# Marine Drive Dye Test

**Report Submitted**
**to**
**The Puget Sound Action Team**

**Written by**

**Geoff Menzies**

**for**

**The Puget Sound Restoration Fund**

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## Introduction

In spite of improving trends in water quality over the prime shellfish growing areas in Drayton Harbor, high fecal coliform concentrations persist in the commercial portion of Blaine Harbor. Hirsch's February 6, 2003 Technical Memorandum to the Port of Bellingham summarizes the results of the Port's water quality monitoring program for 2002. It concludes that fecal coliform bacteria levels reported for 2002 were generally higher than in 2001, and that repairs made to the Blaine sewer collection system along Marine Drive in 2001 have not resulted in improved water quality in Blaine Harbor. Fourteen samples were collected from each of the five stations which represent the commercial portion of Blaine Harbor(stations A,B,C,D,E) during 2002. The Geometric Means for fecal coliform bacteria at these stations ranged from 54 to 171 FC/100 ml.. These levels are 3.8 to 12.2 times higher than this component of the Department of Health shellfish standard (Geometric mean of 14 FC/100ml). This situation threatens the likelihood for a shellfish upgrade in Drayton Harbor.

The Puget Sound Restoration Fund (PSRF) has been working closely with the City of Blaine, The State Department of Health's Office of Shellfish Programs, Whatcom County Water Resources, the Drayton Harbor Shellfish Protection District, the Port of Bellingham, and volunteers with the Community Oyster Farm Project to address high-priority bacterial pollution problems with on-the-ground water quality sampling programs, marine water circulation studies, and pollution source identification projects.

DOH has communicated the value of either confirming or eliminating the human waste factor from the Blaine Harbor pollution conundrum. There has been speculation that the high fecal coliform numbers seen in this area can only be caused by nearby leaks in the sanitary sewer system. The purpose of this study was to identify whether sewage, possibly leaking from the main sewer lines near the commercial portion of Blaine Harbor, may be responsible for the high bacterial counts observed in nearby marine waters. PSRF partnered with the City of Blaine and DOH to design a test to make this determination. Fluorescein tracer dye provided by Ozark Underground Laboratory was delivered to several sewer manholes in the area and leakage to marine waters was tracked by using absorbent charcoal packets which were attached to small floats positioned in nearby waters. Key partners in this project are the Puget Sound Action Team, City of Blaine, DOH, Community Oyster Farm volunteers, and Ozark Underground Laboratory, which specializes in this type of work.

This report summarizes the findings of this 3-week test, which was completed on June 9, 2003. The base map shown in Figure 1 shows the key features in the study area.

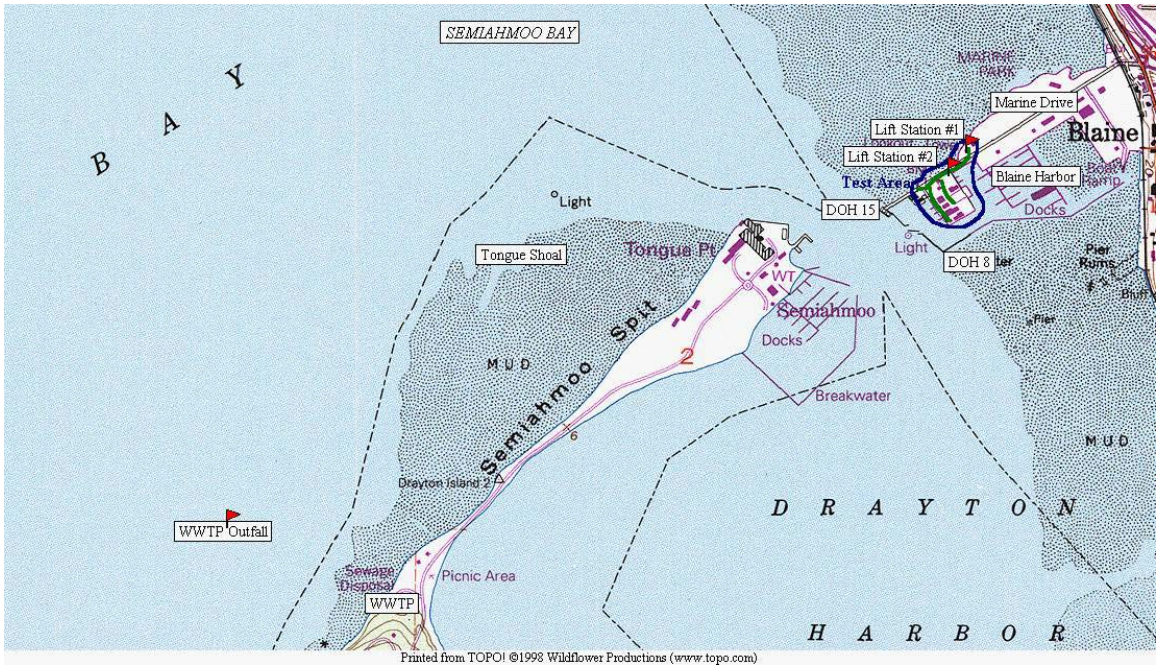


**Figure 1. Base Map**

## Methods and Materials

Charcoal Packet Placement

Charcoal packets provided by Ozark Underground Laboratory were used as the primary method to determine whether fluorescein tracer dye placed in sewer manholes made its way into marine waters. Each packet contains 4.5 grams of 12- mesh coconut-activated charcoal. One week before the dye test, charcoal packets suspended from crab pot floats were placed at eight marine locations (see figure2). These sites were chosen based on discussions with Frank Meriwether, Engineer with the DOH Shellfish Program. Four sites (sites 3-6) were inside Blaine Harbor( Port of Bellingham stations A,C, and E, and adjacent to the old tidal grid directly south of station E). There were two sites(sites 7 and 8) near the entrance to Drayton Harbor (DOH stations 8 and 15). There were two sites(sites 1 and 2) in Semiahmoo Bay (just north of Marine Drive midway between Lift Station #1 and the end of Marine Drive, and adjacent to the shoal marker on Tongue Point). The Tongue Shoal site was selected in order to measure the potential influence from tracer dye that had gone through the wastewater treatment plant, exited the outfall into Semiahmoo Bay, and could potentially re-enter Blaine Harbor on a flooding tide.

Styrofoam crab pot floats resting on the water surface were attached by a nylon line to a bottom weight at each of these eight sites. The length of the line allowed the floats to always remain on the water surface with the changing tides, with the exception of sites 1 and 2 which were in the inter tidal area and could go dry for up to a few hours per day during the test. The charcoal packets were attached by nylon ties to the line about 3 inches below the bottom of each float, hence measuring the surface to 3-inch deep zone.

Charcoal packets were placed out at each of these locations on May 20 and removed on May 27 to measure background levels of dye. Tracer dye was placed in manholes the morning of May 27 in cooperation with City of Blaine staff. Charcoal packets were

placed at each station immediately before dye was introduced to the sewer system and then removed and replaced on May 27 (Day 0, at the end of the flood tide), May 28(Day1), May 31 (Day 4), June 3 (Day 7) and then finally removed on June 9(Day 13). After each set of charcoal packets was collected, they were refrigerated and then sent in iced coolers to Ozark Underground Laboratory for analysis.

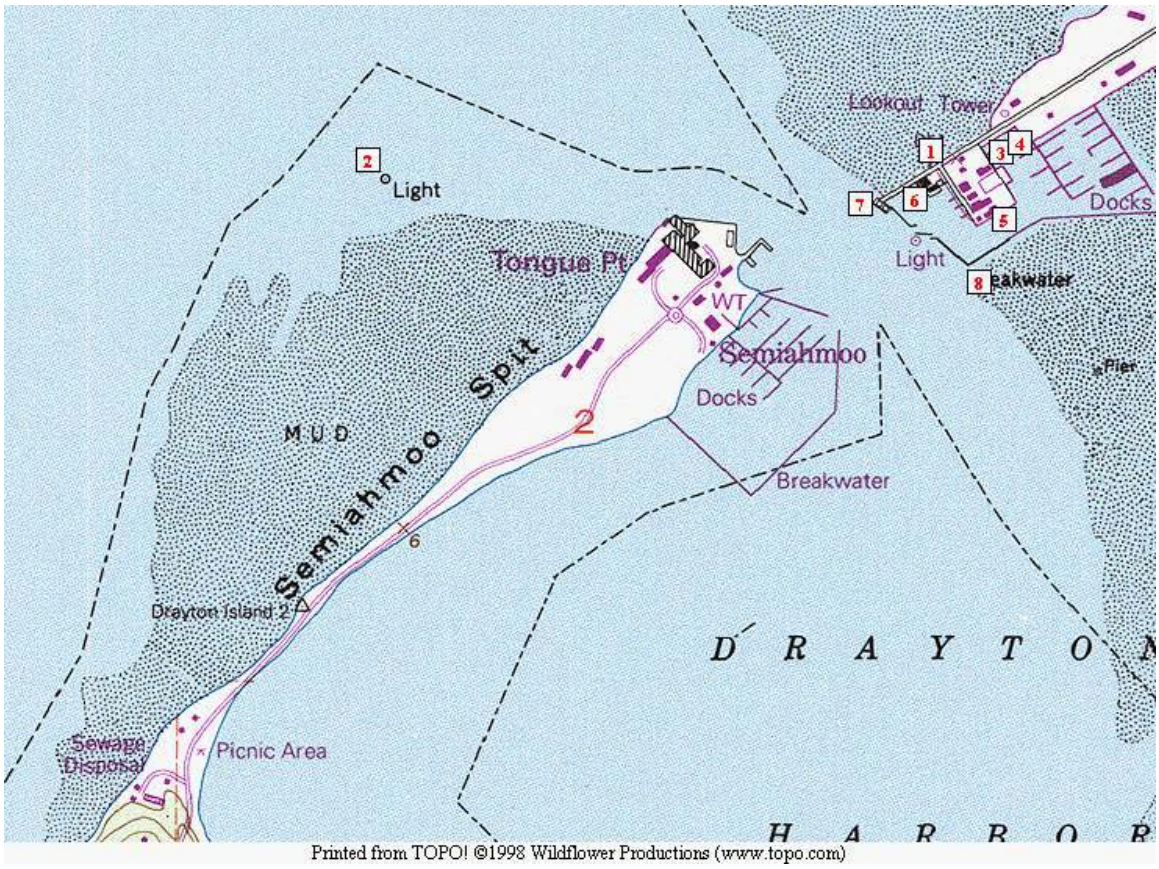


**Figure 2. Charcoal Packet Locations**

Tracer Dye Delivery Locations

One pound of Fluorescein dye (powder, 75%AI) was provided by OUL for this study. It was well mixed with 1 gallon of water. A mixture of 22 ounces of the same tracer dye that was used in a previous study was then added to this gallon and mixed in. This mixture was then divided into 6 separate containers, each containing 25 ounces of tracer dye. These containers were delivered to staff persons from the City of Blaine on the morning of the test. Between 730 and 815 a.m. on May 27, Blaine staff poured one 25-ounce container of dye into each of the following manholes:

- A-4 : adjacent to Star Fish, at old Reef Fish site.
- A5-2: terminal manhole on south end of Sigurdson Ave.
- A5-3: terminal manhole on south end of McMillan Ave.
- LS#2: adjacent to Dakota Fish
- B4-1: manhole in elbow of new line on Marine Drive
- B4-2: manhole in old line across from POB Gate 3

These delivery sites were chosen because they represented the terminal points of the main sanitary sewer system in the area of concern. Dye was delivered to these sites only. Service laterals to individual buildings were not tested in this study.

Treatment Plant Observation and Flood Tide Drogue Test

It was important to determine when the tracer dye reached the wastewater treatment plant and, more importantly, when it made its way through the plant before exiting through the outfall into Semiahmoo Bay. A volunteer with the Community Oyster Farm was positioned at the chlorine contact chamber once the tracer dye reached the plant. This is the last area in the plant where the wastewater stream can be observed before being discharged into Semiahmoo Bay. At the time that the tracer dye was exiting into Semiahmoo Bay, drogues measuring water movement at three depths(surface, 12 feet deep, 24 feet deep) were deployed near the end of the outfall pipe. The actual release site was Lat: N 48.98050, Long: W122.80115. This location was based on coordinates supplied by the City of Blaine Public Works Department. The path that the drogues took was tracked through the duration of the flood tide and drogue positions were recorded on a map using coordinates read from a handheld GPS unit approximately every hour from 1243 to 1747 hours on Day 0, May 27.

Dye Recovery Analytical Methods

The procedures used by Ozark Underground Laboratory to extract, identify, and quantify Fluorescein dye is described in detail in the publication titled: "Procedures and Criteria Analysis of Fluorescein, Eosine, Rhodamine WT, Sulforhodamine B, and Pyranine Dyes in Water and Charcoal Samplers, January 2, 2001", written by Thomas Aley, PHG 179, President of Ozark Underground Laboratory, Inc.. Charcoal packets upon receipt are refrigerated, then cleaned by spraying them with jets of clean water. An eluting solution is then used to recover the dye if present from each charcoal packet. A sample of the elutant is then placed in a Shimadzu spectrofluorophotometer. Where dye is detected, results are reported as peak wavelength in nanometers and the dye concentration, based on either the height of the fluorescence peak or the area within the fluorescence peak, is reported in parts per billion. The fact that a fluorescence peak is identified in their analytical results is not proof that it is fluorescein dye or that it is fluorescein dye from the trace of concern. There are several criterion which must be met in order to confirm that fluorescein dye detected from charcoal packets is from the trace of concern. These include all of the following factors: the fluorescence peak, dye concentration relative to the detection limit, dye concentration relative to background levels, and finally the shape of the fluorescence peak.

**Results**

Tracer dye reached the wastewater treatment plant at 1115 on May 27, approximately three hours after it was placed in manholes near the commercial portion of Blaine Harbor. Within about 45 minutes, the dye reached the chlorine contact chambers. Dye reached the end of the chlorine contact chambers (cover photo) and entered the outfall pipe at 1243. Drogues were then released at the terminal end of the outfall pipe in Semiahmoo Bay. Figures 3,4, and 5 below show the courses taken by each of these drogues.

## Drogue Movement from WTP Outfall on a Flood Tide 5/27/03

Low Tide: + 0.85 ft at 1037 hours
High Tide: + 7 ft at 1724 hours

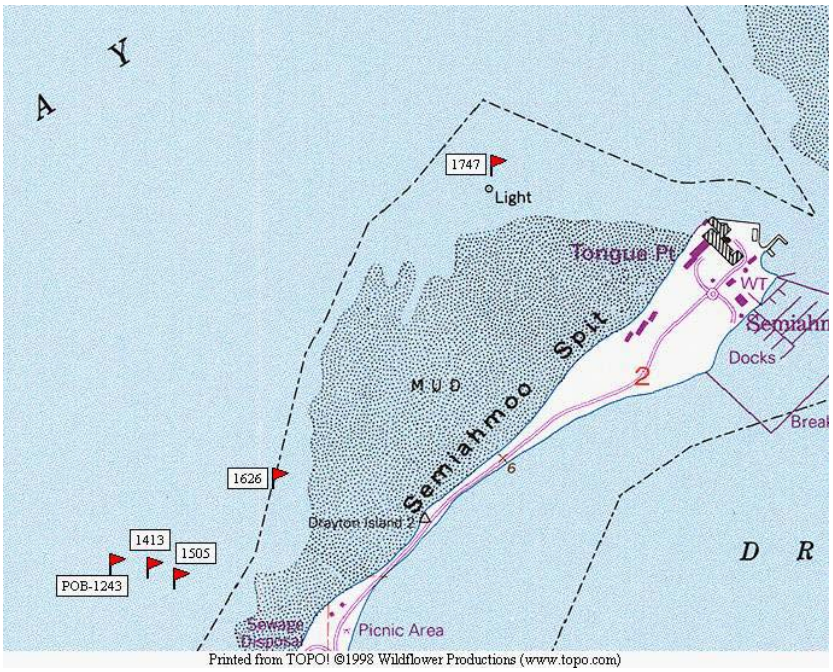


**Figure 3: Surface Drogue Course**

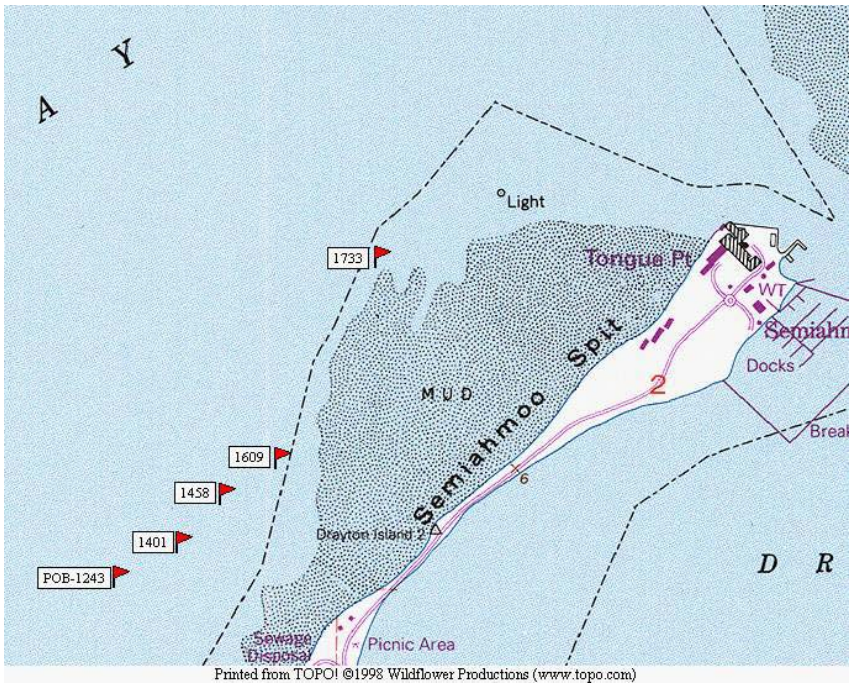


**Figure 4: 12 ft. Deep Drogue Course**

**Drogue Movement from WTP Outfall on a Flood Tide 5/27/03**

Low Tide: + 0.85 ft at 1037 hours
High Tide: + 7 ft at 1724 hours

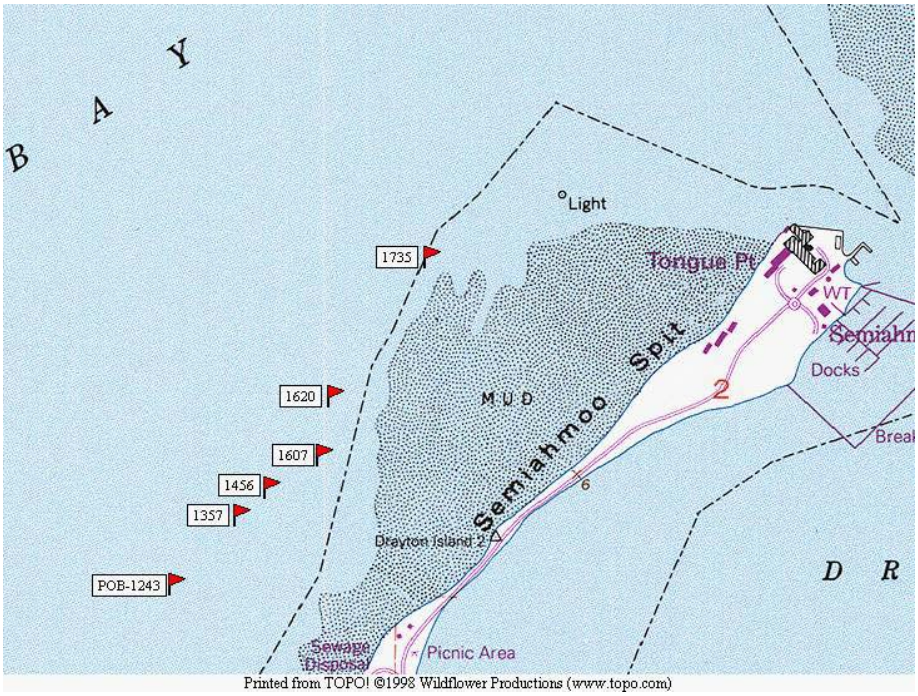


**Figure 5: 24 Ft. Deep Drogue Course**

**Results** (Continued)
None of the drogues re-entered Drayton Harbor by the end of the flood tide. The surface drogue went slightly beyond site 2 near the Tongue Shoal marker and was then removed about five hours after deployment at the end of the flood tide. Figure 3 shows that this drogue remained in the vicinity of the outfall pipe for the first two hours, then moved rapidly in a northeasterly direction towards the Tongue Shoal marker during the last half of the flood tide. The deeper water drogues(figures 4 and 5) followed similar paths, both reaching a point just northeast of the red nun buoy along Tongue Shoal. They were also removed at the end of the flooding tide. Table 1 below shows the tidal elevations from May 27 thru May 29, the first three days of the testing. Tracer dye remained in the plant until the morning of May 29 and was probably at peak concentration on May 28. As table 1 shows, there were four opportunities for tracer dye exiting the plant outfall to approach the Drayton Harbor entrance on the flooding tide during this test. They are shown in **bold blue** in this table.

Table 1: Tide Table for Days 0 thru 2

| Date | Time | Ft. | Time | Ft. | Time | Ft. | Time | Ft. |
|---|---|---|---|---|---|---|---|---|
| | HIGH | | LOW | | HIGH | | LOW | |
| 5/27 | | | 1037 | +0.85 | **1724** | **+7.0** | 2206 | +4.9 |
| 5/28 | **331** | **+8.6** | 1101 | -0.1 | **1815** | **+7.8** | 2254 | +5.7 |
| 5/29 | **346** | **+8.5** | 1126 | -0.8 | 1859 | +8.3 | 2340 | +6.4 |

Tracer dye was observed at the plant during this time period.

**Results** (Continued)
Results of tracer dye retrieval from charcoal packets are summarized in Table 2. The complete report from Ozark Underground Laboratory is attached as an appendix(hard copy). There was no detection of dye at any of the sites in background samples the week prior to adding tracer dye to the sanitary sewer system. Dye was not detected on Day 0 at the end of the flood tide at any location in spite of the fact that surface waters starting from the plant outfall made their way to site 2 near Tongue Point. The only dye detection was at site 2 on Day 1. This detection corresponds with the probable highest concentration of tracer dye in the wastewater treatment plant on the morning of Day 1 and favorable tides for transporting dye from the plant to this location. The fluorescence peak did not meet all of the criteria for a positive dye result, but it is highly likely that this detection was the tracer dye, which traveled over a 24-hour period from the test area through the treatment plant and back to Tongue Point on the flooding tide of May 28.

Dye was not detected at any of the other sites in Semiahmoo Bay, at the entrance to Drayton Harbor, or at any of the locations within the commercial portion of Blaine Harbor for the duration of this study.

The crab float and replacement charcoal packet placed at site 2 on May 31(day 4) was gone on June 3 when it was to be collected for analysis. It was probably stolen. It was not replaced at that time. There was no significant amount of dye remaining in the wastewater treatment plant and this site had served it's purpose in the study; to intercept dye from the plant that might make its way back toward the harbor entrance with a flooding tide.

There was fish processing activity during the first few days of the testing period and this was documented by water meter readings taken by the city of Blaine from two meters which serve Sea K Fish, the only active processor at the time. Readings were taken on the morning of May 27 (Day 0), morning of May 28 (Day 1), and on the morning of June 3 (Day 7). During approximately the first 24 hours of the tracer dye test, Sea K used 1621 cubic feet of water for their processing activities. They used an additional 3581 cubic feet through the morning of June 3. The table below provides a summary of the fish processing activity at Sea K Fish during the study period. It shows daily finished product.

| Day | Pounds of Finished Product |
|---|---|
| May 27 | 2,638 |
| May 28 | 0 |
| May 29 | 6,332 |
| May 30 | 9,146 |
| May 31 | 0 |
| June 1 | 0 |
| June 2 | 1,059 |
| June 3 | 15,890 |
| June 4 | 24,735 |
| June 5 | 6,560 |
| June 6 | 22,402 |
| June 7 | 0 |
| June 8 | 0 |

*Source of data for this table and permission from Lawana Chapman, Sea K Fish*

**Discussion**

In this study, all of the main sanitary sewer lines and manholes in proximity to the commercial portion of Blaine Harbor and the two lines immediately upstream of Lift Station 1 were dye-tested. No tracer dye was detected in the surrounding waters that could be attributed to leakage from these lines or manholes over a period of almost two weeks after the system was dyed. Based upon these test results, it does not appear that the main sanitary sewer system is contributing to the high fecal coliform levels observed in Blaine Harbor.

In addition, although not the focus of this study, the absence of dye at sites 7 and 8 near the entrance to Drayton Harbor indicate that leakage from the underwater force main was unlikely during this testing period. Both the underwater sewer force main and the sanitary collection system in the commercial marina area have been suspected for some time by many as contributors to this problem area. Eliminating human sources of pollution is important in order to achieve a shellfish upgrade in Drayton Harbor. This study makes a strong case that human waste from the main sewer collection system is not causing pollution in the commercial portion of Blaine Harbor.

This study was conducted during a period of active fish processing. DOH has expressed concern in the past that previous dye testing conducted by the Port of Bellingham was not done when fish processors were active and that if there were any cross connections between these systems, they may go undetected.

**Recommendations**

- This report will be shared with members of the Drayton Harbor Shellfish Protection District, Whatcom County Water Resources Division, the City of Blaine, and DOH to focus on follow-up efforts and for any further discussion about the findings.

- These results should be put in the context of recent findings from circulation studies in the commercial portion of the Blaine Harbor and the results of the upcoming marine water dye-testing work from DOH Stations 8 and 15 to be conducted by DOH (scheduled for mid-July 2003).

- As recently suggested by Hirsch, storm water runoff from rooftops, docks, and roadways in the commercial portion of Blaine Harbor should be monitored to estimate fecal coliform loading to surrounding waters.

- Continue to work with live-aboards and commercial vessels to ensure proper pump out procedures and facilities. Facilitate easy access by visiting boaters to pump-out facilities.(A live-aboard, in a conversation with this author while this study was being done, said that the Port should make it easier for visiting boaters to pump out at the visitor dock. During boating season, the Plover is moored right next to the pump out station on the main dock at Gate 2, making it hard to access this station. This live-aboard also commented that with the onset of recent summer boating activity and influx of weekend users, surface water quality appears to have deteriorated).

**Recommendations** (continued)

- Review the recent report by Mandy DeJong, Trinity Western University, which provides bird count results for Blaine Harbor. Available by contacting Ami Stillings, Whatcom County Water Resources - Shellfish Planner: AStillin@co.whatcom.wa.us

**Acknowledgements**

I am grateful to the following people who contributed their time and expertise to this study. They are:

Frank Meriwether, DOH Office of Shellfish Programs
Thomas Aley, President, Ozark Underground Laboratory
Tom Cullen, Drayton Harbor Community Oyster Farmer
Frank Arnett, Wastewater Sampler and Operator, City of Blaine
Steve Banham, Public Works Director, City of Blaine
John Walter, Sewer Collections Lead, City of Blaine
Clifford Ness, Wastewater Treatment Plant Operator, City of Blaine
Luwana Chapman, Sea K Fish Company

**Table 2: Marine Drive Dye Test Results - Background thru Day 1**

| Charcoal Packet Location | | | | | | Ozark Underground Lab Results | |
|---|---|---|---|---|---|---|---|
| Site Description | Site Number | Placement Date | Placement Time | Collection Date | Collection Time | Peak wavelength (nanometers) | Concentration (ppb) |
| PRE-DYE | BACKGROUND | | | | | | |
| Semiahmoo Bay | 1 | 20-May | 1050 | 27-May | 657 | ND | |
| Tongue Point | 2 | 20-May | 1114 | 27-May | 737 | ND | |
| Dakota Fish | 3 | 20-May | 1130 | 27-May | 632 | ND | |
| Old Tidal Grid | 4 | 20-May | 1143 | 27-May | 625 | ND | |
| Westman Marine | 5 | 20-May | 1200 | 27-May | 636 | ND | |
| Star Fish | 6 | 20-May | 1215 | 27-May | 646 | ND | |
| DOH Station 15 | 7 | 20-May | 1325 | 27-May | 709 | ND | |
| DOH Station 8 | 8 | 20-May | 1340 | 27-May | 725 | ND | |
| | Fluorescein tracer dye was poured into sanitary sewer manholes on 5/27 between 730 and 815 am | | | | | | |
| POST DYE | Day 0 | | | | | | |
| Semiahmoo Bay | 1 | 27-May | 700 | 27-May | 1806 | ND | |
| Tongue Point | 2 | 27-May | 739 | 27-May | 1752 | ND | |
| Dakota Fish | 3 | 27-May | 634 | 27-May | 1822 | ND | |
| Old Tidal Grid | 4 | 27-May | 628 | 27-May | 1826 | ND | |
| Westman Marine | 5 | 27-May | 640 | 27-May | 1840 | ND | |
| Star Fish | 6 | 27-May | 650 | 27-May | 1846 | ND | |
| DOH Station 15 | 7 | 27-May | 710 | 27-May | 1802 | ND | |
| DOH Station 8 | 8 | 27-May | 730 | 27-May | 1814 | ND | |
| | Day 1 | | | | | | |
| Semiahmoo Bay | 1 | 27-May | 1808 | 28-May | 725 | ND | |
| Tongue Point | 2 | 27-May | 1755 | 28-May | 741 | 514.6* | 0.281 |
| Dakota Fish | 3 | 27-May | 1824 | 28-May | 804 | ND | |
| Old Tidal Grid | 4 | 27-May | 1828 | 28-May | 808 | ND | |
| Westman Marine | 5 | 27-May | 1841 | 28-May | 816 | ND | |
| Star Fish | 6 | 27-May | 1848 | 28-May | 821 | ND | |
| DOH Station 15 | 7 | 27-May | 1804 | 28-May | 734 | ND | |
| DOH Station 8 | 8 | 27-May | 1815 | 28-May | 755 | ND | |

**FOOTNOTES**

ND = No dye detected

* = A fluorescence peak is present that does not meet all the criteria for a positive dye result but has been calculated as though it were the tracer dye

**Table 2: Marine Drive Dye Test Results - Days 4 thru 13**

| Charcoal Packet Location | | | | | | Ozark Underground Lab Results | |
|---|---|---|---|---|---|---|---|
| Site Description | Site Number | Placement Date | Placement Time | Collection Date | Collection Time | Peak wavelength | Concentration |
| | Day 4 | | | | | (nanometers) | (ppb) |
| Semiahmoo Bay | 1 | 28-May | 730 | 31-May | 845 | ND | |
| Tongue Point | 2 | 28-May | 743 | 31-May | 902 | ND | |
| Dakota Fish | 3 | 28-May | 806 | 31-May | 918 | ND | |
| Old Tidal Grid | 4 | 28-May | 810 | 31-May | 924 | ND | |
| Westman Marine | 5 | 28-May | 817 | 31-May | 930 | ND | |
| Star Fish | 6 | 28-May | 822 | 31-May | 937 | ND | |
| DOH Station 15 | 7 | 28-May | 735 | 31-May | 851 | ND | |
| DOH Station 8 | 8 | 28-May | 757 | 31-May | 910 | ND | |
| | Day 7 | | | | | ND | |
| Semiahmoo Bay | 1 | 31-May | 847 | 3-Jun | 742 | ND | |
| Tongue Point | 2 | 31-May | 904 | 3-Jun | 800(a) | NS | |
| Dakota Fish | 3 | 31-May | 920 | 3-Jun | 820 | ND | |
| Old Tidal Grid | 4 | 31-May | 926 | 3-Jun | 825 | ND | |
| Westman Marine | 5 | 31-May | 932 | 3-Jun | 832 | ND | |
| Star Fish | 6 | 31-May | 940 | 3-Jun | 840 | ND | |
| DOH Station 15 | 7 | 31-May | 853 | 3-Jun | 750 | ND | |
| DOH Station 8 | 8 | 31-May | 912 | 3-Jun | 810 | ND | |
| | Day 13 | | | | | | |
| Semiahmoo Bay | 1 | 3-Jun | 745 | 9-Jun | 1330 | ND | |
| Tongue Point | 2 | 3-Jun | XXX | 9-Jun | XXX | NS | |
| Dakota Fish | 3 | 3-Jun | 822 | 9-Jun | 1400 | ND | |
| Old Tidal Grid | 4 | 3-Jun | 828 | 9-Jun | 1410 | ND | |
| Westman Marine | 5 | 3-Jun | 834 | 9-Jun | 1415 | ND | |
| Star Fish | 6 | 3-Jun | 845 | 9-Jun | 1420 | ND | |
| DOH Station 15 | 7 | 3-Jun | 752 | 9-Jun | 1335 | ND | |
| DOH Station 8 | 8 | 3-Jun | 812 | 9-Jun | 1350 | ND | |

**FOOTNOTES**

ND = No dye detected

* = A fluorescence peak is present that does not meet all the criteria for a positive dye result but has been calculated as though it were the tracer dye

(a) Crab float and charcoal packet were absent on this date and were not replaced.

# Appendix

# Ozark Underground Laboratory Reports