

# VOLUNTEER TRAINING MANUAL



## CITIZEN ENVIRONMENTAL MONITORING PROGRAM (CEMP)

**Fourth Edition  
April 2008**



*Prepared by:*

**Anchorage Waterways Council  
P. O. Box 241774 Anchorage, Alaska 99524-1774  
ph: (907) 272-7335 fax: (907) 277-9207  
e-mail: [monitoring@anchoragecreeks.org](mailto:monitoring@anchoragecreeks.org)  
website: [www.anchoragecreeks.org](http://www.anchoragecreeks.org)**

## ACKNOWLEDGEMENTS

**A**nchorage Waterways Council thanks the many people and organizations that helped make the AWC Monitoring Program a reality. Special thanks to the Cook Inlet Keeper, the U.S. Environmental Protection Agency and the Alaska Department of Environmental Conservation for their support.

And of course we cannot forget the most important resource of all - our volunteer monitors - who have endured cold winds and waters to help us understand the waterways of Anchorage.

AWC adapted the information in this manual from the Volunteer Training Manual for Cook Inlet Keeper's CEMP. Information from this manual can be used freely if properly credited.

### OUR CONTACT INFORMATION

**Mailing Address:**

Anchorage Waterways Council  
P.O. Box 241774  
Anchorage, Alaska 99524-1774

**Physical Location:**

Anchorage Waterways Council  
1565 Bragaw St., Suite 205  
Anchorage, Alaska 99508

**Phone, Fax & Email**

ph: (907) 272-7335  
fax: (907) 277-9207  
e-mail: [monitoring@anchoragecreeks.org](mailto:monitoring@anchoragecreeks.org)

# TABLE OF CONTENTS

<b>I.</b>	<b>INTRODUCTION.....</b>	<b>1</b>
<b>II.</b>	<b>ABOUT THE ANCHORAGE WATERWAYS COUNCIL.....</b>	<b>1</b>
<b>III.</b>	<b>WHY DO WE MONITOR WATER QUALITY?.....</b>	<b>2</b>
<b>IV.</b>	<b>SAFETY &amp; ACCESS ISSUES.....</b>	<b>3</b>
<b>V.</b>	<b>MONITORING OVERVIEW.....</b>	<b>6</b>
<b>VI.</b>	<b>MONITORING PROCEDURES.....</b>	<b>9</b>
<b>VII.</b>	<b>EQUIPMENT CARE &amp; WASTE DISPOSAL.....</b>	<b>22</b>
<b>VIII.</b>	<b>DATA MANAGEMENT &amp; REPORTING.....</b>	<b>24</b>
<b>IX.</b>	<b>QUALITY CONTROL.....</b>	<b>25</b>

## APPENDICES

<b>A.</b>	<b>Glossary of Terms.....</b>	<b>26</b>
<b>B.</b>	<b>Monitoring Policy Statement.....</b>	<b>32</b>
<b>C.</b>	<b>References &amp; Further Reading.....</b>	<b>34</b>
<b>D.</b>	<b>Odor Identification.....</b>	<b>37</b>
<b>E.</b>	<b>CEMP Test Parameters.....</b>	<b>39</b>
	<b>i. Coliscan Colony Color Guide.....</b>	<b>57</b>

# **I. INTRODUCTION**

The purpose of this Manual is to provide Anchorage Waterways Council volunteers with the information needed to monitor water quality in Anchorage watersheds. As human activities in the region continue to expand, it is increasingly important for us to understand the effects of such activities on Anchorage's spectacular resources. This Manual will help achieve that goal by giving citizens the tools they need to sample and test water quality. The material in this manual was developed specifically for use by the Anchorage Waterways Council.

This Manual provides specific step-by-step instructions for all monitoring procedures currently included in AWC's baseline Monitoring Program, based on Citizens' Environmental Monitoring Program (CEMP) protocols. It outlines the Anchorage CEMP monitoring program, and describes the importance of water quality monitoring in general. Safety and access issues are addressed as well as basic water quality monitoring strategies. The Appendices include a detailed description of the testing parameters, a glossary of terms, a list of references for those who may want to learn more, plus a variety of charts and tables to assist you in collecting data.

We welcome your comments, suggestions and participation, and we thank everyone who has volunteered their time, expertise and support. In these times of shrinking federal and state budgets, volunteer monitoring plays an increasingly important role in collecting the data needed to make intelligent decisions about the future of Municipal creeks, and ultimately - Cook Inlet. Federal and state agencies, local governments, schools and businesses can use the data we collect. Everyone involved in the CEMP is making a real contribution toward protecting the watersheds in Anchorage and their spectacular resources.

# **II. ABOUT THE ANCHORAGE WATERWAYS COUNCIL**

The Anchorage Waterways Council is a 501(3)(c) non-profit, member-based organization dedicated to protecting, restoring and enhancing the creeks, lakes and wetlands of Anchorage. Since its inception in 1984, the AWC has involved the community in grassroots watershed projects, such as Creek Cleanup.

The AWC remains the only citizen-based organization exclusively focused on protecting, enhancing and restoring Anchorage waterways. We work primarily through public involvement and education, grassroots advocacy, and collaborating with a network of partners. By having this broad-based connection to the community, we are able to take innovative and cost-effective watershed approaches to fulfilling our mission.

The AWC fosters watershed stewardship and provides outdoor opportunities to the citizens of Anchorage by involving them in the collection of baseline data for surface waters in the Municipality of Anchorage.

The AWC is working in partnership with the Cook Inlet Keeper, Wasilla Soil and Water Conservation District, the Kenai Watershed Forum and other groups to accumulate data on the waters that make up the Cook Inlet. This information will help us assess the conditions, trends and affects of our actions as a network of communities living within a larger watershed. By working together we will have better information and a stronger voice in caring for the places that we live.

In addition to water quality monitoring, AWC engages in a variety of education, outreach and advocacy activities designed to protect Anchorage waterways. For more information, visit AWC's webpage at: [www.anchoragecreeks.org](http://www.anchoragecreeks.org), stop by the AWC office or contact us at: ph: (907) 272-7335; e-mail: [monitoring@anchoragecreeks.org](mailto:monitoring@anchoragecreeks.org).

### **III. WHY DO WE MONITOR WATER QUALITY?**

#### **A. THE NEED FOR MONITORING**

Alaska is commonly presumed to have pristine, unaffected ecosystems. "The vast majority of Alaska's watersheds, *while not being monitored*, are presumed to be in relatively pristine condition..." (Alaska 1996 Water Quality Assessment Report, EPA).

Yet, between 1950 and 2000, Anchorage's population has doubled twice, from just over 30,000 to more than 250,000 people. Such growth has accelerated the surface runoff of trace elements, hydrocarbons, and bacteria to Anchorage streams. The EPA's 1998 list of water quality-limited waters, showed that of the 58 waters in Alaska listed as "impaired," 15 are located in Anchorage.

No long-term water-quality monitoring stations are operated in Anchorage, and as state and federal budgets for water-quality monitoring continue to decline, citizens have stepped in to gauge the health of our viable yet stressed public resources.

As the State of Alaska and the Municipality of Anchorage work to develop watershed management plans, basic information about Anchorage creeks is being met by AWC volunteer monitors.

Since 1998, the AWC's Monitoring Program has trained hundreds of volunteers to collect baseline water-quality data which are used to identify water quality trends and detect pollution. Although numerous organizations have conducted a variety of tests and studies in Anchorage, this is the only program that has created and maintained a comprehensive, continuous water-quality monitoring program. Without this valuable information, the ability to properly manage and protect water resources is diminished.

#### **B. THE WATERSHED CONCEPT**

Watershed-based water quality management is just taking hold in Alaska. Cook Inlet resource managers and citizen groups are quickly moving toward innovative ways to look at water quality

policy. In short, watershed-based directives take a step back from looking at pollution sources and impacts in immediately local areas, and strive instead to look at the complex ecological, chemical and physical interactions of water quality dynamics from a broader, more holistic perspective. This means we must consider the larger geographic area which drains potentially polluting waters into Cook Inlet. For example, a watershed perspective will consider not only the industrial discharge which goes directly into Cook Inlet, but also the septic tanks and other potential pollution sources in the uplands of Anchorage.

### **What is a Watershed?**

A watershed is the land area which drains into a common body of water. As a result, specific watersheds are defined by their receiving waters. The Cook Inlet watershed (i.e. the land area which drains into Cook Inlet) covers over 39,000 square miles. It stretches from the tip of the Kenai Peninsula, across the Kennedy entrance and up through the Susitna River Valley, and includes nearly 2/3 of Alaska's population. There are numerous smaller watersheds "nested" within the Cook Inlet watershed, such as the Kachemak Bay watershed, the Kenai River watershed and the Ship Creek watershed. The AWC strives to address environmental issues on a watershed-basis because nature's complex physical, chemical and biological processes are more-readily understood using such integrated methods.

## **IV. SAFETY & ACCESS ISSUES**

Of paramount importance to the Anchorage monitoring program is to ensure the safety of its volunteers. Assuring reasonable and legal access to sampling stations is another important concern. Please read this section carefully and make sure you understand all the safeguards and practices for protecting yourself and others during monitoring activities. See Appendix E for the AWC's mandatory liability release form.

### **A. PREPARE FOR THE ELEMENTS**

Although there are hundreds of volunteer monitoring programs across the country, few if any, must contend with the severe weather and rough water that make Anchorage unique. As a result, CEMP volunteers must be prepared for cold, dark and wet conditions during the winter months, and wind, rain and extended sun during the summer months. Regardless of the season, water temperatures around Anchorage rarely exceed 50° F, making it necessary to always take care around the sampling station. Here are a few rules which all volunteers must follow:

- ✓ *ALWAYS LEAVE WORD with a reliable source as to where and when you will be sampling.*

- ✓ *ENSURE SUFFICIENT SUPPLIES (e.g. food, water, clothes, fuel, flashlight/batteries, cellular phone) to sustain you and other team members in the event of an emergency.*
- ✓ *DRESS APPROPRIATELY FOR ALL POSSIBLE WEATHER CONDITIONS. Anchorage is notorious for its rugged, fast-changing weather, and volunteers should be prepared with the necessary footwear (e.g. waterproof boots), raingear, gloves, hats, coats, long underwear, sunblock, etc... Remember that you will be outside, remaining fairly still, for 40 to 60 minutes. You may slosh water on yourself. Layered clothing, gloves, and boots are important in colder weather. Wool and polypropylene are the best fabrics to wear to retain body heat when wet.*
- ✓ *SAMPLE WITH A QUALIFIED PARTNER. Volunteers are assigned to monitoring teams when possible and should strive to sample in groups of two or more. You will be given the names and phone numbers of each member of your team as well a list of alternate monitors. If your teammates are not available for a particular sampling event they are responsible for helping you locate a qualified alternate. If no trained alternate is available, please contact the Monitoring Coordinator for assistance.*

## **B. PROTECT YOURSELF AND YOUR EQUIPMENT**

AWC's water quality monitoring kits include a number of chemical reagents which can be harmful if improperly handled or disposed. Please follow these important rules when sampling and testing:

- ✓ *Read all instructions to re-familiarize yourself with the test procedures before you begin, and note all precautions.*
- ✓ *Read the label on each reagent before use. Some containers include precautionary notices or material safety data sheets (MSDS) which provide important safety information. The AWC maintains MSDS on all chemicals and reagents used, and these are provided monitors upon training.*
- ✓ *Avoid contact between chemicals and skin, eyes, nose and mouth.*
- ✓ *Wear safety goggles or glasses and rubber gloves when handling chemicals*
- ✓ *Use test tube caps or stoppers, not your fingers, when shaking or mixing reagents.*
- ✓ *When dispensing a chemical from a squeeze bottle, hold the bottle vertically upside-down (not at an angle) and squeeze gently.*
- ✓ *Rinse test tubes and other containers after use, cap all reagents tightly and wash and dry your hands after each test session.*

- ✓ *Wipe up any chemical spills immediately and dispose of chemical wastes in appropriate waste containers at the AWC office, or flush with plenty of water if your wastewater system does not empty into a septic system.*
- ✓ *Keep all equipment and chemicals out of the reach of young children.*
- ✓ *Avoid prolonged exposure of equipment and reagents to direct sunlight, and protect them from extreme high and low temperatures. Check your reagent solutions for cloudiness or the formation of precipitates. If any of your reagents appear abnormal, call (907) 272-7335 or email [monitoring@anchoragecreeks.org](mailto:monitoring@anchoragecreeks.org) and the Monitoring Coordinator will supply a replacement. Postpone your sampling session until you get the new reagents.*
- ✓ *Check your thermometers to make sure that the fluid inside has not separated, as separation will cause inaccurate readings. If your thermometer fluid has separated, contact the Monitoring Coordinator for a new one.*
- ✓ *In the event of a chemical accident or suspected poisoning, immediately contact the Poison Information Center (1-800-478-3193) and be prepared to provide the name and identification number of the relevant chemical. This information is located on the reagent container. In emergency always call 911.*

## **C. ACCESSING THE SAMPLING STATION**

### **1. Entering Private Property**

Although the State retains ownership of marine tidelands up to the mean high tide line in most places, accessing those areas - and accessing freshwater streams and creeks in the uplands - may involve crossing private property. While access to government land (e.g. state, federal, borough, city) typically is presumed, volunteer monitors must obtain express authorization from private property owners if the volunteer enters or crosses the property owner's land at any point during sampling activities.

The first rule of monitoring on or around private property is NEVER TRESPASS. To avoid unintended trespass, please check the land ownership maps in the AWC office prior to occupying your monitoring station, and obtain written authorization from property owners as needed. See Appendix G for private property access authorization forms.

### **2. Safe & Sound Site Access**

Weather, daylight, rugged terrain, wild and domestic animals and other access issues can impact your sampling efforts. Although sampling stations should be selected in ways that promote accessibility, sometimes the only way to get to a particular waterbody is through or over rugged terrain. In such cases, the monitor should ensure that she/he is fully

prepared - physically and otherwise - to get in and out of the site. Furthermore, because a primary purpose of the AWC monitoring efforts is to promote sound stewardship practices, volunteers should always avoid streambank trampling or accelerating waterside erosion. Here are a few other rules for ensuring a safe and sound sampling experience:

- ✓ *If driving, park your vehicle off roads and out of the way of traffic. Always watch for traffic.*
- ✓ *Use common sense in approaching your site and approach your site carefully. Mud, exposed roots, steep slopes and ice can pose dangerous access problems. Walking sticks, ice axes, toe cleats and other equipment can help make access safer. Getting samples is important, but not at the risk of injury.*
- ✓ *Bring a flashlight to guide you during dark or overcast conditions.*
- ✓ *Take appropriate precautions around domestic and wild animals.*

## **D. AT THE MONITORING STATION**

Prior to sampling, monitors should check their kits and reagents to ensure they have all the chemicals and equipment needed to monitor the full spectrum of parameters. When you arrive at the sampling station, try to find a place to set out your equipment and chemicals where they will not be sitting in strong, direct sunlight. On windy days, beware of small containers being blown into the water. And of course, follow all the safety and access rules outlined in this section.

## **V. MONITORING OVERVIEW**

This section provides a general overview of the tests and procedures you will use to obtain accurate and useful data, and discusses how these tests will help us better understand the health of the Anchorage watersheds.

### **A. SOME TYPES OF WATER QUALITY MONITORING**

#### **1. Baseline Monitoring**

Baseline monitoring involves the collection of various types of data to gain an understanding of "normal" conditions in a particular waterbody. Without such information, we are unable to know what changes human and other impacts are having on our aquatic systems. For example, during the *Exxon Valdez* disaster, biologists were poorly equipped when asked about the ecological impact of the spill. Although they knew that birds and marine mammals were dying, they did not have enough information to make knowledgeable comparisons between the pre- and post-spill environments. This

body of knowledge is critical if we hope to understand the complex effects of human activities on ecological health.

## **2. Compliance and Enforcement Monitoring**

Compliance and enforcement monitoring, as the name suggests, tests whether a certain discharge or effluent is meeting limits imposed by law. For example, under the Clean Water Act's National Pollution Discharge Elimination System (NPDES), anyone who discharges a pollutant into the waters of the United States must obtain an NPDES permit and monitor the discharge to ensure compliance with that permit. In an enforcement scenario, an agency or other organization may take samples to demonstrate that a violation of a permit or standard has occurred.

# **B. WATER QUALITY TEST METHODS**

Below are descriptions of general water quality testing methods, to help clarify how each one works in AWC's monitoring program. Always follow the specific instructions provided in Section VI of this manual.

## **1. Titrimetric**

Titrimetric analyses are based on adding a solution of a known strength (i.e. the titrant) to a specific volume of a treated sample in the presence of an indicator. The indicator produces a color change indicating the reaction is complete. Titrants are generally added using a titrator (graduated dropper) or a precise glass pipette. The Winkler method for measuring dissolved oxygen is an example of a titrimetric analysis.

## **2. Colorimetric**

Colorimetric tests measure the concentrations of various substances by gauging the reaction of an indicator with a known sample amount, and comparing the resulting color with a known range of values. For example, pH is a measure of the concentration of hydrogen ions (i.e. the acidity of the solution) determined by the reaction of an indicator that varies in color depending on the hydrogen ion levels in the sample water. The sample's color is then visually compared to a known range of pH values using an Octet Comparator.

## **3. Electronic Meters**

Specific electronic meters are manufactured for field and laboratory tests of various water quality factors. The AWC uses the Hanna 'Combo' Meter tests for pH, conductivity, temperature and Total Dissolved Solids. Electronic meters must be calibrated periodically to ensure accurate test results.

## **C. SAMPLING SCHEDULE**

Samples are to be taken on the second and fourth Sundays of each month during the months of May, June, July and August and on the fourth Sunday of each month during the remainder of the year (i.e. September through April) for a total of 16 times per year. If monitoring cannot be done on a designated Sunday because of weather, illness, vacations, or for other reasons, it should be scheduled during the day just before or just after the designated date (i.e. Saturday through Monday). If you know in advance that you are going to miss a sampling event altogether, please contact the Monitoring Program Director as soon possible so a replacement can be arranged. "Rovers" are in place to help back up regular monitors in these instances. Please do not complete part of a session one day and finish it up the next. If for some reason you can not complete the entire sample in one day (due to weather, injury, etc.), all procedures should be repeated on the next attempt. We are trying to get a data "snapshot" of the conditions at your site at a particular date and time.

To the extent possible, sampling is to be conducted at 2:00 PM. When this is not possible sampling should be done between the hours of 11:00 AM and 5:00 PM. Some of the parameters to be measured depend on the amount of sunlight available and therefore vary throughout the day - for example, temperature in shallow areas or dissolved oxygen. The shorter days of the winter months pose particular challenges here. Essentially, we have specified a "sampling window" in order to collect comparable data.

The quality of the data collected by our program depends on regular and consistent monitoring. If you anticipate missing an event (for example, if you are going on vacation), it is your responsibility to make arrangements with a trained alternate. If the alternate is not on your monitoring team, make sure they know the exact location of the site. If no trained alternate is available, or in an emergency, please contact the Monitoring Director at (907) 272-7335. It is mandatory that all monitoring be conducted by fully trained personnel. Please do not try to give novices a quickie training session and then send them out on their own. (But feel free to bring them to our next "official" training session - we are always looking for new recruits!)

## **D. SURFACE WATER QUALITY MONITORING KITS**

AWC has adopted the LaMotte shallow water monitoring kit, (with several modifications) to monitor the freshwater sources in the Municipality of Anchorage.

## **E. MONITOR DATA SHEETS**

All data should be recorded on the standardized data sheets provided by the Monitoring Director (Appendix I). Data sheets are printed on "Rite-in-Rain" paper, which is designed to hold up to outdoor conditions better than standard copy paper. Please keep an ample supply of these sheets on hand and use a fresh one for each sampling event at each site. If you are running low, call (907) 272-7335.

Data should be entered using a fine-point "Sharpie" or other indelible marker. If the data sheet is wet and the Sharpie won't write, use a #2 pencil and go over it with a Sharpie when the sheet dries. If you make a mistake, draw one line through the characters in question, enter the new characters to the immediate right of the lined-out entries, and initial the change immediately after the new characters.

It may not always be easy under field conditions, but try to write as legibly as possible, especially when entering numbers. All numeric data should be entered in the appropriate spaces, using the decimal places provided on the form. When entering temperatures, please remember to specify if they are negative. All letters and words should be printed. Record all of your observations and test results as you go along; don't rely on memory!

The first data you record on your data sheet should be the printed names of the monitors, the name and number of the station, the date, and the time. When entering the time be sure to circle either AM or PM.

Finally, do not forget to have all monitors sign the data sheet when testing is complete!

## **VI. MONITORING PROCEDURES**

This section provides a step-by-step guide to the proper field and laboratory techniques needed to successfully obtain credible water quality data.

### **A. FIELD PROCEDURE CHECKLIST**

Below is the recommended order in which to conduct your tests. This order tends to maximize your efficiency. These instructions can also be found in the Field Procedures Guide which you bring with your kit into the field.

- 1) *Calibrate Hanna Meter & record calibration numbers (should be completed at home!)*
- 2) *Travel to site and hang your air thermometer*
- 3) *Record the following information on the data sheet: your name, the date, the time, your site ID*
- 4) *Collect water sample in bucket*
- 5) *Collect bacteria sample*
- 6) *Place water thermometer and Hanna Meter in bucket*
- 7) *Fix Dissolved Oxygen*

- 8) *Record Water Temp #1*
- 9) *Record site information (weather, sketch, photos, air temp)*
- 10) *Record water temp #2 (must be within 5 minutes of recording water temp#1)*
- 11) *Hanna readings*
- 12) *Note apparent color*
- 13) *Turbidity*
- 14) *colormetric pH*
- 15) *Titrate Dissolved oxygen*
- 16) *Ortho-Phosphate*
- 17) *Nitrate*
- 18) *Record total volunteer hours and check data sheet for completeness*
- 19) *Plate Bacteria*
- 20) *Clean equipment for next sampling event*
- 21) *Read bacteria plates and record bacteria data.*
- 22) *Adjust volunteer hours and check data sheet once more for completeness.*
- 23) *Return data sheet to AWC (by mail or drop off)*

*Note: Steps 1 and 19-22 should be completed at home. If, due to weather conditions, you wish to bring the bucket of sample water home, Steps 12-22 could be completed at home.*

## **B. FIELD OBSERVATIONS**

When you arrive at your sampling site, first put on your safety gear, and then collect your water sample following the procedures described below.

### **1. Air Temperature**

The air thermometer should be hung somewhere where it's not leaning against any solid object and where it's protected as much as possible from direct wind and sunlight.

The thermometer will take at least five minutes to equilibrate. It might take longer if it has to adjust for large changes in temperature - for example, if you've been carrying it in a warm car on a cold day. If you've waited the five minutes but the reading looks warmer or cooler than you expected, wait another minute and see if the reading changes. Keep checking at one-minute intervals until the reading comes up the same twice in a row - it shouldn't take longer than ten minutes for this to happen. Once the thermometer has equilibrated, read the air temperature to the nearest 1°F and record it on your data sheet.

While you're waiting for the thermometer to equilibrate, you can fill in the first page of your data sheet, beginning with monitor names, site name, number and location, date and time.

## **2. Wind and Weather**

In light, unsteady winds, you may have trouble judging wind direction - try tying a piece of ribbon or yarn to a pole or other upright object at your site. Record the wind direction as N, NE, E, SE, S, SW, W, or NW. Determine the wind speed using the Beaufort Wind Scale (Appendix H) and record the range you observe at your site in mph. Also note whether the wind is gusty, steady or variable.

Use the list of adjectives in the “Weather” box to describe overall weather conditions and estimate the inches of precipitation during the past 24 hours to the best of your ability. To determine precipitation, check the newspaper for the previous day’s precipitation amount. Report the type of precipitation that has fallen and record the number of consecutive days these weather conditions have persisted, including the day of sampling.

## **3. Comments & Observations**

Now take a moment to exercise your senses. Look around your sampling site. Note how humans, livestock and wildlife are using the water. Look for tracks and other signs of visitors. Listen for birds and other wildlife as well as for the sounds of human activity that might affect water quality. Be aware of any odors in the area and smell the water itself. The human nose can accurately detect a wide variety of smells, making it an effective odor-testing device. Use your hand to wave the air above your water sample toward you.

Record all your observations, including: abnormal color, oil slicks, foam on the water, algae blooms, unusual odors, fish kills or other dead plants or animals, sightings of live fish or other animals including humans, signs of erosion, trash or debris. The comments and observations section should also be used to report any problems you have with sampling procedures or equipment (including the data sheet itself). Suggestions for improvement are always welcome.

#### **4. Photos or Sketch Illustrating Site/Observations**

Space has been provided to attach photos or make to make a sketch showing the layout of your site and the locations of what you have described in your comments and observations. Do your best to make a scale drawing of the area surrounding your site during each sampling event and mark the location of each observation you have recorded.

As cameras are provided by the AWC, take pictures of your site during each sampling event. Always take the picture from the same spot each time and take three pictures in the following order: upstream, sample site, downstream.

### **C. COLLECTING THE WATER SAMPLE**

A few yards away (preferably downstream or down current) from your exact sampling site, rinse the plastic bucket three times with the water to be sampled. Now go over to your site, lower the bucket gently into the water, and fill it to a level about 2 inches from the lip of the bucket. If the water at your site is more than an arm's length away, your bucket should have a rope tied to the handle. After securing the other end of the rope to something solid, fill the bucket by turning it upside down and dropping it straight down into the water. This will help avoid the futility of having the empty bucket floating all over the surface and refusing to fill. If you are working in very shallow water, do not disturb the bottom while collecting the sample.

Be careful not to artificially increase the dissolved oxygen content of the water you're sampling. This can happen if you splash the water around too much before you sample it - that's why you should rinse your bucket a few yards away from your sampling site. Once you've got the sample, handle it gently. Avoid jostling the bucket or sloshing the water around.

### **D. TESTING PROCEDURES**

#### **1. Hanna Meter Calibration (should be completed at home):**

- 1) Record the meter's identification number on the data sheet.
- 2) Soak the meter in pH 7.01 solution in a clean beaker for 5-10 minutes.
- 3) Fill 2 additional beakers, one with pH 4.01 and the other with conductivity solution 1413  $\mu\text{S}/\text{cm}$ .
- 4) While the meter is still submerged in 7.01 solution, turn the meter on by pressing the MODE button until the screen is activated.
- 5) Swirl meter in the beaker and after the readings have stabilized, record the pH and temp readings on data sheet. (if not reading pH, press SET/HOLD until it is in pH measurement mode)
- 6) To calibrate, press and hold the MODE button through the OFF reading until CAL, then release the button. It will indicate that it is calibrating by displaying 7.01 USE and the word CAL will flash in the lower left hand corner.

- 7) After calibrating, it will read 4.01 USE.
- 8) Remove the meter from the 7.01 solution and quickly rinse with distilled water and with a little pH 4.01 solution and place the meter in the beaker with pH 4.01 solution and swirl.
- 9) The meter will indicate it is calibrating by again flashing the word CAL in the lower left hand corner. When it is finished calibrating, the meter will flash 4.01 OK, the CAL will stop flashing, and the meter will display temperature again.)
- 10) Keep swirling for at least 30 seconds or until the pH reading stabilizes. Record the pH reading displayed and the temperature.
- 11) Rinse the meter thoroughly with tap water and distilled water and then submerge the meter in the beaker with conductivity solution.
- 12) Press the SET/HOLD button once to change to Conductivity mode. Continue swirling the meter in the beaker and after the conductivity reading has stabilized, record the Temperature and Conductivity readings on the data sheet.
- 13) To calibrate, press and hold the MODE button through the OFF reading until CAL, then release the button. It will indicate it is calibrating by displaying 1413 USE and the word CAL will flash in the lower left hand corner.
- 14) Once the calibration has been automatically performed, the meter will display OK for 1 second and then return to measurement mode.
- 15) Continue swirling the meter in the solution until the conductivity reading stabilizes, or bounces back and forth between two readings. Record this number on your data sheet.
- 16) Remove the meter from solution and rinse it and beakers with tap water and distilled water. Dispose of calibration solutions according to chemical waste management procedures.
- 17) The unit is now calibrated and is ready for use.

**2. Travel to Site and Set up Air Thermometer:**

Hang air thermometer (red liquid fill) in a shaded area at your site, near the sample bucket, to allow it to stabilize.

**3. Record Information on Data Sheet:**

While waiting for air thermometer to stabilize, record the following information onto your data sheet: your name, the date, the time, the site ID (i.e., MaCam04v) and the monitoring kit number.

**4. Collecting Your Water Sample:**

A few yards away, preferably downstream or down current from your exact sampling site, rinse the 2.5 gallon plastic bucket three times with water from the creek or stream that you are sampling. Now go over to your exact site, lower the bucket gently into the water, and fill it to a level about 2 inches from the lip of the bucket.

*Note: If the water at your site is inaccessible because of a strong flow, your bucket should have a rope tied to the handle. After securing the other end of the rope to something solid, fill the bucket by turning it upside down and dropping it straight down into the water. This will help avoid the futility of having the empty bucket floating all*

*over the surface and refusing to fill. If you are working in very shallow water, do not disturb the bottom while collecting the sample.*

#### **5. Bacteria:**

- 1) Use your Sharpie to mark the lids of 2 bottles of Coliscan Easygel™ with the numbers 1 and 5.
- 2) Use the sterile pipette included in your kit to carefully draw a 1 ml water sample from your sample bucket and deposit it into the Coliscan Easygel™ bottle you have marked as 1.
- 3) Repeat the process once more, this time carefully measuring 3 ml and deposit into the bottle marked 5. Recap the bottle. Then draw 2 ml and deposit into bottle marked 5 for a total of 5 ml.
- 4) Place the Coliscan Easygel bottles labeled 1 and 5 (which now contain 1 ml and 5 ml of sample water) on ice to keep within desired temperatures until plating is completed at home (see Note below).

*Note: The next step in the bacteria test, “plating”, should be done when you get home. Plating should be performed within six hours of the sample and the Coliscan Easygel bottles that now contain sample water should be maintained at temperatures between 4°C to 10 °C until plating occurs.*

#### **6. Place Hanna Meter and Water Thermometer:**

Clip the Hanna Meter on the edge of the bucket with the electrodes submerged in the bucket. Hang water thermometer inside sample bucket.

#### **7. Dissolved Oxygen “Fixing”:**

*Note: As you work through the DO testing procedure, you'll notice the emphasis to avoid trapping any air bubbles in the sample or splashing it around too much. The point is to avoid changing the amount of oxygen dissolved in the water by contact with the oxygen in the air.*

- 1) Rinse each bottle with small amounts of water from the bucket three times. Rinse the outsides of the bottles and the caps as well. DO NOT pour rinse water back into bucket, empty rinse water outside of bucket.
- 2) Tightly cap the mouth of the bottle marked “A”. Holding the bottle sideways, submerge it to mid-depth in the sample bucket, and remove the cap to allow the bottle to fill.
- 3) Turn the submerged bottle slowly to a vertical position (mouth up) and tap the sides with the cap to dislodge any air bubbles clinging to the inside. Hold the cap upside down under water so that no air is trapped in the cap. Screw cap back on bottle while the bottle is still submerged.
- 4) Retrieve the bottle and examine it carefully to make sure that no air bubbles are trapped inside. Once a satisfactory (i.e. bubble-less) sample has been collected, repeat Steps 2 through 4 with bottles "B" and "C".
- 5) Once all 3 bottles (A, B and C) are filled, uncap each bottle. Add 8 drops of manganous sulfate solution (pink reagent) to each sample.

*Note: Drop the solutions in gently to avoid splashing and mixing in air. Hold the reagent bottles vertically, and do not allow the dropper tips to touch the sample.*

- 6) Add 8 drops of alkaline potassium iodide azide (clear reagent) to each sample.
- 7) Cap each sample bottle carefully and mix by holding the bottle by the cap and repeatedly tipping the capped bottle back and forth in a gentle rocking motion for fifteen seconds. A fluffy, white to brownish precipitate will form.

*Note: Avoid holding the bottles in your hand because it may change the temperature of the water and affect the DO reading. It is better to hold onto the cap and touch the bottles as little as possible, while still mixing the bottle enough so that the precipitate forms.*

- 8) Set the bottles in their holes in the LaMotte Shallow Water Monitoring Kit; the Styrofoam will help keep the samples at a constant temperature. Allow the precipitate to settle a third of the way down the bottles (past the neck and down to the shoulder of the bottle), so that it fills only the bottom two-thirds.
- 9) Add 8 drops of sulfuric acid (clear solution, red cap) to each bottle and cap the bottles.
- 10) Mix by tipping gently as before, until the precipitate has dissolved.
- 11) Record the time and temperature of the water in the bucket at this time.

*Note: The DO samples are now “fixed”. Maintain samples between 4 C° to 10 C° until “titration” is completed. Titration can be performed later at home, up to six hours after fixing.*

## **8. Water Temperature Reading #1:**

Read the thermometer and record as Rep #1 on data sheet. Be sure to keep half of the thermometer in the water while taking the reading. Take second replicate within 5 minutes of first.

## **9. Record Site Information:**

While waiting to take the second water temperature reading, record weather, sketch, photos, and air temperature. Report on any precipitation that has fallen in the last 24 hours, making your best estimation of the amount (i.e., trace, under an inch, several inches, heavy, etc.). When recording wind, simply record if it is calm, steady or variable and then refer to the Beaufort Wind Scale on the back cover of this guide. Under Sample Location, check the appropriate descriptions for depth and bottom.

Take up to three photos: 1) downstream view 2) upstream view 3) anything out of the ordinary or noteworthy (dead fish, construction, etc.)

*Note: the Beaufort Wind Scale is located on the back cover of this guide.*

**10. Water Temperature Reading #2:**

Read the thermometer and record as Rep #2 on data sheet. Be sure to keep half of the thermometer in the water while taking the reading. This reading should be taken within 5 minutes of first.

*(Data Quality Objective: Repeat if Rep #2 is not within +/-1.0 °C of Rep #1).*

**11. Hanna Meter Readings**

- 1) After the meter has soaked in the sample water for at least 10 minutes, turn on the meter.
- 2) Gently swirl the meter in the sample bucket. After readings have stabilized, record the initial temperature.
- 3) Continue to swirl the meter in the water. Press SET/HOLD until the conductivity is displayed. Wait 15 seconds and record the first of 3 conductivity readings.
- 4) Press SET/HOLD again and wait 15 seconds. Record the first of 3 pH readings.
- 5) Press SET/HOLD once more and wait 15 seconds. Record the first of three (3) TDS readings.
- 6) Repeat Steps 3-5.
- 7) Repeat Step 6. Continue recording additional readings until QAOs are met for each parameter
- 8) Record the temperature and turn the Hanna Meter off.

**12. Apparent Color:**

- 1) Look at the color of the water in your sampling bucket and record a one or two word description (i.e., the apparent color).
- 2) Take the Turbidity Column marked "S" for sample water and fill it to the 50 ml line with water from the bucket and record its apparent color.

*Note: If you have a Borger color book, find the color that most closely matches the sample water and record that. If it is in between two colors, both colors may be recorded. The Borger color books are currently out of print and we hope they will become available in the near future.*

**13. Turbidity (Clarity):**

- 1) Take the Turbidity Column that you filled with sample water for determining Apparent Color. Make sure it is filled to 50 ml. Check that you can see the black dot at the bottom of tube. If not, empty some water so that the tube is 25 ml full.
- 2) Fill the second Turbidity Column, marked "D", with distilled water equal to the amount of sample being measured (e.g. 50 ml or 25 ml). This is the distilled water or "clear water" tube. Indicate the sample volume being used on your data sheet.

*Note: A 50 ml sample should always be used unless the water is so turbid that you can not see the black dot at the bottom of the tube. Only in that case should a 25 ml sample be used. If the tube is filled with 25 ml of sample water and you still cannot see the dot, record the turbidity as "greater than (>) 200 JTU," otherwise, go to Step 3.*

- 3) Place both tubes side-by-side with the column filled to note color, and note the difference in clarity between the two. If the water in the sample tube (“S”) is less clear than the distilled water (“D”), go to Step 4. If the black dot is equally clear in both tubes, then the turbidity of the sample water is zero, and record the result as 0 additions.
- 4) Shake the Standard Turbidity Reagent bottle vigorously before each addition. Add 0.5 ml to the clear water tube (distilled water tube marked “D”). Stir contents in both tubes to re-distribute the turbid particles. Check the amount of turbidity by looking down through the solution at the black dot. If the turbidity of the sample (“S”) remains greater than the clear water tube (distilled water tube “D”), continue to add Standard Turbidity Reagent in 0.5 ml increments to the sample tube (“S”). Stir after each addition until the turbidity in each tube appears equal. Record the total number of increments/additions of the Standard Turbidity Reagent that were added.

*Note: You are recording the number of 0.5 ml additions of reagent that you added. If you added two 0.5 ml additions, record 2 on your data sheet, not 1.0 ml.*

- 5) Record the temperature of the water in the bucket at the time of the turbidity reading.
- 6) Rinse each tube 3 times with distilled water and repeat Steps 1-3.

*(Data Quality Objective: Repeat if replicates are not within 1 addition of each other.)*

#### **14. Colormetric pH:**

- 1) Rinse 2 small test tubes with sample water three times. Fill each tube to the 5 ml line with sample water.
- 2) While holding the dropper vertically, add ten (10) drops of the green Wide Range Indicator Solution to each test tube.
- 3) Cap, invert and shake each tube several times to mix.
- 4) Remove the caps and insert each tube into the Octet Comparator (Black Box) and match sample color to appropriate color standard.

*Note: Hold the comparator up so that light enters through the special light-diffusing screen in the back, but avoid viewing the comparator against direct sunlight or an irregularly lighted background. Make sure caps are off of tubes to help with light filtration.*

- 5) Read each pH measurement to the nearest 0.25 value, and enter the result for each sample on the datasheet. If there is a significant difference between the 2 measurements (i.e., >0.25 pH unit difference), then make a note and repeat the test.

*(Data Quality Objective: Record to the nearest 0.25 pH units. Repeat if replicates are not within 0.25 units.)*

### **15. Dissolved Oxygen “Titration”:**

*Note: To assure more precise dissolved oxygen measurement, three 60 ml samples will be prepared for titration. You will begin by titrating a 20 ml portion of each of these samples.*

- 1) Rinse the titration vial (it is labeled "Code 0299" and has a flat lid with hole in the center) with a small amount of the solution from the sample bottle, and then fill it to the 20-ml line. Snap on the titration vial cap.
- 2) Depress the plunger of the direct-reading titrator (the small syringe) to expel air. Holding the plunger tightly down, insert the titrator into the plastic fitting of the bottle of sodium thiosulfate (titrator) solution. Invert the bottle and withdraw the plunger slowly until the bottom of the plunger is about half an inch past the zero mark on the titrator scale.

*Note on Preventing Bubbles: As you start to withdraw the plunger, inspect the solution filling the syringe, watching for air bubbles, especially at the tip of the plunger or in a silvery rim around the tip. If bubbles appear while you've only got a small amount of solution in the titrator, pump the solution back into the thiosulfate bottle, pressing the plunger down quickly and firmly. Bubbles tend to be a particular problem when the dry titrator is filled for the first titration of the day. It may be necessary to pump the solution back and forth several times to get the plunger surface wetted. Once you've gotten a small amount of sodium thiosulfate solution into the titrator without bubbles, continue to inspect for bubbles as you slowly withdraw the plunger. If you spot a bubble when the titrator is nearly full, remove the titrator from the thiosulfate bottle, hold it over your wastewater bottle, and press the plunger down until the bubbles are expelled. Reattach the titrator to the thiosulfate bottle and continue filling to the zero mark. Inspect the titrator carefully for air bubbles.*

- 3) Insert the titrator into the central hole of the titration vial cap. Add one (1) drop of sodium thiosulfate and swirl the tube (with the titrator still attached) to mix it. Continue this titration process one (1) drop at a time until the yellow-brown solution in the tube just begins to fade or get lighter. The solution should be a pale yellow color - about the shade of pale straw.
- 4) Gently remove the titration vial cap with the titrator still attached. Be very careful not to change the position of the plunger or to shake any fluid loose from its tip. Add 8 drops of starch indicator solution to the titration tube.
- 5) Replace the cap with the titrator carefully on the titration vial and swirl until the solution turns a uniform blue. Continue the titration process described in Step 3. Be sure to gently swirl after each drop. Continue the titration until the solution turns from blue to clear - the first complete disappearance of the blue color is the endpoint of the titration. (If the solution turns blue again a moment later, ignore it.) Hold the solution against a sheet of white paper (for example, your data sheet) to check the color.

- 6) If your sample has a high oxygen content, you may have to refill the titrator in order to reach the endpoint. Do not completely empty the titrator into the titration sample. The plunger should be lowered only far enough so that the lowermost tip of the green plunger disc is level with the 10-unit mark on the scale. If you reach this point without hitting the endpoint of the titration, remove the titrator from the titration vial. Refill the titrator to the zero mark again as described in Step 3 and continue.
- 7) Read the total number of units of sodium thiosulfate used in the titration from the scale opposite the lowermost tip of the green plunger disc. The divisions are in 0.2 units, but you should be able to read the results to the nearest 0.1 units.
- 8) If you had to refill the titrator, remember to add in the ten units to your recorded measurement. The number of units used equals the milligrams per liter (mg/l) of oxygen dissolved in the water. Record this figure on your data sheet to the nearest 0.1 mg/l.
- 9) Carry out Steps 3 to 8 on the sample bottles marked "B" and "C".

*Note: If any 2 titration readings differ by 0.6 mg/l or more, titrate another 20 ml sample from the bottle whose reading fell outside the 0.6 mg/l range. If the second titration still shows a value different from the others by 0.6 mg/l or more, do not check the use sample box on the data sheet for that sample. If no 2 of your 3 original readings fall within a 0.6 mg/l range, repeat Steps 2 through 9 using 3 new 20 ml portions of each sample. Record the results of all titrations (even those you suspect are in error) and only check the use sample box for samples that meet the DQO. Discard the contents of the sample bottles in your wastewater bottle.*

*(Data Quality Objective: Repeat if the 3 replicates are not within 0.6 mg/l).*

#### **16. Ortho-Phosphate:**

- 1) Rinse 2 square mixing bottles 3 times with sample water and then fill them to the 20 ml mark with sample water.
- 2) Add the contents of one PhasVer 3 Phosphate Reagent Powder Pillow to the each bottle and swirl to mix. Be careful not to shake the bottle vertically.
- 3) Wait 8 full minutes for color development. If Phosphate is present, a blue violet color develops.
- 4) Fill a test tube to the top line (marked with the no. 1730) with sample water.
- 5) Fill the other test tube to the top line (marked with the no. 1730) with prepared sample water.
- 6) Place the second test tube in the top right opening of the Color Comparator.
- 7) Hold the Color Comparator with the test tubes tops pointing toward a light source such as the sky, window or lamp. For better results, rotate the color disc until the color matches in the two openings.
- 8) Write down the result as a fraction, with your result over 50 (i.e., 2.5/50)
- 9) Note the shade of blue (clear, faint, light, medium, dark) of the sample on the data sheet.
- 10) Discard the prepared sample in waste bottle and rinse the test tube thoroughly with distilled water (at least 3 times.) Repeat Steps 1-9 for sample 2.

*(Data Quality Objective: Repeat if replicates are not within 2.5 units.)*

**17. Nitrate Nitrogen:**

- 1) Rinse 2 square test tubes from your LaMotte Nitrate Nitrogen Tablet Kit three times with sample water and fill to the 5 ml line with water from your sample bucket.
- 2) Add one Nitrate #1 Tablet to the tubes. Cap the test tubes and mix by inverting repeatedly until the tablet dissolves completely.
- 3) Add one Nitrate #2 CTA Tablet to the test tubes. Cap the tubes again and mix until the tablet dissolves completely. Wait for 5 minutes.
- 4) Insert the Nitrate-N color slide into the Octa-Slide viewer.
- 5) Insert the first test tube into the top of the slide viewer.
- 6) Note the shade of pink (clear, faint, light, medium, dark) of the sample on the data sheet.
- 7) Match the sample color to a cell of the color slide and record the number of that slide as Nitrate-Nitrogen in ppm on your data sheet.

*(Data Quality Objective: Repeat if replicates are not within 0.5 mg/l.)*

**18. Record Volunteer Hours and Check Datasheet for Completeness:**

Check for completeness of the data sheet and its legibility and have all team members sign the datasheet. Record the total amount of hours (to the quarter hour) it took to complete this sample.

**19. Bacteria Plating and Incubating:**

- 1) Turn on the incubator and insert the air thermometer into a hole near the bottom.
- 2) Mark the lids (the larger half) of two pretreated Petri dishes for the two amounts: 1 ml and 5 ml. (Keep your writing close to the edge of the lids). Match the bottles of Coliscan-water mixture to the Petri dishes marked with the same number. One at a time, pour each bottle of Coliscan-water mixture into the bottom half (the smaller half) of its respective Petri dish. Cover the dishes with the designated lids and gently swirl the liquid so that it covers the entire bottom of the dish.
- 3) Record the time and date plated on your datasheet.
- 4) Place the Petri dishes in the incubator. After about 30 to 40 minutes the Easygel™ will set into a gel form. Once this occurs turn each entire Petri dish over and continue incubating.
- 5) Periodically check the temperature of your incubator and adjust the flaps accordingly, if necessary. The temperature in the incubator should remain between 85-99 °C.
- 6) Incubate for 48 hours and then proceed to Step 21 to count bacteria.

**20. Clean equipment so it is ready for the next sample and dispose of waste properly.**

Cleaning Procedures for Test Tubes and Bottles:

- 1) Rinse all glass and plastic test tubes/bottles thoroughly with tap water.
- 2) Wash with phosphate free soap. Alconox cleaning powder is available at the AWC office. Use brush provided when necessary.
- 3) Rinse thoroughly with tap water.
- 4) Rinse three times with distilled water.
- 5) Allow to dry before returning to kit. Keep tops off of bottles and tubes until fully dry.
- 6) Wipe down inside and outside of kit with damp rag and then dry. Allow the inside of kit to completely dry.

Disposal of Waste after the Sample:

When all tests have been completed, you have two choices for handling the waste that was generated:

- 1) Transfer waste from smaller waste bottles into a gallon jug and keep the jug until filled, then take to the Anchorage Waterways office for disposal. Make sure you clearly label any waste stored in your home.

OR

- 2) After each sampling event, flush waste down the sink, provided it is connected to the Anchorage sewer system. This is an acceptable method of disposal as long as you are not connected to a septic tank.

**21. Read Bacterial Plates:**

After plates have incubated for 48 hours (see Step 19), count the bacterial colonies as follows and record on data sheet:

- 1) After 48 hours have passed, count the number of dark purple and dark navy blue colonies that have formed in the Petri dish. This is the *E. coli* count for this sample.
- 2) Count the number of pink or red colonies, then add this amount to the *E. Coli* count. This is the total coliform count for the sample.
- 3) Count the number of teal colonies.
- 4) Record the teal colonies, *E. Coli* and total coliform counts for each sample (1 ml and 5 ml) on your Monitor Data Sheet.
- 5) Record the day and time you read your bacteria plates on your datasheet.

*Note: Please use the Coliscan Color Guide provided in your Volunteer Manual as an aid in determining colors of colonies if uncertain. Also, if the sheer number of bacteria that have grown in your petri dish plate make counting difficult, you can divide your plate into quarters and count one quarter at a time, or count one quarter and multiply by 4.*

**22. Adjust Volunteer Hours as Needed and Check Datasheet Once More for Thoroughness**

**23. Dispose of Bacteria Plates Properly:**

The easiest way to make used petri dishes safe for the regular garbage is to place 5 ml (about 1 teaspoon) of straight bleach onto the surface of the medium of each plate. Allow to sit at 5 least minutes and then place in a watertight bag and discard in trash.

**E. COMPLETING & SUBMITTING DATA SHEETS**

Please make sure that all monitors sign the Monitor Data Sheet next to their printed name. Send in data sheet(s) as soon as possible (**within 1 week**) after sampling and testing is complete, or drop them off at the AWC office in Anchorage. This will help us keep our database up to date and alert the Monitoring Director to the development of potential problems. If possible, please make a copy of the sheet for your own files before mailing. The copies will be lifesavers if the original sheets get lost in the mail. If you are bringing the sheet in yourself, you can make a copy on our office copier. Data sheets can be mailed or dropped off at the address below:

**Anchorage Waterways Council  
Citizens' Environmental Monitoring Program  
1565 Bragaw St. Ste. 205  
Anchorage, AK 99508**

**VII. EQUIPMENT CARE & WASTE DISPOSAL**

**A. BEFORE SAMPLING BEGINS**

All equipment, meters, and monitoring kits are checked by the Monitoring Director to ensure that they are operating within specifications before they are issued to Volunteer Monitors. Each reagent bottle is dated with the expiration date and lot number prior to being issued. A Kit Inspection Form, including reagent expiration dates, is kept on file at the AWC office. This form is updated each time a kit receives new or replacement equipment or reagents.

Hanna "Combo" Water Test Meters should be brought to the Monitoring Director four times a year for inspection and calibration check. Maintenance logs are kept on each meter.

Before each sampling event you will need to inspect all your sampling equipment. Thermometers (air and water), bottles and test tubes, color comparators, hydrometer, droppers, and other related testing equipment should be examined for cracks or breaks. Thermometers should also be checked to see that the column of indicator fluid is continuous and has not separated. Chemicals should be checked for expiration dates,

sufficient quantities and any discoloration. All testing equipment should be clean and in good working order before it is used for monitoring.

The Monitoring Director maintains a supply of replacement equipment and reagents at the AWC office. If any equipment or chemical reagent is found to be defective in any way please contact the Monitoring Director for immediate replacement. The quantity of reagent and other chemicals needed for most tests is anticipated to assure that you receive replacements before your supplies become exhausted, usually every 3 to 4 months.

## **B. WHEN YOU'RE DONE TESTING**

### **1. Liquid Wastes**

In selecting the testing methods employed by the AWC monitoring program, efforts have been made to minimize the production of hazardous wastes. Still, it is important that you handle all your liquid wastes with care and see that they are disposed of properly. Your kit is supplied with two wastewater bottles. These are to be used to collect all wastes produced while monitoring. These wastes will not react together in a detrimental way when mixed. Thus, there should be no concern with respect to the formation of toxic gases or explosions.

There are two options for disposal of waste after the sample is completed: 1) Transfer waste from smaller waste bottles into a gallon jug and keep the jug until filled, then taken to the Anchorage Waterways office for disposal. Make sure you clearly label any waste stored in your home, or 2) After each sampling event, flush waste down the sink while running the water. This is an acceptable method of *disposal as long as you are not connected to a septic tank*. If you are connected to a septic tank, then follow the 1<sup>st</sup> option for disposal (i.e., bring waste to AWC).

### **2. Disposal of Used Petri Dishes (Bacteria Plates)**

After you have completed the bacteria counts and recorded the information on your data sheet, you will need to properly dispose of the used petri dishes. Place 5 ml (about 1 teaspoon) of straight bleach onto the surface of the medium of each plate. Allow to sit at least 5 minutes. Place in a watertight bag (Ziploc) and discard in trash.

### **3. Equipment and Supplies**

It is important to clean and properly stow all of your equipment and reagents after each monitoring event. Most of your equipment is re-usable and, if properly cared for, will serve you and other volunteer monitors for years to come. A few items, however, are designed to be disposed after one use. They include: any pipette which comes in a sealed plastic wrapper, the pre-treated petri dishes used in the Coliscan test and empty Coliscan Easygel® bottles.

The following pieces of equipment should be thoroughly rinsed with tap water before being stowed in your monitoring kit: rubber gloves, sample bucket, stir rod, thermometers, turbidity columns, all test tubes, all DO sample bottles, titrator, titration vial and cap, and Hanna Combo Meter.

Your color chart and other paper materials should be kept as dry as possible and stored in the Ziploc bags provided for them. All equipment should also be dried and properly stowed in the black plastic case to protect them it excess exposure to light. Keep the case in a dry place protected from extremes of heat and cold. Don't leave it in your car, which can get pretty hot in the summer and pretty cold in the winter. Chemicals may also freeze if kept in a garage or arctic entry.

Always keep all chemicals and equipment out reach of children and pets at all times.

## **VIII. DATA MANAGEMENT & REPORTING**

### **A. VERIFYING ACCURACY**

Check your data sheets prior to sending them in to the AWC office. Look to see that they are complete and that all figures are legible. Be sure that all monitors have signed next to their names and have recorded the number of volunteer hours. Take a final look at all the numbers to see if any seem anomalous. If you find illegible or incorrectly entered data do not attempt to erase them. Draw one line through the entry and write the correct information just to the right of it.

The Monitoring Director will check each data sheet for missing or illegible information, errors in calculation and values outside of the expected range. If questions arise, you may be contacted for clarification, so it's important to keep a copy of each data sheet for your records.

Data is then entered into the AWC data system, which is designed to flag any values that fall outside of the expected range for each parameter.

### **B. DATA ANALYSIS & REPORTING**

Data will be presented annually using graph and report formats to document baseline water quality, identify trends and detect deficiencies in data collection or program design.

### **C. WHAT IT ALL MEANS**

Although it is still relatively pristine, the Cook Inlet watershed is beginning to show the signs of environmental stress associated with increased population, development and urbanization. Long-time residents have seen local declines in inter-tidal biological communities and species abundance in Cook Inlet waters, but there is a lack of

comprehensive data to link pollution and human impacts to this decrease. While government, universities, and industry have done a number of studies, the fact remains that there is not enough baseline data available to determine the effects of point and non-point source pollution on the water quality of the Cook Inlet Watershed.

Cook Inlet waters support multi-million dollar sport and commercial fisheries, and provide important subsistence resources for native and other groups. Citizens, industry and resource managers need a comprehensive ongoing water quality-monitoring program to understand the potential effects of water pollution on Cook Inlet in order to make economically and environmentally sound decisions.

Many state and federal agencies lack the resources to conduct continuous water quality monitoring projects at a representative number of sites throughout the basin. AWC-trained monitors can collect accurate baseline data using in a cost effective manner. With your help we can build a greater understanding of what makes our watershed so abundant, and what might threaten its abundance.

## **IX. QUALITY CONTROL**

The AWC uses a Quality Assurance Project Plan approved by the ADEC. In accordance with this plan the Monitoring Director or a qualified Phase V volunteer will make an effort to join 10% of all volunteer teams once a year to assist with monitoring and ensure that all equipment is functioning properly and all protocols are being followed. One or two Quality Control/Recertification training sessions are scheduled each year. All volunteers are asked to attend at least one session each year to ensure the consistency and accuracy of our water quality monitoring efforts. These quality control sessions will include a laboratory practicum along with discussions of monitoring techniques and suggestions for improving the water quality-monitoring program.

# **APPENDIX A**

## **ANCHORAGE WATERWAYS COUNCIL**

Citizens' Environmental Monitoring Program  
Volunteer Training Manual

### **Glossary of Terms**

## Glossary of Terms

**Acid** - a substance with more hydrogen (H<sup>+</sup>) ions than hydroxide (OH<sup>-</sup>) ions (pH less than 7)

**Algae(pl), alga** - a collective term referring to several groups of simple photosynthetic plants, mostly microscopic, lacking roots, stems and leaves; they can be found in a variety of habitats; many species of algae exist as single cells, others form simple filaments or colonies and others exist as more complex structures like the larger seaweeds

**Algal bloom** - a particularly extensive growth of algae in a body of water; this is usually a result of increased nutrient content

**Alkaline** - a substance with more hydroxide (OH<sup>-</sup>) ions than hydrogen (H<sup>+</sup>) ions (pH greater than 7)

**Ammonia (NH<sup>4</sup>)** - a colorless gas consisting of nitrogen and hydrogen atoms; it is the main substance used by organisms as a source of nitrogen

**Ampule** – sealed container of liquid

**Anoxia** – conditions where oxygen is absent

**Apparent Color** – the color observed in water based on the amount and nature of dissolved and suspended materials and how they refract light

**Axial Reader** – a type of color comparator capable of reading even faint color indicators

**Bacteria** - a group of essentially single-celled microscopic organisms lacking chlorophyll which break down material

**Baseline Water Quality** – a measure of naturally occurring water quality used for comparing water quality over time and identifying water quality trends

**Basin** - an area drained by a given river and its tributaries (see catchment)

**Beaufort Wind Scale** – an internationally agreed upon scale of wind force that has thirteen standardized categories and associated descriptions

**Bioassessment** - the use of living organisms to assess environment health; the examination of biological communities, particularly stream insects (technically called benthic macroinvertebrates), provides an indication of water quality

**Borger Color System** – a standardized system of numbered color chips originally devised to measure the color of flies for fisherman now widely used for determining the apparent color of water

**Catchment** - the area of land that is drained by a river and its tributaries; the dividing line between catchments is physically defined by mountains, crests of hills or the ridge of high ground

**Coliform bacteria** - bacteria, found in the intestines of warm-blooded animals, that aid in the digestion process; used as indicators of fecal contamination in water-quality analyses

**Color Comparator** – device used in colorimetric testing

**Colorimetric** – type of test measuring the concentrations of various substances by gauging the reaction of an indicator with a known sample amount and comparing the resulting

color with a known range of values

**Conductivity** - a measure of electronic resistance caused by organic and inorganic materials in water; conductivity can also be used to measure salinity

**Dissolved oxygen** - the amount of oxygen dissolved in water and available for living organisms to use for respiration

**Distilled Water** – water that has had most of its impurities removed

**Ecosystem** – biotic community (living organisms) and its abiotic (non-living) environment function as one system

**Effluent** - waste material (e.g., smoke, sewage etc.) discharged into the environment

**Equilibrate** – bring into equilibrium or balance

**Erosion** - the wearing away of the land by running water, rainfall, wind, ice or other geological agent or process including weathering, dissolution, abrasion and corrosion

**E. coli (Escherichia coli)** - one of the species of bacteria in the fecal coliform group; it is found in large numbers in the gastro-intestinal tract and feces of warm-blooded animals and humans; its presence in water is considered indicative of fecal contamination

**Estuary** - an open drainage depression adjacent to the sea, typically at the mouth of a river, into which the tide ebbs and flows; tide movements accentuate erosion and continually modify the drainage channels within the estuary

**Eutrophic** - waters enriched with plant nutrients, which may become deoxygenated

**Eutrophication** - the natural and artificial addition of nutrients to a waterbody, which may lead to depleted oxygen concentrations – eutrophication is a natural process that is frequently accelerated and intensified by human activities

**Fecal** - relating to animal, including human, excrement

**Fecal Coliform** – coliform bacteria of the species *Escherichia coli* (occasionally the *Klebsiella* species is included in this category as well)

**Fertilizer** - any substance, natural or manufactured, added to the soil to supply essential plant nutrients for plant growth

**Field Observations** – observational data collected on site

**Fixing** – portion of the dissolved oxygen test procedure by which oxygen molecules are bound or “fixed” in solution

**Flocculent (floc)** – a mass of particles that form into a clump as a result of a chemical reaction

**Galactosidase** – enzyme produced by coliforms during lactose fermentation

**Glucoronidase** - enzyme produced by fecal coliforms during lactose fermentation

**GPS (Global Positioning System)** – satellite based system used to pinpoint geographic position

**Graduated cylinder** – a cylinder used to measure liquids that is marked in units

**Heavy metals** - any element with an 'atomic number' larger than 20 that can be precipitated

by hydrogen sulfide in acid solution; e.g., copper, cadmium, chromium, lead and mercury

**Hydrometer** – instrument used to measure the specific gravity of liquid

**Hypoxia** – depletion of dissolved oxygen in an aquatic system

**Ions** - electrically charged molecules; often formed when an electrically neutral molecule is dissolved in water and disassociates

**Jackson Turbidity Unit (JTU)** – standard measure of turbidity produced by adding measured amounts of a reagent to clear distilled water until its clarity is reduced to match that of a water sample; JTUs can be directly equated to NTUs (Nephelometric Turbidity Units)

**Leaching** - the process by which water percolates through a particular solid, usually layers of soil; when water 'leaches' through the soil it often dissolves and then carries away many other substances

**Macro-invertebrate** - animals without a backbone and visible to the naked eye

**Material Safety Data Sheet (MSDS)** – product safety information sheets prepared by manufacturers and marketers of products containing toxic chemicals

**Maximum dissolved oxygen concentration** – the total amount of oxygen that can be dissolved in water of a given temperature and salinity

**Medium** – a substance in which microorganisms can be grown

**Meniscus** – the curved upper surface of a column of liquid

**Molar volume** – a volume of liquid containing one mol of solute per liter of solvent

**Monitoring** – the periodic collection of information through the measurement and observation of natural phenomena

**Motile** - capable of motion, particularly locomotion

**Nephelometric Turbidity Unit (NTU)** – standard measure of turbidity obtained using an electronic Nephelometer; NTUs can be directly equated to JTUs (Jackson Turbidity Units)

**Nitrate (NO<sub>3</sub>)** - a compound of nitric acid and a given alkali

**Nitrite (NO<sub>2</sub>)** – a salt or ester of nitrous acid

**Nitrogen (N)** – one of the major nutrients required for the growth of plants, present usually as organic nitrogen, ammonia, nitrate, and forms of nitrite; excess nitrogen can cause accelerated eutrophication in waterbodies

**Non-point-source pollution** - a source of pollution that cannot be pinpointed, because it comes from many individual places or a widespread area (e.g., urban and agricultural run-off);

**NPDES Permit** – the National Pollutant Discharge Elimination System is the title of section 402 of the Clean Water Act. NPDES is used to describe all permits issued under this section which deals with point sources of pollution

**Nutrient** - derived from living matter and including elements such as nitrogen, phosphorus and sulfur; nutrients are essential for plant growth but can adversely effect land and

aquatic ecosystems if present at high levels

**Orthophosphate** – inorganic phosphate that is readily dissolved in water

**Oxidation-Reduction Potential** – the capability of a substance to either release or gain free electrons

**Parameter** – measurable value of a physical, chemical or biological component that is used to help define a natural system and its behavior

**Parts per million (ppm)** - the number of parts by weight of a substance per million parts of liquid

**Pathogenic bacteria** – bacterial capable of causing disease

**Percent of saturation** – a comparison of the measure of dissolved oxygen in a liquid against the maximum dissolved oxygen concentration for that liquid at a given temperature and salinity

**pH** - a numerical measure of the hydrogen ion concentration used to indicate the alkalinity or acidity of a substance – measured on a scale of 1.0 (acidic) to 14.0 (basic) where a value of 7 is neutral; as pH is a logarithmic scale, a pH of 3 is 10 times as acidic as a pH of 4 and 100 times as acidic as a pH of 5

**Phosphate (PO<sub>4</sub>)** - a salt or ester of any phosphoric acid: it provides organisms with phosphorus in a useable form; often used in fertilizers and detergents

**Phosphorus (P)** - a non-metallic element that is an important nutrient for all organisms

**Photosynthesis** - the process by which plants produce organic matter from inorganic chemicals, using solar energy, with the liberation of oxygen

**Pipet** – an eye dropper-like instrument that can measure very small amounts of liquid

**Plankton** - small animals and plants which float or drift in the water body

**Point-source pollution** - a source of pollution that can be pinpointed

**Pollution** – when the level or concentration of any contaminant is high enough to have an adverse affect upon other elements of the ecosystem

**Precipitate** – a substance that is separated out from a solution as a solid by the action of chemical reagents, temperature, etc.

**Quality control** – those activities performed during data collection to produce data of a desired quality in order to document that quality

**Reagent** – a substance or chemical used to indicate the presence of a chemical or to induce a chemical reaction to determine the chemical characteristics of a solution

**Redox** – see oxygen reduction potential

**Riffle** – shallow area in a stream where water flows swiftly over gravel and rock

**Run-off** - the portion of rainfall or irrigation (e.g., lawn sprinkler) water that flows across the land's surface, does not soak into the ground and eventually runs into a water body; it may pick up and carry a variety of pollutants

**Salinity** concentration of salts, measured in parts per thousand or grams per litre

**Salts** compounds that dissociate in water to yield a positively charged ion and a negatively charged acid radical ion

**Saturated** – inundated; filled to the point of capacity or beyond

**Secchi depth** – the greatest depth at which a Secchi disk can be seen through water

**Secchi disk** – a plastic disk, 20 cm in diameter divided into black and white quadrants which is used to measure the turbidity or clarity of water by lowering it on a line to the deepest point where it can still be seen

**Sediment** - insoluble material suspended in water consisting mainly of particles derived from rocks, soil and organic materials; can be a major non-point-source pollutant to which other pollutants may attach

**Sessile** – permanently fixed; immobile

**Sewage** - household and commercial waste-water that contains human waste

**Silt** - fine particles of rock, soil or organic material that can be suspended in water

**Specific Gravity** – a measure of the density of a substance divided by the density of pure water at 4°C

**Stewardship** –caring for the land for both short and long term needs within the capacity of the environment to provide those needs

**Surface water** – precipitation which does not soak into the ground or return to that atmosphere by evaporation or transpiration; it is stored in streams, lakes wetlands, reservoirs and other depressions like puddles and ditches

**Suspended solids** – a mixture of fine particles dispersed in a liquid

**Tidal Stage** – a period in the tidal cycle, ie. high tide, high ebb, ebb, low ebb, low tide, low flood, flood, high flood

**Titration** – the addition of small, precise quantities of a reagent to a sample until the sample reaches a certain endpoint – reaching the endpoint is usually indicated by a color change

**Titration** – syringe-like instrument used to add precise amounts of reagent in the process of titration

**Topographical map** - a map that shows (by means of color and contour lines) the ground surface features of a region

**Toxic** - being harmful, destructive or deadly to organisms

**Tributary** - an inflow of water from a smaller body into a larger one; natural examples include streams and creeks, while human-made examples include drains and sewerage pipes

**Trophic** – relative position in the food web in terms of securing nutrients

**Turbidity** – murkiness or cloudiness of water, indicating the presence of some suspended sediments, dissolved solids, natural or human-made chemicals, algae, etc.

**Upwelling** – a process in the sea whereby subsurface water is displaced toward the surface

**Watershed** – total land area that contributes runoff to a particular waterbody

# **APPENDIX B**

## **ANCHORAGE WATERWAYS COUNCIL**

Citizens' Environmental Monitoring Program  
Volunteer Training Manual

### **Monitoring Policy Statement**

## **ANCHORAGE WATERWAYS COUNCIL**

### **Citizens' Environmental Monitoring Program Policy**

---

1. Each monitoring station or site will have one primary monitor or Team Leader and at least one alternate when possible. If both primary and alternate monitors for any particular site are from the same household, a third person may be assigned as alternate to provide coverage for vacations, etc.
2. In order to maximize site coverage in the event of illnesses or vacations, efforts will be made to avoid assigning the same two monitors to any two sites.
3. The ability of individuals under the age of 18 years to be primary monitors will be at the discretion of the Monitoring Director. We encourage those under the age of 18 to form a team with a parent, who can be the primary monitor. People under 18 are welcome to attend training and quality control sessions and to assist other monitors at the sites.
4. All monitors will complete Phases I through III of training prior to monitoring and attend at least one of the two quality control sessions (Phase IV-Recertification) held each year.
5. Each monitoring team will have its own kit. Team Leaders will be responsible for maintaining their kits and for notifying the Monitoring Director of any problems with their equipment. Team Leaders will bring their kits to all quality control sessions.
6. If a Team Leader is not able to monitor on a scheduled date it is their responsibility to locate an alternate monitor and provide them with their monitoring kit. If this is not possible the Team Leader should contact the Monitoring Director to make arrangements, preferably in advance of the sampling session. Monitors are responsible for reporting equipment problems, reagent shortages, etc. to their team leaders or the Monitoring Director.
7. All monitors will take part in monitoring at least once every four (4) months to maintain familiarity with equipment, procedures, and sites.
8. All monitors will have the option of joining an "alternate pool" in addition to their regular teams. The pool will provide coverage when regular monitors are not available at a given site. Only trained monitors may join this pool.
9. All monitors will be responsible for the quality and completeness of the data they themselves collect and for submitting this data to the Monitoring Director within a week of sampling. Monitors will also be responsible for maintaining an ample supply of standardized data sheets.
10. The Monitoring Director will be responsible for the overall quality of the data collected by the program. If problems arise with the data collected by any particular monitor, the Monitoring Director will work with the monitor to resolve these problems.

## **APPENDIX C**

**ANCHORAGE WATERWAYS COUNCIL**  
Citizens' Environmental Monitoring Program  
Volunteer Training Manual

### **References & Further Reading**

## References & Further Reading

Some References used in

Preparing This Manual Include:

### Water Quality Monitoring Manual (1998)

Cook Inlet Keeper  
PO Box 3269  
Homer, AK 99603

### Volunteer Environmental Monitoring Manual (1992)

Texas Watch  
Texas Natural Resources Conservation  
Commission  
P.O. Box 13087  
Austin, TX 78711-3087

### Volunteer Manual (1992)

The Delaware Riverkeeper Network  
P.O. Box 753  
Lambertville, NJ 08530

### Volunteer Stream Monitoring Methods Manual (1995)

Clean Water Initiative  
Tennessee Valley Authority  
1101 Market Street, CST 17D  
Chattanooga, Tennessee 37402-2801

### The Monitor's Handbook (1992)

LaMotte Company  
P.O. Box 329  
Chestertown, MD 21620

### Volunteer Estuary Monitoring:

A Methods Manual (1993)  
U.S. Environmental Protection Agency  
Office of Water  
Office of Wetlands, Oceans and Watersheds  
Oceans and Coastal Protection Division  
401 M Street, SW (4504F)  
Washington, DC 20460

### Standard Methods for the Examination of Water and Wastewater (19<sup>th</sup> Edition, 1995)

American Public Health Association, et.al.  
1015 Fifteenth Street, NW  
Washington, DC 20005

### Volunteer Stream Monitoring: A Methods Manual

U.S. Environmental Protection Agency  
Office of Wetlands, Oceans and Watersheds  
Volunteer Monitoring (4503F)  
401 M Street, SW  
Washington, DC 20460

### **Other Valuable Resources for Volunteer Monitors Include:**

### Streamkeeper's Field Guide (5<sup>th</sup> Edition, 1996)

Paul Murdoch & Martha Cheo  
Adopt-A-Stream Foundation  
600 – 128<sup>th</sup> Street SE  
Everett, WA 98208

### Water Resource Handbook (1996)

Larry W. Mays, Editor-in-Chief  
Department of Civil and Environmental  
Engineering  
Arizona State University  
Tempe, Arizona

### Volunteer Lake Monitoring:

A Methods Manual (1991)  
U.S. Environmental Protection Agency  
Office of Water  
Office of Wetlands, Oceans and Watersheds  
Assessment & Watershed Protection Division  
WH-553  
401 M Street, SW  
Washington, DC 20460

The Volunteer Monitor (Biannual Publication)

Eleanor Ely, Editor  
The Volunteer Monitor  
1318 Masonic Ave.  
San Francisco, CA 94117

Field Manual for Water Quality Monitoring  
(1990)

Mark K. Mitchell & William B Stapp  
2050 Delaware Ave.  
Ann Arbor, MI 48103

Laboratory Manual for Marine Science Studies  
(1993)

LaMotte Company  
P.O. Box 329  
Chestertown, MD 21620

Handbook of Hydrology (1993)

David R. Maidment, Editor-in-Chief  
McGraw-Hill, Inc.  
Princeton Road, S-1  
Highstown, NJ 08520

An Introduction to Environmental Chemistry  
(1996)

J.E. Andrews, P. Brimblecombe  
T.D. Jickells and P.S. Liss  
School of Environmental Science  
University of East Anglia Norwich NR4 7TJ, UK

The HarperCollins Dictionary of  
Environmental Science (1992)

Gareth Jones, Alan Robertson  
Jean Forbes, Graham Hollier  
HarperCollins Publishers  
10 East 53<sup>rd</sup> Street  
New York, NY 10022

McGraw-Hill Series in Water Resources  
and Environmental Engineering (1991)

Terence J. McGhee

McGraw-Hill, Inc.

Princeton Road, S-1

Highstown, NJ 08520

Water on Tap: A Consumer's Guide  
to the Nation's Drinking Water (1997)

U.S. Environmental Protection Agency

Office of Water (4601)

Washington, DC 20460

McGraw-Hill Encyclopedia of  
Ocean and Atmospheric Sciences (1977)

Sybil P. Parker, Editor-in-Chief

McGraw-Hill, Inc.

Princeton Road, S-1

Highstown, NJ 08520

# **APPENDIX D**

## **ANCHORAGE WATERWAYS COUNCIL**

Citizens' Environmental Monitoring Program  
Volunteer Training Manual

### **Odor Identification Chart**

## Odor Identification Chart

A system of qualitative descriptions helps monitors describe and record detected odors. The following classifications are included in the tenth edition of Standard Methods.

NATURE OF ODOR		DESCRIPTION, SUCH AS ODOR OF:
Aromatic (spicy)	camphor, cloves, lavender, lemon	
Balsamic (flowery)	geranium, violet, vanilla	
Chemical	industrial wastes or treatments	
	chlorinous	chlorine
	hydrocarbon	oil refinery wastes
	medicinal	phenol and iodine
	sulfur	hydrogen sulfide (rotten eggs)
Disagreeable (pronounced, unpleasant)	fishy	Uroglenopsis, Dinobryon (dead algae)
	pigpen	Anabaena algae (visit a pig farm to sample this distinctive odor)
	septic	stale sewage
Earthy	damp earth	
	peaty	peat
Grassy	crushed grass	
Musty	decomposing straw	
	moldy	damp cellar
Vegetable	root vegetables	

# **APPENDIX E**

## **ANCHORAGE WATERWAYS COUNCIL**

Citizens' Environmental Monitoring Program  
Volunteer Training Manual

### **Anchorage CEMP Test Parameters**

## **CEMP TEST PARAMETERS**

This section reviews the types of water quality data and other information to be collected and discusses why each is important to understanding the “health” of the Anchorage watersheds.

### **FIELD OBSERVATIONS**

In addition to the water quality parameters you will monitor, there is other important information, which will help draw a more complete picture of the environmental health of your sampling site and the Cook Inlet Watershed as a whole. Gathering this information involves using your senses to observe conditions at your site.

Recording basic observations about your site will put the data you collect into context. You will be producing a record of conditions over time, through changes in tide, weather and season as well as varying human and wildlife activity.

#### **Air Temperature**

Air temperature is a standard measurement taken by most environmental monitoring programs. Recording air temperatures helps to create a complete picture of conditions at the sampling site at the time of monitoring and to document climatic conditions over an extended period.

#### **Wind & Weather**

Weather conditions (whether raining or sunny, windy or calm) can have an impact on physical, chemical and biological activity in the water. Wind speed and direction can be an indication of the source of certain air borne pollutants. It can also affect turbidity, dissolved oxygen and surface water temperature. In the AWC program you will reference the Beaufort Scale to estimate wind speed (see Appendix H).

Rainfall can affect the rate of run-off pollution from land as well as the temperature, pH and turbidity of surface water. Volunteers record current weather conditions and the number of consecutive days prior to sampling that have had similar weather. Monitors also record the type and amount of precipitation at each site for the past 24 hours. You can obtain a rain gauge from the Monitoring Coordinator or, if you live in the same watershed as your site, you may want to find out if a neighbor is already tracking rainfall and is willing to share the information.

#### **Sample Collection Site Collection**

A description of the location in the creek from where your bucket drew the sample is important as it assists in explaining certain results. There are three elements to this description: the depth of the water where the sample was drawn; the substrate of the stream bed; and the type of habitat, which is typically a choice between pool and riffle.

## **Comments & Observations**

Despite being the least quantitative of the parameters, visual assessment of the monitoring site can provide valuable information and assist in interpretation of other physical, chemical and biological data. Visual assessment is simply observing the environmental conditions at the site and recording those that are noteworthy.

Visual information can also provide an account of events or conditions that may help explain the monitoring data collected. For example, if dead fish are floating on the water surface, they may signal a sudden drop in dissolved oxygen levels, the influx of some toxic substance, or a disease or infestation of the fish.

In addition to visual assessment you will also use your ears and your nose to monitor your site. Listen for birds and other wildlife as well as sounds of human activity such as engines. Check for unusual odors. Though quite subjective, water odor can reveal water quality problems that may not be visually apparent. Industrial and municipal effluents, rotting organic matter, and bacteria can all produce distinctive odors. Raw sewage, for example, has an unmistakable aroma.

Additionally, describing the sampling location in terms of depth of water and the substrate on the bottom (cobble, sand, muck, etc), contributed more clues about the characteristic of the sampled water.

## **Photos or Sketches**

A picture should be taken prior to the first round of sampling at each site. Additionally, it is a good practice to take routine pictures of your site at least four times a year, in order to get a sense of its seasonal and other variations over time. If your site is subjected to either long term or sudden environmental impact your photos will help document the effects of these changes.

Regardless of your level of artistic ability, a rough sketch of your site is a valuable tool for physically locating your observations during each sampling event.

Please do not underestimate the importance of this observational data; although it is less “hard” than the numbers and figures you will measure in your water testing, it nonetheless provides an important window into the ecology of your sampling area.

## **WATER QUALITY PARAMETERS**

AWC’s Anchorage Citizens’ Environmental Monitoring Program includes testing for a wide range of water quality indicators. Selection of the parameters to be tested was based on a number of factors including how the collected data would contribute to understanding of water quality and overall watershed “health”, the ease with which tests could be performed and the long term affordability of monitoring equipment and supplies.

## **Apparent Color**

Apparent color of water results from dissolved substances and suspended matter, and provides general but useful information about the water's source and content. Metal ions, plankton, algae, pollution and other natural and human-induced materials may all produce color in water. Depending on the materials in it, water absorbs certain wavelengths of light, and reflects others. The reflected wavelengths are the ones we observe when determining apparent color.

Transparent water with a low accumulation of dissolved materials appears blue and indicates low productivity. Dissolved organic matter, such as humus, peat or decaying plant matter, can produce a yellow or brown color. Some algae or dinoflagellates produce reddish or deep yellow waters. Water rich in phytoplankton and other algae usually appears green. Soil runoff produces a variety of yellow, red, brown and gray.

Uniform color scales are used in determining apparent color to ensure that standardized color information can be shared and compared between researchers. AWC has selected the Borger Color System, (BCS) which was originally devised to measure the color of flies for fishermen, but which is well-suited for water testing too.

## **Turbidity (Clarity)**

Turbidity, or water clarity, is a measurement that pulls together many important features of an aquatic system. Turbidity is caused by suspended solid matter which scatters light passing through the water. Any material mixed and suspended in water will reduce its clarity and make the water turbid (i.e. muddy and cloudy). Such materials can come from many sources. In early spring, the water may become more turbid as silt is carried into the estuary with the spring thaw and run-off. At any time of year, silt-laden surface water can flow into the estuary from tributaries and storm drains during periods of heavy rain and associated runoff. In Cook Inlet, glacial silts are also a major cause of turbidity. In late spring through early fall, turbidity may be caused by plankton as they grow and multiply rapidly in warm, sunlit, nutrient-rich water.

In shallow areas, wind-generated waves and boat wakes can stir up sediments from the bottom. As waves generated by wind and passing boats break on the shore, they can also increase the turbidity. Upstream construction activities, land clearing, or any other activity which erodes the soil, may release sediment to tributaries of Cook Inlet and increase turbidity.

Turbidity affects fish and aquatic life in many ways:

- High turbidity levels interfere with the penetration of sunlight. Submerged aquatic vegetation (SAV) needs light for photosynthesis. If suspended particles block out light, lower rates of photosynthesis produce less oxygen. SAV, like the eelgrasses and kelp in many areas of Cook Inlet, provide important habitat for a diverse community of marine life. These are critical areas where many species including shellfish, waterfowl, and fish can find essential food and shelter. If light levels get too low, photosynthesis can stop all together and the vegetation will begin to die off.

- Large amounts of suspended matter can clog the gills of some species of fish, reducing oxygen transfer.
- Excessive amounts of suspended matter clog the feeding apparatus of bottom-dwelling animals (e.g. crabs, anemones or clams) and may even smother them completely.
- Suspended particles may provide a place for harmful bacteria and microorganisms to settle and grow. The particles can also carry pesticides, toxic metals and excess nutrients down tributaries or throughout the dynamic Cook Inlet estuary. Suspended particles near the water surface absorb additional heat from sunlight and can raise the surface water temperature.

There are several ways to test turbidity and the turbidity test we have chosen is a comparative turbidity test, which uses a chemical reagent in a tube to measure turbidity in Jackson Turbidity Units (JTUs).

### **Water Temperature**

While temperature may be one of the easiest measurements to perform, it is also one of the most important parameters we test because it dramatically affects the rates of chemical and biological reactions within the water. Some of the most common biological, physical and chemical processes that are temperature dependent are listed below.

- The rates of photosynthesis and plant growth both increase in warmer water. Therefore, it is important to understand the connection between the processes of photosynthesis and respiration. In photosynthesis, plants use sunlight, carbon dioxide, and water to create the organic molecules they need to grow. In the process, the plants release oxygen. Respiration is the reverse of photosynthesis; when no light is available, plants respire (i.e. they take in oxygen and break down the stored organic molecules to get energy), releasing carbon dioxide. Thus, temperature changes can dramatically affect plant growth and the amount of oxygen in the water.
- An increase in plant growth and photosynthesis means that more oxygen is produced, but it also means that more oxygen is consumed through plant respiration. The balance between photosynthesis and respiration depends on the availability of sunlight. Especially in summer, when the days are longer, there is a net production of oxygen. Another factor is that when the plants die, oxygen is consumed in the process of bacterial decay.
- Individual organisms living in the water are healthiest when temperatures stay within their range of tolerance. The metabolic rates of organisms increase in warmer water and in many organisms, increased metabolism means increased oxygen demand. Even if there is enough dissolved oxygen to supply the greater demand, under extreme high or low temperature conditions marine organisms become stressed and are more vulnerable to toxic chemicals, diseases, and parasites. The requirements of any one organism change as it goes through different stages of life. For example, fish larvae and eggs usually have a narrower tolerance

range than adult fish; conditions that would have been tolerable for the adults may kill off the larvae before they have a chance to reach adulthood

- Temperature affects the distribution of various types of organisms because different organisms have different temperature requirements and different ways of responding to changes in temperature. Motile organisms - those capable of moving on their own, such as fish - may be able to escape unfavorable temperature conditions by migrating elsewhere. Sessile (i.e. immobile) organisms such as algae and slow-moving organisms such as anemones remain to be weakened or even to die.
- Gases such as oxygen are more soluble in cool water than in warm water. In other words, cool water can hold more dissolved oxygen. Solids, on the other hand, are usually more soluble in warm water. For example, heavy metal compounds deposited in sediments at cooler temperatures can be released at warmer temperatures. First, the compounds already existing in the sediments become more soluble; second, as the concentration of oxygen decreases, the metals react chemically to form new and even more soluble compounds. Once the metals are released from the sediments into the water, they can be taken up by marine life.
- The rates of chemical reactions in fresh and brackish water generally increase with increasing temperature.
- The density of seawater decreases with increasing temperature. This variation of density with temperature affects inversions, mixing, and current movements.
- Because significant portions of Cook Inlet are naturally shallow, the capacity of these parts of the estuary to store heat for long time periods is relatively small. As a result, water temperatures fluctuate considerably over time and by location. In shallow areas, tides, currents, and wind tend to minimize temperature differences between surface and subsurface water.
- In deeper areas, the temperatures of surface and subsurface water often differ. Generally, deeper water is colder and therefore denser. The vertical temperature profile of the water column follows a fairly predictable annual cycle. In spring and summer months, the surface waters are warmed by the sun; the bottom waters remain much cooler. In the fall, the sun gets lower in the sky, the days get shorter, and the air gets cooler. The surface waters also cool, increasing in density. When the surface water is colder and denser than the bottom water, it begins to sink, and vertical mixing occurs. Wind speeds up the process. This annual turnover creates an upwelling of nutrients and minerals from the bottom that are newly available to the phytoplankton and other inhabitants of the surface waters. During the remaining winter, the water temperature becomes nearly constant from surface to bottom. Then, in early spring, the radiation of the sun again warms the surface waters. The top layer warms and the bottom remains cool, until the next fall when turnover and upwelling occur again.

Temperature is measured using a familiar instrument: a thermometer. Most liquids expand with increasing temperature. A thermometer consists of a reservoir of a known liquid in the bulb (in

our case, alcohol mixed with dye) and a narrow-bore tube into which the liquid expands. Measuring the height to which the liquid has expanded in the tube gives the temperature.

Additionally, eleven 'Hobo' Temperature meters will be placed in selected streams which will record water temperatures every hour. Every three months, the data will be downloaded into a program to produce graphs which will demonstrate daily, seasonal and yearly fluctuations in temperature. This method is useful for those streams which have had relatively high temperatures during the summer, potentially harming salmon fry.

Water temperatures will be reported in degrees Celsius, the standard temperature unit for scientific data. On the Celsius scale, fresh water boils at 100°C and freezes at 0°C. Seawater, on the other hand, freezes at a somewhat lower temperature depending on its salinity. Because Americans still frequently rely on the Fahrenheit scale (where freshwater boils at 212°F and freezes at 32°F), it may help you to use the following formula to convert between the two scales:

**To convert from °F to °C:**

$$^{\circ}\text{C} = (^{\circ}\text{F} - 32) \times (5/9) \quad \text{or} \quad ^{\circ}\text{C} = (^{\circ}\text{F} - 32) \div 1.8$$

**To convert from °C to °F:**

$$^{\circ}\text{F} = [(9/5) \times ^{\circ}\text{C}] + 32 \quad \text{or} \quad ^{\circ}\text{F} = (1.8 \times ^{\circ}\text{C}) + 32$$

## **pH**

pH is the measure of how acidic or basic a solution is. Because a variety of chemical and biological processes depend on certain pH values, pH measurements provide important information about the state of water quality. As water travels through the watershed, a number of factors may affect its pH:

- Leaching of soil and rock outcrops, especially during periods of heavy rain or snowmelt.
- Human-generated wastes (e.g. industrial discharges, sewer overflows, lawn runoff).
- Aerosols, dusts and gases picked up from the air.
- Photosynthesis by aquatic plants, which consumes carbon dioxide and can raise the pH of surrounding water.

The pH of the fresh water flowing into Cook Inlet depends on where the water has been and what it is carrying. Once water reaches Cook Inlet, local variations tend to be homogenized, partly by the motion of currents and tides, but also due to the strong buffering of seawater. Local pH values can increase during intense phytoplankton blooms, as the phytoplankton consume carbon dioxide in photosynthesis.

The resistance of water to changes in pH is critical to aquatic life because it determines the range of pH that organisms have to adapt to in order to survive. Generally, the ability of aquatic organisms to complete a life cycle greatly diminishes as pH becomes more than 9.0 or less than

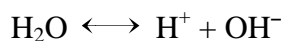
5.0. However, the ideal range for aquatic life in general - including both fresh water and salt water species - falls between 6.5 and 8.2. Marine organisms in the open ocean are usually exposed to an even narrower pH range of 8.1 to 8.3. When water with a low pH value comes in contact with certain chemicals and metals, the acidity of the water may cause these substances to become more soluble or more toxic than normal, increasing the effects of the pollutant load on Cook Inlet. Fish that can stand a slightly acidic pH may die at a more neutral pH if low concentrations of iron, aluminum, lead, or mercury are present. Phytoplankton blooms can play an interesting role here; as a bloom dies off, chunks of it sink to the bottom and decompose. The decomposition process produces organic acids which can lower the pH and react with the sediments to release metals and other toxins into the water.

Pure distilled water has a pH of 7.0 and is said to be neutral. The pH values of natural waters are controlled by the salts and gases dissolved in them. Seawater typically has a pH of 8.1 to 8.3. Because its pH is greater than 7.0, it is said to be basic or alkaline (the two terms are synonymous). The pH of seawater is fairly stable because it is highly buffered - that is, the water contains pairs of ions which react to damp down changes in pH.

The strong buffering and constant motion of seawater tend to minimize variations in pH. Short-lived, local variations may be caused by intense phytoplankton blooms, or at locations where industrial discharges and sewer outflows enter the ocean, or where there are large influxes of fresh water. Natural fresh water typically has a lower pH than seawater. Rain water and snow melt usually has a pH of 5.6 to 6.0. Because its pH is less than 7.0, even unpolluted rain water is said to be acidic. So-called "acid rain" has an even lower pH due to atmospheric pollutants.

<b>Buffers</b>							
Seawater contains both bicarbonate ions ( $\text{HCO}_3^-$ ), which can consume excess hydroxyl ions ( $\text{OH}^-$ ), and carbonate ions ( $\text{CO}_3^{2-}$ ), which can consume excess hydrogen ions ( $\text{H}^+$ ):							
$\text{HCO}_3^- + \text{OH}^- \rightleftharpoons \text{CO}_3^{2-} + \text{H}_2\text{O}$ $\text{CO}_3^{2-} + \text{H}^+ \rightleftharpoons \text{HCO}_3^-$							
The ratio of carbonate to bicarbonate ions present in seawater buffers its pH to a fairly stable value of 8.1 to 8.3. The ratio of borate ions ( $\text{H}_2\text{BO}_3^-$ ) to boric acid ( $\text{H}_3\text{BO}_3$ ) also plays a lesser but significant role in the buffering of seawater.							

pH is defined as the negative logarithm of the concentration of hydrogen ions; the higher the concentration, the lower the pH. In any given aqueous solution, a certain proportion of water molecules dissociate to form hydrogen ( $\text{H}^+$ ) and hydroxyl ( $\text{OH}^-$ ) ions:



In neutral solutions (pH = 7.0), the concentrations of hydrogen and hydroxyl ions are equal. Acidic solutions (pH < 7.0) contain more hydrogen than hydroxyl ions. Basic or alkaline solutions (pH > 7.0) contain more hydroxyl than hydrogen ions.

Because the pH scale is logarithmic, pH does not increase or decrease in a simple linear fashion. Instead, the increases are in powers of 10. For example, at a pH of 5 there are ten times more H<sup>+</sup> than a pH of 6:

$$\text{pH } 6: [\text{H}^+] = 1 \times 10^{-6} = 0.000001$$

$$\text{pH } 5: [\text{H}^+] = 1 \times 10^{-5} = 0.00001$$

Thus, a solution of pH 3 is not simply twice as acidic as one with a pH 6, but 1000 times as acidic.

One of the easiest ways to measure pH is to use an indicator solution. Most indicators are organic molecules which have a hydrogen ion they can easily gain or lose and which happen to change color when this occurs (making the reaction easy to observe). AWC has selected a "wide range" indicator, which can measure pH throughout most of the pH range.

### **Hanna Combo Meters**

Both the '4 in 1' Hanna meter and 'Combo' Hanna meter are used to measure conductivity, temperature, and pH. The difference being the '4 in 1' meter measures oxidation-reduction potential, while the 'Combo' meter measures Total Dissolved Solids. Although temperature and pH measurements duplicate those of previous tests, the meter provides an important check on data accuracy. By also recording conductivity and oxidation-reduction potential or total dissolved solids levels, these meters provide additional insight into water quality.

a)      **Temperature**

As discussed above, temperature is an important factor for many physical, chemical and biological processes in Cook Inlet. Using the Hanna meter for temperature readings at the start and finish of Hanna Meter testing allows for more accurate temperature measurements, and provides a check on thermometer readings.

b)      **pH**

pH is also important for many physical, chemical and biological systems. Taking three (3) sequential readings with the Hanna meter provides for more accurate pH measurement, and a check on the pH value obtained from the Octet Comparator.

c)      **Conductivity**

Conductivity measures the electrical conductance of water, which is proportional to the nature and quantity of total dissolved solids (TDS) in the sample water. The Hanna meter contains electrodes, which measure the electrical current, which is conducted between them in the sample water. Conductivity is measured in micromhos (or micro-Siemens) per centimeter (mhos/cm or  $\mu\text{S}/\text{cm}$ ).

d) Total Dissolved Solids

Related to conductivity, total dissolved solids are material left behind after a water sample is filtered and evaporated. The quantity of dissolved matter depends mainly on the solubility of the rocks and soils the water contacts, and each water body contains a unique mixture of dissolved materials. Total dissolved solids are measured in parts per million (ppm).

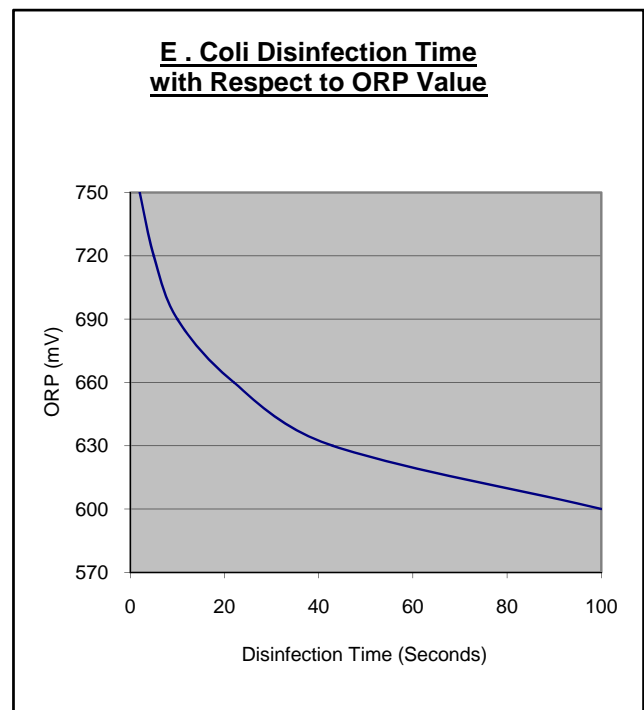
e) Oxidation-Reduction Potential (ORP)

In a manner similar to that in which acidic or alkaline solutions are quantified by pH measurements, solutions can also be graded as oxidizing or reducing based on measurements of ORP (sometimes called ‘redox’) values. The Oxidation Reduction Potential defines the capability of a substance to either release or gain free electrons. Oxidation is always coupled together with reduction so that as one element gets oxidized another automatically is reduced.

Oxidation and reduction reactions mediate the behavior of many chemical constituents in water. The reactivities and mobilities of important elements in biological and chemical systems depend strongly on redox conditions. Measurement of redox potential is useful in developing a more complete understanding of water chemistry.

ORP is also a reliable indicator of bacteriological water quality because the life expectation of bacteria in water is related to this parameter. For example, studies have shown that the life span of bacteria in water decreases more directly due to the ORP value than to the concentration of chlorine in the water. The graph on the right represents the disinfection time for the bacteria *E. coli* with respect to ORP value.

ORP measurements are based on the potential difference between an electrode made of an inert metal (normally platinum or gold) and a



reference electrode. The identical reference system utilized for the pH electrode (Ag/AgCl) is also used for redox measurements.

When the redox electrode is immersed in a solution containing a reversible chemical reaction system, a migration of electrons is established between the electrode and the system. This electron flow can be construed as an exchange current density and is of paramount importance for accurate, fast and reproducible redox potential measurement.

The '4 in 1' meter relies on its sensitive electrodes housed in the meter's black base compartment. These electrodes are fragile and should not be handled.

Electrodes are rinsed with distilled/dionized water prior to and after testing.

### **Dissolved Oxygen**

Dissolved oxygen (DO) is one of the most important indicators of water quality for aquatic life. It is essential for the basic metabolic processes of animals and plants inhabiting our coastal waters. Dissolved oxygen is measured in milligrams per liter (mg/l) which equates to parts per million (ppm). When oxygen levels fall below about 3 to 5mg/l, fish and many other marine organisms are stressed and some cannot survive. Dissolved oxygen is a particularly sensitive constituent because other chemicals present in the water, certain biological processes, and physical factors such as temperature and water clarity exert a major influence on its availability throughout the year.

The maximum amount of oxygen water can hold depends a great deal on its temperature and salinity. A DO test (using a meter or chemical kit) tells you how much oxygen is dissolved in the water, but it does not tell you how much oxygen the water is capable of holding at the temperature and salinity at which it was tested. Warmer water holds less dissolved oxygen; as water approaches its boiling point, it can hold almost no oxygen. Dissolved oxygen also decreases with increasing salinity. When water holds all the dissolved oxygen that it can at a given temperature and salinity, it is said to be 100 percent saturated with oxygen. If water holds only half that amount of DO at the same temperature and salinity, it is said to be 50 percent saturated. The table below shows this relationship for various temperatures and salinities.

<b>TEMPERATURE</b>	<b>SALINITY</b>		
	Freshwater 0 ppt	Brackish water 5 ppt	Open Ocean 35 ppt
0	14.6	14.1	11.3
5	12.8	12.4	10.1
10	11.3	11.0	9.0
15	10.2	9.9	8.3
20	9.2	9.0	7.5
25	8.4	8.2	6.9
30	7.6	7.4	6.1

Potential dissolved oxygen levels in milligrams per liter (mg/l) at sea level

Consider some of the more shallow areas in Anchorage on a hot August day. Except for in glacial streams, stream levels are relatively low at that time of year, so less fresh water is flowing into the Inlet and the salinity is relatively high. The average water temperature in the Inlet is also relatively high (by Alaska standards) and it gets higher locally as the tide comes in over a flat beach that has been baking in the sun. Both the higher salinity and the higher temperature lower the water's ability to hold oxygen. Any events that increase the oxygen demand - e.g. a salmon run, or an influx of nutrients that causes a plankton bloom followed by a die-off - can push the local ecosystem over the edge and cause serious problems.

One of the largest sources of dissolved oxygen is oxygen transferred from the atmosphere into surface waters by the re-aerating action of wind and waves. A second major source is oxygen produced by aquatic plants (including phytoplankton) during photosynthesis. Photosynthesis requires sunlight, so it is limited by depth. In the open ocean, most photosynthetic activity occurs in the upper 80 meters (260 feet), with some activity continuing down to 600 meters (1,970 feet). In coastal areas, the depths at which photosynthesis can occur are more variable and more influenced by activities on land.

Once in the water, oxygen is consumed by marine organisms. Like land animals, fish and other marine species need oxygen for respiration. When no light is available, plants also need oxygen. Bacteria consume oxygen as they decompose dead plants and animals. Oxygen shortages occur when consumption outstrips the available oxygen resources. Oxygen levels may be reduced because the water is over-heated, as it might be near an industrial discharge or marine log storage area; warmer water simply cannot hold as much oxygen as cooler water. If water clarity decreases - that is, the water becomes turbid - due to an influx of glacial silt, organic matter, etc., less sunlight will reach the photosynthesizing plants, and they will be less able to produce oxygen.

Large amounts of organic matter in the water can not only decrease oxygen production, but also increase consumption as bacteria work on breaking down and decaying the matter. When runoff from the land or the addition of sewage effluents provides excessive amounts of nutrients such as nitrogen (in salt water near the coast) or phosphorus, a phytoplankton bloom can occur. The availability of extra nutrients allows the reproductive rate of these microalgae to zoom; the population of some species can double every twenty minutes. The phytoplankton bloom can block sunlight from reaching other types of plants. When the extra nutrients are gone, the bloom suddenly dies off, and huge amounts of oxygen are used up in its decay. A massive phytoplankton bloom can result in anoxic conditions (i.e. absence of oxygen) and can cause substantial die-offs of fish and shellfish in coastal waters.

For surface sampling, dissolved oxygen will be measured using a method called Winkler titration (named after Hungarian chemist Lajos Wilhelm Winkler). One of the immediate problems involved in measuring the concentration of oxygen dissolved in a water sample is to prevent any of the oxygen from escaping. To achieve this, two solutions are added to the sample. One contains manganous ions ( $Mn^{2+}$ ) and the other hydroxyl ions ( $OH^-$ ). Because of its high concentration of hydroxyl ions, the second solution is described as "alkaline." Together, these ions react to form manganous hydroxide, which is fairly insoluble in water and forms a white, fluffy flocculate (or floc). Immediately, the oxygen molecules in the water react with the floc to

convert it from manganous hydroxide to hydroxides of various manganese ions with charges higher than  $+2$  (e.g.,  $+3$ ,  $+4$ , and  $+7$ ). These new hydroxides give a brownish color to the floc.

The next step is to add a strong acid to the sample to dissolve the hydroxides. As the manganese ions are freed from the floc, they react with the iodide ions ( $I^-$ ) contained in the alkaline solution added earlier and form manganous ions (the same kind you started with) and iodine molecules ( $I_2$ ). Because of the iodine, the sample turns a yellow-brown color.

At this point, the oxygen molecules are no longer floating around in the water. Instead, they have been entirely used up in the conversion of the manganese ions. If you are sampling in messy weather or from an unstable surface, you can take the treated sample to some more convenient place to finish the procedure. Protect the sample from light and heat (sample temperature should remain between  $+4^\circ\text{C}$  and  $+10^\circ\text{C}$ ), and finish the procedure within six hours.

A carefully measured portion of the treated sample is "titrated" with thiosulfate ions ( $S_2O_3^{2-}$ ) - that is, sodium thiosulfate solution is added drop by drop to determine the exact amount necessary to consume all of the iodine in a reaction that produces iodide and tetrathionate ions ( $S_4O_6^{2-}$ ). In order to make it easier to see the exact point at which all the iodine is consumed, a starch indicator is added to the titration sample. Starch turns dark blue in the presence of iodine. As the last of the iodine vanishes, so does the dark blue color.

The whole point of this procedure is that all of the oxygen molecules are consumed in the conversion of the manganese ions, but all of the manganese ions are converted back to manganous ions by the iodide ions. The net result is that two iodine molecules are produced for each of the oxygen molecules you started with. Each iodine molecule then converts two thiosulfate ions into one tetrathionate ion.

The titration procedure measures the molar volume of a sodium thiosulfate solution of known concentration needed to consume all of the iodine in a titration sample of known volume. Multiplying the molar volume of thiosulfate solution used by its concentration gives the number of thiosulfate ions that were consumed. The number of iodine molecules involved is one half of this, and the number of oxygen molecules originally dissolved in the titration sample is one half of this again. Dividing the number of oxygen molecules by the volume of the sample gives the dissolved oxygen concentration. In the procedure we're following, a syringe holding 1 milliliter of sodium thiosulfate solution and divided along its length into ten units is used to titrate a 20 milliliter water sample. The concentration of the thiosulfate solution is chosen so that every 1 milliliter used in the titration indicates a DO concentration of 10 mg/l. In other words, each unit marked on the syringe corresponds to 1 mg/l dissolved oxygen in the sample.

## Nutrients

Phosphorus and nitrogen are both nutrients that occur naturally in water. They appear to be the most important nutrients in the eutrophication process and can often become detrimental by accelerating eutrophication, which is the natural aging process of a body of water such as a bay or lake.

Nutrients are also contained in stream sediments. If these are suspended they can maintain eutrophic (increased plant growth) conditions for many years. Many factors influence how much nutrient in a waterway is dissolved (soluble) and how much is attached to particles (particulate). These factors include:

➤ **Environmental factors**

High rainfall causes high-flow events and under these conditions soluble and particulate nutrient concentrations in waterways increase.

➤ **Catchment characteristics**

Factors such as slope, plant cover, soil type and soil moisture content will influence nutrient concentrations and the amount in soluble or particulate forms. Some soil types are more prone to water erosion than others. Sandy soils are most likely to produce the highest soluble phosphate concentrations, but this will depend on the likelihood of run-off or infiltration.

➤ **Management practices**

Water samples collected soon after fertilizer is applied may have high concentrations of soluble phosphate. If particles can settle out from flowing water (say, in a wetland or detention basin), then soluble phosphate concentrations in this basin may represent a very high proportion of the total nutrient load.

## **Phosphorus**

Both phosphorus and nitrogen are essential nutrients for the plants and animals that make up the aquatic food web. Since phosphorus is a nutrient in short supply in the typically clay rich soils of Southcentral Alaska and in most fresh waters, even a modest increase in phosphorus can, under the right conditions, set off a whole chain of undesirable events in a waterbody. These may include accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates and other aquatic animals.

There are many sources of phosphorus, both natural and human. These include soil and rocks, wastewater treatment plants, runoff from fertilized lawns and croplands, outhouses and failing septic systems, animal manure, runoff from disturbed land areas, drained wetlands, water treatment and commercial cleaning chemicals.

Phosphorus has a complicated story. Pure, “elemental” phosphorus (P) is rare. In nature, phosphorus usually exists as part of a phosphate molecule (PO<sub>4</sub>). Phosphorus in aquatic systems occurs as organic phosphate and inorganic phosphate. Organic phosphate consists of a phosphate molecule associated with a carbon-based molecule, as in plant or animal tissue. Phosphate that is not associated with organic material is inorganic. Inorganic phosphorus is the form required by plants. Animals can use either organic or inorganic phosphate.

Phosphorus cycles through the environment, changing form as it does so. Aquatic plants take in dissolved inorganic phosphorus and convert it to organic phosphorus as it becomes part of their tissues. Aquatic animals get the organic phosphorus they need by eating either aquatic plants, other animals or decomposing plant and animal material.

As plants and animals excrete wastes or die, the organic phosphorus they contain sinks to the bottom. Bacterial decomposition converts it back to inorganic phosphorus. Inorganic phosphorus gets back into the water column when the bottom is stirred up by animals, human activity, chemical interactions or water currents. Then it is taken up by plants and the cycle begins again.

In a river system, the phosphorus cycle tends to move phosphorus downstream as the current carries soil, decomposing plant and animal tissue and dissolved phosphorus. It becomes stationary when it is taken up by plants or is bound to particles that settle to the bottom of pools.

In the field of water quality chemistry, phosphorus is described using several terms. Some of these terms are chemistry-based (referring to chemically based compounds), and others are methods-based (they describe what is measured by a particular method).

The term “orthophosphate” is a chemistry-based term that refers to the phosphate molecule all by itself. “Reactive phosphorus” is a corresponding method-based term that describes what you are actually measuring when you perform the test for orthophosphate.

More complex inorganic phosphate compounds are referred to as “condensed phosphates” or “polyphosphates.” The method-based term for these forms is “acid hydrolyzable.”

Monitoring phosphorus is challenging because it can involve measuring very low concentration – down to 0.01 milligram per liter (mg/L) or even lower. Very low concentrations of phosphorus can have a dramatic impact on some waterbodies. Less sensitive methods are used to identify serious problem areas.

There are many tests for phosphorus detection and the Anchorage CEMP volunteers use one of two tests. They both measure total orthophosphate, which is largely a measure of orthophosphate. Because the sample is not filtered, the procedure measures both dissolved and suspended orthophosphate. The method for measuring total orthophosphate is known as the ascorbic acid method. Briefly, a reagent containing ascorbic acid reacts with orthophosphate in the sample to form a blue compound. The intensity of the blue color is directly proportional to the amount of orthophosphate in the water. An Axial Reader type color comparator is then used to determine phosphate levels in parts per million. The difference between the two is the range and sensitivity of the results.

## **Nitrogen**

Nitrogen makes up about 80 percent of the air that we breathe. It is an essential component of proteins and is found in the cells of all living things. Nitrogen is found in several different forms in terrestrial and aquatic ecosystems. These forms of nitrogen include ammonia ( $\text{NH}_3$ ), nitrates ( $\text{NO}_3$ ), and nitrites ( $\text{NO}_2$ ). Nitrates are essential plant nutrients, but in excess amounts they can cause significant water quality problems.

Together with phosphorus, nitrates in excess amounts can accelerate eutrophication, causing dramatic increases in aquatic plant growth and changes in the types of plants and animals that live in a waterbody. This, in turn, affects dissolved oxygen, temperature and other water quality indicators. Excess nitrites can cause hypoxia (low levels of dissolved oxygen) and can become toxic to warm-blooded animals at higher concentrations (1 mg/L or higher) under certain conditions. Hemoglobinemia (blue baby syndrome) is caused by excess nitrites. The natural level of ammonia or nitrate in surface water is typically low (less than 1 mg/L). Nitrites are commonly less than 10 percent of the nitrate/nitrite total. In the effluent of wastewater treatment plants, nitrate/nitrogen can range up to 30 mg/L. The standard for nitrates in drinking water is 10 mg/L. Unpolluted water generally has a nitrate reading of less than 1.00 ppm.

Sources of nitrates include wastewater treatment plants, runoff from fertilized lawns and croplands, outhouses and failing on-site septic systems, animal wastes, acid rain deposition and industrial discharges that contain corrosion inhibitors.

Nitrates from land sources can end up in rivers more quickly than other nutrients like phosphorus. This is because they dissolve in water more readily than phosphates, which have an attraction for soil particles. As a result, nitrates serve as a better indicator of the possibility of a source of sewage or other pollution during dry weather.

Water that is polluted with nitrogen-rich organic matter might show low nitrates. Decomposition of the organic matter lowers the dissolved oxygen level, which in turn slows the rate at which ammonia is oxidized to nitrite (NO<sub>2</sub>) and then to nitrate (NO<sub>3</sub>). Under such circumstances, it might be necessary to also monitor for nitrites or ammonia, which are considerably more toxic to aquatic life than nitrate.

Volunteer monitoring programs typically use one of three methods for nitrate testing: the cadmium reduction method, the nitrate electrode or the new zinc diazotization/coupling reaction. Both the cadmium reduction method and the zinc diazotization/coupling reaction method produce a color reaction that is then measured either by comparison to a color wheel or color comparator, or by use of a spectrophotometer. The cadmium reduction method, however, produces hazardous waste. For that reason, the AWC program has chosen to use the new zinc method for nitrate testing. Monitors add a series of tablets to their water sample causing it to turn a shade of pink whose intensity is proportional to the amount of nitrate in the sample. An Octa-Slide color comparator is then used to determine nitrate levels in parts per million.

### **Coliform Bacteria**

The coliform group of bacteria live by fermenting lactose (milk sugar) and are native to the intestinal tracts of mammals and birds. Although most coliform species can also exist as free-living organisms, species of the genus *Escherichia* cannot. The term "fecal coliform" refers primarily to the species *Escherichia coli* or *E. coli* (and occasionally to *Klebsiella* species as well).

Coliform bacteria are generally pretty harmless alone. In fact, water may contain coliforms from a variety of sources besides sewage. However, the presence of high levels of coliform bacteria and, in particular, of fecal coliforms (which can't live free) suggests that sewage is being discharged into the water. Sewage discharges raise the level of nutrients in the water and can cause phytoplankton blooms. Worse, sewage contains organisms that cause disease: pathogenic bacteria, viruses, protozoans, and parasites. For example, certain species of pathogenic bacteria can cause typhoid fever, dysentery, and cholera.

You might be wondering why we are looking at the relatively "harmless" fecal coliforms. It is because pathogenic bacteria are difficult to culture in the lab, and intestinal parasites and viruses can be even harder to analyze. Furthermore, if you were going to try to detect the disease-causing species directly, you would need to use a different test for each one. By contrast, fecal coliforms are relatively easy to detect and analyze. For these reasons, the fecal coliform group of bacteria is used by the Food and Drug Administration as a microbiological indicator of sewage pollution. In other words, when the FDA closes a shellfish flat, they are doing so on the basis of the fecal coliform count. The species *E. coli* is also used by the EPA to test the quality of fresh water for swimming. (In salt water a non-coliform type of bacteria called enterococci is used).

Traditional tests for coliforms and fecal coliforms require the inoculation of media containing lactose, incubation under carefully controlled temperatures, and examination for the presence of gas from lactose fermentation. Additional special media must then be inoculated and incubated at elevated, carefully controlled temperatures to confirm the presence of fecal coliforms (*E. coli*). All these require extra equipment and careful regulation of time and temperature. This approach is not only expensive and time consuming, but can be less than precise in indicating the numbers of specific organisms present.

As a result of the difficulties and lack of precision inherent in the older technology, new approaches have been developed and are being used very successfully. One of the best approaches is based on the fact that in order for coliforms to ferment lactose, they must produce certain enzymes which can be identified and used to verify the presence of the coliforms. General coliforms produce the enzyme galactosidase in lactose fermentation and fecal coliforms produce the enzyme glucuronidase in addition to galactosidase.

The "Coliscan" method used in the AWC program takes advantage of these facts. It provides a simple, accurate and quantitative way to identify and differentiate coliforms and fecal coliforms from other bacteria. This method incorporates two special chromogenic substrates which are acted upon by the presence of the enzymes galactosidase and glucuronidase to produce pigments of contrasting colors. All that is needed to identify the presence and numbers of coliforms and fecal coliforms is to add a test sample to the medium, pour it into a petri dish and incubate it at room temperature or at a higher controlled temperature. General coliforms will produce the enzyme galactosidase and the colonies that grow in the medium will be a pink color. Fecal coliforms (*E. coli*) will produce both galactosidase and glucuronidase and will therefore grow as purple colonies in the medium. It is simple to count the purple colonies (*E. coli*) which indicate the number of fecal coliforms per sample. The pink colonies indicate the number of general coliforms per sample. The combined general coliform and fecal coliform number equals the total coliform number. Any non-colored colonies which grow in the medium are not coliforms, but may be members of the family

Enterobacteriaceae. Since the Coliscan contains inhibitors, most other bacterial types will not grow. The EPA guideline for E. Coli is 126 col/100ml)

In addition to this 'coliscan' method, the monitoring program collects water samples for laboratory analysis from selected watersheds and pre-determined sites. Because the 'holding times' for this analysis, the monitoring coordinator collects these samples independent of volunteers. These samples are analyzed for Fecal Coliforms and Enterococci bacteria, using a membrane-filtration, which is an EPA-approved method. The specific methods are SM9222 D and SM9230 B respectively.

Fecal Coliforms are a worthwhile parameter as it is the only bacteria for which the State of Alaska has a water-quality standard for (100 col/100ml).

Enterococci is a subgroup of the fecal-streptococci bacteria and a more specific indicator of fecal contamination in water than fecal-streptococci bacteria. Unlike the other three bacterial tests performed, measuring enterococci levels. The EPA guideline for enterococci is 33 col/100ml.