QUALITY ASSURANCE PROJECT PLAN UPDATE
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PROJECT NAME: Whatcom County Volunteer Monitoring Program for Drayton Harbor, Birch Bay, and Chuckanut Bay Watersheds

Subcontract with Puget Sound Restoration Fund
For Whatcom County Public Works Department Stormwater Division

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Project Description

Background

The Whatcom County Marine Resources Committee received grant funds (administered by Whatcom County Public Works, Stormwater Division) through the Northwest Straits Commission to implement a volunteer water quality monitoring program in the Drayton Harbor and Birch Bay watersheds. Water quality degradation has been a concern for shellfish growing areas in Drayton Harbor, Birch Bay and Chuckanut Bay. Drayton Harbor/ Semiahmoo Spit has historically provided tribal and recreational shellfish harvesting opportunities, as well as commercial harvest. After the initial downgrade of shellfish growing areas by Washington State Department of Health (DOH), in 1995 and subsequent closure of remaining growing area in 1999, portions of Drayton Harbor were upgraded for "Conditional Approval" in June 2004. Harvest is currently conditioned upon closure following storm events of 0.75 inches of rainfall in a 24-hour period. The remainder of Drayton Harbor continues to be classified "Prohibited" for shellfish harvest. Birch Bay has been and is one of the largest and most productive clamming areas in the state of Washington (Larson, 2006). In April 2003, Birch Bay was listed as a "Threatened" shellfish growing area by DOH due to degrading water quality. Birch Bay remained on the threatened list as of April 2005. In 1994 DOH closed Chuckanut Bay to recreational shellfish harvest based upon water quality and sewage disposal conditions in the area. (Whatcom County Health Department, 1997).

Drayton Harbor has a history of volunteer involvement going back more than a decade, from the Shellfish Protection District Advisory Committee to volunteer participation in the Puget Sound Restoration Fund's (PSRF) Community Oyster Farm. Community involvement and commitment have been drivers behind focusing attention and resources toward improving water quality in Drayton Harbor. While water quality issues related to shellfish harvest in Birch Bay have come to the forefront more recently, there is already a strong volunteer commitment to water quality improvement manifested by the Birch Bay Storm Water and Shellfish Task Force. Chuckanut Bay is included in Whatcom County's volunteer monitoring project due to interest by volunteers and continued concern over water quality and on-site sewage disposal. This project will involve volunteers in the collection of water quality data and assist in community outreach efforts emphasizing the need for clean marine waters for safe shellfish harvesting and future clam enhancement projects. Following a training workshop and group sampling event, volunteer monitors will begin collecting samples monthly at selected sampling sites in the Drayton Harbor, and Birch Bay watersheds in June 2006 and the Chuckanut Bay watershed in August 2006. The project will continue through March 2007. Data collected by volunteers will be compiled into a final report. This narrative describes the project, prefaced with a discussion of the study areas including a general location description, an overview of land uses, and a summary of existing data.

Study Areas

Drayton Harbor and Birch Bay are located in the northwest corner of Whatcom County, Washington and they are shown in Figure 1. Chuckanut Bay is located along the south eastern shoreline of Bellingham Bay as shown in Figure 2.

Drayton Harbor

The Drayton Harbor watershed straddles the international border with Canada. The watershed encompasses 35,102 acres including 256 acres in British Columbia. There are 129 miles of tributary streams contained within the Drayton Harbor Watershed. California and Dakota Creeks discharge into the harbor from the southeast and constitute the primary freshwater inputs to the Harbor draining over 90% of the watershed area (Peterson, 1995). The remaining portion of the watershed drains directly into Drayton Harbor. The mouth of Drayton Harbor lies just south of Semiahmoo Bay, which is bisected by the international border with Canada. Figure 1 shows the boundaries of the Drayton Harbor watershed. Total annual rainfall recorded at Blaine averaged 41 inches per year between 1948-1998 with about 68% in the fall and winter and ranged from 24.8 inches in 1952 to 52.7 inches recorded in 1997. The highest daily rainfall value was 3.4 inches in November 1955 (Determan, 1999).

Drayton Harbor is an enclosed marine embayment with a rich history as a shellfish resource. Shellfish harvest and growing has been restricted intermittently due to fecal pollution since 1952. In 1988 the Drayton Harbor watershed was designated the priority watershed in Whatcom County by the Puget Sound Water Quality Authority. Classification by the Washington State Department of Health (DOH) resulted in closure and restriction of portions of Drayton Harbor in January 1995. In September 1999, the remainder of the shellfish growing area was downgraded to Prohibited status.

In response to the January 1995 closure, Whatcom County established the Drayton Harbor Shellfish Protection District in July of 1995. In 2001 the PSRF gained approval from DOH to seed two acres in the central portion of Drayton Harbor with Pacific oysters as the Drayton Harbor Community Oyster Farm. The goal of the project was to involve community members in growing Drayton Harbor oysters for harvest in 2004. The oyster farm inspired efforts by various local agencies to control fecal pollution sources and water quality improvements were realized. In June 2004, DOH reopened 575 acres in the central portion of Drayton Harbor for conditional harvest based upon rainfall. Shellfish harvest was closed for five days immediately following more than ½ inch of rainfall in a 24-hour period (Lennartson, 2004). Recently, the thresholds for the conditional approval were adjusted resulting in a six-day closure following a rainfall event of ¾ inches in a 24-hour period. Since the summer of 2004, 2000 bushels of oysters have been harvested most of which have been exported to China. Drayton Harbor has been included on the state 303(d) list for fecal coliform bacteria and has been selected by the Washington State Department of Ecology (Ecology) for a Total Maximum Daily Load (TMDL) beginning in 2006 (Hood, 2006).

Land Use

Land use in the Drayton Harbor watershed is diverse. Urban, residential, agriculture (commercial and hobby farms), surface mining, forestry, and marinas including industry are all identified as significant land uses in the watershed by the 1995 Drayton Harbor Management Plan. The incorporated city of Blaine flanks the eastern shore of Drayton Harbor just south of the Canadian border. The Resort Semiahmoo and residential development borders the western shore of the harbor. The estimated population of Blaine for 1999 was 3,640 (OFM, 1999). Growth rate increase in Blaine to 4.8% per year is attributed primarily to the development of Resort Semiahmoo (City of Blaine, 1999).

Land use in the California and Dakota creek basins is rural residential with a high concentration of hobby farms and certified dairies. As of 1991 54% of land in the Drayton Harbor watershed was in rural/agricultural use with the majority used as pastureland. There are 18 dairies in the Drayton Harbor watershed (Kaufman, 2001). In 1998 Whatcom County passed the Agricultural Nutrient Management ordinance (WCC 16.28) regulating ground application of liquid manure (Whatcom County, 1998). In 1991 the Puget Sound Cooperative River Basin Team counted 255 hobby farms (less than 20 acres) by visual inspection (PSCRBT, 1991). The Whatcom Conservation District's 2005 Livestock Survey estimated 253 farms (commercial and hobby) with approximately 11,878 animals in the Drayton Harbor watershed of which 94% were cattle (WCD and NRCD, 2005).

Custer is an unincorporated town located in the California Creek drainage. On-site sewage systems (OSS) serve the sewage disposal needs for rural residential and unincorporated areas. Ninety-six percent of the soils within the Drayton Harbor watershed have severe limitations for on-site sewage systems. In 1991, 2.5 percent of the watershed area was occupied by urban uses, mostly residential, with 40% in forestry, and 54% in rural/agricultural use (PSCRBT, 1991).

Birch Bay

The Birch Bay watershed is located south of the Drayton Harbor watershed and includes the coastline from just north of Neptune Beach, north to the north end of the Semiahmoo Peninsula (Whatcom County 2006). Birch Bay itself lies between Point Whitehorn to the south and Birch point to the north including approximately 10 shoreline miles (DOH, 1994). The drainage area encompasses 19,840 acres (31 square miles). Terrell Creek is the major freshwater tributary to Birch Bay draining Lake Terrell and most of the southern portion of the watershed and emptying into Birch Bay from the southeast. Fingalson Creek is a major freshwater tributary to Terrell Creek. The Terrell Creek estuary drains 40 acres of marshlands. In addition there are numerous short unnamed tributaries that drain directly to Birch Bay or Georgia Strait (Whatcom County 2006). Thirty-five percent of the watershed is covered by wetlands including peat bogs lying above a shallow perched aquifer. The basin is low lying with a high point at 350ft above sea level. Most of the Birch Bay shoreline is low to no bank with intertidal sand and mudflats with bluffs at Birch Point to the north and Point Whitehorn to the south.

Precipitation in the Birch Bay watershed averages 45-50 inches per year.

Birch Bay has a popular recreational shellfish beach area at Birch Bay State Park consisting of 192 acres with 600 feet of shoreline (DOH 1994). Birch Bay boasts one of the largest clam harvests in the state (Larson, 2006). Birch Bay had been classified "Approved" for commercial shellfish harvest until April 2003 when it was listed as a "Threatened" due to degrading water quality. The last sanitary survey by the DOH was completed in 1994.

Land Use

Land use around the Birch Bay shoreline is primarily residential and vacation homes with a mix of commercial waterfront. The upper portion of the watershed is dominated by agriculture, rural residential, undeveloped forest and wetlands and some industrial land uses (Whatcom County, 2006). Birch Bay is an unincorporated community that is growing at a rapid rate as evidenced by new construction within the urban growth area. Development around the shoreline is characterized by a mix of residential and commercial uses. Birch Bay Village, located in the northern portion of Birch Bay, is a private development with primarily single family residences zoned for medium density, urban residential housing (URM-6) (Kask, 2004). Birch Bay Village has a golf course and a marina with approximately 300 slips. South of Birch Bay Village to Birch Bay State Park are single and multi family residences, commercial and resort development with a golf course, zoning is URM-6, resort commercial, and general commercial (Kask, 2004). Birch Bay State Park is less developed with roads, parking and restroom facilities. South of the state park residential development is moderate to low density (Whatcom County, 2006) UR4 zoning (Kask, 2004). Land use in the upper Terrell Creek and Lake Terrell drainages is primarily rural residential and agricultural interspersed with forest and wetlands (Whatcom County, 2006). The Terrell Creek drainage has an estimated 19.4% impervious surface. The Whatcom Conservation District's 2005 Livestock Survey estimated 56 farms (hobby and commercial) with a total of 715 animals in the Birch Bay watershed of which 76% were cattle. By comparison, the California Creek sub-basin of the Drayton Harbor watershed alone had an estimate of 111 farms with 4,276 animals or more than 5 times the numbers of the entire Birch Bay watershed (WCD, 2005).

The Birch Bay Water and Sewer District provides wastewater collection and treatment for 6,700 acres of the 19,840 acre watershed. The service area is contained within the urban growth area for Birch Bay (Kask Consulting Inc., 2004). The district has 8 wastewater lift stations located around Birch Bay. Soils in Birch Bay are moderately to well drained gravelly loam over glacial till rated severe for OSS due to cemented pan, wetness, slope, and poor filtration (DOH, 1994). In 2002 Whatcom County Health Department documented 620 OSS in the Birch Bay watershed. Since that time some systems have connected with the sewer utility. In 2002, 4 OSS or 3.6% out of the 110 systems surveyed were failing (Arthur, 2006).

Chuckanut Bay

Chuckanut Bay is a fairly shallow and small embayment contiguous with outer Bellingham Bay. The Chuckanut Bay sub-basin lies within Whatcom County's Bellingham Bay Water Management Unit (WMU). Chuckanut Bay is located along the south eastern shoreline of Bellingham Bay and is bounded by Clark's Point to the North and Governor's Point to the South (Figure 3). The northern portion of the Chuckanut bay shoreline lies within the City of Bellingham with the remainder in unincorporated Whatcom County. Chuckanut Creek is the major freshwater tributary to Chuckanut Bay with a drainage area of approximately 4,834 acres. The Chuckanut Creek basin drains the slopes of Lookout and Chuckanut mountains (COB, 2005). Chuckanut Creek discharges to an estuary in Chuckanut Bay, Approximately 16% of Chuckanut Creek's drainage area lies within the City of Bellingham with the remaining 84% in unincorporated Whatcom County (COB, 1995) Most of the Chuckanut Creek shoreline lies within the City of Bellingham except for the 200 ft upstream of the Bellingham city limit. In addition there are a few intermittent small streams that drain to Chuckanut Bay.

Precipitation ranges from more than 35 inches in and around Bellingham Bay to as much as 65 inches on the slopes of Lookout Mountain. The majority of precipitation falls as rain from October to January. Regulated critical areas in the Chuckanut Creek shoreline include critical aquifer recharge area, wetlands, urban natural open space, and seismic hazard areas Chuckanut sedimentary bedrock bounds the WMU along the marine shoreline and to the east where Lookout Mountain dominates the landscape. Marine shorelines are comprised of post-glacial deposits and sandstone bedrock. The majority of soils found in the Chuckanut basin are silt loam with moderate percolation rates (COB, 1995). Vegetation is dominated by mature and immature forest canopy.

In 1994 DOH closed Chuckanut Bay to recreational shellfish harvest based upon water quality and sewage disposal conditions in the area. (Whatcom County Health Department, 1997). A commercial shellfish growing area is also reported in Chuckanut Bay (Whatcom County, 2006)

Land use

Most of the Chuckanut Bay shoreline bears a shoreline designation of rural residential. Most of the shoreline is developed with single-family residential (0.25 to 2-acre lots) on the north end. Clark's Point is undeveloped forested land. The south end is less dense single family residential (5 to 10-acre lots), park land associated with Larrabee State Park, and undeveloped forested land (Whatcom County, 2006). Human disturbance in the Chuckanut Creek basin is relatively low except for residential development at the lower reach and in its flood plain. Here homes are served by septic systems. Existing land use and zoning along Chuckanut Creek in unincorporated Whatcom County is low density (5-acre lots) rural residential. Under existing zoning and comprehensive plan land use designations, future development in the inventoried reach is not likely to change significantly (Whatcom County, 2006). There are some hobby farms with livestock and Interstate 5 crosses over the creek at the base of Lookout Mountain. the northeast corner

of the Chuckanut Mountain Recreation Area is located across Lake Samish Road from the stream. The Burlington Northern Santa Fe railway crosses Chuckanut Bay at Clark's Point and follows near the shoreline south past Governor's Point. Chuckanut Bay Village, located adjacent to the northern portion of Chuckanut Bay and within Bellingham city limits is a residential neighborhood served by septic systems. Soils in this area are tidal, poorly drained and rate as severe for septic tank systems due to flooding and soil saturation (DOH, 1994a). The City of Bellingham has enacted a growth moratorium at Chuckanut Bay Village due to OSS failures (COB, 1995). Whatcom County staff indicates there are about 400 known OSS systems in the Chuckanut Creek/Chuckanut Bay watershed and estimate there are actually about 500. There may be additional OSS systems on the north and west sides of Chuckanut Bay that are included in the South Bellingham Bay watershed (Arthur, 2006)

Beneficial Uses

Under the 1997 version of the Washington State Surface Water Quality Standards, Drayton Harbor and Chuckanut Bay were classified by Ecology as Class A waterbodies, with excellent water quality and Birch Bay was classified AA with extraordinary water quality (WAC-173-201A-140, 1997). Class A waters are considered excellent where water quality shall meet or exceed the requirements for all or substantially all uses. Class AA waters are considered extraordinary where water quality shall markedly and uniformly exceed requirements for all or substantially all uses. Under the 2003 marine use designations Drayton Harbor and Chuckanut Bay are classified as excellent for aquatic uses and Birch Bay is classified as extraordinary.. All three waterbodies are classified for shellfish harvest, primary contact recreation, wildlife habitat, harvesting, commerce/navigation, boating and aesthetics (WAC-173-201A-612, 2003). Tributaries of the waterbodies are given the same classification as the waterbody into which they merge. Characteristic uses include:

- Water supply (domestic, industrial and agricultural)
- Stock watering
- Fish (including salmonid) and shellfish spawning, rearing, migrating, and harvesting
- Wildlife habitat
- Recreation including primary contact (swimming), sport fishing, boating, and aesthetic enjoyment
- Commerce and navigation

Fecal coliform standards for Class A and AA waters:

Freshwater:	A	Geometric mean shall not exceed 100 colonies/100mL *and* not more than 10% of all samples shall exceed 200 colonies/100mL
	AA	Geometric mean shall not exceed 50 colonies/100mL *and* not more than 10% of all samples shall exceed 100 colonies/100mL
Marine	A, AA	Geometric mean shall not exceed 14 colonies/100mL *and* not more than 10% of all samples shall exceed 43 colonies/100mL. These is also the National Shellfish Sanitation Program (NSSP) criteria for approved shellfish growing waters except that NSSP uses the estimated 90th percentile calculation (NSSP, 1997).

DOH shellfish growing area classification maps for Drayton Harbor and Birch Bay are shown in Appendix A.

Drayton Harbor

Historically, Drayton Harbor has been a significant shellfish resource for several user groups. Environmental conditions were ideal for the harvest and farming of several species of clams and oysters. The Lummi Nation and the Nooksack Tribe hold ceremonial and subsistence rights to shellfish harvesting in the Harbor. Commercial shellfish growing began in 1905 when the Drayton Harbor Oyster Company seeded 500 acres in the southern portion of Drayton Harbor. Neptune Aquafarms grew shellfish for commercial markets on 400 acres in the 1970s and 1980s until their assets were purchased by the Drayton Harbor Oyster Company in 1992 (Menzies, 1999). Commercial shellfish harvest by Drayton Harbor Oyster Company continued until 1997 after their shellfish growing area was downgraded. In past years, Semiahmoo Spit and the west side of Drayton harbor has produced 10-20% of the Lummi Nation shellfish harvest (Cochrane, 1999). Recreational harvest of shellfish has been popular at public and private beaches. Recreational harvest includes hard-shell clams, butter clams, and Dungeness crab.

Drayton Harbor watershed provides groundwater for the city of Blaine's public drinking water supply, small community water supplies, and individual wells. The City of Blaine also provides Birch Bay its drinking water supply.

Drayton Harbor watershed provides habitat for a variety of marine and freshwater fishes. Drayton Harbor and its tributaries, including ditches, support migration, rearing, and spawning of anadramous salmonids. Drayton Harbor watershed also supports spawning and rearing of native resident salmonids. The predominant species are coho and chum salmon, steelhead, and cutthroat trout. Chinook salmon also utilize the Drayton Harbor

watershed (Peterson, 1995). The native spring chinook is listed as threatened under the federal Endangered Species Act. Forage fish (e.g. Pacific herring, sand lance, and surf smelt provide an important food source for salmonids and many marine birds and mammals in Drayton Harbor. The intertidal shoreline of Drayton Harbor and subtidal areas support extensive eelgrass beds that are sensitive spawning habitat for forage fish. Out migrating juvenile salmon and Dungeness crab also utilize these nearshore areas (PSCRBT, 1991). While California Creek is important from the fisheries standpoint, production is limited by stream channelization and ditching (Peterson, 1995).

Drayton Harbor is a popular destination for contact recreation, sport fishing, boating, and shellfish harvest. The Resort Semiahmoo and housing development is a destination location on Semiahmoo Spit offering proximity to a county park, beaches, recreational shellfish beds, and a 300 slip marina for pleasure craft. The Port of Bellingham operates a 681slip marina for commercial and pleasure craft at the northeastern side of the mouth of Drayton Harbor.

Birch Bay

Birch Bay is a significant recreational shellfish growing area. The Birch Bay State Park beach has one of the highest producing clam harvests in the state with littleneck, manila, and butter clams. The first record of clam harvest goes back to 1896 when the Old Settler's picnic and clambake began. Historically, horse clams and butter clams were harvested recreationally throughout the Birch Bay shoreline. Since 1980, little neck, manila and small butter clams have been predominantly harvested (Larson, 2006). There is record of commercial harvest in Birch Bay in 1939, however the extent and type of clams harvested is unknown. The DOH 1998 Annual Inventory shows both commercial and recreational classifications in Birch Bay (DOH, 1998). Dungeness crabs are also harvested in Birch Bay (Larson, 2006).

The Birch Bay watershed has extensive wetlands and critical aquifer recharge areas. The watershed provides habitat for a variety of marine and freshwater fishes. Eelgrass beds dominate shoreline vegetation and support spawning of Pacific herring, surf smelt, and Pacific sandlance. Marine mammals such as harbor seals, Orca whales, and porpoises utilize the sheltered waters of Birch Bay, (Whatcom County, 1987). The Terrell Creek estuary and smaller pocket estuaries provide habitat for juvenile salmonids including chinook salmon. Coho and chum salmon populations that historically used Terrell Creek for spawning and rearing have declined (Whatcom County, 2006). Terrell Creek also supports bull trout, sea-run and resident cutthroat trout, and winter steelhead populations Lake Terrell and Terrell Creek support bald eagle breeding and migratory waterfowl. Lake Terrell hosts one of few breeding sites for the Western Washington common loon. Due to a barrier at the outlet to Terrell Creek, the lake is not used by salmonids but is stocked with rainbow and cutthroat trout. Largemouth bass, yellow perch, and bullhead catfish provide additional recreational fisheries and Lake Terrell is

also a popular duck and game bird hunting area. The Lake Terrell Wildlife area is managed by the Washington Department of Fish and Wildlife. Birch Bay State Park provides camping fishing, beach activities, clamming and an interpretive trail (Whatcom County, 2006).

The Birch Bay coast is identified as a "critical faunal area" for a number of migratory bird species including northern bald eagles, black brandts, red throated loons, western grebes, black bellied plovers and others (Whatcom County, 1987). There is a great blue heron rookery near Birch Bay State Park.

Chuckanut Bay

In the past there has been recreational shellfish harvest area along the northwest side of Chuckanut Bay. There are reports of past commercial shellfish harvest (Whatcom County, 2006). Mud flats in Chuckanut Bay support many species of clams including native littlenecks, manila, butter, horse, and cockles (DOH 1994). Currently, shellfish harvest is closed based upon water quality and sewage disposal conditions in the area.

Chuckanut Bay is a Pacific sand lance and herring spawning area with patches of eelgrass. Conservation areas are mapped for bald eagle, peregrine falcon, harbor seal, and eel grass. Salt marshes occur at the mouth at of Chuckanut Creek along the estuary shoreline and riparian wetlands are found along the Chuckanut creek corridor. Coho, chum spawn in Chuckanut Creek and steelhead, cutthroat trout, and native char are presumed to use it as well (Whatcom County, 2006). The Bellingham Maritime Heritage Hatchery plants coho and chum salmon eggs in the upper reaches of Chuckanut Creek (COB, 1995). Regulated critical areas in the Chuckanut Creek and Chuckanut Bay shoreline include critical aquifer recharge area, wetlands, urban natural open space, and seismic hazard areas Whatcom County, 2006).

Potential Pollution Sources

Drayton Harbor

Pollution sources identified in the 2004 sanitary survey (Lennartson, 2004) with the potential to impact affected shellfish growing areas include:

- Agricultural discharges: deficient manure management practices on farms located in the Dakota and California Creek watersheds;
- Port of Bellingham Marina: boat wastes from commercial and recreational watercraft; also, feces from large bird populations (gulls, cormorants, pigeons, ducks, etc.) on the rip-rap breakwater and the various building roofs and docks;
- Semiahmoo Marina: boat wastes from recreational watercraft and bird populations within the marina; also, feces from concentrations of seals which haul out on the floating breakwater surrounding the marina;
- Blaine sewage collection system: cracks or breaks in pipes, manholes, or lift

stations located along Marina Drive; and, the jointed submarine force main which transports untreated sewage under the harbor mouth;
- Blaine sewage treatment plant (STP): discharges of partially treated effluent from the STP into Semiahmoo Bay;
- Seafood processors: discharge of process wastewater from these facilities into the area around sampling station 15;
- Stormwater discharges: several discharge points along the shoreline potentially transport pollution to the harbor from a variety of sources; and
- Individual on-site septic systems (OSS): failing OSS situated along the creeks and the eastern and southern shoreline of Drayton Harbor.

Birch Bay

The Shoreline Survey of Birch Bay completed by DOH in 1994 identified the following potential fecal pollutant sources:

- Stormwater and drainage ditches along the shoreline. Six pipes were identified with the potential for seasonal impacts.
- Agricultural impacts were identified in the upper reaches of Terrell Creek from livestock pasturing.
- Birch Bay Village Marina is surrounded by a "Prohibited" shellfish closure zone with the potential for boater's waste discharges.
- Wildlife (bird) feces at the Terrell Creek estuary.
- Birch Bay Water and Sewer District lift stations were identified with the potential for overflows.

The DOH recommendations included:

- Insuring use of legal sewage disposal methods at all residences by Whatcom County Health Department (WCHD).
- Administration of OSS O&M program by WCHD in areas with the potential to impact shellfish growing areas.
- Notification of any sewage lift station bypasses to Lummi and Nooksack tribes.
- Prohibition of shellfish harvest at the mouth of Terrell Creek.
- Small closure zone around stormwater outfall draining the public golf course.

With increased urban development and impervious surface short travel times for stormwater could result in contaminated runoff from sources such as pet waste.

Chuckanut Bay

In 1994 DOH closed Chuckanut Bay to recreational shellfish harvest based upon recommendations from a shoreline survey due to water quality and sewage disposal conditions (DOH, 1994a). The DOH shoreline survey identified the following potential

fecal pollutant sources:

- Individual on-site septic systems (OSS); failing septic systems and grey water discharges.

- Stormwater and drainage ditch run-off year round with a high seasonal water table.
- Agricultural impacts were identified in the upper Chuckanut Creek basin from small hobby farms.

The DOH shoreline survey recommendations included:

- Correction of failing OSS and grey water discharges.
- Insure all residences are equipped with sewage disposal systems complying with code.
- Additional fecal coliform sampling in Chuckanut Bay including sampling for paralytic shellfish poisoning.
- Detailed OSS review of systems in the area.
- Closure of the recreational shellfish harvesting area.

In 1997, Whatcom County Health Department conducted an OSS sewage disposal survey at Chuckanut Bay Village. The area is served by OSS systems many of which are older systems installed prior to county sewage control regulations in unsuitable soils or in the flood plain (Whatcom County, 1997). Thirteen or 28% of the 46 OSS systems identified during the 1997 survey were found to be failing at the time of the survey. This is a higher than the average statewide failure rate of 22 %. Chuckanut Bay may be vulnerable to non-point sources of pollution such as fecal coliforms from septic systems, nutrient, pesticide, and herbicide runoff from lawns, and minor spills of hydrocarbons and other toxics from households. Two hazardous materials sites have been identified near the Chuckanut bay shoreline associated with properties having underground storage tanks. The Ecology (2004) 303(d) list designates Chuckanut Creek for water quality violations as impaired for dissolved oxygen and fecal coliform and as an area of concern for temperature and pH (Whatcom County, 2006).

Existing Water Quality Monitoring Data

Drayton Harbor

Several agencies conduct regular water quality monitoring in the Drayton Harbor watershed including the DOH, the Port, and the Northwest Indian College (NWIC). The DOH has been the primary source of fecal coliform data for shellfish growing areas in Drayton Harbor. The DOH has monitored shellfish growing operations in Drayton Harbor since 1952 for the purpose of classifying shellfish beds for commercial harvest. Currently, the DOH samples Drayton Harbor six times each year as part of their

systematic random sampling (SRS) program. These data were supplemented by bi-monthly sample collection by the PSRF in 2004/2005. Since June 2004, PSRF has conducted wet weather marine sampling to provide additional data for use in supporting an increase in the rainfall threshold that triggers growing area closure under the DOH conditional classification. Current DOH classification is shown in Appendix A. Of 12 sampling stations, five meet the NSSP standards for harvest under low rainfall conditions but not under high rainfall conditions (4 of these stations are classified for conditional harvest), 3 stations do not meet standards under either rainfall condition, and 3 stations meet standards under both conditions (DOH, 2006).

The Port of Bellingham has conducted marine sampling since 1997 in Blaine Harbor, Semiahmoo Bay and near the mouth of Drayton Harbor in part to satisfy requirements of their moorage expansion in 2000. In general, water quality in Blaine Harbor exceeds Washington State marine fecal coliform bacteria water quality standards and DOH shellfish growing area criteria.

The NWIC collects water quality data for freshwater tributaries to Drayton Harbor including 3 stations along the mainstem of California Creek and 3 stations along the mainstem of Dakota Creek that have been sampled since 1999. In 2001 the Drayton Harbor Community Shoreline Project sampled freshwater tributaries to Drayton Harbor and in 2002-2003 additional seasonal tributaries were sampled as part of the Non-Point Pollution Solutions educational program. During the spring/summer of 2004 and 2005, the Nooksack tribe sampled nearshore sites on the north side of Semiahmoo Spit in Semiahmoo Bay. A sampling project collecting fecal coliform bacteria loading data for tributaries of California Creek is currently underway.

Past studies have documented violations of fecal coliform water quality criteria in freshwater tributaries and nearshore marine waters in Drayton Harbor (Cook, 1987; Dickes, 1992; Saban and Matthews, 1992; Cykler, *et al.*, 1995; Vasey Engineering, 1995 and Matthews *et al.*, 1997, PSRF 2002). In 2003 a watershed analysis of California and Dakota Creek sub-basins included sampling at the sub-basin level for dissolved oxygen, nitrates, and conductivity on two occasions (Stanley et al., 2004). The study conducted by Cykler, Haggerty and Matthews in 1995 sampled at 26 tributaries that drain directly into Drayton Harbor during summer.

Birch Bay

In contrast to Drayton Harbor relatively little water quality data have been collected in the Birch Bay watershed. The DOH has been the primary source of fecal coliform data for shellfish growing areas in Birch Bay. The DOH has monitored shellfish growing operations in Birch Bay since the mid 1990s for the purpose of classifying shellfish beds for commercial and recreational harvest. Currently, the DOH samples 10 stations in Birch Bay six times each year as part of their systematic random sampling (SRS) program.

The Nooksack Salmon Enhancement Association (NSEA) sampled Terrell Creek for salinity, conductivity, dissolved oxygen, and temperature from the lake outlet to the mouth at Birch Bay from 2003 to 2006 and fecal coliform bacteria were sampled in 2004 and 2005, (NSEA, 2005). The Birch Bay Storm Water and Shellfish Task Force, in conjunction with NSEA, sampled freshwater inputs to Birch Bay during 2004 and 2005 on five occasions (NSEA, 2005).

Chuckanut Bay

The City of Bellingham has sampled a site at the mouth of Chuckanut Creek since 1990 (COB 2005). The Class A water quality standard for fecal coliform bacteria has been exceeded every year since 2001. The geometric mean for 12 sampling events in 2005 was 98 FC/100mL with 25% of the counts greater than 200 FC/100 mL.. Chuckanut Creek maintained dissolved oxygen levels at or above the Class A standard and met the Class AA standard for temperature. Turbidity levels generally remained at background levels (COB, 2005). Samples collected by Whatcom County Health Department at 2 sites in the lower reach of Chuckanut Creek on 3 occasions during spring 1996 showed FC levels greater than or equal to 400 FC/100 mL in 42% of the samples (Whatcom County Health, 1997)
The Ecology (2004) 303(d) list designates the lower reach of Chuckanut Creek as impaired (Category 5) for fecal coliform and dissolved oxygen and as an area of concern (Category 2) for temperature and pH (Arthur, 2006).

Sampling Objectives

Project objectives include:

- Involvement of volunteers in the collection of water quality data to assist in community outreach efforts emphasizing the need for clean marine waters for safe shellfish harvesting and future clam enhancement projects.
- Collection of fecal coliform bacteria data and loading estimates at priority freshwater inputs around the west shore of Drayton Harbor and at Chuckanut Bay in order to augment data collected by other programs.
- Collection of baseline fecal coliform bacteria data and loading estimates for freshwater inputs to Birch Bay.

Justification for Sampling

Water quality degradation has been a concern for shellfish growing areas in both Birch Bay and Drayton Harbor. Birch Bay has been and is one of the largest and most

productive clamming areas in the state of Washington. Drayton Harbor/Semiahmoo Spit has also historically provided tribal and recreational shellfish harvesting opportunities, as well as commercial harvest. In April 2003, Birch Bay was listed as a "Threatened" shellfish growing area due to degrading water quality. Birch Bay remained on the threatened list as of April 2005. Portions of Drayton Harbor have recently been upgraded to "Conditional Approval", while other portions remain "Prohibited" for shellfish harvesting. Drayton Harbor is scheduled for a TMDL by Ecology. In 1994 DOH closed Chuckanut Bay to recreational shellfish harvest based upon water quality and sewage disposal conditions in the area. (Whatcom County Health Department, 1997). Involving volunteers in the collection of water quality data will assist in community outreach efforts that will emphasize the need for clean marine waters for safe shellfish harvesting and future clam enhancement projects. Data collected by volunteers will augment information collected by other organizations. At Drayton Harbor this program will provide data for comparison with data collected in 1995 and at Birch Bay it will provide needed baseline data collection.

Project Organization and Responsibility

Project Manager:	Betsy Peabody – Puget Sound Restoration Fund, Bainbridge Island, Washington, (206) 780-6947
Preparation of QAPP:	Julie Hirsch - Hirsch Consulting Services, Lummi Island Washington, (360)758-4046.
Training Personnel:	Julie Hirsch - Hirsch Consulting Services, Lummi Island Washington, (360)758-4046.
Analytical Services:	Edge Analytical – Burlington, Washington (800) 755-9295.
Reporting:	Julie Hirsch - Hirsch Consulting Services, Lummi Island Washington, (360-758-4046).
Quality Assurance:	Julie Hirsch - Hirsch Consulting Services, Lummi Island Washington, (360-758-4046).
County Project Lead:	Erika Stroebel and Atina Casas – Whatcom County Public Works Stormwater Division, Bellingham Washington, (360-715-7450).
Volunteer Coordination:	Erika Stroebel and Stephanie Williams – Whatcom County Public Works Stormwater Division, Bellingham Washington, (360-715-7450).

Sampling Design and Locations

This project is designed to provide community outreach and to train a core group of volunteers in techniques for collection of fecal coliform bacteria samples and flow data for loading estimation. Sampling will be conducted at freshwater inputs to Drayton Harbor and Birch Bay. A training session will include a classroom/workshop format followed by a creek/shoreline walk at Birch Bay on the same day in May 2006. The beach walk will entail collection of up to 25 fecal coliform samples with flow estimates along the Birch Bay shoreline. A second session to train additional volunteers is scheduled for November 2006. Volunteer samplers will then collect samples monthly at assigned locations for nine months from June 2006 through March 2007. Sampling dates synchronized with low tides (2.00 ft. or less) will be selected by the project coordinator prior to the beginning of the sampling program. Samples will be collected monthly at 5 sites around the Drayton Harbor shoreline 10 sites at Birch Bay, and 4 sites at Chuckanut Bay. There may be additional sampling dates added during rainfall events to ensure that critical conditions are represented in the data set. At Drayton Harbor, shellfish harvest is conditioned upon rainfall and at Birch Bay many of the outfalls drain stormwater. At Chuckanut Bay there are OSS systems in the floodplain that can be prone to failure during saturated soil conditions. Sample sites have been selected from a list of priority sites provided by Whatcom County and field verification representing,

- priority freshwater inputs around the west shore of Drayton Harbor in order to augment data collected by other programs.
- baseline sites for freshwater inputs to Birch Bay.
- sub-basins and reaches of Chuckanut Creek and potential problem areas for input to Chuckanut Bay

Site access and volunteer's safety were considered in the selection of each site. Sample sites are described in Tables 1 through 3 and shown in Figures 3 through 5. Final sample site selection will take into consideration ease of access and safety based upon the ability of volunteers. Many of the freshwater inputs to Birch Bay are small seasonal streams or stormwater conveyances that may not be flowing during the dry season. Site selection for the ambient portion of the Birch Bay volunteer program will be finalized based upon observed flows during the shoreline walk (in May). Whatcom County staff is working with Birch Bay Village to gain access for volunteer sampling. In the event that access is not possible, alternate sites will be selected. Due to tidal influence at many sites in both study areas it will be necessary to sample during low tidal conditions. Because sampling at some sites will not be possible until the program is underway it may be desirable to extend the sampling period in order to collect adequate data.

Data will be collected for fecal coliform bacteria analysis. Flow estimates will be made when possible at each site to provide fecal coliform bacteria loading.

Two tiered thresholds will be used in reporting to indicate a threat to water quality at shellfish growing areas in Drayton Harbor and Birch Bay. The first and lesser tier is 43 FC/100mL, the Washington State marine water quality standard for fecal coliform bacteria. While this threshold does not account for bacterial die-off, dilution, or salinity it will serve as a conservative alert mechanism for managers. The second threshold will be invoked when more than 10% of samples at a station exceed 100 FC/100 mL and fail the 2nd part of the state freshwater quality standard. It is assumed that violation of this standard will negatively impact Drayton Harbor and Birch Bay. These thresholds were selected because they are accepted regulatory standards.

Safety and Health

The health and safety of sampling personnel is the foremost consideration during sampling operations. Measures must be taken to protect personnel from the physical hazards of field sampling and from exposure to potentially hazardous materials. A safety checklist is provided in Appendix B that addresses chemical hazards in addition to physical hazards. Because this program will not be sampling hazardous chemicals or chemically contaminated sites, hazards will be primarily physical. Some sampling sites (especially along the west shore of Drayton Harbor) are located on steep banks. Each volunteer should visit their assigned sampling site(s) prior to sampling to determine whether he or she is comfortable with the physical demands of the site. If the volunteer is not comfortable with the site, the project coordinator should be contacted for an alternate site assignment. It is recommended that each volunteer be assigned a sampling partner for field work. Each volunteer may be asked to sign a waiver. Below is a list of precautions that should be observed for this project:

- Sample with a partner.
- Appropriate clothing should be worn in the field including boots and raingear (when needed).
- Ensure sufficient supplies e.g. food, water, clothes, fuel, flashlight/batteries, cellular phone) to sustain you and other team members in the event of an emergency.
- Keep all equipment and chemicals out of the reach of young children.
- No eating, drinking or use of tobacco products should be allowed during sampling operations.
- Because the water being sampled is potentially contaminated with fecal coliform bacteria, it is recommended that volunteers clean their hands between sampling sites with a waterless antibacterial cleaner. This measure will also prevent cross contamination between samples.
- Read all instructions to re-familiarize yourself with the test procedures before you begin, and note all precautions.
- Plan for incoming tides at marine or estuarine sampling stations.
- Make sure that someone knows when and where you are sampling and when you expect to return.

Access

It is important that samplers assure reasonable and legal access to sampling stations. It may be necessary to access sampling stations through private property. Many states retain ownership of marine tidelands and beaches. This is not always the case in Washington. While access to government land (e.g. state, federal, borough, city) typically is presumed, monitors must obtain express authorization from private property owners if the monitor enters or crosses the property owner's land at any point during sampling activities. Each volunteer should make a preliminary visit to each site to assess potential access issues. This can be accomplished along with the safety assessment discussed above. Because ownership of tidelands is not always apparent, the project coordinator will be available to assist in assessment of property ownership.

The following procedures should be followed when sampling in respect of property owners and the environment.

- Determine whether you will need to access private property during project planning and prior to sampling.
- Contact private property owners for written permission when you need to access sampling stations through their property.
- Avoid stream bank trampling when accessing a sampling site.
- Be careful not to litter.
- Carry a letter explaining the purpose of the sampling program including contact information for the project coordinator that can be shown to property owners encountered during sampling.

Sampling Methods

Water samples will be collected by hand dipping in midstream. All sample containers will be pre-cleaned and provided by the selected analytical laboratory. Fecal coliform bacteria sampling will be conducted in accordance with the water sampling protocol detailed in Standard methods 9060A and 9060B (APHA, 1992). Samples will be collected in 100ml sterile plastic bottles, which will immediately be placed on ice in a cooler. Samples will be delivered to the laboratory within 8 hours of sampling.

Stream flows will be measured using the time of travel method from the EPA volunteer manual in the case of open channels (EPA, 1997). Piped flow measurements will be estimated using catchment, timed flow volume using a bucket and stopwatch. A list of materials needed for sampling is included as Appendix C. Standard operating procedures for fecal coliform bacteria sampling, and flow estimation methods are provided in Appendix D.

Sample Custody and Documentation

Samples will be placed into ice chests upon collection. Samples will be hand delivered to

a laboratory to be selected by Whatcom County. A chain-of-custody (COC) form provided by the laboratory will accompany all samples to the laboratory. Copies of results and chain of custody sheets will be sent to both Whatcom County Public Works Stormwater Division for their files and to Hirsch Consulting Services for entry into a database and for data analysis.

Analytical Methods

Fecal coliform bacteria samples will be analyzed by a laboratory accredited by Ecology and to be selected by Whatcom County. Fecal coliform bacteria will be enumerated using the membrane filtration method, Standard Methods 9222 (APHA, 1992). The selected laboratory will be accredited for fecal coliform bacteria analysis by the above method. Fecal coliform bacteria samples will be delivered to the laboratory and analyzed the same day as sampling. Analytical methods are summarized in Table 3.

Quality Control Requirements

Quality assurance/ quality control (QA/QC) refers to a broad plan for maintaining quality in all aspects of a program such as this quality assurance project plan (QAPP). This plan describes how the monitoring will be undertaken: proper documentation of procedures, training of volunteers, study design, data management and analysis, and specific quality control measures. The primary measures of data quality are accuracy and precision or reproducibility. Data quality objectives are standards that data must meet to be accepted. Quality control procedures are measures taken to ensure and demonstrate the accuracy and precision of data collected. Quality assessment is the assessment of the overall precision and accuracy of data, after analysis (EPA, 1997).

The quality of data necessary to serve this project's objectives is a comparable level of data quality to allow comparison with past, present and future data sets. The water quality parameter of interest in this project is fecal coliform bacteria. The microbial analysis method employed is Standard Methods 9222, membrane filtration. The surface water sampling protocols are from Standard methods 9060A and 9060B 9APHA, 1992). These methods are established regulatory and programmatic elements approved by Ecology and used in Total Maximum Daily Load analysis. The analytical precision and bias achievable by the routine application of these methods constitutes an acceptable level of data quality. Laboratories employed by this project are certified for applicable analyses and will follow required quality control procedures. The analytical laboratory will follow their quality assurance/quality control (QAQC) plan that will include analysis of blanks with each sample batch. Fecal coliform results are flagged when the number of colonies grown on a plate falls outside limits for the method.

A field replicate will be collected with each fecal coliform sample set submitted for laboratory analysis, (10% replication). Data will be qualified as estimates when the replicate falls outside of the 95% confidence interval for the analytical method. A

temperature control sample will be submitted to the laboratory with each cooler of samples. Samples will be accepted for analysis only if the temperature control is measured below 10°C at the time of sample submittal. Ten percent of samples collected for flow will be replicated in the field (field replicates. If the results for any analyses are beyond limits of acceptability, corrective action will be taken and documented.

All flow estimates will be duplicated in the field. Field replicates for flow will entail collection of 2 sets of flow data at ten percent of the sites. The average of the 2 measurements will be utilized to estimate fecal coliform loading. Vessels used for manual flow estimation will be graduated to at least 500 mL or quart increments.

Prior to sampling, all volunteers will receive classroom and field training in sample collection/storage techniques, flow estimation methods, quality assurance/quality control procedures, safety precautions, and access procedures. All volunteers will use field data sheets provided by the project coordinator that will include a QC checklist (Appendix E). After each sampling event volunteers will submit field data sheets to the project coordinator before the end of each month. The project coordinator will collect field data sheets and send a packet to H.C.S. monthly. Field data, COC forms, and laboratory data will be reviewed monthly and any needed corrective actions will be communicated to the project coordinator and to volunteer monitors in a timely manner.

Representativeness, Completeness and Comparability

This project plan has been developed to provide representative, complete, and comparable data. The sampling methods and the equipment used to collect samples, as outlined, will ensure that samples will be representative.

Sample bottles will be packed tightly with ice in the cooler immediately upon collection and hand delivered to the laboratory. All sample containers will be labeled with a self-adhesive label including sample identifiers. Monthly review of volunteer data sheets and laboratory data will identify any problems with missing data as they arise. These sample handling techniques, should result in near 100% completeness.

Sample collection, processing, and analysis techniques are standard and widely accepted. Using these standard methods will result in data that is comparable to most other surface water monitoring studies.

Data Assessment Handling and Reporting

Volunteer field data, COC forms, and laboratory data will be reviewed monthly and any needed corrective actions will be communicated to the project coordinator and to volunteer monitors in a timely manner. Analytical data received from the laboratory will be transcribed into an Excel computer database. Each data point will be checked to insure accuracy in data entry and incorrect entries will be corrected when found. Flow data will be transcribed from field data sheets into the computer database and each entry will be checked for accuracy and incorrect entries will be corrected when found.

A report will be prepared to summarize the results for all sampling events. Fecal coliform bacteria concentrations will be compared with Washington State Surface Water Quality Standards and fecal coliform bacteria loads will be calculated.

Two tiered thresholds will be used in reporting to indicate a threat to water quality at shellfish growing areas in Drayton Harbor and Birch Bay. The first and lesser tier is 43 FC/100mL, the Washington State marine water quality standard for fecal coliform bacteria. While this threshold does not account for bacterial die-off, dilution, or salinity it will serve as a conservative alert mechanism for managers. The second threshold will be invoked when more than 10% of samples at a station exceed 100 FC/100 mL and fail the 2nd part of the state freshwater quality standard. It is assumed that violation of this standard will negatively impact Drayton Harbor and Birch Bay water quality. These thresholds were selected because they are accepted regulatory standards.

Data reporting will be in the form of tables, graphs, maps and discussion in a final report. Reporting will include field data sheets, chain of custody documentation, laboratory analytical reports and a hard copy of the computer database. All QA/QC data and data qualifiers will be reported. Any deviations from methods or procedures stated in the QAPP will be reported.

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Tables

Table 1. Drayton Harbor Volunteer Monitoring Program Site Locations.

Sample Site #	1995 *	2002 *	2004 *	Lat (48.)/long(122.)		Location and Description	Land Use	Flow method	Comments
DH1	14			95971	74187	18" Cement outfall 35 m SW of 4789 DH Rd.	Wetland, forested	Time of travel	Reference site, relatively little development, shoreline outfall, lowbank, tidal influence
DH2	16a			95688	74801	Ditch on E.Side of Harborview @Harborview & DH Rd. above 24"cement outfall on shoreline	Residential w/OSS, wetland, Harborview Rd	Time of travel	
DH2 outfall	16a			95732	74818	outfall location (about 10 ft. E. of DH3 or to the right of DH3 when facing the water)			
DH3	16b			95728	74834	24"cement pipe 10 m W. of 16a	Residential w/OSS, undeveloped field,forested Harborview Rd	Catchment	
DH11	19a			96180	76256	ditch across street from outfall @DH 11	Residential w/OSS	Time of travel	Easy access to ditch
DH11outfall	19			96159	76244	6# green plastic just W of 5157 DH Rd.		Catchment	High bank
DH5				97007	78321	Semiahmoo Harbor Hillside Phase 1, 8" PVC pipe via public trail @ main entrance, small trail below bioswale	Residential,forested hillside, biofiltration swale	Time of travel, channel on shoreline	
DH14				96162	76233	1565 DH Rd., ditch @ property corner between driveway and DH Rd.	Residential w/OSS	TT	Landowners have been notified
Alternate sites									
DH7	10*	9	9*	96857	73200	"Noname Creek"Hall & Dearborn, 20 m S. small stm	Residential, w/septic systems	Time of travel	Tidal influence, sampled in 2 previous sampling programs
DH8	15*			95814	74647	18" Cement pipe 75m SW of 4789 DH Rd.		Time of travel	
DH9	18a			96232	76405	18" metal pipe @ DH & Schintaffer Rd.(2m below Rd surface	Residential w/OSS	Catchment	High bank, drip flow on 3/13/06 and difficults access
DH10	18b			96237	76405	16" metal pipe 10m SE of DH Rd. & Schintaffer	Residential w/OSS	Catchment	High bank, blackberries need to be cleared for access to pipe
DH4	16c*			95791	74950	24"cement pipe 20 m W. of 16b near 4985 DH Rd.	Residential w/OSS	Catchment	High priority site for Cycler & Haggerty, but low loading when compared to other high priority sites.
DH12	20*			96144	76158	18"metal pipe 10 m SE of 5157 DH Rd.5m below Rd	Residential w/OSS	Catchment	High bank, difficult sampling
DH13	21*			96107	75991	24" by 30" pipe in dip W. of 5097 DH. Rd.	Residential w/OSS	Catchment	

*Designated priority site by authors of previous studies, Cykler, Haggerty and Matthews (1995),Menzies(2002),and H.C.S.,2004

Table 2. Birch Bay volunteer monitoring site locations (S to N).

Sample Site Number*	Lat (48.)	long(122.)	Location and Description	Land Use	Comments
BB1	91462	74577	Barnes Crk @ Woolrich & Morrison, tributary to Terrel Crk	Residential	
BB2	92125	74359	Leisure Pk. @ mouth of Terrel Ck., sample upstream channel across street ahead of 48"? Concrete culvert. Major outfall	shoreline residential and peat bog wetland, undeveloped	Tidal influence, closure zone suggested in 1994 DOH sanitary survey @ mouth of Terrell Crk.
BB3	92882	74460	Birch Bay Golf Club, 7900 BB. Dr. sample upstream channel across street ahead of 48"? Concrete culvert. Major outfall	golf course, urban residential, County Equestrian Center in upper drainage	DOH harvest closure zone around outfall
BB4	93234	74753	8036 BB Dr., Mariners Cove 24" concrete pipe on shoreline, 1/2 submerged. Major outfall	drains stormwater detention pond from residential development (latitude 49)	
BB5	93426	74926	24"concrete pipe on shoreline across BB Dr. from Century Realty Bldg.(Triangle Bldg). Major outfall	Residential,commercial parking lot , and forested wetland	Pipe leaks does not capture flow completely
BB6	93675	75259	Ditch near Thai Steakhouse. Major outfall.	Residential,commercial, forested, future development site	
BB7	94007	75678	8178, BB Dr. & Beach Way, channel along rd @ Van's Lodge, Major outfall.	Residential, parking lot	ditch on Beach Way, private property, Bill Thompson
BB7 outfall	93913	75736	8178, BB Dr. & Beach Way, outfall for BB7		
BB8	94182	75827	Stream @ Halverson County Pk (upstream side of Cedar St.) flows to shorline outfall @ 8208 BBDr.(submerged)	County Park (forested), wetland, drains stormwater detention pond	
BB8 outfall	94029	76004	8208 BB Dr., shoreline outfall for BB7		outfall submerged

*Site #s in bold will be included in beachwalk sampling and monthly sampling, all other site #s will be included in beach walk only,

when sampling at an outfall appears impractical, an upstream site has been selected.

Table 2 (continued). Birch Bay volunteer monitoring site locations (S to N).

Sample Site Number*	Lat (48.)/long(122.)		Location and Description	Land Use	Comments
BB9	92432	74539	7808 Black Plastic pipe @ Jacobs Landing	Residential, commercial	
BB10	93716	75446	8142 BB Dr. 24" pipe	Residential	
BB11	94269	76889	Deer Trail, Birch Pt. Rd1/2 submerged 12" metal pipe	Residential	Difficult flow collection
BB12	94209	76582	5216 Birch Pt Rd & Shintaffer shoreline pipe	Residential	
BB13	94289	77031	Rogers Slough Birch Pt Rd across from Birch Pt Loop	Residential (Birch Bay Village) and slope above Birch Pt Loop, site of future Bogancamp development	Tidal influence
BB14	94317	77317	Channel along Birch Pt Loop & Birch Pt. Rd. just before it enters culvert	forested slope above Birch Pt Loop, site of future Bogancamp development	
BB15	93687	78471	BB. Village, structure draining "Big Lake" detention pond to Marina	BB Village stormwater detention pond & residential	flow measurement will be a problem, no pipe or open channel access
BB16	93572	78823	BB. Village, Unnamed Creek inlet structure to Marina	residential and golf course	tricky flow measurement

*Site #s in bold will be included in beachwalk sampling and monthly sampling, all other site #s will be included in beach walk only,

when sampling at an outfall appears impractical, an upstream site has been selected.

Table 3. Chuckanut Bay volunteer monitoring sites.

Sample Site Number*	Lat N (48.)/long W (122.)		Location and Description	Land Use	Comments
CB1	69860057	497614013	Woodstock Farm: From Chuckanut Drive take a right at the Woodstock Farm sign (turn is on a sharp corner ~1/4 mile south of intersection of Chuckanut Dr and Lake Samish Rd). Proceed passed the gate, houses and park in parking lot near old homestead.	Farm being converted to City of Bellingham Park. Livestock on-site (sheep).	Walk down driveway toward the barn and enter the latched gate (leave it as found, open or closed). Follow the footpath north along fence and take a right into the wooded area. The station is located at the dam over the outflow pipe of Woodstock Creek.
CB2	702038342	488022405	Arroyo Park: From Chuckanut Drive turn left onto Lake Samish Rd and park at the first parking area of Arroyo Park on the right. Take the trail into the park and turn right at the first fork, towards Chuckanut Drive. At the bottom of the hill take the 1st right, passed a small pond on the left. Turn left just after the pond and the station is located directly ahead at the creek.	City of Bellingham Park, wooded with walking trails.	The gravel bar can be more easily accessed via a side trail on the right. Mapped sampling location is about 150 feet SSE of the actual collection point on the creek due to GPS satellite visibility.
CB3	700727367	493703632	18th St. alley: From Chuckanut Drive take a right at Fairhaven Ave to enter into Chuckanut Bay Village. Proceed on Fairhaven Ave. turn left on 18th St, left on Rainier Ave and the next right onto the 18th St. Alley. The station is located just upstream from the bridge.	Single family residential with OSS	Park on the south side of the bridge.
CB4	699142464	496136699	Lower Chuckanut: Same directions at CB 1, continue over dam at Woodstock Creek and follow the trail down hill about 200 feet. When the trail starts to head up hill again turn left at a pile of boulders and follow the footpath to lower Chuckanut creek. The station is located at the end of the footpath, downstream from a fork in the stream.	Farm being converted to City of Bellingham Park. Livestock on-site (sheep).	

Table 4. Summary of sample handling and analytical methods[1].

Parameter	Description	Method	Sample Container	Preservation	Holding Time	Precision/ Quantitation Limits
Fecal coliform bacteria	Membrane filtration	APHA, 9222D	PE, 125 mL, sterile	4 °C, dark	24-hours	1.0 cfu/100mL

[1]APHA, 1998. Standard Methods for the Analysis of Water and Wastewater, 20th Edition.

Figures

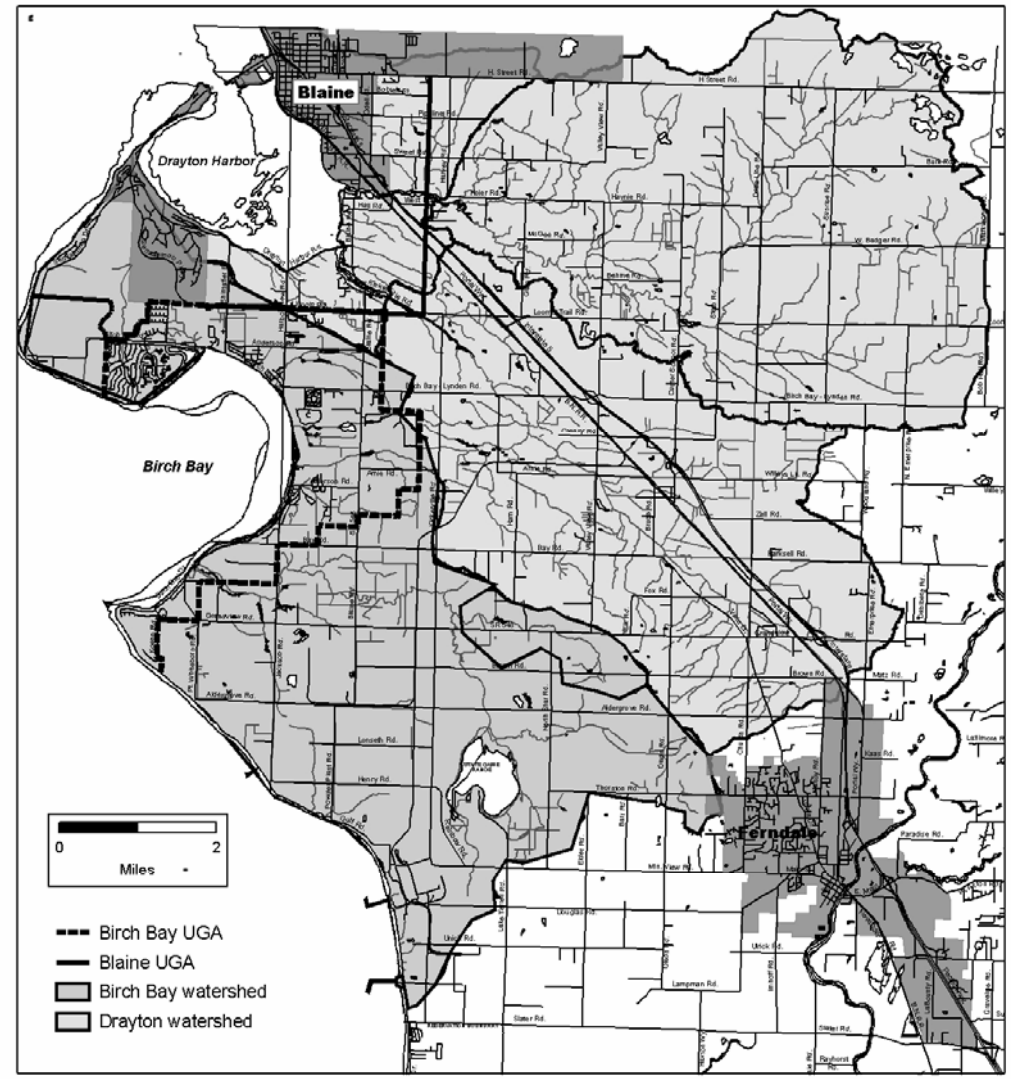


Figure1. Drayton Harbor and Birch Bay vicinity map.

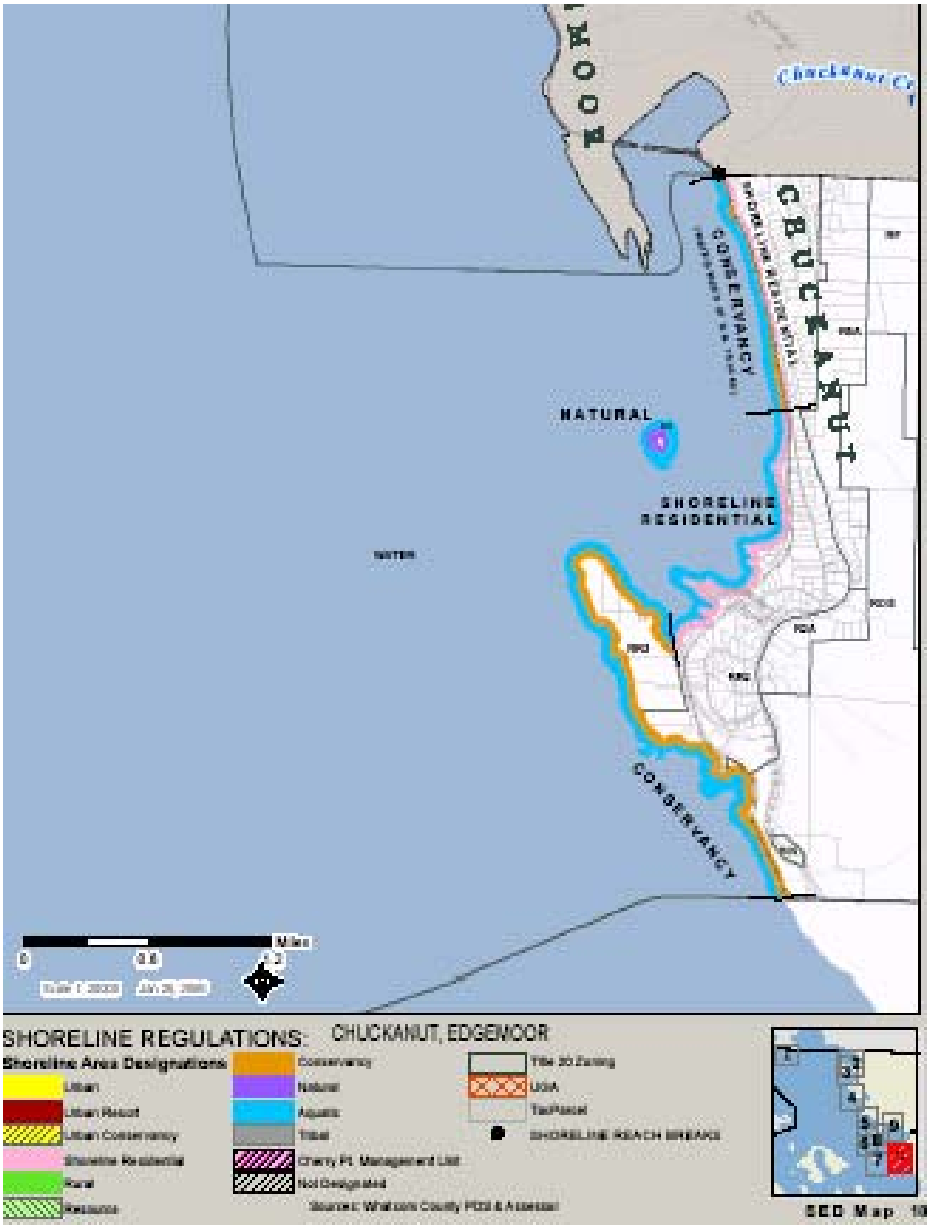


Figure 2. Chuckanut Bay vicinity map (from Whatcom County, 2006).

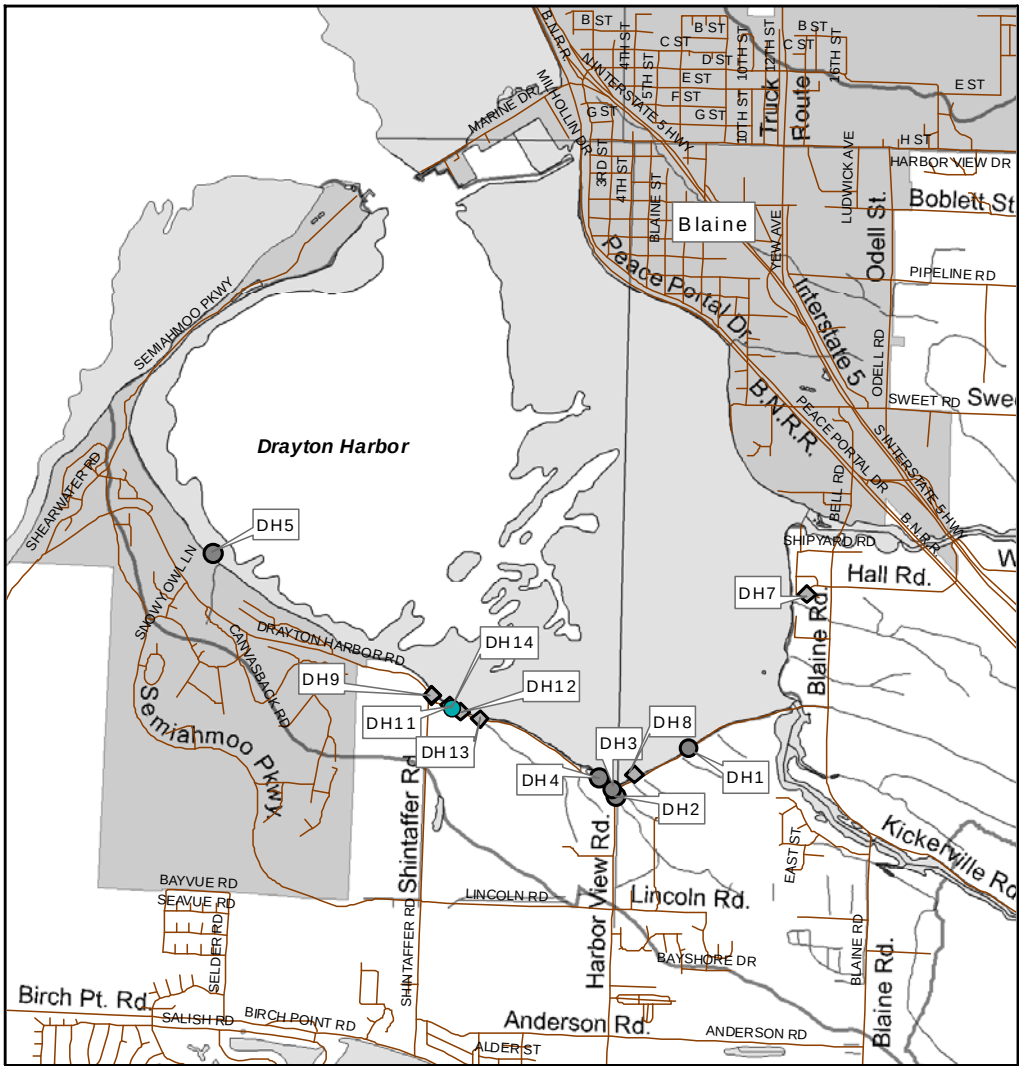


Figure 3. Drayton Harbor volunteer monitoring site locations.

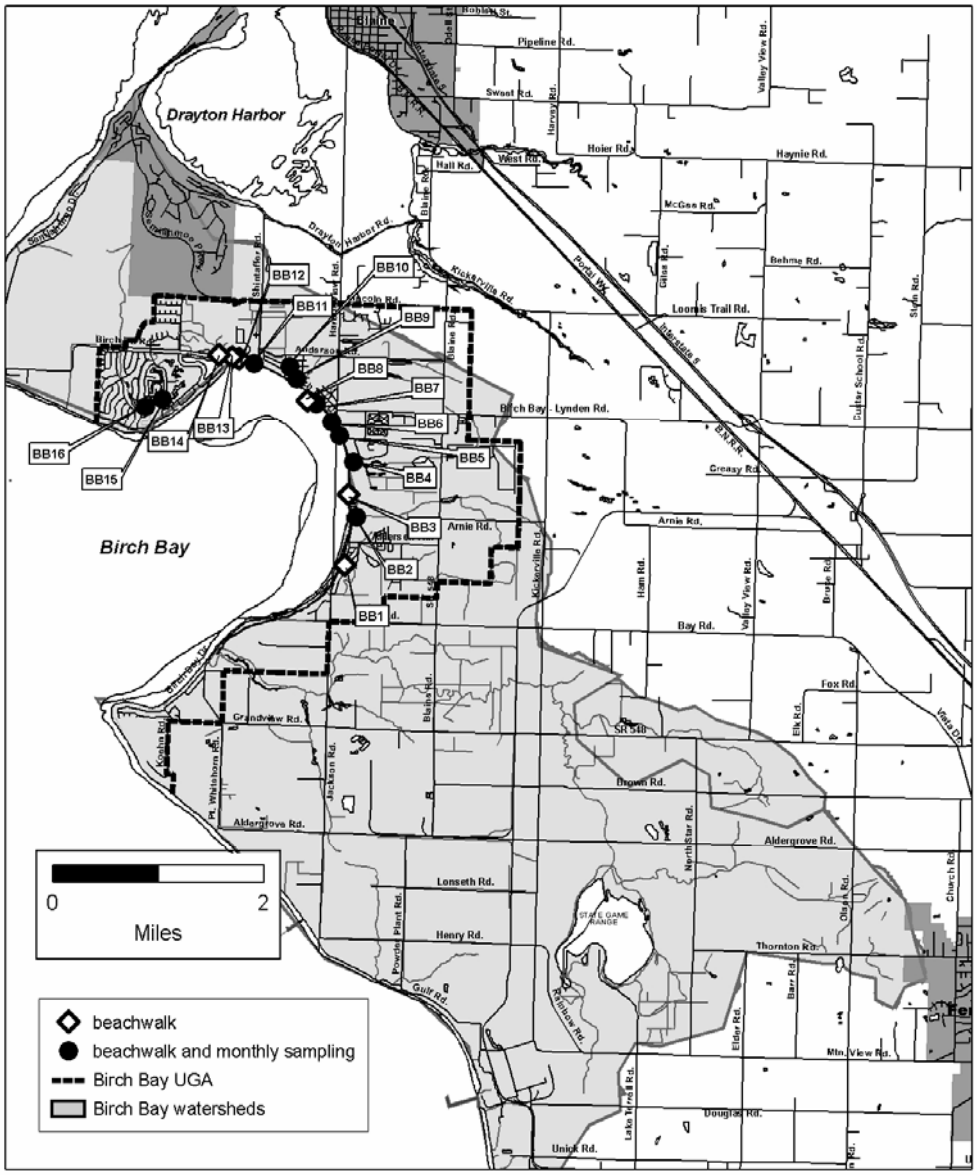


Figure 4. Birch Bay watershed volunteer monitoring site locations.

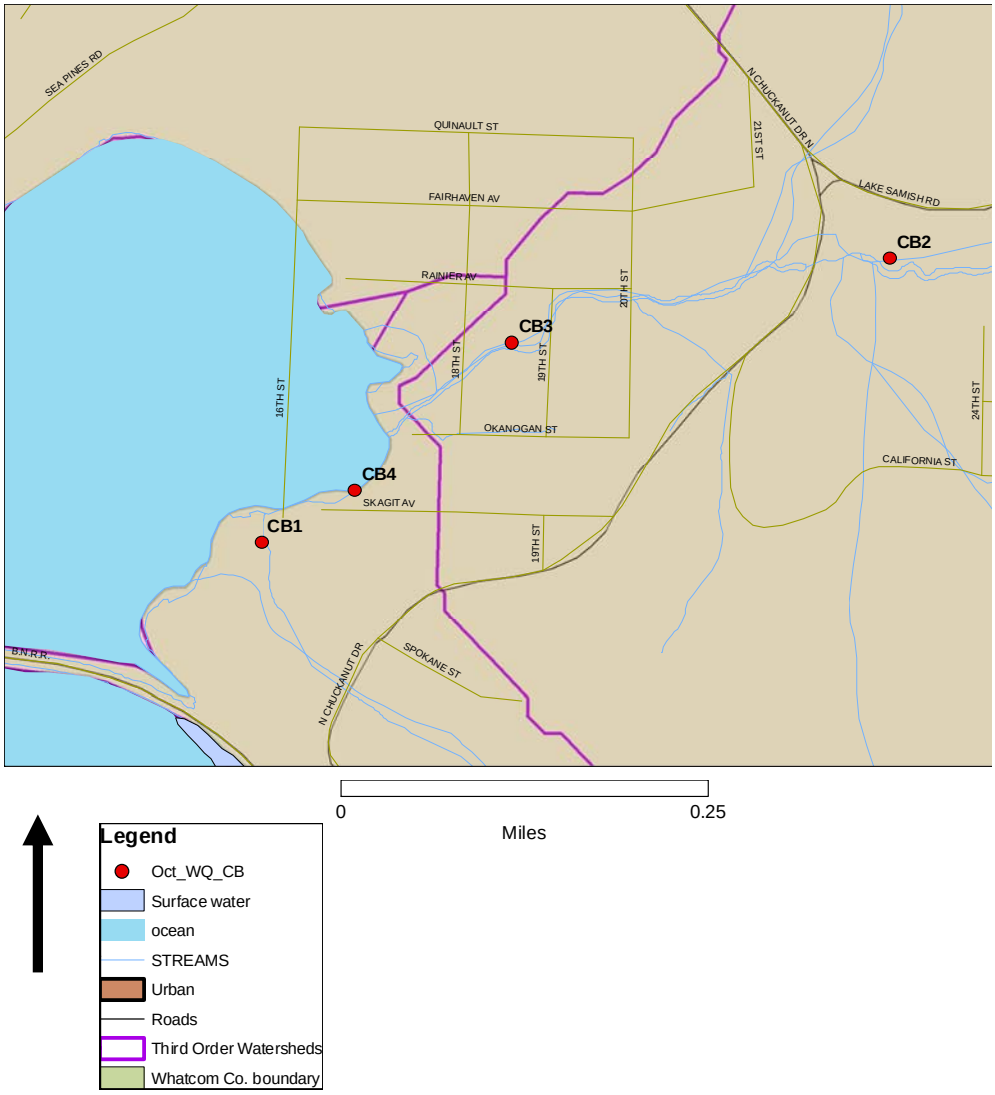
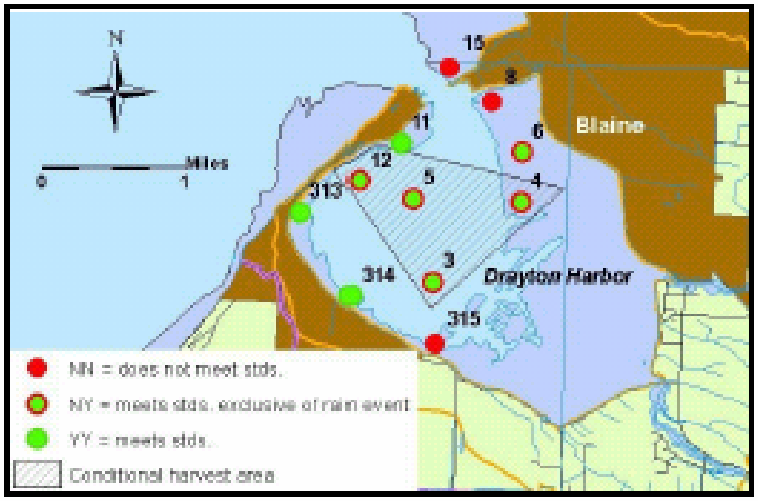


Figure 5. Chuckanut Bay sub-basin volunteer monitoring site locations.

Appendix A: DOH Shellfish Growing Area Classification for Drayton Harbor and Birch Bay

(From Whatcom County, 2005 and DOH, 2004)

Drayton Harbor Marine Stations
Water Quality Status
1/08/03-12/12/05



	All Sampling Days Included				Rain Event Samples Excluded			
Station	**90th %**	**GeoMean**	**N***	**Status**	**90th %**	**GeoMean**	**N***	**Status**
3	77.4	10.4	44	•	34.6	7.3	31	•
4	54.6	8.5	44	•	31.5	6.1	31	•
5	60.4	7.7	44	•	25.4	5.2	31	•
6	48.5	8.4	44	•	38.5	7.4	31	•
8	297.6	48.5	41	•	281.9	46.1	30	•
11	21.8	5.0	4	N/A	14.0	14.0	1	N/A
12	55.7	6.9	44	•	24.1	5.2	31	•
15	164.7	22.3	42	•	116.6	16.9	31	•
313	42.6	6.1	18	N/A	22.1	4.4	12	N/A
314	27.7	6.0	18	N/A	40.5	7.6	12	N/A
315	90.1	12.4	17	N/A	52.1	10	11	N/A

* 'N=' the number of samples. The shellfish standards require a minimum of 30 samples.
** The geometric mean and 90th percentile values in this table are approximations for illustration of water quality status at each sampling station. The Washington State Department of Health calculations provide the official values that are used for shellfish growing area classification.

National Shellfish Sanitation Standards for Marine Waters:
- Geometric mean <14 fecal coliform/100mL, and
- Estimated 90th percentile <43 fecal coliform/100mL.

Conditional Approval for Portions of Drayton Harbor:
- Shellfish Growing Areas Closed for Two Days Following Rainfall Events of 0.5" (24 hour)

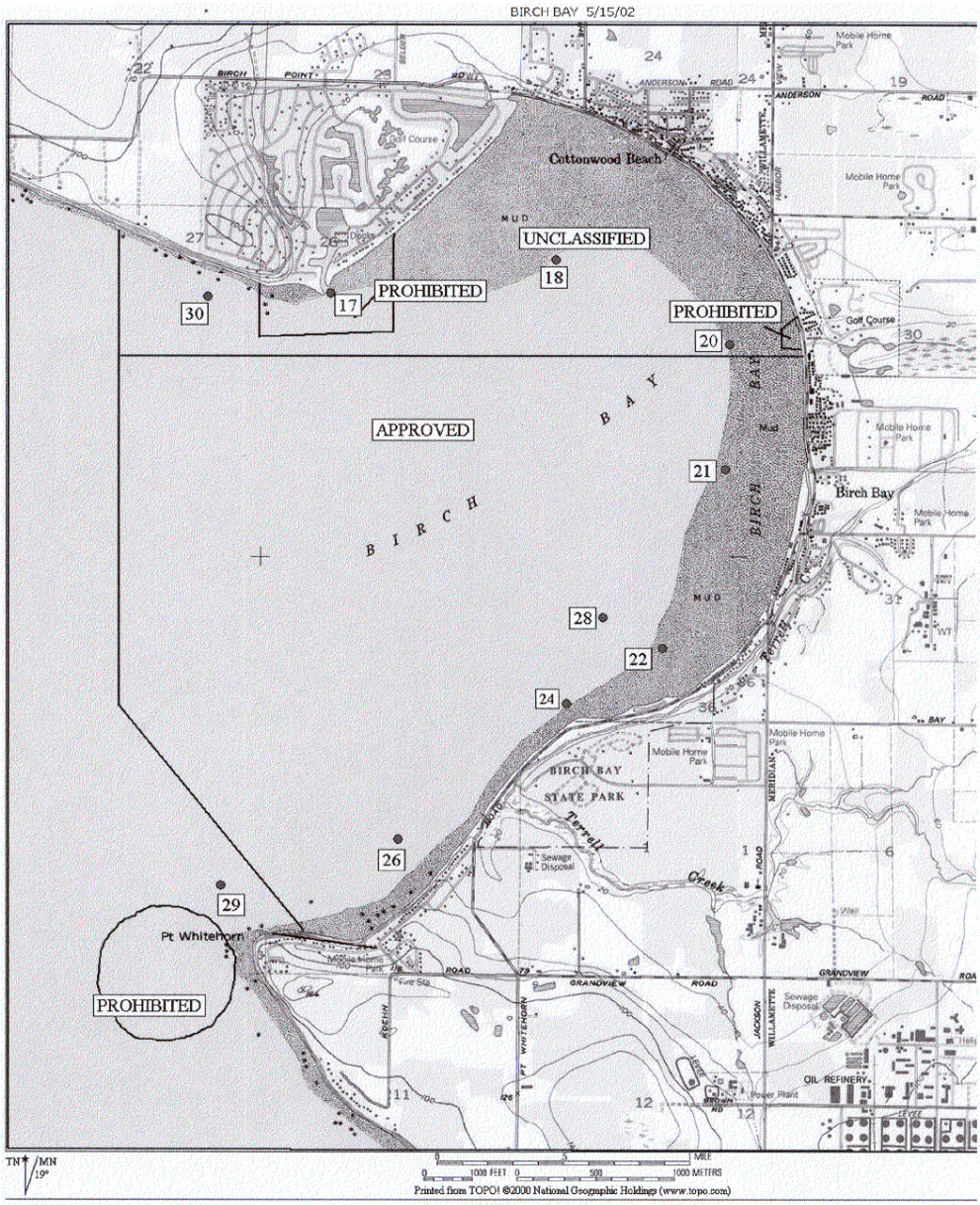


Figure 1: DOH Shellfish Classification and Sampling Stations in Birch Bay

SUMMARY OF MARNE WATER DATA (SRS)

Growing Area:

BIRCH BAY

Classification:

Approved, Prohibited,Unclassified

From **07/08/1999** To **10/14/2004**

FECAL COLIFORM ORGANISMS/100 ML

Station Number	Classification	Number of Samples	Range	Geometric Mean	Est. 90th Percentile	Meets Std.
21	Approved	31	1.7 - 49.0	4.0	15.0	Yes
22	Approved	31	1.7 - 79.0	4.9	31.0	Yes
24	Approved	31	1.7 - 79.0	3.7	17.0	Yes
26	Approved	31	1.7 - 130.0	2.7	9.0	Yes
27	Approved	16	1.7 - 11.0	1.9	3.0	*N/A
28	Approved	30	1.7 - 79.0	4.6	24.0	Yes
31	Approved	16	1.7 - 13.0	2.6	6.0	*N/A
17	Prohibited	31	1.7 - 130.0	4.9	33.0	Yes
18	Unclassified	31	1.7 - 130.0	3.6	14.0	Yes
19	Unclassified	19	1.7 - 33.0	3.0	9.0	*N/A
20	Unclassified	31	1.7 - 110.0	3.0	12.0	Yes
29	Unclassified	30	1.7 - 17.0	2.3	5.0	Yes
30	Unclassified	31	1.7 - 130.0	2.9	13.0	Yes

All tides information is presented
The standard for approved shellfish growing waters is fecal coliform geometric mean not greater than 14 organisms/100 ml and an estimate of the 90th percentile not greater than 43 organisms/100 ml. The above table shows bacteriological results in relation to program standards.

* N/A - SRS criteria require a minimum of 30 samples from each station. *

Appendix B: Environmental Sampling Safety and Health Checklist

The health and safety of sampling personnel is the foremost consideration during sampling operations. Measures must be taken to protect personnel from the physical hazards of field sampling and from exposure to potentially hazardous materials. Site specific health and safety plans and hazardous materials training are required by WISHA/OSHA for the following projects:

- Sediment sampling at locations listed under the Model Toxics Control Act

(MTCA),
- Sediment sampling at locations listed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and
- Sediment sampling at locations listed under the Sediment Management Standards (SMS).
- Any project at a location where contamination by toxic materials is known.

Locations to be sampled should be researched to determine whether special health and safety considerations are required.

General health and safety procedures include:

- Keep all equipment and chemicals out of the reach of young children.
- No eating, drinking or use of tobacco products should be allowed during sampling operations.
- Read all instructions to re-familiarize yourself with the test procedures before you begin, and note all precautions.
- Read the label on each reagent before use. Material safety data sheets (MSDS) should be obtained from reagent manufacturers and kept on file for all chemicals. The MSDS should be read before reagent use and health precautions taken accordingly.
- Goggles and chemical resistant (nitrile) gloves should be worn when coming into contact with reagent chemicals.
- Avoid contact between chemicals and skin, eyes, nose and mouth.
- All accidents (or near-accidents), including instances of possible exposure to health-threatening elements, should be reported to the program director within 24 hours of occurrence.
- Use test tube caps or stoppers, not your fingers, when shaking or mixing reagents.
- When dispensing a chemical from a squeeze bottle, hold the bottle vertically upside-down (not at an angle) and squeeze gently.
- Rinse test tubes and other containers after use, cap all reagents tightly and wash and dry your hands after each test session.
- Wipe up any chemical spills immediately and dispose of chemical wastes in appropriate waste containers at the Keeper office.
- Sampling personnel should wear, at a minimum, chemical-resistant gloves when coming in contact with contaminated sediment.
- In the event of a chemical accident or suspected poisoning, immediately contact the **Poison Information Center (1-800-732-6985)** and be prepared to provide the name and identification number of the relevant chemical. This information is located on the reagent container.
- Appropriate clothing should be worn in the field including boots and raingear (when needed).
- Ensure sufficient supplies e.g. food, water, clothes, fuel, flashlight/batteries, cellular phone) to sustain you and other team members in the event of an emergency.
- Plan for incoming tides at marine or estuarine sampling stations.
- Sample with a partner whenever possible.

- Make sure that someone knows when and where you are sampling and when you expect to return.

References

Alliance for the Chesapeake Bay, 2001. *Chesapeake Bay Citizen Monitoring Program Manual.* Richmond, Virginia, May 2001, page 2.

PSWQA, 1997. *Recommended Guidelines for Sampling Marine Sediment, Water Column, and Tissue in Puget Sound.* Prepared by the Puget Sound Water Quality Action Team for the USEPA, Olympia, Washington, April 1997, pages 49-52.

Appendix C: Volunteer Monitoring Materials List

- Field data sheets printed on write-in-the-rain paper (1/sampling event/ sampling team plus at least 2 extras).
- Set standard operating procedures (1/sampler)
- Access letter printed on write-in-the-rain paper (1/sampler)
- Several gallon sized ziploc bags for additional protection for printed material (1 set/sample team)
- Clipboard (1/sample team)
- Calculator (1/sample team)
- 4 pencils (1 set/sample team)
- 2 Sharpie indelible markers (1 set/sample team)
- Sterile 120mL sampling bottles provided by analytical laboratory (1/ site/sampling event, plus 3 extra/sampling event for temperature control, duplicate, extra bottle). (1 set/sample team)
- Small sized plastic cooler (1/sampling team)
- Blue Ice, 1 Weekender (7x 6) paks and 1 Can Coolers (1 set/cooler)
- Sample sized bottle waterless hand sanitizer (2/ volunteer)
- Tape measure, at least 20ft graduated in 10ths/ft (1/sample team).
- Stopwatch (1/sample team)
- Yardstick (1/sample team)
- Bucket, 1, 5 gal plastic with handle (1/sample team)
- Mix n' Measure plastic container set (1/sample team)
  5 qt graduated to 1/2 liters and quarts/oz
  21/2 qt graduated to 1/4 L, pints/oz
  1/qt graduated to100mL, 4 oz
- 4 stakes for anchoring tape measure and marking stream reach (1 set/sample team)
- Ball of string for marking transects (1 per sample team)

Appendix D: Standard Operating Procedures: Fecal coliform bacteria sampling, discharge time of travel, discharge catchment.

Fecal Coliform Bacteria Sample Collection

Modified from APHA, 1998 and DOH, 1996

EQUIPMENT LIST

- Sterile 120mL sampling bottles provided by analytical laboratory (1/ site/sampling event, plus 3 extra/sampling event for temperature control, duplicate, extra bottle). Bottles should have tape over the cap or some seal or marking to indicate that they have been sterilized.

- Small sized plastic cooler with "Blue Ice"
- Hand sanitizer
- Chain of Custody (COC)form from laboratory
- Field data sheet
- Pencil

PREPARATION

Before sampling prepare data sheets and COC form. Enter date, tidal information, sampler(s), sample site numbers, and method of analysis on COC. Label sample bottles with site identification number using a waterproof marker.

SAMPLE COLLECTION

Collect bacteria sample first, before the stream bottom has been disturbed. If you must stand in the stream to collect the sample, stand downstream and lean upstream collecting the sample at arm's reach.

- Remove the cap from the sample bottle taking care not to touch the inside of the cap, the lip, or inside of the bottle. Hold the cap facing downward while sampling. If you feel that the bottle has been contaminated discard it and prepare a new one.
- To avoid collecting the surface layer, hold the bottle upside down and plunge it into the water, then sweeping the bottle upstream an inch under the surface in a single motion avoiding contact of sample water with contaminants that may be present on the outside of the bottle. Right the bottle to a vertical position before removing it from the water column.
- Leave about ½ inch of air space at the top of the bottle so that the sample can be mixed at the laboratory without removing the cap. If necessary, carefully pour out a little sample water before replacing the cap.
- Replace the cap without touching the lip of the bottle or the inside of the cap and place the sample upright in the cooler surrounded by "Blue Ice" as soon after collection as possible. Exposure to ultraviolet light can kill fecal coliform bacteria. It is important not to expose the sample to direct sunlight, and to place in a light-tight cooler immediately after collection.
- Enter time sample collected on field data sheet and complete COC.
- Deliver to laboratory within 6 hours of collection and sign COC upon delivery.

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Stream Discharge Measurement: Time of Travel

VSMP 2002 adapted from EPA, Volunteer Stream Monitoring: A Methods Manual

EQUIPMENT LIST

100-ft. tape measure
Yardstick
4 stakes or flags
Stopwatch
Float, such as an orange
Field data sheet
Calculator
String or rope

SITE SELECTION AND PREPARATION

Select a stretch of stream where the water is at least 6 inches deep and does not contain a pool or area of very slow moving water. Measure out 20 feet or 10 meters along the bank. Clearly mark the upper and lower ends of the measured section by running a transect line across the stream using string and stakes. The string should be taut and near the water surface. The upstream transect is #1 and the downstream, #2.

MEASURE CHANNEL WIDTH

Select an accessible section of stream and stretch a tape measure across it from bank to bank. Measure from the edge of the water rather than from the top of the bank and record this as wetted width on the data sheet.. Repeat for transect 2.

MEASURE CROSS SECTION

One person uses the yardstick to measure channel depth at regular intervals across the channel width. Calculate an average depth by adding together all the values and dividing by the number of depth measurements. Repeat for transect #2. Calculate cross-sectional area of the stream by multiplying stream width by average water depth.

MEASURE VELOCITY

Have one person stand in the water at transect #1 and, on command from the person with the stopwatch, gently release the float into the water. A second person stands in the water at transect #2 to catch the float. The third person records the time, in seconds, that it takes the float to reach the downstream person. Repeat the process at least three times and calculate an average “time of travel”. To calculate surface velocity for each trial, divide the number of feet traveled by the number of seconds of travel time. Record and average the surface velocity measurements for 3 trials. Record Average Surface Velocity in feet/second. Calculate Average Velocity by multiplying Average Surface Velocity by 0.8 for rocky bottom streams and 0.9 for muddy bottom streams. Record Average Velocity in feet/second.

SPECIAL INSTRUCTIONS

- Person 1 must drop the float away from their body. Standing immediately upstream of the drop location will interfere with the measurement.
- Person 1 must DROP the float, not toss it. The float should not have momentum other than the water velocity.
- Release the float ABOVE transect #1 and start the stopwatch as it reaches the string.
- If the float drags on the bottom of the stream or brushes overhanging vegetation, redo the trial. Do not use a measurement if there was any interference of flow of the float.

VSMP 2002 adapted from EPA, Volunteer Stream Monitoring: A Methods Manual

Stream Discharge Measurement: Catchment

EQUIPMENT LIST
Stop watch
5 gallon bucket and Mix n' Measure graduated plastic container set
Data sheet

SITE SELECTION
The catchment method is used to measure water exiting a pipe or culvert where there is sufficient drop to catch flow in a bucket.

SAMPLE COLLECTION
Hold bucket under flow while sampling partner uses a stopwatch to time flow collection. Carefully measure volume in graduated container to nearest 500 mL or quart increment. When flows are excessive, estimates will be made from collection from a portion of the flow and then calculated to estimate total flow. Record volume and time. Repeat twice for a total of 3 replicate collections. Average volume and times and report in cubic feet/sec.

Appendix E: Field Data Sheets

Whatcom County MRC Volunteer Water Quality Monitoring Field Data

Watershed: (circle one) Drayton Harbor Birch Bay Chuckanut Bay

Samplers_____

Weather_____

Station #	Date	Time	Flow (ft^3/sec)*	Flow Method**	Observations/comments***
FD_____					
FD_____					
Temp. Control		_____**°C**			

*Transcribe flow data from flow measurement sheets

**Flow methods: C= catchment, TT= time of travel

***Record special site conditions eg wildlife, odors, appearance of turbidity, land use

Tide		
	Height (ft)	**Time**
High		
Low		

Transcribe tide from sampling calendar

Quality control checklist
_____ Temperature control
_____ Duplicate sample
_____ Triplicate flow measurements
_____ Check field data entries

Whatcom County MRC Volunteer Water Quality Monitoring Field Data

Flow Datasheet for Catchment Method

Date___________ Sampler(s)____

Site	Time (sec)	Volume (mL)	Cubic feet/second (cfs)
			$\frac{\text{avg mL }/(3785\text{mL/gal})/(7.48\text{gal/ft}^3)}{\text{avg sec}} = \frac{\text{ft}^3}{\text{sec}}$
	avg	avg	

Site	Time (sec)	Volume (mL)	Cubic feet/second (cfs)
			$\frac{\text{avg mL }/(3785\text{mL/gal})/(7.48\text{gal/ft}^3)}{\text{avg sec}} = \frac{\text{ft}^3}{\text{sec}}$
	avg	avg	

Site	Time (sec)	Volume (mL)	Cubic feet/second (cfs)
			$\frac{\text{avg mL }/(3785\text{mL/gal})/(7.48\text{gal/ft}^3)}{\text{avg sec}} = \frac{\text{ft}^3}{\text{sec}}$
	avg	avg	

Site	Time (sec)	Volume (mL)	Cubic feet/second (cfs)
			$\frac{\text{avg mL }/(3785\text{mL/gal})/(7.48\text{gal/ft}^3)}{\text{avg sec}} = \frac{\text{ft}^3}{\text{sec}}$
	avg	avg	

Site	Time (sec)	Volume (mL)	Cubic feet/second (cfs)
			$\frac{\text{avg mL }/(3785\text{mL/gal})/(7.48\text{gal/ft}^3)}{\text{avg sec}} = \frac{\text{ft}^3}{\text{sec}}$
	avg	avg	

Whatcom County MRC Volunteer Water Quality Monitoring Field Data

Time of Travel Flow Measurement

Date_____ Sampler(s)_____

Site# _____

Total wetted width (ft/10)_____ Length of reach (ft/10)_____

Transect 1					Transect 2				
Cell	Cell depth (ft/10)				Cell	Cell depth (ft/10)			
1					1				
2					2				
3					3				
4					4				
T_1	avg depth	x	width =	area$_1$(ft^2)	T_2	avg depth	x	width =	area$_2$(ft^2)
		x	=				x		

AVG cross-sectional area = (T_1area ft^2)____ (T_2area ft^2)_____=_____ft^2

Travel time (seconds)	
1	
2	
3	
avg	

A = Average cross-sectional area of the stream. L = Length of the stream reach.
C = correction factor (0.8 for rocky-bottom streams or 0.9 for muddy-bottom streams).
T = Time, in seconds, for the float to travel the length of L.

Flow = $\frac{ALC}{T}$ = (ft^3/sec)

Site# _____

Total wetted width (ft/10)_____ Length of reach (ft/10)_____

Transect 1					Transect 2				
Cell	Cell depth (ft/10)				Cell	Cell depth (ft/10)			
1					1				
2					2				
3					3				
4					4				
T_1	avg depth	x	width =	area$_1$(ft^2)	T_2	avg depth	x	width =	area$_2$(ft^2)
		x	=				x		

AVG cross-sectional area = (T_1area ft^2)____ (T_2area ft^2)_____=_____ft^2

Travel time (seconds)	
1	
2	
3	
avg	

A = Average cross-sectional area of the stream. L = Length of the stream reach.
C = correction factor (0.8 for rocky-bottom streams or 0.9 for muddy-bottom streams).
T = Time, in seconds, for the float to travel the length of L.

Flow = $\frac{ALC}{T}$ = (ft^3/sec)