Oakland Bay and Skookum Inlet Bacteria Study

Quality Assurance Project Plan

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September, 2000

Waterbody Numbers:
WA-14-1850 (Campbell Creek)
WA-14-1800 (Uncle John Creek)
WA-14-1400 (Skookum Creek)

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Project Description

Introduction

Fecal coliform contamination has become a chronic problem in Watershed Resource Inventory Area (WRIA) 14 (Figure A1) in Mason County, where a number of short, low-gradient tributaries flow into small, shallow inlets prone to bacterial pollution. Animal management practices and failing septics are major contributors to fecal coliform loads in most watersheds, many of which are characterized by impermeable glacial soils unsuited for on-site waste systems. Bacterial levels typically increase during periods of high rainfall, resulting in the imposition of conditional harvest restrictions on shellfish in many areas of South Puget Sound.

The Department of Health regularly monitors marine fecal coliform throughout all commercial harvest areas, and conducts shoreline inventories to document sources of bacterial discharge into marine waters. However, in many rural areas, less effort has been put into investigating and remediating freshwater sources. In Mason County, several streams have been placed on the 1998 303(d) list of impaired and threatened surface water bodies for fecal coliform, including Goldsborough, Shelton, Uncle John and Campbell Creeks in the Oakland Bay watershed, and Skookum Creek in the Totten Inlet watershed (Figure A2) (Ecology, 1998). Most of the listings are based upon ten-year-old data not reflective of current conditions. At present these listed streams are not being monitored, with the exception of Skookum Creek, which is routinely sampled by the Squaxin Island Tribe.

The purpose of this preliminary investigation is to determine if Campbell, Uncle John, and Skookum Creeks should remain on the 303(d) list for exceeding bacterial standards, and to better identify potential bacterial sources in preparation for later development of a Total Maximum Daily Load (TMDL).

Background

Skookum Creek originates from perennial springs near the Grays Harbor/Mason County line and flows approximately nine miles into Little Skookum Inlet (Figure A3). Although the headwaters and tributaries drain the steep ridges of the Black Hills, most of the lower mainstem meanders in a northeasterly direction through a wide, alluvial valley characterized by several large farms, private and commercial timberlands, and low-density rural housing.

The Oakland Bay watershed is bordered to the north by Hood Canal and the Skokomish River, to the east by Pickering Passage, and to the south by Little Skookum and Totten Inlets. The surrounding landscape consists of a series of glacial outwash plains punctuated by low hills and ridges. Soils are comprised predominantly of unconsolidated glacial material or compacted till. Eight major tributaries flow into the bay, of which Campbell and Uncle John Creeks are two of the shortest. Both originate from low gradient lakes and wetlands on the Agate Peninsula and flow less than three miles into Chapman Cove, a productive shellfish growing area (Figure A4).

Land use is typified by small farms and private timber lots, with more extensive residential development occurring around Timber Lakes, at the head of Campbell Creek.

Oakland Bay is under conditional status for shellfish harvest, necessitating closure if more than one inch of rain falls within a 24-hour period (Table A1). In past years, high marine fecal coliform concentrations in Oakland Bay have been attributed largely to Shelton and Goldsborough Creeks, which flow into the west end of the bay at Shelton. Both were placed on the 303(d) list for violating the state Class A water quality standards (Table A2) based upon studies by Michaud (1987; 1988) that documented stormwater runoff contaminated by sewer overflow entering both creeks. This source of contamination has since been at least partially eliminated by improvements to Shelton's stormwater collection system, resulting in a marked decline in marine bacterial counts (Determan, 1999). However, no recent account has been made for bacterial contamination of marine waters by streams entering the upper end of the bay. Listings for Uncle John and Campbell Creeks are based upon a Mason County Water Quality Program study conducted between January 1988 and March 1989 (Brown and Caldwell, 1990) (Appendix B, Tables B1 and B2). The Oakland Bay Watershed Management Plan (Brown and Caldwell, 1990) identified animal management practices as likely sources in both streams, and no significant restoration efforts or land use changes have occurred since that would mitigate this effect.

Totten and adjoining Little Skookum Inlet remain one of the few areas in South Puget Sound unconditionally open to shellfish harvest, but this status is threatened by increasing shoreline development and improper livestock management. Fecal coliform concentrations in the lower Skookum Creek have regularly exceeded state Class AA water quality standards (Table A2) for at least 15 years. Intensive ground surveys in 1984-85 identified four farms that were contributing to high fecal coliform loads (McNichols, 1986) (Appendix B, Figure B2). A segment of lower Skookum Creek was later placed on the 303(d) list for fecal coliform based upon data collected by the Squaxin Island Tribe during 1995 and 1996 (Appendix B, Table B3) that showed violation of Class AA standards at two stations. Quarterly monitoring by the Tribe through 2000 shows continuing low-level concentrations (Table B3).

Under a one-time grant in the early 1990's, Mason County Conservation District identified priority farms in the watershed and assisted with creation of farm plans. One minor success in the program was the fencing and planting of a small tributary with horse access that had contributed significantly to fecal coliform loading in lower Skookum Creek. However, these efforts have since been discontinued, and documented instances of farm runoff still occur.

Objectives

1. Determine fecal coliform and Enterococcus bacterial levels in the Uncle John, Campbell, and Skookum Creek watersheds.
2. Evaluate whether additional sampling will be needed to isolate stream segments as sources of bacterial loading.
3. Compare bacteria results from sampled streams to the state water quality standards to determine if 303(d) listings are warranted.

Study Design

The objectives of the project will be met through collection and analysis of bacterial samples from the study streams. A total of 10 routine sample surveys are planned: five bi-weekly dry season surveys will be conducted from August to October 2000, and five bi-weekly wet season surveys from February through April 2000. In addition, two storm events will be sampled within both basins during the wet season and the results compared to the results of routine sampling to determine priorities for defining non-point source loading. Storm events will be defined as a rainfall event exceeding 0.5 inch of precipitation, within the 24 hours preceding sampling, on the rising limb of the hydrograph. To ensure that wash-off is occurring and that storm event conditions are met, sampling will occur after verification that groundwater is recharged and surface soils saturated. This will be accomplished by following precipitation and stream discharge. When small rainfall events result in large increases in discharge, the groundwater will be considered recharged.

Squaxin Island Tribal staff will be collecting the water quality samples with assistance from Ecology. The schedule for proposed field surveys is listed under *Sampling Schedule*. Samples will be collected from eight sites on Skookum Creek during both the wet and dry seasons (Figure A5) and at six sites on Campbell/Uncle John Creeks during the wet season, since the latter do not flow throughout the year (Figure A6). Site descriptions are provided in Table A3.

Under this sampling regime, a total of 14 wet season and eight dry season sites will be sampled for bacteria, conductivity, temperature, and stream flow. Conductivity and temperature will be measured on site, *in situ* with a Beckman meter and a calibrated field thermometer, respectively. Flow will be measured within approximately 100 feet of the sample site using a Marsh-Birney velocity meter unless changes in water height made at established reference points indicate no significant change between sampling periods. Bacteria samples will be collected by hand, at wrist depth, placed on ice, and sent to Manchester Environmental Laboratory (MEL) for analysis. A sample from every site will be tested for fecal coliform, and at a subset of sites for *Enterococcus*.

Project Organization and Responsibility

The following individuals and organizations will be involved in the project:

Kim Taylor (Squaxin Island Tribe): Project manager and principal investigator, responsible for overall project management. Develops the project objectives, scope, and study design; prepares the QAPP; and collects the samples and analyzes the results and writes the study report. (360/426-9783)

Randy Coots (Ecology): Technical support to the Tribe. Responsible for assistance in developing the project objectives, scope, design, and preparation of the QAPP; coordinating sample analysis and shipment; transferring data to the Tribe, and training Tribal staff in sample collection; and assistance in analysis of data. (360/407-6000)

Dale Norton (Ecology): Contaminant Studies Unit Supervisor. Responsible for review of the project QAPP. (360/407-6765)

Stuart Magoon (Ecology): Director, Ecology portion of the Manchester Environmental Laboratory. Responsible for oversight of laboratory analysis. (360/871-8801)

Cliff Kirchmer (Ecology): Quality Assurance Officer responsible for the review of the project QAPP. (360/895-4649)

Data Quality Objectives

The data from the laboratory's standard quality control procedures and replicate field samples will provide the information to determine if data quality objectives have been met. The lab routinely runs two split samples per survey batch and two blanks, one before and one after the run, to check dilution water quality.

Precision and Bias

Standard protocols for data and sample collection will be followed throughout the study to limit sources of bias. Sources of bias from sampling procedures and sample handling will be minimized by adherence to standard operating procedures listed in the WAS protocol manual (WAS, 1993). Results from bacteria samples will be considered acceptable when lab split sample pairs and field replicate pairs are within 50% relative percent difference (RPD). If sample pair data differ by greater than 50% RPD, a judgement will be made to either flag or discard the data. Measurement accuracy will be optimized by following manufacturers recommendations for proper calibration and maintenance of conductivity meters, flow meters, and thermometers.

Representativeness

The sampling design was developed to ensure that the data are representative. Survey stations in Campbell/Uncle John Creeks will be sampled on five occasions during the wet season while Skookum Creek sites will be sampled five times during the wet season and five times during the dry season. Two storm event samples will also be collected at all sites during the wet season to evaluate run-off. To assess the total variability of the data (field variability plus laboratory variability), a minimum of 10% of the stations per survey day will be selected and sampled in replicate for all parameters. Replicate samples are defined as one sample or measurement taken immediately following the first. The RPD will be calculated for replicate pairs to determine total variability.

Completeness

The amount of usable data obtained by this study will be maximized by careful planning of field surveys and employing standardized protocols for sample collection and analysis. All personnel involved with sample collection will be familiar with the WAS field sampling and measurement protocol manual (WAS, 1993). Training will be provided by the Ecology technical support staff.

Comparability

Under the assumption that data collection for earlier studies in the Skookum and Campbell/Uncle John Creek watersheds followed standard procedures, data comparability will be ensured by adherence to standard microbiological and field methods as listed in the WAS protocol manual (WAS, 1993) and in *Standard Methods for the Examination of Water and Wastewater* (APHA, 1995).

Laboratory and Field Determinations

The analytical methods and reporting limits for laboratory and field measurements of conventional and biological parameters for the study are listed in Table A4. The *Enterococcus* analysis is included in the project in the event the state water quality standards for bacteria are changed during the course of the project. Field sampling and measurement techniques will adhere to protocols described in the WAS protocol manual (WAS, 1993).

Sampling Procedures

Bacterial sample collection and handling will follow procedures described in *Standard Methods* (APHA, 1995), and all measurements made in accordance with WAS protocols (WAS, 1993). Grab samples for bacterial analysis will be collected directly into pre-cleaned containers supplied by MEL and described in the *Manchester Environmental Laboratory Users Manual* (MEL, 1994). Meters will be calibrated and post-calibrated in accordance with the manufacturer's recommendations.

Quality Control Procedures

Total variability for field sampling and laboratory analysis will be assessed through collection of field replicates. A minimum of 10% of the stations per survey day will be selected and sampled in replicate for all parameters. The laboratory will follow standard operating procedures for quality control as described in the *Manchester Environmental Laboratory Users Manual* (MEL, 1994).

All laboratory analyses listed in Table A4 will be performed in accordance with *Standard Methods* (APHA, 1995). Field sampling and measurement protocols will follow those described in the WAS protocols manual (WAS, 1993). Meters will be calibrated and post-calibrated per manufacturer's instructions. Bacteriological samples for laboratory analysis will be preserved on ice as specified by *Manchester Environmental Laboratory Users Manual* (MEL, 1994) and delivered to the lab within 24 hours of collection.

Data Assessment Procedures

The data reduction, review and reporting will follow the procedures outlined in the *Manchester Environmental Laboratory Users Manual* (MEL, 1994). Data will be transferred to the Ecology contact electronically from MEL through the Ecology environmental information management (EIM) system to avoid transcription errors. Before entering data into a final project database, 100% of the data will be reviewed for missing or improbable values. The Ecology contact will then transfer laboratory results to the project manager. Sample holding times will be reviewed to assure results are properly flagged. Total variability for field replicates and laboratory variability for lab splits will be quantified by calculating the RPD for sample pairs. At the conclusion of the study, all quality assured project data will be archived into the Ecology EIM database.

Data Analysis

Project data will be entered into Excel spreadsheets. Statistics will be calculated using spreadsheets and results will be compared to state water quality standards for compliance.

Sampling Schedule

Sampling dates for the proposed study are listed below. Five sample surveys are scheduled for the dry season and five sample surveys and two storm event surveys for the wet season. Samples will be taken bi-weekly between August and October 2000, and February and April 2001 with specific dates as follows:

* August 8, 2000
* August 21, 2000
* September 5, 2000
* September 19, 2000
* October 3, 2000
* February 6, 2001
* February 20, 2001
* March 6, 2001
* March 20, 2001
* April 3, 2001

Project Schedule and Laboratory Budget

The schedule of the proposed project is as follows:

Draft QAPP to Signature list for review	July 31, 2000
Final QAPP	August 31, 2000
Field Surveys	August 2000 – April 2001
EIM Data Entry Completion/Final Report	July 30, 2001

The laboratory budget is presented in Table A5. The total laboratory expense for the project is estimated to be S5038 ($1580 for the dry season sampling; $2,470 for the wet season sampling; and $988 for the storm events).

References

APHA. 1995. *Standard Methods for the Examination of Water and Wastewater.* 19th ed. American Public Health Association, American Water Works Association, and American Environment Federation, Washington, D.C.

Brown and Caldwell Consultants. 1990. Oakland Bay Watershed Management Plan. Final Report. December 1990.

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Washington State Administrative Code. 1997. Water Quality Standards for Surface Waters of the State of Washington. Chapter 173-201A-030 (2) and (3).

WAS, 1993. *Field Sampling and Measurement Protocols for the Watershed Assessments Section.* Washington State Department of Ecology. Ecology Publication No. 93-e04. EAP Program. Olympia, WA

Appendix A

Figures and Tables

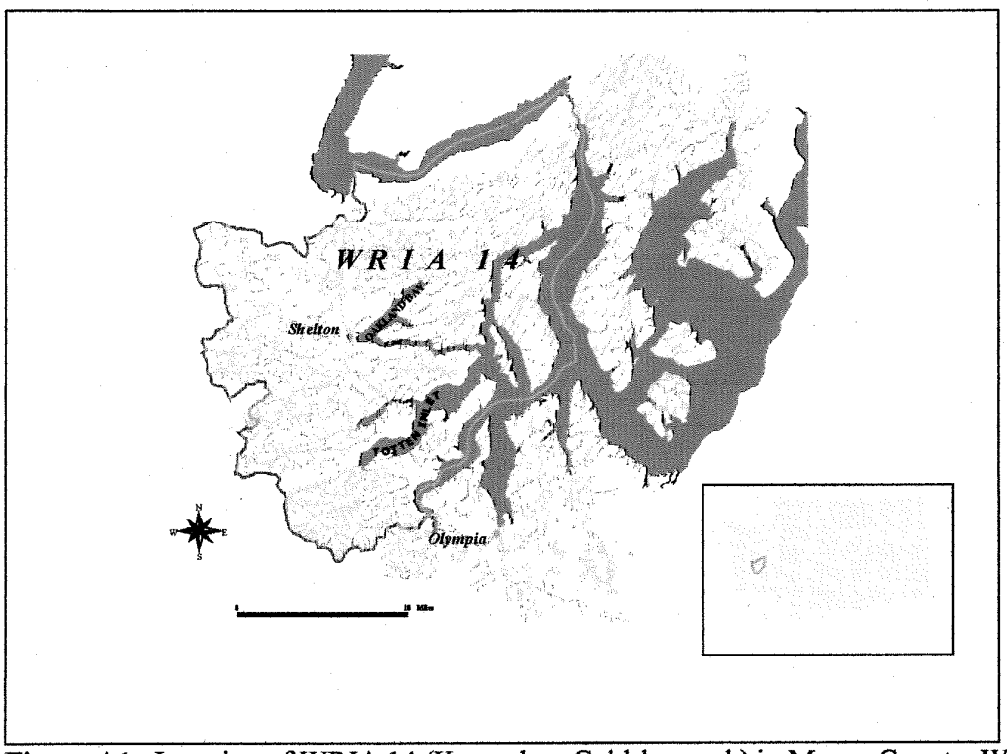

Figure A1. Location of WRIA 14 (Kennedy – Goldsborough) in Mason County, WA.

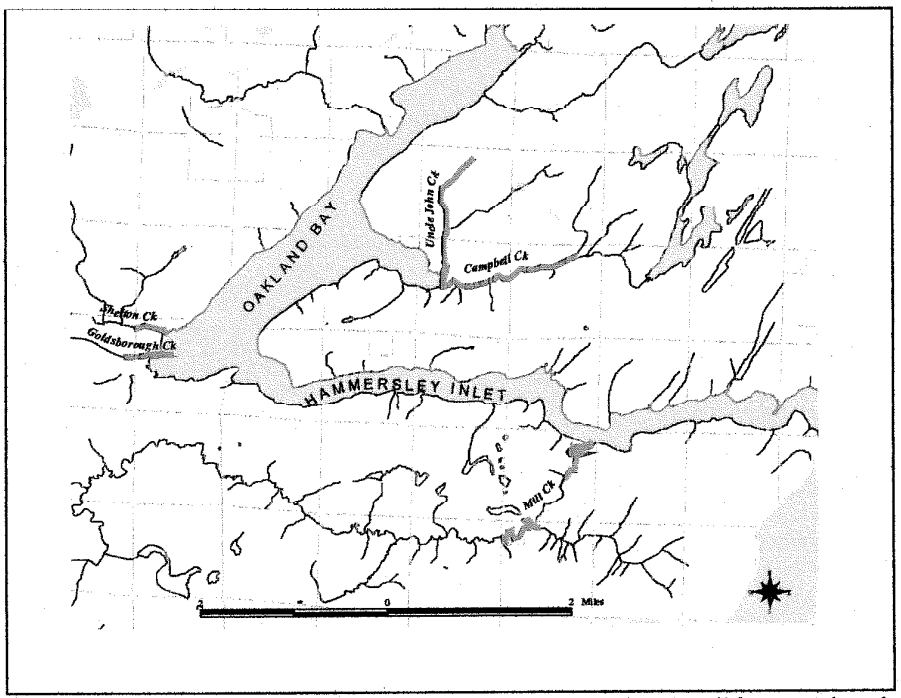

Figure A2. Streams in WRIA 14 on the 303(d) list for fecal coliform. Listed segments are shown in red.

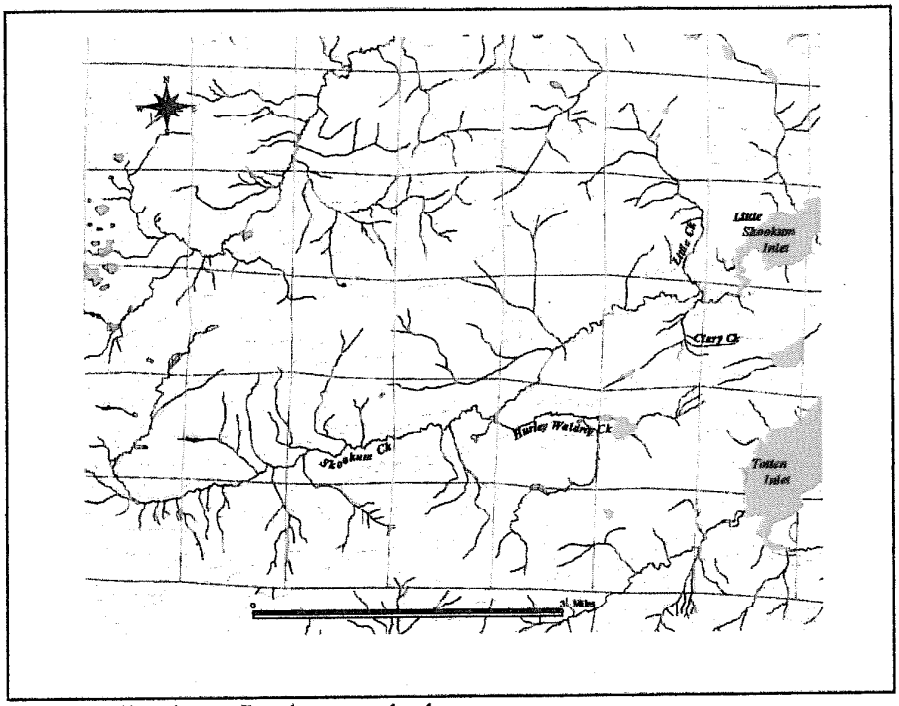

Figure A3. Skookum Creek watershed.

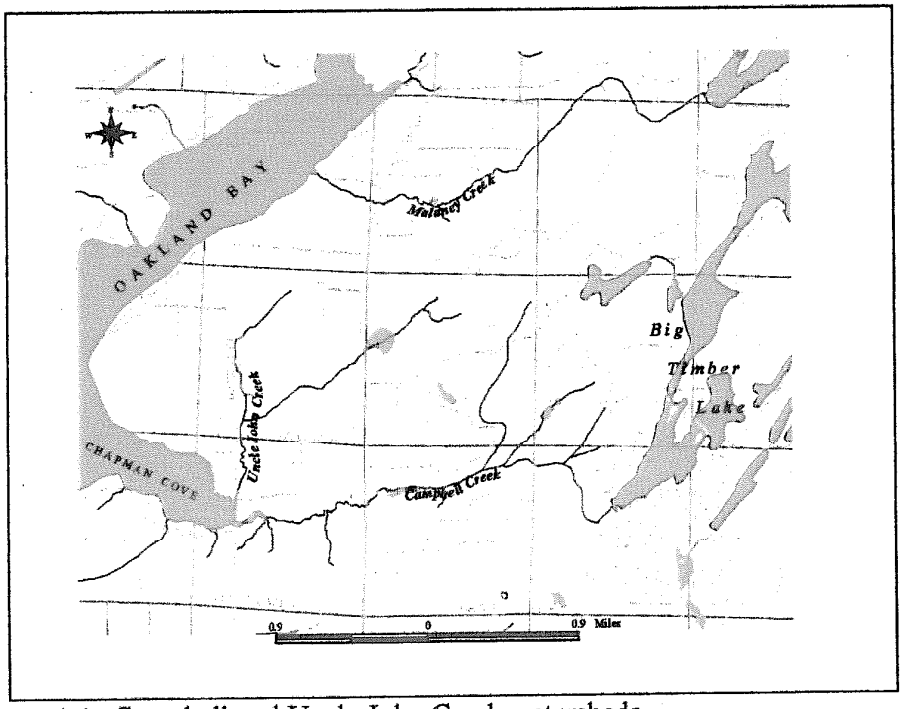

Figure A4. Campbell and Uncle John Creek watersheds.

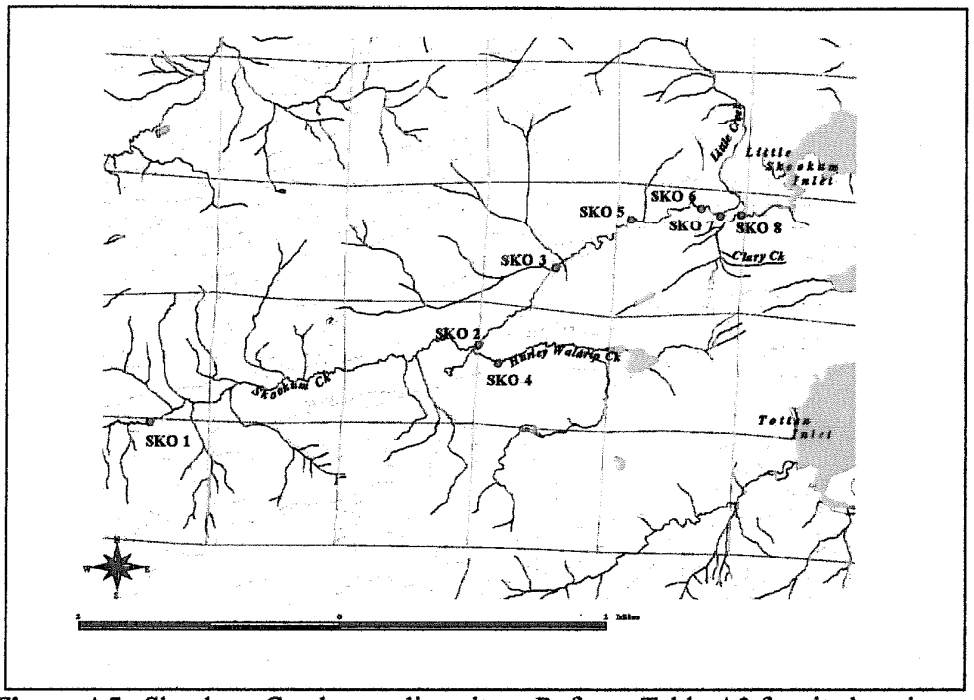

Figure A5. Skookum Creek sampling sites. Refer to Table A3 for site locations and descriptions.

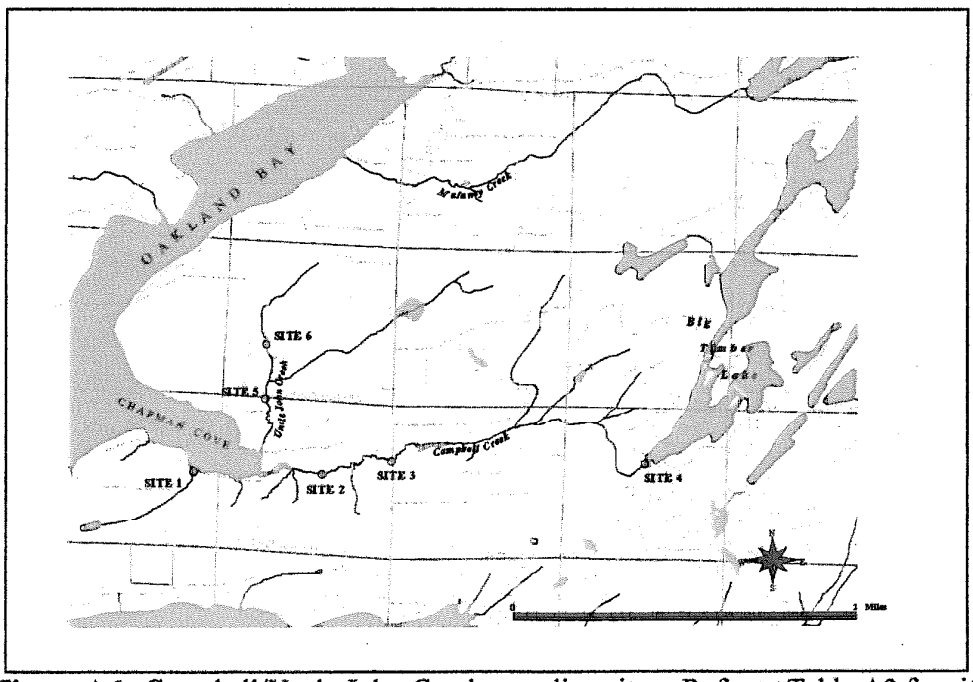

Figure A6. Campbell/Uncle John Creek sampling sites. Refer to Table A3 for site locations and descriptions.

Table A1. Classification of shellfish growing areas (adopted from Michaud, 1987).

Status	Restrictions	State Water Quality Standard
Approved Outer Hammersley from Church Point east; Totten Inlet	Approved for growing or harvesting shellfish for direct marketing	Geometric mean <= 14 colonies/100 mL and not more than 10% of samples exceeding 43/100mL
Conditionally Approved Upper Oakland Bay north of sanitary line drawn from Munson Point to western shoreline	Approved for growing or harvesting shellfish during predictable periods when the area meets "Approved" area conditions. Approval based on performance standards specified in a management plan.	Must meet "Approved" area standards during periods when it is open to harvesting.
Restricted Upper Oakland Bay under conditions outlined in 1998 Management Plan (WDOH 1998)	Shellfish harvest allowed only if permitted, and shellfish are subjected to a suitable and effective purification process.	GM <+ 88/100 mL with not more than 10% of samples exceeding 260/100 mL.
Prohibited Inner Harbor of Oakland Bay south of sanitary line, western end of Hammersley Inlet to Church Point	Closed to the harvesting of shellfish at all times	Bacteria concentrations exceed "Restricted" area limits, or where pollution sources may unpredictably contaminate the area.

Table A2. State water quality standards for Class A and AA waters (Washington Administrative Code, 1997).

Class A	
Marine (Oakland Bay exclusive of Shelton Harbor)	Geometric mean not to exceed a geometric mean of 14 colonies /100 mL with not more than 10% of samples exceeding 43 colonies/100 mL
Freshwater (All tributaries to Oakland Bay)	Geometric mean not to exceed a geometric mean of 100 colonies/100 mL with not more than 10% of samples exceeding 200 colonies/100 mL
Class AA	
Marine (Little Skookum and Totten Inlets)	Geometric mean not to exceed 14 with 90^{th} percentile not exceeding 43
Freshwater (All tributaries to Little Skookum and Totten Inlets)	Geometric mean not to exceed 50 with 90^{th} percentile not exceeding 100

Table A3. Wet and dry season sampling site descriptions and locations.

Site Number	Description	Sampling Season
SKO1	Hwy 108 bridge at RM 6.6	Wet/dry
SKO2	Bridge on Eich Road	Wet/dry
SKO3	Bridge on McDonald farm	Wet/dry
SKO4	Hurley Waldrip Ck above Hwy 108 culvert	Wet/dry
SKO5	Hwy 108 bridge at RM 2.0	Wet/dry
SKO6	West Casino boundary	Wet/dry
SKO7	Below Hwy 101 bridge	Wet/dry
SKO8	At Clary Creek confluence/railroad crossing	Wet/dry
CMP1	Chapman Cove tributary at Sunset Rd culvert	Wet
CMP2	above Agate Loop Rd bridge	Wet
CMP3	Agate Rd culvert	Wet
CMP4	Below Timber Lake dam	Wet
UNJ5	Agate Loop Rd culvert	Wet
UNJ6	Daniels Rd culvert	Wet

Table A4. Summary of field and laboratory measurements, performance characteristics, and methods.

Parameter	Performance Characteristics	Method
Field Measurement		
Temperature	± 0.2° C	Alcohol Thermometer
Conductivity	1 umhos/cm at 25° C	Beckman Meter
Streamflow	0.01 f/s	Marsh-Birney flowmeter
Microbiology		
Fecal Coliform	2 cfu/100 mL	SM 18 Membrane Filter 9222D
Enterococcus	2 cfu/100 mL	SM 18 Membrane Filter 9230C

Table A5. Laboratory budget for the proposed Oakland Bay/Skookum Inlet bacteria study.

Laboratory Parameter	Unit Cost	Samples/ Surveys	Number of Surveys	Total Cost
Dry Season				
Fecal Coliform (MF)	$20	10	5	$1,000
Enterococcus (MF)	$29	4	5	$580
Wet Season				
Fecal Coliform (MF)	$20	16	5	$1,600
Enterococcus (MF)	$29	6	5	$870
Storm Event				
Fecal Coliform (MF)	$20	16	2	$640
Enterococcus (MF)	$29	6	2	$348
Grand Total				**$5,038**

Appendix B

Historical fecal coliform data and figures for
Campbell, Uncle John, and Skookum Creeks

Table B1. Fecal coliform loading estimates from the Mason County Water Quality program investigation, Oakland Bay watershed, January 1988 – March 1989 (Brown and Caldwell, 1990). Refer to Figure A6 for sampling sites.

Station	cfu/100 mL, GMV	Streamflow - sampling period average (cfs)	Number of samples	Average bacterial loading/ day x 10E+9	Relative bacterial contribution
Dry Season					
Campbell Creek (downstream)	73	2.96	5	5.30	1.79
Uncle Johns Creek (downstream)	901	0.35	3	7.79	22
Wet Season					
Campbell Creek (downstream)	80	24.4	6	47.87	1.96
Uncle Johns Creek (downstream)	1389	0.22	1	7.47	34

Table B2. Fecal coliform data summary from the Mason County Water Quality program investigation, Oakland Bay watershed, January 1988 – March 1989 (Brown and Caldwell, 1990). Refer to Figure A6 for sampling sites.

Station	Cfu/100 mL, GMV	Total samples	% greater than 200 cfu/100 mL	Water quality standard noncompliance	
				Part 1 (GMV > 100 cfu/100 mL)	Part 2 (10% > 200 cfu/100 mL)
Dry Season					
Campbell Creek (upstream)	284	4	50	X	X
Campbell Creek (downstream)	86	6	0		
Uncle Johns Creek, Agate Loop	34	11	0		
Uncle Johns Creek, (midstream)	319	10	80	X	X
Uncle Johns Creek, (downstream)	209	13	54	X	X
Wet Season					
Campbell Creek (upstream)	121	3	33	X	X
Campbell Creek (downstream)	80	6	33		X
Uncle Johns Creek, Agate Loop	62	7	29		X
Uncle Johns Creek, (midstream)	414	3	67	X	X
Uncle Johns Creek, (downstream)	168	6	50	X	X

Table B3. Squaxin Island Tribe fecal coliform sampling on Skookum (SK) and Little Creek (LC, 1995 - 2000). Refer to Figure A5 for sampling locations.

Date	SK7	SK6	SK5	SK1	LC1	LC2	LC3	LC4
May 95	36	32	---	---	3	4	11	---
Sept 95	200	80	---	---	320	18	32	---
Jan 96	20	22	---	---	8	14	10, 34	---
April 96	500	320	---	---	36	20	24, 34	---
Aug 96	140	70	---	---	250	140	210	---
Oct 98	56	40	44	82	20	2	34	---
Jan 99	40	40	30	16, 14	4	4	10	4
Mar 99	100	112	31	100, 88	1	6	7	5
June 99	56	79	87	204	13, 12	9	8	636
Aug 99	52, 47	164	171	28	56	27	36	18
Nov 99	24, 26	21	28, 30	6	5	9	14	1
Mar 00	15	14	17	8, 3	0	0	4	---
June 00	66	64	54	19	15	19	9	20, 15

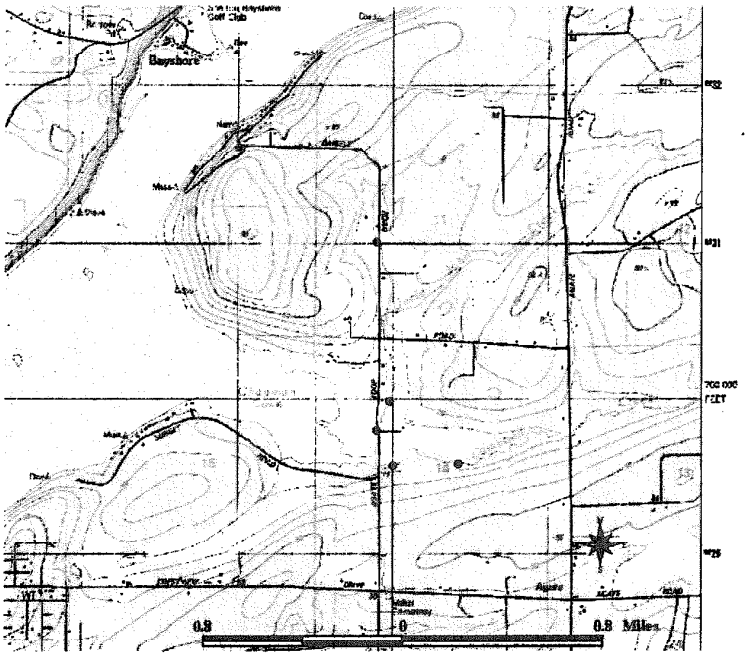

Figure B1. 1988-1989 sampling locations for Campbell and Uncle Johns Creeks (Brown and Caldwell, 1990).

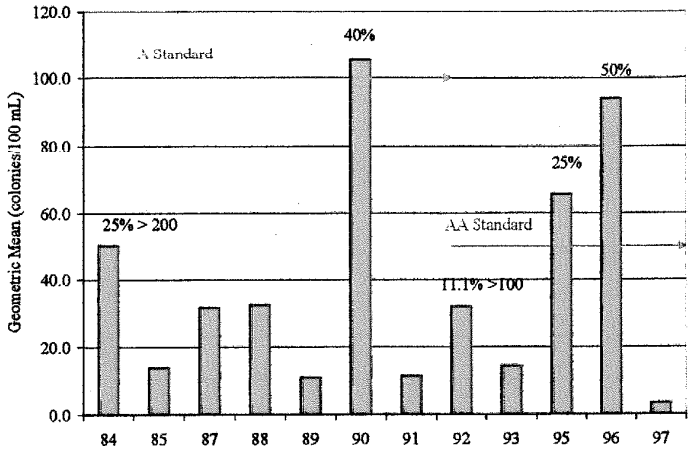

Figure B2. Fecal coliform counts in Skookum Creek, 1984-1997. Red bars indicate a) years the geometric mean of all samples either exceeded 100 colonies/100 mL (prior to 1992), or 50 colonies/100 mL, or b) years that 10% or more samples used to calculate the geometric mean exceeded 200 colonies/100 mL (prior to 1992), or 100 colonies/100 mL. Data from McNichols (1986), Mason County (1992), and Squaxin Island Tribe unpublished data (Taylor, 1999).