WATER QUALITY TREND MONITORING PLAN, STREAMS AND MARINE WATERS

Kitsap County Health District
Water Quality Program

Revised March, 2010

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(The Appendices listed above are not included with this document, but are available upon request.)

1. Introduction

The purpose of the Water Quality Trend Monitoring Plan, Streams and Marine Waters (plan) is to determine ongoing, long-term water quality trends for marine waters and streams in Kitsap County. This plan details the goals, objectives, and methodologies of the trend monitoring program and serves as a guide to Health District monitoring staff. As needed, this plan will be reviewed and amended in response to changes in monitoring goals, objectives, and practices.

Consistent with the Health District's mission, the primary focus of this monitoring program is assessing long-term trends in parameters associated with human sewage and animal waste from nonpoint pollution sources. The Health District assesses water quality trends by analyzing bacteria data from streams, lakes, and marine waters throughout Kitsap County. Fecal coliform bacteria are used as an indicator organism in streams and marine water, and levels of E. coli are used for lakes.

In addition to the bacterial data, basic water chemistry parameters (temperature, dissolved oxygen, pH) have been measured at some stations over time. This monitoring data is available to the Kitsap County Surface and Storm Water Management Program (SSWM), residents of Kitsap County, and staff from other local, state, and tribal water quality programs.

Because Kitsap County municipalities do not participate in the SSWM Program, no data is collected on Bainbridge Island or from surface waters exclusively within the jurisdiction of a municipality. Additionally, stormwater monitoring is the responsibility of the Kitsap County Department of Public Works and is *not* addressed in this plan. Coordination with these agencies occurs to the extent necessary to meet the goals and objectives stated in this plan and in the SSWM Program scope of work. Groundwater monitoring is also *not* included in this plan. The Health District's lake monitoring activities are discussed in a separate plan.

In Kitsap County, as elsewhere, surface water quality provides an early warning in determining whether development, land uses, and other human activities are being managed to effectively protect public health and the environment. Because County streams are relatively small, pollution impacts manifest themselves more readily, and damage occurs more quickly. Because all County streams discharge to the marine waters of either Puget Sound or Hood Canal, polluted streams have the potential to impact nearshore marine areas as well.

The major types, and sources, of pollution affecting Kitsap County's surface waters and their resources are:

- Human Sewage and Animal Waste from failing on-site sewage systems, inadequate livestock keeping practices, pet and wildlife waste, combined sewer overflows, inadequate community wastewater treatment systems, sewage spills from municipal wastewater treatment plants and sewage collection systems, and sewage discharges from boats. Assessing trends associated with this pollution source is the primary focus of the program.

- Sedimentation and soil erosion from improper land clearing and logging activities, poor construction practices, inadequate livestock keeping practices, insufficient stream buffers and storm water control/treatment, wetlands elimination, and the re-channeling and culverting of natural streams. Assessing trends associated with this pollution source is *not* the primary focus of the program.

- Toxic chemicals and metals from industrial and military wastewater and storm water discharges, urban storm water runoff, closed or abandoned landfill sites, and the illegal dumping or mismanagement of solid and hazardous wastes. Due to funding constraints and the overlap with other local, state, and federal monitoring efforts in this area, these pollution sources are not typically monitored or assessed under this program.

This plan does not address monitoring conducted by the Health District for the following programs:

- Pollution Identification and Correction Program.
- Recreational Shellfish Program.
- Swimming Beach (Lake) Monitoring Program.
- All Other Water Quality Monitoring Projects.

Monitoring plans for these programs are discussed in separate Health District documents.

2. Monitoring Goals and Objectives

The goals and objectives of the monitoring program are provided below.

2.A. Monitoring Goals

The goal of this program is to develop and implement a comprehensive, County-wide, water quality monitoring plan that will:

- Protect and preserve public health and the environment;
- Identify and correct sources of water pollution caused by human sewage and animal waste;

- Inform and educate the public, private industry, and governmental agencies on specific Kitsap County surface water quality issues;
- Provide the public, private industry, and governmental agencies with current surface water quality information in a timely and effective manner; and
- Promote stewardship of the County's waterways and their respective resources.

2.B. Monitoring Objectives

The objectives of the monitoring program are:

- Implement a long-term monitoring program to measure, assess, and characterize surface water quality trends in Kitsap County with the primary focus on the impacts caused by human sewage and animal waste pollution;
- Compare and assess surface water quality results to applicable surface quality standards, criteria, and guidelines with the primary focus on the impacts caused by human sewage and animal waste pollution;
- Provide monitoring data to prioritize nonpoint pollution problem areas in Kitsap County for Health District pollution source investigation and correction efforts;
- Identify specific surface water public health concerns based on the assessment of monitoring results and trends;
- Provide the public with specific health advisory information related to surface water and shellfish tissue quality through the local press, signage, Internet home page, public presentations, and the Health District's 1-800-2BE-WELL hotline number;
- Provide data and comment to SSWM and the State Department of Ecology to evaluate waterbodies included on the state's Clean Water Act Section 303(d) List for bacterial contamination, i.e., specifically compare fecal coliform bacteria results against the state standard for this parameter;
- Provide data and comment to the State Department of Health and SSWM to justify the upgrade, or prevent the downgrade, of commercial or recreational shellfish areas as applicable; and
- Provide surface water information to SSWM, the public, or other private or governmental entities by responding to data requests and by preparing summary reports.

3. Water Quality Standards and Criteria

The Washington State Department of Ecology (Ecology) establishes surface water quality standards in Chapter 173-201A Washington Administrative Code (WAC). The Health District continues to compare monitoring results against the current Washington State water quality standards, as amended.

Surface waters in Kitsap County are designated in the WAC as either Primary or Extraordinary Primary waters. Both earn this designation by markedly and uniformly exceeding established criteria related to watershed use and water quality. Applicable surface water quality standards are summarized in **Table 1**.

TABLE 1
Surface Water Quality Standards and Related Criteria

Parameter	Freshwater Standard		Marine Water Standard	
	Extraordinary Primary	**Primary**	**Extraordinary Primary**	**Primary**
Fecal Coliform Bacteria (FC)	Part 1: ≤50 FC/100 mL (geomean). Part 2: Not more than 10% of all samples obtained for calculating a geomean >100 FC/100 mL.	Part 1: ≤100 FC/100 mL (geomean). Part 2: Not more than 10% of all samples obtained for calculating a geomean >200 FC/100 mL.	Part 1: ≤14 FC/100 mL (geomean). Part 2: Not more than 10% of all samples obtained for calculating a geomean >43 FC/100 mL.	Part 1: ≤14 FC/100 mL (geomean). Part 2: Not more than 10% of all samples obtained for calculating a geomean >43 FC/100 mL.
E. Coli Bacteria	≤126 organisms/100 mL (geomean)[1]		None	None
Dissolved Oxygen	> 9.5 mg/L	> 8.0 mg/L	> 7.0 mg/L	> 6.0 mg/L
pH	6.5 – 8.5 units	6.5 – 8.5 units	7.0 – 8.5 units	7.0 – 8.5 units
Temperature	16.0° C[2]	18.0° C[2]	13.0° C[2]	16.0° C[2]
Turbidity	Not >5 NTU over background when background turbidity <50 NTU, or not >10% increase in turbidity when background turbidity >50 NTU	Not >5 NTU over background when background turbidity <50 NTU, or not >10% increase in turbidity when background turbidity >50 NTU	Not >5 NTU over background when background turbidity <50 NTU, or not >10% increase in turbidity when background turbidity >50 NTU	Not >5 NTU over background when background turbidity <50 NTU, or not >10% increase in turbidity when background turbidity >50 NTU

[1] U.S. EPA criterion (U.S. EPA 1986A).

[2] Shall not exceed standard due to *human activities*. When natural conditions exceed these standards, no human caused temperature increases are allowed which will raise the receiving water temperature by greater than 0.3° C.

The temperature standard in WAC 173-201A can only be *violated* as a result of human activities. However, the highest temperature in the temperature standard "range" is often *exceeded* as a result of natural conditions. Likewise, dissolved oxygen and pH levels may also exceed the range established in the standards as a result of natural conditions.

The turbidity standard in Chapter 173-201A WAC for freshwater and marine water states that turbidity shall not exceed five (5) nephelometric turbidity units (NTU) over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10% increase in turbidity when the background turbidity is more than 50 NTU. Since no background samples are collected as part of this monitoring program, Health District turbidity data cannot be compared to this standard. Starting in the 2006 water year, the Health District no longer routinely collected turbidity data for Kitsap County streams and marine waters.

4. Monitoring Strategy

A ***stratified random sampling*** strategy is used to determine current conditions and track long-term water quality trends.

Stratified random sampling involves some limited grouping of the population of interest, and then randomly sampling each group or stratum. This type of approach is often used in water quality sampling because certain parameters are known to vary by the time of day, season, precipitation levels and duration, or some other factor(s). The advantages of a stratified random sampling strategy include (MacDonald, 1991; Journel, 1989):

- Improves the efficiency of sampling;
- Provides separate data (i.e., data collected during different times, seasons, and weather conditions) on each stratum (or matrix); and
- Enhances the sensitivity of future statistical tests by separating the variability among the strata (e.g., station locations, surrounding land uses, etc.) from variability within the strata (e.g., season, time of day, tide cycle, precipitation conditions, etc).

A stratified random sampling approach is employed by both the Washington State Department of Health (DOH) Shellfish Program in their classification of commercial and recreational shellfish areas, and Ecology's Environmental Investigations and Laboratory Services Program for their ambient marine water monitoring for the Puget Sound Ambient Monitoring Program (PSAMP).

Both stream and marine water stations are typically monitored monthly to provide a base of continuous, widespread, long-term water quality monitoring results for Kitsap County. Monitoring results provide a basis for determining the following:

- Compliance with the state surface water quality standards (Chapter 173-201A WAC), National Shellfish Sanitation Program surface water criteria, and other applicable standards, criteria, or guidelines where applicable;
- Classification on the State's 305(b) and 303(d) Lists;
- Temporal changes and spatial differences in water quality between offshore and nearshore sampling locations, and between urbanized and rural based watersheds or waterbodies;
- Annual, seasonal, and rainfall related variability of marine water and stream quality;
- Changing water quality conditions and emerging problems or improvements; and
- Relationships with spatial patterns and temporal trends from other monitoring programs (i.e., DOH Shellfish Program, PSAMP, etc.).

Fecal coliform samples are analyzed at the Health District contracted laboratory, which is accredited by the Department of Ecology. Data on basic water chemistry parameters (temperature, dissolved oxygen, pH) may be collected in the field through the use of electronic monitoring equipment (Hydrolab® or YSI units). Weather and tidal information are collected through the use of published information and access to Internet sites. Rainfall data for Kitsap

County is provided by the Kitsap Public Utility District #1. If necessary, targeted parameters that cannot be analyzed by the Health District contract laboratory are sent to other Department of Ecology accredited laboratories. All applicable Puget Sound Estuary Program protocols and methods are followed.

5. Monitoring Parameters

The parameters monitored and analyzed under the marine and stream monitoring component include the following:

- Biological: Fecal coliform and E.Coli bacteria (E.Coli - lakes only).
- Conventional: Temperature, pH, conductivity, and dissolved oxygen (stream). Temperature and salinity (marine).
- Environmental: Rainfall amounts and tidal conditions.

5.A. Biological

The analysis for fecal coliform bacteria is the Health District's primary indicator of nonpoint pollution when evaluating surface water quality. The sample is collected in a 100 mL sterile water bottle, stored at 4^0C, and transported to the Health District laboratory for analysis.

The Health District laboratory has used the multiple-tube fermentation technique, also called the Most Probable Number (MPN) method, of fecal coliform analysis for surface water samples for samples collected prior to January, 2010. This analysis followed Fecal Coliform Procedure 9221-E, "Fecal Coliform Direct Test (A-1 Medium)", described in Standard Methods for the Examination of Water and Wastewater (APHA, 1998). This method of fecal coliform analysis uses dilutions of the water sample to obtain statistically valid MPN estimates of fecal coliform densities through gas production in the incubated samples.

As of January 4, 2010, the District switched to using the membrane filter (MF) method to analyze for fecal coliform. (Method 9222D) This change was made for the following reasons:

- Increases capacity of our contract laboratory to analyze fecal bacteria samples.
- This method gives a more accurate count of fecal colonies in the sample than MPN.
- The MF method costs less per sample which will save the District around $4600/year.
- The MF method is more environmentally friendly, producing less laboratory waste.

5.B. Conventional

Conventional parameters may be measured in the field using an electronic multi-probe sensor, such as Hydrolab® or YSI. Conventional data consist of temperature, pH, conductivity, salinity, and dissolved oxygen. This type of data was collected at stream

stations during trend monitoring events through September 2008. Temperature and salinity continue to be collected for marine stations.

5.C. Environmental

Environmental parameters are collected from outside data sources to assess weather and tidal characteristics that can influence water quality. These conditions are reviewed when conducting water quality data analyses.

In summary, the parameters, analytical procedures, method detection limits, and method accuracies are summarized in **Table 2** below.

TABLE 2
Analysis Methods, Detection Limits, and Accuracy

Parameter	Method of Analysis	Method Detection Limits	Accuracy
Fecal Coliform Bacteria (prior to 1/4/2010)	APHA Procedure 9221-E, MPN Fecal Coliform Direct Test (A-1 Medium)	2 to 1,600 col/100 mL (without dilution)	1 col/100 mL
Fecal Coliform Bacteria (after 1/4/2010)	APHA Procedure 9222-D, Fecal Coliform Membrane Filter	1 to 200 col/100ml (without dilution)	1 coliform/100 mL
Temperature	Field Meter: Hydrolab Model MS5, EPA Method 170.1	-5 to 50° C	± 0.1° C
pH	Field Meter: Hydrolab Model MS5, EPA method 150.1	0 to 14 units	± 0.2 units
Dissolved oxygen (luminescent)	Field Meter: Hydrolab Model MS5 , Hach Method 10360	0 to 20 mg/L	± 0.1 mg/L (<8.0) ± 0.2 mg/L (<8.0)
Specific Conductance	Field Meter: Hydrolab Model MS5, EPA Method 120.1	0 to 100 mS/cm	± .001 mS/cm
Salinity	Field Meter: Hydrolab Model MS5, SM2520B	0 to 70 ppt	± 0.2 ppt

6. Monitoring Station Locations

The number of stations actively monitored by the Health District varies from year to year. Currently the Health District has 198 active trend monitoring station locations (77 marine water and 121 stream). Detailed descriptions of each station are listed in Appendix A. Maps showing the location of trend analysis stations are provided in each annual water quality monitoring report prepared by the Health District. Station locations are determined through review and consideration of the following:

- Geographical and hydrological characteristics of each watershed;
- Kitsap County waterbodies on the state 303(d) List;
- Water quality results and findings from earlier watershed assessment projects;
- Types, locations, and densities of land uses within each watershed;
- Locations of public parks and recreational shellfish beaches;

- Monitoring station locations from other monitoring efforts (PSAMP, Public Utility District No. 1 of Kitsap County, etc.);
- "Positioning Protocols for Sampling in Puget Sound" (EPA, 1986A); and
- "Technical Guidance for Assessing the Quality of Aquatic Environments" (Ecology, 1992).

Precision, comparability, and reproducibility of station locations are achieved through the identification and documentation of major landmarks and road crossings (visual and descriptive), on-water triangulation, and identification of Geographic Positioning System (GPS) coordinates of latitude and longitude. The Health District boat is equipped with a Garmin GPSMAP unit to locate marine water stations in a consistent manner. Detailed sampling station lists, maps and descriptions ensure consistency in locating the stream stations.

6.A. Marine Water Stations

The majority of marine water stations are located in nearshore areas adjacent to potential sources of pollution such as:

- Stream mouths;
- Major stormwater outflows;
- Wastewater treatment plant outfalls or combined sewer overflows; and
- Marinas.

The purpose of siting the majority of marine water stations in these nearshore areas is to assess water quality and public health impacts to the areas most accessible to, or accessed by, Kitsap County residents and visitors.

Because tide changes mix marine waters, and water quality problems from one watershed may affect the water quality of another, several offshore marine water stations have also been established to provide background data for each major water body. This data compliments the ambient monitoring information currently collected through PSAMP.

6.B. Stream Stations

Most of the stream stations are located at, or near, the mouths of streams prior to their discharge to the marine environment. The purpose of siting stream stations at the mouths is to assess the cumulative impacts of the stream basin on overall stream water quality.

The remaining stream stations are sited at either strategic segment locations upstream of the mouth station and/or near the headwaters of the stream. Segment stations help to assess an individual segment's contribution to overall stream water quality and help to separate and identify pollution problem areas.

Nearly all of the stream stations are located in public access areas, such as road right-of-ways, to ensure unlimited and continued access to these sites over the long term.

7. Monitoring Schedule

Monitoring is conducted in ten (10) of the eleven (11) Kitsap County watersheds (the Health District does not conduct routine water quality monitoring on Bainbridge Island). All stream stations are monitored monthly, and the marine stations have been monitored monthly and semi-monthly at times.

This schedule enables Health District staff to capture major seasonal hydrographic conditions and makes our data more comparable to similar monitoring programs such as PSAMP and DOH Shellfish.

8. Monitoring Procedures

The monitoring procedures provided herein were developed from Health District and other established monitoring protocols identified in this document. These procedures do not address every possible monitoring situation. As such, guidance from the program manager should be sought in determining the best course of action during unusual circumstances.

8.A. Monitoring Event Preparation

Prior to conducting a complete and successful monitoring event, certain preparations must be made. Monitoring event preparations are coordinated by program staff and shall include the following:

- Checking and following the applicable monitoring schedule.
- Identifying the number and location of monitoring stations for that event.
- Identifying and scheduling field staff.
- Ensuring that the necessary field equipment will be available, calibrated, and ready for monitoring.
- Obtaining the correct type and number of sampling containers.
- Coordinating sample delivery and analysis/holding times with the receiving laboratory.
- Reviewing tide charts before planned monitoring events.
- Developing a monitoring route.

8.B. Equipment and Supplies Checklist

The Equipment and Supplies Checklist provided in **Table 3** below should be referenced by field staff prior to performing fresh and marine water monitoring events.

TABLE 3
Equipment and Supplies Checklist

General Monitoring Checklist	Additional Fresh Water Monitoring Checklist	Additional Marine Water Monitoring Checklist
Cooler with Ice Packs	Health District/Personal Vehicle	Tool Box
Sample Bottles	Waders	Boat Safety Box (Green)[1]
Sampling Wand	Hydrolab field storage tube	Health District Truck
Marking Pen		Health District Boat
Hydrolab MS5 and Surveyor		Boat Motor Oil (Truck)
Field book / pencil		Life Jackets (Truck)
Station List/Map		Cleaning Supplies[2]
Cellular Phone		
Digital Camera		

[1] The Health District's Boat Safety Box includes the following equipment and supplies: Radio, Garmin GPS Unit, Flares, Fire Extinguisher, Air Signal Horn, Flashlight, First Aid Kit, Boat Binder, Manuals/Instruction Books, and Marine Charts.
[2] Cleaning supplies are used to clean the boat and truck after a marine event and include the following: wash bucket, soap, sponge, and scrub brush.

8.C. Pre-Monitoring Activities

All field monitoring activities will be conducted in the same manner for all monitoring stations. The standard sequence of events for each monitoring site, where applicable, is as follows:

- Put on field gear and protective clothing appropriate for the sampling event and weather conditions.
- Park vehicle in a safe and clearly visible location that provides staff a safe exit from the vehicle.
- Enter monitoring event information in field notebook (see Section 8.E).
- Gather all applicable field equipment and approach the specific monitoring station

8.D. Monitoring Activities

The following text summarizes the applicable monitoring protocols used for fresh water streams and marine waters. Variations from approved monitoring protocols, when necessary, are noted. For specific information related to a monitoring protocol, please refer to the published document.

<u>Fresh Water Streams</u>

Fresh water stream samples are collected and analyzed according to the following monitoring protocols (as cited or as amended):

- "Recommended Protocols for Measuring Conventional Water Quality Variables and Metals in Fresh Water of the Puget Sound Region" (EPA, 1990); and

- "Guidance for Conducting Water Quality Assessments and Watershed Characterizations Under the Nonpoint Rule (Chapter 400-12 WAC)" (Ecology, 1995).

Fresh water stream stations will be monitored and sampled as follows:

- Stations shall be approached from a down-stream direction. Care shall be taken to avoid disturbing bottom sediments.
- The Hydrolab multisonde shall be deployed up-stream of the path of approach. As the Hydrolab is a sensitive piece of electronic equipment, care must be taken when deploying unit. In shallow water conditions, ensure the probes on the unit are submersed in the water.
- Once at the station location, sample containers to be used at that site shall be labeled per Section 8.F.
- Samples shall be collected while facing upstream (against the flow) at approximately 12 inches below the water surface, or at half the depth of the water column (when the depth of the stream is 23 inches or less). To address the fact that bacteria concentrate in the surface micro layer, sample bottles will be filled using the "U" scoop motion. The "U" scoop motion ensures that the sample will not be biased with micro layer bacteria. The sample will then be sealed, placed in a cooler and held at four degrees Celsius. Sample analysis will begin no later than 24 hours from collection.
- Data from the Hydrolab, along with any notes of interest, shall be recorded in the field notebook and/or the Hydrolab Surveyor.
- After the data is recorded, the Hydrolab shall be pulled from the water and placed in its field travel container until deployment at the next station.

Marine Water Monitoring Procedures

Marine water samples will be collected and analyzed according to the following monitoring protocols (as cited or as amended):

- "Recommended Protocols for Microbiological Studies in Puget Sound" (EPA, 1986B); and
- "Recommended Guidelines for Measuring Conventional Marine Water Column Variables in Puget Sound" (EPA, 1991).

In summary, marine water stations are monitored and sampled as follows:

- Each station is located through the use of the Garmin GPSMAP unit and the station description as described in Section 6.
- Stations shall be approached from a "down-current" direction. Care shall be taken to avoid stirring up bottom sediments by remaining in at least six feet of water.

- Once at the sample station, deploy the Hydrolab meter outside of the influence of the motor prop.
- Sample containers are labeled and filled using the "U" scoop motion. Samples shall be collected at approximately 15 - 18 inches below the water surface.
- Sample bottles are then sealed, immediately put into a cooler, and held at four degrees Celsius.
- Data from the Hydrolab, along with any notes of interest, shall then be recorded in the field notebook and/or the Hydrolab Surveyor.
- After the data is recorded, the Hydrolab shall be pulled from the water and placed in its travel container until deployment at the next station.

8.E. Field Data Documentation Procedures

Water resistant field books will be used during every monitoring event. Entries shall be made in pencil. Field books will be used to record, at minimum, the following:

- Sampling date and time;
- Field personnel present;
- Type of matrix (e.g., marine water, fresh water streams, etc.);
- Watershed or area being monitored;
- Hydrolab and Surveyor ID numbers for the units being used for the event;
- General weather conditions (e.g., dry or rainy, windy or calm, cloudy or sunny, air temperature);
- Sampling location identification number;
- Parameters monitored (e.g., water temperature, salinity or conductivity, dissolved oxygen concentration, etc.); and
- Related field observations (e.g., color and/or smell of water, potential sources of pollution observed, notes on sampling collection, etc.).

Area-specific precipitation amounts are retrieved from local rainfall stations established by the Kitsap County PUD No. 1. Tidal stage readings are retrieved from localized tide charts.

8.F. Sample Container Identification and Labeling Procedures

All sample containers must be marked with the pre-assigned monitoring site identification code. A complete list of all monitoring locations and their assigned sample identifications can be found in Appendix A of this document.

Field duplicate samples always end with the letter "R" (e.g., field samples DF01 & DF01R). Refer to Section 9., "Quality Assurance/Quality Control", for additional information regarding trip blank and field duplicate samples.

9. Quality Assurance and Quality Control

Quality assurance (QA) provides a process for ensuring the reliability and value of measured data (Lombard, 2001). Sound QA practices are essential to acquire data of the necessary type and quality for their intended use. To be scientifically and legally defensible, data must be of documented quality.

9.A. Data Quality Objective

The primary data quality objective of this monitoring program is to measure the concentration of fecal coliform bacteria and specified field parameters at the stream and marine water monitoring sites described in this plan, and to compare these results with state water quality standards. These results will be used to report compliance with the state standards and to report water quality trends over the long term.

9.A.1 Bias

Bias is considered the consistent deviation of measured values from the true value, caused by systematic errors in a procedure. Bias within the monitoring program will be reduced to the extent practicable by the following:

- Strict adherence to the sampling procedures of this plan;
- Complete data collection and organization;
- Regular and documented calibration and maintenance of field equipment.
- Periodic reviews and evaluations of field sampling procedures; and
- Analyzing data in an appropriate manner based upon essential considerations, such as temporal variations.

9.A.2 Precision

Precision is a measure of the variability in the results of replicate measurements due to random error (Lombard, 2001). Random errors are always present due to normal variability in the many factors affecting the measurement results. Precision will be determined by the following:

- Collection and analysis of field duplicates (not splits) for fecal coliform will be conducted for a minimum of 10%of the samples collected each monitoring day or event. When possible, duplicates will be collected from sites with expected higher concentrations of fecal coliform in order to determine variability of bacterial concentration.
- Calculation of the percent relative standard deviations (%RSD) of the pooled log transformed fecal coliform measurement results. Results pooled by magnitude will be evaluated allowing the higher percentage %RSDs of low values to be taken into account.

- Documentation of ongoing field equipment maintenance, calibration, and operation.

The total precision for field duplicate measurements should not exceed 10% RSD for results at or above 10 times the reporting limit. Precision up to 50% of the RSD for any lower field replicate results, and for the fecal coliform duplicates, is acceptable. At levels close to the method detection limit (marine water FC data typically is close to detection limit), %RSDs greater than 50% are to be expected and are acceptable. Duplicate samples that are "non-detects" shall not be used to measure precision.

Using this methodology, the overall variability will be calculated. Overall variability includes the natural environmental variability of the measured parameter, sampling variability, and lab variability (lab method and lab analyst). The overall variability of the parameter will be taken into consideration in the interpretation of the results.

9.B. Data Representativeness, Completeness, and Comparability

Representativeness of the analytical data is simply described as an adequate number of samples and monitoring events to determine water quality trends. Representativeness will be primarily achieved through the following:

- Strict adherence to the specific procedures of this plan including the selection of correct monitoring stations and methods;
- Thorough documentation of applicable environmental factors (e.g., weather and tidal conditions, observable changes, fish present, etc.); and
- Entering all applicable environmental information for each monitoring station into the water quality database for use in reporting data collected under this plan.

Completeness is considered and will be expressed as the percent of valid data obtained as compared to the amount of data planned for each particular reporting period.

Comparability of the data will be attained through strict adherence to the plan and thorough documentation of that adherence. The plan has been based on accepted protocols and procedures, and has been made consistent with other applicable monitoring efforts.

9.C. Field Quality Assurance

Quality assurance for the field monitoring activities covered under this plan will be achieved through documentation of the following:

- Consistent adherence to monitoring protocols identified within this plan; and
- A determination of whether the project objectives and data quality objectives have been met for specific set of data and information at the time of reporting.

With the beginning of the 2005 water year (October 1, 2004), "blue ice" packs and water have been used to cool and hold fecal coliform samples at 4°C. Previously only "blue-ice" packs were used. "Blue ice" is placed in the bottom of the cooler, samples are placed in a wire rack on top of the "blue ice", and then cold water is added until approximately 1" of the bottle is submerged.

9.C.1. Personnel Training

All field personnel will be trained in, and be required to demonstrate competency of, the monitoring components contained herein. The Program Manager will ensure that personnel are given first-hand field and data management training. The Program Manager will ensure that only trained personnel having demonstrated competency are allowed to perform the work contained in this plan.

The Program Manager will conduct periodic performance checks to ensure that staff adhere to the procedures described herein. The performance checks will be performed, at minimum, concurrent with the standard employee performance evaluation process.

9.C.2. Maintaining and Calibrating Field Equipment

Having well maintained and properly calibrated monitoring equipment is an essential element to collecting scientifically valid and defensible data of known precision and accuracy. Staff will reference the binder entitled "Hydrolab Probe Calibration & Maintenance Records" located in the Health District water quality laboratory, for detailed instructions regarding equipment calibration and maintenance activities.

9.C.3. Monitoring Procedures

Consistent and properly implemented monitoring procedures are an essential element to collecting scientifically valid and defensible data of known precision and accuracy. Staff will reference Section 8.0 for detailed instructions regarding monitoring activities.

9.D. Laboratory Quality Assurance

Laboratory QA/QC for the work covered under this plan will be assured through the lab's participation in the Washington State Department of Ecology accreditation program. The laboratory will follow the QA/QC requirements specified in standard analytical methods. See **Appendix C** for a description of the Health District's Standard Operating Procedures including QA procedures.

9.E. Data Management Quality Assurance

As discussed in Section 10 below, only acceptable high quality data will be entered into the water quality database and used for reporting purposes. Data will be reviewed by field staff for acceptance prior to being entered into the database. Health District staff should reference **Appendix B**, "Water Quality Database Data Entry and QA/QC Procedures," for a detailed explanation of the QA process for data entry.

10. Data Management, Assessment, and Reporting

Proper data management is essential to water quality assessment activities necessary for the completion of written reports. In-house data management activities include the following:

10.A. Data Review, Reduction, Database Entry, and Storage

All water quality data will be reviewed by staff prior to being accepted and entered into the Health District's water quality Access™ database. Data review requires that staff review all field notes and laboratory results prior to entering the data electronically. Staff will review this information to ensure the following:

- All required data sets have been included;
- Parameters monitored are characteristic of expected results; and
- Laboratory analytical results are characteristic of expected results.

Should Health District staff determine the dataset is either incomplete or includes uncharacteristic results, the Program Lead or Program Manager will be consulted for a decision regarding the validity of the data. Data may only be excluded with the approval of the Program Lead or Program Manager. Once it is determined that the data is acceptable, staff may begin performing data entry procedures. Health District staff should reference **Appendix B** of this document for specific data entry procedures.

All acceptable data collected through this program will be stored in two ways:

- The Water Quality Program central files, filed by watershed.
- Electronically in the Water Quality Microsoft Access™ database.

For each monitoring event the following documentation will be entered into the files:

- The printed database record entry sheet;
- Original copy of the "Chain Of Custody/Laboratory Analytical Results" form; and
- Original field notes from the field book.

The water quality database serves as the repository for acceptable data. Only data that meets the data quality objectives and quality assurance and control requirements (see Section 9.0) will be entered into the database. In this way, only valid data will be retrievable

from the database. All data input to the database will have a 100% review after input is complete to assure no transcription errors have occurred. The water quality database is automatically backed-up on a daily basis to minimize the loss of data caused by electrical or computer malfunctions.

10.B. Data Assessment and Reporting

Once data is entered into the database, it will be assessed by running standardized queries with the Microsoft Access™ database, and exporting the desired information from the water quality database to an Excel™ spreadsheet.

Annual Water Quality Monitoring Reports are prepared by Health District staff and distributed to SSWM, the local press, and other interested parties. More specific data summaries are available upon request. Water quality information is available through the Water Quality Program Homepage located at www.kitsapcountyhealth.com/environmenta_health/water_quality/wq_index.htm, and the Health District's public health advisory hotline number (800-2BE-WELL).

The Annual Water Quality Monitoring Report provides information to meet the monitoring objectives listed in Section 2.B. These reports typically include discussions of the following for ten of the eleven watersheds in Kitsap County:

- Watershed Background Information
- Watershed Focus Areas (State 303(d) listed waterbodies, shellfish classifications, and specific watershed water quality improvement projects)
- Annual Stream Monitoring Data and Long-Term FC Trends
- Annual Marine Monitoring Data and Long-Term FC Trends
- Annual Lake Monitoring Data and Long-Term Trends
- Monitoring Station Maps

Long-term FC trends are determined according to procedures described in **Appendix D**. To better define the precision of the fecal coliform sample results, the Annual Water Quality Monitoring Report will also include a discussion of the variability of the fecal coliform data collected. See Section 9.A.2 for a discussion of the procedure used to estimate variability.

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