Quality Assurance Project Plan

Old Stillaguamish River Channel Diel Surveys

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Old Stillaguamish River Channel Diel Surveys

October 2004

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User Study ID: SCOF0001

Approvals

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Abstract

The Old Stillaguamish River Channel is one of two channels connecting the Stillaguamish River to the Puget Sound in Western Washington State. Low freshwater inflow during the dry season causes the channel to function like a tidal slough. Segments of the Old Stillaguamish River Channel were included on the 1998 and Draft 2002/2004 Section 303(d) lists. Two modifications have recently been made in the Old Stillaguamish River Channel with the potential to affect water quality, including a reverse tide gate and upgrades to the City of Stanwood Wastewater Treatment Plant (WWTP).

The primary objective of the Old Stilliguamish River Channel diel surveys is to provide new water quality baseline data that reflects any changes the new tide gate may have on water quality in the channel. The data will help to determine the assimilative capacity of the Old Stillaguamish River Channel for a future Total Maximum Daily Load (TMDL) study addressing the 303(d) listings.

Background

Introduction

The Stillaguamish River runs from the Cascade Range to Port Susan of Central Puget Sound in Western Washington State (Figure 1). At river mile 2.75, the river splits into the Old Stillaguamish River Channel and Hatt Slough (Figure 2). The Old Stillaguamish River Channel was the primary channel to Port Susan until a series of floods redirected flow to Hatt Slough over 70 years ago. Hatt Slough provides a direct pathway to Port Susan; the Old Channel meanders for eight miles until it splits into the South and West Passes. The South Pass transports approximately 80 percent of the flow to and from Port Susan, and the West Pass transports the remaining flow to and from Skagit Bay.

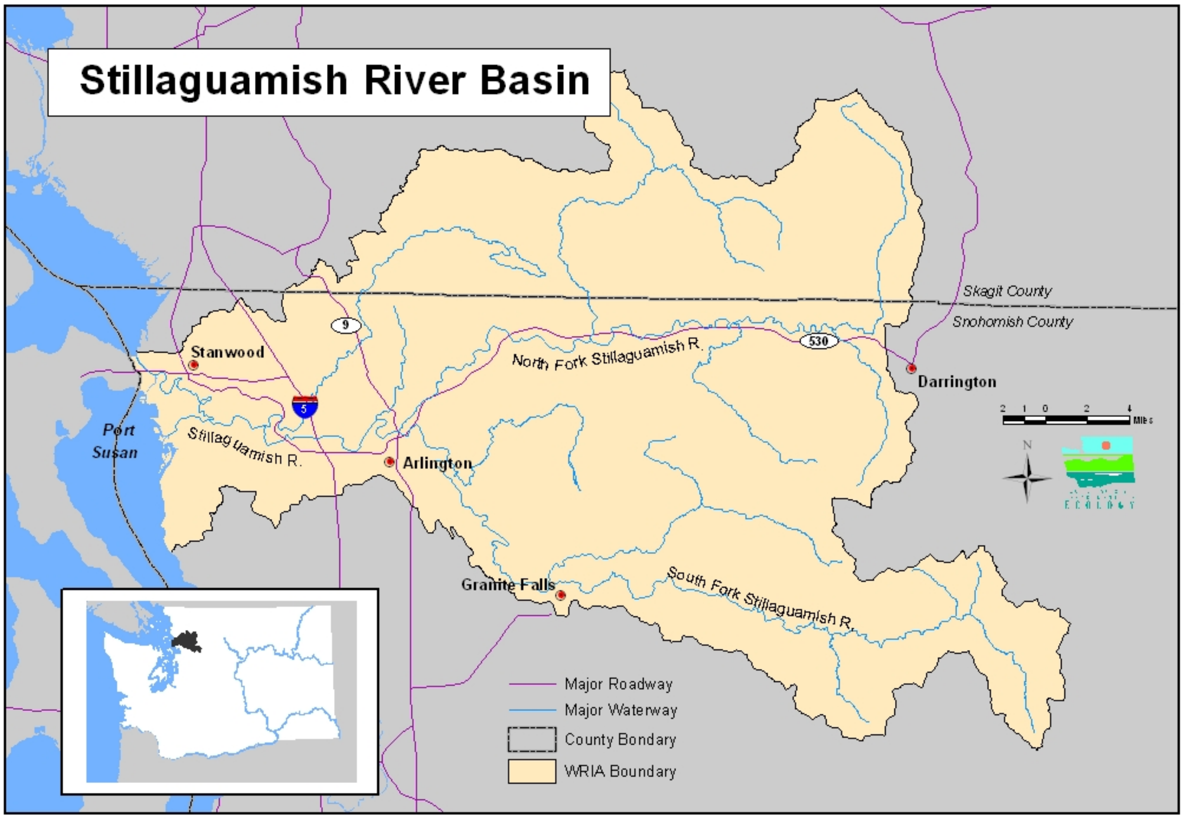

Figure 1. Overview of the Stillaguamish River Basin.

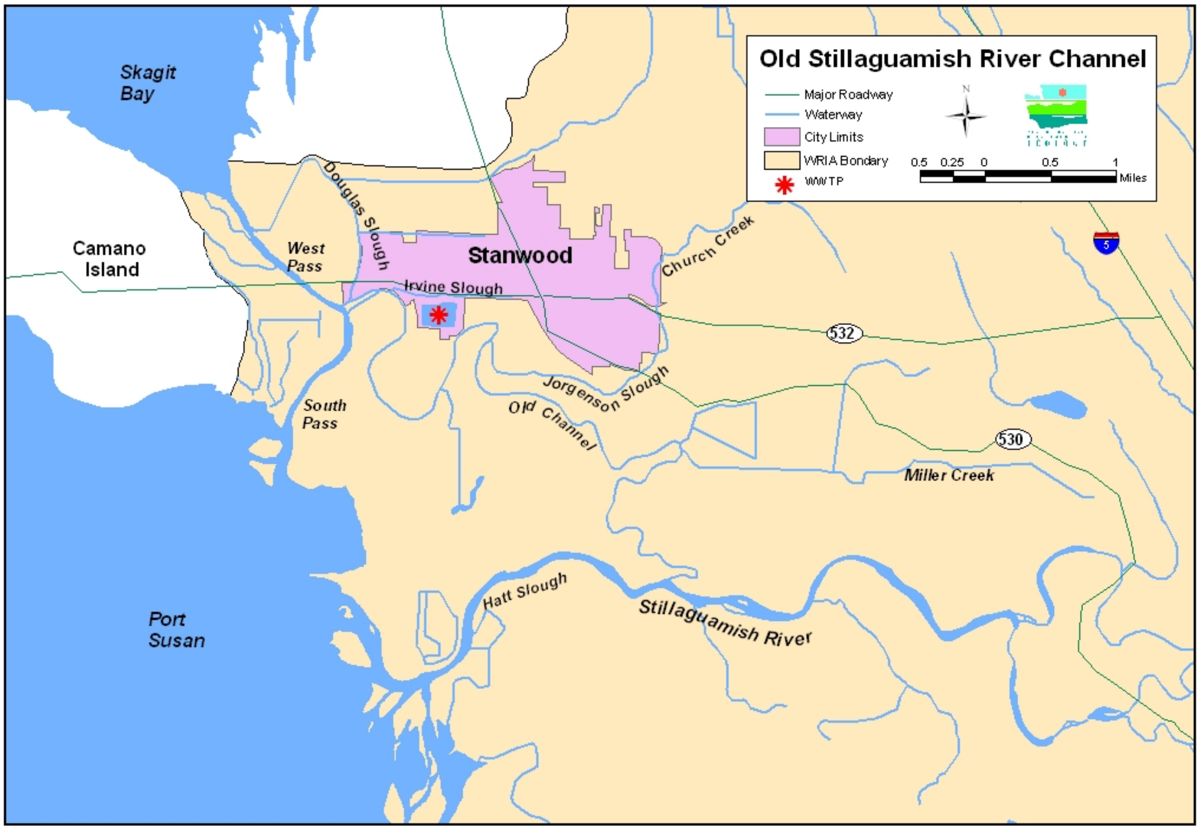

Figure 2. Overview of the Old Stillaguamish River Channel.

The major source of freshwater to the Old Stillaguamish Channel is the Stillaguamish River. Church Creek, Miller Creek, Jorgenson Slough, Irvine Slough, Douglas Slough, and multiple drainage ditches also discharge into the Old Stillaguamish River Channel (Figure 2). During the dry season, freshwater inflow from the Stillaguamish River, tributaries, and drainage ditches is limited and the Old Channel functions much like a tidal slough. During the wet season, the Old Channel is flushed by increased discharge from the Stillaguamish Basin. Fewer flood events in the past couple of years have resulted in a build up of sediment and vegetation in the Old Channel.

Land surrounding the channel is primarily privately owned and used predominately for agricultural purposes. The city of Stanwood (population est. 3,345) is located north of the channel and has an active urban growth area (Figure 2). The city operates a wastewater treatment plant (WWTP) that discharges into the channel. Twin City Foods, Inc. applies food processing wastewater onto land bordering the south end of the channel.

Water Quality Issues

The Old Stillaguamish River Channel and associated tributaries provide a passage for fish migration, habitat for wildlife, sites for secondary contact recreation, and a source of industrial and agricultural water. Federally threatened Puget Sound chinook salmon and bull trout use the Old Stillaguamish River Channel as a migration route.

Calculations estimate the flushing rate of the Old Stillaguamish River Channel to be three days during the dry season (Glenn, 1996). Poor flushing of contaminants may be contributing to water quality problems in the channel, especially upstream of the Stanwood WWTP outfall.

According to Chapter 173-201A of the Washington State Administrative Code (WAC), the Old Stillaguamish River Channel and associated tributaries are designated as Class A waterbodies. Some areas of the Old Channel qualify as Class A marine water because of salinity concentrations. Classifications are assigned based on general characteristics, characteristic uses, and water quality criteria.

In 1998, the Washington State Department of Ecology (Ecology) listed segments of the Old Stillaguamish River Channel on the Section 303(d) list of the Federal Clean Water Act as not meeting water quality standards for fecal coliform bacteria, ammonia, lead, copper, and nickel. The draft 303(d) list for 2002/2004 lists fecal coliform bacteria, temperature, fish habitat, dissolved oxygen, ammonia, and pH as parameters of concern in the Old Stillaguamish River Channel.

Water quality issues have also been reported in tributaries to the Old Stillaguamish River Channel. Jorgenson Slough was included on the 1998 303(d) list for not meeting water quality standards for fecal coliform bacteria (Table 1). It was listed again, along with Church Creek, Miller Creek, and Irvine Slough, on the draft 2002/2004 303(d) list (Table 1). Parameters of concern, listed on the draft 2002/2004 303(d) list, for tributaries to the Old Stillaguamish River include fecal coliform, fish passage, fish habitat, instream flow, and dissolved oxygen (Table 1).

Table 1. 1998 and Draft 2002/2004 Section 303(d) Listings for the Old Stillaguamish River Channel and Associated Tributaries.

Water Course #	Name	1998 303(d) Listings	2002/2004 Draft 303(d) Listings[1]
QE93BW	Old Stillaguamish River Channel	Fecal Coliform, Ammonia, Copper, Lead, Nickel	Fecal Coliform, Temperature, Fish Habitat, Dissolved Oxygen
GH05SX	Church Creek		Fecal Coliform, Fish Passage Barrier
GH05SX	Jorgenson Slough	Fecal Coliform	Fecal Coliform, Fish Habitat, Instream Flow
HS19KT	Irvine Slough		Fish Habitat
KX60NO	Miller Creek		Fecal Coliform, Fish Habitat, Dissolved Oxygen

[1] Categories 5 (TMDL required), 4 (Impaired but no TMDL required), and 2 (Waters of concern).

In 2004, Ecology completed a Total Maximum Daily Load (TMDL) study analyzing fecal coliform, dissolved oxygen, pH, mercury, and arsenic water quality violations in the Mainstem Stillaguamish River and Hatt Slough (Joy, 2004). Ecology plans to carry out a TMDL addressing water quality issues in the Old Stillaguamish River Channel and associated tributaries in the future.

Study Objectives

Two modifications have recently been made in the Old Stillaguamish River Channel with the potential to affect water quality. The local Flood Control District began operating a reverse tide gate at the head of the Old Channel during the 2003 low-flow period to enhance freshwater inflow. In 2004, the city of Stanwood upgraded the WWTP to improve effluent quality and increase capacity. The facility has requested a National Pollutant Discharge Elimination (NPDES) permit that would authorize continuous year-round discharge.

The Stillaguamish Tribe, in cooperation with the Stillaguamish Flood Control District, currently monitors several locations in the Old Stillaguamish River Channel on a quarterly basis. The tribe records instantaneous temperature, pH, conductivity, salinity, and dissolved oxygen data and collects fecal coliform, hardness, alkalinity, and total suspended solids grab samples.

Continuous monitoring data of parameters with strong diel changes are needed during critical seasonal events so diel minimums and/or maximums can be observed. The primary objective of the Old Stillaguamish River Channel diel surveys is to provide new baseline data that reflects any changes the new tide gate may have on water quality in the channel. The data will help to determine the assimilative capacity of the Old Stillaguamish River Channel when the TMDL evaluation is conducted.

Project Description

Two diel surveys will be conducted in the Old Stillaguamish River Channel during the 2004 low-flow period (July-September). Diel surveys will be scheduled to coincide with diurnal surveys of the channel performed by the Stillaguamish Tribe. During each diel survey, multi-probe data loggers will be deployed at three sites in the channel to log temperature, pH, dissolved oxygen, and salinity data every 30 minutes for 48 hours. Sites will be located along the upper end of the channel between the new tide gate and the Stanwood WWTP (Figure 3). Diel monitoring sites are listed in Table 2.

Table 2. Potential Monitoring Sites for the Old Stillaguamish River Channel Diel Surveys.

Ecology Station ID	Stillaguamish Tribe Station ID	Station Description	Latitude	Longitude
OSRC1	090	Old Stillaguamish River Channel at Norman Rd. bridge	48.2132 N	-122.3268 W
OSRC2	145	Old Stillaguamish River Channel off Florence Rd.	48.2213 N	-122.3310 W
OSRC3	165	Old Stillaguamish River Channel at Marine Dr. bridge	48.2257 N	-122.3382 W
OSRC4	066	Old Stillaguamish River Channel at private dock off Leque Rd.	48.2360 N	-122.3650 W

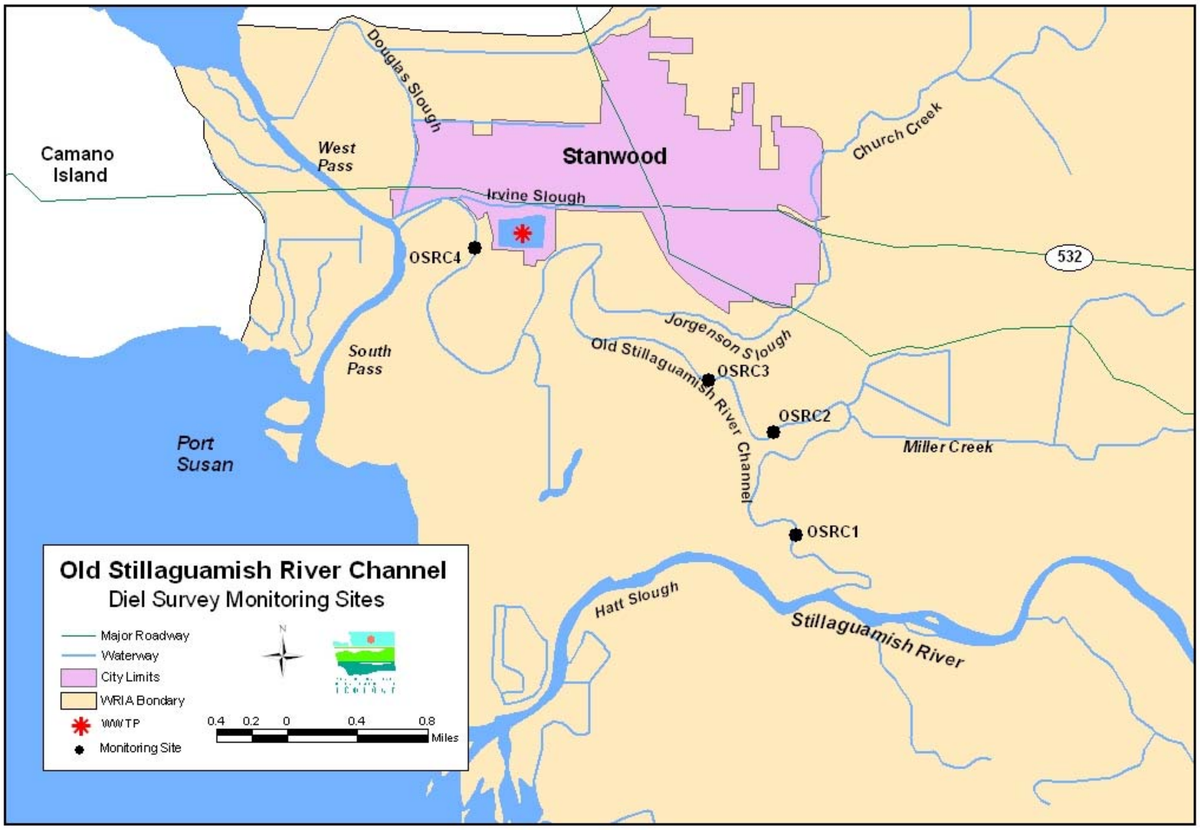

Figure 3. Potential Monitoring Sites for the Old Stillaguamish River Channel Diel Surveys.

Project Organization

The diel surveys will be conducted as a joint effort between Ecology and the Stillaguamish Tribe. Ecology will supply, calibrate, deploy, and pick-up the data loggers in addition to performing Winkler titrations of dissolved oxygen samples. The Stillaguamish Tribe will supply and calibrate field meters, collect instantaneous field data measurements, and perform mid-cycle checks of the data loggers. Ecology will prepare a Quality Assurance (QA) Project Plan and data summary of the diel survey results.

Methods and Data Quality Objectives

Field measurements, methods, and associated data quality objectives are outlined in Table 3. Ecology personnel will follow Watershed Assessment Section protocols when using the multi-probe data loggers and performing Azide-modified Winkler titrations (Ecology, 1993). Stillaguamish Tribe personnel will follow protocols set forth in their own standard operating procedures (SOPs) when operating their field meters. Stillaguamish Tribe SOPs for collecting dissolved oxygen, pH, temperature, and conductivity measurements are presented in the Appendix. An SOP for salinity measurements has not yet been written. The tribe currently uses conductivity readings to determine salinity using the Electrical Conductivity Method (APHA, 1998).

Table 3. Field Measurements, Methods, and Associated Data Quality Objectives Employed in the Old Stillaguamish River Diel Surveys.

Analysis	Method	Precision	Bias % Deviation from True Value	Required Reporting Limits Concentration Units
Dissolved Oxygen	Data logger/ field meter	NA	0.6 mg/L	0.1 mg/L to 15 mg/L
	Azide-modified Winkler[1]	0.2 mg/L	NA	0.1 mg/L to 15 mg/L
pH	Data logger/ field meter	0.05 s.u.	0.10 s.u.	1 to 14 s.u.
Salinity	Data logger/ field meter	<10% RSD[2]	5	0.1 ppt
Specific Conductivity	Data logger/ field meter	<10% RSD[2]	5	1 umhos/cm
Temperature	Data logger/ field meter	0.025 °C	0.05 °C	1°C to 40°C

[1] Ecology, 1993

[2] Relative Standard Deviation

Quality Control Procedures

Data loggers and field meters will be calibrated according to manufacturer instructions. Calibration data will be used to evaluate field measurement accuracy. Field meters will be used to monitor data logger performance at deployment, mid-cycle (~24 hours), and pick-up. Dissolved oxygen samples for Winkler titration will be used to monitor the performance of field meter and data logger dissolved oxygen probes. Field replicates of dissolved oxygen samples will be collected at a frequency of at least 10 percent to evaluate sampling precision. Field meter data may be adjusted for bias based on Winkler titration data.

Project Schedule

Project Task	**Expected Date of Completion**
Diel Surveys	Two 48-hour surveys; July through September 2004
Data Quality Assurance	November 2004
EIM Data Entry	December 2004
Data Transmittal Memo	December 2004

Data Reporting

Data collected during the Old Stillaguamish River Channel diel surveys will be reviewed for quality assurance, entered into Ecology's Environmental Information Management (EIM) system, and presented in a technical memo to NWRO and the tribe. The primary objective of the diel surveys is to provide updated background data. As a result, a report analyzing the data is not scheduled.

References

APHA, et al., 1998. Standard Methods for the Examination of Water and Wastewater. Twentieth Edition. American Public Health Association, American Water Works Association, and Water Pollution Control Federation. Washington D.C.

Ecology, 1993. Field Sampling and Measurement Protocols for the Watershed Assessments Section. Publication No. 93-e04. Environmental Assessment Program, Washington State Department of Ecology, Olympia, WA. http://www.ecy.wa.gov/biblio/93e04.html.

Glenn, N., 1996. An Analysis of the Effect of Discharged Wastewater on the Stillaguamish River at Stanwood. Publication No. 96-330. Washington State Department of Ecology, Olympia, WA.

Joy, J., 2004. Stillaguamish River Watershed Fecal Coliform, Dissolved Oxygen, pH, Mercury, and Arsenic Total Maximum Daily Load Study. Publication No. 04-03-017. Washington State Department of Ecology, Olympia, WA. http://www.ecy.wa.gov/biblio/0403017.html.

Appendix

Stillaguamish Tribe
Standard Operating Procedures (SOPs) for Collecting Dissolved Oxygen, pH, Temperature, and Conductivity Measurements

SOP-STILL-FM-1 – Dissolved Oxygen

STANDARD OPERATING PROCEDURES

January 10, 2003 – Revision 1. 4 pages

Title: **Dissolved Oxygen, Routine measurements: Membrane Electrode**

Purpose: To obtain accurate and precise measurements of dissolved oxygen in water and wastewater.

Summary: This procedure describes the methods and calibration of a dissolved oxygen meter and probe for the determination of dissolved oxygen in water and wastewater. Dissolved oxygen meters are used routinely in standardized laboratory and field monitoring regimes

The attached Standard Operating Procedure was prepared by:

____
Name and Title

____
Signature and Date Signed

The attached Standard Operating Procedure was reviewed by:

____
Name and Title

____
Signature and Date Signed

Follow only the most recent issue of this SOP

Dissolved Oxygen Measurements: Membrane Electrode

Methodology:

Method: EPA 360.1
EPA-600 / 4-79-020 Methods of Chemical Analysis of Water and Wastes.
EPA Office of Research and Development, Cincinnati, Ohio 45268
(March 1979)

YSI Model 51-B Operators Manual
YSI Model 85 Operators Manual

EQUIPMENT

Calibration and Use:

Instrument probes used for determining dissolved oxygen are dependent upon electrochemical reactions. Steady state conditions are necessary for proper and accurate readings. This requires the probe to be in thermal equilibrium with the solution or calibration media.

1) Before calibrating, allow probe to come to temperature equilibration with the media being measured. This could be in any body of water, stream or laboratory setting. Equilibrium is reached in about 1 min.
2) For field calibrations we will use the air calibration method. Refer to manufactures instruction manual attached to this SOP for precise procedures.
3) Compare air saturation readings with the values listed on the back of the DO meter or in the Tables for solubility of oxygen exposed to water saturated air. Also, refer to correction tables for high altitudes and low barometric pressure. In estuaries or marine waters it will be necessary to know the salinity of the water. Use the S-C-T Meter for salinity observations.
4) If readings are erratic or unreasonable it may be necessary to do one of the following checks:
    * Check battery condition. Replace if necessary.
    * Inspect rubber seals on the probe and calibration chamber for proper fit. Water must be excluded from the chamber.
    * Ensure that the end of the calibration chamber is open to atmospheric pressure.
    * Check and replace the membrane on the DO probe if damaged or oiled. See manufactures use and operations manual attached to this SOP.
5) Record DO readings on the data sheet. Be sure to take water temperature so % DO saturation can be calculated. In estuaries or marine waters record the salinity.
6) Leave the instrument ON between measurements to avoid the necessity to repolarize the probe.
7) Obtain duplicate readings at appropriate locations to satisfy QA/QC Protocols.
8) Store membrane electrode between analyses and when not in use in the airtight plastic bottle with moistened sponge.
9) Refer to SOP-STILL-QC-1; In-house Data Checks for mathematical computations and statistical evaluations.
10) All maintenance is to be recorded in the bound lab notebook. Examples of maintenance are; DO membrane replacement, new batteries, electrode cleaning, cable replacement and factory service.

DISSOLVED OXYGEN METER CALIBRATION AND USE

PROCEDURE

The procedures for preparing the oxygen probe, and the calibration procedures for using the oxygen meter are somewhat detailed. Rather than rewriting the guides, the manufacture's instruction and operation manuals for the dissolved oxygen meter and probe are attached to this SOP.

Calibration of the meter should be conducted prior to each day’s use. The results of the calibration will be noted. If calibration is not attainable then the troubleshooting guide is to be followed to solve the problem.

All maintenance is to be recorded in the bound lab notebook. Examples are; DO membrane replacement, new batteries, cleaning, and other pertinent information. Copies of this information should be placed into the Dissolved Oxygen notebook in the lab.

SOP-STILL-FM-1
STANDARD OPERATING PROCEDURES

Title: **Dissolved Oxygen, Routine measurements: Membrane Electrode**

This SOP is a guide for conducting and understanding dissolved oxygen measurements in freshwater, wastewater and marine environment. It is also to ensure that the best possible data is generated from field collection activities and laboratory analyses. From time to time, this SOP will be reviewed by staff for QA/QC purposes.

The attached Standard Operating Procedure for pH measurements was reviewed by:

Name and Title	Signature and Date Signed

Follow only the most recent issue of this SOP

SOP-STILL-FM-2 - pH

STANDARD OPERATING PROCEDURES

January 10, 2003 – Revision 1. 5 pages

Title: **pH; Routine measurements for surface waters; Electrometric Measurement**

Purpose: To obtain accurate and precise measurements of pH in water and wastewater.

Summary: This procedure describes the methods and calibration of a pH meter and associated electrodes. pH meters are used routinely in standardized laboratory and field monitoring programs. pH measurements will always be taken within the top 10 cm. of aqueous solutions and follow operations as recommended by the manufacturer.

The attached Standard Operating Procedure was prepared by:

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Name and Title

____
Signature and Date Signed

The attached Standard Operating Procedure was reviewed by:

____
Name and Title

____
Signature and Date Signed

Follow only the most recent issue of this SOP

pH: Calibration and routine measurements for surface waters; Electrometric Measurement

Methodology:

- Method: EPA 150.1
  EPA-600 / 4-79-020 Methods of Chemical Analysis of Water and Wastes.
  EPA Office of Research and Development, Cincinnati, Ohio 45268
  (March 1979)
- Orion 720-A Operators Manual
- Orion 250-A Operators Manual
- Water Quality: Basic Principles and Experimental Methods; J Richard Mayer,
  Huxley College of Environmental Studies. Western Washington University; Bellingham, WA. 1995 pp. 45-60

EQUIPMENT

Calibration and use:

- Combination glass pH electrode (recommend Orion 8102-BNC ™)
- pH meter
- Distilled or deionized water
- Wash bottle
- pH buffer solutions (4,6,7,8, and 10)
- Kimwipes™ or equivalent
- Electrode filling solutions
- Electrode storage solutions; saturated KCL
- Ring stand or support

PROCEDURE

Calibration and Use:

The procedures for determining pH values require special attention be given to the monitoring systems as a whole if valid data is to be obtained. Steady state conditions are necessary for proper and accurate readings. In-situ measurements are strongly desired. This requires the pH probe to be in thermal equilibrium with the solution or calibration media even though the probe and meter are temperature compensated.

When conducting field measurements, pH calibration results are entered on the field data sheets along with the time calibration occurred. Laboratory calibration checks are recorded and kept in the pH meter maintenance logbook. Serial numbers of pH probes are recorded on data sheets.

pH Calibration Procedures

Calibration:

1) Staff members shall read and be familiar with the operations manual provided by the manufacturer
2) New glass electrodes and those stored dry shall be conditioned and maintained as recommended by the manufacturer.
3) Before calibrating , allow pH probe and calibration standards to come to temperature equilibration with the media being measured. This could be accomplished by securing probe and standards to a support stand, placed in any body of water, stream or laboratory setting. Ten minutes is probably sufficient for field measurements.
4) Use of a meter with temperature compensation is preferable. If manual temperature compensation is to be used, adjust temperature according to manufacturers recommendations.
5) Choose two pH calibration buffers that will bracket your expected sample range. (i.e. pH 7 and either pH 4 or pH 10).
6) Immerse the electrode into the first reference buffer solution. Wait for a stable pH display. Determine the correct pH value by first reading the temperature of the pH buffer and then by using the pH buffer label, ascertain the correct pH value assigned for that temperature. Set the known pH of the reference buffer solution in accordance with the manufactures instructions.
7) Record this reading on the data sheet in the proper location. Also include the time The calibration was performed.
8) Rinse the electrode with distilled water. Blot gently and place into the second buffer solution. Wait for stable pH display. Determine the correct value as in step 6 above. Record this reading as in step 7 above.
9) Recheck the pH 7 buffer. Readings should be within 0.01units of the original setting. If readings are more than 0.05 units above or below the buffer value, recalibrate (steps 5 through 10).
10) For environmental sampling, record the values of buffers, pH 6, pH 7 and pH 8.
11) Rinse and blot electrode between measurements. They will be used as calibration checks during subsequent monitoring.
12) If erratic readings continue, consult the manufactures operating instructions.

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pH Routine Measurements

Use:

1) After calibration has been completed, rinse the electrode with distilled water and blot dry.
2) For stream monitoring, set a support stand into the water and secure the pH probe for the duration of the measurements. Care must be taken to avoid submerging the probe or getting the meter wet.
3) Gently place the electrode into the solution being measured.
4) Rotate the pH probe, in its holder, so that the frit is facing downstream. Avoid STREAMING conditions. (see manufactures operations manual) In rare cases a subsample of water may have to be tested.
7) When pH reading stabilizes, record to the nearest 0.05 unit. Also record the temperature to the nearest 0.1° C.
8) Leave the meter ON so that the calibration sequence doesn't have to be performed At each station. Simply measure and record the pH 6, pH 7, and pH 8 buffers at each station. If values for these buffers differ significantly from the initial calibrations, then recalibration will be necessary.
7) Insert the moistened protective sleeve over the pH probe during transport between sampling sites. Distilled or tap water is sufficient. Do not let the probe dry out.
8) When left overnight, the electrode should be placed into the electrode storage solution (saturated KCL).
10) All maintenance to the pH system is to be recorded in the laboratory notebook. Examples of maintenance are; new batteries, electrode cleaning, buffer solution replacement and factory service.

SOP-STILL-FM-2
STANDARD OPERATING PROCEDURES

Title: **pH; Routine measurements for surface waters; Electrometric Measurement**

This SOP is a guide for conducting and understanding pH measurements. It is also to ensure that the best possible data is generated from field collection activities and laboratory analyses. From time to time, this SOP will be reviewed by staff for QA/QC purposes.

The attached Standard Operating Procedure for pH measurements was reviewed by:

Name and Title	Signature and Date Signed

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SOP-STILL-FM-3 - Temperature

STANDARD OPERATING PROCEDURES

January 10, 2003 – Revision 1. 5 pages

Title: **Temperature; Routine measurements for surface waters: Thermometric**

Purpose: To obtain accurate and precise measurements of temperature in water and wastewater.

Summary: This procedure describes the methods for use and calibration of thermometers. Thermometers are used routinely in standardized laboratory and field monitoring programs for measuring temperature in water, air and other media. Thermometers are calibrated in the laboratory against a NIST certified thermometer prior to field sampling.
Temperature recording devices such as thermographs are calibrated before deployment and after recovery.

The attached Standard Operating Procedure was prepared by:

Name and Title

Signature and Date Signed

The attached Standard Operating Procedure was reviewed by:

Name and Title

Signature and Date Signed

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Temperature: Calibration and routine measurements

Methodology:

- Method: EPA 170.1
  EPA-600 / 4-79-020 Methods of Chemical Analysis of Water and Wastes.
  EPA Office of Research and Development, Cincinnati, Ohio 45268
  (March 1979)
- Water Quality: Basic Principles and Experimental Methods;
  J Richard Mayer,
  Huxley College of Environmental Studies. Western Washington
  University; Bellingham, WA. 1995 pp. 45-60

EQUIPMENT

Calibration and use:

Note:

If a certified NIST precision thermometer is used, then no additional calibrations are necessary. For non-certified thermometers, calibrations must be conducted.

* Certified NIST precision thermometer (for reference)
* Mercury-filled glass thermometer reading in ± 0.1 degrees centigrade (º C.)
* Water bath
* Hot plate
* Ice
* Rock sale (optional)
* Magnetic stir plate and stir bars.
* YSI Model 85; Operations Manual

PROCEDURE

Calibration and Use:

A temperature calibration at three points is recommended. Low, mid-range and high. Steady state conditions are necessary for proper and accurate readings. This requires the thermometers to be in thermal equilibrium with the water bath. Laboratory calibration records are kept in the thermometer maintenance log book. Serial numbers of thermometers are recorded on data sheets.

Temperature Measurements

<u>Calibration:</u>

1) Place a certified thermometer along with the other non-certified laboratory thermometers into a water bath at the temperature to be monitored.
2) If the water bath is placed on a magnetic stirrer, then stir bars can circulate the water and maintain a steadier water temperature. An insulated water bath may be necessary when calibrating thermographs at specific temperatures.
3) Rock salt and shaved ice can be used to achieve temperatures near 0 ° to 1° C.
4) Allow the thermometers to stabilize. Two or three minutes should be sufficient
5) When no changes are observed in 15 to 20 seconds, record the readings of all the thermometers on the calibration form. This is the <u>Certified Reading</u> or the NIST thermometer and the <u>lab reading</u> for non-certified thermometers. (see attachment 1)
6) If the lab thermometer does not match the <u>actual</u> certified thermometer temperature then:
    (a) either add or subtract the two numbers to derive the laboratory thermometer correction factor. (Example: if the certified thermometer temperature (corrected) of the water was 25.1° C and the lab thermometer reads 25.7 ° C, then the laboratory correction factor is – 0.6 ° C) Record this reading on the data sheet in the proper location.
    (b) label the laboratory thermometer with the current correction factor and date

8) Repeat this procedure for calibration points at different temperatures.
9) After calibration has been completed, thermometers are ready for field use. Frequency of calibration should be:
    (a) with newly purchased thermometers
    (b) every 6 months.

<u>Use:</u>

1) Submerse the thermometer into the sample. Read the temperature to the nearest 0.1 ° C after no temperature change has been noted for 15 to 20 seconds.
2) After the temperature has been accurately measured, apply the correction factor as labeled on the thermometer. This value is recorded as the actual temperature of the sample.

Thermometer Calibration Worksheet

NIST Certified Thermometer Number:____

Service Dates:____

Calibration of laboratory thermometers

NIST Certified Reading (º C)	NIST Correction Factor (º C)	Actual Temp. (º C)	Lab Thermometer/ Thermograph ID	Lab Thermometer Reading (º C)	Lab Correction Factor (º C)	Date	Initials

Laboratory Thermometer Number:	Service Dates

SOP-STILL-FM-3
STANDARD OPERATING PROCEDURES

Title: **Temperature; Routine measurements for surface waters: Thermometric**

This SOP is a guide for conducting and understanding temperature measurements. It is also to ensure that the best possible data is generated from field collection activities and laboratory analyses. From time to time, this SOP will be reviewed by staff for QA/QC purposes.

The attached Standard Operating Procedure for pH measurements was reviewed by:

Name and Title	Signature and Date Signed

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SOP-STILL-FM-4 – Specific Conductance

STANDARD OPERATING PROCEDURES

January 10, 2003 – Revision 3. 5 pages

Title: **Specific Conductance; Routine measurements for drinking, surface, and saline waters, as well as for domestic and industrial wastes.**

Purpose: To obtain accurate and precise measurements of conductivity in water and wastewater.

Summary: Conductivity (specific conductance) is a measure of the ability of water to conduct electricity. The standard unit is the “mho”, the inverse of electrical resistance (“ohm”). Conductivity is also an indirect way to estimate the total dissolved solids (TDS) in a water sample. Conductivity is generally reported as µmhos/cm at 25° C; or sometimes microsiemens/cm. (µS/cm x 1.0 = µmhos/cm)

The attached Standard Operating Procedure was prepared by:

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Name and Title

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Signature and Date Signed

The attached Standard Operating Procedure was reviewed by:

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Name and Title

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Signature and Date Signed

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Conductivity: Calibration and routine measurements

Methodology:

- Method: EPA 120.1 (Specific conductance, μmhos at 25° C.)
  EPA-600 / 4-79-020 Methods of Chemical Analysis of Water and Wastes.
  EPA Office of Research and Development, Cincinnati, Ohio 45268
  (March 1979)
- ASTM Designation; D 1125-82 (Standard Test Method for Electrical Conductivity and Resistivity of Water) 1989
- Water Quality: Basic Principles and Experimental Methods; J Richard Mayer, Huxley College of Environmental Studies. Western Washington University; Bellingham, WA. 1995 pp. 24-27

EQUIPMENT

Calibration and use:

- YSI Conductivity Meter or equivalent.
- Conductivity standards, traceable to NIST
- Magnetic stir plate or stirring hot plate
- Water bath
- Magnetic stir bars
- Baxter High Purity Water ® (Reagent Grade; Type 1) or equivalent
- NIST certified thermometer
- YSI Model 85; & Operators Manual

PROCEDURE

Calibration and Use: YSI Model 33 S-C-T Meter; SR# 91-D 027567

Note:

Calibration procedures for accurate conductivity measurements are dependent on the temperature of the solution being measured. Instrument instruction manuals from YSI should be read and understood prior to conducting calibration sequences. They are attached to this SOP. The following calibration and use sections are designed to provide a general overview of operations.

Calibration and Use: YSI Model 33 S-C-T Meter; SR# 91-D 027567

PROCEDURE

Calibration and Use:

The procedures for determining conductivity values are important especially when investigating waters with low concentrations of dissolved materials. The carbon dioxide normally present in the air can drastically change the conductivity / resistivity of pure waters. It is best to measure this value in-situ. The conductivity probe should be in thermal equilibrium with the solution or calibration media. Some conductivity meters are temperature compensated.
When conducting field measurements, conductivity data and temperature are entered on the field data sheets along with the time of observation. Laboratory calibration checks are recorded and kept in the conductivity meter maintenance logbook. Serial numbers of conductance probes are recorded on data sheets.

Specific Conductance Measurements

Calibration and use:

1) Staff members shall read and be familiar with the YSI Operators Manual provided by the manufacturer; particularly pages 1 and 2 attached to this SOP.
2) Cleaning and storage of the electrode should follow the recommendations of the manufacturer.
3) Before calibration begins, allow the conductivity electrode and calibration standards to come to room temperature, preferably 25.0° C. If the calibrating standards and probe are not exactly at 25.0° C, then a temperature compensating formula must be used to derive the true conductivity value after the measurement. Use of a meter with temperature compensation is preferable.
4) When taking field measurements, allow the probe to reach thermal equilibrium with the water being sampled. This could take 5 to 10 minutes depending on the water temperatures.

Standardization and Calculations:

1) The meter should be standardized using a standard solution of known conductivity. Begin with 0.010 M KCL, which has a conductivity of 1413 µmhos/ cm at 25.0° C. Use the following formula to determine the correct conductivity if the sample was measured at 25.0° C.:

$$K_{\text{sample, 25, corrected}} = \frac{1413\ \mu\text{mhos/ cm} \times K_{\text{sample, 25,}}}{K_{\text{standard, 25}}}$$

2) Samples are preferably analyzed at 25.0° C. A temperature correction can be applied to a conductivity measurement, $K_{t,}$, determined at temperature t, to correct the result to 25.0 ° C. Use the following formula to determine the correct conductivity if the sample was not measured at 25.0° C.:

$$K_{25} = \frac{K_{t,}}{1 + \left[0.0191 \times (t - 25)\right]}$$

OR

$$K_{\text{sample, 25, corrected}} = K_{\text{sample, measured at temp. (t)}} \left[A + B(t) + C(t)^2\right]$$

Where: $_{(t)}$ = Temperature of sample
Where: A = 0.5407
Where: B = 0.0173
Where: C = 0.000043

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SOP-STILL-FM-4
STANDARD OPERATING PROCEDURES

Title: **Specific Conductance; Routine measurements for drinking, surface, and saline waters, as well as for domestic and industrial wastes.**

This SOP is a guide for conducting and understanding conductivity measurements in freshwater, wastewater and in marine environments. It is also to ensure that the best possible data is generated from field collection activities and laboratory analyses. From time to time, this SOP will be reviewed by staff for QA/QC purposes.

The attached Standard Operating Procedure for pH measurements was reviewed by:

Name and Title	Signature and Date Signed

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