# Mission Creeks

## Water Quality Assessment

November 2009

Hood Canal Salmon Enhancement Group
Belfair, WA 98528

and

Mason County Public Health
Shelton, WA 98584

Funded by the
Washington State Department of Ecology
Water Quality Program
Olympia, WA 98504-7710

# Abstract

The Hood Canal Salmon Enhancement Group (HCSEG) collaborated with Mason County Public Health (MCPH) to conduct a two-year investigation of fecal coliform bacteria sources on Big Mission Creek and Little Mission Creek located near Belfair, Washington. This project was funded through the Washington State Department of Ecology's Water Quality Program. Big Mission Creek and Little Mission Creek flow into the marine waters of Hood Canal and have an impact on the commercial and recreational shellfish harvest areas along the adjacent shoreline. The shellfish harvest has been restricted in this area, and this project is designed to identify sources of fecal pollutants and work with landowners to make the appropriate corrections.

Big Mission Creek and Little Mission Creek are approximately eight miles and two miles in length, respectively. Each is characterized by residential development in the lower portions of the watershed. The main stem of each stream was segmented with water sampling points. Nine sampling points were established on Big Mission Creek and three on Little Mission Creek. Monthly water sampling at these points shifted in Y2 to the lower portions of each watershed where the greatest fecal coliform pollution risk was evident. Trained citizen volunteers were a vital component of the sampling regime.

During the project period, seven of twelve sampling stations exceeded one of the WA State Standards for Class AA Surface Waters. These stations had more than 10 percent of all fecal coliform samples exceed 100 fecal colonies / 100 mL of water sample over the course of the year. None of the sample locations exceeded the allowable geometric mean value over the same period.

During the second year, water sampling combined with MCPH sanitary surveys focused within the lower portion of the watersheds. Eighty-four land parcels were identified for potential sanitary surveys. Thirty-one parcels represent vacant land. Four land-owners denied access. Sanitary surveys were completed on 24 of the potential 49 land parcels.

In addition, two separate intensive surveys were conducted over two-day time periods to assess hourly fecal coliform fluctuations. Morning and afternoon peaks in fecal coliform were evident during one intensive survey, but not the other. During the first year sampling, bi-monthly water samples were also analyzed for dissolved metals (cadmium, copper, lead, and zinc), total recoverable mercury and total suspended solids (TSS). Analysis showed results were low and well within ranges provided as state standards. These observations now serve as a baseline for this data type.

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# Acknowledgements


- Funding for the Mission Creeks Water Quality Assessment (MCWQA) was provided through the Washington State Department of Ecology's Water Quality Program by a grant from its Clean Water Act Section 319 Nonpoint Source Fund.
- The Hood Canal Salmon Enhancement Group was awarded the grant and partnered with Mason County Public Health (MCPH) to perform sanitary surveys and for lab analysis of the fecal coliform samples.
- Responsibilities for this project:

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  Water sampling coordinator and field data manager.

  Debbie Riley and Seth Book. Mason County Public Health.

  Water Quality Project Coordinator.

  Carol Spaulding. Mason County Public Health.

  Lab analysis for fecal coliform.

  Amy Georgeson and Wendy Matthews. Mason County Public Health.

  Sanitary Surveys.

  Steve Twiss. Twiss Analytical, Inc. Analytical and Environmental Laboratories.

  Lab analysis for dissolved metals.

  Brooks Rand LLC. Lab analysis for dissolved metals, total recoverable mercury, hardness and total suspended solids.

- The following participants contributed to the MCWQA Steering Committee meetings:
  WA Department of Ecology. Sarah Davenport-Smith.
  Hood Canal Salmon Enhancement Group. Neil Werner, Dan Hannafious, Renee Rose-Scherdnik.
  Mason County Public Health. Debbie Riley, Seth Book, Amy Georgeson, Wendy Matthews.
  Lower Hood Canal Watershed Coalition. Bob Hager, Teri King, Constance Ibsen.
- Water sampling teams were led by Renee Rose-Scherdnik (HCSEG) and Seth Book (MCPH). These teams mostly consisted of trained volunteers and interns who performed the majority of

the field sampling.  This project was fortunate to have had such a wonderful group of volunteer samplers.  They participated in training, had a high level of commitment (rain, shine or snow), demonstrated quality sampling technique, and were enthusiastic about becoming involved in their community.  Their contribution is gratefully acknowledged.  The primary sampling team who contributed between thirty to fifty hours in the field consisted of Loy (Mac) McInturff, Kim Jones, and Cheryl Loddo.  Many others participated throughout this project: Toby Tahja-Syrett, Lynn Fisher, Michele Fisher, Chuck Williams, and Shannon Stragier.  HCSEG interns included Jessica Peters, Mya Keyzers, Victoria Worm and Marissa Garvin.  Over the course of this study, volunteers donated over 160 hours in the field.

- Flow monitoring was led by Sean Hildebrandt (HCSEG) and included HCSEG staff Matt Korb, Don Husted, Scott Sperling, along with interns Peter Kauhanen and Nick Holm.
- HCSEG staff Mendy Harlow and Julie Easton assisted with transporting water samples to multiple laboratories for analysis.
- Lab analysis for fecal coliform was performed by Carol Spaulding and Seth Book with Mason County Public Health (Shelton, WA).
- Lab analysis for metals and TSS was provided by Amanda Fawley at Brooks Rand (Seattle, WA) and Steve Twiss, Twiss Analytical Laboratories (Poulsbo, WA).
- Sanitary surveys were performed by Amy Georgeson and Wendy Matthews at Mason County Public Health.
- Thank you local landowners within the Mission Creeks watersheds and the Mission Creek Corrections Center for Women for permitting access to sampling sites.

*Thank you all for contributing your time, effort and expertise!*

# Introduction

Water quality is of paramount concern as the region moves into the future. The Washington State Department of Ecology has encouraged the collection of data for the purpose of conducting trend monitoring (Seiders and Yake, 2002). There is also a parallel concern for the water quality as it relates to the aquatic environment. The lower Hood Canal, in particular, supports self-sustaining populations of chinook, fall chum, summer chum (ESA-listed salmon), coho, steelhead, and cutthroat trout (CTC, 2000).

Hood Canal has long attracted folks to the region of western Washington due in large part to the quality of life that it provides. Summertime brings an influx of people that more than doubles the population of the shoreline region. People come to enjoy water sports, boating, crabbing, shrimping, and the recreational harvest of shellfish and just to enjoy the splendor of the scenery. Several state parks provide opportunities to visitors with the chance to enjoy local activities and landscapes. A world class conference center is located on its southern shoreline. Local tribes rely on Hood Canal as their usual and accustomed treaty rights area. This area provides for economic and cultural natural resources from the entire upland watershed and the marine water. The world market is developing a taste for Hood Canal shellfish from an industry providing oysters, clams, mussels and geoducks.

Considering the economic, recreational and cultural aspects of the watershed, all of these facets require that the waters of Hood Canal remain of the highest quality. Development pressures are being recognized as a potential threat to these things. In 1987, 630 acres of lower Hood Canal were classified as “prohibited” for the harvest of shellfish. By 1993 an additional 960 acres were added to the “prohibited” area for the harvest of shellfish. The Department of Social and Health Services reported in 1998 that failed on-site sewage systems were negatively affecting the water quality in the Lynch Cove area of Hood Canal. Near this time, the on-site sewage treatment facility at Belfair State Park was failing and was eventually closed.

Fish kills in 2003 and 2004 drew attention to the dynamic and perplexing issue of annual variability of low dissolved oxygen in the marine waters. It has been recognized that nutrient loading of the marine water plays a role in marine water chemistry and dissolved oxygen levels (Newton, et al, 1995). The factors that may drive low oxygen levels have been implicated with surface, groundwater, and river contributions (Messman, 1991). It has been inferred that fecal coliform may have a positive relationship with the nutrient loads, although this is speculative and is currently being addressed through more intensive shoreline monitoring.

Conditions and events have been pushing against the ability of the Hood Canal watershed to retain its water quality. However, people have been pushing back. On-site sewage system inspections along marine shorelines and stream corridors were conducted in response to shellfish concerns.

Belfair State Park replaced their aging failed septic system that had been used as a recreational vehicle sewage dump station. Through continued monitoring, WDOH has proposed to reopen some of the tidelands adjacent to the park for recreational shellfish harvest. By 1998, nearly 1000 acres of tideland areas were reclassified as “approved” for shellfish harvest.

Local WRIA planning groups have developed recommendations to boards representing the tribes and county commissioners.  In 2003, a multi-level partnership, Hood Canal Dissolved Oxygen Program (HCDOP) was formed to better understand the forces driving marine water conditions in Hood Canal.  In 2005, the Puget Sound Partnership was formed through the Governor's Office to strategize the means to improve the overall health of Puget Sound and Hood Canal marine waters.

Water quality concerns remain paramount and the health of our waterways is recognized as an indicator of overall environmental health.  Impacts to our waterways are primarily from human sources, although wildlife has been implicated.  References have been made in recent years regarding the need to better understand the contribution of birds (primarily waterfowl) to the elevated fecal coliform counts along the shoreline adjacent to Belfair State Park (Barnes, et al, 1995).  In a report on Morro Bay contamination, researchers using DNA testing determined that oysters were impacted more by bird sources than by human or cattle (Kitts and Moline, 2002).

Although this project will not address the independent impacts of wildlife along the shoreline, it will help to identify sources contributing fecal coliform pollution. The creek is a conduit for fecal pollution to the shoreline from the watershed.  This project will help to better understand the timing of fecal coliform contribution to the shoreline.  It has been hypothesized that fecal loading may be greater during low flow periods (Barnes, et al, 1995).   This earlier study reported data suggesting the lower segment of Big Mission Creek 'lost' stream flow in relation to a monitoring station upstream, and speculated that the glacial till soils may play a hydrodynamic role in the fecal coliform loading during high flows and low flows.

A steering committee composed of representatives from the Hood Canal Salmon Enhancement Group, Mason County Public Health, Lower Hood Canal Watershed Coalition (LHCWC), and WA Department of Ecology initially met and designed this investigation.  The steering committee met quarterly to guide the project, provide recommendations and provide comments for this report.  Updates on the water quality results were presented and discussed at several LHCWC meetings.

Big Mission Creek and Little Mission Creeks (WRIA 15) border both sides of Belfair State Park as they enter the marine waters of Hood Canal (refer to figures 1 and 2).  These streams have an impact on the commercial and recreational shellfish harvest areas which have in the past been closed due to elevated levels of bacteria.  The quality of recreation experiences at Belfair State Park are compromised when water quality standards are not maintained.

## Project Goals

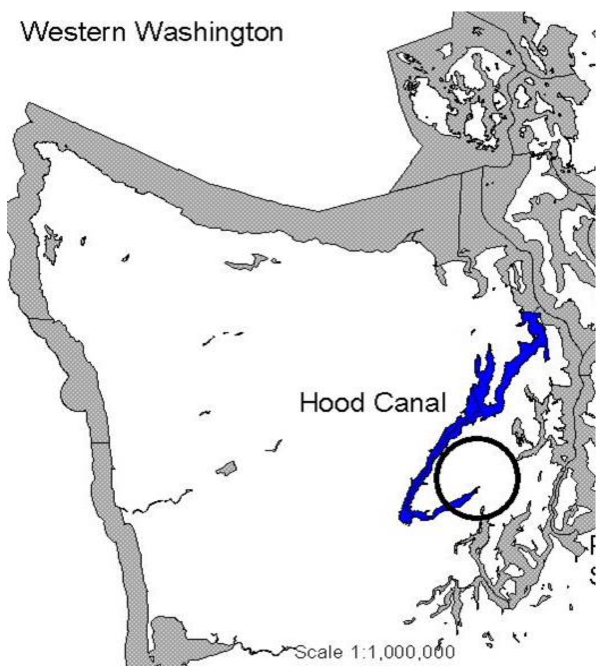
The primary goal of this project was to investigate fecal coliform bacteria sources in Big Mission Creek and Little Mission Creek (WRIA 15) during various stream flows, and to work with property owners to manage their fecal pollution contributions to the marine waters.  The investigation was performed with water sampling, sanitary surveys and dye tests. Remedial action was recommended to the property owners as results dictated, and implementation and/or commitment to make corrections was reported.

These river systems were also sampled for the occurrence of dissolved metals (cadmium, copper, lead, and zinc), total recoverable mercury and total suspended solids (TSS) in order to establish a baseline of this data type within the developing area.

Objectives

- Obtain water samples within discrete segments of these streams in order to isolate sources of fecal coliform bacteria.
- Determine properties affecting these waterways in order to develop remedial action plans to correct sources of pollution.
- Establish the level of dissolved metals or total recoverable mercury in these waterways.

**Figure 1.** Mission Creeks Project Area.




## Project Area Description

The sampling area for this study is composed of sampling locations along the mainstem and tributaries of Big Mission Creek and within the mainstem of Little Mission Creek. The majority of the sites are in the lower reaches of the watershed. Refer to Figure 1, Mission Creeks Project Area.

Big Mission Creek site MC-01 is within Belfair State Park downstream of the Highway 300 bridge. Sites MC-02, -03 and -04 can be accessed along Mission Creek Road. Sites MC-05, -06, and -07 are all in vicinity of each other off Sand Hill Road. Site MC-08 is also along Sand Hill Road. MC-09 is under the overpass where Bear Creek-Dewatto Road meets Gold Creek Road.

Little Mission site LM-01 is within Belfair State Park upstream of the new vehicle bridge. Site LM-02 is just downstream of the Beck Road culvert. Site LM-03 is upstream of the last property along Lil' Mission Creek Road.

**Figure 2.** Project Vicinity Maps for Big and Little Mission Creeks.

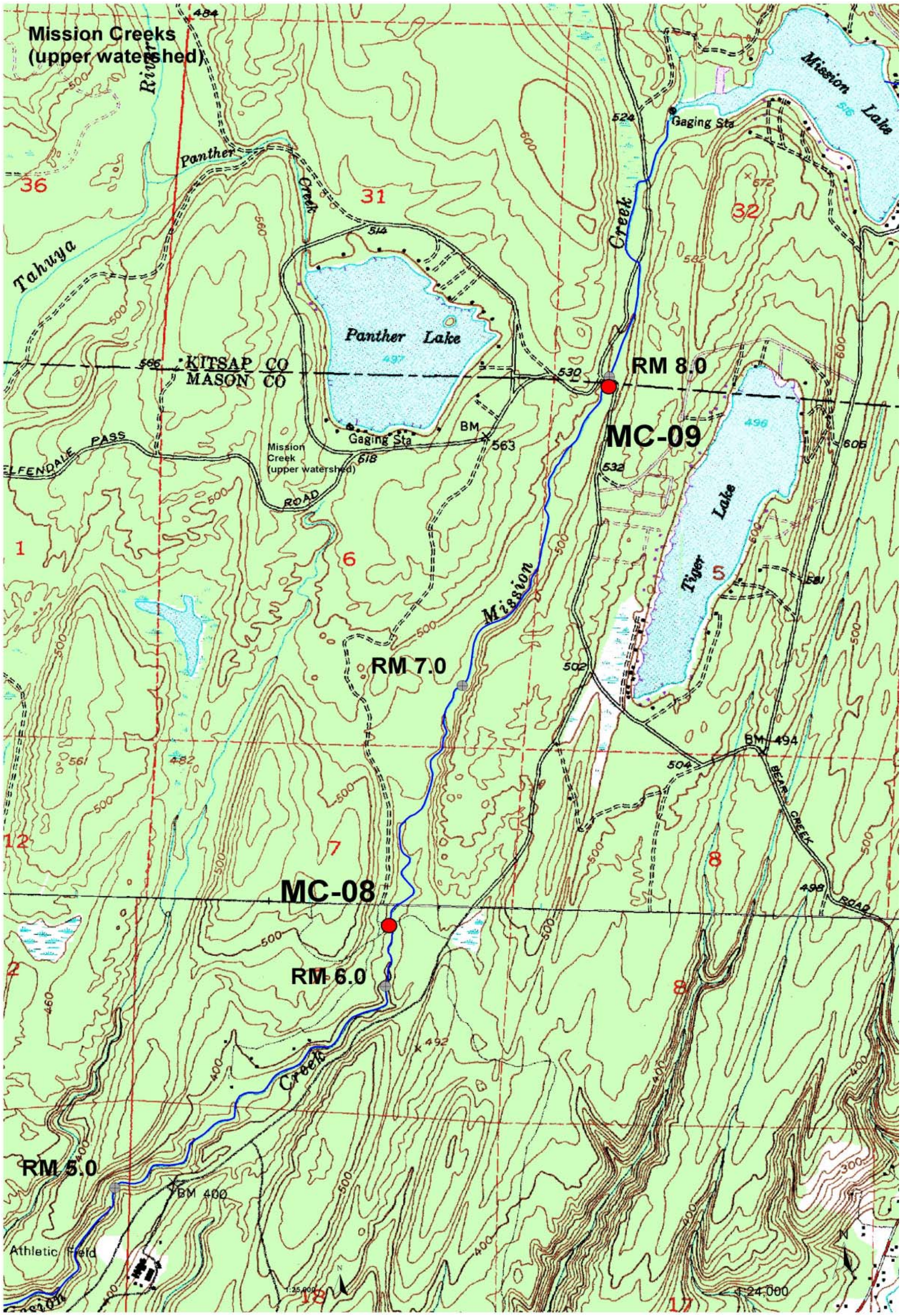



**Figure 2-A. Upper portion of Big Mission Creek watershed.**

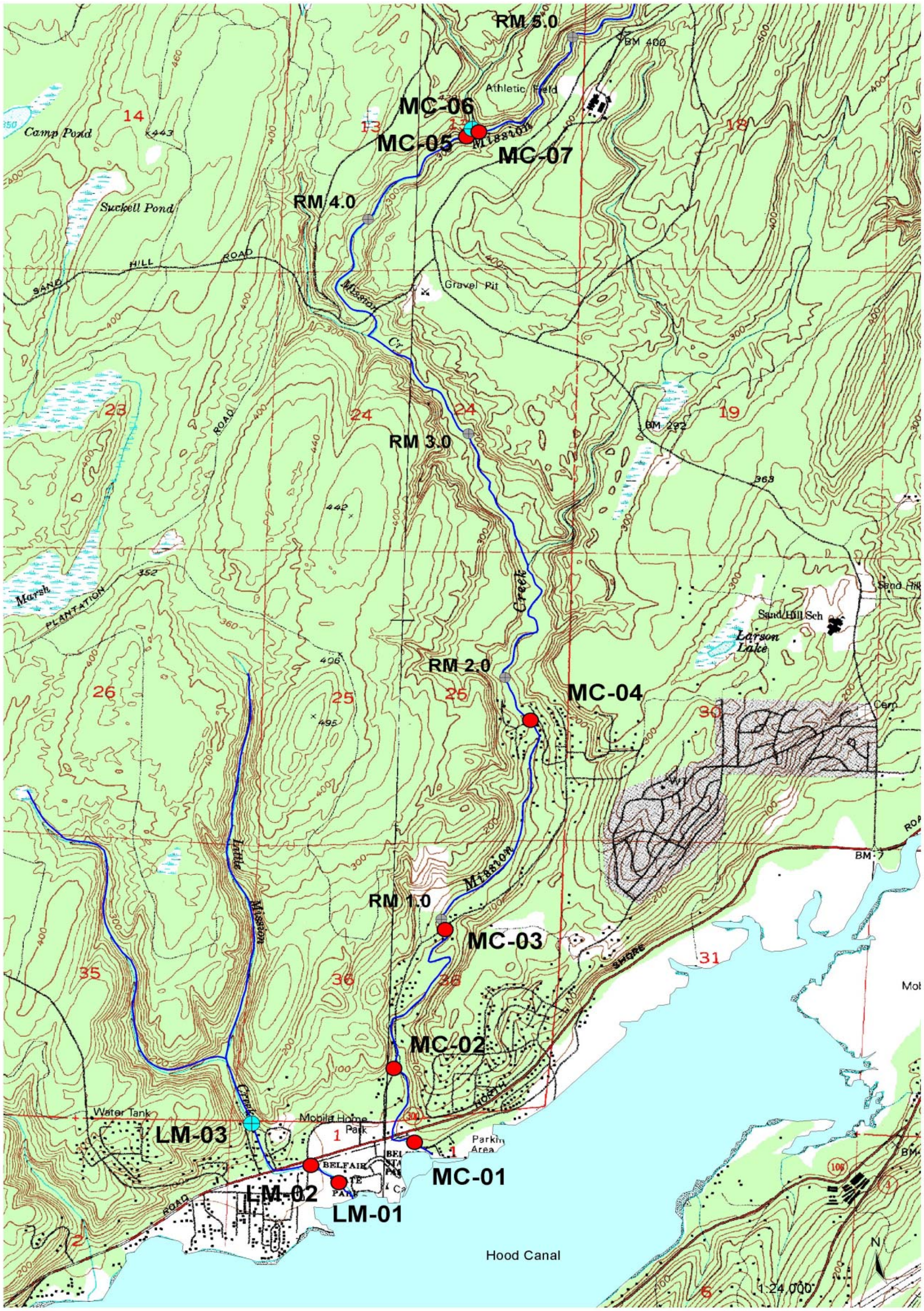



Figure 2-B. Lower portion of Little Mission and Big Mission Creek watersheds.

# Project Design and Methods

**Task 3. Water Quality Sampling**
Hood Canal Salmon Enhancement Group

Teams of trained volunteers coordinated and led by Hood Canal Salmon Enhancement Group staff, collected monthly water samples from August 2006 to July 2008. The sampling effort was conducted in pursuant of an Ecology-approved quality assurance project plan (HCSEG and MCPH, 2006). Funding was provided by the Clean Water Act Section 319 Nonpoint Source Fund (Grant Number: G0600304) through the Washington State Department of Ecology's Water Quality Program. Raw data collected from this sampling effort can be found in the Appendices, and an electronic version has been submitted to Ecology's online Environmental Information Management Program.

**Sampling Design**

The sampling plan was designed to identify sources of fecal coliform pollution through water sampling, and use sanitary surveys to assess the risk of fecal pollution from developed land parcels within Big Mission Creek and Little Mission Creek. The scope of this project spanned two years of monthly water sampling and was conducted in two general phases. Water sampling stations were established to segment the streams. Nine stations were established along the mainstem of Big Mission Creek and three stations were established in Little Misison Creek. Water sampling at each station was conducted monthly over the first year to monitor the various levels and distribution of fecal coliform pollution in each stream system. The second phase was determined by results from the first year. Refined sampling coupled with sanitary surveys more narrowly identify the sources of pollution. The landowners identified with parcels contributing fecal pollution sources were contacted and consulted about appropriate corrective action measures.

During the first year, the sampling plan also included bimonthly sampling (every other month) for the presence of total recoverable (TR) mercury, dissolved metals (cadmium, copper, lead and zinc), hardness (calcium and magnesium) and total suspended solids (TSS).

Two intensive surveys were planned to assess fecal coliform concentration fluctuations throughout the day. Since sampling for fecal coliform is known to be quite variable, the effort was designed to better understand the daily (hourly) contribution of contamination to Big Mission Creek. This sampling utilized the same procedures as the monthly monitoring, but occurred hourly (for 12 hours) on two consecutive days (Sunday-Monday) in order to compare the differences in weekend and weekday fecal loads to the river. This survey took place in August 2007 during a time of low flow and again in January of 2008 when flows were higher. The sampling occurred at one station, MC-01 (most downstream station, within Belfair State Park).

The sampling schedule displayed in Table 1 illustrates the timing of various water parameters which were monitored over the two year study.

**Table 1.** Schedule of water sample collection.

| | 2006 | | | | | 2007 | | | | | | | | | | | | 2008 | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | S | O | N | D | J | F | M | A | M | J | J | A | S | O | N | D | J | F | M | A | M | J | J |
| Fecal Coliform | ■ | ■ | ■ | * | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | | ■ | ■ | ■ | | ■ | ■ |
| Metals | | ■ | | * | | ■ | | ■ | | ■ | | | | | | | | | | | | | | |
| TSS | | ■ | | * | | ■ | | ■ | | ■ | | | | | | | | | | | | | | |
| 2-Day Intensive Survey: | | | | | | | | | | | | | | | | | | | | | | | | |
| Fecal Coliform | | | | | | | | | | | | | ■ | | | | | ■ | | | | | | |

* Monthly sampling for November 2006 took place 12/5/06. This sampling date was rescheduled due to snow and slick road conditions.

**Sampling Locations**

Water sampling locations were selected in order to partition the rivers into manageable segments for the purpose of identiying and correcting contaminant sources. Segments were smaller near areas of housing development and larger in areas that are less developed. The developed areas of each stream occur primarily in the lower reaches. There was a control site located above the development on Little Mission Creek, and two alternating control sites located in the upper watershed on Big Mission Creek (MC-06 tributary confluence near river mile (RM) 4.5 and MC-08 near RM 6.2).

Sampling sites were established based on the following criteria:

- Field reconnaissance and local knowledge of the watershed for identifying potential sources of contamination.
- Sampling by river segments to help narrow potential sources of pollutants.
- Sampling locations recommended from previous monitoring studies.
- Tributaries associated with undeveloped areas to serve as control sites.

**Photo 1. Cheryl collecting field data.**

*Big Mission Creek*

Based on development and population density, the lower two miles were partitioned into four segments. From RM 2.0 to 8.5 on Big Mission Creek, there was little development and the river was partitioned into five segments. Mission Lake (~90 acres) is located in the upper watershed (above RM 8.5) and is more than 50% developed. It represents the uppermost segment of the river.

Nine sampling stations were established on Big Mission Creek which created nine segments (refer to figures 2-A and 2-B). These segments vary in length and are smaller in the vicinity of developed areas (which also coincides with the lower portion of the river). These stations were sampled monthly. The most downstream station is located just above the the tidal influence and is adjacent to the east side of Belfair State Park. In an attempt to address the uncertainties of seasonal loading rates of fecal coliform, two intensive sampling periods on Big Mission Creek, one in August 2007 and one in January 2008 were performed. Each intensive sampling period spanned a minimum of twelve hours during consecutive days.

*Little Mission Creek*

This river traverses approximately 0.5 miles from the marine water before splitting into two branches of similar length. All development occurs in the segment below the confluence of the two branches.

Due to the short length of the development along Little Mission Creek, the waterway had three sampling points and was divided into just three segments (refer to Figure 2-B). One sampling point captured the water above the development (LM-03 - control), the second sampling point captured water as it entered Belfair State Park (BSP) within the developed area (LM-02), and the last site downstream of the developed area is within BSP (LM-01). The most downstream sampling point is located just above the the tidal influence and is adjacent to the west side of Belfair State Park.

**Table 2.** Water Sampling Sites and Purpose (Refer to Figure 2 for Vicinity Map.)

| Site ID | Location | RM | Control Site | Analyzed Parameters |
|---|---|---|---|---|
| *Big Mission Creek* | | | | |
| MC-01* | First bridge crossing DS Hwy 300 | 0.3 | | fecal, diss. metals/Hg |
| MC-02* | Second bridge crossing above Hwy 300 | 0.6 | | fecal, diss. metals/ Hg |
| MC-03 | Third bridge crossing above Hwy 300 | 1 | | fecal |
| MC-04 | Residential access (Steelhead DR bridge) | 1.8 | | fecal |
| MC-05 | DS correctional facility; DS of trib MC-06 | 4.5 | | fecal |
| MC-06* | Tributary confluence | 4.5 | X | fecal, diss. metals/ Hg |
| MC-07 | DS correctional facility; upstream trib MC-06 | 4.4 | | fecal |
| MC-08 | Mission Wood DR | 6.2 | | fecal |
| MC-09* | Bear Creek-Dewatto RD crossing | 8 | | fecal, diss. metals/ Hg |

*Little Mission Creek*

| | | | | |
|---|---|---|---|---|
| LM-01* | First bridge crossing within Belfair St. Park | .2 | | fecal, diss. metals/ Hg |
| LM-02 | Belfair St. Park DS of Beck Rd culvert | .2 | | fecal |
| LM-03* | End of Little Mission Rd (last property on creek) | .5 | X | fecal, diss. metals/ Hg |

* sample locations for metals collected every other month
DS – downstream
*Note: Sampling locations were readjusted on the first sampling day due to accessibility. Stations MC-08 and MC-09 had intermittent seasonal flow. Control station MC-08 was changed to MC-06 since it maintained measurable surface flow year-round.*

**Sample Collection and Field Procedures**

Two teams of trained volunteers and staff from HCSEG and MCPH collected water samples on a monthly basis. While one team collected all water quality parameters, the second team followed collecting stream flow measurements. Dividing into teams made it possible to complete sampling and deliver water samples to proper laboratories in a timely manner. Sample collection typically occurred on weekdays (M, T, or W) and commenced at 9:00 A.M. This was necessary as it corresponded with schedules from multiple laboratories.

All water samples were collected as simple grab samples after wading into the center of the stream channel. During high flow events, samples were collected from the bank using a pole with a sampling bottle attached. Stream flow was not directly measured during high flow events due to safety issues. Sample bottles were provided by laboratories providing the analysis. A list of parameters with corresponding bottle types, sample methods and reporting limits can be found in Appendix B.

*Fecal Coliform Sampling*

Fecal coliform samples were delivered to MCPH laboratory the same sampling day. The samples were stored in a cooler at <10°C and placed in a laboratory refridgerator upon arrival. One field replicate and one field blank were collected each sampling day.

Photo 2. Cheryl assists Loy as he double-bags a water sample to be analyzed for dissolved metals.

Handling and chain-of-custody procedures were followed as the sampling teams reported back to the HCSEG office in Belfair, and continued on to Mason County Public Health Lab in Shelton. Samples were delivered to Mason County Public Health or arrangements were made with Mason County Public Health staff for pick-up.

*Metals and TSS Sampling*

All water samples were collected as simple grab samples. Sample bottles were supplied by Brooks Rand or Twiss Analytical Lab. Dissolved metals and mercury samples were placed in a sealed plastic bag. Individual samples for total recoverable mercury were placed in two sealed plastic bags. All samples were held on ice during the sampling process and for transport to the lab.

Handling and chain-of-custody procedures were followed as the sampling teams reported back to the HCSEG office in Belfair. Samples were either delivered to Brooks Rand by FedEx or delivered to Twiss Analytical Laboratory in Poulsbo by HCSEG staff.

*Ancillary Paramters*

In-situ measurements were collected for pH, dissolved oxygen (DO), water temperature, conductivity, and turbidity simultaneously utilizing Hydrolab DataSonde/ SURVEYOR 4a and/or a YSI Model 556 multi-parameter probe.

Flow measurements were collected at most stations using a Swoffer current velocity meter (Model 2100) by HCSEG staff and trained volunteers.

Field notes and lab results were entered into an Excel spreadsheet.

**Photo 3. Kim analyzes the water for turbidity.**

**Quality Assurance**

*Field Sampling*

The QA plan for field sampling is outlined in the project QAPP (HCSEG and MCPH, 2006). This QA plan involves adherence to the standard sampling procedures, instrument calibration methods per manufacturer's instructions performed prior to sampling day, and the collection of field quality control samples collected at 10% or one time each sampling run.

The field quality control samples consisted of replicate samples and blanks.

Replicate Field Samples – An additional sample was collected directly after the initial sample at a station. These replicate samples therefore represent the variability due to short-term in-stream processes, sample collection and processing, and laboratory analysis.

Field Blanks – These sample bottles were filled with deionized water in the field to simulate collection of a water sample. The analysis result is expected to be at the reporting limit for that parameter. If exceeding that value, sample contamination may have occurred during field sampling, processing, or during laboratory analysis. In such case, all samples from that parameter on that particular sampling day would be in dispute.

Volunteers were trained in the field using standard methodologies outlined in the project QAPP (HCSEG and MCPH, 2006) and accompanied by HCSEG and MCPH staff.

*Laboratory Analysis*

Water samples were sent to multiple certified laboratories for analysis. The fecal coliform samples were analyzed by the MCPH (Shelton, WA), and the metals and TSS samples were sent to Brooks Rand LLC in Seattle, WA. Twiss Analytical Laboratory (Poulsbo, WA) analyzed the hardness and TSS samples on one sampling day (9/27/06) and afterwards it was decided to keep samples together and send them all (excluding fecal coliform) to Brooks Rand.

Fecal coliform samples were analyzed using most probable number (MPN) method, Standard Methods #9221 E (Clescerl, 1999) which had a maximum detection limit of 1600 col/100 mL of water sample.

The quality assurance (QA) protocol at Brooks Rand includes the use of matrix spikes and laboratory duplicates, laboratory blanks, check standards, and other quality control factors. These are located in appendices C –F. The MCPH laboratory protocol includes a laboratory duplicate, Appendix G.

### Task 4. Sanitary Surveys

Mason County Public Health

One way to evaluate a land parcel for potential fecal coliform pollution contribution to a waterway is to perform a field survey, called a 'sanitary survey' of the land. This type of survey is done with the permission of the landowner/resident. The survey involves a sequence of activities that are initiated with a review of the county parcel file in order to provide a sense for the size, age, location, and septic system design. This is followed by a field evaluation of the land site to validate the as-built design and to evaluate the site drainage and discharge points. Sanitary surveys also provide detailed educational information regarding best land management practices to the homeowner, tailored to their properties. The information provided includes things such as the use of pesticides/herbicides, household chemicals, water usage within the house, native plantings, animal waste management, rain gardens and stormwater management. The surveys can last between 20 minutes and several hours depending on the amount of information the homeowner is interested in.  If necessary, a dye test is conducted to further investigate the functionality of the septic system including the drainfield.  (Refer to Appendix H, Mason County Sanitary Survey Procedure.)

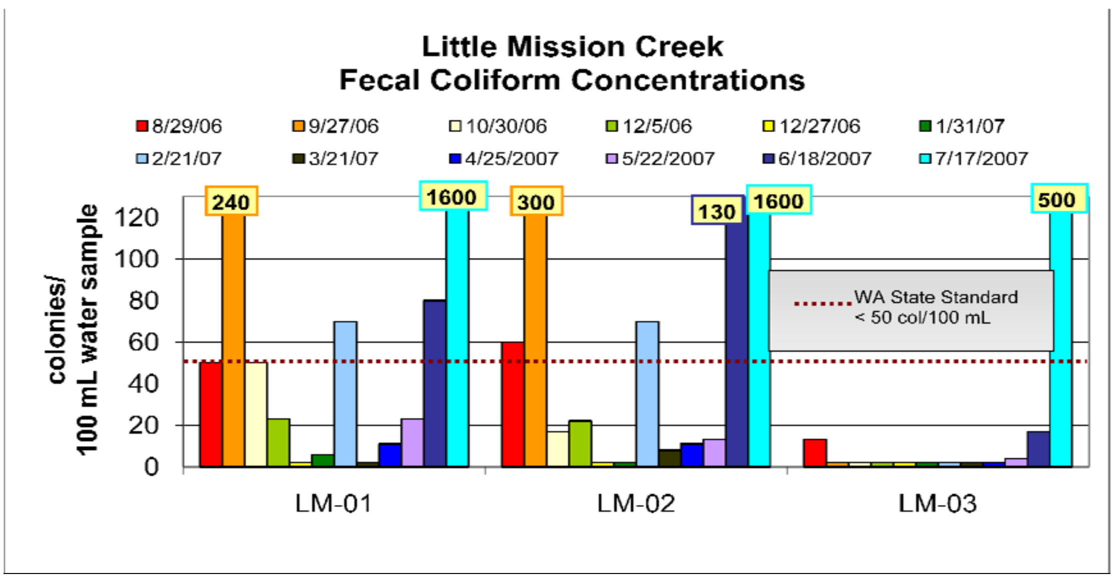
# Results and Discussion

**Task 3.  Water Quality Sampling**
Hood Canal Salmon Enhancement Group

## Fecal Coliform Bacteria

A total of twelve stations were sampled on a monthly basis during the first year of sampling (August 2006 through July 2007).  During the second phase in year two, the fecal sampling mostly targeted the lower portions of the watershed, in efforts to identify sources of fecal coliform.  Figure 3 illustrates Phase One of sampling (the first year) for Little Mission Creek.  The analysis for fecal coliform has a maximum detection limit of 1600 colonies per 100 mL of water sample, using the most probable number method (#9221 E) from Standard Methods (Clescerl, 1999).

**Figure 3.**  Fecal Coliform Concentrations on Little Mission Creek, Phase One




These represent three stations on Little Mission Creek.  Station LM-03 is the control station (sampled from the mainstem, but upstream of most human development).  Station LM-01 is the most downstream station and LM-03 is the furthest upstream sampling site along Little Mission Creek.

Figure 4 represents fecal coliform concentrations from Big Mission Creek during the first year.  Similar to the previous graph, the x-axis depicts the sampling stations from left to right as you move further upstream.  Station MC-06 represents the control tributary (sampled upstream from its confluence with Big Mission Creek).  The red dotted line at 50 colonies per 100 mL of water sample, represents the WA State Standard for fecal coliform bacteria for Class AA freshwater.  During the first year of sampling, nineteen samples exceeded this limit.  The two stations in the uppermost part of the watershed (MC-08 and MC-09) were subsurface and dry for five months out of the year.  These intermittent sections of the stream were draining larger wetland areas.

**Figure 4.** Fecal Coliform Concentrations on Big Mission Creek, Phase One

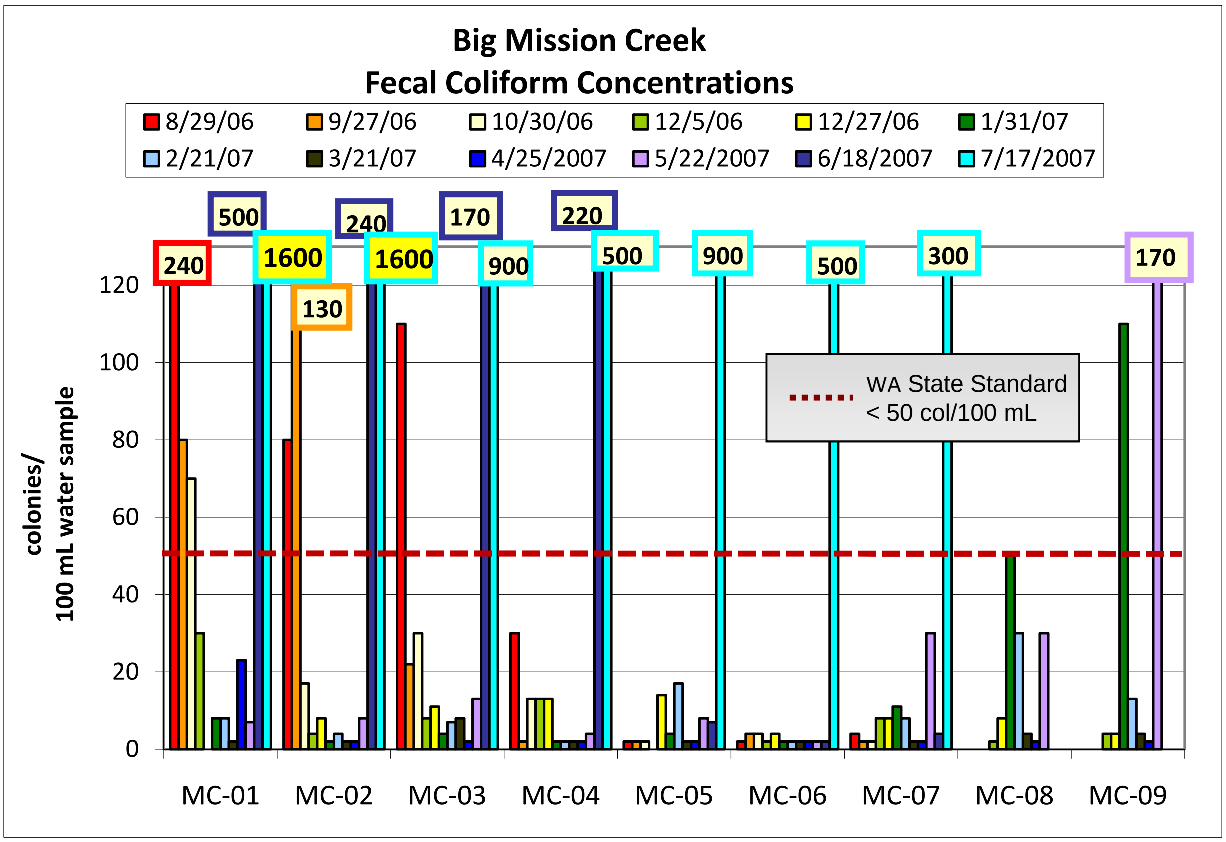



Table 3 compares the fecal coliform results against the WA State standards for surface waters.  Big and Little Mission Creeks are designated as “Class AA” water bodies, which must adhere to the following criteria as listed in WAC 173-201A-030 for freshwater:

> *“fecal coliform organism levels shall both*
>
> *(1) Not exceed a geometric mean value of 50 colonies/ 100 mL and*
> *(2) Not have more than 10 percent of all samples obtained for calculating the geometric mean value exceeding 100 colonies/ 100 mL.”*

The water quality standards also describe some general guidelines in regards to the averaging periods when calculating the geometric mean value (GMV):

> *"In determining compliance with the fecal coliform criteria in WAC 173-201A-030, averaging of data collected beyond a thirty-day period, …shall not be permitted when such averaging would skew the data set as to mask noncompliance periods."*

In most cases, the geometric mean at each station was collected from monthly samples collected over a twelve month period. During periods of no flow (or if a site was not sampled) a sample was not collected and the GMV was calculated using less than twelve samples.

These samples were collected by volunteers and analyzed in the MCPH Water Lab in Shelton, WA by most probable number test method (MPN, Standard Methods #9221 E). The analysis has a maximum detection limit of 1600 colonies per 100 mL of water sample.

**Table 3.** Fecal Coliform Concentrations Compared to WA State Surface Water Standards (Class AA).

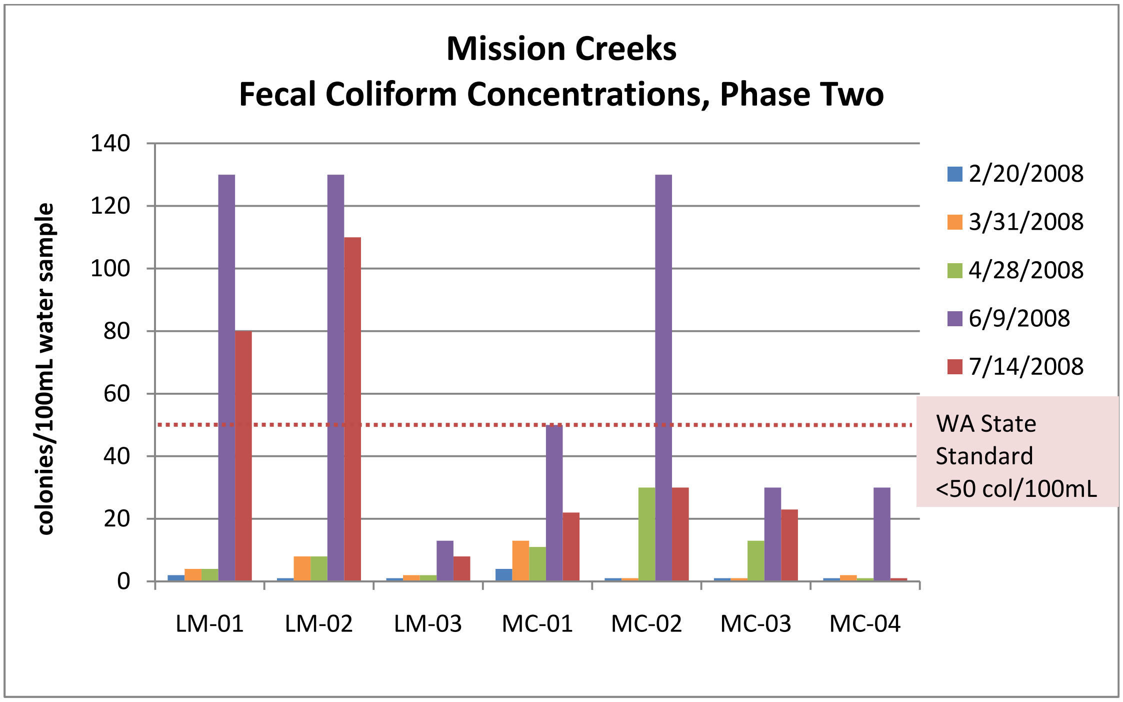
| | | | WA State Standards for Class AA Surface Waters* | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Geometric Mean Value (GMV) of <50 col/100mL | | <10% of samples shall be >100 col/100mL | | | |
| Site | # of Samples | Range (FC/100mL) | GMV | Meets Standard | # Samples > 100 col/ 100 mL | % Samples > 100 col/100mL (max 10%) | Meets Standard | Meets Both Standards |
| Little Mission Creek | | | | | | | | |
| **LM-01** | 12 | 2-1600 | 31 | Y | 2 | 17% | N | N |
| **LM-02** | 12 | 2-1600 | 30 | Y | 3 | 25% | N | N |
| **LM-03** | 12 | 2-500 | 5 | Y | 1 | 8% | Y | Y |
| Big Mission Creek | | | | | | | | |
| **MC-01** | 11 | 2-1600 | 42 | Y | 3 | 27% | N | N |
| **MC-02** | 12 | 2-500 | 15 | Y | 3 | 25% | N | N |
| **MC-03** | 12 | 2-900 | 21 | Y | 3 | 25% | N | N |
| **MC-04** | 12 | 2-500 | 10 | Y | 2 | 17% | N | N |
| **MC-05** | 11 | 2-900 | 7 | Y | 1 | 9% | Y | Y |
| **MC-06**** | 12 | 2-500 | 4 | Y | 1 | 8% | Y | Y |
| **MC-07** | 12 | 2-300 | 7 | Y | 1 | 8% | Y | Y |
| **MC-08** | 7 | 2-50 | 9 | Y | 0 | 0% | Y | Y |
| **MC-09** | 7 | 2-170 | 12 | Y | 2 | 29% | N | N |

| | |
|---|---|
| * | WAC 173-201A for Class AA Surface Waters |
| (grey) | control station |
| ** | tributary to Mission Creek |
| (green) | meets both standards |
| (yellow) | meets one standard but not another |
| (red) | does not meet either standard |

Five out of the twelve stations (42%) met both of these criteria (represented in Table 3 in green). While they all met the GMV criterion, seven stations (58%) did not meet the second (less than 10% of samples had to have been less than 100 colonies per 100 mL of water sample; represented in yellow). Each of the control stations met both standards. In general, stations in the lower portion of the watershed failed to meet the second criterion.

During Phase Two (the second year of sampling), the sampling effort was focused on the lower portion of the watershed. Figure 5 displays the fecal coliform concentrations from 2008, Phase Two.

**Figure 5.** Fecal Coliform Concentrations, Mission Creeks, Phase Two




Although the sampling effort was not intending to capture rain events (storm events), two were sampled which adhered to the US EPA's criteria for classifying stormwater events. These criteria include sampling an event which produces at least 0.1 inches of total rainfall, and the event is preceded by at least 72 hours of dry weather. Sampling dates from July 2007 and April 2008 met both these criteria. Table S-1 in Appendix S summarizes rainfall data for each sampling date from various rainfall gages maintained by Kitsap PUD in outside watersheds.

In Year One (Y1) the last sampling date ($17^{th}$ of July 2007) unintentionally occurred during a rain event, which had been preceded by sixteen days without rain. The nearest rain gage was down during this time period. However gages maintained by Kitsap Public Utilities Department (KPUD) from Gorst and Twin Lakes (about 12 miles away) estimated total rainfall accumulation for the day at 0.35 and 0.4 inches. Rainfall reported at 15-minute intervals was captured that day, but the nearest site was in Port Orchard at the West Sound Utility building (a KPUD gage about 17 miles away). This site only reported 0.26 inches of total accumulation, but 2.0 inches fell from 9 A.M. to 2 P.M. The rest occurred after sampling commenced. Assuming rainfall in Belfair followed this same pattern, this sampling day on the $17^{th}$ of July 2007 qualified as a storm event ("first flush" event).

All the stations from this July sampling event resulted in fecal coliform concentrations that were well above the state standard, ranging from 300 to the maximum detection limit of 1600 colonies/ 100 mL. The control sites, LM-03 and MC-06 were elevated at a level of 500 colonies/ 100 mL and increased downstream within the developed areas. Site MC-01 was 1600 colonies/ 100 mL. On all other sampling months these controls were typically less than four colonies/ 100 mL (with the exceptions of two months at station LM-03 which were still less than 20 colonies/ 100 mL).

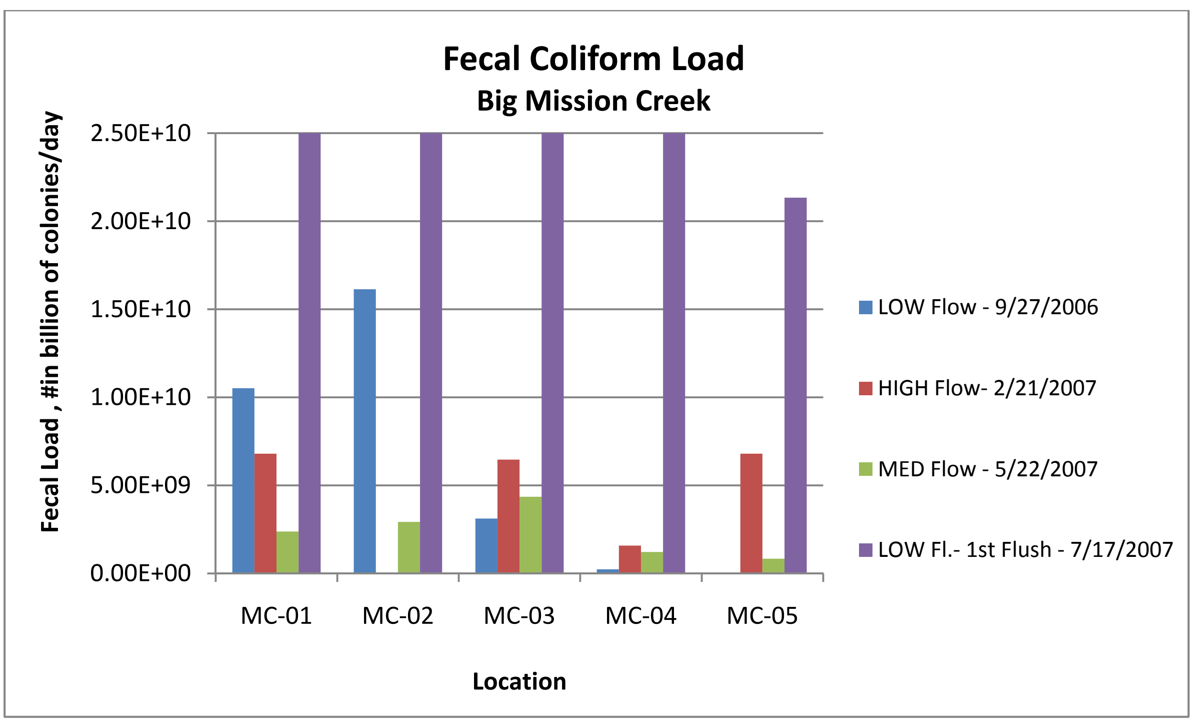
All sampling blanks were analyzed and reported at less than two colonies per 100 mL of water sample. It is important to note that although all samples from the 17th of July sampling date were elevated, the blank was still less than two colonies per 100 mL of water sample (and the water temperature in the cooler was 4.5 °C). This indicates that the samplers did not contaminate the water samples, nor were they contaminated in the laboratory.

During the few high fecal coliform spikes observed in the upper portion of the watershed at station MC-09, field samplers also observed and reported animal sign (beaver) in close proximity to where the sample was collected.

In Year Two (Y2), July sampling occurred during a dry period (no rain for eight days) without stormwater runoff as a factor in the fecal coliform concentrations. This July 2008 sampling is more representative of fecal coliform concentrations during a period of low flow from the influences of surface and groundwater.

Figure 6 illustrates the fecal coliform load on five stations from the lower part of Big Mission Creek watershed during the first year of sampling. The graph compares a low, medium, and high flow event. It also includes the fecal coliform load from the 'first flush' event in July of 2007 as a comparison. The Y-axis represents the fecal load in billions of colonies per day (0, 5, 10, 15, 20, and 25 billion colonies per day are shown on this graph). The highest load came from station MC-01 (furthest downstream station) during July 2007 (first flush event) with a fecal load of approximately 350 billion colonies per day.

**Figure 6.** Fecal coliform load on Big Mission Creek: a low, medium and high flow event.



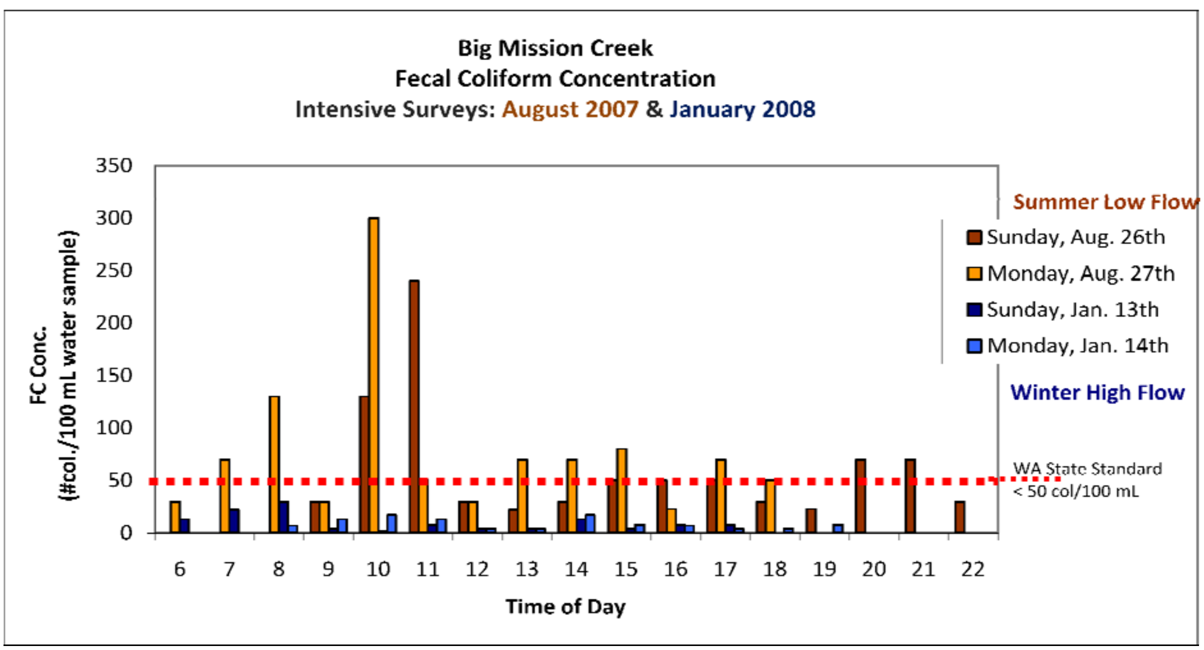
Just as a comparative example, an average (a low average) flow for Big Mission Creek is about 20 cfs (at station MC-01) and the fecal coliform concentration of 50 colonies (per 100/mL of water sample) is in general the state standard (a high average). The resulting fecal load would be approximately 24 billion colonies per day. The July 2007 sampling event was greater than this 'average sampling' by a magnitude of almost 15.

**Intensive Sampling for Fecal Coliform**

Both intensive sampling events for fecal coliform took place at station MC-01 within Belfair State Park (furthest downstream station) over the course of two days (Sunday and Monday). The first intensive sampling event took place from Sunday, August 26th through Monday, August 27, 2007. This was during a period of low flow. Flow measurements were captured about three times each day and on average the discharge at this station was about 5.8 cubic feet per second (CFS). Fecal coliform concentrations were collected hourly throughout a twelve hour period. The greatest fluctuations took place in the morning, between 8 A.M. and 11 A.M. Then these concentrations remained less than 80 colonies (per 100 mL of water sample) throughout the remainder of the day. Figure 7 displays this first August two-day intensive sampling event in orange and dark orange.

The second intensive sampling occurred in January of 2008. It also spanned a Sunday and Monday, but occurred during a time of greater discharge (about 116 cfs). Figure 7 displays the results of the two-day January intensive survey for fecal coliform concentrations in light and dark blue. The red line represents the WA State Standard for surface waters for Class AA streams, 50 colonies per 100 mL of water sample.

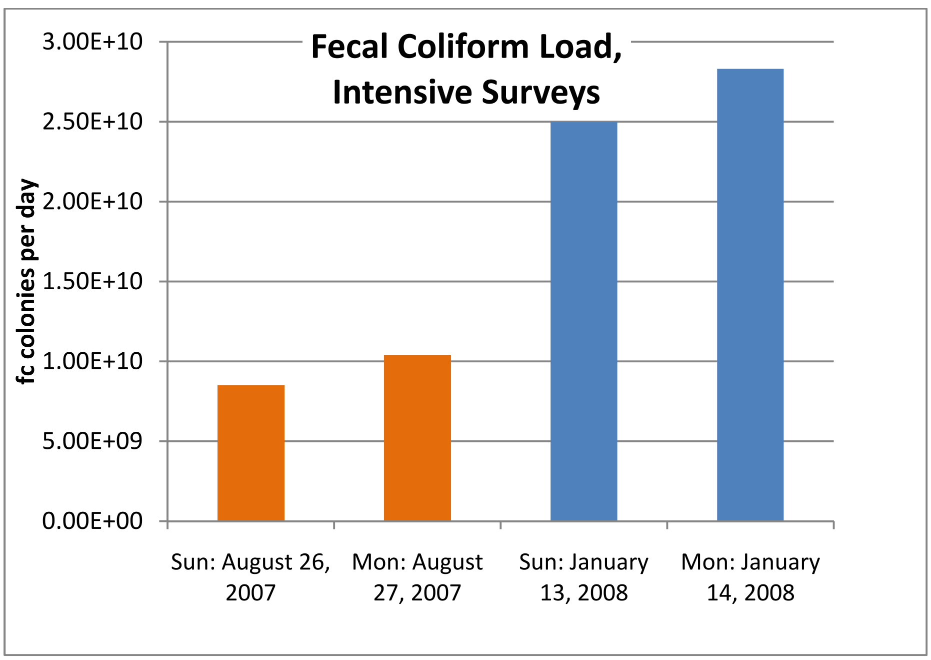
**Figure 7.** Intensive survey results for fecal coliform concentrations at MC-01, August 2007 and January 2008.



The purpose of the intensive sampling was to gain a better understanding of how fecal coliform concentrations fluctuated throughout the day, and if spikes in fecal coliform concentrations would be significant during time periods when homeowners might be utilizing water resources at home more frequently.

Figure 8 illustrates the fecal coliform loading at station MC-01 for each of these intensive sampling days. It is valuable to consider the pollutant loading, since the concentration can be influenced by stream flow. (A pollutant in large volumes of fast-moving water can be more diluted and flushed out of the system more quickly than an equal amount of pollutant in a smaller volume of slower moving water.) The load was calculated by multiplying the average stream discharge (in gpm) by the average fecal coliform concentration collected over the course of that particular day.

**Figure 8.** Intensive survey results for fecal coliform load at MC-01, August 2007 and January 2008.




When stream flow is taken into account, the January 2008 sampling actually had a higher fecal coliform daily load than the August sampling event which had high concentrations, but a low stream discharge.

**Comparison to Marine Waters**

Washington State Department of Health (WDOH) collects fecal coliform data in the marine waters of Hood Canal near the mouth of Big Mission Creek (station number 268). This potential shellfish growing area is classified as prohibited to shellfish harvest due to a history of poor water quality. During the course of this investigation, WDOH station number 268 reported an overall geometric mean of 6.2 fecal coliform organisms/ 100mL, with samples ranging from 1.7 to 33 fecal coliform organisms per 100 mL. These WDOH marine shoreline samples were collected about every other month and did not coincide with sampling from this project. The WDOH shoreline data on average were lower than what was being reported in the river, which is also a sign that the fecal coliform sources in the river still pose a risk for opening shellfish beds in the marine waters. Refer to Appendix T for WDOH marine shoreline sampling map and data results.

## Metals Concentrations

A selection of dissolved metals was screened for at six sites in the surface waters of Big and Little Mission Creeks from September 2006 through May 2007. These stations were sampled every other month for dissolved metals (cadmium, copper, lead and zinc) as well as total recoverable mercury. Calcium and magnesium concentrations were also collected and reported as hardness. These samples were analyzed by Brooks Rand LLC (Seattle, WA). Samples analyzed for TSS and hardness from field sampling day 9/27/06, were analyzed by Twiss Analytical Laboratory (Poulsbo, WA).

### Dissolved Metals

*Big Mission Creek*

Summarized dissolved metals data are presented in Table 4 for cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn). This data includes all Big Mission Creek mainstem stations, and excludes the tributary which was used as the control station (MC-06).

**Table 4:** Summary Statistics of Dissolved Metals Concentrations on Big Mission Creek

| | | **Dissolved Metals** (µg/L) | | | |
|---|---|---|---|---|---|
| | | **Cadmium** | **Copper** | **Lead** | **Zinc** |
| Maximum | ▼ | 0.010 | 0.330 | 0.140 | 0.870 |
| 75th percentile | ◆ | 0.005 | 0.265 | 0.081 | 0.665 |
| median | ■ | 0.005 | 0.235 | 0.059 | 0.525 |
| 25th percentile | ▲ | 0.004 | 0.188 | 0.043 | 0.490 |
| Minimum | ▲ | 0.004 | 0.160 | 0.009 | 0.160 |
| mean | ● | 0.005 | 0.231 | 0.062 | 0.532 |
| standard deviation | | 0.002 | 0.053 | 0.038 | 0.219 |
| reporting limit* | ····· | 0.004 | 0.04 | 0.006 | 0.06 |

Figure 9 illustrates these summary statistics for Big Mission Creek. The box plots illustrate the distribution of these results for each of these dissolved metals. The key is included in Table 4. The dotted line represents the reporting limit for the specific parameter.

**Figure 9.** Box plots of dissolved metals (cadmium, copper, lead and zinc) from Big Mission Creek stations from September 2006 through May 2007.

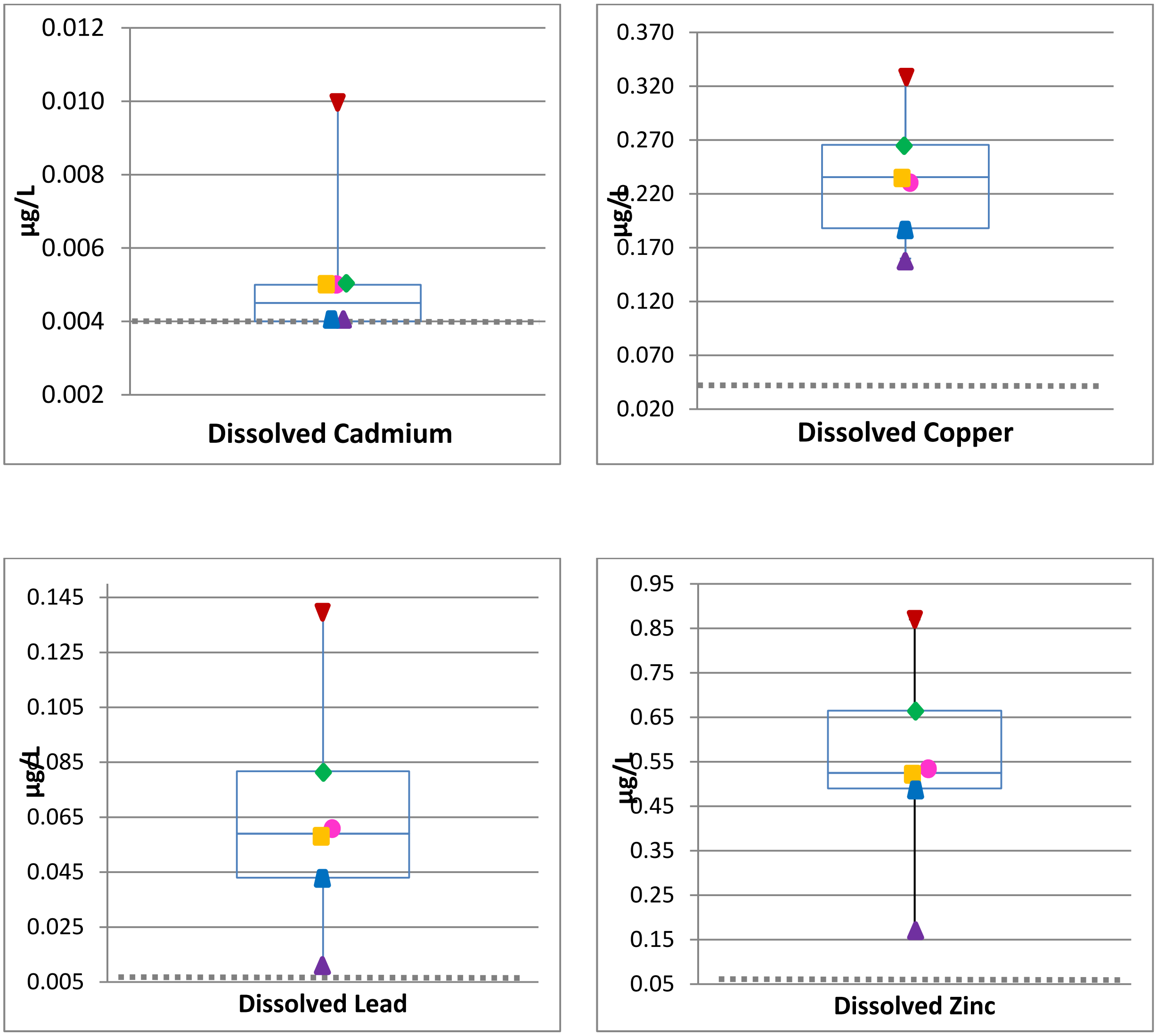



Table 5 compares the dissolved metal ranges to the WA State Surface Water Standards for Class AA Streams for Toxic Substances (WAC 173-201A-204). The appropriate criterion for each dissolved metal concentration range is calculated using the hardness which was also collected at the time of sampling and laboratory analyzed. Therefore these standards vary with hardness. Hardness results ranged from the minimum at 8.04 to the maximum at 40 mg/L as $CaCO_3$. These minimum and maximum hardness values are the corresponding numbers used to calculate the standard values. Refer to Appendix M for hardness results. Equations used for calculating the hardness-dependent standards for Cd, Cu, Pb, and Zn can be found in Appendix K.

When comparing the sampling results to WA State standards, note that this sampling program was not designed to conform to chronic* sampling criteria as described below (a four-day average concentration). These standards were included as a comparison only. Both laboratory result and state standards are reported in µg/L. In all cases, the sampling results were lower than the state standard. Reporting limits are listed in Table 4.

**Table 5:** Dissolved Metals Concentration Ranges from Big Mission Creek Compared to WA State Standards

**Dissolved Metals Compared to WA State Standards**

| | | Sampling Result | Chronic* Standard | Acute** Standard |
|---|---|---|---|---|
| **Dissolved Cadmium** | | *µg/L* | | |
| | min | 0.004 | 0.16 | 0.24 |
| | max | 0.010 | 0.52 | 1.4 |
| **Dissolved Copper** | | *µg/L* | | |
| | min | 0.160 | 1.3 | 1.6 |
| | max | 0.330 | 5.2 | 7.2 |
| **Dissolved Lead** | | *µg/L* | | |
| | min | 0.009 | 0.15 | 3.8 |
| | max | 0.140 | 0.92 | 24 |
| **Dissolved Zinc** | | *µg/L* | | |
| | min | 0.160 | 12 | 14 |
| | max | 0.870 | 48 | 53 |

* Chronic – A 4-day average concentration not to be exceeded more than once every three years on average.
**Acute – A 1-hour average concentration not to be exceeded more than once every three years on the average.
Min – minimum values for standards were calculated with a hardness of 8.040 mg/l as $CaCO_3$ (min hardness collected).
Max – maximum values for standard were calculated with a hardness of 40 mg/L as $CaCO_3$ (max hardness collected).

*Little Mission Creek*

Table 6 below tabulates the summary statistics for dissolved metals (Cd, Cu, Pb, and Zn) on Little Mission Creek. These results are similar and even lower than what was reported for Big Mission Creek.

**Table 6.** Summary Statistics for Dissolved Metals (µg/L) on Little Mission Creek.

| | Dissolved Metals (µg/L) | | | |
|---|---|---|---|---|
| | Cadmium | Copper | Lead | Zinc |
| maximum | 0.008 | 0.260 | 0.100 | 1.080 |
| 75th percentile | 0.004 | 0.248 | 0.052 | 0.665 |
| median | 0.004 | 0.230 | 0.046 | 0.550 |
| 25th percentile | 0.004 | 0.185 | 0.015 | 0.340 |
| minimum | 0.004 | 0.140 | 0.006 | 0.130 |
| | | | | |
| mean | 0.005 | 0.213 | 0.042 | 0.541 |
| standard deviation | 0.001 | 0.043 | 0.030 | 0.271 |
| reporting limit | 0.004 | 0.04 | 0.006 | 0.06 |

Table 7 compares these results to WA State Surface Water Standards for Toxic Substances (WAC 173-201A-204). The hardness values ranged from 26 to 50 mg/L as $CaCO_3$. These hardness values were a little higher than what were reported on Big Mission Creek, which is why the hardness-dependent standards are also higher. As for Big Mission Creek, Little Mission results for dissolved metals were less than WA State standards.

**Table 7:** Dissolved Metals Concentration Ranges from Little Mission Creek Compared to WA State Standards

**Dissolved Metals Compared to WA State Standards**

| | | Sampling Result | Chronic* Standard | Acute** Standard |
|---|---|---|---|---|
| **Dissolved Cadmium** | | *µg/L* | | |
| | min | 0.004 | 0.16 | 0.24 |
| | max | 0.008 | 0.53 | 1.4 |
| **Dissolved Copper** | | *µg/L* | | |
| | min | 0.140 | 3.6 | 4.8 |
| | max | 0.260 | 6.3 | 8.9 |
| **Dissolved Lead** | | *µg/L* | | |
| | min | 0.006 | .57 | 14 |
| | max | 0.100 | 1.17 | 30 |

| **Dissolved Zinc** | *µg/L* | | |
|---|---|---|---|
| min | 0.130 | 33 | 37 |
| max | 1.08 | 58 | 64 |

* Chronic – A 4-day average concentration not to be exceeded more than once every three years on average.
**Acute – A 1-hour average concentration not to be exceeded more than once every three years on the average.
Min – minimum values for standards were calculated with a hardness of 26 mg/l as $CaCO_3$.
Max – maximum values for standard were calculated with a hardness of 50 mg/L as $CaCO_3$.

Table 8 summarizes the top three highest dissolved metals locations for each parameter. These occurred in January and May 2007.

**Table 8.** Top three highest sites for dissolved metals.

| Dissolved Metal | Sampling Result | | Sampling Date | Site ID |
|---|---|---|---|---|
| Cadmium | 0.01 | µg/L | 1/31/2007 | MC-01 |
| | 0.008 | µg/L | 1/31/2007 | LM-01 |
| | 0.006 | µg/L | 1/31/2007 | MC-09 |
| Copper | 0.33 | µg/L | 1/31/2007 | MC-01 |
| | 0.3 | µg/L | 5/22/2007 | MC-09 |
| | 0.28 | µg/L | 1/31/2007 | MC-09 |
| Lead | 0.14 | µg/L | 1/31/2007 | MC-01 |
| | 0.11 | µg/L | 1/31/2007 | MC-09 |
| | 0.11 | µg/L | 1/31/2007 | MC-06 |
| Zinc | 1.08 | µg/L | 1/31/2007 | LM-03 |
| | 0.87 | µg/L | 1/31/2007 | MC-09 |
| | 0.8 | µg/L | 5/22/2007 | MC-06 |

For funding reasons these stations were only sampled five times throughout the year (with the exception of stations MC-08 and MC-09 which were dry for part of the year). These results provide some limited background information.

**Total Recoverable Mercury**

Mercury samples were collected at the same six stations and analyzed as total recoverable (TR). Twenty-nine samples were collected and results ranged from 0.230 to 3.060 ng/L. The lowest results were from the September 2006 sampling period and the highest were from May 2007. Table 9 provides some summary statistics on the metals sampling comparing Little Mission and Big Mission Creeks. This table also compares the control stations for each creek. The control station on Little Mission (LM-03) is upstream of development, but collected from the mainstem of the creek, and the control station for Big Mission Creek is a tributary creek (MC-06).

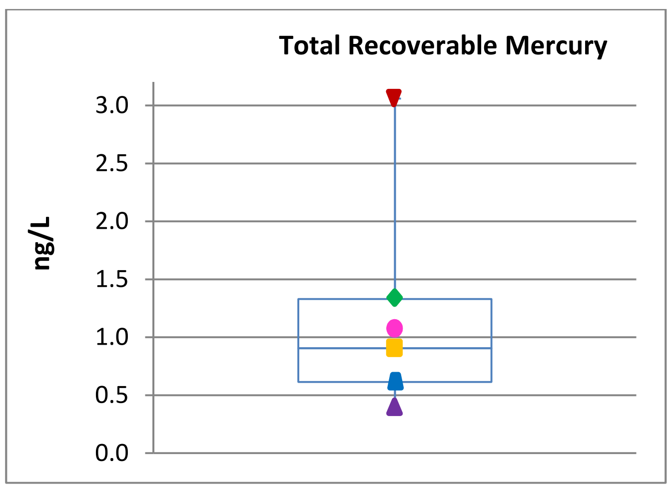
**Table 9.** Summary Statistics for Total Recoverable Mercury for Little and Big Mission Creeks

| | Total Recoverable Mercury - ng/L | | | |
|---|---|---|---|---|
| | Little Mission Creek | | Big Mission Creek | |
| | LM-01 | LM-03 - control | MC stations | MC-06 – control |
| maximum | 1.920 | 2.380 | 3.060 | 1.920 |
| 75th percentile | 0.900 | 0.860 | 1.330 | 1.410 |
| median | 0.740 | 0.850 | 0.905 | 1.050 |
| 25th percentile | 0.630 | 0.580 | 0.615 | 0.880 |
| minimum | 0.340 | 0.230 | 0.370 | 0.360 |
| mean | 0.906 | 0.980 | 1.141 | 1.124 |
| standard deviation | 0.603 | 0.824 | 0.789 | 0.584 |

Figure 10 represents combined total recoverable mercury (ng/L) results as a box plot. The majority of the sampling results ranged from 0.615 to 1.330 ng/L.

**Table 10, Figure 10**. Box Plot Representing Total Recoverable Mercury (ng/L)

| | Total Recoverable Mercury |
|---|---|
| maximum | 3.060 |
| 75th percentile | 1.330 |
| median | 0.905 |
| 25th percentile | 0.615 |
| minimum | 0.370 |
| mean | 1.141 |
| standard deviation | 0.789 |




The top three highest results were all from the month of May, 2007. Station MC-09 (uppermost station on Big Mission draining from wetland at Bear Creek-Dewatto RD bridge) was reported at 3.060 ng/L. The next two were from MC-01 (within Belfair State Park, most downstream on Big Mission) and LM-03 (the control station on Little Mission). Their corresponding results were 2.540 and 2.380 ng/L.

The three lowest reported results were all from the September 2006 sampling and ranged from 0.230 to 0.360 ng/L.  These were from sites MC-06 (Mission Creek control tributary), LM-01 (most downstream Little Mission station within Belfair State Park), and LM-03 (Little Mission control station). These data can be found in Appendix N.

Table 11 compares the TR mercury ranges for both Little Mission and Big Mission Creek to the WA State Surface Water Standards for Class AA streams for toxic substances (WAC 173-201A, 204). These results are reported in ng/L. Results from this sampling period were well below the state standards for mercury.

**Table 11.** Total recoverable mercury ranges compared to WA State Standards (ng/L).

| | Little Mission | Big Mission | WA State Standard Acute* max | WA State Standard Chronic** max |
|---|---|---|---|---|
| min | 0.230 | 0.370 | 2100 | 12 |
| max | 2.380 | 3.060 | | |

*Acute – A 1-hour average concentration not to be exceeded more than once every three years on the average.
** Chronic – A 4-day average concentration not to be exceeded more than once every three years on average.

## Total Suspended Solids

During these five months of bimonthly sampling, total suspended solids results were very low. Big Mission Creek ranged from 0.400 to 1.400 mg/L and Little Mission Creek ranged from 0.500 to 1.300 mg/L. There are no WA State standards for TSS.

## Task 4. Sanitary Surveys of On-Site Wastewater Systems

Mason County Public Health

**Results**

*Phase One / Year One (Y1)*

After the first year of the water sampling and analysis for fecal coliform, the upper watershed of both streams showed little risk for human-source fecal pollutants to the stream. There was a single spike in the annual fecal analysis results from a July sampling period. This sampling coincided with a significant rain event which followed a period of dry weather. Based on the high levels of fecal coliform recorded in all the sampling stations, it seemed evident this rain event served to mobilized pollutants stored in the watershed. Field samplers had regularly recorded observations of deer and beaver activity in the upper watersheds. The human-source contribution of fecal contaminant was not evident in these areas of the watershed as it is sparsely populated with only a few developed land parcels which are not along the stream.

The results from the first year did show that the lower watershed required further investigation into the sources of fecal pollutants. This area of the watershed is also more populated with developed parcels adjacent to the stream. Based on the results from the Y1 (Year One) sampling regime, the focus for the sanitary survey effort was targeted in the lower watershed.

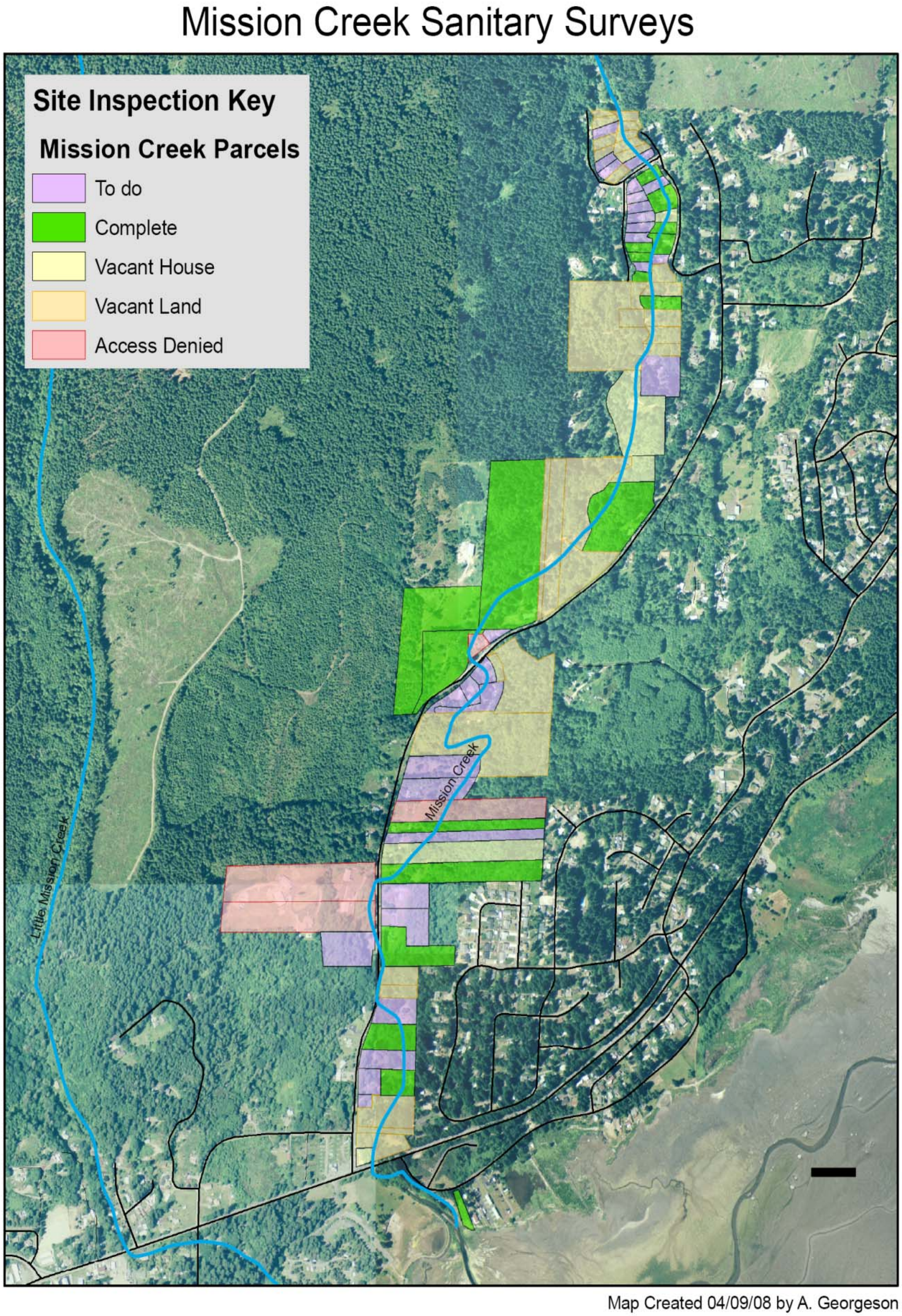
*Phase Two / Year Two (Y2)*

During the second year of the study, MCPH staff initiated the process of conducting sanitary surveys on Big Mission and Little Mission Creeks. The sanitary surveys provide a more robust evaluation of the land as a function of the septic systems and help to identify potential sources of fecal coliform pollution.

Using parcel searches from the Mason County GIS database, 84 parcels were identified in the lower watershed of Big Mission Creek for potential sanitary surveys, refer to Figure 11 for parcels map. These parcels included all the riverside parcels in the residential developments. Thirty-one parcels were determined to be vacant and four property owners denied access for surveys. The remaining 49 properties fell in the scope of the sanitary survey process.

Of the remaining 49 parcels, 24 sanitary surveys were completed (refer to Appendix Q for a parcel map of sites completed). Twenty sanitary surveys were required under the contract agreement between MCPH and HCSEG. Of the remaining 25 parcels to be surveyed, 15 were visited but the landowners were not available, four were not available due to lack of information, and six sites had vacant residences. The complete survey summary can be found in Appendix R.

Figure 11: Sanitary Surveys- Site Inspection Parcels Map along Big Mission Creek.



The Mason County Public Health (MCPH) has a system for rating the concern level associated with the functionality of the septic systems. The level of concern is based on several factors including the proximity of the drainfield and septic system to waterways, the observed condition of the drainfield and the ratio of occupants at a house versus the designed size of the septic system.

Four sites had been identified as higher level of concern, five sites had been identified as medium level of concern and one site had been identified as low level of concern. Seventeen of the surveyed sites had been identified as No Apparent Problem (NAP).

There are several factors which must be considered in order to justify the initiation of a dye test. The parcel must first meet qualifying criteria from a sanitary survey and the environmental conditions must be favorable for a dye test to work adequately.

MCPH staff completed one dye test during the project period. The test did not show any failures to the system. This particular test was administered based primarily off a previous dye test in which dye was identified but there were not elevated fecal coliform levels associated with the findings.

Another home owner provided information about how they routinely check their septic tank to ensure that no effluent is making it out to their drainfield which is not accepting water. This person was under the impression that the planned Belfair Sewer would be coming out to their area soon. For this reason they had not completed any repairs at the site. Although there are plans for the development of a sewer system to service the Belfair area, the system at this point would not be operational for many years. It was relayed to the resident that the initial sewer build out plans are not intending to extend outside of the Belfair Urban Growth Area to the Big Mission Creek area. This resident was also provided information about the current Shorebank Loan program which provides funds to homeowners for septic system repairs. After the survey process, a formal letter was sent requesting that their system be considered for repair. Contact time with residents was an important element in the process of this project to investigate pollutant sources, and the door-to-door method was the most effective.

It was noted at one site in which no one had been home, that their septic tank was uncovered. This site was inspected. The homeowner had their system uncovered because roots from a nearby vine had grown into the inlet of the septic tank. The homeowner had the vines removed and showed MCPH the inside of his tank. He did not have the tank lid covered when the inspection was performed.

In addition to the sanitary surveys and contact time with residents, there were notes recorded on the number of animals which were observed during the field investigations. The following numbers of animals recorded are likely a conservative estimate considering many of the sites were not accessed. It was noted that 20 properties had domestic animals with a total of 21 dogs. There were only four sites in which no dogs were observed. MCPH does provide educational information to homeowners on best practices for waste management of domestic animals during the sanitary survey process. The field notes indicate that one property in the lower section of Big Mission Creek which has two horses, and another property which has birds (chickens, turkeys, peacocks) and three goats. The project team made contact with the owner of the horse and completed a sanitary survey of the parcel. There were horse management issues on this property and the owners were requested to investigate ways to minimize the impact to the stream and adjoining property. The land owner made a pledge to install an appropriate fence in order to restrict the horse from the stream and reduce the impact to the adjacent land.

Most land owners which communicated with the project team claimed to pick up their pet waste over the year, however it was noted that many dogs roam free and it is likely their waste is not routinely being picked up.

**Discussion**

The project plan was for the dye tests to be administered at the end of the first year of water sampling. The results from the first year of water sampling would provide the focus for the subsequent effort to identify sources of fecal coliform. As it turned out, the results demonstrated that the lower segments of each stream show the highest level of fecal coliform pollution. This was not surprising as the lower segments of these streams both coincide with higher residential development.

The sanitary surveys were completed between January 2008 and April 2008. They were focused on the lower part of the Mission Creek watershed as it was apparent via the fecal coliform analysis that the fecal pollution was located primarily in the lower watershed. Beyond May 2008, the Mason County project staff had their responsibilities diverted from the project.

The water quality testing provided insight into the levels and timing of fecal coliform pollution to the Big and Little Mission Creeks. This water testing also provided the relative source locations of the pollution, but it was not possible to rely on the water testing alone to identify the specific sources. This was compounded by the fact that all of what was measured via water sampling was non-point source pollution. There were no point sources of pollution observed during this project period. Considering the large number of animals associated with the project area, it creates uncertainty in the effectiveness of focusing solely on the human sources of fecal coliform pollution.

A review of the county parcel files and the initial field surveys did not give indications of individual septic systems that could be identified as sources of the elevated fecal coliform levels recorded in the lower watershed. Based on the limited finding from this project, this does not imply there are no land parcels with faulty or failing septic systems, but it does put an increased emphasis on investigating the animal sources of fecal coliform pollution. Sanitary surveys are an investigative tool used in the process to determine sources of fecal coliform pollution, but there are limitations to the effectiveness of this type of system. In addition, Sanitary Surveys provide education and information to homeowners regarding best practices in their home and on their properties.

The landowners must be willing to participate in the process in order for there to be confidence that the septic system and the associated land are functioning as well as they can. Unless there are obvious system failures or surface flows or piped outflows observed, it is difficult to adequately research the functionality of septic systems without the cooperation and permission of the landowner.

Dye tests initiated during the height of the summer dry season are most effective if there is a direct discharge or an elevated water table that continually seeps/drains throughout the dry months. Dye tests work well when performed under rainy conditions when the water table levels are elevated, but these conditions are also more likely to compromise the OSS.

There may be a case for investigating the contribution of fecal pollution from the dog population. Since licensing for dogs is not mandatory in Mason County, there is no simple way to estimate the dog population. Dogs roam through much of the lower watershed. The community is connected with roads and spur roads that are primarily adjacent to the stream. The main road parallels the stream and there are several bridge crossings that support land development within proximity of the stream.

The water sampling project crew and sanitary survey field crews attempted to make very general counts of animals when conducting field surveys and site visits. Both water sampling crews and sanitary survey field crews noted many dogs roaming free during field visits. During the sanitary surveys (as noted before) 20 parcels had domestic animals with a total of 21 dogs. It appears that only four of the surveyed sites had no dogs.

It was also noted that dogs are often observed in Belfair State Park, often not on a leash and just as often unattended (likely just roaming the neighborhood). In order to derive more confidence in whether dogs impact the fecal coliform pollution issue, there may be a greater need to enforce pet rules/regulations in regards to collecting dog waste.

The analysis of the water samples did not discriminate between the different sources generating the fecal coliform. The results of the water analysis clearly show that fecal coliform levels fluctuate seasonally and at times exceed the allowable levels. Due to the inability to account for the different sources of fecal coliform (i.e. human vs. animal), it is more difficult to take the appropriate corrective actions for reducing the fecal coliform levels to acceptable levels for shellfish harvest and general human health concerns.

### Task 5. Community Outreach

Community outreach started early in the project with a mailing distributed for the recruitment of interested volunteers to participate in the capacity of the steering committee and/or assisting with the water sampling. There were no responses for the request to participate on the steering committee, but several community volunteers were trained for water sampling.

The Theler Community Center is a focal point for a variety of community activities and events serving the lower Hood Canal region. Data, information, and progress on the Mission Creeks Water Quality Assessment Project were made available at several public events including the Clean Water Festival held at the Theler Community Center in July of 2006, and at the Healthy Hood Canal Celebration held at the Theler Community Center in July 2008. Each of these day-long events were well attended by the community in general, and with specific interest in the progress of the Mission creeks water sampling.

Midway through the project, a direct mailing was provided to the watershed landowners specifically asking for their permission to access properties to conduct sanitary surveys. This mailing also included information on the project progress and results to date. Response to this mailing was small which in turn required an extra effort on the part of the sanitary survey team to contact landowners prior to commencing on the surveys. It turned out that making direct contact with the landowners was one of the more valuable means of relaying project information.

During the sanitary survey process, a door hanger was left at all residences which were visited when no one was home. The door hanger provided another opportunity to share information and progress on the project.

There were two intensive water sampling periods, in which water was sampled for fecal coliform analysis, from single location every hour from early morning to evening. During that time, a project team member set up a 'mobile' booth for distributing project information to those interested in stopping. The sampling location was at a station in the lower watershed which was adjacent to Belfair State Park. Over the two sampling periods, which spanned a total of four days, many people did stop to question the activity. Since the location was adjacent to the state park, only a portion of those were residents of the watershed, but it did provide contact time with folks visiting the area.

The lower Hood Canal region is served by a coalition of concerned residents that focus their concerns on water quality, especially related to low oxygen and fecal coliform. Several of the members also served as members to the steering committee for this project. Project team members were provided the opportunity on several occasions to present the progress and results to this group and members of the public that attend the monthly meetings. The discussions in these meeting provided some healthy guidance on the development of the project and the documentation of the results.

A final community meeting that was planned near the end of the second year of the project was postponed and eventually cancelled due to the sanitary survey work being pushed back.

# Conclusions

- It is evident that fecal coliform pollution has relevance to both Big Mission Creek and Little Mission Creek. The highest values of fecal coliform were observed during the fall months, and in the summer following rain events. The results of the water sampling investigation made it quite evident that the more developed regions in the lower segment of each watershed are strongly associated with fecal coliform pollution.

- The original water sampling regime partitioned each river into segments in order to more narrowly identify sources of fecal pollution. At the end of Y1 (Year One) it was evident that the upper watershed of each stream was not a significant contributor to the fecal pollution. The water sampling during Y2 (Year Two) focused on the lower watershed of Big Mission below RM 1.0. This area also coincided with the area of considerable residential development. The results of the water sampling at the end of Y2 showed this area continued to contribute fecal pollution although the results were more variable.

- Even though no site exceeded a geometric mean value of 50, seven stations had more than 10 percent of all fecal coliform samples exceeding 100 colonies/ 100 mL. State standards are not being met during periods of low flow during the summer months and/or after a rain event.

- The project did not identify any obvious signs of failing septic systems in either stream system, although circumstances did not allow for all of the land parcels identified for sanitary surveys to be investigated. It was noted during the course of the project however, the great number of dogs roaming the neighborhoods and dogs on properties could likely play some factor in the fecal pollution. Because Mason County does not require that dogs are licensed, it is difficult to estimate their potential contribution to the fecal pollution.

- There was an attempt to look more closely at the variability of the fecal coliform pollution on an hourly basis over two separate two-day events. The results of this testing did show a large variability in fecal coliform over the course of a day that is not necessary taken into account during typical monitoring efforts which tend to collect water samples in one location at one point in time, once a month.

- A fecal coliform load was calculated from the results of the two intensive surveys from August 2007 and January 2008. Although August concentrations were much higher than January (70 versus 10 colonies/ 100 mL, on average), the stream flow was much less. While January had fairly low levels of fecal coliform concentrations, when stream flow was taken into account the load was much greater in January (25 billion versus eight billion colonies passing through station MC-01 per day).

- The results of the analysis for chemical toxins (cadmium, copper, lead, zinc) showed no areas of either stream with levels approaching allowable levels for these dissolved metals. These results have provided a baseline for such information within these watersheds. This information was unknown previous to this project and the results add to the understanding of dissolved metal inputs into the receiving marine waters. A similar water quality project was undertaken on a watershed adjacent to the Big Mission Creek and the Little Mission Creek watersheds. This adjacent watershed comprised of the Union River drainage and is a much larger watershed with considerably more developed. There were no elevated levels of chemical toxins found in the Union River. The results from that water quality investigation also served as a baseline of information (HCSEG et al., 2006).

# Recommendations

- It may be worth investigating whether a greater understanding of the daily/hourly variability of fecal coliform in the stream system may affect management decisions of shellfish beaches. The two-day intensive monitoring in August showed evidence of rising fecal coliform values in the morning that dropped off in the afternoon. Routine monitoring could inadvertently select for times of higher or lower values. Better understanding this variability may have value when determining safety limits for shellfish harvesting.

- It may be that communities in rural landscapes often do not make the appropriate association with animals and the human health concerns related to fecal coliform pollution. If the animal contribution of fecal pollution could be better documented it would give more credence to recommending the most appropriate corrective actions for reducing fecal pollution.

- Complete the sanitary surveys and necessary dye tests on the properties adjacent to either Mission or Little Mission Creek, and develop an action strategy of corrective actions based on the pollution risk identified with the properties.

- Establishing county regulations for licensing pets would help to frame the magnitude of pet ownership and conversely the risk for fecal coliform pollution. This information could also be used to better align education/outreach efforts. People share the rural landscape with domestic and wild animals, yet there is considerable attention targeting septic systems. Incorporating the assessments of 'hobby farm' activity provided by the local conservation district could help to frame the corrective actions recommendations.

- The project personnel found that direct contact with landowners is the most reliable means for sharing information and developing a working relationship that can affect change. Direct mailings, door hangers and community meetings had little impact on making changes within the watershed. We recommend building time into a work plan that would provide the ability for contact time with residents during the evening and weekends.

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# Acronyms and Abbreviations

| | |
|---|---|
| EPA | US Environmental Protection Agency |
| ESA | Endangered Species Act |
| GMV | Geometric mean value |
| HCDOP | Hood Canal Dissolved Oxygen Program |
| HCSEG | Hood Canal Salmon Enhancement Group |
| KPUD | Kitsap Public Utilities Department |
| LM | Little Mission Creek |
| MCDHS | Mason County Public Health (Dept. of Health Services) |
| MCPH | Mason County Public Health |
| MCWQA | Mission Creeks Water Quality Assessment |
| MC | Big Mission Creek |
| MI | Big Mission Creek |
| QA | Quality Assurance |
| RM | River Mile |
| SM | Standard Method |
| WAC | Washington Administrative Code |
| WDOE | Washington State Department of Ecology |
| WDOH | Washington State Department of Health |

| | |
|---|---|
| WRIA | Water Resource Inventory Area |

**Parameters**

| | |
|---|---|
| Ca | calcium |
| Cd | cadmium |
| Cu | copper |
| DO | dissolved oxygen |
| FC | fecal coliform |
| Hg | mercury |
| Mg | magnesium |
| Pb | lead |
| TSS | total suspended solid |
| Zn | zinc |

**Units**

| | |
|---|---|
| cfs | cubic feet per second |
| cm | centimeters |
| gpm | gallons per minute |
| mL | milliliters |
| mg/L | milligram per liter (equivalent to parts per million, ppm) |
| µg/L | microgram per liter (equivalent to parts per billion, ppb or ug/L) |
| ug/L | microgram per liter (equivalent to parts per billion, ppb or µg/L) |
| ng/L | nanogram per liter (equivalent to parts per trillion, ppt) |
| MPN | Most Probable Number (fecal coliform test method) |
| NTU | Nephelometric turbidity units |

# Appendices