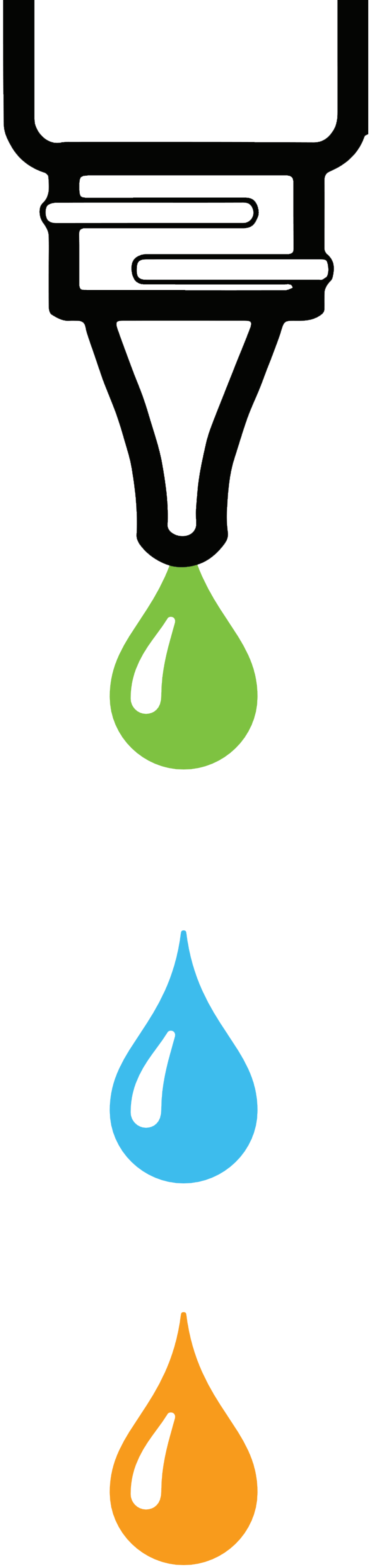

WATER QUALITY MONITORING MANUAL 2019-20

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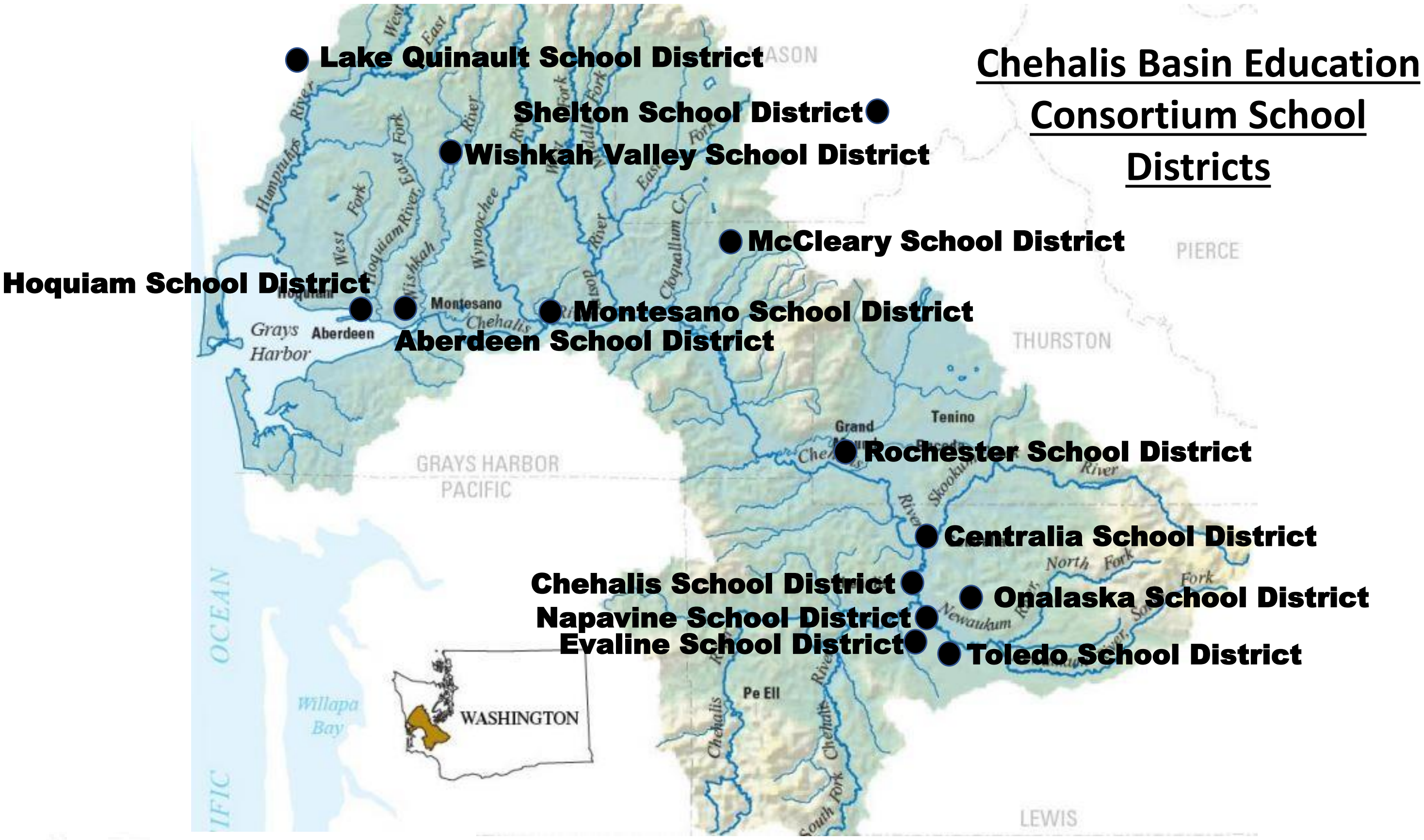
1

History of Water Quality Monitoring Day

All 3 watershed education programs are modeled after the GREEN program, which was founded in 1989 by Bill Stapp. The Global Rivers Environmental Education Network (GREEN) creates opportunities for young people to learn more about the watersheds they live in and to use what they learn to create lasting solutions for pressing water quality issues. The program engages young people to be knowledgeable about watersheds and their issues, to have the skills to solve those problems, and to be motivated to work toward a solution.



Chehalis Basin Education Consortium

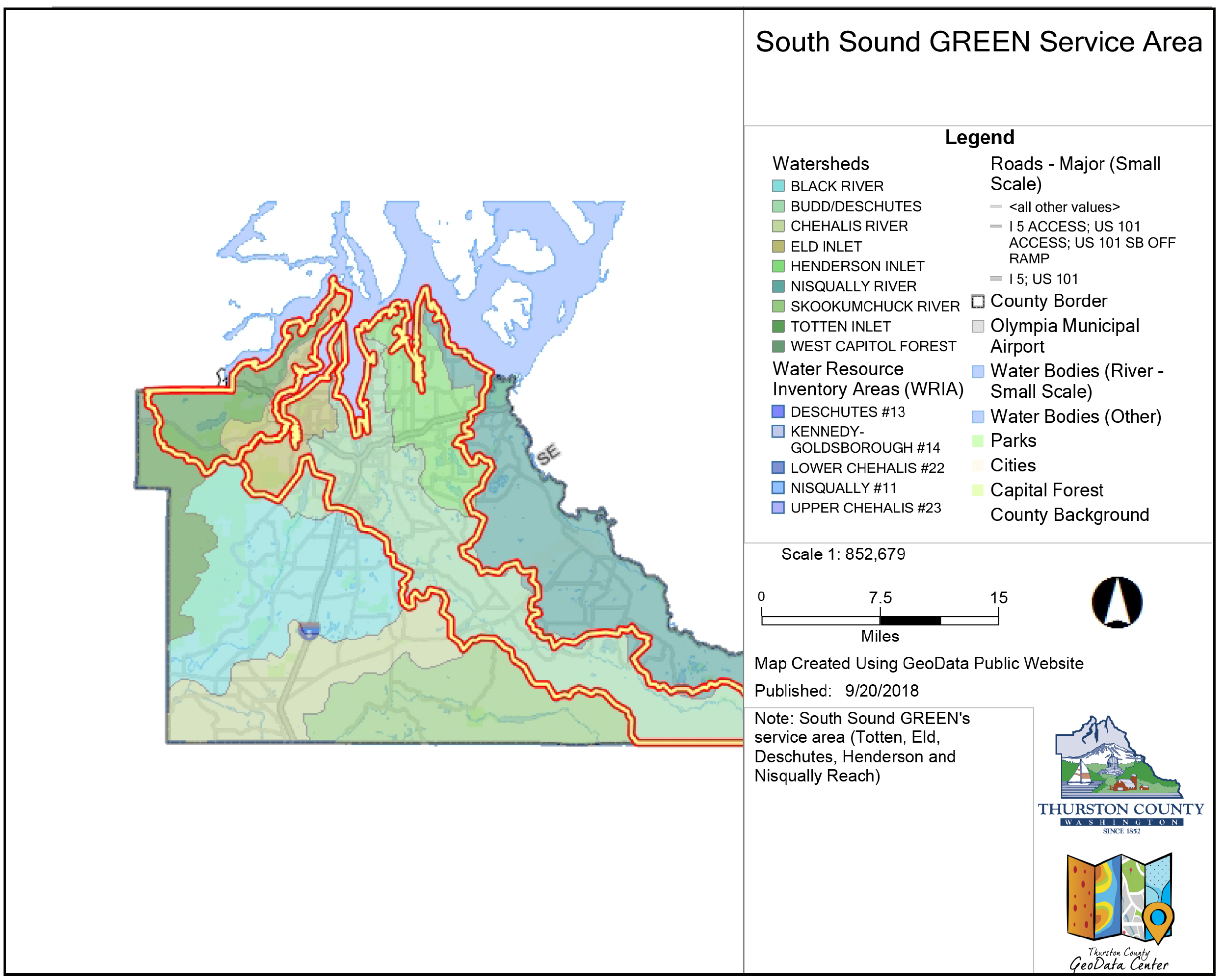
Since 1999, the Chehalis Basin Education Consortium has raised the awareness of teachers and students about water quality issues in the Chehalis basin. Students are given the opportunity to learn about the environment and are provided with hands-on experience in water quality monitoring, riparian restoration, and other projects that help protect and improve water quality. The Chehalis Basin Education Consortium (CBEC) is a partnership comprised of Educational Service District 113, school districts, natural resource agencies, Centralia College and other nonprofit agencies within the Chehalis watershed.

The Chehalis basin is the second largest watershed in the state. It covers 2,660 square miles. Its boundary on the west is the Pacific Ocean, the east, the Deschutes River basin, on the north, the Olympic Mountains, and on the south, the Willapa Hills and Cowlitz River basins. Major population centers include Chehalis, Centralia, Aberdeen, and Hoquiam.

SOUTH SOUND
GREEN

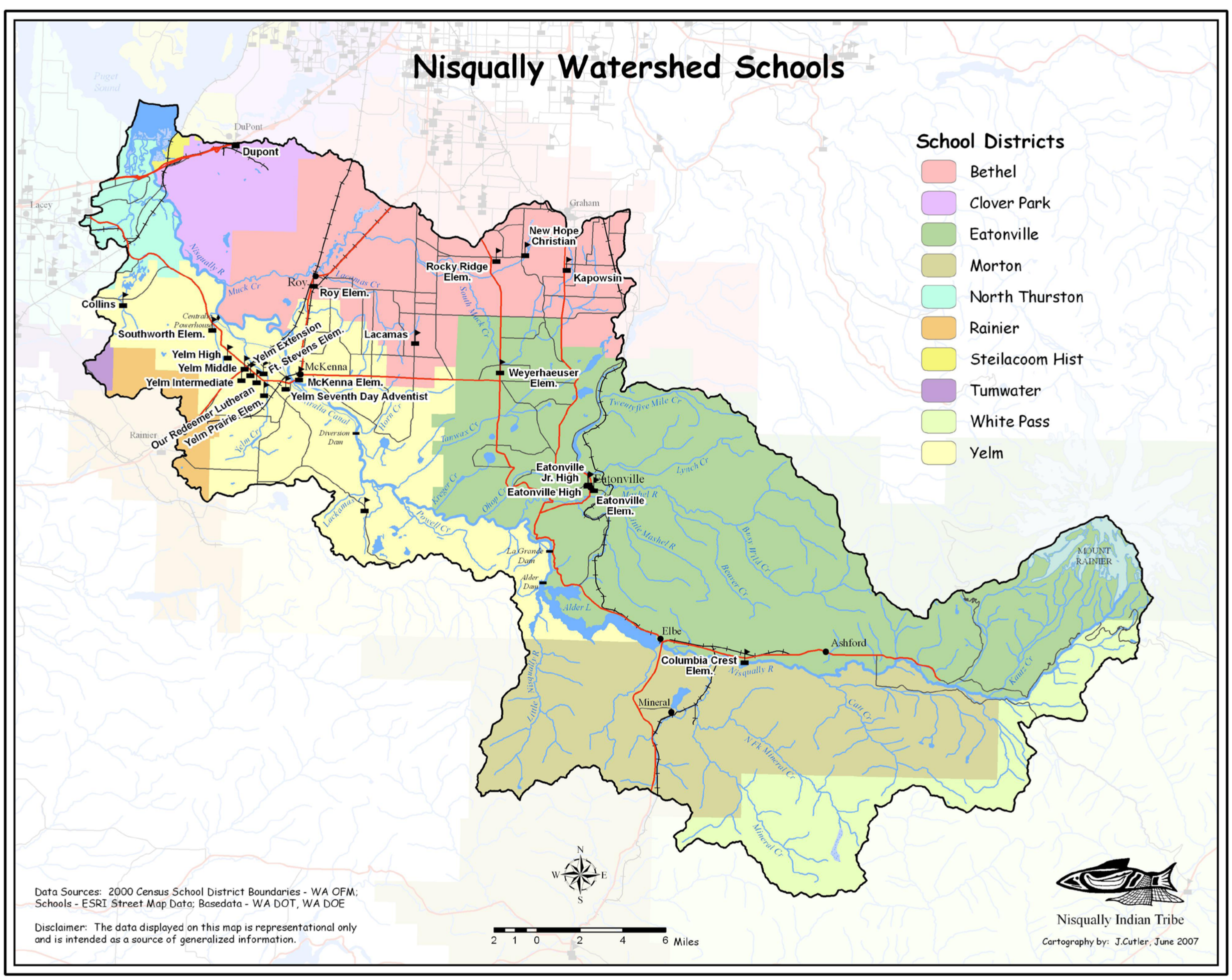
Global Rivers Environmental Education Network

GREEN stands for Global River Environmental Education Network and is an international watershed education program. South Sound GREEN started in the early 1990's (originally called Budd-Deschutes GREEN) when several teachers, community groups, and businesses, including Trout Unlimited, Rotary, and Hulbert Auto, as well as local natural resource focused agencies, heard about the program. The group invited the national GREEN coordinator, Bill Stapp, renowned educator from the University of Michigan, to Olympia to explain the program. Donations were pieced together, and a program coordinator was hired on a contract basis. Teachers were eager for the training and the opportunity to get their students into the field to do "real science". Since the early 1990's, the program has grown to serve teachers not only in the Budd/Deschutes watershed, but also Henderson Inlet, Eld Inlet, and Totten Inlet watersheds…hence the name change to South Sound GREEN. Today over 60 teachers participate in South Sound GREEN each school year, engaging thousands of students in authentic science and engineering practices in their communities.



The Nisqually River Project (NREP) is a watershed education program which implements key elements of the Nisqually Watershed Stewardship Plan, providing students service learning projects that link Washington State learning goals and standards with local environmental issues, inspiring stewardship of the Nisqually Watershed and the world. The Nisqually River Education Project has a proven history of successfully implementing watershed based education and environmental action projects which engages students and teachers in protecting and enhancing the water quality and salmon habitat of the Nisqually River watershed. By making the involvement of schools possible, the NREP directly supports the efforts of the Nisqually River Council and the Nisqually Tribe in creating a healthier Nisqually River and the preservation of its fisheries and shellfish resources.

The Nisqually River Education Project started water quality monitoring more than 27 years ago after attending a training offered by Project GREEN, the Global Rivers Environmental Education Network. Each year, the NREP actively involves hundreds of student participants in an on-going water quality monitoring program. These students then engage in problem-solving and action projects. For example, some students restore salmon habitat with riparian plantings at key sites in the Nisqually watershed. Other students create educational outreach presentations and materials about non-point pollution prevention, present their water quality findings to the Nisqually River Council, or implement recycling or composting programs at their schools. In short, the NREP seeks to create a new generation of students who have a true sense of stewardship for the Nisqually River watershed and the southern Puget Sound.



2

Preparing for Water Quality Monitoring

Water Quality Parameters

These tests are indicators of water quality for the health of salmon.
Each is a piece of the puzzle that fits together for overall water quality health.

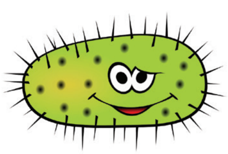
TEMPERATURE

Fish, insects, plankton and other aquatic organisms all have a preferred temperature range. For salmon, no other environmental factor affects their development and growth more than water temperature. Many life cycle stages such as spawning and egg hatching are signaled by annual temperature changes. Temperature has a direct effect on the amount of dissolved oxygen in the water.

Dissolved Oxygen (D.O.)

Like land animals, aquatic plants and animals use oxygen to breathe. Dissolved oxygen is the amount of oxygen gas in water that can be used by fish and other aquatic life. If the amount of oxygen is too low, living organisms may not survive. Low levels of D.O. are often a sign of water pollution. When water temperature increases, the level of D.O. decreases as oxygen gas escapes into the air. Cold water holds more oxygen than warm water.

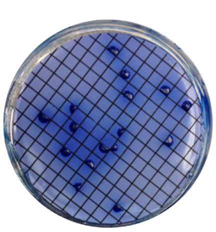
Biochemical Oxygen Demand (B.O.D.)



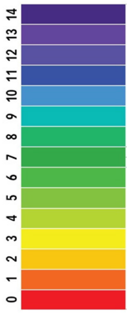
B.O.D. is a measure of the amount of oxygen consumed by the respiration (breathing) of micro-organisms in the water. Microorgansisms decompose dead plants (like algae) and animals while feeding on them. The more oxygen they use, the less oxygen there is in the water for the salmon and other aquatic life. To calculate B.O.D., subtract Day 5 D.O. from Day 1 D.O.

Day 1 D.O.	-	Day 5 D.O.	=	**B.O.D.**
10 mg/L		8 mg/L		**2 mg/L**

Fecal Coliform



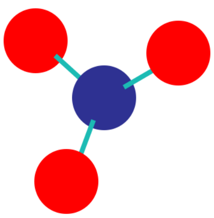
Fecal Coliform bacteria indicate the likely presence of water-borne pathogenic (disease causing) bacteria or virus. Fecal Coliform bacteria are used as indicators of these more harmful bacteria or viruses. Fecal Coliform bacteria are present in the intestines of warm blooded animals, including humans. Fecal Coliform is measured in the number of colonies found for every 100 mL of water tested. (FC/100mL). This test is important for human health and safety. It is not considered a problem for fish or other wildlife.



pH

pH is a measure of the relative acidity or alkalinity of water. pH stands for potential hydrogen and is measured on a scale from 0 - 14. If pH levels fall below 6.5, fewer salmon eggs hatch and aquatic insect levels drop. **7 is neutral**. Below 7 is acidic. Above 7 is basic.

Nitrates

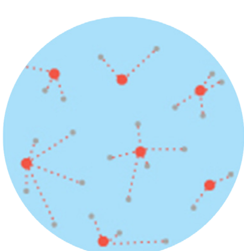


Nitrates found in water are the nutrients needed for many aquatic plants to grow, such as algae. Excessive levels of nitrates in water can accelerate algae growth, resulting in harmful algal blooms, which can lower dissolved oxygen levels, often leading to fish kills.

Turbidity

Turbidity is the measurement of how cloudy the water is. Sediment, silt and particles like dirt, mud, algae, etc. can make it harder for sunlight to travel through the water. Very cloudy water can make it hard for underwater plants to survive, harm the gills of organisms and even affect the ability of juvenile fish to catch prey. The particles in turbid water absorb sunlight, causing the water to get warmer. Salmon will avoid water with high turbidity and will cease to move through water where visibility is extremely low. This can delay salmon migration and smother eggs.

Total Suspended Solids (T.S.S.)



Total suspended solids is a dry-weight measure of the suspended particles that are not dissolved in a sample of water. If turbidity is a measure of how clear or cloudy the water is visually, then T.S.S. is a measure of how much that cloudiness weighs. High volumes of T.S.S. can harmfully impact a salmon's ability to see and smell, both of which are necessary for them to find food and avoid predators.

Optimal Values

TEMPERATURE

Stream temperature controls the metabolic function of cold-blooded animals and plants as well as their reproductive timing and duration; in other words, the life cycle of aquatic organisms. Temperature can also affect other water quality parameters like dissolved oxygen. Remember, warmer water contains less dissolved oxygen; water can be 100% saturated at higher temperatures but still contain levels of dissolved oxygen that stress fish and other aquatic organisms.

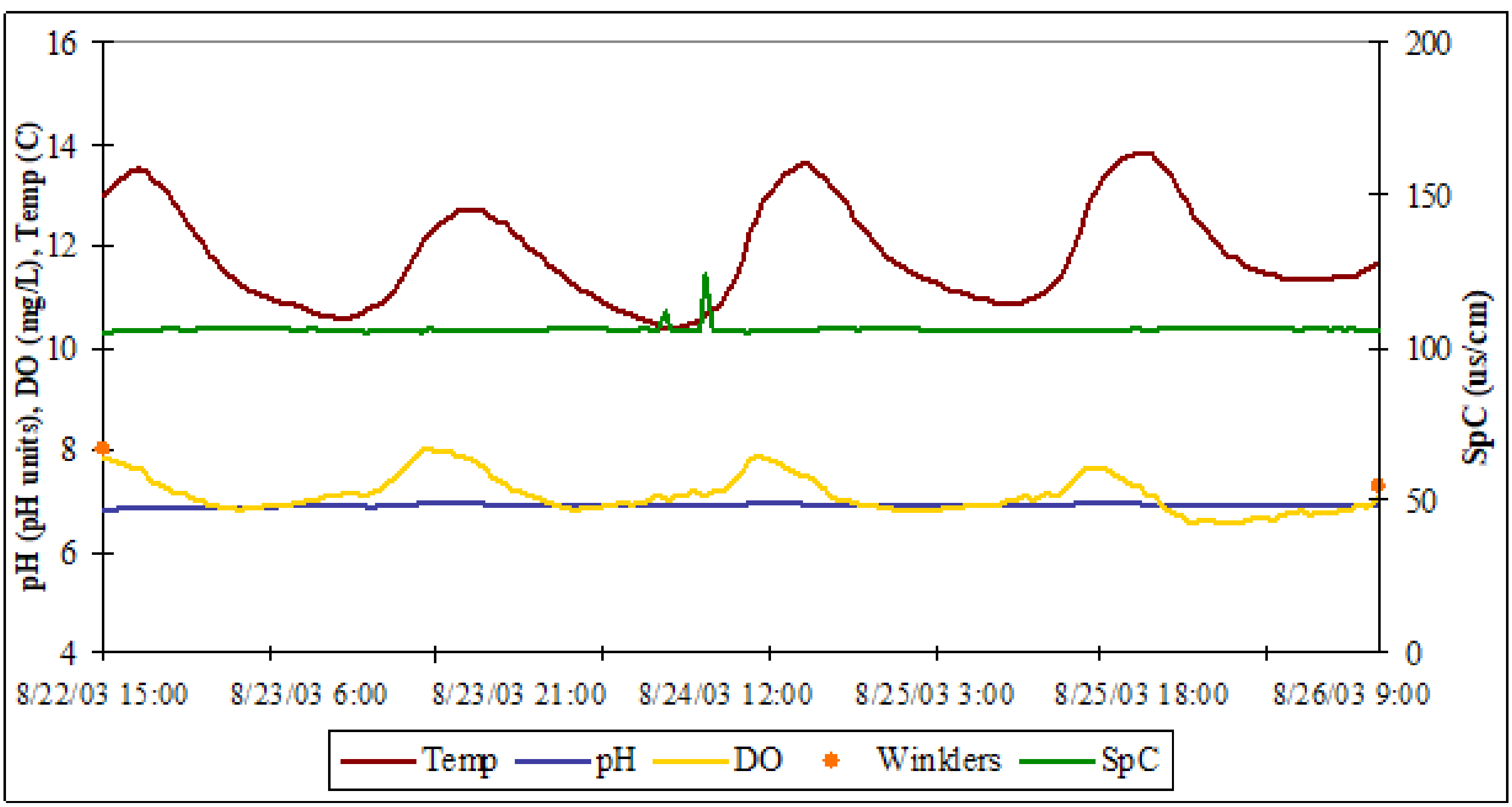
Temperature is one of the most important parameters for fish, especially salmon. Y**oung salmon need temperatures of around 9º Celsius; adult salmon need 12º Celsius or colder.** Stream temperatures should not exceed 18º Celsius and anything over 21º Celsius can be fatal.

***Easy way to quickly convert Celsius to Fahrenheit and vise versa: ***

Celsius = Fahrenheit -30 then divide by 2

Fahrenheit = Celsius x 2 then add 30

Key Point: Lowest D.O. levels occur just before dawn and are highest in the mid-afternoon (see graph below).



Dissolved Oxygen (D.O.)

Just like people need oxygen to live, aquatic animals (fish, aquatic insects, etc.) and aquatic plants need dissolved oxygen in their environment in order to survive. D.O. is simply oxygen that is dissolved in water. Sources of oxygen for water include the absorption by water at the air-water interface and the by-product of aquatic plant photosynthesis (the method of how plants make food).

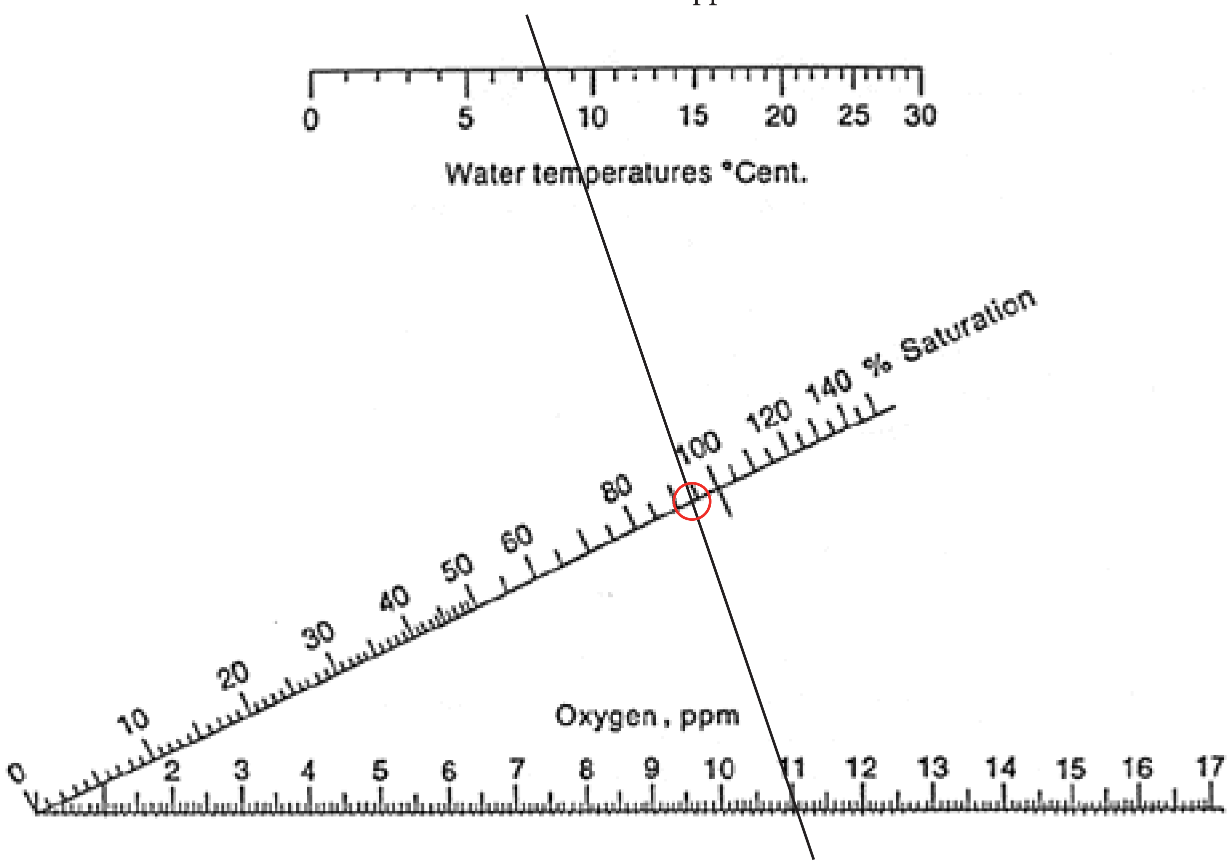
Optimal levels for salmon are > 9.0 mg/L
7.0 - 8.0 mg/L is acceptable
3.5 - 6.0 mg/L poor

Anything below 3.5 mg/L is fatal to salmon. D.O. levels below 3.0 mg/L are stressful to most forms of aquatic life.

Measuring D.O. in water tells you how much dissolved oxygen is present but now how much oxygen the water is capable of dissolving. When water dissolves all of the oxygen it is capable of holding at a given temperature, the water is said to be 100% saturated.

For a quick and easy determination of the percent saturation value for dissolved oxygen at a given temperature, use the nomogram below. Pair up the mg/L of dissolved oxygen you measured and the temperature of the water in degrees Celsius. Draw a straight line between the water temperature and the mg/L of dissolved oxygen. The percent saturation is the value where the line intercepts the saturation scale.

Example:	Temperature	Dissolved Oxygen	**94% saturation**
	8° Celsius	11 ppm	



You can also use an online tool to calculate at http://www.waterontheweb.org/under/waterquality/dosatcalc.html

Biochemical Oxygen Demand (B.O.D.)

B.O.D. is the amount of oxygen consumed during the decomposition of plant and animal material. This is important to know because if there is high B.O.D. it means that oxygen levels can become very low and cause problems for aquatic life in the stream. The optimal level for B.O.D. is < 6 mg/L.

B.O.D. = (D.O. day 1) - (D.O. day 5)

Tip: B.O.D. should never be negative. This is an error in testing.

pH

pH is a measurement of the hydrogen ion concentration of a solution. This tells us whether a solution is acidic or basic. pH values range from 0 to 14; values with a pH less than 7 are considered acidic, 7 is neutral and above 7 is considered basic.

The determination of the pH of a waterbody is dependent on:

- The natural geology of the area (some rocks have minerals that, when dissolved in water are acidic or basic).

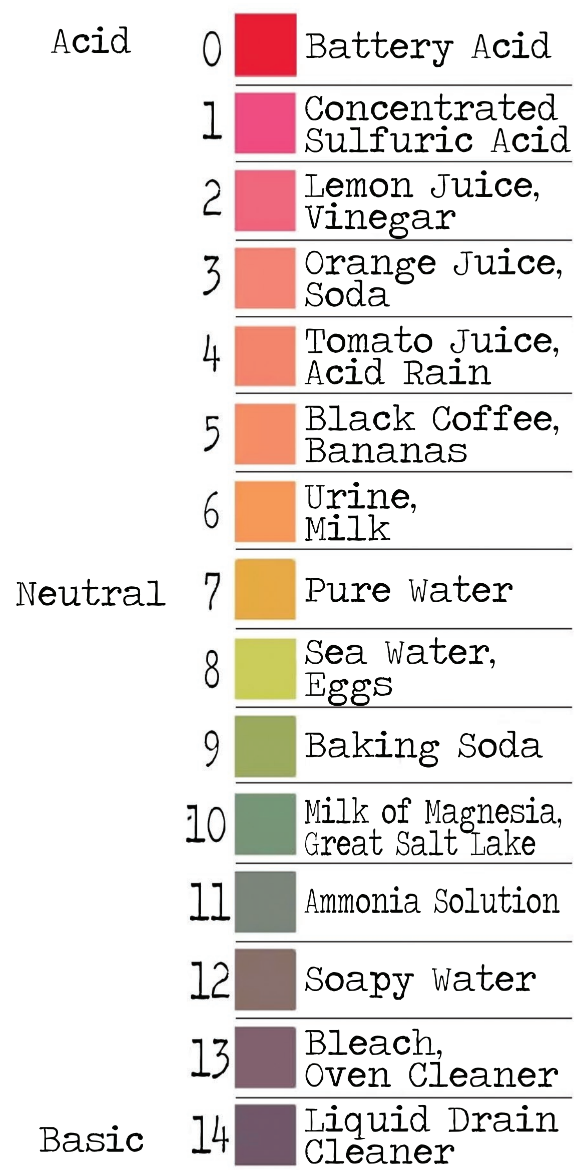
- The type of vegetation in and near a waterbody (bogs and swampy areas typically have much more acidic water).

- Human influences. Some of the human influences on a water body's pH include acid rain (when fossil fuels are refined or burned and the resulting chemicals mix with rain), stormwater and sewage effluent.

- When aquatic plants and algae are photosynthesizing (making food) during daylight hours, pH values can rise because carbonic acid (dissolved carbon dioxide gas in water) is removed as part of the photosynthesizing process, thereby making the water more alkaline or basic. The opposite occurs at night when the plants are respiring (producing energy from carbohydrates), carbon dioxide is given off (making carbonic acid) and the water becomes more acidic.

Ideal pH values should range between 7 - 8. A pH range between 6.5 and 8.5 is generally suitable. If pH levels drop below 6.5, fewer salmon eggs hatch and aquatic insect levels drop.

Tip: Remember, when you're calculating pH, record the MODE, not the average.



Nitrates

Nitrate is the form of nitrogen which is used as food by plants and animals - both aquatic and terrestrial. The concentration and supply of nitrates to a waterbody is intimately connected with the land use practices of the surrounding watershed. Nitrates can come from animal waste (including human sewage), fertilizers and stormwater runoff.

Excessive amounts of nitrates can cause too much aquatic plant and algal growth which can lower the dissolved oxygen levels when the plants die and decompose. In salt water systems, nitrogen (in the form of nitrate) is typically the nutrient which is in the shortest supply. Therefore the nutrient which is the most limiting with regard to plant and algal growth. In a freshwater system, phosphorus is typically the nutrient which limits plant and algal growth. **Nitrates in a freshwater system should be below 1.0mg/L.**

Another problem associated with high nitrate levels is when the nitrates enter our drinking water systems. This can lead to a medical condition called methemoglobinemia which affects the blood's ability to carry oxygen. It was historically referred to as "blue-baby syndrome" because the lack of oxygen caused the veins and skin to appear blue; pregnant women and the elderly can also be affected. The EPA has determined levels of nitrates in drinking water should be no more than 10 mg/L.

Turbidity/Total Suspended Solids

Turbidity and total suspended solids (TSS) measure the amount of solid material suspended in the water. This solid material can be a combination of sediment, algae, aquatic animals; anything that can be suspended in the water.

Turbidity measures the scattered light from a sample (the light that bounces off of suspended solids in the water sample). The more suspended solids, the more scattering of light. The turbidity units are called Jackson Turbidity Units (JTU).

To measure total suspended solids, the water sample is filtered and the filter paper is put in a drying oven for a set period of time. The filter is then weighed and the total suspended solid result is shown as the weight of the material per volume of water sampled, typically in mg/L.

Erosion in the watershed (from logging, construction, fires, etc), excessive plant and algae growth (caused by too much nitrogen and phosphorus in the water) and stormwater can all contribute to higher levels of turbidity and total suspended solids. Problems which occur can include:

- The sediment can settle into the streambed reducing good fish spawning habitat.
- Waters that are high in turbidity and total suspended solids can also reduce the amount of light coming into the water and affect the ability of aquatic plants to photosynthesize (make food).
- Sediment particles provide an attachment for bacteria and metals.
- Turbid waters can impede a fish's ability to see and catch prey or escape predators.
- Sediment absorbs more sunlight; increasing water temperature.

Optimal Turbidity levels should be < 20 JTU's.

Fecal Coliform

There are thousands of different kinds of bacteria. The group of bacteria called "total coliforms" includes a sub-group called fecal coliforms. They are found in the intestinal tract of warm-blooded animals (mammals and birds). Fecal coliforms are transmitted to water and soil by human and animal feces.

Not all bacteria are harmful to humans, even some of the fecal coliform bacteria. Bacteria live in our digestive tract and help in digestion; other bacteria help keep the world clean by decomposing plant and animal remains. Some bacteria produce the essential vitamin K and the B-complex vitamins.

Some bacteria are harmful and produce toxins. One strain of the bacteria E. coli is well known to most people as causing serious symptoms ranging from diarrhea to kidney failure and even death.

It is important to protect humans from these harmful bacteria which could occur both in our drinking water as well as in the lakes and rivers where people recreate. Because it would be impossible to test for every kind of bacteria that is harmful to people, we limit our testing to the fecal coliform group since they serve as an "indicator" of those bacteria which are harmful to people.

Ideal fecal coliform colonies should be < 50 colonies/100mL of sampled water.

Human Sanitation Levels:
Drinking Water 0 FC/100mL
Swimming 200 FC/100mL

Optimal Results

Dissolved Oxygen	> 9 mg/L
Biochemical Oxygen Demand	< 6 mg/L
Temperature	< 9^{o} C
pH	7-8 pH units
Fecal Coliform	<50 colonies/100mL
Turbidity	< 20 JTUs
Nitrates	< 1 mg/L
Total Solids	< 25 mg/L

Watershed Etiquette and Student Safety

Adults should be the only people in the water gathering samples.

Be aware of the traffic near your water quality site, especially if your water quality site is near a busy road. Cars are probably your biggest danger.

Students are to **wear gloves and goggles at all times** while performing their water quality tests. Some of the chemicals are very hazardous!

All water used in testing should be disposed of in the wastewater collection jar and taken back to your school.

Don't drink the water from the stream or river. Though water quality may be excellent microscopic organisms normally live in streams which can cause severe flu-like symptoms in humans.

Dress appropriately for the weather! Layers of non-cotton material, rubber boots and a waterproof layer are recommended.

Take your trash and recycling back to school with you.

Observe wildlife and their evidence. Don't remove their eggs or nests. "Miss Mayfly" says "Take only pictures, leave only footprints".

Don't pick wildflowers or remove plants. They provide food and shelter for wildlife.

A dead tree trunk or hole in the ground may be home to many kinds of wildlife. Take care not to disturb or alter wildlife habitat.

Use the trails and paths in your watershed. They help keep you from getting lost and protect fragile areas.

Try to minimize the impacts on the stream and it's fragile stream banks. Breakdown of stream banks increases erosion and adds excessive sediment to a stream. Only those people actually making measurements should be on the stream banks. Choose access points to the stream which cause the least disturbance.

Know what kinds of fish live in a stream and their life histories. Know when they spawn and when young fish emerge from the gravel stream bed. Fish are most vulnerable at these times and they should be disturbed as little as possible.

Put any rocks you remove back into the stream. They are habitats for fish, bugs and plants.

Walk through your watershed quietly. Listen to the sounds of the wildlife residents. Disturb them as little as possible.

Suggested Student Training Steps

First - Introduce the water quality parameters and overview the test kits.

Introduction to Stream Ecology (NREP Powerpoint)
Demonstrate kits in front of class
Guest speaker (your coordinator, Dept. of Ecology)

Second - Students practice the tests!

Plan ahead and get extra hands to help out - parents, volunteers, aides or older students.
Ask students to bring water from a creek or pond near their home, test the school aquarium water, the school tap water or collect samples on your way to school from your water quality site.

Third - Follow up practice day: Using Scientific Practices

Ask Questions: What were the test results from the practice day?
Develop Models: What might your data show about watershed health?
Plan Investigations: Why might your results be innacurate?
Analyze Data: What might your results reveal about your testing site?
Construct Explanations: What about your site might cause water quality issues?
Engage in Argument from Evidence: How can your data be interpreted?
Obtain and Communicate Information: How can your data be demonstrated (graphs, charts, etc.)

pH - add vinegar or baking soda
Dissolved oxygen - vigorously shake bottles or leave bottles in warm spot
Nitrates - add a fertilizer
Turbidity - add something cloudy, like chalk or flour.

Fourth - Make next hypothesis for Monitoring Day at your Stream.

Tips and Tricks for Taking Kids Outside

By Nalani McCutcheon and Andrea Swanson

If the best learning lies on the edge of chaos, then in order to be comfortable there, you need to be sure of your footing when you are close to that line.

In the middle of the night, are you jolted from your bed by nightmarish images of children running hither and yon in the wilderness as you take them out to the investigate water quality in the nearby stream, play a predator-prey game, or study the life cycle of monarchs? If so, you are not alone.

Many educators have tackled these fears and made such adventures seem routine. It just takes practice - and keeping in mind a few key guidelines.

Have clear expectations.
Before you walk out the door and into the wilderness - or even into the schoolyard - with your very excited and enthusiastic class, discuss behavioral expectations. T**his conversation can make or break your time together outside.** Allowing students to help determine expectations (including the agreement to have expectations in the first place) sets up an atmosphere of mutual respect and ensures greater understanding of the rules and a greater willingness to follow them. Make a list of a few specific behaviors and state them in the positive. For example, an expectation that there will be "no yelling and screaming" may have the same intent as "use quiet voices," but the latter is a positive statement of the specific behavior you wish to see.

Plan the logistics.
- Have a plan, while still being open to teachable moments, and let your students know what it is.
- Have a clear signal for getting everyone's attention and gathering. Practice it before you go outside.
- Discuss where you will gather when you get outside. If you will be on trails, establish clear meeting places such as trail intersections and trailheads.
- Explain to students that, if they get separated from the group, the should sit down and wait.
- Someone will come for them.
- Decide who will lead the group as you travel down the trail. Create opportunities for children to take turns leading.
- If possible, provide opportunities to walk and run. Let children know that this will happen. Use a variety of group sizes. Have students spend some time working in large groups, small groups, pairs, and independently.
- To help focus attention, give specific assignments.
- Discuss safety. If you will be near water, clearly explain the potential hazards. If you will be walking in the hot sun, make sure everyone has drinking water, sunscreen on exposed skin, and hats on heads. If you are using snowshoes or cross-country skis, discuss their appropriate use.
- Bring a first aid kit and, if someone is allergic to bees, a bee-sting kit.
- Be ready for any kind of weather and dress appropriately. Bring extra mittens, hats, and boots if necessary. Rain gear and warm coats will make an enormous difference in the outcome of your outdoor activity.

Evaluate your time together when you return indoors. Discuss what went well and what didn't. Gather suggestions for activities and behavioral expectations for future trips outside.

Practice and model activities.
Having clear assignments for students to complete when they go outdoors will help focus their attention. The clearer your goals and expectations, the safer and more comfortable children will feel. This added comfort will increase their willingness to participate and complete their work. Whether it is a paper-and-pencil activity or an active game that illustrates an ecological concept, your expectations will be clearer to students if you practice before going outside. Even as you head out the door, you may want to have a few practice runs at gathering together using your signal. That way, you too can enjoy the experience outside and not have to worry continually about gathering the flock.

Whenever possible, model what you want your students to do by becoming an active participant yourself. For example, if your students are drawing or writing in their journals along the trail, you should do it as well. This not only demonstrates that you value the activity, it is also an opportunity to show your students that you too are a student.

Be flexible.
No matter how wonderful a teacher you are, natural lessons outdoors will sometimes be more compelling than the task at hand. The turkey vulture soaring overhead or the rabbit running across the trail may interrupt your lesson, but accept that it is a natural attention magnet for students.

Take the broader view of learning and turn these opportunities to your advantage. They are the moments your students will likely never forget, and if you can bridge these spontaneous events to the lesson at hand, you will likely cement the learning. Your challenge is to find the bridge - and there will be one. The great thing about the natural world is that everything is connected to everything else!

Communicate strategically.
In communicating with students outdoors, be prepared to face noise, atmospheric conditions, and other distractions that you cannot control. Take a lesson from the interpretive field and keep the following in mind:

- Make sure the sun is in your eyes; then you can be sure that it isn't in your student's eyes.
- Put the wind to your back. This will put the sound of your voice toward the students.
- As you talk to students, try to reduce the distance between your mouth and their ears. Unless you are working with older students, this means kneeling down when talking. It keeps your voice from being lost in the wind and gives you a better perspective on what the world looks like from their view.
- If you are on a narrow trail and some students are having trouble seeing or hearing, have students form a double-file line. Stop the group, step off the trail, and walk toward the middle of the group. Have the students turn to face the side of the trail you are on and have those in the front row kneel down. That way, everyone can see and hear without tromping off the trail.
- If you see something that you want to look at as a group (and it is appropriate to walk off the trail to it), lead the students in a single- or double-file line behind you and form a circle around it. Step into the center, and everyone can see.
- If you are on a trail you use often, place flags or markers along the way. Then if you want to allow students to travel up ahead of you, you can tell them to move at their own pace, but to stop at the next flag.

Bring props.
At first you may fear having unfocused students and not knowing how to reclaim their attention. Many teachers use a prop bag packed with focusing games (nature bingo, scavenger hunts, recipe of a forest), natural artifacts (seeds, leaves, antlers, fur, feathers), tools (hand lenses, binoculars), and other aids.

When you need to focus students' attention, pull an appropriate item out of the bag. Students usually can't wait to see what will come out next. In fact, you may find that you want to continue to use this technique even after you gain proficiency in taking your students outside.

Empower yourself.
Let's face it: To be a good teacher, you have to know yourself. You must have clear expectations and personal goals and a sense of their priority so you can monitor and adjust in a heartbeat to assure that the end result is satisfactory. If the best learning lies on the edge of chaos, then in order to be comfortable there, you need to be sure of you footing when you are close to that line. Just as an athlete takes time to practice on a new field before a competition, so too must a teacher take time to establish a personal comfort with the new learning environment.

Prior to taking your students outside, visit the area and become familiar with it. Visualize in your mind where your students will be during different parts of the lesson and what areas you want to make sure they avoid.

Structure your lessons to take advantage of the opportunities available while remembering the potential challenges. A trip to the pond is full of exciting learning possibilities, but there are wet shoes and clothing to think about as well.

The size of your group should depend on your comfort level, the nature of the site, and your field-trip objectives. Some people enjoy larger groups of 20 to 25 while others prefer groups of 10 to 15.

Bringing additional adults to assist with your outdoor adventure can be helpful, and most schools have policies that require a certain ratio of children to adults. Make sure the supporting adults are aware of your expectations, both of the children and of them.

Finally, remember that your comfort is not built by your classroom walls; it is built within your mind. If you set clear expectations, plan ahead, and follow a few key guidelines, you will eliminate most potential stumbling blocks. You will also find that your outdoor excursions will be more fun for everyone, including you.

Now sleep well!

Nalani McCutcheon is executive director and Andrea Swanson is regional educator at the School Nature Area Project at St. Olaf College in Northfield, Minnesota. Reprinted with permission from Green Teacher 60 (Spring 2001),pp. 23-25;
www.greenteacher.com

Water Quality Monitoring Day Field Investigation

Materials: See **Monitoring Day Supply List**, in the Water Quality Monitoring Manual

Preparation:

1. Divide your class into groups of 4 students/group.
2. Assign each student group a Water Quality Monitoring Day task.
   a. Required groups include: Dissolved Oxygen*, Turbidity*, nitrates, temperature, pH. (*These groups are best for HCAP students and those with good fine motor skills.)
   b. Suggestions for additional student groups & activities include the following, which can be found in the Water Quality Monitoring Manual:
      i. **Streamwalk Survey**
      ii. **Illustrated Site Survey**
      iii. **Small Noticings 1 & 2**
      iv. **Sensory Scavenger Hunt**
      v. **Supplemental Group Activities**
      vi. others?
   c. Other roles for individual students who need special consideration may include:
      i. A "runner" to accompany you or the water quality sample collector streamside. They will deliver water samples to each testing group. This is a great position for a student with lots of energy!
      ii. A water sample helper. This student will hand you water sample bottles while you are in the stream and take them from you as you fill them. They can label your Fecal Coliform and Total Suspended Solids bottles and wrap your Biochemical Oxygen Demand bottles in foil.
      iii. A photographer to document each group's activities.
3. Recruit 5-8 volunteers, 1 for each student group. Prioritize volunteer coverage for the most difficult water quality tests (Dissolved Oxygen, Turbidity, Temperature)
4. At your Water Quality Site Visit, identify testing locations for each group. Fill this into your Water Quality Task Assignment Sheet.
5. Plan a time before Water Quality Monitoring Day to:
   a. Inventory your Water Quality Kits or have your student groups do this in class. (See **Monitoring Day Supply List** in the Water Quality Monitoring Manual, pg. 42)
   b. Schedule times for training your students on the use of the kits (See **Suggested Student Training Steps**, in the Water Quality Monitoring Manual, pg. 15) This is a great day to ask for support from volunteers or project staff.

      i. Consider assigning roles for each student in their testing groups. (See **Appendix B - Assigning Water Quality Testing Roles)**

6. Make a rain plan! Whether you decide to collect the water before school by yourself, or shorten your field trip to the bare minimum (15-20 minutes), make sure you:
   a. Take the air temperature (5 minutes hanging from a branch or etc. in the air)
   b. Take the water temperature (2 minutes as near the center of the stream or river, horizontally and vertically, as can be safely achieved)
   c. Collect pH, turbidity and nitrates samples.
   d. Collect 6 Dissolved Oxygen Samples
      i. Wrap 3 in foil for the Biochemical Oxygen Demand test, done 5 days after sampling.
      ii. Add the first three chemicals to the other three Dissolved Oxygen sample bottles to "fix" your sample
7. Identify the supplemental activities for the test groups that will finish earlier than Dissolved Oxygen.

On Water Quality Monitoring Day

1. Before getting off the bus, set expectations for behavior.
   a. Explain "Pack it in/Pack it Out" of "Leave No Trace" principles. Your Water Quality Site should look the same or better than you found it! Some people say "Take only photos, leave only footprints!"
   b. Identify each group's designated area for completing their work.
2. Have groups disperse to their areas. Student in Water Quality Test Groups should be waiting in their areas for Water Quality Sample delivery from your runner.
3. Collect and deliver Dissolved Oxygen samples first. pH water sample should be last.
4. Students conduct the tests. Ideally a volunteer is leading each group while you, the teacher, are supervising and roaming.
5. After the Water Quality Tests are complete and the data is recorded for each testing group:
   a. All garbage should be collected.
   b. All water should be in waste containers.
   c. Collect student data sheets and other assignments.
   d. All testing equipment will be inventoried and put away.
   e. Return to bus and school. Congratulations

Day-Of Timeline

Time	Activity	Student task breakdowns??
15 minutes	**Arrive (On Bus)** -Go over behavior expectations -Review groups and tasks -Introduce volunteers	Listen/review expectations
15 minutes	**Set Up** -Set up stations and tarps for each group -Fill out names and site labels on data sheets -Collect water (adult), deliver to stations (student), package BOD and FC samples (student) -Start air temperature	1-3 students can act as helpers/runners with water collection and supply delivery Temperature group should start with air temp and then transition to a site observation/other activity
60-80 minutes	**Testing** -Groups conduct and record tests, 3 replicates each, with volunteer help -As groups finish, transition to supplementary activity (scavenger hunt etc.)	Test groups: D.O. (4 students, highly capable, takes 40 minutes) Nitrates (4 students, takes 20-30 minutes) Turbidity (4 students, takes 20 minutes) pH (4 students, takes 20 minutes) Temperature (2 students, takes 20 minutes) Site observations (remaining students in small groups, times vary) As groups finish their tests, have a scavenger hunt or other supplemental activity they can transition to. Not everyone will finish that second activity depending on which test group they're in.

20 minutes	**Clean Up** -Collect data sheets -Review clean-up tasks -Pack up site and equipment -Reflection (time permitting)	

After Trip

1. 5 days after your trip, complete your Day 5 Dissolved Oxygen tests in order to calculate your Biochemical Oxygen Demand.
2. Complete your Master Data Sheet and send it in to your coordinator ASAP. Options include:
   a. Snail mail
   b. Fax (360)438-8742
   c. Scan and email sheila@nisquallyriver.org, rstendahl@esd113.org, sbishop@thurstoncd.com
   d. ***coming soon*** on-line form
3. Review your Water Quality Monitoring Day results with your class. (See Water Quality Manual, Section III: **Optimal Water Quality Results, Factors Affecting your Water Quality Results, Making Water Quality Connections** and the results from your **Streamwalk Survey** &/or **Illustrated Site Survey** for context and background information)
   a. Identify good Water Quality results and celebrate them!
   b. Identify poor Water Quality results.
      i. Brainstorm potential causes.
      ii. Brainstorm solutions to these causes.
      iii. **BONUS POINTS*** Make an action plan to improve Water Quality issues and propose it to your program leader!

Assigning Water Quality Testing Roles

Give each student in the group a letter, A-D. For each rotation (3 replicates), have students follow these

	Rotation 1	Rotation 2	Rotation 3
Reader	Student A	Student B	Student C
Do-er 1	Student B	Student C	Student D
Do-er 2	Student C	Student D	Student A
Safety Manager & Data Recorder	Student D	Student A	Student B

Monitoring Day Reminders

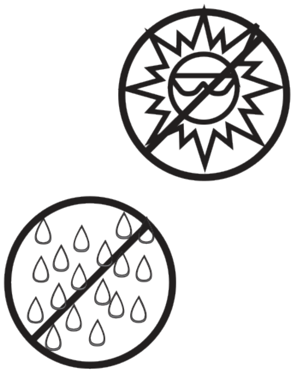
- Get **permission from landowner** prior to **EACH** monitoring day.
- Submit **FIELD TRIP REQUEST FORM** to your principal/office.
- Get **permission slips** from parent/guardian.
- Schedule **bus transportation and substitute** if needed.
- **Check over monitoring kits**. Replace chemicals and supplies if needed at networking meetings or connect with your coordinator.
- **Visit monitoring site** prior to taking students there; check for safe access to water, best places to minimize impact on bank, bus parking availability, presence of bathroom, etc. Be sure site has **flowing water** on monitoring day. (Some sites may be dry during the fall monitoring date.)
- **Review monitoring instructions and safety precautions carefully with students.**
- **Practice water quality tests before water quality monitoring day!**
- Bring **gloves and goggles** for all participants.
- **Call or email your coordinator with your monitoring day schedule** in order for them to possibly visit you or arrange for publicity.
- **RECRUIT AND TRAIN ADULT VOLUNTEERS** to help on monitoring day. Be sure they know their specific roles. Call your coordinator if you need help finding volunteers.

3

Water Quality Monitoring Tests

General Water Quality Safety

1.



Store the test kit in a cool dry area.

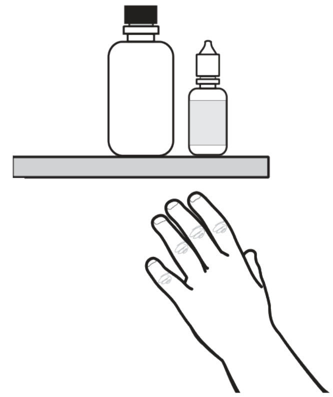
2.

Read all instructions and note precautions before performing the test procedure.

3.

Read the labels on all reagent bottles. Note warnings and first aid information. Read all Material Safety Data Sheets.

4.



Keep all equipment and reagent chemicals out of the reach of young children.

5.

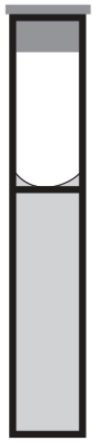
Avoid contact between reagent chemicals and skin, eyes, nose, and mouth. Always wear gloves when handling chemicals.

6.

Wear safety goggles when performing test procedures.

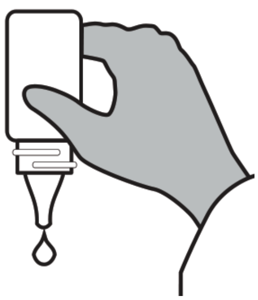
Procedures

1.



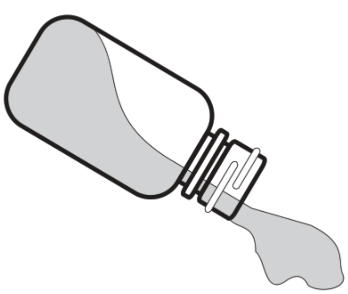
Use test tube caps or stoppers, not your fingers, to cover tubes during shaking or mixing.

2.



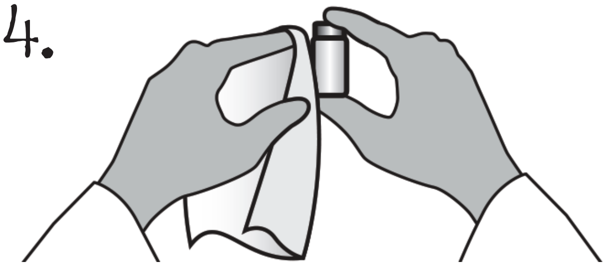
Hold dropper bottles vertically upside-down, and not at an angle when dispensing reagent. Squeeze the bottle gently to dispense the reagent one drop at a time.

3.



Wipe up any reagent chemical spills immediately.

4.

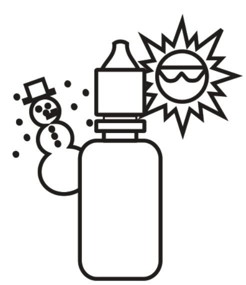


Thoroughly rinse test tubes before and after each test.

5.

Tightly close all containers immediately after use. Do not interchange caps from containers.

6.



Avoid prolonged exposure of equipment and reagents to direct sunlight. Protect reagents from extremes of temperature.

Temperature

TIPS:

Measure in the middle of the stream, in fast moving water.

Try to take measurement in part of the stream that is representative of the stream at your site.

Lack of streamside vegetation can lead to higher stream tepmeratures - take temperature in non-shaded region.

Try not to sample near where a tributary comes into your stream - you have no control over groundwater!

Steps:

1. Remove thermometer from wrapping and allow to sit out for FIVE MINUTES (make sure to hang from a branch or somewhere not touching the ground or yourself).

2. Record air temperature.

3. Determine 3 safe places to take stream temperature. NEVER enter the stream or river if you can't tell how deep it is.

4. Start at the most downstream location.

5. Wade into the water so that it is possible for the thermometer to be roughly four inches below the surface (or as deep as you can without touching the bottom).

6. Hold thermometer under water for two minutes.

7. Read and record what you see!

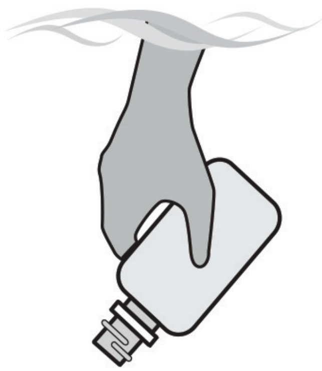
8. Repeat at least three times (in order to get an average).

Dissolved Oxygen

...the most important indicator of the health of a water body and its capacity to support a balanced aquatic ecosystem of plants and animals.

Collecting the Water

1.



Rinse the water sampling bottle with the sample water.

2.

Tightly cap the bottle, then submerge it to the desired depth.

3.

Remove the cap and allow the bottle to fill.

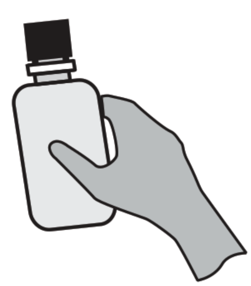
4.

Tap the sides of the bottle to dislodge any air bubbles. Keep the bottle under water for 1 minute.

5.

Replace the cap while the bottle is still submerged.

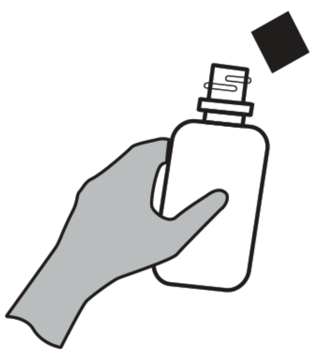
6.



Retrieve the bottle and make sure that no air bubbles are trapped inside.

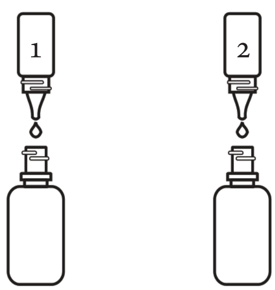
Adding the Reagents

1.



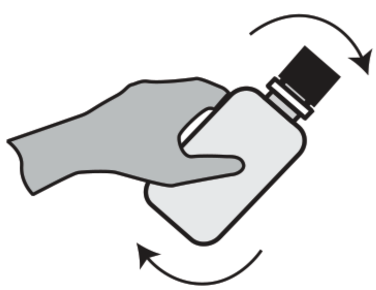
Remove the cap from the bottle.

2.



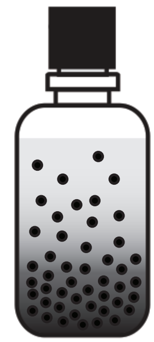
Add 8 drops of Manganous Sulfate Solution (1) and add 8 drops of Alkaline Potassium Iodide (2).

3.



Cap the bottle and mix by inverting several times. A precipitate will form.

4.

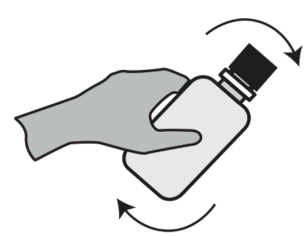


Allow the precipitate to settle below the shoulder of the bottle.

5.

Add 8 drops of Sulfuric Acid (3).

6.



Cap and gently invert the bottle until precipitate has totally dissolved. The solution will be clear yellow to orange if oxygen is present.

NOTE: After this step, the sample is “fixed” and you have up to 6 hours to finish this test.

The Titration

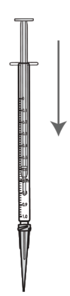
7.

Fill the titration tube to the 20mL line with the fixed sample. Cap the tube.

8.

Add 8 drops of Starch Indicator Solution (4). The sample should turn blue or purple.

9.

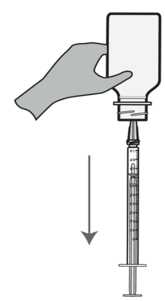


Depress the plunger of the Titrator.

10.

Insert the Titrator into the top of the Sodium Thiosulfate (5) titrating solution.

11.



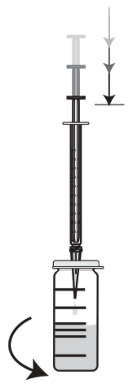
Over the waste container, invert the bottle and slowly draw the plunger until the ring on the plunger is opposite the zero (0) line on the scale. Make sure there are no air bubbles in the titrator.

12.

Insert the tip of the Titrator into the opening of the titration tube cap.

The Titration
continued

13.



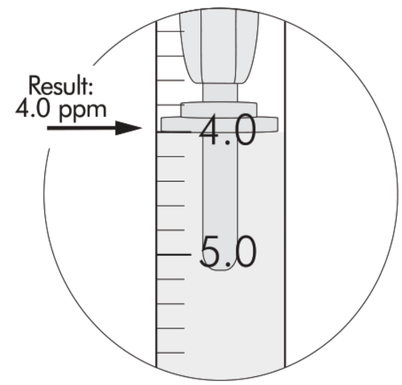
Slowly depress the plunger to dispense titrating solution a few drops at a time, stopping to swirl the contents. Continue until the mixture becomes pale blue.

14.

Continue titrating **one drop at a time** until the blue color disappears and the solution becomes colorless.

NOTE: If the plunger ring reaches the bottom line of the scale (10ppm) before the solution becomes clear, refill the titrator and continue titration. Add this value (10ppm) to the titrator amount when recording the test result.

15.



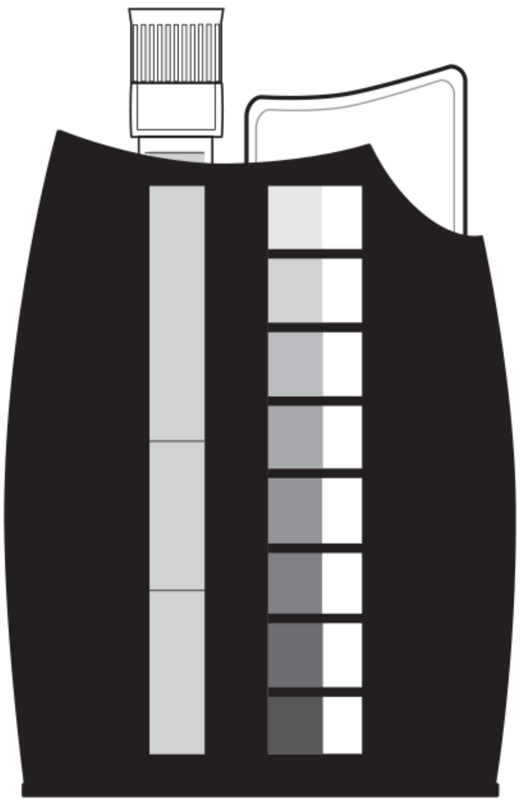
Read the test result directly from the scale where the large ring on the Titrator meets the Titrator barrel. Record as ppm Dissolved Oxygen. Each minor division on the Titrator scale equals 0.2 ppm.

NOTE: When testing is complete, discard the titrating solution in the Titrator into your waste container. Rinse Titrator and titration tube thoroughly. DO NOT remove plunger or adapter tip.

Nitrates

...an essential nutrient source of nitrogen (N) for plants. High nitrate levels can cause algal blooms which decrease dissolved oxygen and increase turbidity.

Nitrates Procedure



The Octa-Slide 2 Viewer should be held so non-direct light enters through the back of the Viewer. Insert the Octa-Slide 2 Bar into the Viewer. Insert the reacted sample into the top of the Viewer. Match the color of the reaction to the color standards.

1.

Insert Nitrate-Nitrogen Octa-Slide 2 Bar into the Octa-Slide 2 Viewer.

2.

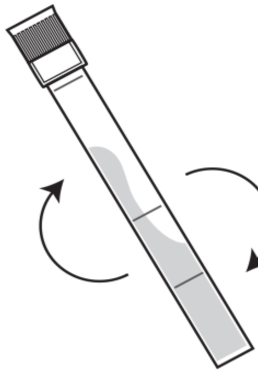
Fill a test tube to the 5 mL line with sample water.

3.

Add one Nitrate #1 tablet.

Nitrates Procedure

4.

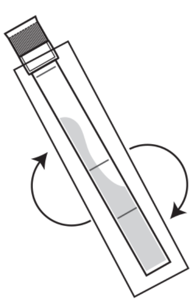


Cap and mix until tablet disintegrates.

5.

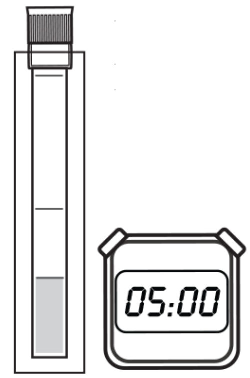
Add one Nitrate #2 CTA Tablet. Immediately slide the test tube into the Protective Sleeve.

6.



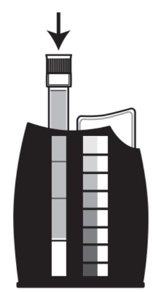
Cap and mix for two minutes to disintegrate the tablet.

7.



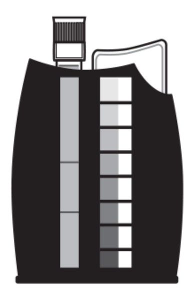
Wait 5 minutes. Remove the tube from the protective sleeve.

8.



Insert test tube into Octa-Slide 2 Viewer.

9.



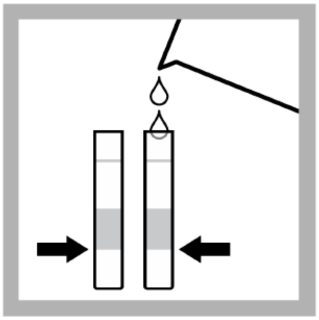
Match sample color to a color standard. Record as ppm Nitrate Nitrogen.

pH

...a measure of how acidic or basic the water is. Extremes in pH can make rivers harmful to insects and fish.

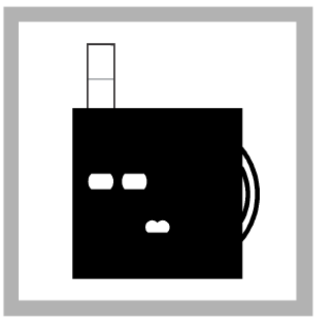
pH Test Procedure

1.



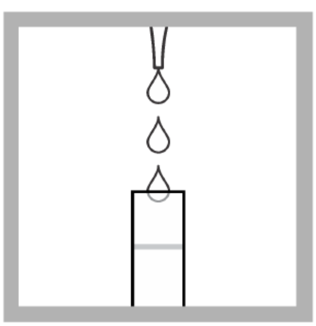
Fill two tubes to the first line (5 mL) with sample. See above.

2.



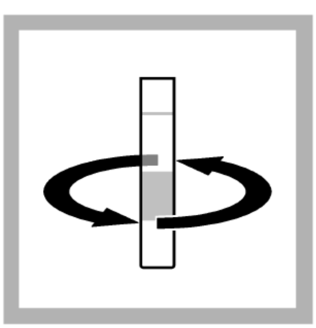
Put one tube into the left opening of the color comparator box.

3.



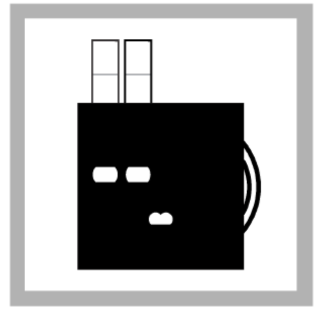
Add 6 drops of wide range pH indicator solution to the second tube.

4.



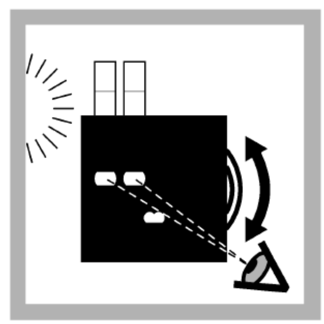
Swirl to mix.

5.



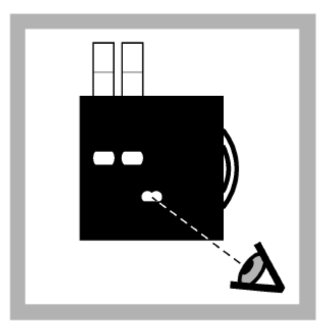
Put the second tube into the color comparator box.

6.



Hold the color comparator box in front of a light source. Turn the color disc to find the color match.

7.



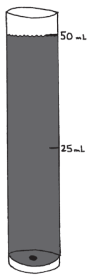
Read the result in pH units in the scale window.

Turbidity

...the cloudiness or haziness of water caused by suspended solids that are usually invisible to the naked eye.

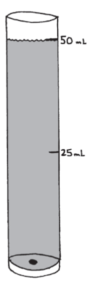
Turbidity Procedure

1.



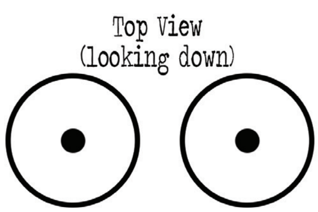
Fill one Turbidity Column to the 50 mL line with the sample water.

2.



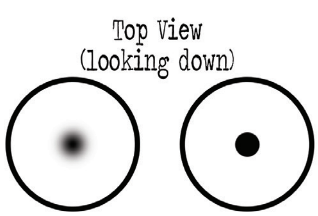
Fill the second Turbidity Column to the 50 mL line with distilled water.

3.



Place the two tubes side by side and note the difference in clarity. If the black dot is equally sharp or clear in both tubes, the turbidity is zero.

4.

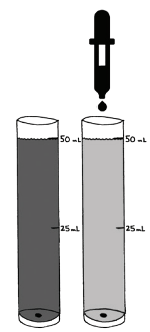


If the black dot in the sample tube is less clear, proceed to step 5.

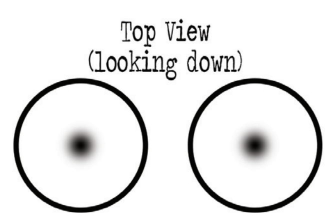
5.

Shake the Standard Turbidity Reagent vigorously each time you prepare to dispense droplets.

6.



Add 0.5 mL of Standard Turbidity Reagent to the “clear water” tube. Use the stirring rod to stir contents of both tubes. Check the turbidity again by looking down through the tubes at the black dots. Repeat this process until both dots appear the same.



Each 0.5 mL of solution added is equal to 5 Jackson Turbidity Units. Record this number on your data sheet.

Turbidity Test Results

Number of Measured Additions	Amount in mL	Result in JTU's
1	0.5	5JTU
2	1.0	10 JTU
3	1.5	15 JTU
4	2.0	20 JTU
5	2.5	25 JTU
6	3.0	30 JTU
7	3.5	35 JTU
8	4.0	40 JTU
9	4.5	45 JTU
10	5.0	50 JTU
15	7.5	75 JTU
20	10.0	100 JTU

4

Water Quality Monitoring Day

Monitoring Day Supplies List

General
___ extra thermometer
___ total solids bottle
___ fecal coliform bottle (sterilized)
___ folding table
___ cooler
___ waders or boots
___ extra gloves
___ extra distilled water
___ sample water bottles
(turbidity, pH, nitrates)
___ paper towels
___ first aid kit
___ cell phone
___ camera
___ aluminum foil
___ garbage bags
___ buckets with warm soapy water
___ hand sanitizer

Dissolved Oxygen
___ test kit
___ directions/data sheet
___ gloves
___ goggles
___ tarp
___ sample bottles (6)
___ paper towels
___ thermometer
___ distilled water & rinse bottle
___ waste water container

Nitrates
___ test kit
___ directions/data sheet
___ gloves
___ goggles
___ tarp
___ water bottle
___ paper towels
___ trash container
___ timer/stopwatch
___ distilled water & rinse bottle
___ waste water container

Turbidity
___ test kit
___ directions/data sheet
___ gloves
___ goggles
___ tarp
___ water bottle
___ paper towels
___ distilled water & rinse bottle
___ waste water container

pH
___ test kit
___ directions/data sheet
___ gloves
___ goggles
___ tarp
___ distilled water & rinse bottle
___ waste water container

Fecal Coliform
___ gloves
___ goggles
___ tarp
___ sample bottle (sterilized 500mL)
___ incubator (turned on)
___ fecal coliform broth
___ directions/data sheet
___ paper towels
___ petri dishes
___ filter paper
___ forceps
___ lighter
___ alcohol
___ permanent marker

Water Quality Sampling Instructions

Supplies- general: Sharpie, thermometer, tin foil, boots or waders, paper towels

Temperature:
Air – Let thermometer sit in air for 5 minutes while gathering DO samples.
Water – Lower thermometer 4 inches below water surface in the main area of the main stream flow. Keep the thermometer in the water without touching the bottom until a constant reading is attained, approximately 2 minutes.

Dissolved Oxygen:
Start with these first if students are waiting to do the test!
1- Facing upstream, rinse the sample bottle in stream and replace the cap.
2- Submerge the sample bottle and remove the cap.
3- Hold the sample bottle under water, at a slight angle facing into the water flow for one minute to allow the water to flow in and out of the sample bottle. While the bottle is still underwater, tap the sides of the bottle with the cap to release any air bubbles.
4- While the bottle is still submerged, replace the cap and retrieve from the stream.
5- Check for air bubbles; if they are present, repeat Steps 1-4
6- Collect 3 samples for DO and 3 more for BOD. Wrap in foil and label BOD bottles.
7*- If you are not performing the tests immediately, executing steps 1-3 will "fix" for later testing.

Fecal Coliform
1- Sterile bottle!
2- Stand facing upstream.
3- Hold the sample bottle by the bottom and unscrew cap.
4- Turn bottle upside down and plunge it straight down into the water.
5- When bottle is completely submerged, tip the bottle opening up and into the current at about a 45 degree angle.
6- Fill bottle completely
7- Take bottle out of the stream and pour off enough water to leave about on inch of air space. Cap bottle immediately.
8- Cover lid with aluminum foil to prefent outside bacteria from sneaking into your sample.
9- Put in cooler on ice.

Total Solids
1- Stand facing upstream
2- Remove cap.
3- Rinse once, dumping downstream.
4- Fill bottle.
5- Leave 1 inch space.
6- Put in cooler on ice.

Nitrates, pH, Turbidity
1- Stand facing upstream
2- Remove cap.
3- Rinse once, dumping downstream.
4- Fill bottle.

Bottle Basics

Sample	Sample Bottle	Sample Handling	Destination - NREP	Destination - SSG
Fecal Coliform (FC)*	Wide mouth at least 500 mL sterilized (boiled for 5 minutes)	Keep on ice in dark cooler. Needs to be processed within 6 hours.	Check with your coordinator	Check with your coordinator
Total Suspended Solids (TSS)**	provided bottle filled to 1/2" from top (leave shaking room)	Keep on ice in dark cooler	Deliver to your fecal coliform processing site	Thurston Conservation District – 2918 Ferguson St. SW, Tumwater
Dissoloved Oxygen (D.O.)	60 mL glass - 3 bottles	60 ml glass – 3 bottles The first three chemical reagents must be added within 20 minutes of sampling. Remainder of the test can be completed later in the day if necessary.	N/A	N/A
Biochemical Oxygen Demand (B.O.D.)	60 mL glass - 3 bottles	Cover with foil and put in a dark cupboard in your classroom; Run DO tests on the samples on Day 5 (Tuesday following monitoring)	N/A	N/A
Additional samples for nitrates, turbidity and pH	No special bottle required	No special handling	N/A	N/A

* All FC samples should include a label with date, teacher name, sampling location and sample type (FC). NREP participants are provided FC sample bottles at Networking Meeting.

**All TSS samples should include a label with date, teacher name, sampling location and sample type (TSS). NREP and SSG participants are provided TSS sample bottles at Networking Meeting.

Temperature Data Sheet

Step #1: Fill out all the information below.

School:______________________________

Teacher:______________________________

Names of Monitors:______________________________

Stream Name:______________________________

Test Location:______________________________

Weather: ______________________________

Air Temperature: ______________________________

Therm Brand: (Hach, LaMotte or other)______________

Date:______________________________

Time:______________________________

Step #2: Record air temperature.

Test Results **Date:**____________	_____________ °c	**Comments:**______________________________ ______________________________ ______________________________ ______________________________

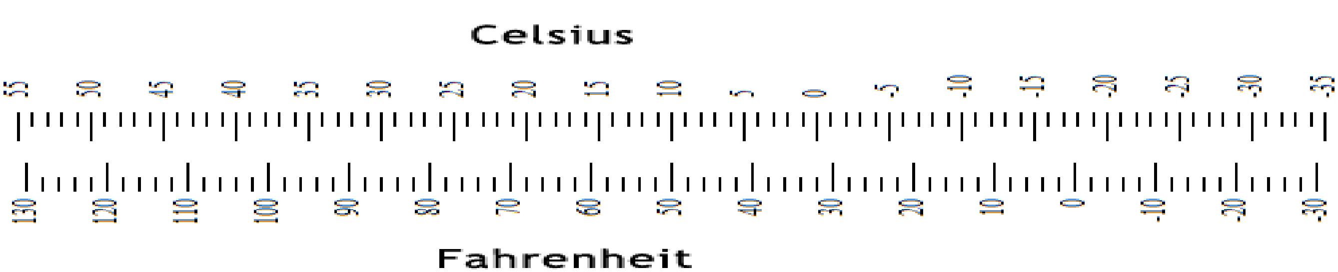
Step #3: Record at least 3 replicate sample values in the chart below. Values should be similar, re-test any samples with values at least 10 degree difference.

Replicate #1	**Replicate #2**	**Replicate #3**	**Replicate #4** **(if needed)**
_____________ °c	_____________ °c	_____________ °c	_____________ °c

Step #4: Record the **average** of your 3 replicate samples in the box below. Record any comments or observations.

Test Result (record the average)	_____________ °c	**Comments:**______________________________ ______________________________ ______________________________

Step #6: Draw the average for what you found!



Optimal Temperature Values

Hatching Salmon	Adult Salmon	Aquatic Insects	Not Acceptable
<48ºF or 9ºC	<54ºF or 12ºC	<50ºF or 10ºC	<65ºF or 18ºC

Dissolved Oxygen Data Sheet

Step #1: Fill out all the information below.

School:____________________________________
Teacher:____________________________________
Names of Monitors:__________________________
Stream Name:_______________________________
Test Location:______________________________

Weather:__________________________________
Air Temperature:__________________________
Test Kit: (Hach, LaMotte or other)______________
Date:____________________________________
Time:____________________________________

Step #2: Record at least 3 replicate sample values in the chart below. Values should be similar, re-test any samples with values at least 0.8 mg/L different from other replicates.

Replicate #1	Replicate #2	Replicate #3	Replicate #4
__________mg/L	__________mg/L	__________mg/L	__________mg/L

Step #3: Record the water temperature in degrees Celsius in the box below (make sure the thermometer has been in the stream **at least 2 minutes.**)

Step #4: Record the average of your 3 replicate samples of dissolved oxygen in the box below.

Temperature Test Result	__________°C	Dissolved Oxygen Test Result (record the average)	__________mg/L

Step #5: Record two dissolved oxygen and temperature test results from previously recorded data for your site in table below.

Test Results 1	Date: __________	__________mg/L	__________°C
Test Results 2	Date: __________	__________mg/L	__________°C

Step #6: Using the Nomogram D.O. Saturation Chart to find the percent saturation of dissolved oxygen.

D.O. Saturation	__________%

Optimal Temperature Values			
Hatching Salmon	Adult Salmon	Aquatic Insects	Not Acceptable
9°C	12°C	10°C	18°C

Step #7: Have the recorder sign once each step is complete.

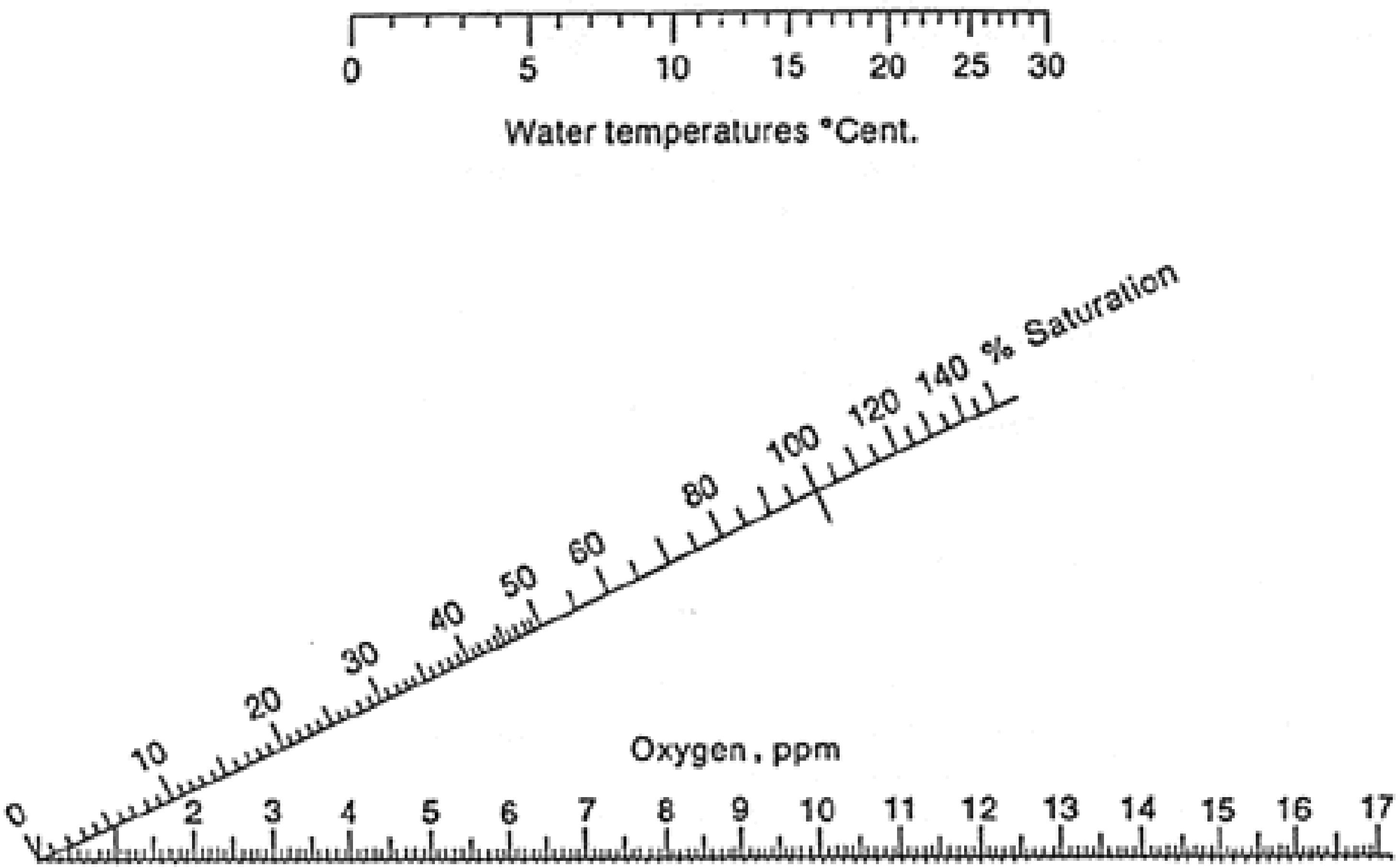
Test Completed________________ **Date:**________

Data Reviewed________________ **Date:**________

Transferred to Master ________ **Date:**________

Optimal Dissolved Oxygen Values			
Optimal	Acceptable	Poor	Fatal
>9 mg/L	7-8 mg/L	3.5-6 mg/L	<3.5

NOMOGRAM


0
5
10
15
20
25
30
Water temperatures °Cent.
0
10
20
30
40
50
60
80
100
120
140
% Saturation
Oxygen, ppm
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17

Nitrate Data Sheet

Step #1: Fill out all the information below.

School:____________________________________
Teacher:____________________________________
Names of Monitors:____________________________
Stream Name:________________________________
Test Location:________________________________

Weather:____________________________________
Air Temperature:____________________________
Test Kit: (Hach, LaMotte or other)________________
Date:______________________________________
Time:______________________________________

Step #2: Record at least 3 replicate sample values in the chart below. Values should be similar, re-test any samples with values at least 1.0 mg/L unit different from other replicates. Do **NOT** multiply by 4.4.

Replicate #1	Replicate #2	Replicate #3	Replicate #4
__________ mg/L	__________ mg/L	__________ mg/L	__________ mg/L

Step #3: Record the **average** of your 3 replicate samples in the box below. Record any comments or observations.

Test Result (record the average)	__________ mg/L	**Comments:**____________________

Step #4: Record two turbidity test results from previously Recorded data for your site in table below.

Step #5: Record comments from your comparison.

Test Results **Date:**________	__________ mg/L	**Comments:**____________________
Test Results **Date:**________	__________ mg/L	

Step #6: Have the recorder sign once each step is complete.

Test Completed________________________
Date:________________________________

Data Reviewed________________________
Date:________________________________

Data Transferred to Master Data Sheet____________________
Date:________________________________

Optimal Nitrate Values: Nitrate values in unpolluted water bodies should generally be below 1.0 mg/L. High nitrate values can artificially stimulate plant growth resulting in algal blooms which speed up the aging process of aquatic systems. The main sources of nitrates are from failing septic systems, fertilizers, and runoff from pet wastes, cattle feedlots, dairies, and barnyards.

pH Data Sheet

Step #1: Fill out all the information below.

School:______________________________

Teacher:______________________________

Names of Monitors:______________________________

Stream Name:______________________________

Test Location:______________________________

Weather:______________________________

Air Temperature:______________________________

Test Kit: (Hach, LaMotte or other)______________________________

Date:______________________________

Time:______________________________

Step #2: Record at least 3 replicate sample values in the chart below. Values should be similar, re-test any samples with values at least 2.0 pH units different from other replicates.

Replicate #1	Replicate #2	Replicate #3	Replicate #4
____________pH units	____________pH units	____________pH units	____________pH units

Step #3: Record the **mode**, the most common pH value (*this is different than the average!)* of your 3 replicate samples in the box below. Record any comments or observations

Test Result (record the mode)	____________pH units	**Comments:**______________________________

Step #4: Record two pH test results from previously recorded data for your site in table below.

Step #5: Record comments from your comparison.

Test Results **Date:**____________	____________pH units	**Comments:**______________________________
Test Results **Date:**____________	____________pH units	

Step #6: Have the recorder sign once each step is complete.

Test Completed____________________ **Date:**__________

Data Reviewed____________________ **Date:**__________

Data Transferred to Master Data Sheet____________________ **Date:**__________

Optimal pH Values for Salmon		
Optimal	**Acceptable**	**Poor**
7-8	6.5-8.5	Below 6.5

Optimal pH Values: pH values between 7.0-8.0 are ideally suited to support a diverse aquatic system. If pH declines below 6.5, fewer salmon eggs hatch and aquatic insect levels drop.

Turbidity Data Sheet

Step #1: Fill out all the information below.

School:____________________

Teacher:____________________

Names of Monitors:____________________

Stream Name:____________________

Test Location:____________________

Weather:____________________

Air Temperature:____________________

Test Kit: (Hach, LaMotte or other)____________________

Date:____________________

Time:____________________

Step #2: Record at least 3 replicate sample values in the chart below. Values should be similar, re-test any samples with values at least 10 JTU units different from other replicates. **Remember: 1 dropper (or 0.5 ml) = 5 JTUs.**

Replicate #1	Replicate #2	Replicate #3	Replicate #4
______ JTUs	______ JTUs	______ JTUs	______ JTUs

Step #3: Record the **average** of your 3 replicate samples in the box below. Record any comments or observations.

Test Result (record the average)	______ JTUs	**Comments**:____________________

Step #4: Record two turbidity test results from previously recorded data for your site below.

Step #5: Record comments from your comparison.

Test Results **Date:**________	______ JTUs	**Comments**:____________________
Test Results **Date:**________	______ JTUs	

Step #6: Have the recorder sign once each step is complete.

Test Completed____________________

Date:____________________

Data Reviewed____________________

Date:____________________

Data Transferred to Master Data Sheet____________________

Date:____________________

Optimal Turbidity Values:

Since salmon rely greatly on their visual abilities, the lower the turbidity the better. Less than 20 JTU's are optimal. Salmon will avoid water with high silt loads, which cloud the water, and will cease to move through water where visibility is extremely low. High turbidity can delay salmon migration.

Biochemical Oxygen Demand Data Sheet

Step #1: Fill out all the information below.

School:____________________________________
Teacher:____________________________________
Names of Monitors:____________________________
Stream Name:________________________________
Test Location:_______________________________

Weather:____________________________________
Air Temperature:____________________________
Test Kit: (Hach, LaMotte or other)_______________
Date:______________________________________
Time:______________________________________

Step #2: After storing sample covered for 5 days at room temperature, test for the level of dissolved oxygen by following dissolved oxygen testing procedures. Record at least 3 replicates.

Replicate #1	Replicate #2	Replicate #3	Replicate #4
____________mg/L	____________mg/L	____________mg/L	____________mg/L

Step #3: Record the **average** of your 3 replicate samples from day 5 in the box below.

Step #4: Now subtract the D.O. average after 5 days from your original D.O. test result. Record B.O.D. test result.

D.O. Test (Day 5)	B.O.D. Test Result
________mg/L (record the average)	_______mg/L - ______mg/L = ______**mg/L** (Day 1 D.O.) (Day 5 D.O.) (B.O.D. Test Result)

Step #5: Record two B.O.D. test results from previously recorded data for your site

Test Results 1 **Date:**______	________mg/L	Comments: __________________________ __________________________________ __________________________________ __________________________________
Test Results 2 **Date:**_____	________mg/L	

Step #6: Have the recorder sign once each step is complete.

Test Completed__________________
Date:________

Data Reviewed___________________
Date:________

Transferred to Master ____________
Date:________

Optimal Biochemical Oxygen Demand:
B.O.D. should be < 6.0 mg/L. In streams with high B.O.D. levels, aerobic bacteria will rob other aquatic organisms of the oxygen they need to survive. The result is a less diverse stream with only low-oxygen tolerant organisms.

Nisqually River Education Project
Master Data Sheet

School		Weather	
Teacher		Air Temperature	
Site Name		Test Kit(s):	
Stream/River Location		# of Students Participating	
Date		# of Volunteers and Hours	
Time		Longitude	____°____'____"
Nearest Street Access		Latitude	____°____'____"

Transfer the final 3 replicate sample values from the individual data sheets onto this Master Data Sheet.

Test	Replicate #1	Replicate #2	Replicate #3	Final Test Result	Previous Data for your site Date:
Dissolved Oxygen	____mg/L	____mg/L	____mg/L	____mg/L (record mean)	____mg/L
Water Temperature	____° C	____° C	____° C	____° C	____° C
D.O. % Saturation	____ %	____ %	____ %	____ %	____ %
B.O.D. (Biochemical Oxygen Demand)	____mg/L	____mg/L	____mg/L	____mg/L (record mean)	____mg/L (D.O. day 1 avg – D.O. day 5 avg)
Fecal Coliform	____FC/100ml	____FC/100ml	____FC/100ml	____FC/100ml	____FC/100ml
pH	____pH Units	____pH Units	____pH Units	____pH Units (record mode)	____pH Units
Nitrates (Do Not Multiply by 4.4)	____mg/L	____mg/L	____mg/L	____mg/L (record mean)	____mg/L
Turbidity	____JTUs	____JTUs	____JTUs	____JTUs (record mean)	____JTUs

Fax or email to: Brandon Bywater – Nisqually River Education Project

Fax # 360.438-8742 brandon@nisquallyriver.org 12501 Yelm Hwy SE Olympia, WA 98513 360.561.0203	Comments:

South Sound GREEN
Master Data Sheet

South Sound GREEN

School		Weather	
Teacher		Air Temperature	
Site Name		Test Kit(s):	
Stream/River Location		# of Students Participating	
Date		# of Volunteers and Hours	
Time		Longitude	
Nearest Street Access		Latitude	

Transfer the final 3 replicate sample values from the individual data sheets onto this Master Data Sheet.

Test	Replicate #1	Replicate #2	Replicate #3	Final Test Result	Previous Data for your site Date:
Dissolved Oxygen	______mg/L	______mg/L	______mg/L	mg/L (record mean)	______mg/L
Water Temperature				______ ° C	______ ° C
D.O. % Saturation	______ %	______ %	______ %	______%	______%
B.O.D. (Biochemical Oxygen Demand)				(record mean) _____mg/L ______ mg/L (D.O. day 1 mean – D.O. day 5 mean)	______mg/L
Fecal Coliform	______FC/100ml	______FC/100ml	______FC/100ml	______FC/100ml	______FC/100ml
pH	______pH Units	______pH Units	______pH Units	______pH Units (record mode)	______pH Units
Nitrates (Do Not Multiply by 4.4)	______mg/L	______mg/L	______mg/L	______mg/L (record mean)	______mg/L
Turbidity	______JTUs	______JTUs	______JTUs	______JTU's (record mean)	______JTUs

Fax (preferred) to (360)236-0941 or email to sbishop@thurstoncd.com Stephanie Bishop South Sound GREEN Thurston Conservation District 2918 Ferguson St. SW, Building One, Suite A Tumwater, WA 98512	Comments:

Chehalis Basin Education Consortium

Master Data Sheet

School		Weather	
Teacher		Air Temperature	
Site Name		Test Kit(s):	
Stream/River Location		# of Students Participating	
Date		# of Volunteers and Hours	
Time		Longitude	_ _ ° _ _ ' _ _ "
Nearest Street Access		Latitude	_ _ ° _ _ ' _ _ "

Transfer the final3 replicate sample values from the individual data sheets onto this Master Data Sheet.

Test	Replicate #1	Replicate #2	Replicate #3	Final Test Result	Previous Data for your site Date:
Dissolved Oxygen	mg/L	mg/L	mg/L	mg/L (record mean)	mg/L
Water Temperature	N/A	N/A	N/A	OC	•C
D.O.% Saturation	%	%	%	%	%
B.O.D. (Biochemical Oxygen Demand)	________mg/L	________mg/L	mg/L	________mg/ L (record mean)	mg/L (D.O. day 1 avg- D.O. day 5 avg)
Fecal Coliform	FC/lOOml	FC/100ml	FC/lOOml	FC/lOOml	FC/100ml
pH	pH Units	pH Units	pH Units	pH Units (record mode)	pH Units
Nitrates (Do Not Multiply by 4.4)	mg/L	mg/L	mg/L	mg/L (record mean)	mg/L
Turbidity	________ jTUs	________]TUs	________lTUs	TUs (record mean)	________ lTUs

Fax (preferred) or email to: Rachel Stendahl, Chehalis Basin Education Consortium, ESD 113

Fax# 464-6917 rstendahl@esdl13.org 6005 Tyee Dr. SW Tumwater, WA 98512 Phone #464-6722	Comments:

Don't forget to add your data to the CrowdMap! Go to www.cbecesd113.crowdmap.com

Teacher's Guide to Streamwalk Survey

Introduction

The Environmental Protection Agency (EPA) Region 10 office in Seattle was asked by several groups and agencies to create a standardized, easy to use screening tool for monitoring stream corridor health. We responded by developing a Streamwalk Survey. We decided to call it Streamwalk.

Streamwalk Is designed to be used by people who are Interested In learning more about their streams and rivers. We anticipate the data people collect will be used as a screening tool to focus attention on areas that might be of concern, and to help direct further evaluation by experts. If all goes as we hope, and enough good data is collected, we should be able to make comparisons and evaluate trends over time for rivers and streams.

Our objectives in developing Streamwalk are to:
- develop a screening tool to identify potential problem areas
- provide a standardized data collection method so regional and trend comparisons can be made
- focus experts' limited resources on suspected problem areas
- encourage citizen commitment to protecting streams
- educate people about the relationship between streams and watersheds

The following is a recommended list of items to have along on your Streamwalk:
- Photocopies of topographic map of stream to be walked
- Comfortable rubber boots
- Clothing that is appropriate for the weather
- Clip board with waterproof cover
- Streamwalk data forms
- Two pencils
- Folding ruler or tape measure
- Camera in waterproof bag
- Whistle
- Extra clothes in a waterproof bag
- Small First Aid kit

Documentation
Survey data sheets

Please keep your original data sheet and topographic map. You may want to use the information you have generated to note trends and changes. The information may also be of use to your local environmental organization or government.

Documentation

1. Weather

   The concern with weather relates to amount of rainfall which potentially can affect flow, clarity and amount of water in a stream. Weather/rainfall reports are available in the daily newspaper or by calling the local weather service. Definitions of weather conditions established by the Weather Service are:

   Rain - 1/3'in 24 hours -light steady rainfall.
   Showers- 1/3'- 1' in 24 hours, intermittent and viable in intensify.
   Storm -1·or more rain in 24 hours, usually accompanied by winds.

2. Stream Description

   This Information will give a description of the stream water at your site. Please Indicate if your response is estimated or measured. Remember, it is best to estimate if taking measurements will disturb habitat, require that you wade in deep water or disturb stream banks. Do not attempt to cross in high flows. If it feels even mildly unsafe, do not try it at all. Remember, this is a screening tool, not the last word.

Water Clarity

The clearness of the water is observed to determine if sediment pollution is entering the stream. Cloudy or different colored water can be a result of natural processes or of land use in the surrounding watershed. Sediments can adversely affect habitat conditions such as food, health of fish, and breeding environment for macro-invertebrates. In some areas grey or white water can be a result of natural processes such as glacial sources for streams.

3. Water Flow: Pools, Riffles and Runs

   The variety of flow in relation to depth creates habitat to support fish and invertebrate life. This variety can be seen by looking for pools and riffles. Pools are deeper than adjacent areas. They provide feeding, resting, and spawning areas for fish. Riffles and/or runs are flows swift in comparison to surrounding areas. Riffles are shallow and fast water, runs are deep and fast water and pools are slow and deep water.

4. Stream Bottom (Substrate)

   Indicate the most common type of material on the stream bottom.

   Silt/mud: This substrate has a sticky, cohesive feeling. The particles are fine. The spaces between the particles hold a lot of water, making the sediments behave like ooze.

   Sand (up to .11nch): Sand is made up of tiny particles of rock.

   Gravel (.1 - 2 Inches): A gravel stream bottom is made up of stones ranging from tiny quarter inch pebbles to rocks of about 2 Inches.

   Cobbles (2 -10 Inches): The majority of rocks on this type of stream bottom are between 2 and 10 inches. The average size is about the size of a grapefruit.

   Boulders (greater than 10 Inches): Most of the rocks on the bottom will be large, greater than 10 inches.

   Bedrock: This kind of stream bottom is solid rock.

5. Streamside Vegetation

A description of the presence and type of streamside vegetation provides much information about the stream due to its important role in molding the stream environment. Vegetation acts as a filter for sediment and pollution coming in from nearby land activities. It provides habitat for the many creatures that are dependent on and influence the stream. Branches, logs and leaves enter the stream from this region. Vegetation also provides shade, which keeps the water cool. On the data sheet mark all the categories that apply.

Conifer: A cone bearing, evergreen tree or shrub
Deciduous: A tree which sheds it's foliage at the end of the growing season.
Small trees or shrubs: Either conifers or deciduous bushes less than 20 feet high.
Grasses: Any of numerous plants with narrow leaves, jointed stems and spikes or clusters of inconspicuous flowers.
Invasive: Note any non-native invasive species such as Japanese Knotweed, Himalyan Blackberry, etc.

6. Width of Natural Streamside Corridor

The streamside corridor, riparian area or zone of influence are terms that describes the natural vegetated area on either side of the stream. It, along with the stream, forms the habitat of the river. It includes vegetation that shades the water, holds the soil in place, adds nutrients to the stream in the form of leaves and during flooding, and provides habitat for streamside wildlife. Estimate as best you can width of the corridor at your site. Indicate with an "x" on the bar graph the width. Note: Left and right are based on looking down stream. If the vegetation is pasture, lawn barked or landscaped, this is not a natural state so mark "o".

7. Overhead Canopy (Stream Cover)

This is the amount of vegetation that overhangs the stream. It focuses on several important values of streamside vegetation: offering protection and refuge areas for fish and other organisms, shading the stream and keeping the water cool, and providing launching areas for insects that might fall into the river. Estimate as best as you can, about how much of the river is overhung by vegetation, whether it be grasses, shrubs or trees. Please check the category that is appropriate for the current condition of your site. For example, if in the winter there are no leaves on the trees in your segment you might check 0-25%. However, in the summer when the trees have leaves, you might check 50-75%.

8. Presence of logs or woody debris in stream

Logs and woody debris (not twigs and leaves) can slow or divert water to provide important fish habitat such as pools and hiding places. So please mark the general amount of logs and woody debris in the stream.

9. Stream Conditions: Stream Banks

Natural plant cover degraded: Indicate if streamside vegetation is trampled, missing, or replaced by landscaping or cultivation.
Banks collapsed/eroded: Note if banks or parts of banks have been washed away or worn down.
Banks artificially modified: Indicate if banks have been artificially modified by construction or placement of rocks, wood or cement supports or lining.
Debris/Trash adjacent to stream: Indicate if human made materials are present.

10.Stream Channel

Mud/slit/sand on bottom/entering stream: Excessive mud or silt entering the stream and clouding the water can interfere with fishes' ability to sight potential prey. It can also clog fish gills and smother fish eggs in spawning areas on the stream bottom. Mud/silt/sand can be an indication of poor construction practices in the watershed; where runoff coming off the site is not adequately contained. It can also be a perfectly normal occurrence, especially if, for example, a muddy bottom is found along a very slow-moving segment or wetland. Use your best judgment.

Artificial Stream modifications: Please note if the stream water has been dammed, dredged, filled, or channelized through culverts or if other large scale activities such as log removal are apparent.

Excessive vegetation in stream (Algae/Canary Grass): Evidence of algae (very tiny plants that can color the water green or can resemble seaweed can point to a problem such as an upstream source adding too much nutrient (fertilizer) to the water. This is your chance to point out litter problems: tires, hot water heaters, car bodies, and garbage dumps.

11.Other

12. Adjacent land uses:

Adjacent land use has a great Impact on the quality and state of the stream and riparian areas. Enter a "1' if the land use is present and a '2" if it is clearly impacting the stream. If you cannot determine the type of housing, industry or development, please make your best estimate.

13. Agricultural:

14.Roads/Pavement

15.Construction Activity

16.Observations: (fish, weather, recreational activities, odors, scum, etc.)

NREP/SSG/CBEC GREEN Site Survey Data Form

Watershed: ______________________________

Stream Name: ______________________________

Stream Location: ______________________________

Investigators (school, teacher, students): ______________________________

Weather

☐ Storm ☐ Overcast ☐ Rain ☐ Clear ☐ Showers

Stream Description

1. Depth: ☐ feet ☐ measured ☐ estimated

Width: ☐ feet ☐ measured ☐ estimated

Clarity- does water appear ☐ Clear ☐ Cloudy

2. Are pools and riffles and/or runs present? ☐ Yes ☐ No

3. Stream Bottom (put X in box of most prevalent, check others present)

☐ Silt/Mud ☐ Sand ☐ Boulders (over 10") ☐ Gravel (.1-2") ☐ Cobbles (2-10") ☐ Solid Bedrock

4. Streamside Vegetation

	None/Sparse	Occasional	Common
Conifers	☐	☐	☐
Deciduous	☐	☐	☐
Small trees and shrubs (<20')	☐	☐	☐
Grasses	☐	☐	☐

Vegetation appears **natural** ☐ or **cultivated** ☐

5. Average width of riparian corridor in feet ☐ **ft.**

6. Extent to which trees and other vegetation shade stream:

☐ 0-25% ☐ 25-50% ☐ 50-75% ☐ 75-100%

7. Presence of logs or other large woody debris in stream:

☐ none ☐ occasional ☐ common

Stream Conditions:

Stream banks

- [ ] Streamside vegetation trampled
- [ ] Banks collapsed/eroded
- [ ] Banks artificially reinforced (concrete, rip rap, etc.)
- [ ] Debris/trash adjacent to stream

Stream channel

- [ ] Mud/silt in or entering stream
- [ ] Steam modifications (dams, culverts or other in-stream structures)
- [ ] Excessive vegetation in stream (algae, canary grass, etc.)
- [ ] Debris/trash in stream

Other

- [ ] Cattle or other livestock in stream or with unrestricted access to stream
- [ ] Drainage ditches entering stream
- [ ] Discharge pipes entering stream

Adjacent Land Uses:

Residential: (put X in box of most prevalent, check others if present)

- [ ] Single family housing
- [ ] Multi-family housing (apartments, etc.)
- [ ] Commercial development (shopping center, mini-mall, etc.)
- [ ] Light industry

Agricultural: (put X in box of most prevalent, check others if present)

- [ ] Grazing/Pasture land
- [ ] Barns or other animal holding areas
- [ ] Cropland
- [ ] Logging/ tree plantations

Roads/Pavement: (put X in box of most prevalent, check others if present)

- [ ] Paved roads
- [ ] Parking lots
- [ ] Unpaved roads

Construction Activity: (put X in box of most prevalent, check others preser

- [ ] Residential housing units
- [ ] Commercial developments (shopping center or minimal, etc.)
- [ ] Industrial
- [ ] Roads or parking lots

Observations: (fish, weather, recreational activities, odors, etc.)

____

____

____

____

Illustrated Site Survey

Water Quality Test Site Information

Investigators:

Site Name:

Stream/River Location:

Longitude: _____°_____' _____"   Latitude: _____°_____' _____"

Nearest Street Access:

Public Access ___ Yes ___ No

Draw a map that shows how to get to the stream from your school.

Weather

____Storm
____Rain
____Showers
____Overcast
____Clear

Date of Last Storm ___________

Temperature _____°F or °C

Stream Description (at testing site)

1. Depth: ______feet ____measured ____estimated

   Width ______feet ____measured ____estimated

2. Clarity: Does the water appear ______clear ____cloudy

3. Check if Present: ____pools ____riffles ____runs

4. Stream Bottom (put an X in box of most common/prevalent, check others present)

____Silt/Mud ____Sand
____Gravel (.1-2") ____Cobbles (2-10")
____Boulders (over 10") ____Solid Bedrock

Streamside Vegetation

Vegetation Type	Common	Occasional	None/Sparse
Conifers			
Deciduous			
Small Trees and Shrubs (less than 20' high)			
Grasses			
Invasive Species			

Make a drawing of the stretch of stream that you are observing. Note the pools, runs and riffles. Note the areas of rocks and sand on the stream bottom. Note the gravel bars. Note the areas of vegetation.

Do you notice any leaf litter in the stream? _______yes _________no

Draw the shape of the leaves you notice.

Stream Conditions (Be sure to include these when you sketch and label your drawing.)

Check All That Apply

Stream Banks	**Present**		**Stream Channel**	**Present**
Streamside vegetation trampled			Mud/silt entering the stream	
Banks Collapsed/Eroded			Stream Modification (culverts, dams or other in-stream structures)	
Banks artificially reinforced (concrete, rip rap, etc.)			Excessive vegetation in stream (algae, canary grass)	
Debris/trash adjacent to stream			Debris/trash in stream	

Other	**Present**		**Additional Observations** (human activities, animals, etc.)	**Present**
Cattle or other livestock (in stream or with unrestricted access to stream)				
Discharge pipes entering stream				
Drainage ditches entering stream				
Leaf litter in stream				

Adjacent Land Uses – at the site and immediately upstream and downstream

(You may need to use paper or digital maps or other sources back in your classroom to complete these charts.)

(Put an X for the most common/prevalent. Put a √ if others are present.)

Residential	**X or √**		**Agricultural**	**X or √**
Single Family housing			Grazing/Pasture Land	
Multi-family housing (apartments, townhomes, etc.)			Barns or other animal holding areas	
Commercial Development (shopping center, mini-mall, etc.)			Cropland	
Light Industry			Logging/Tree Plantations	

Roads/Pavement	**X or √**		**Construction Activity**	**X or √**
Paved Roads			Residential housing units	
Parking Lots			Commercial developments (shopping center or mini-mart)	
Unpaved Roads			Industrial	
Culverts			Roads or parking lots	

Google Map the land adjacent to the stream location. Based upon the Google Map, draw a map that includes labels for the various land uses nearby.

Adjacent Land Uses:

Additional Observations: Make drawings of three things you notice at the site. This could include leaf shapes of the trees, shrubs or herbs; insects; rocks; birds, etc.

Map the sounds you hear at the site. Label each sound. To map a sound, make a drawing that feels like the sound.

X

Name:______________________________

Watershed Sensory Scavenger Hunt

To help you focus and observe what is around you, working by yourself, find:

Something older than yourself:______________________________

Something that makes you laugh:______________________________

Something that has a smell:______________________________

Something with spots:______________________________

Something smooth as glass:______________________________

Something that flies:______________________________

Something you want to remember:______________________________

Make a rubbing or drawing of a fun texture that you find!

5

Additional Water Quality Monitoring Activities

Making Water Quality Connections

Water Quality Conditions Observed	Possible Associated Problems	Possible Associated Causes
Decrease in Dissolved Oxygen	Temperature increase	Reduction in vegetation shading body of water; increase in sediment or suspended solids; industrial cooling processes
	Organic waste – once part of a living plant or animal (food, leaves, feces, etc.)	Leaking or failing septic systems; waste from farms and animals (pets and feedlots); discharge from food-processing plans, meat packing houses, dairies and other industrial sources; garbage; industrial waste (organic fibers from textile, paper, and plant processing); sewage treatment plants, natural processes; grass, tree and shrub clippings; urban runoff; agricultural runoff
	Chemical runoff – herbicides, pesticides, insecticides	Golf courses; residential lawns; agricultural lands; recreational parks
	Trash	Litter washed into sewer systems
	Lack of algae and rooted aquatic plants	Multiple sources of water pollution (e.g. chemicals, toxins)
	Low water levels	Climatic or weather change
Fecal Coliform Bacteria **E. Coli** **Enterococci**	Organic waste – feces from human beings or other warm-blooded animals	Leaking or failing septic systems; failing sewer systems Direct discharge from mammals and birds with access to waterways or waste entering a body of water as runoff
Increase in Temperature (Thermal Pollution)	Organic waste – once part of a living plant or animal (food, leaves, feces, etc.)	Natural processes; grass clippings; tree and shrub clippings; unnatural fish or animal kills
	Reduction in vegetation shading body of water	Shade trees and shrubs removed from stream bank for urban development, irrigation, and industrial and agricultural expansion, exposing the water to direct sunlight
	Industry and power plant discharge	Water returned to source is at higher temperature than at initial intake point
	Runoff from warmed urban surfaces	Impervious land cover such as paved streets, sidewalks and parking lots Urbanization leading to increased numbers of buildings, homes and roads on lands which previously were natural areas, and absorbed rain and snowmelt more efficiently
	Suspended solids	Removal of streamside vegetation; overgrazing; poor farming practices and construction causing excessive soil erosion
	Flow of water impeded	Dams, dikes and diversions for agricultural, industrial or municipal practices decrease flow rate of river, absorbing more heat from sunlight Dams created from beavers or log jams

Water Quality Conditions Observed	Possible Associated Problems	Possible Associated Causes
Turbidity	Suspended solids (ranging from clay, silt and plankton, to industrial wastes and sewage)	Erosion from agricultural fields; construction sites; residential driveways, roads and lawns; natural and accelerated erosion of stream bank; excessive algae growth
High Total Dissolved Solids/Total Solids		Leaves and plant materials Wastewater treatment plant Run off from urban areas Dredging waterways Waste discharge (garbage, sewage) Excessive population of bottom-feeding fish (such as carp) that stir up bottom sediments
Excessive Phosphates	Human wastes Organic waste – once part of a living plant or animal (food, leaves, feces, etc) Run-off from fertilized land Industrial waste	Leaking or failing septic systems; sewage treatment plants Waste containers leaking; lack of waste storage facilities; animals have direct access to waterways Pet wastes not collected and disposed of appropriately Removal of natural vegetation for farming or construction practices, causing soil erosion Draining swamps and marshes for farmland or commercial/residential development Drained wetlands no longer functioning as filters of silt and phosphorous Agricultural fields, residential lawns, home gardens, golf courses, recreational parks
Excessive Phosphate	Detergents Natural events	Poorly treated sewage; broken pipes; farms; golf courses; sewage treatment facilities; industrial discharges Household and commercial cleaning agents washing into the water and sewage systems Forest fires and fallout from volcanic eruptions
pH	Vehicles for transportation Industrial waste Runoff from fertilized land	Improper engine maintenance of vehicles (emissions systems) Industrial or mining drainage; sewage treatment plants Agricultural fields; residential lawns; golf courses; recreational parks

Water Quality Conditions Observed	Possible Associated Problems	Possible Associated Causes
Excessive Nitrate	Runoff from fertilized land Human wastes Animal wastes Organic waste – once part of a living plant or animal (food, leaves, feces, etc.)	Agricultural fields; residential lawns; golf courses; recreational parks Leaking for failing septic systems; sewage treatment facilities Waste containers leaking; lack of waste storage facilities; animals (particularly ducks and geese) that have direct access to waterways Pet wastes not collected and disposed of appropriately Natural processes; grass clippings; tree and shrub clippings; unnatural fish or animal kills
pH & Alkalinity	Acid rain (beginning in neighboring regions) Natural processes	Excessive air pollution from burning fossil fuels for automobiles, boats, planes, etc. Surrounding geologic features (soil and rock) • High alkalinity may be a result of high levels of limestone • Low alkalinity may be a result of high levels of granite
Salinity	Salt and oil runoff Bodies of salt water mixing with fresh water Natural processes	Paved roads cannot absorb substances, such as salts used on roads in winter; irrigation water picks up salts in soil Water tables decrease in areas where water is being pumped (used) at levels exceeding replenishment capability Surrounding geologic features (soil and rock) may have high salt levels
High Conductivity **Low Conductivity**	Discharges into the water Natural processes Discharges into the water Natural processes	Failing sewage systems High Temperature Water used for irrigation Discharge of heavy metals into the water Surrounding area contains a lot of clay soils Oil spill Low temperature Water runs through area of granite bedrock

Rural Observations	Possible Associated Problems	Possible Associated Causes
Agriculture – crop production	Chemical runoff – pesticides, herbicides, insecticides	Poor farming practices causing excessive erosion of sediment and chemicals from fields
	Temperature increase in body of water adjacent to agricultural fields	Shade trees and shrubs removed from stream bank for irrigation or agricultural expansion, exposing the water to direct sunlight
	Natural flow of water impeded	Dams, dikes and diversions for agricultural practices decrease flow rate of river, absorbing more heat from sunlight
		Draining swamps and marshes for farmland
	Reduced ability to contain suspended solids, chemicals and excess water from runoff	Improper containment of farm animal waste
	Organic waste entering water from runoff	Discharge from food-processing plants, meat packing houses and dairies
Animals – feedlots		Direct discharge from farm animals with access to waterways or waste entering a body of water as runoff
Homes	Organic waste entering water from runoff	Leaking or failing septic systems
	Human wastes – gray water leaking into groundwater	Household and commercial cleaning agents washing into the water and sewage systems

Rural to Urban Observations	Possible Associated Problems	Possible Associated Causes
Residential/Commercial/ Industrial	Excess water and chemical runoff	Urbanization leads to increasing numbers of building, homes and roads on lands which previously were natural areas, and absorbed rain and snowmelt more efficiently
	Sediment and suspended solids	Construction of new buildings and homes, and streets causes excessive erosion
		Paved roads cannot absorb chemicals, soil and suspended particles in runoff
		Draining swamps and marshes for commercial or residential development reduces water catchment ability and filtering of silt and suspended solids
		Dredging waterways
	Temperature increase	Dams, dikes and diversions for drinking water intake decreases flow rate of river, absorbing more heat from sunlight

Urban Observations	Possible Associated Problems	Possible Associated Causes
Residential Buildings/Construction/Public Use (Parks and Zoos)	Organic waste – once part of a living plant or animal (food, leaves, feces, etc.)	Leaking or failing septic systems; failing sewer systems
		Wastewater treatment plants
		Direct discharge from mammals and birds as waste entering a body of water as runoff
		Pet wastes not collected and disposed of appropriately
		Grass, tree and shrub clippings washed into sewer systems
Residential/Commercial Buildings	Detergents	Household and commercial cleaning agents washing into water and sewage systems
	Trash	Litter washed into sewer systems
	Reduction in vegetation shading body of water	Shade trees and shrubs removed from watershed for urban development, exposing the water to direct sunlight and increasing sediment and suspended solids entering a body of water from erosion
Agricultural and Recreational Areas/Public Use (Airports and Train Stations)	Runoff from fertilized and impervious land	Chemical runoff from golf courses, residential driveways and lawns, and recreational parks entering a body of water as runoff
		Impervious land cover such as paved streets, sidewalks and parking lots causes excessive runoff from warmed urban surfaces
Industrial	Industry and power plant discharge	Industrial cooling process: water returned to source body of water is at higher temperature than at initial intake point
		Industrial or mining drainage
	Organic waste – once part of a living plant or animal (food, leaves, feces, etc.)	Discharge from food-processing plants, meat packing houses, dairies and other industrial sources
		Organic waste from fibers originating from textile and plant processing plants
Ports		Wastewater treatment plants
	Petroleum Products	Chemical pollutants from point or nonpoint source pollution

Physical Observations	Possible Associated Problems	Possible Associated Causes
Water Appearance		
Green, Green-Blue, Brown or Red	Indicates the growth of algae	High levels of nutrient pollution, originating from organic wastes, fertilizers, or untreated sewage.
Muddy, Cloudy	Indicates elevated levels of suspended sediments, giving the water a muddy or cloudy appearance	Erosion is the most common source of high levels of suspended solids in water. Land uses that cause soil erosion include mining.
Dark Reds, Purple, Blues, Blacks	May indicate organic dye pollution	Originating from clothing manufacturers or textile mills.
Orange-Red	May indicate the presence of copper	Copper can be both a pollutant and naturally occurring. Unnatural occurrences can result by acid mine drainage or oil-well runoff.
Blue	May indicate the presence of copper, which can cause skin irritations and death of fish	Copper is sometimes used as a pesticide, in which case an acrid (sharp) odor might also be present.
Foam		Excessive foam is usually the result of soap and detergent pollution. Moderate levels of foam can also result from decaying algae, which indicates nutrient pollution.
Rusty	Tannic Water (natural)	Leaves
Multi-Colored (oily sheen)	Indicates the presence of oil or gasoline floating on the surface of the water. Oil and gasoline can cause poisoning, internal burning of the gastrointestinal tract and stomach ulcers.	Oil and gasoline pollution can be caused by oil drilling and mining practices, leaks in fuel lines and underground storage tanks, automotive junk yards, nearby service stations, wastes from ships, or runoff from impervious roads and parking lot surfaces.
No unusual color	Not necessarily an indicator of clean water.	Many pesticides, herbicides, chemicals, and other pollutants are colorless or produce no visible signs of contamination.
Odors		
Sulfur (rotten eggs)	May indicate the presence of organic pollution.	Possible domestic or industrial wastes.
Musty		May indicate the presence of sewage discharge, livestock waste, decaying algae, or decomposition of other organic pollution.
Harsh		May indicate the presence of industrial or pesticide pollution.
Chlorine	May indicate the presence of over-chlorinated effluent	Sewage treatment plant or a chemical industry.
No unusual smell	Not necessarily an indicator of clean water.	Many pesticides and herbicides from agricultural and forestry runoff are colorless and odorless, as are many chemicals discharged by industry.
Dead Salmon Smell?	Spawned out Salmon carcasses	Spawned out Salmon

Modified from Earth Force Materials

Water Quality Monitoring Field Trip
Possible Learning Activities to Assign to Groups

Look for signs of animal habitats and record your observations in your journal

List all of the species of plants and trees that you can observe and identify. (Provide ID cards or field guides)

Imagine that you are a Native American in this location before European settlers arrived; record your thoughts, feelings imagined observations, and ideas about this land – use descriptive language.

Start writing a creative myth about this area or its inhabitants (salmon, deer, ravens, wildcats, etc.)

Write a journal entry that a young boy or girl settler who has just arrived in this new territory might write—imagine his/her adventures, fears, observations, etc.

Stop, sit down, and sketch carefully what you see—pick a special tree or plant.

Take notes in your journal from an interpretive sign post. If there are none, design your own!

Have your group sit silently in a spot with their eyes closed for 3-5 minutes, and then record in their journals all of the sounds that they heard.

Describe and list all of the different colors of green that you can see.

Take a rubbing from an old tree…then write about that tree.

Write a poem about your hike through these woods.

Try to determine the height of any tree…the tallest tree…describe your thinking.

Pretend to be a salmon returning to these water to eventually spawn; write about your experiences or thoughts.

Write a journal entry telling why it is important to have places like parks to be in nature.

Describe in careful detail a bird that you observed or spotted.

"Randomness Bird" Poetry Activity

(Adapted from "The Word as Catalyst, Igniting Children's Imagination through Creative Writing")

This exercise allows students to experience the pleasure of using words in unexpected ways. Pass out a list of one hundred words (or so) to each student and tell them to keep the list face down until the instructor says to turn it over. Allow the students a fixed amount of time(between ten seconds and one minute) to choose and circle ten words on the list. Then allot them five minutes to write a poem using these words. This arbitrary time limit encourages students to take a lighter approach to the task and cuts out the agonizing stages that many students go through. With younger students, you might say that you want them to write a story linking the words; if they can't think of something, suggest they write sentences using the words. (This exercise works especially well with middle school students because it helps them break out of their self-consciousness.)

You can make up your own list of words by looking through poetry anthologies, magazines or newspapers and pulling out words that students may like. The key is to stay with action verbs and object nouns.

One Hundred Watershed Words (or so):

Moon	Migratory	Salty	Plumage	Breeding
Light	Roll	Mollusk	Flocks	Midair
Listen	Swamp	Habitat	Glide	Dark
Osprey	Drum	Plover	Grazing	Shorebird
Eagle	Deschutes	Salt marsh	Feeding	Waves
Majestic	Salmon	Creek	Tributary	Skim
Soars	Alder	Wintering	Sun	Wet
Estuary	Alaska	Calls	Riparian	Night
Dives	Searching	Forest	Refuge	River
High tide	Hunts	Stream	Nearshore	Rainstorm
Beach	Cedar	Fledgling	Call	Watershed
Coyote	Foggy	Frog	Graceful	Camouflage
Rainy	Oysters	Cliff	Mudflats	Rest
Nesting	Probe	Falcon	Eelgrass	Hoots
Migration	Sky	Fishing	Winged	Wading
Wetland	Predator	Beak	Tidal	Raptor
Worms	Gentle	Puget Sound	Behavior	Wild
Petal	Bill	Catch	Honking	Scavenge
Coloration	Flies	Heron	Talons	Fast
Low tide	Nettles	Soil	Winding	Bog
Muck	Roots	Seaweed	Shells	Basalt

Small Noticings

Writing/Poetry Assignment

(From Finding Your Sense of Place Through Observation, Art, Journaling and Poetry Activities, Chehalis Basin Education Consortium)

How often do you stop to just notice some small sensory detail that catches your attention during the day? Paying attention to these things is what gives good writers the concrete details to their writing that come alive for the reader. Here are some examples of "small noticings":

- The silver trail left by a snail crawling along a leaf
- Fire, dancing and crawling along a piece of dry firewood
- Mist slowly lifting off the lake's surface at dawn
- A leaf gliding on top of the water
- Shadows growing longer throughout the day

Keeping your senses open: sight, sound, touch and smell, write 5 "noticings" from your water quality monitoring site. Be ready to share with the class after the field trip!

1.____

2.____

3.____

4.____

5.____

Use this space to draw one of your findings:

Watershed Vocabulary

Biochemical Oxygen Demand (BOD)-The amount of oxygen consumed from biological activity and respiration of microorganisms while feeding on decomposing organic material such as algae and other plants. Also measures the oxygen removed from water during chemical reaction, such as the oxidation of sulfides, ferrous iron, and ammonia, or from biological activity.

Convert- To change (something) into another form, substance, state, or product; transform

Data- Individual facts, statistics, or items of information which are the results of scientific study.

Disintegrates- To become reduced to components, fragments, or particles.

Dissolved Oxygen (D.O.)- The concentration of free (not chemically combined) molecular oxygen (a gas) dissolved in water, usually expressed in milligrams per liter, parts per million, or percent of saturation. Adequate concentrations of dissolved oxygen are necessary for the life of fish and other aquatic organisms and the prevention of offensive odors. DO levels are considered the most important and commonly employed measurement of water quality and indicator of a water body's ability to support desirable aquatic life.

Ecosystem (ecology)- A community of animals, plants, and bacteria, and its interrelated physical and chemical environment. An ecosystem can be as small as a rotting log or a puddle of water, but current management efforts typically focus on larger landscape units, such a mountain range, a river basin, or a watershed.

Estuaries- The place where fresh and salt water meet and mix. Drainage channels adjacent to the sea, frequently mouths of streams, which are subject to the periodic rise and fall of tides. An important ecosystem for anadromous fish as they prepare to enter salt or fresh water.

Eutrophication- The result of a process where water rich in mineral and organic nutrients promotes a proliferation of plant life, especially algae, which overproduce, and die off. The bacteria that decomposes the plant life eventually reduces the dissolved oxygen content, sometimes causing the extinction of other organisms (fish, macroinvertebrates); typically in a lake or pond.

Erosion- The gradual wearing away of land surface materials, especially rocks, sediments, and soils, by the action of water, wind, or a glacier.

Fecal coliform- This is a naturally occurring bacteria present in all warm blooded animals. Bacteria that may indicate the presence of pathogens (disease causing organisms). Related to or composed of feces.

Fertilizer- Any of a large number of natural and synthetic materials, including manure and nitrogen, phosphorus, and potassium compounds, spread on or worked into soil to increase its capacity to support plant growth.

Hazardous- Involving great risk

Increments- Something added or gained

Mg/liter- A measurement of some water quality results. For example 1 mg is equal to a paper clip and a liter is the size of a pop bottle. So, a thousandth of a paper clip in a pop bottle is essentially 1mg/liter.

Monitoring site- The place where you sample and test water quality.

Nitrates- A plant nutrient that can cause eutrophication. Sewage and fertilizers are two examples of sources added by human activities.

Non-point source pollution- The source of human pollution cannot be identified from a specific outfall or pipe. Example: fertilizer runoff, pet waste.

Nutrient- Any substance that can be used by a plant or animal to give energy and build tissue. Excess nutrients can be associated with non-point pollution sources such as synthetic fertilizers and failing septic systems.

Organism- A form of life considered as an entity; an animal, plant, fungus, protistan, or moneran.

Particles- A small quantity of solid or liquid matter

pH- The measurement of the acidity or alkalinity of a substance on a scale of 1-14 with 7 being neutral. Generally referred to as hydrogen ion concentration of hydroxide ions when it is dissolved in water. Mathematically it is defined as the negative of the logarithm of the hydrogen ion concentration.

Point source pollution- The source of human pollution can be identified from a specific place. Example: water pollution from an oil refinery wastewater discharge outlet, or air pollution from a power plant flue gas stack.

Reagent- A compound or mixture added to a system to cause a chemical reaction or test if a reaction occurs.

Sediment- Created from natural process of erosion, where wind, water, frost and ice slowly break down rocks in to finer and finer pieces. Runoff often carries sediment into nearby waterways.

Septic tank- An onsite treatment tank used at homes in which solid organic sewage is decomposed and purified by anaerobic bacteria.

Sewer- An artificial conduit, usually underground, for carrying off waste water and refuse, as in a town or city.

Solution- A homogeneous mixture of one or more substances (solutes) dispersed molecularly in a sufficient quantity of dissolving medium (solvent).

Temperature- A measure of the warmth or coldness of an object or substance with reference to some standard value. Many species live within specific temperature ranges, and many biological processes such as spawning are geared toward annual temperature changes.

Tributary- A stream that flows to a larger stream or other body of water.

Watershed Vocabulary

Turbid- Thick or opaque as if with roiled sediment

Turbidity- The clarity or cloudiness of water due to the presence of suspended and colloidal matter. Technically, turbidity is an optical property of the water based on the amount of light reflected by suspended particles.

Water- A transparent, odorless, tasteless liquid, a compound of hydrogen and oxygen, H_2O, freezing at 32°F or 0°C and boiling at 212°F or 100°C, that in a more or less impure state constitutes rain, oceans, lakes, rivers.

Watershed- The region of land draining into a river, river system or other body of water. Also known as a drainage basin.

6

WQM & NGSS

NEXT GENERATION SCIENCE STANDARDS

Grades 3-5

3-ESS2 Earth and Space Standard Two: Earth's Systems

3-ESS2-1. Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season.
[Clarification Statement: Examples of data could include average temperature, precipitation, and wind direction.] [Assessment Boundary: Assessment of graphical displays is limited to pictographs and bar graphs. Assessment does not include climate change.]
3-ESS2-2. Obtain and combine information to describe climates in different regions of the world.

4-ESS2 Earth and Space Standard Two: Earth's Systems

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
[Clarification Statement: Examples of variables to test could include angle of slope in the downhill movement of water, amount of vegetation, speed of wind, relative rate of deposition, cycles of freezing and thawing of water, cycles of heating and cooling, and volume of water flow.] [Assessment Boundary: Assessment is limited to a single form of weathering or erosion.]
4-ESS2-2. Analyze and interpret data from maps to describe patterns of Earth's features.
[Clarification Statement: Maps can include topographic maps of Earth's land and ocean floor, as well as maps of the locations of mountains, continental boundaries, volcanoes, and earthquakes.]

5-ESS2 Earth and Space Standard Two: Earth's Systems

5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.
[Clarification Statement: Examples could include the influence of the ocean on ecosystems, landform shape, and climate; the influence of the atmosphere on landforms and ecosystems through weather and climate; and the influence of mountain ranges on winds and clouds in the atmosphere. The geosphere, hydrosphere, atmosphere, and biosphere are each a system.] [Assessment Boundary: Assessment is limited to the interactions of two systems at a time.]
5-ESS2-2. Describe and graph the amounts of salt water and fresh water in various reservoirs to provide evidence about the distribution of water on Earth.
[Assessment Boundary: Assessment is limited to oceans, lakes, rivers, glaciers, ground water, and polar ice caps, and does not include the atmosphere.]

5-ESS3 Earth and Space Standard Two: Earth and Human Activity

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

NEXT GENERATION SCIENCE STANDARDS

Grades 6-8

MS-ESS2 Earth and Space Standard Two: Earth's Systems

MS-ESS2-1. Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.
[Clarification Statement: Emphasis is on the processes of melting, crystallization, weathering, deformation, and sedimentation, which act together to form minerals and rocks through the cycling of Earth's materials.] [Assessment Boundary: Assessment does not include the identification and naming of minerals.]
MS-ESS2-2. Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
[Clarification Statement: Emphasis is on how processes change Earth's surface at time and spatial scales that can be large (such as slow plate motions or the uplift of large mountain ranges) or small (such as rapid landslides or microscopic geochemical reactions), and how many geoscience processes (such as earthquakes, volcanoes, and meteor impacts) usually behave gradually but are punctuated by catastrophic events. Examples of geoscience processes include surface weathering and deposition by the movements of water, ice, and wind. Emphasis is on geoscience processes that shape local geographic features, where appropriate.]
MS-ESS2-4. Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.
[Clarification Statement: Emphasis is on the ways water changes its state as it moves through the multiple pathways of the hydrologic cycle. Examples of models can be conceptual or physical.] [Assessment Boundary: A quantitative understanding of the latent heats of vaporization and fusion is not assessed.]

MS-ESS3-1 Earth and Space Standard Two: Earth and Human Activity

MS-ESS3-1. Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.
ESS3.A: Natural Resources
Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.
[Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]