Skagit Stream Team 2002 Citizen Monitoring Water Quality Summary:

Nookachamps, Samish, and Padilla Bay Watersheds

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2000-2001 Skagit Stream Team Program

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SKAGIT STREAM TEAM

2001 Citizen Monitoring

Water Quality Summary

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I. INTRODUCTION

Program Summary

This report summarizes the results of the 2000-2001 Skagit Stream Team Program. The Skagit Stream Team Program was established in 1998 to educate and involve local citizens in the protection and stewardship of local streams. Sponsored by the Skagit Conservation District (SCD) in partnership with the Padilla Bay National Estuarine Research Reserve (PBNERR), the program completed its third year of water quality sampling on June 30, 2001. Funding for implementation of the 2000-2001 Skagit Stream Team Program was provided by the Washington State Conservation Commission, the Washington State Department of Ecology's Centennial Clean Water Fund Program, and Skagit County through grants received by the Skagit Conservation District. Volunteers gave of their own time (unpaid) for the duration of the study.

Program Objectives

From October 2000 through July 2001, thirty-seven dedicated Skagit Stream Team Volunteers monitored the water quality of freshwater streams that drain into Skagit County's three priority Watersheds: Nookachamps Creek; Padilla Bay; and Samish Bay. The primary objectives of the program are:

- To inspire community stewardship in regards to water quality by educating local citizens about land use and non-point sources of pollution by involving them in the process of water quality data gathering;
- To develop and implement a routine sampling program that can be used to assess water quality trends, to characterize the existing water quality of priority freshwater drainages, and to determine if violations of the Washington State Water Quality Standards are occurring in the study areas;
- To document improvements in water quality as a result of the implementation of Best Management Practices on farmlands and the repair and/or replacement of failing septic systems;
- To teach community volunteers the sampling and analytical techniques used by environmental professionals, how to manage the data collected and create a database, and the importance of establishing a long-term water quality monitoring program.

Volunteers sampled for fecal coliform (FC) bacteria, dissolved oxygen, water temperature, turbidity, and total depth to identify problems, possible sources, and potential solutions. Some of the questions the study hoped to address were:

How are water quality conditions for salmon in these watersheds?
Are the fecal coliform problems in the watersheds similar to the previous two years?

Background

Significant water quality degradation within the Nookachamps, the Padilla Bay, and the Samish Watersheds has been observed by recent and historical water quality monitoring programs, including consistent violations of water quality standards for fecal coliform bacteria. In 1988, the Skagit County Watershed Ranking Committee identified the Nookachamps, the Padilla Bay, and the Samish Watersheds as the first, second, and third (consecutively) priority watersheds in the county in need of protection and clean up from non- point sources of pollution. The ranking was based on verbal reports and local knowledge of water quality conditions, potential problems and the important beneficial uses. The ranking was followed by the development of Watershed Action Plans for the three priority watersheds, conducted under the guidance of Chapter 400-12 of the Washington Administrative Code.

- Nookachamps Creek

The Nookachamps watershed includes 202 miles of creeks and streams draining primarily forest and agricultural lands. It has been identified as the first important salmon-producing tributary in the Skagit River, and a key habitat for a successful, wild Coho stock. It supports both residential and anadromous populations of salmonids. A large trumpeter swan population depends on the watershed for resting, feeding, and night roosting. Ducks, eagles, Canada Geese, and osprey, and snow geese are present, as well as aquatic fur-bearers that include beaver, mink, otter, and muskrat.

The watershed provides half of the water for the Judy Reservoir, which is the major drinking water source for the Mt. Vernon area. Local residents also use drinking water from Turner and Mundt creeks, Big Lake, and from wells. These and other parts of the watershed are used for many recreational activities such as swimming, fishing, and water skiing.

A 1993 report on the water quality of the Lower Skagit River Basin identified problems in the Nookachamps with elevated temperatures during low flows, low dissolved oxygen, high turbidity levels during storm events, and high fecal coliform counts. Nonpoint loading sources as it flow through the basin include animal wastes, sanitary sewer outfalls, failing septic systems, landfills, and wildlife.

- Samish Bay

There are approximately 340 miles of stream in the watershed. Of these approximately 100 miles are considered major fish bearing waters. Anadromous species found include fall Chinook, Coho, Chum, winter Steelhead, coastal sea-run Cutthroat and Smelt. Resident fish include Cutthroat, eastern Brook Trout, Kokanee, Pike Minnow, Pea-mouthed Chub and Sculpin.

Approximately 1,100 acres of saltwater mudflats in Samish Bay are currently farmed for commercial production of shellfish, primarily Pacific Oysters and Manilla Clams. Recreational shellfish harvest also occurs in several areas. Samish Bay supports large eelgrass beds, which are important habitat for a number of marine species, waterfowl and juvenile anadromous fish. The

bay and surrounding farmland is a significant wintering area for many raptors and thousands of waterfowl. Many of the recreational activities for which the watershed is most known are dependent on clean water. These include fishing, shellfish harvesting, bird watching, duck hunting and boating.

Both the Washington State and Skagit County Department of Health have documented high fecal coliform concentrations in the watershed. This is of particular concern because shellfish are harvested from Samish Bay, and an outbreak of gastroenteritis led to a restriction of shellfish beds in 1994. New, community on-site septic systems in Blanchard and Edison had lowered fecal coliform concentrations enough for parts of the shellfish beds to be recently upgraded.

- Padilla Bay

Padilla Bay is designated as a National Estuarine Research Reserve. The bay contains one of the largest concentrations of eelgrass on the pacific coast and provides habitat for many invertebrates, fish, birds, and marine animals. Padilla Bay provides excellent estuarine habitat; it supports anadromous and marine fish species as well as numerous species of raptors and waterfowl.

The freshwater sloughs of the watershed provide a water supply for agriculture. In present condition they provide little habitat to support any viable fishery population. However, Padilla Bay supports shellfish, anadromous and marine fish species. Approximately 50 fish species inhabit Padilla Bay. All five Pacific salmon species, as well as steelhead trout, cutthroat, and Dolly Varden char, use Padilla Bay for one or more life-history phases. The bay is an important migration route for juvenile anadromous fish. The juvenile salmon use the shallow areas of the bay during feeding and the eelgrass for cover and protection.

Both commercial and recreational harvesting of shellfish occurs within Padilla Bay. The commercial harvesting of Dungeness crabs takes place on the edge of the bay. There are several endangered, threatened, and sensitive animal species found within the watershed, including the bald eagle, peregrine falcon, blue heron, black brant, trumpeter and tundra swan.

The marine waters of Padilla Bay represent a valuable aesthetic and recreational resource for local residents and tourists. The recreational use of Padilla Bay is impressive. Each year more than 20,000 people visit the Breazeale Interpretive Center, which is located at the Research Reserve.

Five major drainages, or sub-basins surround Padilla Bay: Joe Leary Slough, Bayview, No Name, Little Indian Slough, Big Indian Slough, and March Point. All six of these basins were tested in a 1994 water quality study, and all showed violations of State standards. The freshwater sloughs have continued to show some of the worst water quality in the County (Stream Team report, 1999, 2000) Joe Leary Slough is the largest drainage and has the highest concentration of fecal coliform.
Human actions that diminish the quality of water are failing on-site septic systems, excessive stormwater runoff, forest/timber harvest, poor crop or livestock practices, industrial/commercial development, and poor dairy farming practices

II. METHODS

Efforts were made to insure high quality data from this volunteer-based study. A Quality Assurance/Quality Control (QA/QC) plan was submitted to and approved by the WA Department

of Ecology in December 1988. The plan has since been updated and revised each successive year. Volunteers were given ten hours of training before sampling in the field. All analysis and collection methods are outlined in the QA/QC plan, and are referenced in this document as *Appendix B* and *Appendix C*

Based on the number of volunteers, each of the three watersheds was divided into two study areas. Nookachamps Creek watershed was divided into two upper and two lower volunteer teams coached by John Schuh, SCD. The Samish watershed was divided into two upper and two lower teams, and was coached by Lori Kyle, SCD. The Padilla Bay watershed had two teams on No Name Slough, and two teams on Joe Leary Slough coached by David Henry, PBNERR.

Samples were taken once or twice monthly and tested for the following parameters: turbidity (NTU's via turbidimeter), fecal coliform, temperature, dissolved oxygen, depth, water color, smell, and stream bed coating. All of these parameters are key indicators in assessing the biological health of the drainage. Monitors also checked for biological indicators (i.e. fungal growth, algal growth, fish, birds...).

Field measurements and samples were taken just below the surface, in the deepest part of the stream that could be reached. FC samples and turbidity samples were taken back to the lab. All other parameters were recorded on-site.

The data was recorded on field sheets *(See Appendix E)* and transferred to a Microsoft Excel spreadsheet by an adult volunteer. Because this was a citizen and student-based study, there were times when some data was unusable or unrecordable. These and other data constraints were recorded in the Metadata report. Volunteer FC test documented a high and low reading. An average from these was then computed and used for all final statistical/graphing purposes. Quality control checks were conducted periodically in the lab and in the field to assure that volunteers were using proper and consistent protocols, and to emphasize the importance of quality control measures.

Final FC data compilation was based upon consultation with the Washington State Department of Health's Food, Safety, and Shellfish division in order to accurately represent field conditions, as recorded, in the final data compilation. For the sake of accuracy, and simplicity, the FC data will only be considered by the geometric mean component of State water quality and health standards, and not the estimated 90th percentile based upon standard deviation. (State Health standards are based on *both* Geometric Mean and 90th percentile). The geometric mean provides the best overall presentation of data as it compresses outlyers and minimizes the harmful effect of any erroneous or artifact data. It was also determined that any TNTC (Too Numerous To Count) value must reflect the next order of magnitude from what is being monitored, and an assigned value of 1,001 more than the highest recorded value for each site would be a conservative estimate based upon past recorded readings of that level. It was again noted that the best way to more accurately depict these data in the future is to have lab volunteers run an extra, lower dilution on any samples that smell or look like they might have an inordinately high amount of sewage/fecal contamination.

Each Stream Team sample site had a high and low FC reading. Geometric means were calculated for all high readings, and all low readings. These two geometric means were then averaged together for the final results. For the sake of calculation, the following modifications were made to the data: any site that had a reading of zero FC was entered as 1 FC/100 ml, any site that had a TNTC (too numerous to count) was entered with an increase of 1,001 FC/100 ml higher than the yearly high for that site, any site that had no value (for any number of reasons) was not entered

into the calculation. For consistency, any comparisons made with the 1998-1999/1999-2000 data set are based upon these same procedures.

Averages were calculated for dissolved oxygen levels, and turbidity levels based upon usable data from the year. The following section provides an explanation of the water quality parameters selected:

DISSOLVED OXYGEN (DO) – almost all living organisms are dependent upon oxygen to maintain the metabolic processes that produce energy for growth and reproduction. Salmonids and their preferred invertebrate foods inhabit water with DO concentrations consistently above 5 mg/l.

Dissolved oxygen content is critical to the survival and metabolism of aquatic organisms. DO is an important factor in determining the type, variety, and density of biological organisms. Its reduction results in lowered metabolism, slower growth, and weakened condition. The absence of DO results in septic conditions and the destruction of most life forms dependent upon free oxygen. DO concentrations are influenced by several interacting physical, biological, and biochemical processes. Most important are transfer of oxygen from the atmosphere and use of oxygen by living organisms. Other important factors are the velocity of flow, water surface turbulence, turbidity, type of pollutants present, and temperature. The amount of oxygen water can hold varies inversely with temperature. Cold water can contain more oxygen than warm. DO levels can be depressed by input of organic wastes that increases the activity of aerobic bacteria, by aquatic plant growth that results from nutrient (nitrogen, phosphorous) increase and by low flow rates.

State Standard: For Class A freshwater dissolved oxygen shall exceed 8.0 mg/l.

FECAL COLIFORM BACTERIA (FC) - Members of two bacteria groups, coliforms and fecal streptococci, are used as indicators of possible sewage contamination because they are commonly found in human and animal feces. Although they are generally not harmful themselves, they indicate the possible presence of pathogenic (disease causing) bacteria, viruses, and protozoans that also live in human and animal digestive systems. Therefore, their presence in rivers suggests that pathogenic microorganisms might also be present and that swimming and eating shellfish might be a health risk. The enumeration tests for fecal coliform can not distinguish between human sewage (which can be a vector for human viruses) and livestock wastes.

Sources of fecal contamination to surface waters include wastewater treatment plants, failing on-site sewage systems, domestic and wild animal feces, livestock, and storm water runoff.

In addition presenting a possible health risk, the presence of elevated levels of fecal bacteria can also cause cloudy water, unpleasant odors, and an increased oxygen demand.

The use of fecal coliform as an indicator of human viral pathogen contamination was developed in the 1920's in response to a typhoid epidemic on the East Coast that was attributed to consumption of sewage-contaminated shellfish (Cabelli, 1970).

State Standard: For Class A freshwater fecal coliform organism levels shall both; 1) not exceed a geometric mean value of 100 colonies/100 mL, and 2) not have more than 10 percent of samples exceed 200 colonies/100 mL. The geometric mean is a number derived from a calculation of the nth root of n products. The intention behind the use of the geometric mean is to reduce the impact on the average value of a few extreme values.

TEMPERATURE – influences the chemical and biological processes in water. Fish and other aquatic animals have temperature tolerances outside of which they cannot live or reproduce.

Temperature is a primary factor in determining which organisms survive in surface waters. Temperature governs the rate of chemical and biological reactions. Since fish and invertebrates are cold blooded (ectothermic), their activity and survival depend directly upon this parameter. For example, the concentration of oxygen in water, exertion of BOD (Biological Oxygen Demand), and oxygen production by photosynthesis are all functions of temperature. Seasonal variation of temperature causes major changes in dissolved oxygen concentrations: higher concentrations are found in winter when temperatures are lowers.

State Standard: For Class A freshwater the temperature shall not exceed 18 degrees Celsius (freshwater) due to human activities. When natural conditions exceed 18 degrees Celsius, no temperature increases will be allowed which will raise the receiving water temperature greater than 0.3 degrees. Incremental temperature increases resulting from nonpoint source activities shall not exceed 2.8 degrees Celsius.

TURBIDITY – is a measure of the cloudiness of water. Cloudiness is caused by suspended solids (mainly soil particles), and plankton (microscopic plants and animals) that are suspended in the water column. Moderately low levels of turbidity may indicate a healthy, well-functioning ecosystem, with moderate amounts of plankton present to fuel the food chain.

However, higher levels of turbidity pose several problems for stream systems. Turbidity blocks out the light needed by submerged aquatic vegetation. It also can raise surface water temperatures above normal because suspended particles near the surface facilitate the absorption of heat from sunlight.

Suspended soil particles may carry nutrients, pesticides, and other pollutants throughout a stream system. Settling particles can bury and suffocate salmon eggs and other bottom (benthic) dwellers. Turbid waters may also be low in dissolved oxygen. High turbidity may result from sediment bearing runoff, or nutrient inputs that cause plankton blooms.

State Standard: For Class A freshwater the turbidity shall not exceed 5 NTU (Nephelometric Turbidity Unit) over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

III. RESULTS

This section presents the data collected in this project and provides a preliminary overview and summary of the data. The data summary primarily focuses on fecal coliform results of the study, as well as dissolved oxygen, turbidity and temperature. Below is a textual summary of the results followed by detailed graphs on the following pages:

1. Nookachamps Creek *(See maps on pages 9 and 14 for site locations)*

For the third straight year, the highest fecal coliform (FC) readings in the entire watershed were recorded at site #4 (Knapp Rd.-UN), and the second highest were at site #1 (College Way-LN) But it is worth noting that the overall geometric mean at these sites this year did not exceed the Washington State Class A standard (100 FC/100 ml).

Also for the third straight year, the highest turbidity readings in the lower Nookachamps, were at site #1 (College Way), but overall both the upper and lower Nookachamps had the lowest turbidity readings of all three priority watersheds.

Dissolved Oxygen levels had always been above State Standards at all sites, but this year the McMurray Estates (UN #1) came in with many low readings that brought the average down to 6.3 mg/L, below both Class A and AA standards. All temperature readings were within State Class A Standards.

2. Samish Bay *(See maps on pages 9 and 16 for site locations)*
For the past two years, the highest average FC results had been at LS site #2 (Edison Liquor Store), but this past year two sites were higher. In the lower Samish site #1 (Edison Bus Barn), and #3 (Samish River Bridge) had the highest overall FC readings, but their readings were similar to those recorded in past years. Both exceeded State Standards.

The highest turbidity was recorded at LS site #2 (Edison Liquor Store). All the turbidity readings at sites in the lower Samish exceeded those of the upper Samish.

Average dissolved oxygen and temperature readings at all sites met State Class A standards.

3. Padilla Bay *(See maps on pages 9 and 18 for site locations)*
For the first time, the highest average FC levels of all the watersheds were not recorded at Joe Leary Slough (See Discussion). No Name Slough's first two sites (Marihugh and Bayview Rd) had the highest FC readings in the Padilla Bay watershed and were in violation of State Class standards.

Joe Leary site #3 (Avon/Allen and Josh Wilson) had the highest turbidity reading. Joe Leary Sites #2.) and #4 (Tide Gate) were also high.

The dissolved oxygen levels at all four Joe Leary Slough sites were below State Class A Standards, and sites #1 (Dahlstedt Rd) and #4 (tide gate) were the lowest of all the watersheds.

See the graphs and maps on the following pages for details of the results

SPECIAL NOTE ON GEOMETRIC MEANS - Please note that a geometric mean produces a considerably LOWERr number than an average. The average FC reading for all of these sites is 2 to 6 times higher than the FC geometric mean. For example:

- The FC geometric mean for Wilson/Avon-Allen Rd's is 35, while the FC average is 206.
- The FC geometric mean for BayView Rd is 120, while the FC average is 486.

IV. DISCUSSION

Fecal Coliform (FC)

This sampling year shows a remarkable decline in FC levels from previously recorded years. Is this true? The answer is a disappointing "we don't know, nor will we ever know." The reason for this is that we were victims of one of the driest winters on record in Western Washington. It never rained, and when we run volumes of water in our FC tests, it is based on past results and normal stream flows. Some sites have had such high levels of FC that we run only a small amount of water through the test. If we run a lot of water through the test, our petri dishes are covered with so many bacteria that they are unreadable, resulting in what we enter as "Too Numerous to Count" (TNTC). Therefore, we ran regular low volumes of water in the test, but because of the low stream conditions, many petri dishes did not show any FC. We had to enter all these tests as "0" and as a result, our final geometric mean is lowered. This is the nature of bacterial testing. You never know what is in a stream and so you guess based on past experience.

The result is that the final FC numbers for half of the basins (Joe Leary Slough, the Upper Samish, and the Lower Nookachamps) were lowered significantly by "0" readings in 27-39% of the FC tests run on them. For example, if you remove those five "0's" in the data from Joe Leary Slough Site #1 (Dahlstedt Rd.) the Geometric Mean jumps from 37 to 170, a significant increase. On the bright side, a value of 170, while still exceeding State Standards, represents a 60% decrease in FC at that site from the previous two years. But beyond this sort of speculative analysis, not many conclusions can be drawn from this year's FC data because of the data anomalies. The affected sites, that had three to five "0" values, are Joe Leary Slough (Site #'s 1 and 2), the Upper Samish (Site #4), and the Lower Nookachamps (Site #4).

But based on the data we do have, there is good and bad news. The good news is that No Name Slough was the only site to exceed State Standards, the bad news is that it was for the third straight year. It is good that FC levels in the lower Samish dropped after a marked increase the previous year, but not so good that they have worked their way up the overall rankings each year from fourth worst to third worst and this year to second worst. *(See Average FC Level graph on page 10)*

The data from the past two years identified three out of six study areas (50%) exceeding State FC standards (based upon geometric mean). This year's data only showed one, but no strong conclusions can be made from this fact because three watersheds were affected by data anomalies. Like last year, no duplicate FC sample comparisons were done this year with the Skagit Health Department.

Many previous FC problem areas were again documented by this study. In the Lower Samish, two out of four sites exceeded State standards. However, the area of greatest concern must be the high readings recorded on the main-stem of the Samish River going into Samish Bay (LS#3). This site has far and above the greatest flow in the bay, and when combined with exceedingly high FC levels, could result in the greatest overall FC load to Samish Bay.

Dissolved Oxygen

The results from these data show that the average DO reading met State Standards at all sampling locations except in Joe Leary Slough. These data are slightly misleading in terms of salmon survival. High average DO levels don't assure survival as much as levels that never drop below

4.0 mg/L. Levels below 4.0 were recorded. Anaerobic conditions were documented in Joe Leary Slough at Sites #1 (Dahlstedt Rd) and #4 (Tide Gate). *(See Average DO level graph on page 11i)*

Turbidity

For the third straight year the highest turbidity levels were, in order, Joe Leary Slough, the Lower Samish, and No Name Slough. But all three watersheds showed a marked decrease in turbidity this year, which may be attributed again to the record low rainfall. These results cannot be used in reference to State standards because background levels have, as far as we know, not been established. *(See Average Turbidity level graph on page 12)*

Temperature

The temperature at all sites fell within the State standards. The lower Samish had the highest recorded temperatures, and the Upper Samish had the lowest. Joe Leary Slough had the second highest temperatures. *(See Average Temperature level graph on page 13)*

Overall Grades

If we had to give out grades based on this year's results, we'd give:

Nookachamps OVERALL GRADE: **A** Outstanding. Watch FC in lower sites.

Samish OVERALL GRADE: **B** Lower Samish is still high in FC and turbidity.

Padilla Bay OVERALL GRADE: **C** Need to improve all areas: turbidity, DO, FC.

V. CONCLUSION

The 2000 - 2001 Stream Team was a success in and by itself, but it was also successful in terms of building upon the success of two previous years, to provide an unprecedented third year in background WQ levels in Skagit County's three priority watersheds. Each year of data increases the value of all the data. The data will be shared with Skagit County Public Works, the Skagit Conservation District, The Skagit Watershed Council, Skagit County Department of Health, Washington State Department of Health, the Washington State Department of Ecology, and anyone else interested. As residents of this State and this watershed we hope that our data is useful in identifying problem areas that need the attention of the appropriate agencies.

The real success again is that student and adult volunteers were exposed to a firsthand view of the impact that non-point source pollution has on local water quality. Along the way they also experienced sampling and analytical techniques used by environmental professionals, how to manage the data collected, create a database, and the importance of establishing a long-term, routine sampling program.

We collected substantial amounts of good data that documented baseline FC, DO, temperature and other water quality conditions. FC levels documented by volunteers in all three watersheds show both some improvement, and some violations in State Standards (WAC 173-201) for bacteria levels. Other data shows the parts of our watersheds that are healthy in terms of water quality, and presently meet State Standards for temperature and oxygen. This is all important data for the long-term protection of our water resources.

We had problems with getting the FC tests right because of the unusually low flows. Next year we will provide lab managers with the option of running two different sets of volumes: higher test volumes can be run when it has not been raining, and stream volumes are low, lower test volumes when it has been raining and the streams are running normal to high. We have no way of knowing how many bacteria are in a stream, and therefore what volumes to run in the test. We can only guess based on past experience, and hope for the best.

For the third straight time in Skagit County's history, citizen volunteer documented baseline water quality conditions weekly in three different watersheds over a nine-month period. Twenty-four sites were sampled over 411 times during 2000-2001 samplings with two fecal coliform tests performed each of these times. At current lab rates of $27 for a sanitary survey, volunteers analyzed over $22,000 worth of fecal coliform tests alone. This rough number does not even take into account the other parameters tested, field time, nor data compilation time.

The 2000-2001 Skagit Stream Team program built on the success of previous years. Together the Skagit Stream Teams have now provided three years worth of data; all collected with a Department of Ecology approved QA/QC plan. The data documents violations and compliance's of state standards for fecal coliform, temperature, turbidity, and dissolved oxygen. We have all learned a tremendous amount about non-point source pollution and water quality monitoring. We hope to add our work to the data that is available to citizens and agencies, assessing what conditions are today so that water quality improvements can be made, and documented in the future.

ATE WQ STANDARDS

APPENDIX B. ANALYSIS EQUIPMENT SPECIFICATIONS

matrix	variable	precision (Rel. Std. Dev.)	accuracy	detection level
water	D.Oxygen (DO)			
	(YSI 55 Probe)	UA	± 0.3 mg/l	0-20 mg/l
water	total depth	± 20%	± 0.05 meters	0 - 2 m
water	turbidity	UA	0.01 NTU	0-19.9 NTU 0-199.9 NTU
water	temp.			
	(YSI 55 Probe)	UA	0.2° C	°-5 to 45° C

matrix	variable	test equipment	filter type	incubation
water	Fecal Coliform bacteria	Millipore sterifil aseptic system	47 mm membrane filter .45 um pore space	Millipore single chamber incubator temp. range 30°c (±0.5) 44.5°c (±0.2)

UA = Unavailable

APPENDIX C. COLLECTION EQUIPMENT SPECIFICATIONS

matrix	variable	sampling equipment	sample container	sample preservation	maximum holding time
water	fecal coliform	glass bottle	glass bottle pre-sterilized	ice chest with ice pack	1 hr
water	D.Oxygen (YSI Probe)	probe	instream	none	immediately
water	total depth	Measuring Tape	instream	none	immediately
water	temperature	thermometer YSI probe	instream instream	none none	immediately immediately
water	turbidity	turbidimeter	glass bottle, wide-mouth	ice chest	2 hrs

1. Total depth is measured by lowering the weighted end of a measuring tape to the surface of the water and measuring up to a landmark on a permanent structure, near to the nearest centimeter.

2. Water clarity will be determined by placing a sample into a turbidimeter (EPA approved VWR 66120-200)

i. Warm-up Turbidimeter 30 minutes and calibrates w/ 0 NTU polymer standard using the "zero-adjustment".
ii. Thoroughly shake the water sample in a clean sampling jar.
iii. Pour sample into unscratched, clean, and Chem-wiped vial. Mix again
iv. Place in turbidimeter w/ index line facing directly out to the front.
v. Read and record the steady reading after the highest readings settle.
vi. If reading is greater than 200 NTU, dilute the sample by 50%. (x by 2).

3. Fecal coliform bacteria - samples will be taken by holding a glass sample bottle upside down and plunging it below the water surface, avoiding sampling the surface water (the surface film often contains higher numbers of bacteria and can bias results). The bottle will then be turned upright into the current and filled completely. Samples are labeled with site #, time, date and variable. Samples are preserved in an ice chest for maximum holding time of 1 hr. They are then taken back to the lab and analyzed according to Standard Method 9222 D. Fecal coliform membrane filter procedure using a Millipore Sterifil Aseptic System and Portable Single Chamber Incubator. Results will be recorded as FC/100 ml.

4. Upon arriving to a sampling site volunteers will visually search for living or dead juvenile or adult fish, or any other large incidental events. Large and small bird activity will be noted.

APPENDIX E. REFERENCES

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