by Segment**). MCPH determined that there are approximately 2302 parcels from within the study area. Of those, approximately 1509 parcels (65.6%) are classified as developed under the land use codes that are assigned by the Mason County Assessors. There are 1297 parcels (86% of the developed parcels) that have either known or assumed OSS. The study area for this project is comprised of 3460 acres that are represented along 33 miles of shoreline.

*Photo 15 Olympic Mountains peaking over the Northshore of Hood Canal*

*Figure 7. Development and OSS by Segment*

| Segment | W | Y | Z | AA | BB | CC | DD | EE | FF | GG | HH | II | JJ | **Totals or Avgs. NSPIC** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Parcels | 474 | 120 | 143 | 152 | 99 | 89 | 182 | 82 | 95 | 217 | 210 | 267 | 46 | **2302** |
| Approximate developed | 371 | 84 | 100 | 114 | 80 | 67 | 124 | 56 | 66 | 158 | 120 | 112 | 16 | **1509** |
| % of parcels developed | 78.3% | 70.0% | 69.9% | 75.0% | 80.8% | 75.3% | 68.1% | 68.3% | 69.5% | 72.8% | 57.1% | 41.9% | 34.8% | **65.6%** |
| Approximate Parcels with OSS | 353 | 75 | 89 | 103 | 59 | 47 | 89 | 34 | 53 | 143 | 100 | 103 | 13 | **1297** |
| % of dev with OSS | 95.1% | 89.3% | 89.0% | 90.4% | 73.8% | 70.1% | 71.8% | 60.7% | 80.3% | 90.5% | 83.3% | 92.0% | 81.3% | **86.0%** |
| Acres | 383 | 160 | 169 | 172 | 186 | 123 | 167 | 158 | 126 | 478 | 348 | 745 | 244 | **3460** |
| Density (avg.) (res/acre) | 0.97 | 0.53 | 0.59 | 0.66 | 0.43 | 0.54 | 0.74 | 0.35 | 0.52 | 0.33 | 0.34 | 0.15 | 0.07 | **0.44** |
| Density (avg.) (OSS/acre) | 0.92 | 0.47 | 0.53 | 0.60 | 0.32 | 0.38 | 0.53 | 0.22 | 0.42 | 0.30 | 0.29 | 0.14 | 0.05 | **0.37** |
| Miles of Shoreline | 3.19 | 1.31 | 1.22 | 1.35 | 1.47 | 0.97 | 1.22 | 1.25 | 1.08 | 2.78 | 2.76 | 5.91 | 1.92 | **33** |

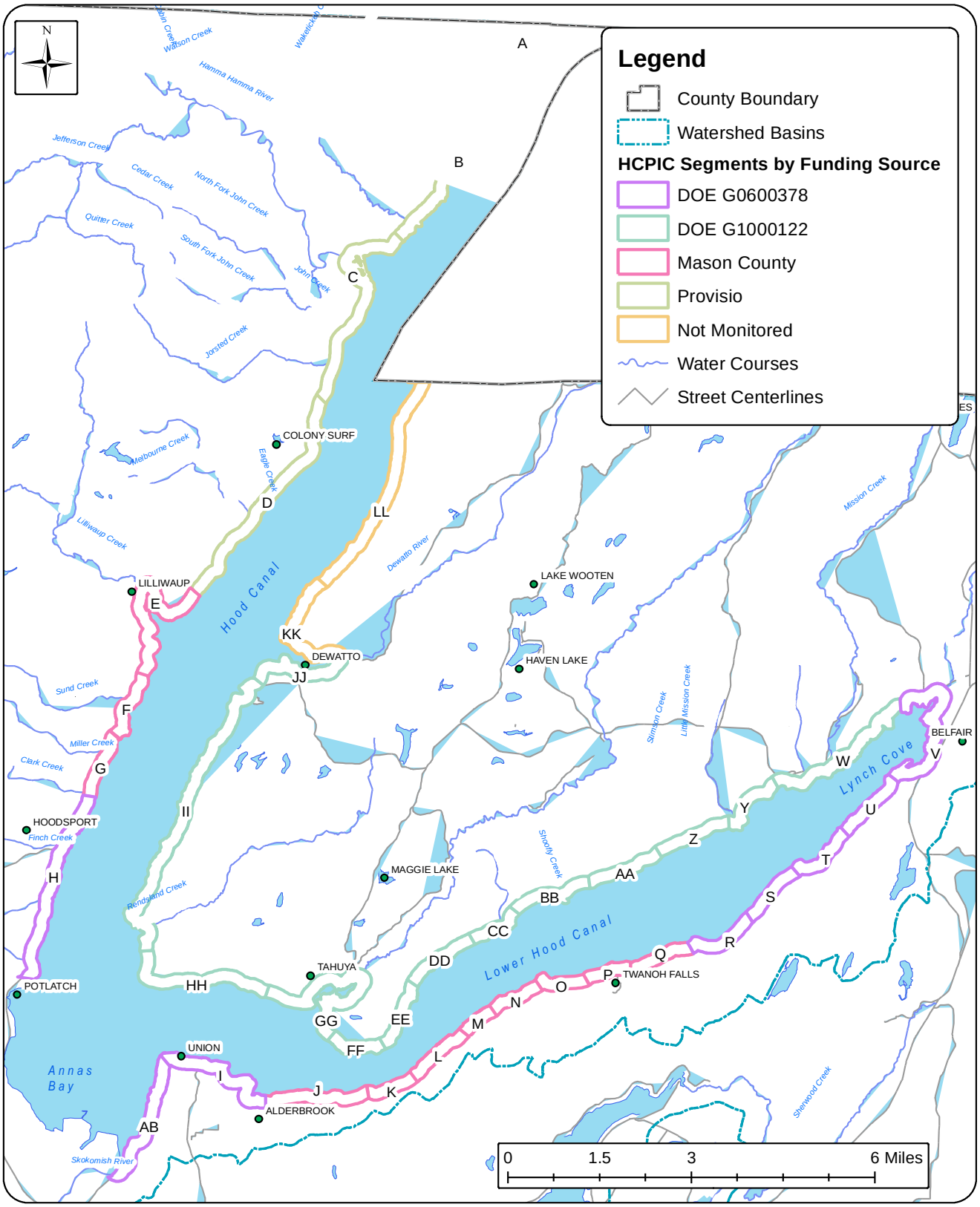
Figure 7. Development and OSS by Segment, demonstrates that segment W has the most parcels the greatest number of parcels that are developed, while segment BB has the highest percentage of parcels that are developed. Although segment W does not include Belfair, it does include a portion of several developments that make up what some may call the suburbs of Belfair. As you travel west along the Northshore Rd, most development is clustered on either side of the main throughway. If you look at the densities of OSS by segment, segment W also has the most OSS, with an average density of 0.92 OSS/acre, the next highest density segment is 0.74 OSS/acre in segment DD. Segment DD is of interest because of its steep sloped bank, which has been prone to slide during major precipitation events. There was also a lot of water coming off of this hillside during our monitoring.

Work performed under this grant includes all fecal coliform monitoring in the following segments w, y, z, aa, bb, cc, dd, ee, ff, gg, hh, ii and jj. In addition, nutrient monitoring occurred in segments dd, ee, ff, gg, hh, ii and jj (see **Map 3 HCPIC Completed Segments**).

This project is the continuation of the Mason County Hood Canal Pollution Identification and Correction Project. Prior to this grant, MCPH assessed 44.4 miles of shoreline Hood Canal for fecal coliform pollution, including 8.3 miles of monitoring with nutrient analysis. Previous fecal coliform monitoring occurred in segments a-v, including segment ab (for Annas Bay), which is located in between segment h and segment i. Previous nutrient monitoring occurred in segments h, ab and i, which extend from approximately Hoodsport south to the Skokomish Nation and then from the east side of the Skokomish River north to Union and then west to Alderbrook.

*Photo 16 Culvert Monitoring Location*

## Map 3 HCPIC Completed Segments




Map Created December 16, 2011 by A. Georgeson

# 3. Project Goals and Objectives

*Photo 17 Staff Collects a Sample from a Bulkhead Drain*

The NS-HCPIC project was designed to complete the shoreline survey of Hood Canal within Mason County. Freshwater inputs were analyzed for FC pollution along the shoreline. The monitoring was used to identify locations that had elevated levels of fecal coliform and assess nutrient levels. After identifying an elevated level, the goal was to identify the source of the pollution and correct any anthropogenic pollutions source(s). The primary focus was the identification and correction of failing OSS.

Public education regarding other pollution sources of FC (e.g. pet & livestock waste) and nutrients (e.g. yard waste, fertilizers) was addressed during Mason County Sanitary Surveys (referred to as Sanitary Survey for the remainder of this document) and at public meetings held over the course of this project (see **Sections 4.3 Sanitary Surveys** and **6. Public Education and Outreach**).

Mason County established five goals to achieve improved water quality in freshwater inputs to Hood Canal:

- Reduce FC pollution in Hood Canal from a variety of sources, including failing OSS and inadequate animal waste management within the project area.
- Provide water quality data from a limited study area to determine if there is a relationship between FC levels and nutrients that discharge to the marine shoreline.
- Provide 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.
- 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.

*Photo 18 Monitoring Location*

To accomplish these goals, the following objectives were developed:

- Collect samples for fecal coliform analysis from all freshwater discharges that flow into Hood Canal along the Northern and Eastern Shorelines of Hood Canal in Mason County.
- Reduce fecal coliform pollution entering into Hood Canal from Belfair along the Northern and Eastern Shores to Dewatto (see **Map 1 Northshore HCPIC Final Project Boundaries**) by identifying and correcting FC pollution sources.
- Measure FC and nutrient concentrations in freshwater discharges to the marine shoreline in a limited study area.
- Attempt to reduce nutrient pollution entering into Hood Canal in the *intensive nutrient study area* by identifying and correcting nutrient pollution sources.
- Where elevated FC pollution sources are identified, determine FC and nutrient concentrations in discharges before and after FC source correction.
- Perform sanitary surveys to educate residents about FC and nutrient pollution impacts to Hood Canal, and actions they can take to limit their affect.

*Photo 19 Hood Canal, View towards Lynch Cove*

# 4. Project Design and Method

There are two main components of a Pollution Identification and Correction Project, the **shoreline survey** and the **sanitary surveys**. This project was designed to assess the remaining shoreline discharges that flow into Hood Canal. It is the continuation of the HCPIC Project (2005-2008).

The purpose of the shoreline survey is to identify FC-contaminated discharges. Contaminated discharges are then used to trace the FC pollution to a property(s). Although, PIC projects normally focus on fecal pollution and fecal coliform, in order to supplement data acquired during the earlier HCPIC investigations and to better understand the relationship between nutrients and fecal coliform along the shoreline, nutrient data was collected throughout the project at sites with elevated levels of fecal coliform and at from all sites within selected segments. Nutrient sampling was not completed at all fecal coliform sites due to time, budget and logistical constraints.

MCPH then contacts the owner or occupant of the property(s) near the contaminated discharge a sanitary survey. The sanitary survey includes an interview with the homeowner(s) in an attempt to identify pollution sources and correct the anthropogenic fecal coliform or nutrient pollution source(s). The sanitary surveys are part educational and part compliance driven and customized to the individual property. The shoreline survey is performed according to Section 4.2.6 Water Quality Evaluation and the sanitary survey is performed according to Section 4.1 of the SOP.

*Photo 20 Different Types of Shoreline Monitoring Locations*

## 4.1. Shoreline Survey (Shoreline Evaluation Methods)

The target population for this project was *freshwater* shoreline discharges located in the intertidal zone prior to entering Hood Canal, including but not limited to: bulkhead drains, stormwater drainages, and shoreline seeps (collectively referred to as discharges for the remainder of this document). The main determining factors for sample site selection included salinity, flow and potential pollution impacts from the shoreline.

The sampling schedule was highly variable, mostly due to tidal fluctuations. Sampling for fecal coliform was focused on shorelines with on- and near-shore developed areas, but also included some short stretches of beach that were undeveloped

Tides of 5.5 feet or less were targeted because they are desirable for best access to the shoreline. 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. Most commonly this is the intertidal area located between the bulkhead or the ordinary high water line and the marine water.

When shoreline discharges were sighted, staff collected 100mL samples of water, observing all procedures from the Northshore Hood Canal PIC Quality Assurance Project Plan QAPP (Georgeson, NS-HCPIC QAPP, 2010) and MCPH's SOPs (see Section 2.0. Monitoring Parameters and Field Procedures)(Georgeson, Mathews, Book, & Kenny, 2007). Determining where to monitor a seep can be problematic. For long sheeting-seeps professional judgment was used to determine where and how many samples were needed for each seep. Staff assessed the potential impact from the shoreline to help determine where to sample.

The bacteria criteria guiding corrective action is based on Chapter 173-201A of the Washington Administrative Code (WAC)(WAC 173-201A, 2011). For freshwater, the geometric mean cannot exceed 50 FC/100ml and no more than 10% of samples (or any single sample when less than 10 samples exist) exceeding 100 FC/100mL. All of Hood Canal in Mason County is classified to meet the Extraordinary Contact Water Quality Standard.

*Photo 21 Staff Collects a GPS Point from a Monitoring Location*

Staff traversed 26.4 miles of shoreline and collected water samples for laboratory analysis. MCPH traversed each segment at least once and most segments were traversed twice. The area that was only traversed once included an area north of Rendsland Creek that was inaccessible during the winter, due to a lack of access.

Where initial FC results were ≥ 200 FC/100mL, MCPH returned to those sites to perform confirmation FC monitoring. High confirmation results triggered Mason County Sanitary Surveys.

If confirmation sample results were below 200 MPN FC, a confirmation re-sample was scheduled, preferably during wet weather. Generally, MCPH attempts to re-sample during wet weather, when an OSS is more likely stressed. This is due to problems such as high ground water levels and increased surface water runoff resulting in potential inundation of the OSS thereby preventing proper treatment. 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.

As per the MCPH SOP, a photo of each monitoring location, written description and GPS coordinates of each sampling location was collected. Samples were analyzed for FC and nutrients at the DOE-accredited Mason County Water Lab using DOE-accredited methods.

## 4.1. Salinity

Fecal coliform bacteria have reduced life expectancy in water with higher salinity, as reflected in the different state Water Quality Standards for fresh and marine water. Some drainages can be influenced by salt-water recharge discharging onto the beach and can exceed 20 parts per thousand (ppt) during outgoing tides. During previous PIC projects, MCPH has found that samples with high salinity readings were generally not associated with upland flows and typically had low levels of FC. MCPH is most interested in monitoring freshwater flowing out onto the beach. Therefore samples were (generally) not collected at sites with salinity readings above 10 ppt. However, in areas where no other water was available for monitoring, professional judgment was used to make a site specific determination on whether to perform monitoring.

Salinity measurements were taken in the field using a refractometer and the reading was recorded in the field notebooks.

*Photo 22 Staff uses a Refractometer to Determine Salinity*

*Photo 23 Culvert Monitoring Location*

## 4.2. Nutrient Study Method

The nutrient monitoring portion of Mason County's North Shore HCPIC was designed to gather data to help assess the concern about cultural eutrophication, contributing excess anthropogenic nutrients, to Hood Canal from *shoreline* discharges and to determine if there is a connection between fecal coliform and nutrients and to better understand the relationship between OSS and nutrients. Nutrient analysis of shoreline discharges cannot completely assess the relationship between FC and nutrients due to unknown variables such as the contribution of background, non-OSS or animal waste sources of nutrients or the spatial, temporal or environmental variation of FC and nutrients.

Since nitrogen is the limiting nutrient in the Hood Canal, MCPH had samples analyzed for ammonia-nitrogen and nitrate+nitrite-nitrogen. MCPH also included ortho-phosphate, since it is often associated with grey water discharges. MCPH found that in the previous HCPIC project, that these

nutrients can help identify failing OSS or greywater discharges, and provide an indication of the distance of the failure to the monitoring location. MCPH selected segments in areas to assess what kind of nutrient inputs are entering the marine waters from selected shorelines near to the Great Bend area. In addition to the nutrient segments, nutrient samples were also collected from sites where the initial FC result was ≥ 900.

*Photo 24 Creek Monitoring Location*

MCPH originally selected four segments, z, aa, hh and ii, for intensive nutrient monitoring (see Map 1 Northshore HCPIC Final Project Boundaries). However, MCPH changed to segments dd, ff, gg, hh and ii during the first monitoring event and then picked up segments ee and jj during the second monitoring event. In these segments, nutrient sampling was conducted at all discharges in combination with fecal coliform monitoring.

*Photo 25 Seep Monitoring Location*

Segment dd and segment gg were chosen for intensive nutrient analysis because they have high development density along the North Shore. Segments hh and ii were originally chosen for their mixed development and their proximity to the Great Bend/Annas Bay area, the area most susceptible to fish kills. Segments ee and jj were included in the second round of monitoring to collect more data from a broader area and because there was additional monitoring funds, since there were far fewer monitoring locations than MCPH had anticipated. Segment ii and jj were the least developed segments that were monitored within the project study area.

*Photo 26 Culvert Monitoring Location*

The data collected from these segments is being used to assess the relationship between nutrient pollution and FC pollution. It has also helped to establish a baseline of the average shoreline inputs of freshwater nutrients entering into the marine water. Currently the data is being used, in combination with USGS's groundwater flow estimate to assess the findings of the HCDOP models and to help determine if shoreline OSSs are a significant source of nitrogen to Lower Hood Canal.

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, minimizing fertilizer use and properly maintaining an OSS).

*Photo 27 Northshore of Hood Canal and the Olympic Mountains*

Twiss Analytical Labs performed nutrient analysis for ammonia-nitrogen, nitrate+nitrite-nitrogen and orthophosphate. The sample 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. All methods for monitoring, recording and quality assurance followed those prescribed in the QAPP.

## Map 4 Nutrient Monitoring Segments


*Photo 28 Tahuya Neighborhood Sign*

## 4.3. Sanitary Survey Methods

MCPH identified sites for sanitary surveys either from elevated fecal coliform results from shoreline monitoring locations or from sites that were ranked as having a high fecal pollution potential. MCPH identified FC sources following the Mason County Sanitary Survey procedures outlined in the Mason County SOP. Pollution sources are corrected whenever possible. MCPH assesses the functionality of OSSs, through dye testing, to determine if it is a fecal coliform pollution source. During sanitary surveys, MCPH educates residents about proper domestic animal waste management and about other best land-use practices to minimize the risk of polluting surface waters.

MCPH prioritized and ranked parcel data to identify additional sites for sanitary surveys. For the parcel ranking, MCPH utilized existing data, collected on October 15, 2010, including:

- Parcel Data, including Assessor's information
- Segment Data
- Type of OSS
- OSS installation date
- Last OSS service date
- Unsatisfactory service events
- 1990s Lower Hood Canal sanitary survey data
- State Department of Health OSS data
- OSS complaints

*Photo 29 Surfacing Sewage*

Sanitary Surveys include:

- a staff review of parcel and OSS-records (a copy of the records were provided to the homeowner)
- an OSS O&M database search, to determine if the OSS had proper O&M and if there were any issues identified through a service event
- an interview with the homeowner or resident
- a property survey to identify the location of OSS components and their above-ground condition
- providing homeowners with best land-use practices to minimize FC and nutrient pollution risks

*Photo 30 Staff Placing Charcoal Packets for a Dye Test*

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, to identify any OSS/surface water connection, incomplete treatment, greywater discharges, etc.

Sanitary surveys provide the opportunity to educate resident about proper O&M of their OSS in order to prolong its life and ways to protect it from unintentional damage. Sanitary surveys also provide 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.

All data collected from surveys was recorded onto survey forms including the following:

- ❖ Property Information
  - Parcel
  - Address
  - Owner, etc.
- ❖ Septic System Information
  - System type
  - OSS Install Date
  - Alterations or repairs
  - O&M status
  - If As-built Records exist
  - Household water usage
- ❖ Field Inspection Information
  - OSS condition
  - Surface water management
  - Native Vegetation and Natural Plantings
  - Pet or livestock, etc.
- ❖ Final Rating OSS
  - No Apparent Problem
  - No Records
  - Non-Conforming
  - Suspect
  - Failure

Data collected during the surveys was then entered into the North Shore HCPIC's OSS Tracker (Excel database) and summary data was populated (**5.2 Sanitary Survey Results** below). Carmody was updated with the O&M status and system type information.

*Photo 31 Creeks and Culverts*

# 5. Results and Discussion

## 5.1. Shoreline Survey Results (Monitoring)

Since July 2010, Mason County Public Health has surveyed 26.4 miles along Hood Canal for shoreline discharges. MCPH collected over 800 water samples, which were analyzed for FC bacteria, from 467 individual shoreline monitoring locations. Samples were collected a period of 49 monitoring days (see **Map 5 Overview of FC Monitoring Locations** and **Figure 8. Samples by Season**).

The discharges ranged from small seeps that surface out on the tidal mud flats to major rivers that flow into Hood Canal. The segments with the most samples collected during dry weather monitoring were y, dd and ii. The segments with the most samples collected during wet weather are w, y and dd. Generally, these segments have dense development along the shoreline, poor soils and are areas prone to excess surface and groundwater run-off. Some of these segments namely, y and w, may also have more full-time residences.

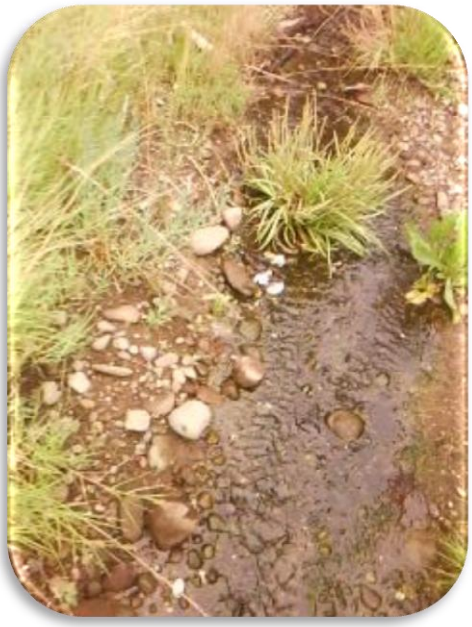
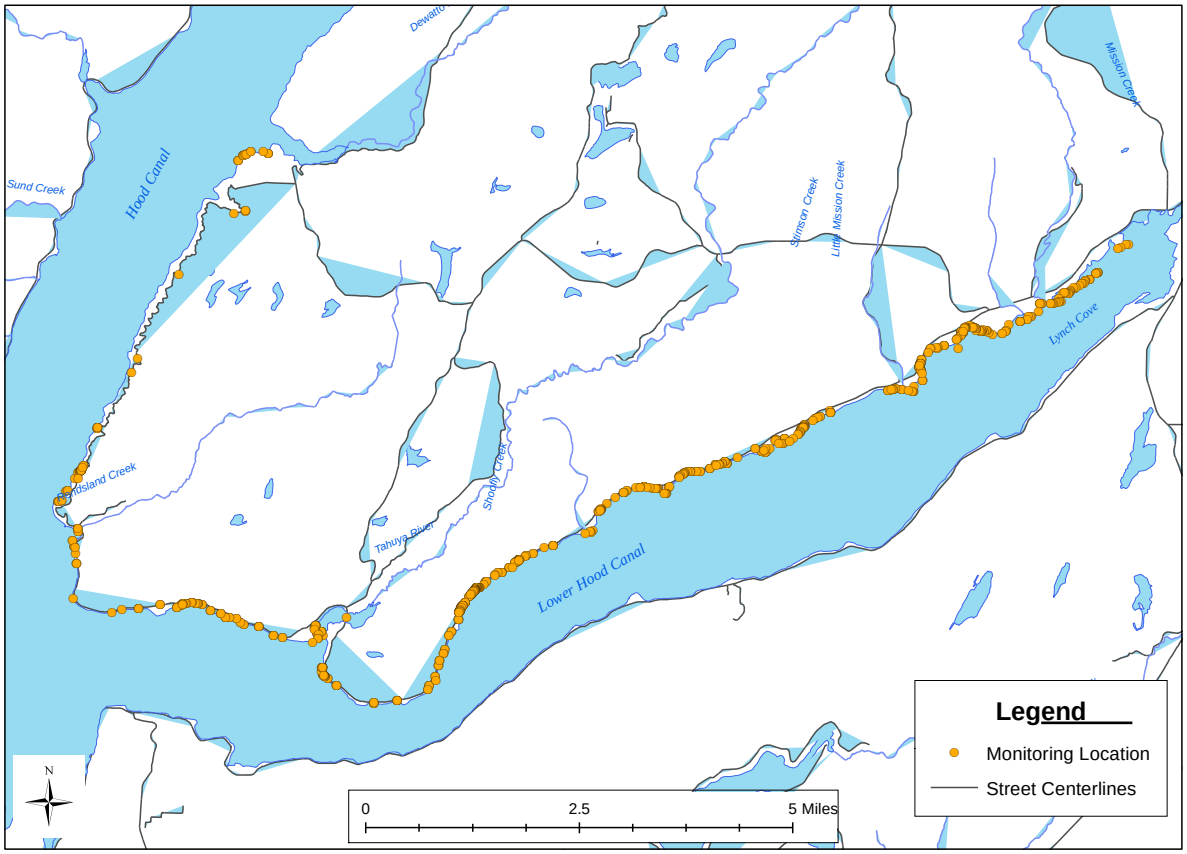


*Photo 32 Small Creek on the Northshore*

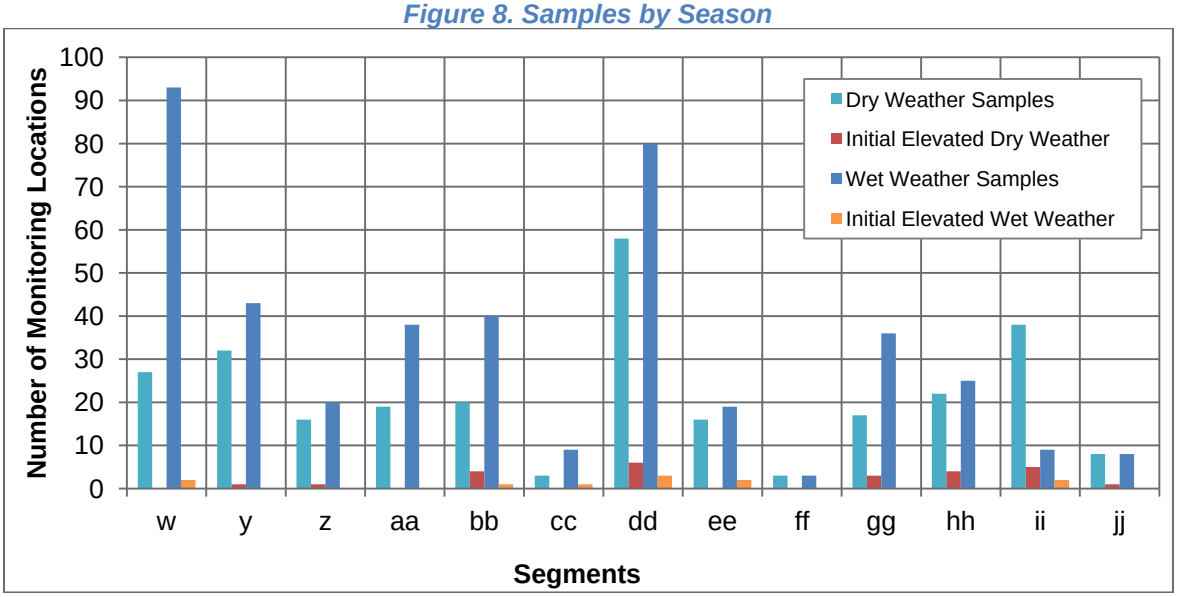
**Map 5 Overview of FC Monitoring Locations**




Created for Mason County Public Health by A. Georgeson November 9, 2011

MCPH compared samples collected during the dry season and wet season and the number of elevated samples from each season. There was a 20% increase in the number of wet weather monitoring locations versus dry weather monitoring locations, while there was a 24% decrease in the total number of elevated samples from wet weather to dry weather. MCPH hypothesizes that this is due to the seasonal nature of many of the residents in this area. If an OSS was failing, it would be unlikely that MCPH would be able to identify it when the residence is not being occupied.

***Figure 8. Samples by Season***



MCPH also compared monitoring events in wet and dry weather and monitoring results between Memorial Day and Labor Day (Summer Vacation Residences) versus Labor Day to Memorial Day (Full Time Residences). It is evident that there is a higher percentage of elevated sample results in the both the dry season or the vacation season (see **Figure 9. Dry/Wet and Vacation/Full-time Sample Comparison**). This data supports performing intensive PIC monitoring during the summer, in areas such as Hood Canal with a high seasonal population. This data also supports performing dye test during the summer months in these areas.

*Figure 9. Dry/Wet and Vacation/Full-time Sample Comparison*

| Monitoring Type | Dry | Wet | Vacation | Full Time |
|---|---|---|---|---|
| Dates | 6/28/10 - 10/5/10 & 7/25/11 - 8/2/11 | 11/3/10 - 7/25/11 & 10/4/11 - 10/5/11 | Memorial Day - Labor Day | Labor Day - Memorial Day |
| Monitoring Events | 26 | 23 | 29 | 20 |
| Samples (includes multiple at one site) | 413 | 452 | 504 | 361 |
| Number of samples >200 | 27 | 9 | 30 | 6 |
| Percent Elevated/Total # of Samples | 6.5% | 2.0% | 6.0% | 1.7% |

Of the 730 monitoring results (not including field duplicates or blanks), 36 (5%) of the initial sites had results that were above the 200fc/100-mL threshold. MCPH was able to obtain confirmation samples from 28 (78%) monitoring locations. MCPH was not able to perform confirmation monitoring at 7 locations (see **Figure 10. Sites without Confirmation Samples**).

*Figure 10. Sites without Confirmation Samples*

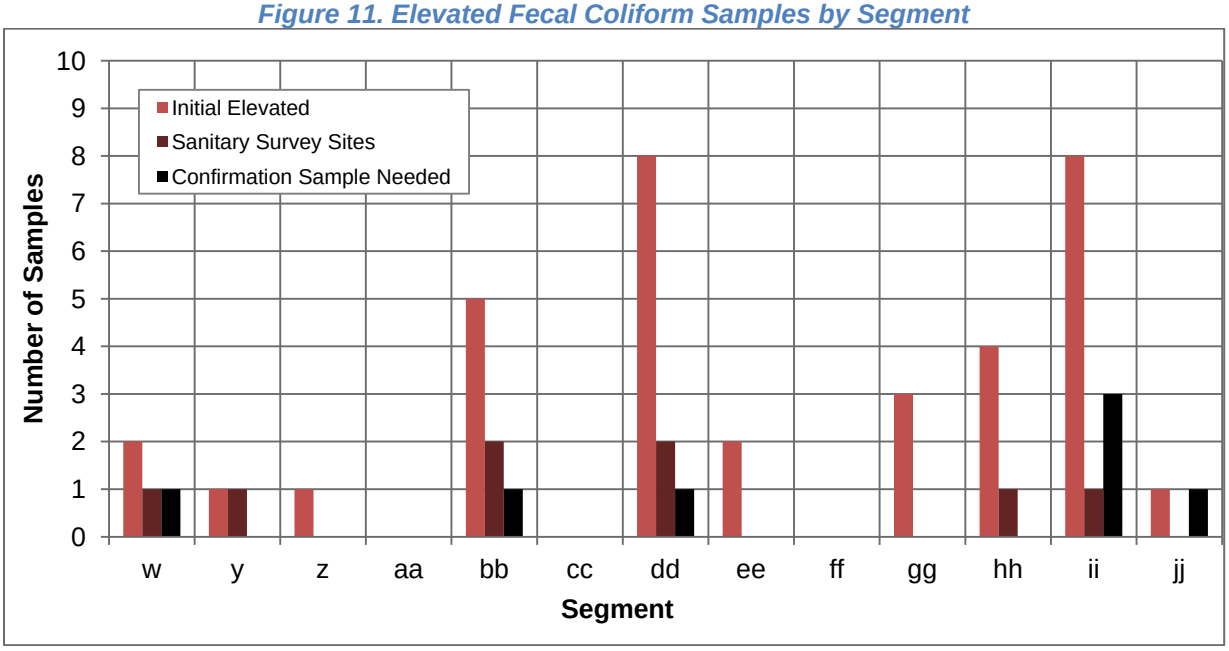
| Site Number | Type of Discharge | Justification for not performing a confirmation sample |
|---|---|---|
| bb-020d | bh drain | No flow 6/29/11 or 10/4/11, appeared to be seasonal occupancy, |
| dd-003 | bh drain | No flow 6/29/11 or 10/4/11, appeared to be seasonal occupancy |
| hh-007 | bh drain | Confirmation sample taken at hh-007a above NSR, inaccessible on 10/4/11 |
| ii-005 | small creek | 1st elevated sample, 7/27/11, no flow on 8/1/11, inaccessible on 10/4/11 |
| ii-006 | small creek | 1st elevated sample, 7/27/11, no flow on 8/1/11, inaccessible on 10/4/11 |
| ii-025a | roadside drainage | Sampled on the last day of monitoring 10/5/11 |
| jj-002 | bh crack | Tide was too high to access on 10/4/11 or 10/5/11 |
| w-021e | 1" pipe | Stormwater Drainage, no flow 4/19/11 or 10/4/11 |

Of the confirmation samples, only 8 results (1% of all samples) were above the 200fc/100-mL threshold. The segments with the highest number of elevated FC sample results include bb, dd and ii (see **Figure 11. Elevated Fecal Coliform Samples by Segment**).

MCPH determined the average density of monitoring locations per mile, by segment, within the project area (see **Figure 12. Density of Monitoring Locations**). The average density is useful in determining which segments had the most run-off during the time that MCPH performed the water quality monitoring. Segments with more surface water discharges are of greater concern. This is due to:

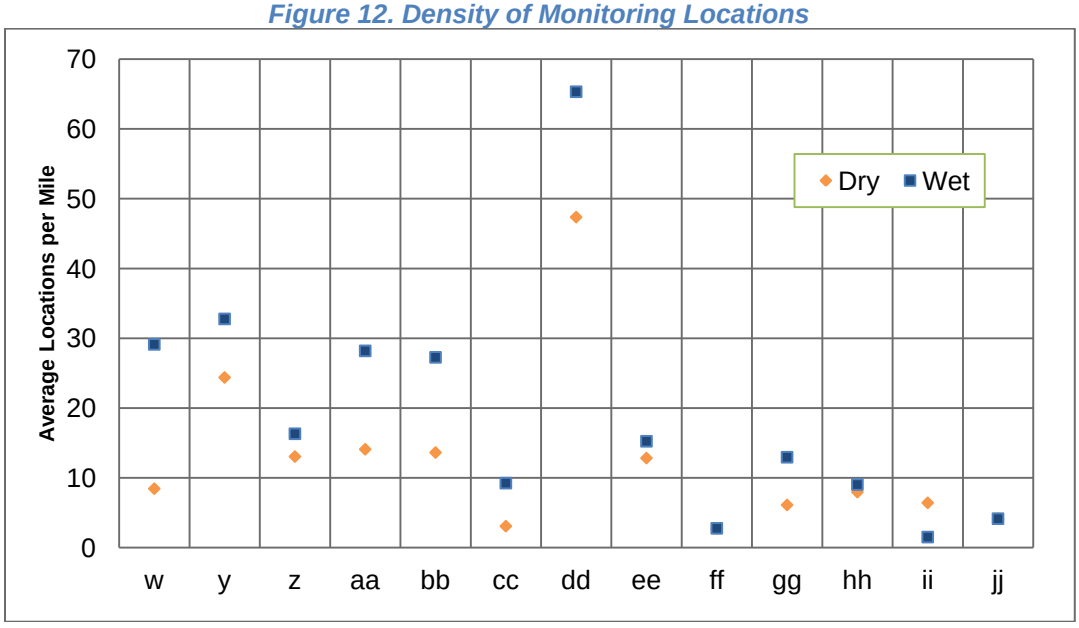
- the potential inundation of OSS, which can stress or cause failure of the system and
- the primary method used to identify an OSS failure is the an elevated FC results in combination with a positive dye test, so there is an increased likelihood of identifying an OSS failure

*Figure 11. Elevated Fecal Coliform Samples by Segment*




Therefore, those segments with more surface water are more likely to produce the necessary evidence of an OSS failure, while MCPH will find it more difficult to identify OSS failures in those segments where there are fewer discharges. This is evident in segment dd, which had the highest density of monitoring locations and the highest number of elevated fecal coliform sites/mile.

*Figure 12. Density of Monitoring Locations*




When an initial sample result is elevated, followed by a confirmation sample result that is not elevated (<200FC/100mL), MCPH's standard procedure is to perform a confirmation re-sample at that site. MCPH identified 25 sites to perform confirmation re-sampling because the original result was elevated followed by a confirmation sample that was not elevated. Of the 25 sites, 17 were re-sampled as part of this project. An additional 8 sites did not receive confirmation re-sampling mostly due to timing, because the confirmation sample was taken on one of the last days of monitoring or no flow.

*Figure 13. Sites without Confirmation Re-sample*

| Site Number | Type of Discharge | Justification for not performing a *confirmation re-sample*: |
|---|---|---|
| dd-003d | bh drain | Confirmation sample taken on the 2nd to the last day of monitoring 10/4/11 |
| ee-002 | bh drain | Confirmation sample taken on the last day of monitoring 10/5/11 |
| ee-012 | 24" Culvert | Confirmation sample taken on the 2nd to the last day of monitoring 10/4/11 |
| gg-005b | seep | Confirmation sample taken on the last day of monitoring 10/5/11 |
| ii-008 | Hillside drip | No flow 7/27/11, tide too high to access on 10/4/11 or 10/5/11 |
| ii-026 | bh drain | Confirmation sample taken on the last day of monitoring 10/5/11 |
| ii-031 | bh drain | Confirmation sample taken on the last day of monitoring 10/5/11 |
| ii-101 | roadside drainage | Confirmation sample taken on the 2nd to the last day of monitoring 10/4/11 |

Based on monitoring results, MCPH determined that further investigations were needed at 7 sites including sanitary surveys and potentially dye tests. MCPH was not able to make contact with the homeowners of these 7 during the course of this project.

## 5.2. Sanitary Survey Results

MCPH identified sites for sanitary surveys either from sites that were *ranked* as *having a high fecal pollution potential,* based off of existing data or from *elevated fecal coliform results* collected from shoreline monitoring.

*Photo 33 Culvert Monitoring Location*

### 5.2.1. Sanitary Surveys based on Existing Data

As part of the ranking process, MCPH used data obtained on 10/15/10 to identified ~1298 "developed" parcels from within the Northshore Hood Canal Study Area. MCPH then utilized ArcMap to join parcel data with the data listed in section 4.3 sanitary surveys. MCPH performed analysis on these parcels to rank those that are most likely to be contributing to fecal pollution in surface water. Each of the ranking criteria received a score between 1 and 5. However, each of the following categories was weighted with a higher score between 30 and 35, because they are categories that pose a significantly greater pollution risk:

- Drainfield less than100' from surface water
- Seepage pits
- Sites with unsatisfactory OSS service events

The total minimum score was 4 and the maximum was 92. A score of 4 represents a site where everything is known (system type and age, location, proper O&M and no known issues). While a score of 92 represents a site with a seepage pit that has had an unsatisfactory O&M service event and has no as-built. The average score is 27. Only 10% of the sites that were ranked had a score greater than or equal to 42. MCPH prioritized properties for sanitary surveys that received a score of 36 or higher.

During the ranking process, MCPH prioritized 286 (14%) properties for sanitary surveys from within the study area. MCPH's goal was to complete sanitary surveys at about 1/3 of those sites. Based on previous projects MCPH knew that it is important to include many more sites than you are hoping to survey. This is because of many different factors including, sites where no one is home during the site visit, sites that are vacant, sites where we are denied access, etc.

MCPH performed sanitary surveys at 51 sites (18% of the 286 sites identified for sanitary surveys). While attempting to perform sanitary surveys, 6 sites (6%) denied access and 9 sites (10%) chose not to participate. Denied access represents those sites where the owner/occupant actually instructs us to leave the

property. Whereas 'did not participate' represents properties that seem willing to have a sanitary survey performed and they do not outright ask us to leave the property, but for one reason or another, the survey is not completed, such as already knowledgeable in water quality pollution prevention/OSS, scheduling conflicts, too busy, uninterested, etc.

*Photo 34 Looking Northwest from the Eastern Shore of Annas Bay*

MCPH had issues finding sites where the owners were actually home so that sanitary surveys could be performed. In order to gain greater participation MCPH tried the following:

- MCPH made multiple sites visits. MCPH made 176 initial site visits. Of the 176 sites, at least 27 have had a 2nd site visit and at least 12 have had a 3rd site visit[7]. These site visits, also include the sites where surveys were eventually performed.
- MCPH compared all of the mailing addresses to the site addresses, assuming that those sites where the addresses were the same would be more likely to have people actually living at them. MCPH prioritized those sites for field inspection; however MCPH was still unable to make contact with the homeowners. MCPH hypothesizes that these sites may also be part-time occupancy or they work the same normal business hours that MCPH works.
- MCPH sent out letters to 40 homeowners in January, 2011, in an attempt to get homeowners to contact us to schedule an appointment for a sanitary survey at their convenience, which included the option to schedule sanitary surveys in the evening or on weekends. MCPH did not receive any responses to these letters.
- MCPH attempted to perform sanitary surveys on several Saturdays. MCPH was able to obtain participation from a few residents, but not enough to continue to warrant working on Saturdays.
- MCPH left door hangers that requested residents to contact MCPH to schedule a sanitary survey and educational packets at 55 residences, which were picked up by the residents[8]

*Photo 35 Birds Flying over Hood Canal*

[7] MCPH did not initially track the number of visits to each site, so the number of follow-up visits is actually higher.
[8] MCPH left additional door hangers/educational packets, but if they were not removed by the resident, when MCPH returned to the area, we retrieved the door hangers, in case the residence was vacant.

### 5.2.2. Sanitary Surveys based on Elevated Fecal Coliform Results

*Photo 36 Culvert Monitoring Location*

MCPH identified 7 properties (1.5% of total monitoring locations) for sanitary surveys based on elevated confirmation sample results. MCPH was unable to survey any of the properties associated with elevated fecal coliform samples, either because the property owners did not respond to MCPH's requests or MCPH was unable to contact the owner within the time allotted. Several sites appear to be seasonal use. At the sites that were identified earlier on in the project, MCPH made several site visits to each site, but was unable to make contact with residents. Two properties were identified at the end of the project, leaving little time to attempt to contact the residents (See **Figure 14. Properties that did not receive Sanitary Surveys** and **Section 8. Recommendations**, for further information on work that needs to be performed at these properties). Although MCPH was not able to perform sanitary surveys at these sites during this grant period, MCPH does have another DOE grant project (G1000278) that will allow us to continue to attempt to follow-up at these sites to determine if there are failing OSS or animal waste management issues that can be resolved.

***Figure 14. Properties that did not receive Sanitary Surveys***

| Sites that need SS | Type of Discharge | Level of Concern | Reason SS has not been performed | Notes |
|---|---|---|---|---|
| **w-022b** | Drainage Pipe on Beach | High | NOH (No One Home) | One of two sites of interest was suspect during the Lower Hood Canal Sanitary Surveys of the 90s. |
| **bb-017** | Culvert | High | NOH | Water daylights briefly upstream of NSR, flow comes from area of drainfield, OSS is of concern. |
| **dd-004** | BH Drain | High | Sampled at end of Project | Two structures built out over the water, tank right behind bulkhead, unsure of drainfield location, one structure was being remodeled during 2011. One structure was previously suspect with dye at bulkhead in multiple locations. |
| **dd-007** | Seep | High | NOH | Seep out on the beach, the structure does have an OSS tank located on the beach, but it on the other side of the structure from this site. Water and wetland type plants on the upland side of NSR. The structures in this area appear to be built on fill or are out over the water. OSS is of concern. |
| **y-014** | Culvert | Medium | Seasonal Use and NOH | Documented grey-water discharge, unsure of if there is an additional fecal coliform source. |
| **hh-007** | 12" Culvert | Medium | Sampled at end of Project | This site has several large dogs, also this tight-lined stream may have a hydrologic connection with a drainfield, OSS is of concern. |
| **ii-030** | Seep on Beach | Medium | Seasonal Use and NOH | Both of the fecal coliform levels were elevated, but low, not sure if there were residents present during either monitoring event, OSS is of concern. |
| **bb-017b** | Downspout | Low | Source Identified, No Survey | Direct Discharge from roof, birds are the source of fecal pollution |

### 5.2.3. Other Identified or Repaired Failures

MCPH identified one OSS failure from the shoreline. There was a cracked transport line under the structure, prior to reaching the septic tank. The structure was built out over the water. MCPH has notified the out of state homeowner. After several months without any contact from the homeowners, MCPH posted this structure for non-occupancy. This site continues to be posted for non-occupancy and the homeowner has not yet attempted to contact MCPH.

MCPH oversaw repairs of an OSS that was identified as a failure during the 1990's Lower Hood Canal Sanitary Surveys. The structure had not previously been posted for non-occupancy. MCPH posted the structure for non-occupancy, while the homeowner requested and received a variance to install a holding tank at his property. The variance required a 1200 gallon tank with audio and visual alarms and an annual pumping contract. It also included a notice to title, which describes that there is only a holding tank at the site. An additional stipulation of the variance is that no new building permits can be issued without installing a conforming drainfield. The holding tank and alarms have been installed; however the postings have not been removed because the designer has not provided an as-built.

*Photo 37 Creek Monitoring Location*

In addition, MCPH permitted 6 new OSS and 18 repair or replacement OSS within the study area between July 2010 and December 2011. Since 1992, the year that Mason County Public Health started keeping electronic track of permits for OSS, there have been 292 OSS (22% of parcels with an OSS within the study area), which have either had an OSS installed or replaced.

## 5.3. Nutrient Study Results

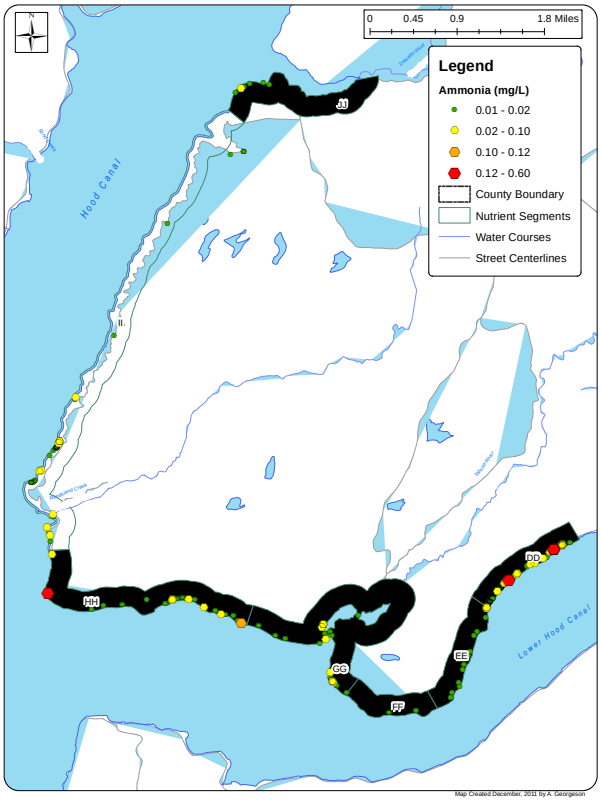
Since August 2010, MCPH has surveyed ~16.93 miles of Hood Canal Shoreline for freshwater discharges, which were analyzed for nutrients, in addition to fecal coliform. This includes segments that were monitored in both the wet and dry seasons. The water samples were analyzed for the following nutrients: ammonia-nitrogen ($NH_3$-N), nitrate+nitrite-nitrogen ($NO_2$+$NO_3$-N) and ortho-phosphate ($PO_4$-P). MCPH collected ~351 shoreline samples from ~222 individual monitoring locations (see **Map 6 Overview of Nutrient Monitoring Locations**). These samples were collected over a period of 24 days. The discharges range from small seeps to rivers.

*Photo 38 Dewatto Bay*

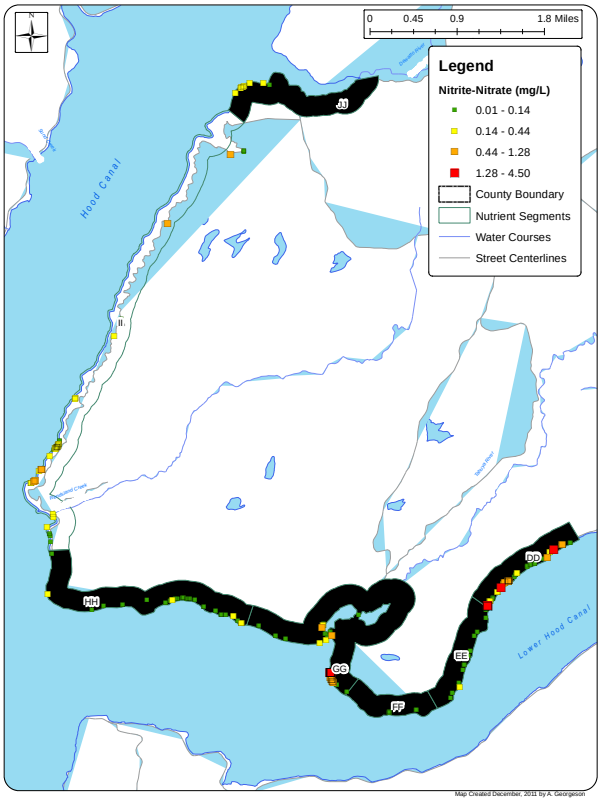
## Map 6 Overview of Nutrient Monitoring Locations


Map Created December, 2011 by A. Georgeson

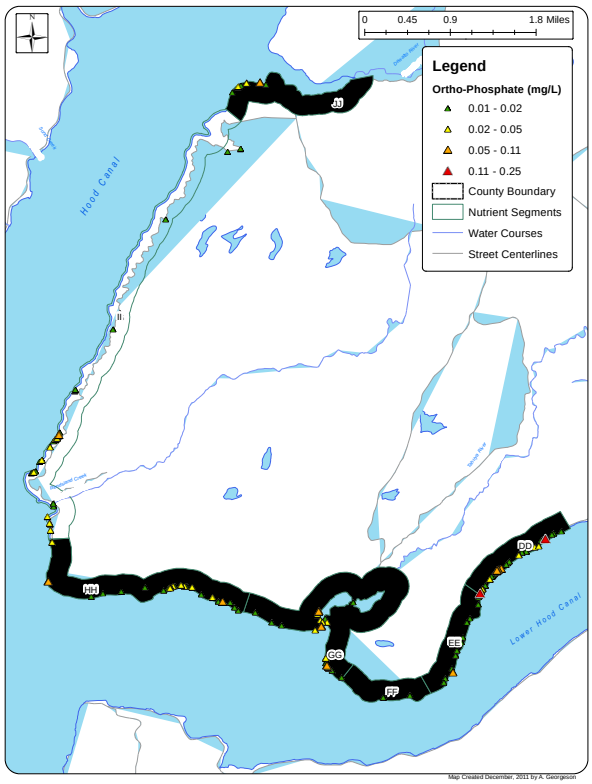
## Map 7 Overview of Ammonia Results




## Map 8 Overview of Nitrate+Nitrite Results




## Map 9 Overview of Orthophosphate Results



### 5.3.1. MCPH Nutrient and Fecal Coliform Analysis

Since MCPH has not confirmed any failures through this project, MCPH can only compare data related to those sites where the fecal coliform level does not meet the extraordinary water quality standard (any single sample that exceeds 100 FC/100mL). MCPH found that of the 351 total nutrient samples that were taken, 40 (12%) were associated with a fecal coliform results greater than 100 FC/100mL, while 307 (88%) were associated with fecal coliform levels below 100 FC/100mL.

*Photo 39 Seals and Blue Herons at the Mouth of the Hamma Hamma River*

MCPH first analyzed nutrient data by looking at all of the original data, including samples taken in both wet and dry weather and multiple samples taken from a single location (see **Figure 15. NS-HCPIC Summary Statistics of Nutrient Monitoring Results**). The overall message from this data is that low levels of nutrients are entering the marine water from these shoreline discharges.

For the NS-HCPIC data, the average for ammonia-nitrogen was 0.02; while the median and mode were both 0.01 and the minimum detection limit was 0.01 and the maximum result was 0.60. The average for Nitrate+nitrite-nitrogen was 0.21; while the median was 0.07 and mode was 0.01. The minimum detection limit was 0.01 and the maximum result was 4.50. The average for orthophosphate was 0.03; while the median and mode were 0.01 and the minimum detection limit was 0.01 and the maximum result was 0.25.

*Photo 40 Looking North from the Eastern Shore of Hood Canal*

*All FC results are in FC/100-mL and all nutrient results are in mg/L in the following data sets.*

***Figure 15. NS-HCPIC Summary Statistics of Nutrient Monitoring Results***

| | Ammonia ($NH_3$-N) as Nitro-gen (N) | Nitrite-Nitrate as N | NH3 + NO2 + NO3 - N | Ortho-Phosphate | Salinity |
|---|---|---|---|---|---|
| **Average** | 0.02 | 0.21 | 0.23 | 0.02 | 1 |
| **Median** | 0.01 | 0.07 | 0.09 | 0.01 | 0 |
| **Mode** | 0.01 | 0.01 | 0.02 | 0.01 | 0 |
| **Max** | 0.60 | 4.50 | 4.51 | 0.25 | 20 |
| **Min** | 0.01 | 0.01 | 0.02 | 0.01 | 0 |
| **90th Percentile** | 0.04 | 0.49 | 0.52 | 0.05 | 3 |
| **St. Dev.** | 0.05 | 0.43 | 0.43 | 0.03 | 3 |
| **Count** | 347 | 347 | 347 | 347 | 347 |

MCPH then compared the NS-HCPIC data with the data that was collected under the HCPIC project. The HCPIC project study area included samples taken from the Western and Southern Shores of Hood Canal in Mason County. The monitoring was performed between 2007 and 2008.

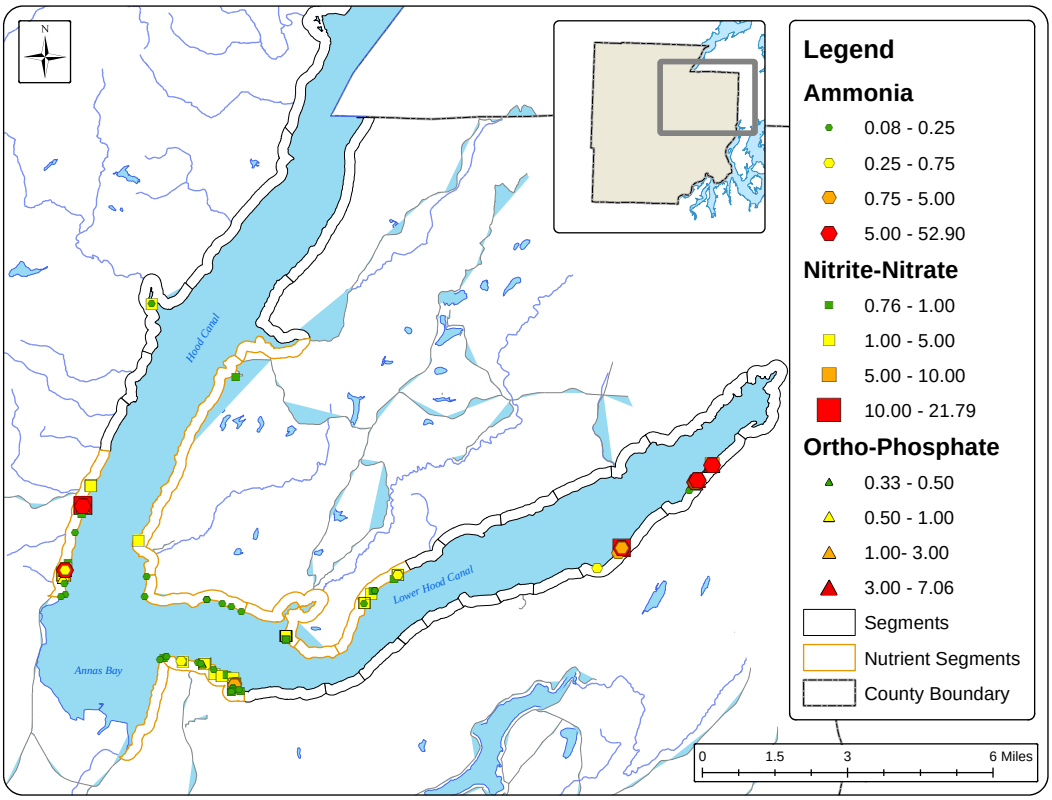
***Figure 16. HCPIC Summary Statistics of Nutrient Monitoring Results***

| | Ammonia ($NH_3$-N) as Nitro-gen (N) | Nitrate+Nitrite as N | NH3 + NO2 + NO3 - N | Ortho-Phosphate | Salinity | FECAL COLIFORM |
|---|---|---|---|---|---|---|
| **Average** | 0.36 | 0.49 | 0.85 | 0.23 | 6 | 448 |
| **Median** | 0.02 | 0.21 | 0.27 | 0.06 | 2 | 7 |
| **Mode** | 0.01 | 0.06 | 0.11 | 0.02 | 0 | 2 |
| **Max** | 52.90 | 21.80 | 65.30 | 7.06 | 30 | 160000 |
| **Min** | 0.01 | 0.01 | 0.02 | 0.01 | 0 | 2 |
| **90th percentile** | 0.12 | 0.89 | 1.14 | 0.65 | 20 | 240 |
| **STDEV** | 3.15 | 1.31 | 3.75 | 0.61 | 8 | 6690 |
| **Count** | 593 | 593 | 593 | 593 | 432 | 593 |

For the HCPIC data, the average for ammonia-nitrogen was 0.36; while the median was 0.02 and the mode was 0.01. The minimum detection limit was 0.01 and the maximum result was 52.90. The average for nitrate+nitrite-nitrogen was 0.49; while the median was 0.21 and mode was 0.06. The minimum detection limit was 0.01 and the maximum result was 21.80. The average for orthophosphate was 0.23; while the median was 0.06 and mode was 0.02. The minimum detection limit was 0.01 and the maximum result was 7.06.

*Photo 41 Culvert and Stair Seep Monitoring Locations*

**Map 10 All Hood Canal PIC Nutrient Results above the "Level of Concern"**



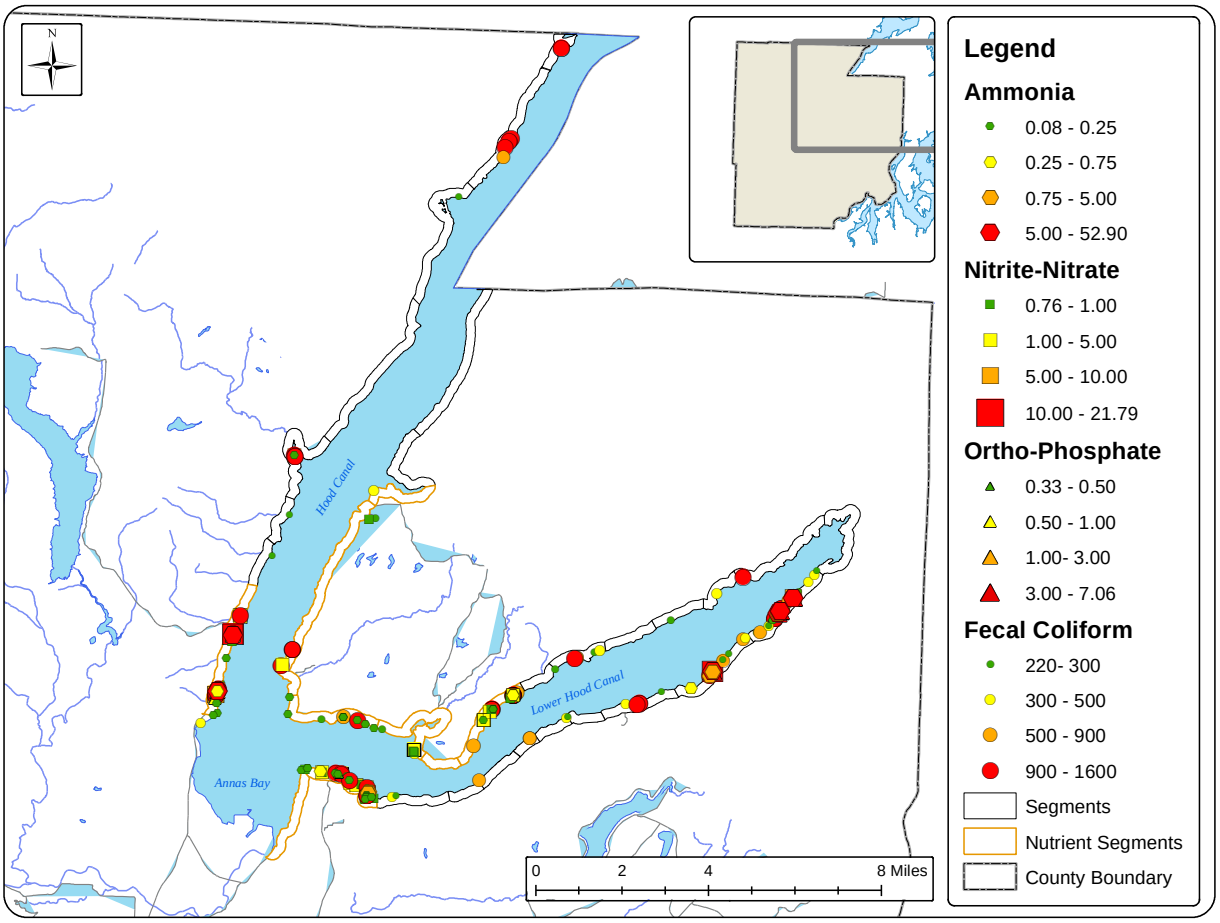

The NS-HCPIC had lower overall nutrient levels then the HCPIC project, and the HCPIC project identified more failing OSS.

Finally, MCPH combined all existing nutrient data collected under both NS-HCPIC and HCPIC projects since 2005. This data has all of the nutrient sample results, including those samples taken before and after OSS correction, samples taken as confirmation at sites with initial fecal coliform samples that were elevated, samples taken in both the wet and dry season and samples that had a variety of salinity values.

***Figure 17. HCPIC and NS-HCPIC Summary Statistics of Nutrient Monitoring Results***

| | Ammonia ($NH_3$-N) as Nitro-gen (N) | Nitrate+Nitrite as N | NH3 + NO2 + NO3 - N | Ortho-Phosphate | FECAL COLIFORM | Salinity |
|---|---|---|---|---|---|---|
| **Average** | 0.24 | 0.39 | 0.62 | 0.16 | 312 | 4 |
| **Median** | 0.01 | 0.15 | 0.19 | 0.04 | 4 | 0 |
| **Mode** | 0.01 | 0.06 | 0.03 | 0.01 | 2 | 0 |
| **Max** | 52.90 | 21.80 | 65.30 | 7.06 | 160000 | 30 |
| **Min** | 0.01 | 0.01 | 0.02 | 0.01 | 2 | 0 |
| **90th Percentile** | 0.09 | 0.74 | 0.87 | 0.33 | 216 | 15 |
| **St. Dev.** | 2.51 | 1.08 | 3.00 | 0.50 | 5317 | 7 |
| **Count** | 940 | 940 | 940 | 940 | 940 | 779 |

**Map 11 All Hood Canal PIC Project Elevated Nutrients and Fecal Coliform Results**




### 5.3.2. Nutrient Results above the "Levels of Concern"

In the previous HCPIC project, MCPH used the 90th percentile value of all samples for each analyte as the 'level of concern'. This data was collected from developed shorelines (see **Figure 18. HCPIC Nutrient 'Levels of Concern"**). MCPH also compiled the 90th percentile data for the NS-PIC (see **Figure 19 NS-HCPIC Nutrient "Levels of Concern"**), which has considerably lower results than the HCPIC data.

*Figure 18. HCPIC Nutrient 'Levels of Concern"*

| | $NH_3$-N | $NO_2$+$NO_3$-N | DIN | $PO_4$-P |
|---|---|---|---|---|
| **90th Percentile** | 0.12 | 0.89 | 1.14 | 0.65 |

All units are mg/L.

*Figure 19 NS-HCPIC Nutrient "Levels of Concern"*

| | $NH_3$-N | $NO_2$+$NO_3$-N | DIN | $PO_4$-P |
|---|---|---|---|---|
| **90th Percentile** | 0.04 | 0.49 | 0.52 | 0.05 |

All units are mg/L.

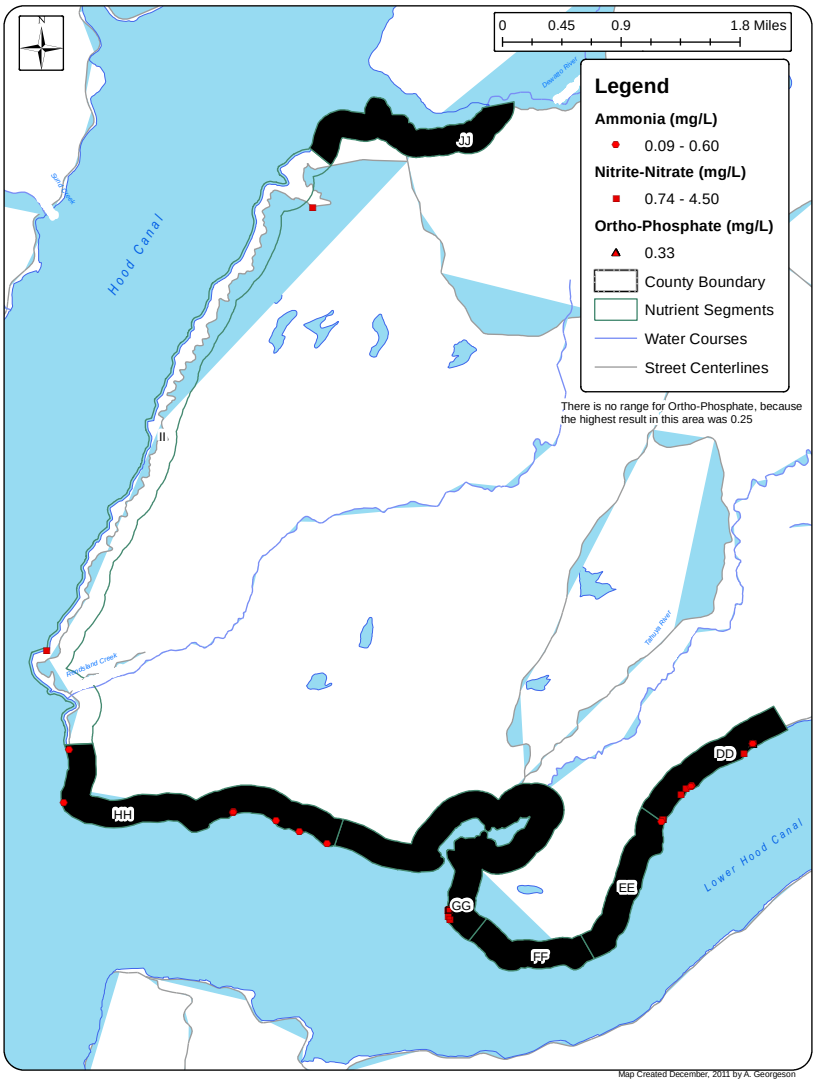
Since MCPH collected additional nutrient data, MCPH included all of the data to determine the new 90th percentile. MCPH used these amounts as the 'level of concern' for this report. This includes the data collected from the NS-HCPIC project and the HCPIC project (see **Figure 20. HCPIC and NS-HCPIC Nutrient "Levels of Concern")**.

*Figure 20. HCPIC and NS-HCPIC Nutrient "Levels of Concern"*

| | $NH_3$-N | $NO_2$+$NO_3$-N | DIN | $PO_4$-P |
|---|---|---|---|---|
| **90th Percentile** | 0.09 | 0.74 | 0.87 | 0.33 |

All units are mg/L.

**Map 12 Northshore Nutrient Results above the 'Level of Concern'**




MCPH did not have the time needed to follow-up at those sites with elevated nutrient levels to determine what the potential source was. MCPH recommends that, as funding becomes available, the monitoring locations with nutrient results above the 'level of concern' be investigated further (see section 8 Recommendations).

MCPH identified 30 (9%) of the 347 samples that had at least one nutrient analyte above the 'level of concern'.

To better understand the relationship of the nutrient "levels of concern" and fecal coliform pollution for the 30 samples, MCPH compared nutrient results above the "levels of concern" to fecal coliform results and to the properties that were selected for sanitary surveys (see **Figure 21. 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 OSSs and FC levels. The nutrient combinations represent 30 different samples. Each of those 30 samples was analyzed for all three nutrients ($NH_3$-N, $NO_2$+$NO_3$-N & $PO_4$-P). This creates seven different possible combinations of nutrient results above the "level of concern." The

potential combinations are either each individual analyte, two of the analytes or all three analytes. The data in the figure below represents nutrient results that were greater than or equal to their respective 90th percentile. In the figure, 6 of 7 sites identified for sanitary surveys (based on 2 elevated FC results) also had at least one nutrient result above the "level of concern."

***Figure 21. Analysis of Nutrient Monitoring Results above the "Levels of Concern"***

| Nutrients Above the 'level of concern' (≥ 90th percentile) | Total Samples of Concern* | | Results from Sanitary Survey Sites** | | FC ≥ 100 FC/100-mL** | | ≥ 200 FC/100-mL** | |
|---|---|---|---|---|---|---|---|---|
| $NH_3$-N, $NO_2$+$NO_3$-N & $PO_4$-P | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| $NH_3$-N & $NO_2$+$NO_3$-N | 1 | 3% | 1 | 100% | 1 | 100% | 1 | 100% |
| $NH_3$-N & $PO_4$-P | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| $NO_2$+$NO_3$-N & $PO_4$-P | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| $NH_3$-N | 11 | 37% | 3 | 10% | 3 | 10% | 2 | 7% |
| $NO_2$+$NO_3$-N | 18 | 60% | 2 | 7% | 2 | 7% | 2 | 7% |
| $PO_4$-P | 0 | 0% | 0 | 0% | 0 | 0% | 0 | 0% |
| Total Number of results for all Nutrient Combinations | 30 | 9%*** | 6 | 20% | 6 | 20% | 5 | 7% |

These numbers reflect all monitoring events at each monitoring site, which may include multiple samples per monitoring site.
* Percentage of the 30 samples of concern (except ***)
** Percentage of total samples of concern for each category
***This is the percentage of all 347 nutrient samples taken

In **Figure 21. Analysis of Nutrient Monitoring Results above the "Levels of Concern"**, MCPH shows both 100 FC/100-mL and 200 FC/100-mL thresholds. This is because 100 FC/100-mL is the freshwater extraordinary contact water quality standard for a single sample, while 200 FC/100-mL was the threshold for further action under this project.

*Photo 42 Looking Northwest at Sister's Point from the South Shore*

## 6. Public Education and Outreach

MCPH participated in three educational events during the course of this project. MCPH presented to the Lower Hood Canal Watershed Coalition at the North Mason School District Administration building, in March, 2011 and in December, 2011. MCPH in collaboration with WSU-ext presented an OSS class that highlighted this project at the Belfair Timberland Library, in February, 2011.

# 7. Project Outcome

## 7.1. Overall Accomplishments

Mason County was able to attain the following goals and objectives of this project:

- MCPH identified 467 freshwater discharges along the Northern and Eastern Shores of Hood Canal and performed FC and nutrient (in selected segments) monitoring at those discharges.
- MCPH measured FC and nutrient levels in discharges to the marine shoreline in a limited study area. This information is useful in assisting to determine both the cumulative average of freshwater FC and nutrients entering the marine water from shoreline discharges and provided data to better understand the relationship between FC and nutrients.
- MCPH provided education to residents, through 51 sanitary surveys and 3 public meetings, about FC and nutrient impacts on the Canal, and actions individuals can take to limit their affect.
- In combination with previous monitoring performed under the HCPIC project; MCPH has monitored and assessed freshwater discharges from along 74.2 miles of Hood Canal Shoreline between July, 2005 and October, 2011. MCPH collected ~2432 FC samples from ~ 1917 individual monitoring locations and ~940 nutrients samples from ~703 individual monitoring locations. In total, MCPH identified 194 (7.9%) sites that had initial elevated FC levels. MCPH determined that there was an average of 2.7 elevated initial FC sample/mile (see **Figure 17. HCPIC and NS-HCPIC Summary Statistics of Nutrient Monitoring Results**).

Overall, this project was successful in identifying shoreline discharges along Hood Canal and collecting FC and nutrient water quality data. Over 90% of initial samples taken met the extraordinary FC standard. MCPH completed sanitary surveys and provided site specific pollution reduction and elimination techniques at 51 sites, in order to protect water quality along the shorelines of Hood Canal.

Also, as part of the data gathered under this grant, MCPH determined that approximately 22% of Hood Canal shoreline OSS have been repaired or replaced since 1992.

## 7.2. Logistical Problems

MCPH encountered the following logistical problems:

- The biggest limitation of this project was the high seasonal occupancy. This presented issues both in identifying elevated FC sites (and therefore failing OSS) and for gaining participation in sanitary surveys.
- Areas of the shorelines were impassable or MCPH could not obtain access; this was especially true on the eastern shoreline north of Rendsland Creek. This area is sparsely populated; making it difficult to find access locations. The area north of Dewatto only has private gated roads that lead to the shoreline, which prevented access. Also part of Lynch Cove, near where the Union River enters Hood Canal, was inaccessible because of dangerous body-swallowing mud flats in that area. A boat would have allowed access into these areas where we could not access from the shoreline.
- Some follow-up monitoring was not performed either because the sample sites had no flow during repeat visits or the tidal levels were too high to access the locations.
- MCPH was not able to perform sanitary surveys at any of the 7 sites that were identified with elevated levels of fecal coliform. MCPH attempted to make contact at most sites on several occasions.
- MCPH identified less monitoring locations than had been anticipated. There were far fewer flows on the Northern and Eastern shores of Hood Canal compared to the Western and Southern shorelines. This allowed MCPH to cover the shoreline faster, but decreased the likelihood of identification of a failing OSS based on elevated FC from a shoreline discharge.

### 7.3. Follow-up Actions

MCPH was not able to complete the following goals and objectives under this grant, but intends to perform follow-up work under grant G1000278, which has a study area that includes the NS-HCPIC study area and has funds available for sanitary surveys and dye tests and a minimal amount of additional monitoring.

- MCPH will attempt to perform sanitary surveys at the 7 sites that had elevated levels of FC, in order to identify and correction the fecal pollution source. Correcting the fecal pollution source will allow MCPH to reduce FC pollution in Hood Canal from a variety of sources.
- At any site that a FC pollution source is identified and corrected, MCPH will perform post-corrective action monitoring to provide water quality data to determine if correction of FC sources leads to a reduction in nutrients.
- MCPH, as time allows, will reduce nutrient pollution entering into Hood Canal by educating homeowners on best land-use practices to minimize nutrient pollution.

## 8. Recommendations

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

### 8.1. Site Specific Recommendations

As time and funding allow, MCPH recommends:

1. Performing confirmation monitoring at the following sites:
   **bb-020d, dd-003, ii-005, ii-006, ii-025a, jj-002 & w-021e**[9]
2. Performing confirmation-repeat monitoring (obtained proceeding a confirmation sample with a FC result <100) at the following sites:
   **dd-003d, ee-002, ee-012, gg-005b, ii-008, ii-026, ii-031 & ii-101**[10]
3. Performing sanitary surveys and dye tests (where needed) based on elevated FC levels at the following sites:
   **w-022b, y-014, bb-017, dd-004, dd-007, hh-007, ii-030**
4. Performing confirmation nutrient monitoring (sites with nutrients above the 'level of concern') at the following sites:
   **dd-012a, dd-019, dd-021, dd-027, dd-038, dd-056a, ee-001a, gg-006b, gg-006c, hh-001, hh-005, hh-007, hh-016, hh-017a, hh-021, hh-022, ii-0009 & ii-93**
5. Performing sanitary surveys based on two or more monitoring events where a nutrient result was above the 'level of concern' at the following sites:
   **dd-003d, dd-057, gg-006, gg-007, gg-008**
6. If any OSS failures are identified through sanitary surveys or dye tests than the distance from each OSS failure to the monitoring location(s) should be identified.
7. Performing post-repair monitoring (for both FC and nutrients) at all sites that have OSS repairs or replacement.
8. 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, especially along the Southern Shoreline.

[9] If funding is not available for confirmation or confirmation-repeat monitoring, but there is funding available for sanitary surveys, MCPH recommends performing sanitary surveys at all sites that had an initial elevated FC result.
[10] See footnote 9.

## 8.2. Project Recommendations

These recommendations are intended to help MCPH better perform PIC work in the future.

- MCPH recommends that when funding is available, nutrient samples should be taken in conjunction with fecal coliform samples in order to better identify and assess failing OSS. At a minimum, whenever a suspected failing OSS is investigated and water samples are taken, nutrient analyses should be performed in addition to fecal coliform analyses.
- MCPH recommends that flow measurements be taken in conjunction with nutrient monitoring to enable the calculation of nutrient loading entering the marine water, and facilitate statistical evaluation of the data.
- 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 study areas so confirmation samples, sanitary surveys, and corrections can be performed in a reasonable/practical/logical amount of time.
- MCPH recommends that when PIC work is performed in areas with a large seasonal population, intensive monitoring be performed during the summer months (or the period of seasonal occupancy).
- To better assess shoreline discharges, there should be multiple monitoring teams performing shoreline assessments and sanitary surveys during the summer months, when the seasonal residents are better represented.
- In addition, especially in areas with seasonal populations, MCPH may want to consider performing sanitary surveys at sites that have a single elevated FC result. Because of the seasonal nature of the residents; it may be difficult to time the confirmation sampling during a time that the residence is being occupied. Sites that have failing OSS that are not occupied probably will not have sample results that are elevated.
- Explore funding to conduct a pollution identification and correction project in Lower Hood Canal, specifically along the Southern Shore, as an *intensive nutrient study area.* Studies have determined that there is a persistent low DO problem in the Hood Canal from Lynch Cove to the Great Bend. Although the data collected under this project does provide some nutrient data along the North Shore from approximately Sister's Point to almost Dewatto Bay, this area does not represent the same population that is found along the Southern and Northern Shores near Belfair.

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