Mason County Public Health Department
Environmental Health Division
Water Quality Program

MASON COUNTY
SEPTIC SYSTEM SURVEYS AND
DATABASE ENHANCEMENT
QUALITY ASSURANCE PROJECT PLAN

May 2, 2007

Funded by:

Centennial Clean Water Fund
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MASON COUNTY
SEPTIC SYSTEM SURVEYS AND DATABASE ENHANCEMENT QUALITY ASSURANCE PROJECT PLAN

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CENTENNIAL CLEAN WATER FUND

GRANT AGREEMENT
BETWEEN THE
STATE OF WASHINGTON DEPARTMENT OF ECOLOGY
AND
MASON COUNTY PUBLIC HEALTH DEPARTMENT

Approved as to form and content:

_____	_____
Tammy Riddell *date*	Debbie Riley, R.S. *date*
Grant Officer	Project Manager
Washington State Department of Ecology	Mason County Public Health
_____	_____
Amy Georgeson *date*	Wendy Mathews, R.S. *date*
Field Staff	Field Staff
Mason County Public Health	Mason County Public Health

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List of Plan Recipients

- **Tammy Riddell**, Contract Administrator, W.S. Dept. of Ecology Southwest Regional Office, Water Quality, PO Box 47775,
  Olympia, Wa 98504-7775
  (360) 407-6295
  trid461@ecy.wa.gov

- **Kecia Whitehall,** Chemist,
  Twiss Analytical Laboratory, Inc.
  PO Box 2399
  Poulsbo, WA 98370
  (360) 779-5141
  kwhitehall@twisslabs.com

Plan Authors

- **Amy Georgeson**
  Environmental Health Specialist II

- **Wendy O'Donnell Mathews, R.S**.
  Environmental Health Specialist II

- Adapted by Permission from:
  Hood Canal Shoreline Survey Quality Assurance Project Plan, January 2005
  Kitsap County Health District
  Surface and Storm Water Mgmt
  Water Quality Program
  Mindy Fohn, EHS and
  Leslie Banigan, R.S., EHS

1. Background and Problem Statement

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 human sewage and animal waste and their associated pathogens.

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

Additionally, the Washington State Department of Health (WSDOH) performs shoreline surveys to identify the potential of fecal pollution sources in order to classify commercial shellfish beds. In shoreline surveys of the Mason County Hood Canal shoreline (Hood Canal Growing Areas 4 through 9) from 1996 to 2005, WSDOH identified approximately 826 "potential sources" of fecal pollution based upon their staff field observations. These 826 properties extend from Triton Head, located at the northern border of Mason County on the western shore of Hood Canal, around the Big Bend at Annas Bay, to Belfair at the southeastern tip of the Canal, and around the north shore up to Dewatto.

Sources of human and animal waste can be identified by analyzing shoreline discharges for fecal coliform (FC) bacteria. The Kitsap County Health District developed and utilizes the Manual of Protocol: Fecal Coliform Bacteria Pollution Identification and Correction Projects – Version 9, Kitsap County Health District, November 2003, as a standardized method of evaluating discharges and identifying and correcting FC sources such as failing onsite sewage systems and inadequate animal waste management. Mason County Public Health adapted and adopted the Pollution Identification and Correction protocols as found in the Mason County Standard Operating Procedures, Chapter 4.0.

This study has been modeled after the Kitsap County Pollution Identification and Correction Program which locates the sources of FC pollution entering the canal via sources such as seeps, stormwater runoff and bulkhead drains. When failing on-site sewage systems were located as sources, Kitsap staff implemented the correction of those systems and demonstrated a reduction in FC pollution associated with them (see *Kitsap County Health District Water Quality Analysis of Hood Canal Shoreline Discharges – Part, November 2006*). To correct other types of fecal pollution, such as improper management of animal wastes, Kitsap staff responded with education, assistance, and enforcement in remedying the problem. In addition, a special study was conducted to determine whether a correlation exists between FC pollution and nutrient levels.

The Mason County Hood Canal Pollution Identification and Correction project's proposed study area will include the Hood Canal shoreline within Mason County (see Figure 1 Mason County Hood Canal Pollution Identification and Correction Project

Boundaries). Sampling for fecal coliform will be focused on shorelines with on- and near-shore developed areas, but will include some stretches of undeveloped shoreline as well, to provide what is thought to be background levels. The bacteria criteria guiding corrective action will be based on Chapter 173-201A of the Washington Administrative Code (WAC).

NUTRIENT POLLUTION

Aquatic life needs dissolved oxygen in order to breathe. Hood Canal has had a history of low dissolved oxygen levels, which have caused periodic fish kills. Records of fish kills date back to the early 1960s. Recent oxygen levels are the lowest in recorded history, prompting increasing concerns about the long-term health of the canal.

In June and October of 2003, and again in September of 2006, low-oxygen conditions killed thousands of juvenile perch and left numerous octopuses, sea cucumbers and other marine life suffocating and dying. In winter, oxygen levels generally rebound with an exchange of water from the ocean. The Washington State Dept. of Ecology (DOE) monitoring stations in Hood Canal show that hypoxic conditions may persist year-round in the southern portion, and 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 as of 2005 (http://www.prism.washington.edu/hcdop/index.html).

The organic materials associated with fecal pollution deplete dissolved oxygen as they break down in the surface water. In addition, nutrients associated with fecal pollution may provide a nutrient source for algae to bloom. When algae die, their decomposition also consumes oxygen from the water. In 2005, Kitsap County Health District conducted a FC bacteria and nitrate+nitrite nitrogen correlation study, as reported in the *Kitsap County Health District Water Quality Analysis of Hood Canal Shoreline Dishcarges – Part I, November 2006.* The results of this limited study found no correlation between FC and nitrate+nitrite nitrogen. However, they completed all sampling during wet weather, when denitrification is more likely to occur in the soils because of elevated groundwater levels (Cogger, 1988).

The direct relationship of fecal pollution and nutrient pollution is not fully understood. It has been proposed that both functioning as well as failing onsite sewage systems may contribute to the nutrient load. In an effort to supplement Kitsap County's investigation, nutrient sampling will be conducted in selected segments to determine if there is a relationship between fecal coliform and nutrient pollution.

Logistical problems include the following: access to the shoreline will necessitate gaining permission from owners of properties adjacent to the shoreline; shorelines may present impassable or dangerous sections preventing access; sampling is tide-dependent meaning that low tides are required during the daylight working hours in order to capture flows; limited project time frame (less than seven months to complete the surveys).

2. Project Description

The presence of FC pollution, which can indicate conditions that may be detrimental to human health, has been documented in Hood Canal. In this project, Mason County Public Health (MCPH) water quality staff will attempt to identify and correct sources of FC pollution. Issues regarding excess nutrients, including the contribution to the low levels of dissolved oxygen in the canal and their possible relationship with FC levels, will be investigated. The communities in the watershed play a vital role in addressing these concerns. MCPH will continue to educate area residents concerning Hood Canal pollution issues, and support best landuse practices in order to minimize collective anthropogenic pollution inputs.

This project has four distinct goals:

- Reduce FC pollution in Hood Canal from a variety of sources, including failing On-site Sewage Systems (OSS) and inadequate animal waste management, along the entire developed Hood Canal shoreline within Mason County.
- Provide water quality data from a limited study area to determine if there is a relationship between FC levels and nutrients in discharges to the marine shoreline.
- Provide water quality data to determine if correction of FC sources leads to a reduction of nutrients.
- Provide water quality data to establish a baseline of the cumulative inputs of freshwater nutrients into the marine water surrounding the Annas Bay/Great Bend areas.
- Educate residents of the Hood Canal watershed about the FC and nutrient impacts on the Canal, and actions they can take to limit their affect.

To complete the goals of this project, water quality data for FC (and nutrients under conditions enumerated below) of shoreline discharges will be collected from water entering the canal, including but not limited to bulkhead drains, stormwater drainages, and shoreline seeps. Some sections of shoreline are almost entirely undeveloped; investigations in these areas may be curtailed in order to focus on areas with a higher chance of achieving corrections. Staff will walk the shoreline and collect water samples for analysis in the lab. FC data will be used to identify FC sources following the Mason County Sanitary Survey (referred to as Sanitary Survey for the remainder of this document) procedures outlined in the Mason County Water Quality Standard Operating Policies and Procedures, January 2007 *(WQ SOPs)*. Sources will then be corrected if possible. For instance, if the source is found to be a migrating herd of elk, then the correction is less tenable. However, if the source is determined to be a failing On-site Sewage System (OSS), it will be directed to the Mason County On-site Septic System Program to be corrected. It should be noted here that correcting some OSS failures can take many months and may only be initiated and not necessarily completed, during the period of this contract.

In order to supplement the data acquired during investigations by Kitsap County staff in the KCHD Pollution Identification and Correction project, nutrient data will be collected throughout the project at sites with elevated levels of fecal coliform. Measurements will be taken before and after correction of the FC source to determine whether correction has an effect on nutrient levels. (Nutrient sampling will not be completed at all fecal

coliform sites around Hood Canal due to time, budget and logistical constraints). In addition, four segments have been selected for more *intensive nutrient sampling*. In these segments nutrient sampling will be conducted at all sites where fecal coliform sampling occurs. This data will be used to address nutrient pollution where it occurs either with or without FC pollution, to examine the possible relationship between FC and nutrients, as well as to establish a baseline of the cumulative inputs of freshwater nutrients into the marine water surrounding the Annas Bay/Great Bend areas.

Nutrients, especially Nitrogen, are the limiting growth factors for algae in Hood Canal. Algal blooms occur when nutrients are plentiful, and days are warmer and sunnier – typically in late summer. As the blooms die and decompose, dissolved oxygen is consumed from the water. In 2003 and 2006 low dissolved oxygen caused fish kills that originated in the Potlatch/Annas Bay area (and then extended north). Therefore, we selected segments in this immediate area to assess what kind of cumulative nutrient inputs are entering the marine waters from these shorelines. Three segments were selected to represent developed areas. These segments (see Figures 3 and 4) span from Hoodsport to Potlatch (segment H), the Skokomish River to Union (segment AB), and Union to Alderbrook (segment I). Also in the vicinity, we selected a segment on the northeast shore of the Great Bend (segment JJ) to represent an undeveloped shoreline. From this segment we hope to gain knowledge of "background" levels of nutrients entering the marine shoreline as well as to generate data on the cumulative nutrient inputs in this region.

In all of four of these segments, we will record changes in fecal coliform and nutrient levels before and after pollution correction(s) occur. We will sample for ammonia-nitrogen and ortho-phosphate, in addition to nitrate-nitrogen (Section 4.4 Summary of Sampling Design for FC and Nutrients). Other nutrients/analytes will not be addressed due to time and budget constraints. This project may reduce oxygen demand from nutrient contamination to Hood Canal within the Hood Canal watershed.

Nutrient analysis of shoreline discharges may not completely answer the above stated objectives due to unknown variables such as the contribution of background, non-OSS or animal waste sources of nutrients, or the variation of FC and nutrients over time of day. In addition, the availability of low tides will be a limiting factor in accessing the shoreline, and may affect the ability of staff to acquire data from all shorelines in both wet and dry seasons.

The specific objectives of the shoreline survey are to:

- reduce fecal coliform pollution entering into Hood Canal from the northern Mason County borders to Lynch Cove (Figure 1) by identifying and correcting FC pollution sources,
- attempt to reduce nutrient pollution entering into Hood Canal in the *intensive nutrient sampling area* by identifying and correcting nutrient pollution sources,
- measure FC and nutrient concentrations in discharges to the marine shoreline in a limited study area, and
- determine FC and nutrient concentrations in discharges where elevated FC pollution sources are identified before and after FC source correction.

3. Project Organization and Schedule

3.1. Project Organization

The following individuals were key to this plan's development, and to its implementation:

Tammy Riddell, **(360) 407-6295, Washington State Dept. of Ecology Southwest Regional Office.** Contract Administrator. *Responsible for general project oversight/management for nonpoint pollution (activity) water quality grants and loans administered through the Water Quality Program. Confirms adherence to contract requirements.*

Debbie Riley (360) 427-9670 x358. Mason County Department of Health Services. Environmental Health Manager. *Supervising field and monitoring staff and ensuring that all aspects of the grant agreement are carried out.*

Amy Georgeson (360) 427-9670 x544 and Wendy Mathews (360)427-9670 x529. Mason County Public Health Department. Lead field staff. *Responsible for project planning, shoreline surveys, sanitary surveys and public education activities*

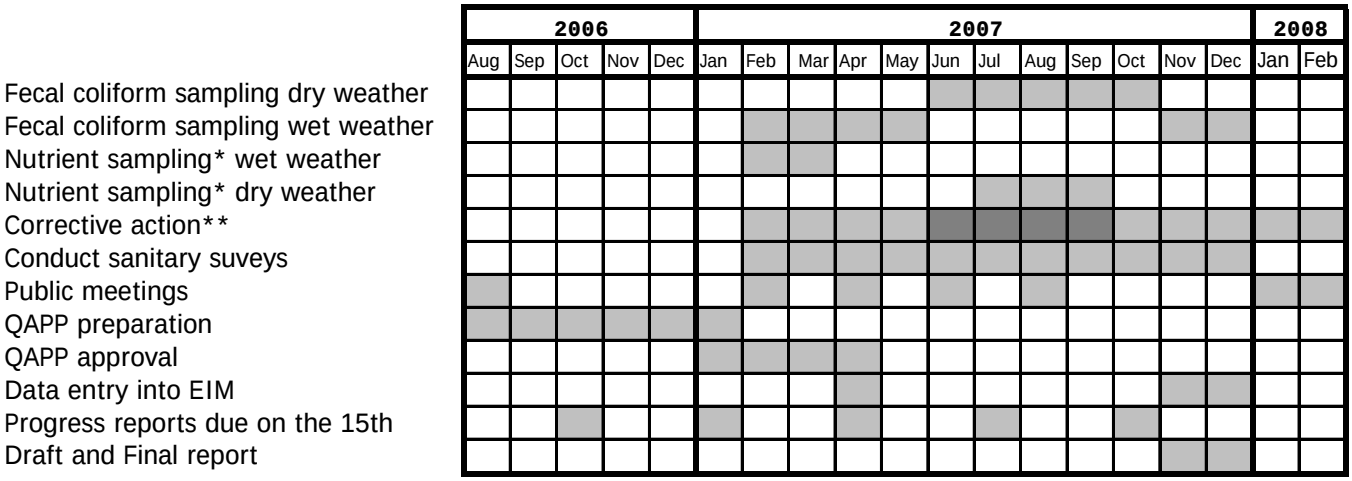
Carol Spaulding (360) 427-9670 x580. Mason County Water Laboratory. Laboratory Manager. *Perform lab analysis for fecal coliform.*

Kecia Whitehall, (360) 779-5141, Twiss Analytical Laboratory, Inc. Laboratory Chemist. *Perform lab analysis for nutrients.*

3.2. Project Schedule

Table 1. Shoreline Survey Project Schedule

Hood Canal Shoreline Survey Project Schedule



* Nutrient samples will be taken from 4 study areas, in the months indicated by shading. However, nutrient samples will be taken at fecal coliform site where the first fecal coliform sample is >900 fc/100mL. These samples will be taken throughout the year.

** Septic system replacement will occur during the dry months, however minor fixes may occur at any time.

The sampling schedule is highly variable, mostly due to tides that may be too high to allow access to structures (like bulkheads) or seeps. Tides of three feet or less are desirable for best access to shoreline seeps but, depending on the shoreline topography, a higher tide may still allow access. Best efforts will be made to take advantage of lower tides during daylight working hours, and generally, shoreline work will be conducted at tides of less than 5.5 feet. In addition, due to the great extent of shoreline and the uncertainty of the distance that may be gained per day, gaining access from property owners prior to the sampling day is not practical. Impassable or dangerous outcroppings may also affect the ability of the staff to continue on a particular day of sampling.

4. Field Sampling Design

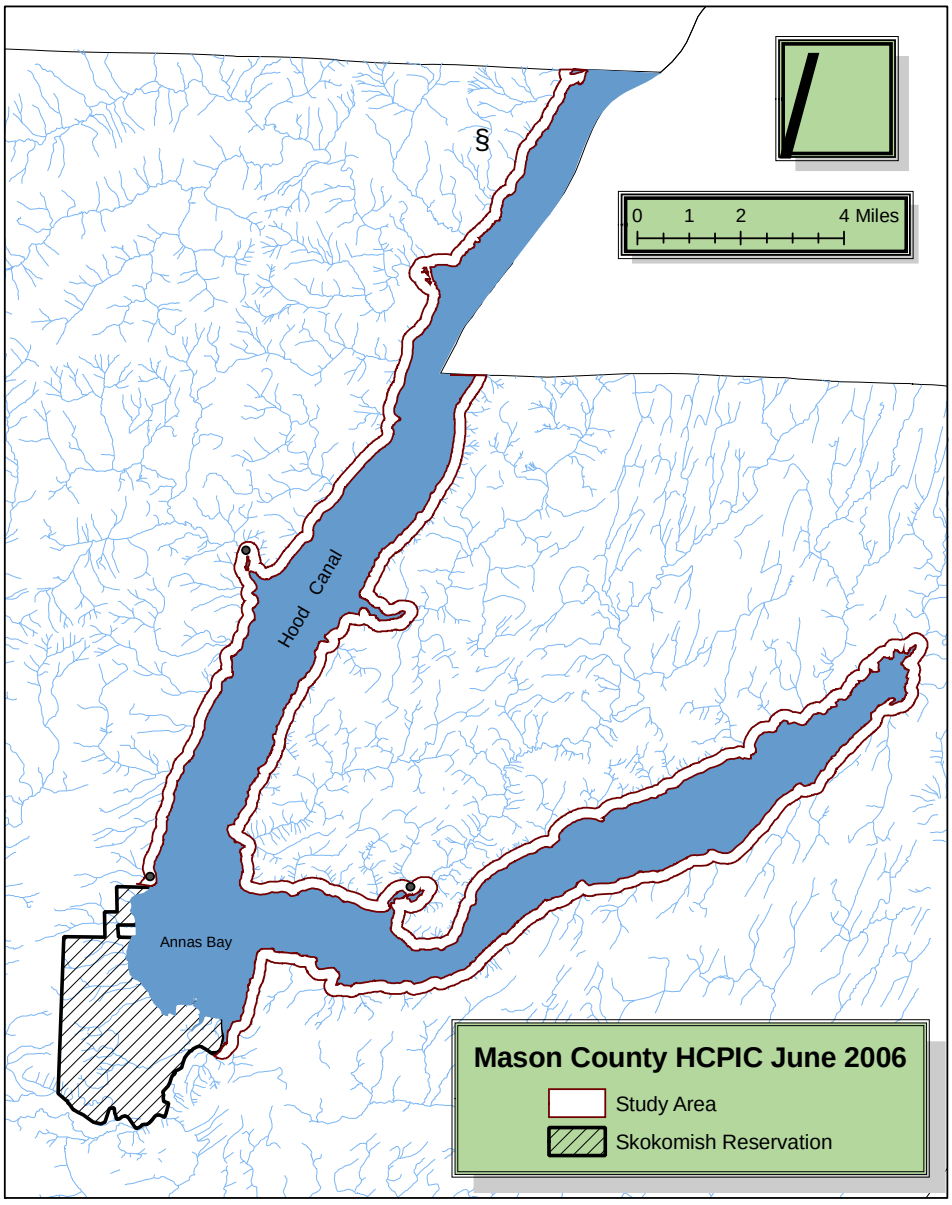
4.1. Survey Area Description

4.1.1. Shoreline

A survey of the shoreline will be conducted to identify FC-contaminated discharges. Property surveys are performed to identify and correct the FC sources. This document, "Hood Canal Shoreline Survey Quality Assurance Project Plan", explains the site-specific details for the shoreline survey portion of the Scope of Work to be conducted by the MCPH. It is a supplement to the standard protocols defined in the *WQ SOPs*. Figure 1 shows the shoreline project area to be surveyed.

Figure 1. Project Area

Mason County
Hood Canal
Pollution Identification and Correction
Project Boundaries



Areas to be surveyed are adjacent to the shoreline and were identified using aerial photos and property parcel map printouts. The survey will be performed on foot in these identified areas with an emphasis on developed shorelines. The shoreline survey was divided into 39 segments. The segments, the approximate number of residences per segment, and segment shoreline length in miles are shown in Table 2. See Figures 2 through 5 for maps showing delineation of segments.

Table 2. Shoreline Survey Areas

Hood Canal Pollution Identification and Correction Program

Segment Delineations

Segment Name	Approximate residences	Miles of shoreline	Density (avg) Residences/mile
A	56	1.6	35
B	26	3.6	7
C	40	4.3	9
D	116	4.1	28
E	61	3.3	19
F	35	1.3	26
G	31	1.1	55
H	128	3.4	38
AB	38	2.8	13
I	135	2.5	55
J	59	1.8	34
K	48	0.8	61
L	66	1.1	58
M	26	0.6	41
N	48	0.9	53
O	26	0.9	28
P	63	0.8	75
Q	68	1.0	67
R	67	1.2	55
S	72	1.1	67
T	90	1.2	75
U	55	1.3	44
V	22	4.2	5
W	40	1.8	23
X	54	0.9	62
Y	59	1.3	47
Z	82	1.2	67
AA	85	1.2	71
BB	58	1.4	41
CC	43	1.1	41
DD	52	1.2	45
EE	46	1.5	31
FF	52	1.1	48
GG	99	3.6	27
HH	33	1.1	29
II	44	1.5	29
JJ	106	3.8	28
KK	33	6.9	5
LL	17	3.9	4
Totals:	2309	78.4	

Figure 2 - Hood Canal Segments A-E and KK-LL

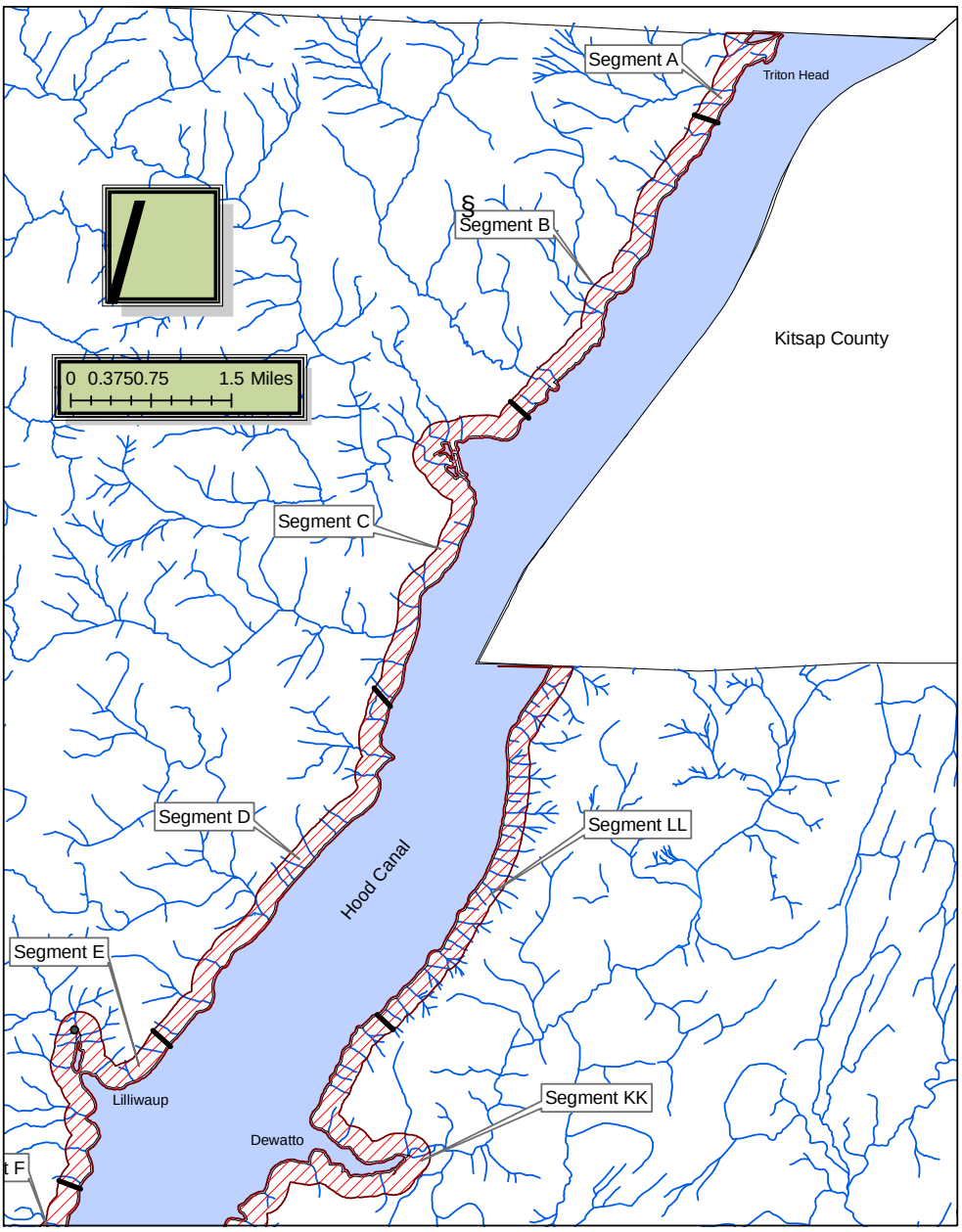


Figure 3 - Hood Canal Segments E-H and KK-HH

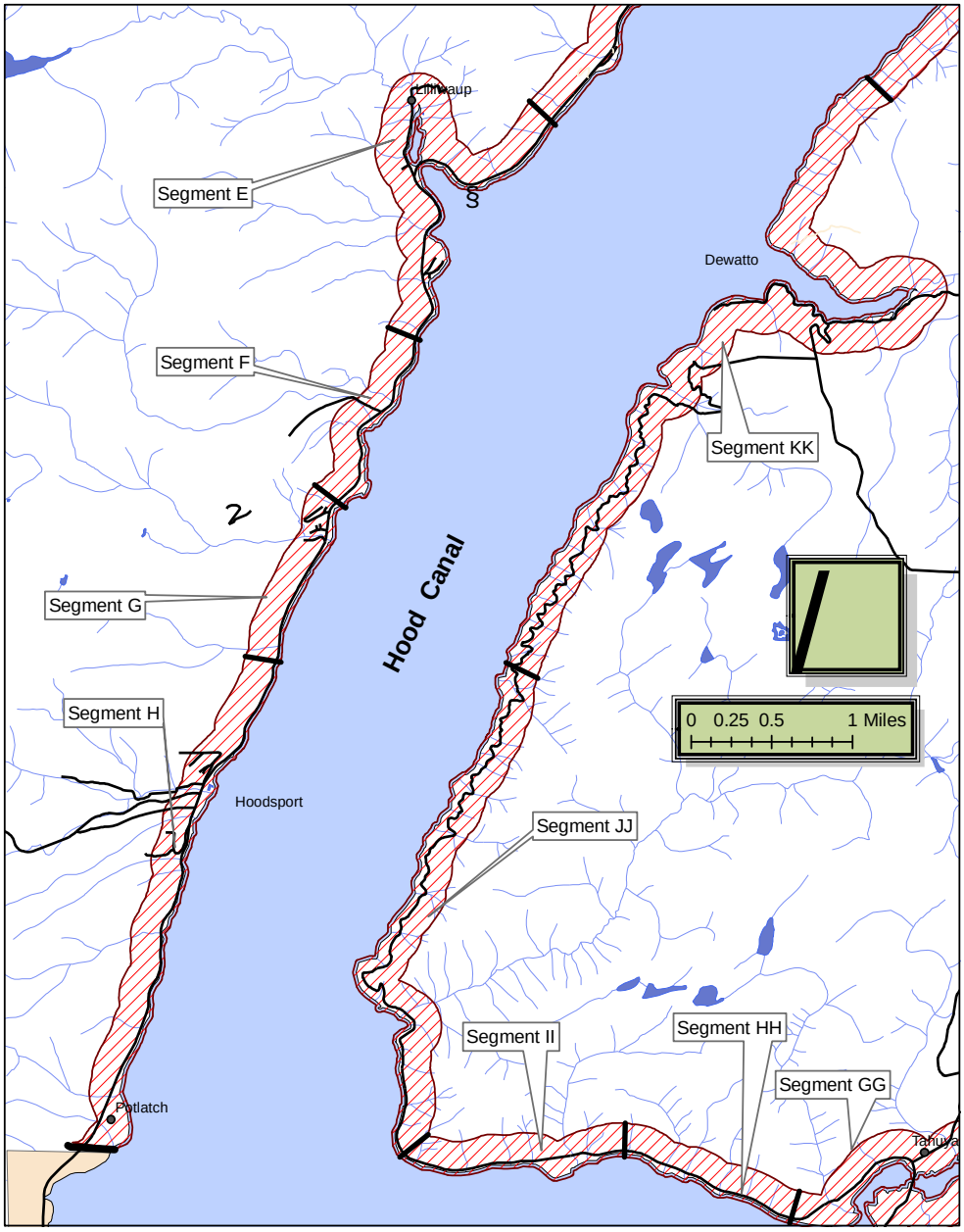


Figure 4 - Hood Canal Segments AB-N and CC-JJ

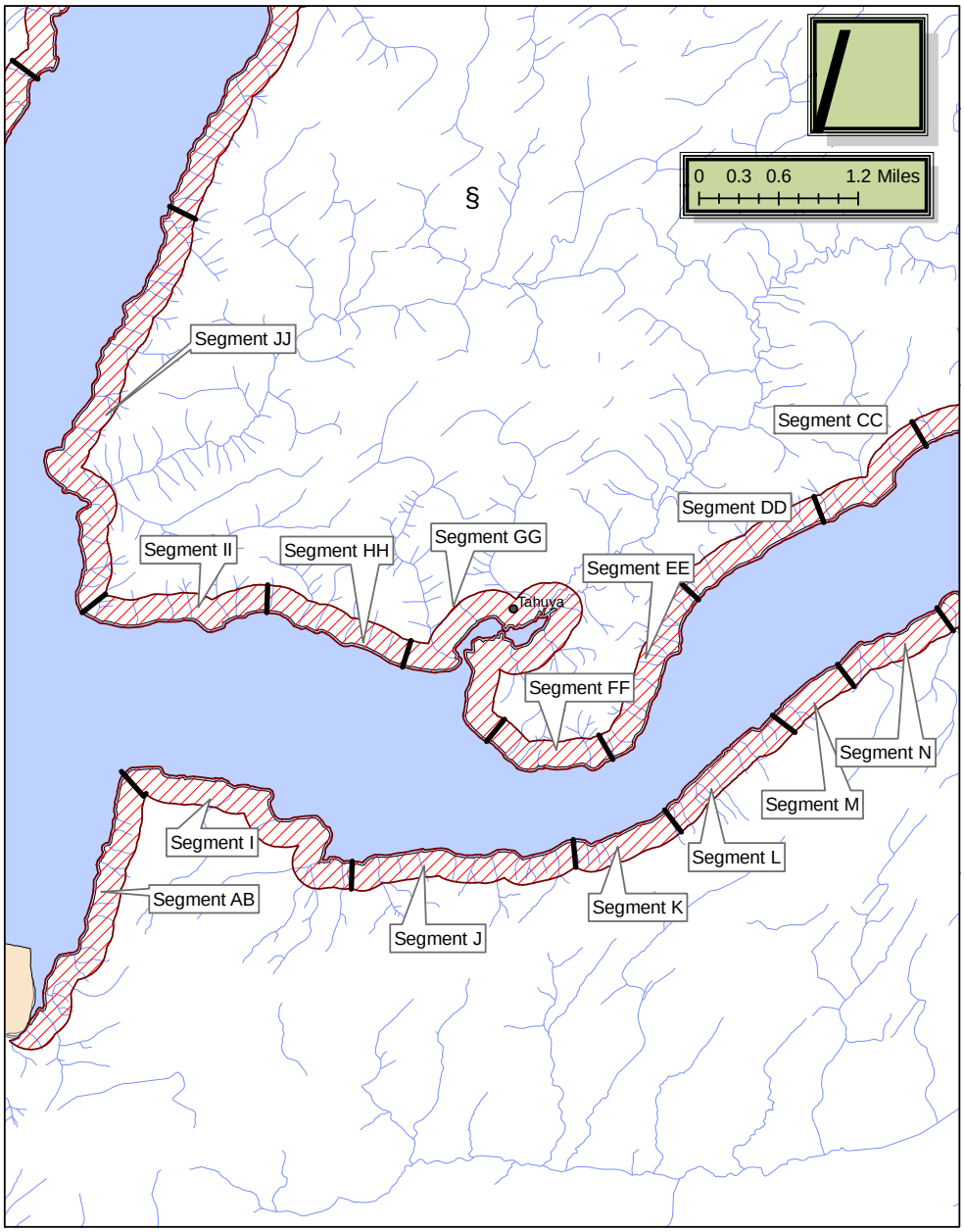
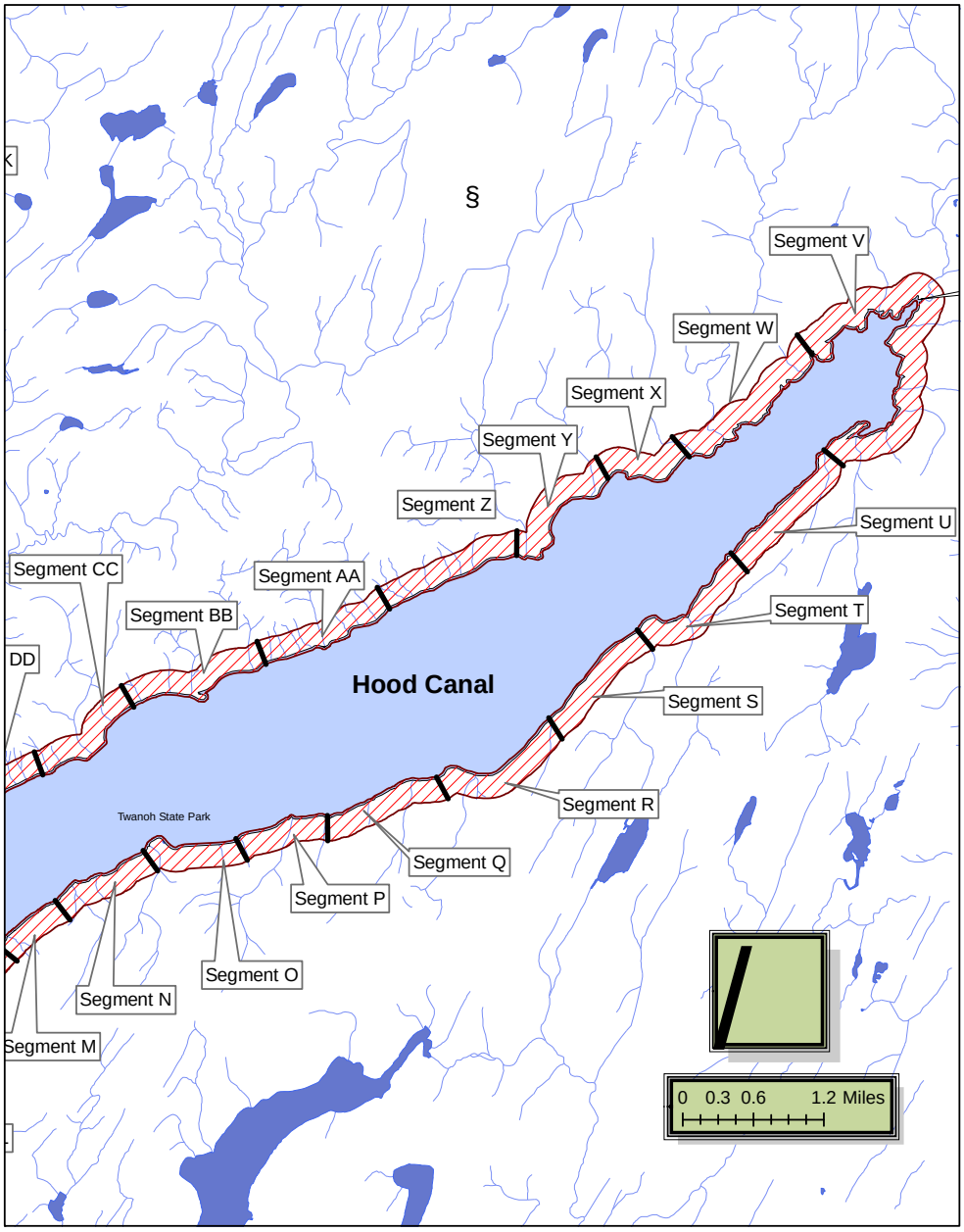


Figure 5 - Hood Canal Segments M - CC



The total shoreline to be sampled is seventy-five miles and approximately 2309 residences. The most densely populated shorelines are segments K, L, P, Q, S, T, X, Z and AA, all of which have an average of greater than 58 residences per mile.

Each segment should be traversed twice: once during wet weather and once during dry weather. However, the time frame for this grant will not allow for each location around the entire Hood Canal to be visited twice. Data collected previous to this grant can provide a more complete data set. Each site that has previously been

sampled will be sampled once more during the course of this grant (i.e. segments that have had wet-weather sampling done previously will have dry-weather sampling done during this grant and visa versa). The previous sampling was conducted as described in Section 4.2 Shoreline Survey FC Source Identification Sampling, and will be compiled and presented in the final report.

Sampling in segments A through D, a portion of segment E, and segments O through P have had one dry weather-sampling event previous to this grant. Sampling in the remaining portion of segment E, segments F through G and segments J through N have had one wet weather-sampling event previous to this grant. Segments H and I have not yet had any sampling performed. These segments were selected for nutrient investigation. Sampling will occur in these segments, as well as all remaining segments, after acceptance of this Quality Assurance Project Plan.

DOH information will be reviewed in addition to the shoreline survey. Approximately 826 properties were classified during DOH shoreline surveys as "potential" sources of contamination. These properties will be prioritized for pollution risk and will be assessed as time allows.

OSS records and OSS complaint files, if available, will be reviewed prior to all sanitary surveys.

4.2. Shoreline Survey FC Source Identification Sampling

The purpose of the shoreline survey is to identify discharges with high FC concentrations. Identified discharges are then used to trace the FC source of contamination to a property. The identified property is contacted to survey for the source of FC contamination. The shoreline survey is performed according to Section 4.2.6 Water Quality Evaluation, *WQ SOPs*.

The shoreline survey and confirmation water sampling will be performed during low tides of less than 5.5 feet (approx.) during both dry and wet weather conditions.

Flows from the shoreline including pipes, drainages, and seeps will be sampled for FC. According to the *WQ SOPs*, a photo of the location, written description and GPS coordinates of each sampling location will be collected.

Discharges with values greater than or equal to 200 fc/100ml will be selected for FC confirmation sampling. As stated in the *WQ SOPs*, sample results greater than 500 fc/100mL indicate a high degree of FC contamination, sample results of 200 to 500 fc/100mL indicate a medium degree of FC contamination, and sample results of less than 200 fc/100 mL indicate a low degree of FC contamination. Discharges with values less than 200 fc/100ml will no longer be assessed for FC source correction.

Confirmation samples will be collected during a second sampling event, and nutrient sampling for FC results of 900fc/mL or greater, will take place at that time. The geometric mean of the two FC samples (initial and confirmation) determines the ranking

of the sites for priority in conducting property surveys. High and medium priority locations are contacted for property surveys.

4.3. Property Surveys

FC source identification and correction will be performed as described in Section 4.1 Sanitary Survey, *WQ SOPs*. Shoreline properties with high priority FC results (≥500 FC/100ml) will be contacted for property surveys first, and then properties with medium priority FC results (200 to <500 FC/100ml) will be contacted for property surveys second. Properties with low priority FC results (less than 200 FC/100ml) will not be contacted for property surveys.

A property survey, or a Mason County Sanitary Survey, may produce evidence of a septic system that is not functioning properly (broken baffles or leaky tank, clogged drainfield, etc.), often by sewage collecting on the surface of the ground. Once a septic system is determined to be the likely source of the high FC sample results, the information will be transferred to the MCPH Onsite Program for correction. Please see a complete description of the sanitary survey procedure in Section 4.1 Sanitary Survey, *WQ SOPs*.

However, if a septic system is not found to be the source of the pollution, the Sanitary Survey may produce evidence of another source, such as animal waste being carried to the sample location by storm water. The water quality staff will address such sources, if possible, by educating the homeowner on best landuse and household practices to prevent such contamination.

A similar process will occur when sampling results show high nutrient levels. The Sanitary Survey will be conducted in an effort to discover the source of high nutrients, such as septic issues, piles of grass clippings, or household/landuse practices (discovered through the homeowner interview). When such evidence is found, the water quality staff will conduct homeowner education to abate the pollution source, or refer the case to MCPH Onsite program if a septic system failure is found. Sanitary Survey procedures will be adapted (to exclude FC-specific protocols) from the procedures found in Section 4.1 Sanitary Survey, *WQ SOPs*.

4.4. Summary of Sampling Design for FC and Nutrients

Sampling for FC and nutrients loosely follows the design of Kitsap County's Pollution Identification and Correction Program. The sampling design below is constructed to address the questions:

- Is there a change in nutrient levels if there is a change in FC levels?
- What are the cumulative freshwater shoreline inputs of nutrients into the marine water surrounding the "Annas Bay/Great Bend" area (see Figures 3 and 4)?
- Is there a relationship between FC and nutrient concentrations?

The three nutrients to be sampled are nitrate-nitrogen, ammonia-nitrogen and phosphorus. Approximately 40-50% of total nitrogen (originating as ammonia-nitrogen and converted

to nitrate-nitrogen) in septic tank influent is removed by conventional on-site systems (Kitsap County Health District, January 2005). Although plant uptake may account for up to 50% of additional nitrogen removal, OSS's are suspected to be a source of nitrogen to Hood Canal due to incomplete nitrogen uptake. Additionally, phosphorus is a nutrient required to increase primary productivity and may be present in septic tank influent. However, phosphorus migrates through soils more slowly and binds to soil particles. It may be a contributor to nutrient problems from heavily loaded older drainfields or illegal gray water discharges.

Nutrient concentrations, especially nitrite+nitrate, demonstrate a seasonal pattern. Nutrient data from King County Land and Water Resources, http://dnr.metrokc.gov/wlr/waterres/streams/bear_trend.htm, monthly stream monitoring shows that nutrients are consistently higher during December and January; concentrations naturally decline in February and March. Sampling should be performed during high groundwater conditions (which typically end in early April) to assure movement of nutrients through the area to the sampling stream. However, because many residences of Hood Canal demonstrate a seasonal occupancy, an additional focus on the summer holiday season (please refer to the Shoreline Survey Project Schedule above) will be required. An additional consideration for observing nutrients in the dry season is the tendency for denitrification in hydric soils. It is possible that the samples collected by Kitsap County during wintertime wet season could show high fecal coliform levels but low nutrient levels due to this tendency. Summertime sampling may provide an opportunity to test this assumption.

Sampling for nitrate-nitrogen will be performed in conjunction with FC sampling, to determine if a relationship between FC and nutrients exists. Nitrate-nitrogen was chosen because previous preliminary sampling of small basins by the Kitsap County Health District for ammonia, nitrate and phosphorus determined the following:

- Ammonia-nitrogen is present above the detection limit only when the sample is collected close to the failing OSS. High FC results often occur in discharges of failing OSS and ammonia is not detected.
- Phosphorus is present above the detection limit only when the sample is collected close to a confirmed gray water discharge.
- Nitrate-nitrogen is detected at concentrations well above the detection limit and results are in ranges from 0.01mg/L to 3.5 mg/L.

Nitrate-nitrogen is theorized as the primary nutrient of interest at this time in regards to being a major contributor to low dissolved oxygen conditions. However, all three nutrients will be sampled and evaluated because they may represent an improperly functioning septic system. These will assist in answering the questions posed above.

The overall design is to collect FC and nutrient samples from the same sites and compare the results. MCPH will collect the data for comparison in two ways: 1) by performing FC and nutrient sampling before and after FC pollution source correction, and 2) by performing simultaneous sampling for FC and nutrients at all sites within the four *intensive nutrient sampling areas*.

At sampling locations throughout the Hood Canal shoreline, initial sampling for FC will take place. If the FC sample results are 900fc/mL or greater then a nutrient sample will be collected when the FC confirmation sample is collected. This will provide a Hood Canal-wide snapshot allowing a comparison of high FC levels with nutrients.

The four segments selected as *intensive nutrient sampling areas* reflect different levels of development. Segment H (Hoodsport to Potlatch) and Segment I (Union to Alderbrook) will reflect the impacts to water quality from landuse practices in more developed areas. These segments are characterized by small lots that provide diminished infiltration of stormwater, minimal soil for sewage treatment or Onsite Sewage System (OSS) replacement, etc. The unique shoreline along Annas Bay (Segment AB) will extend from the northeast shore of the Skokomish River to Union. In addition, Segment JJ, a relatively undeveloped segment of shoreline located south of Dewatto, will reflect minimal human impacts, and will serve as the control segment.

In the segments selected as *intensive nutrient sampling areas*, initially one FC and one nutrient sample will be collected from each sample site. A FC result of 200fc/mL or greater will be followed by a FC and nutrient confirmation sample. Looking at many data points comparing FC levels with nutrient levels may provide a more complete picture of the relationship between FC and nutrients. In addition, this data will help establish a baseline of nutrient inputs from shoreline freshwater flows in this area with persistent low dissolved oxygen problems.

In either of the sampling designs above, if the pollution source is identified and corrected (repaired or replaced septic system, animals restrained from water flows, etc.), then another set of samples – one FC and one nutrient sample – will be collected for comparison to the pre-correction results. All three nutrients will be included in the evaluation of nutrient reduction before and after FC source correction to more thoroughly understand the presence and change in concentrations of these nutrients.

Sanitary Surveys will be performed for elevated nutrient levels. Surveys will be preformed at all sites with nutrient levels above state drinking water standards and at sites with relatively high levels. Since the range of nutrient values we may encounter is unknown, we will attempt to calculate which sample results are high relative to the others in order to prioritize for sanitary surveys. As the most effective method of calculation and prioritization of sites is determined, the QAPP will be updated and submitted for DOE review. The method and rationale will be presented in the final report.

4.4.1. Evaluation of Relationship between FC and Nutrients

Mason County Public Health staff will collect water samples from shoreline discharges for FC according to Section 4.2.6 Water Quality Evaluation, *WQ SOPs* for the 39 shoreline segments. This sampling will provide an indication of the locations with high FC concentrations. Nutrient samples will be collected throughout the 39 segments and in the four segments selected for *intensive nutrient sampling*, as stated in Section 4.4 Summary of Sampling Design for FC and Nutrients.

The time of collection of samples before and after FC source correction should be performed to minimize seasonal influences. Due to the focus on periods of seasonal occupancy, confirmation samples and post-correction samples will be collected under as similar conditions as possible.

Field notes will be collected during sampling events and will include observed potential impacts such as visible impacts to drainfields, pet waste on or near the shoreline, presence of livestock, birds or other animals. Additionally, each discharge can be assessed for potential human impacts from aerial photos. This information may be used to better understand or interpret the resulting data.

In order to address the three questions stated in Section 4.4 Summary of Sampling Design for FC and Nutrients,

- Is there a change in nutrient level if there is a change in FC levels?
- What are the cumulative freshwater shoreline inputs of nutrients into the marine water surrounding the "Annas Bay/Great Bend" area (see Figures 3 and 4)?
- Is there a relationship between FC and nutrient concentrations?

data will be organized such that comparisons can be made between FC levels and nutrient levels. We will be comparing the results to see whether nutrient levels are reduced when FC levels are reduced and to see if there is a relationship between FC levels and nutrient levels.

Each sample location for which a pollution source is identified and corrected for FC and/or nutrients, will include a graphical and a tabular representation of the data, as well as a narrative. The graphs will reflect a comparison of the FC and nutrient data. The tables will include date, site, sample results (FC and nutrient), confirmation results, corrective action(s), and post-corrective action results (if available). The narrative will discuss observations that may have an affect on the results such as wildlife, piles of grass clippings, gray water discharges, etc., as well as temporal effects (ie wet or dry season) and occupancy.

Data compiled from within the four *intensive nutrient sampling areas* will be presented in two ways. To demonstrate the relationship or lack of relationship between FC and nutrient levels, a graph will provide a visual representation of all sites comparing these levels. A statistical evaluation of this data is not possible without flow measurements, but the comparison may provide the impetus to pursue a more correlative study of these analytes.

In addition, a table of sample results will provide information regarding the cumulative nutrient inputs from the shoreline to the marine water in the Potlatch/Annas Bay area (*intensive nutrient sampling areas*). The table will include the segment, sample site, sample date, and each nutrient sample result, as well as a total for each nutrient.

4.5. Monitoring Parameters

Water discharges to the shoreline in the survey area will be collected and transported according to the methods specified in Chapter 2.0 Monitoring Parameters and Procedures, *WQ SOPs.* FC will be analyzed according to Table 3 Laboratory Measurement Procedures (see Section 6 Laboratory Procedures).

Samples for nutrients will be analyzed for dissolved ammonia-nitrogen, nitrate+nitrite-nitrogen and ortho-phosphate. These nutrient parameters were selected because they represent the bioavailable forms of nitrogen and phosphorus.

Samples will then be stored and/or preserved, and analyzed according to Section 6 Laboratory Procedures, below.

Salinity will be measured in parts per thousand (ppt) using a Vista model A366ATC refractometer (0-10% salinity). Salinity values are used to distinguish between marine and freshwater which have different FC standards. Salinity values may also help determine from where the source of the flow is coming (recharge from the beach v. groundwater from an adjacent property).

Rainfall data will be collected from the George Adams Fish Hatchery to correlate rainfall depth with wet weather conditions.

5. Field Procedures

Field Procedures will be conducted according to Chapters 2.0, 4.1 and 4.2 of the *WQ SOPs,* which outline the Monitoring Procedures, Sanitary Surveys and Pollution Identification and Correction.

5.1. FC and Nutrient Sample Collection

FC samples will be collected in Nalgene 100mL bottles and analyzed for FC only. Nutrient samples will be collected in HDPE 125mL bottles and analyzed for Ammonia-Nitrogen, Nitrate+Nitrite-Nitrogen, and Orthophosphorus.

Sampling for FC evaluation will be conducted on Mondays, Tuesdays and Wednesdays during dry and wet sampling events during tides of less than 5.5 feet. Samples will be transported by cooler at or below 10° Celsius and stored in the Mason County Laboratory refrigerator. Analysis will be performed within 24 hours of the sampling time at the Mason County Water Lab.

Sampling for nutrient evaluation will be performed on Mondays, Tuesdays or Wednesdays during dry and wet season sampling events during tides of less than 5.5 feet. Samples taken each day will be transported in a cooler either directly to Twiss Lab or by courier. The contracted lab will analyze the samples within the holding time for each analyte.

Table 3. Sample Containers, Preservation and Holding Times

Parameter	Matrix	Minimum Quantity Required	Container	Preservative	Holding Time
Ammonia-Nitrogen	Freshwater	100 mL	HDPE 125 mL bottle	4°C, (H_2SO_4 pH<2)*	24 Hrs (28 days)*
Nitrate+ Nitrite-Nitrogen	Freshwater	100 mL	HDPE 125 mL bottle	4°C, (H_2SO_4 pH<2)*	48 Hrs (28 days)*
Ortho-phosphate	Freshwater	100 mL	HDPE 125 mL bottle	4°C, (H_2SO_4 pH<2)*	48 Hrs
Fecal Coliform	Freshwater	100 mL	Nalgene 125mL bottle	N/A	24 Hours at <10°C

*Preservatives will not be used for this project. All analyses will be performed within Holding Time

6. Laboratory Procedures

Twiss Analytical Laboratory, Inc. in Poulsbo is accredited by the Department of Ecology (#C1316) and will conduct nutrient measurements, as well as corrective action procedures in conformance with their Quality Assurance program.

The analytes, sample matrix, analytical methods, method detection limits and holding times for these nutrients are summarized in Table 4 below:

Table 4. Laboratory Measurement Procedures

Lab and DOE Lab Accreditation Number	Analyte	Sample Matrix	Laboratory Analytical Method (DOE-Accredited)	Method Detection Limit	Holding Time
Twiss Analytical Labs, Inc. (#C1316)	Ammonia-Nitrogen	Non-potable Water (filtered)	4500-NH3 F or G, SM 19/20	0.0083 mg/L	24 Hrs (28 days)*
Twiss Analytical Labs, Inc. (#C1316)	Nitrate+ Nitrite-Nitrogen	Non-potable Water (filtered)	4500-NO3 F, SM	0.0073 mg/L	48 Hrs (28 days)*
Twiss Analytical Labs, Inc. (#C1316)	Ortho-phosphate	Non-potable Water (filtered)	4500-P E, SM	0.0071 mg/L	48 Hrs
Mason County Water Lab (#M1464)	Fecal Coliform	Non-potable Water	APHA Procedure 9221-E, MPN Fecal Coliform Direct Test (A-1 Medium)	<2 to ≥1600 fc/100mL	24 Hours at <10°C

Table 5. Measurement Methods (Laboratory)

Analyte	Sample Matrix	Samples [Number/ Arrival Date]	Expected Range of Results	Reporting Limit	Sample Prep Method	Analytical (Instrumental) Method
Ammonia-Nitrogen	Non-potable Freshwater	Max. allowed: 60/day Ave. submittal: 35/day	0.02 - 0.40 mg/L	0.02 mg/L	Filter	4500-NH3 F or G, SM 19/20
Nitrate+ Nitrite-Nitrogen	Non-potable Freshwater	Max. allowed: 60/day Ave. submittal: 35/day	0.01 – 3.5 mg/L	0.02 mg/L	Filter	4500-NO3 F, SM
Ortho-phosphate	Non-potable Freshwater	Max. allowed: 60/day Ave. submittal: 35/day	0.01 – 1.5 mg/L	0.02 mg/L	Filter	4500-P E, SM
Fecal Coliform	Non-potable Freshwater	Max. allowed: 60/day Ave. submittal: 35/day	<2 to ≥1600 fc/100mL	<2 to ≥1600 fc/100mL	APHA Procedure 9221-E, MPN Fecal Coliform Direct Test (A-1 Medium)	APHA Procedure 9221-E, MPN Fecal Coliform Direct Test (A-1 Medium)

7. Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) procedures are measures taken to ensure that data are accurate and useful primarily by measuring and minimizing errors. The Mason County Public Health Water Quality Program staff have developed the Water Quality Standard Operating Procedures (*WQ SOPs*) so that water quality activities are conducted in a consistent and reliable manner.

Data collected for the Hood Canal Pollution Identification and Correction program (as in all programs) will aim to be unbiased, precise, representative, and have good comparability. Field, laboratory and office procedures will be followed in order to assess precision of data and overall variability (natural environmental variability of the measured parameter, sampling variability, and lab variability), as well as precision and overall variability of each parameter.

All information in the following QA/QC sections can be more thoroughly examined in the Mason County Water Quality Standard Operating Procedures.

7.1 Quality Control Procedures

7.1.1 Field Quality Control

Field staff will record field notes that include specific cataloging of sample location data (sample number, site number, time, etc.) as well as all relevant observations (any feature or occurrence that may affect the sample) in appropriate waterproof field notebooks. In addition at each location, laboratory sheets (used to identify and track samples as they move from the field to the lab) will be filled out with essential data for submittal to the lab. The information will be retained for review and for data entry into computer databases where Quality Assurance procedures will be applied (see below). GPS points as well as photos will be taken from each location, their identifiers also recorded in the field notebook and/or lab sheet. Staff will follow the procedures in the *WQ SOPs* for aspects such as sample collection, sample storage and sample transport to the laboratory.

Replicates
Field replicate sampling for bacteria will provide an additional field quality control. Replicates are two samples collected at the same time and location. Although bacteria typically "clumps" and may show great variability between samples, the difference can be measured to determine the precision. Please see the Precision section under Quality Assurance below.

Blanks
Field blanks for bacteria will be included for each sampling event. Deionized (DI) water is carried into the field and then is poured into a sample bottle. The field blank is handled, transported and analyzed in the lab like a sample to evaluate whether field staff are handling samples in such a way as to not contaminate them.
Temperature
Temperature control is maintained in the field and during transport by packing samples in a cooler with blue ice. One temperature control bottle per cooler is carried with samples during the sampling event and temperature is measured upon arrival at the Mason County Water Lab. See *WQSOPs* for details of the procedure.

7.1.2 Laboratory Quality Control

Fecal Coliform Analysis
The Mason County Water Laboratory (MCWL) is accredited by the Washington Department of Ecology (accreditation# 1464). Lab processes must produce valid results for data acquired through sample analysis to be useful. The MCWL performs the following procedures to validate results:

- Positive and negative culture controls, as well as sterility and pH tests, are run for each batch of media.
- Sterility controls are run on vessels and autoclave. Sterility and pH controls are run on each batch of freshly made media and buffer solution.
- Monthly Heterotrophic Plate Count (HPC), pH, and conductivity checks are run on DI water.

- Preventive maintenance of equipment is performed. In the event of equipment failure/malfunction, no data will be reported, and the chain of custody will be marked as "invalid test due to equipment failure." The incident will be discussed with the Environmental Health Manager and corrective action(s) will take place.
- Precision and overall variability is assessed through analysis of field replicate samples, laboratory method duplicates and laboratory method recovery results.

Nutrient Analysis

The Twiss Analytical Laboratory (TAL) is accredited by the Washington Department of Ecology (accreditation# C1316) and will be performing all nutrient analyses. TAL is in the process of updating their QA/QC Manual and will forward it in May 2007. However, the procedures in the existing Manual that are currently in use were available for review at the time of accreditation.

Table 6. QC Samples, Types and Frequency

Parameter	Field		Laboratory			
	Blanks	Replicates	Check Standards	Method Blanks	Analytical Duplicates	Matrix Spikes
Ammonia-Nitrogen	N/A	1 per 10 samples	1 per 10 samples	1 per 10 samples	1 per 10 samples	1 per 10 samples
Nitrate+ Nitrite-Nitrogen	N/A	1 per 10 samples	1 per 10 samples	1 per 10 samples	1 per 10 samples	1 per 10 samples
Ortho-phosphate	N/A	1 per 10 samples	1 per 10 samples	1 per 10 samples	1 per 10 samples	1 per 10 samples
Fecal Coliform	1 blank per sampling event	1 per 10 samples	N/A	N/A	10%	N/A

7.2 Quality Assurance Procedures

Quality Assurance (QA) provides a process for ensuring the reliability and value of measured data. Sound QA practices are essential to acquire data of the necessary type and quality for their intended use. To be scientifically and legally defensible, data must be of documented quality.

7.2.1 Data Quality Objectives

The primary data quality objective of the Mason County HCPIC program is to estimate the concentration of bacteria and specified field parameters at sampling sites. These results will be used to assess compliance with the state standards, and in the course of the HCPIC project, may trigger sanitary surveys, dye traces, and septic system repairs or replacements.

Bias

Bias is considered the consistent deviation of measured values from the true value, caused by systematic errors in a procedure. Bias within the sampling process will be reduced to the extent practicable by the following:

- Strict adherence to the sampling procedures of the *WQ SOP*
- Periodic reviews and evaluations of field sampling procedures
- Complete data entry, standardized organization, and data retention.
- Analyzing data in an appropriate manner based upon pertinent variables, such as temporal variations.
- Regular and documented field meter calibration and maintenance

Precision

Precision describes the repeatability of the methods. It is a measure of the variability in the results of replicate measurements due to random error. Random errors are always present due to normal variability in the many factors affecting the measurement results. Precision will be determined by the following:

- Collection and analysis of field replicates (not splits) for bacteria at a minimum of 10% for each monitoring day or event. Consistent with the data quality objectives, replicates will be collected randomly. The Relative Percent Difference (RPD) will be calculated for each set of field replicates as well as lab duplicates using the following equation:

  * RPD = 100. X (Duplicate 1 – Duplicate 2) / (Average of the two duplicates)
  Where Average = (Duplicate 1 + Duplicate 2) / 2

  *acquired from: the Chehelis River Council at http://www.crcwater.org

  Variability in bacteria sampling results are common due to the "clumping" nature of bacteria, therefore RPD's greater than 40% will be flagged. The difference between the two results can be used to discover what variability is possible, and what influences might explain that variability (such as in-stream factors, collection techniques and processing, and laboratory analyses).
  In addition, at sites where the first sample is high in fecal coliform or nitrate, the repeat sampling conducted will also allow for data analysis for precision.

- Documentation of ongoing field equipment maintenance, calibration, and operation.

Data Representativeness

Representativeness of the data is described as an adequate number of samples and monitoring events to satisfy program objectives. It describes how well the sample represents the environmental condition being measured. Representativeness will be primarily achieved through the following:

- Strict adherence to the specific procedures of the *WQ SOPs.*
- Thorough documentation of applicable environmental factors (e.g., weather and tidal conditions, observable changes, wildlife present, etc.).
- Recording all data for each site in appropriate spreadsheets from the field notebook and the lab sheet, and attaching photos and GPS identifiers.

- A determination of whether the project objectives and data quality objectives have been met for specific sets of data and information at the time of reporting. The HCPIC project relies on a single sample from a sampling site to trigger follow up procedures. A natural variation of bacteria levels due to clumping or intermittent conditions (presence of wildlife or groundwater, for instance) is expected. Repeat sampling at a single location is also subject to natural variability. However, if a high hit of fecal coliform or nutrient is followed by a high hit in a repeat sample, and a source of pollution is then located (and hopefully corrected), it may be determined that the representativeness of the data is sufficient for the purpose of the project.

Data Completeness

The EPA has defined completeness as a measure of the amount of valid data that needs to be obtained from a measurement system. By applying the measures delineated in this Data Quality Objectives section, completeness will be addressed during the project design phase (prior to implementation of a project or sampling event), and again upon determination of representativeness (completion of a project or sampling event). A statement of completeness will be included in reports compiled at the end of a project, and may include qualifying data, observations, and/or complications encountered during the project. Sampling events will include qualifying data and the recording of observations and/or complications in designated field notebooks and/or databases.

Data Comparability

Data Comparability describes how well the data can be compared with other data. Comparability of data will be addressed during the project design phase when determining data objectives, parameters and sampling methods, environmental conditions, and temporal and other pertinent variables and controls, analytical methods, and data reporting and detection limits. Comparability will be ensured by strict adherence to appropriate *WQ SOPs*, project and sampling plans, data management, and field and laboratory QAQC procedures.

The comparability to data acquired by the Kitsap County Health District during their Pollution Identification and Correction projects has been determined to be of high value. To this end, the HCPIC staff will submit all nutrient data to the same lab that processes Kitsap's samples, Twiss Analytical Laboratory in Poulsbo, WA. The same procedures are used in Kitsap's and Mason County's PIC projects except for collection of flow data with associated statistical analysis. However, laboratory methods and procedures will be identical.

7.2.2 Field Quality Assurance

Quality assurance for the field activities covered under the *WQ SOPs* will be achieved through documentation of the following:

- Consistent use of the standard operating procedures
- Consistent use of, and adherence to, applicable QAPP or other monitoring plans

Sampling Procedures
Consistent and properly implemented monitoring procedures are an essential element to collecting scientifically valid and defensible data. Staff will reference Chapter 2.0 Monitoring Parameters and Field Procedures of the *WQ SOPs* for detailed instructions regarding sampling activities that were based on the Kitsap County Health District's highly successful PIC program.

Maintaining and Calibrating Field Equipment
Having well maintained and properly calibrated monitoring equipment is an essential element to collecting scientifically valid and defensible data of known precision. Please see Chapter 5.0 of the *WQ SOPs* for specific Equipment Calibration and Maintenance.

7.2.3 Laboratory Quality Assurance

Laboratory QA/QC will be assured through the labs' participation in the Washington State Department of Ecology Laboratory Accreditation program. The Mason County Water Lab is currently accredited for the MPN method of fecal coliform analysis. The Mason County Water Lab will follow the QA/QC requirements specified in the fecal coliform MPN method, laboratory SOPs, and accreditation requirements (see Section 7.1.2 Laboratory Quality Control, above).

Twiss Analytical Lab is currently accredited for nutrient analyses listed in Tables 4 and 5. See Table 7 for specific Quality Control procedures, as well as Section 7.1.2 Laboratory Quality Control, above).

Table 7. Measurement Quality Objectives
(Laboratory Analyses of Water Samples)

Laboratory	Twiss Analytical Labs, Inc. (#C1316)	Twiss Analytical Labs, Inc. (#C1316)	Twiss Analytical Labs, Inc. (#C1316)	Mason County Water Lab (#M1464)
Parameter	Ammonia-Nitrogen	Nitrate+ Nitrite-Nitrogen	Ortho-phosphate	Fecal Coliform
Quality Control Procedure	~	~	~	~
Check Standard (LCS) % Recovery Limits	90 – 110%	90 – 110%	90 – 110%	N/A
Duplicate Samples RPD	20%	20%	20%	10%

Table 7. Measurement Quality Objectives
(Laboratory Analyses of Water Samples)
(Continued)

Laboratory	Twiss Analytical Labs, Inc. (#C1316)	Twiss Analytical Labs, Inc. (#C1316)	Twiss Analytical Labs, Inc. (#C1316)	Mason County Water Lab (#M1464)
Parameter	Ammonia-Nitrogen	Nitrate+ Nitrite-Nitrogen	Ortho-phosphate	Fecal Coliform
Quality Control Procedure	~	~	~	~
Matrix Spikes % Recovery Limits	80 – 120%	80 – 120%	80 – 120%	N/A
Matrix Spike-Duplicates RPD	20%	20%	20%	N/A
Surrogate Standards	N/A	N/A	N/A	N/A
Lowest Concentrations of Interest	0.01	0.01	0.01	N/A
% Recovery Limits	LCS 90 – 110%	LCS 90 – 110%	LCS 90 – 110%	N/A
Relative Percent Difference (RPD)	Duplicate 20%	Duplicate 20%	Duplicate 20%	N/A
% Recovery Limits	Matrix spike 80 – 120%	Matrix spike 80 – 120%	Matrix spike 80 – 120%	N/A
Relative Percent Difference (RPD)	Matrix spike 20%	Matrix spike 20%	Matrix spike 20%	N/A
% Recovery Limits Surrogate	N/A	N/A	N/A	N/A
Units of Concentration	Mg/L	Mg/L	Mg/L	N/A

7.2.4 Office Quality Assurance

Quality Assurance in the office will be ensured through careful record keeping and documentation.

Lab sheets for the MCWL are initialed by the field person turning in the samples. Also recorded on the lab sheet are the samplers' names, date, time each sample was

taken, date and time of submittal to the lab, temperature of temperature control sample, weather conditions for the sampling event, type of sampling (investigative), matrix, and project code. Lab sheets are submitted to the lab with the samples collected that day. After results have been entered to the lab sheet, the original is filed in the lab's office and a copy is provided to the HCPIC staff. The results and other pertinent data are entered into the appropriate Excel spreadsheets, and then filed into a 3-ring binder in the HCPIC staff office. Verification of data is done immediately following data entry by comparing values in the database to values on the lab sheet.

Lab sheets combined with Chains of Custody will be used to submit nutrient samples to Twiss Analytical Lab, Inc, in Poulsbo. Lab sheets will accompany samples and will be delivered either directly to Twiss Lab by HCPIC staff or by courier. Each person handling the coolers containing the samples will sign off when he/she receives or relinquishes the coolers. Sampling times will be coordinated with the Twiss chemist to assure analysis can be done within holding times. Results will be returned to staff via electronic mail with a hard copy to follow. All results will be entered into project databases and binders the next office day after the field day. Verification of data is done immediately following data entry by comparing values in the database to values on the lab sheet.

All photos and GPS coordinates are downloaded and labeled the next office day after a field day. These data are entered into an Excel spreadsheet that tracks sampling locations and descriptions. Verification of data occurs at the time data is transferred from field notebooks to Excel spreadsheets. Photos are attached according to the identifiers assigned while in the field. Descriptions written in the field are compared to photos at the time they are attached and labeled in the database. GPS points are attached to the data in the database at this time as well.

Field notebooks are used until filled and then are retained in a file in the office. Field notebooks can be useful in the event of unexpected or unusual lab results. Observations such as the presence of birds or other wildlife, or the presence of a large development above a sampled storm drainage, can help explain the results from a particular site.

All paperwork generated during the project (notebooks, copies of lab sheets with results, photos, maps, etc.) is kept in 3-ring binders in the HCPIC staff office, and all computer documents are maintained in the Mason County Environmental Health computer network.

8. Data Management

Detailed observations and field data will be collected in designated field notebooks and will be retained by Mason County Public Health. Data validation and verification will be performed at the time of data transfer from field notebooks into Excel spreadsheets, and after calculations and graphical representations have been done. Data will be handled in accordance with procedures delineated Section 7. Quality Assurance /Quality Control above.

All fecal coliform and nutrient sampling data will be submitted for inclusion to DOE's EIM database.

The Hood Canal OSS Tracker (Excel spreadsheet) to be submitted will include data in tabular form of all on-site septic system and Sanitary Survey information gathered along the Hood Canal Shoreline.

Excel spreadsheets will help organize and facilitate analysis of the fecal coliform and nutrient data. Spreadsheets will include sampling results, geometric mean calculations, site descriptions and GPS coordinates.

The PowerPoint presentation developed to inform residents of the Hood Canal Pollution Identification and Correction project, Onsite Sewage System function and Operation & Maintenance (O&M), and Best Landuse and Household Practices for Water Quality, will be submitted electronically and on CD according to contract requirements.

Reports, spreadsheets, educational materials and any other information pertaining to this grant will be maintained by the County on the Environmental Health network.

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