Code 5906

EARTH FORCE®

elementary education

WATERSHED Field Trip

Earth Force is youth for a change! Through Earth Force, youth discover and implement lasting solutions to environmental issues in their community. As a result, youth gain life-long habits of active citizenship and environmental stewardship. Earth Force's innovative tools for educators combine the best of civic engagement, environmental education and service learning.

Learn more about
Earth Force programs
at www.earthforce.org/GMGREEN

WARNING! This set contains chemicals that may be harmful if misused. Read cautions on individual containers carefully. Not to be used by children except under adult supervision.

Table of Contents

Earth Force: Youth for a Change
www.earthforce.org/GMGREEN

Introduction

In this manual you will find everything you will need to take your class on a fascinating field trip through your local watershed. This manual provides:

- ***a brief discussion of what young people can learn from testing the water in your watershed***
- ***an easy to use guide for taking your students on a watershed field trip***
- ***simple guidelines for conducting water quality tests***
- ***data sheets to help your class collect data and understand what they have discovered about their watershed***

Why Watersheds?

Watersheds are a reliable and informative index of the environmental quality of the area. And, water is an essential substance for all human, animal and plant life. What better way is there for young people to understand the environment and the effect that human beings have on nature than through the study of nature's most basic component in its natural state? For young people, water is something they can see, touch and even taste.

Young people are naturally attuned to the study of water and watersheds because it is fun and it relates to a nature that they come into contact with everyday. Young people can see the rain as it falls, watch it run down their streets and have all seen a stream or river in their community. All we need to do is connect all of these elements in a way that they can understand and learn from.

To help young people understand watersheds and their local community, the ***Elementary Education Watershed Field Trip Kit*** has been designed with a special emphasis on human interaction with water resources. By identifying how specific substances are added to water through natural processes and comparing those to the substances that are added by everyday activities, the kit is designed to help young people understand that they live in and have an effect on their local environment.

This kit provides basic information concerning chemical influences to your watershed. For more information, activities, projects, examples, and more, go to the Earth Force website at ***www.earthforce.org***

The Watershed Story

Have you ever stood on the banks of a river and wondered—where did it begin and where is it going? This section is designed to help you explain to your students how a stream begins, adapts and changes as it follows a path. The Watershed Story is an imaginary journey in which you and your students will travel down a river to learn about the water in the river and how a watershed can affect a river. The Watershed Story is an excellent way to explain to young people that there are many substances in water naturally and that people add to those substances through everyday activities.

The Watershed Story illustrates three essential concepts for understanding chemical analysis:

- ***Definition of a Watershed***
- ***Natural Substances in the Water***
- ***How Watersheds Can Affect the Water***

Concept 1: The Definition of a Watershed

The water that flows along a river or stream is like a memory of the land through which it flowed. Land that is abused and polluted is reflected in the quality of the water. The land through which streams flow and gather momentum is called the watershed. A watershed is defined as the land area where all of the water above and below the ground drains to a common channel or body of water.

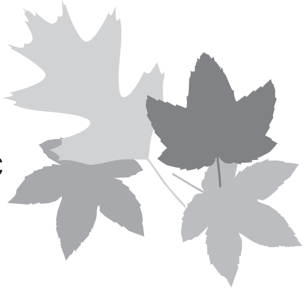
Rivers may begin as headwater streams that flow from hillsides, wetlands, lakes and as meltwater from glaciers and snowpack. Some streams are temporary, and can only be seen during times of rain or snowmelt. Other streams are permanent and are fed by groundwater and by rains and runoff from the land. Headwater streams seek lower ground and join other streams to form larger streams that in turn join others, eventually to form one river channel at its mouth. The network of streams forms a branching system like the arteries in your body or the branching of a tree.

A good way to illustrate the concept of a watershed is to use the "Sum of the Parts" activity included separately in this kit.*

Concept 2: Natural Substances in the Water

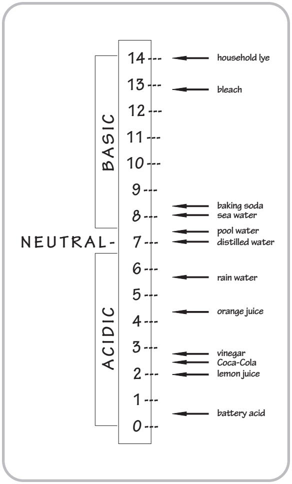
At our watershed's headwaters—trees, shrubs and other plants shade the water and keep the water temperature cool. As the stream moves along, the water falls over small rocks and glides over riffles, adding oxygen to the water.

Leaves, sticks and other plant debris fall into this stream and provide an important energy source for aquatic insects and other invertebrates. In turn, aquatic insects release nitrogen and



phosphorus as they digest the plants and give off waste. The nitrogen and phosphorus are nutrients which, when added in the proper amounts, help aquatic plants grow and prosper.

As the stream flows down river, it moves over rocks - influencing its pH level. pH refers to the acidity of water and is measured on a scale of 0 to 14. If the stream flows and gurgles over gravel and small rocks that rest upon limestone bedrock, this makes the stream more “basic” with a pH of 8. Streams flowing over granite and igneous rocks usually have a neutral or slightly acidic pH of 6-7.

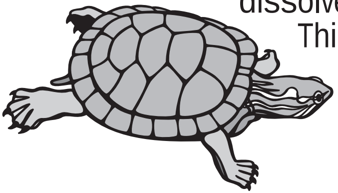


The type of soil in the streambed influences whether sediments will be carried in the stream—causing high turbidity. Turbidity is the murkiness of the water that blocks sunlight from reaching the bottom. At the headwater of our stream are small rocks paving the bottom and so the water has very little suspended sediment (low turbidity). Down river the water is probably turbid because there are areas of clay and fine-grained soils that are easily suspended in the river.

Concept 3: Water changes as it moves through the watershed

How does the dynamic system of a river change as the watershed is developed and as the river channel is physically changed? Watersheds—if they are large enough—may have many kinds of human imprints: farming, recreation, cities, suburbs and industries. Let's continue our imaginary journey down river.

There are many farms along the river in this watershed. One farmer spreads manure on farm fields and with the first rain, the manure washes into the river and with it, concentrated levels of nitrate and phosphate. There is also bank erosion along the shoreline where soil washed away with the rain. The water is murkier (more turbid) here from soil erosion. A small lake near the river looks green from too much algal growth—a sign of eutrophication (see glossary). As this algae and other plants die and decay, small organisms feed upon this decay and demand a lot of oxygen. As a result, dissolved oxygen levels can become very low. This makes life difficult for animals like dragonfly nymphs and turtles.



Farther down the river is a town. If you could look under the streets and buildings of this community, you would see a network of various-sized pipes (sewers) underneath. Some of these storm water pipes discharge directly to the river.

When it rains in this town, the water falls on many impervious (hard) surfaces that do not absorb water. In the summer, storms send rain shooting across hot parking lots and the warmer water follows the storm drains to the river. The storm sewers carry the remains of human activity into the river during rains: excess fertilizer, bacteria from pet wastes, litter, oil and pesticides. The river below town is very turbid, especially when compared to the water up the river. The flow of the river responds quickly during major rains and swells to almost double its volume. In those cases, high bacteria levels, and concentrated nitrate and phosphate are found in the river below this point.

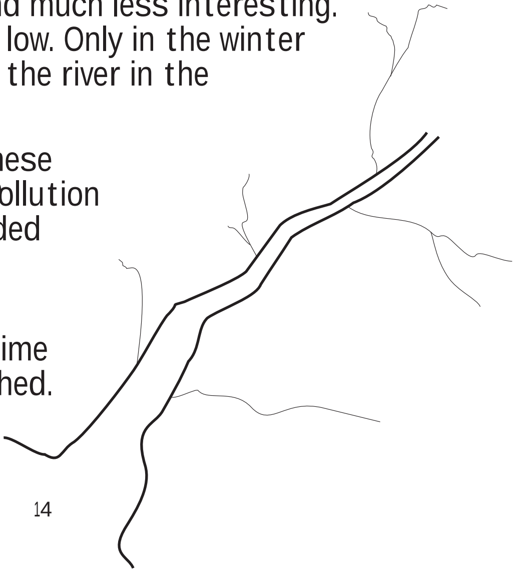
Our watershed has changed from its headwaters to its mouth. In its head-waters, the stream flow was moderated by vegetation and by a steady source of ground-

water. Dissolved oxygen is high and the temperature of the streams does not change much, creating a stable environment for animals. Nutrient levels were tied to natural rhythms and the biological action of the animals living there. Everything was in balance.

Down river our watershed looks and feels different. Here the river flow is erratic and linked to storm sewers. Biologically, the river is less complex and much less interesting. Dissolved oxygen levels are low. Only in the winter can one see the bottom of the river in the shallow water.

A good way to illustrate these concepts is through the “Pollution in my Water” activity included separately in this kit.

Now that we know how a watershed changes—it’s time to study your local watershed.



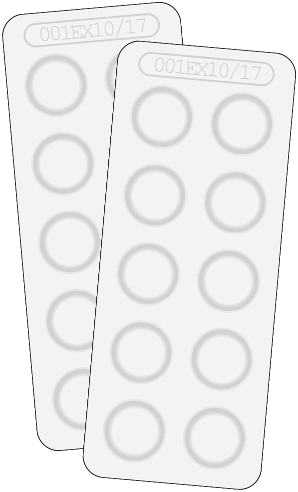
Getting Prepared

To make sure that you are ready to go, we suggest that you find a suitable water monitoring site along a river or stream in your watershed before the day of the field trip.

The students will be testing the water for six parameters: pH, nitrate, phosphate, dissolved oxygen, turbidity and temperature. The students should be broken into groups of two students. By doing this, each student will be able to do some real hands-on testing. Each pair of students will have the reagents and equipment that they need to perform one test for one parameter. You should have at least one pair of students working on each parameter.

We recommend that you divide the materials into a package for each pair of students before arriving at the site. You will need approximately 30 minutes to do this.

Each set of materials should be placed in a package of some type (a plastic bag will work fine) and marked to indicate what the package contains. Once you are on-site, the packages can be distributed to the students and they can begin testing the water.



Your kit includes everything that you need to have 30 students perform the water quality tests. You will need 15 packages for 30 students. The following list outlines the reagents and items necessary for each parameter for a group of 30 students. Groups of different sizes should be divided so that tests are performed for all parameters.

Parameter	# Packages/ # of Students	Items Per Package	
pH	4/8	(1)	Test Tube (0106)
		(1)	pH Wide Range TesTab (6459A)
Nitrate	4/8	(1)	Test Tube (0106)
		(1)	Protective Sleeve (0106-FP)
		(1)	*Nitrate WR TesTab (3703A)
Phosphate	4/8	(1)	Test Tube (0106)
		(1)	Phosphorus TesTab (5422A)
Dissolved Oxygen	4/8	(1)	Small Tube (0125)
		(2)	Dissolved Oxygen Testab (3976A)
Turbidity	1/2	(1)	Kit Container
		(1)	Secchi Disk Icon Sticker
Temperature	1/2	(1)	Set of Two Thermometers

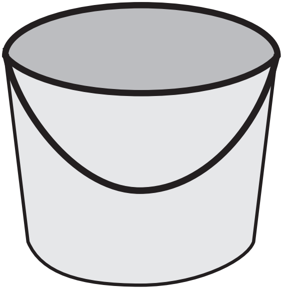
*WARNING: Reagents marked with an * are considered to be potential health hazards. To view or print a Safety Data Sheet (SDS) for these reagents go to www.lamotte.com. Search for the four digit reagent code number listed on the reagent label, in the contents list or in the test procedures. Omit any letter that follows or precedes the four digit code number. For example, if the code is 4450WT-H, search 4450. To obtain a printed copy, contact LaMotte by email, phone or fax. Emergency information for all LaMotte reagents is available from Chem-Tel: (US, 1-800-255-3924) (International, call collect, 813-248-0585).

Field Trip Day

We recommend that you divide your students into pairs and assign tests to each pair prior to leaving school grounds. Keep a list of which students are conducting each test.

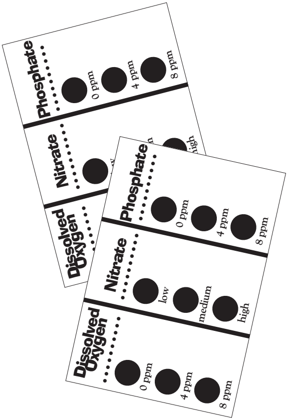
Once you arrive at the site you will want to follow the collection procedures for river site testing. You should not have each pair of students attempting to gather their own water. Instead, collect the water in a large container and use that water for all of the tests.

Once you have a sample you can begin testing. The first test you conduct should always be temperature because the temperature of the water will change the longer it is out of the river. Temperature is an important factor in the dissolved oxygen test that will be conducted later on.



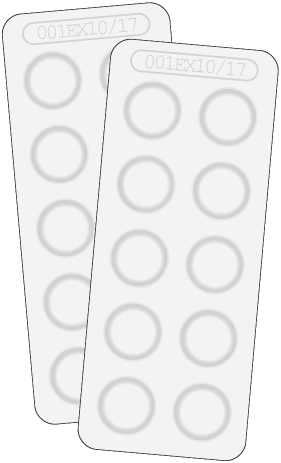
Once everyone has conducted their tests you can start reporting results. Each group of students conducting a specific test (e.g., all students conducting pH tests) will need to compare their results versus the color chart included in the kits. The kit includes five color charts to allow each group to have its own chart (the temperature test does not require a chart).

As your students are reporting their results, someone should be recording the results on the data sheet included in this manual. You may want to copy the data sheet so that all of the students can keep their own record of the test results.



Finally, you can calculate the Water Quality Index (WQI) to determine the overall health of your watershed. Instructions on calculating your WQI are included with the data sheet.

Test Kit Safety



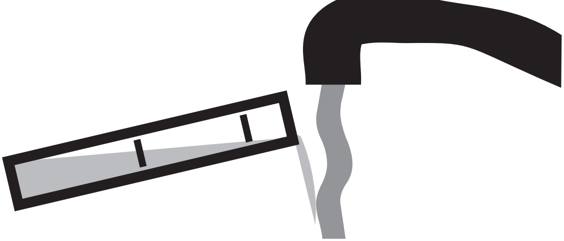
The TesTabs® reagents used in this kit are designed with safety in mind. The single-unit, foil packaged TesTabs are easy to distribute and dispense. Store TesTabs in a safe, cool, dry place and only open the foil when ready to use the tablet. TesTabs should not be ingested. Additional information for all LaMotte reagents is available in the United States, Canada, Puerto Rico, and the US Virgin Islands from Chem-Tel by calling 1-800-255-3924. For other areas, call 813-248-0585 collect to contact Chem-Tel's International access number. Each reagent can be identified by the four digit number on the packaging, in the contents list and in the test procedures.

Safety Note:

Wear eye protection during experiments. Wash hands after performing experiments. Follow all safety rules and guidelines provided by your school or organization regarding laboratory and outdoor activities.

After Testing...

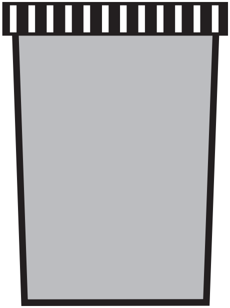
All reacted test samples can be disposed of by flushing down the drain with excess water. While in the field, reacted samples can be poured together into a waste container for later disposal.



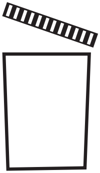
Collection of Water Sample

Collect the water sample in a sterile, wide mouthed jar or container (approximately 1 liter) that has a cap. If possible, boil the sample container and cap for several minutes to sterilize them and avoid touching the inside of the container or the cap with your hands. The container should be filled completely with your water sample and capped to prevent the loss of dissolved gases.

Test each sample as soon as possible or within one hour of collection. When possible, perform the Dissolved Oxygen procedure at the monitoring site immediately after collecting the water sample.

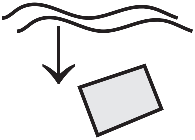


collection procedure

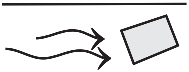


1. Remove the cap of the sampling container.

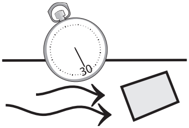
2. Wear protective gloves. Rinse the container 2-3 times with the stream water.



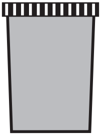
3. Hold the container near the bottom and plunge it (opening downward) below the water surface.



4. Turn the submerged container into the current and away from you.



5. Allow the water to flow into the container for 30 seconds.



6. Cap the full container while it is still submerged. Remove it from the river immediately.

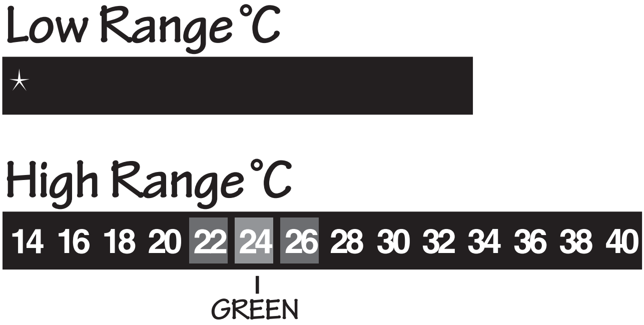
Temperature

Temperature is very important to water quality. Temperature affects the amount of dissolved oxygen in the water, the rate of photosynthesis by aquatic plants, and the sensitivity of organisms to toxic wastes, parasites and disease. Thermal pollution, the discharge of heated water from industrial operations, for example, can cause temperature changes that threaten the balance of aquatic systems.

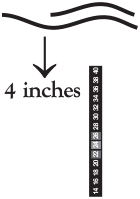
Use Of The Thermometer

The two thermometers have an adhesive back. Adhere them to the kit container or another object to make grasping them easier.

The temperature is indicated by a liquid crystal number on the Low Range thermometer and a green display on the High Range thermometer.

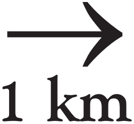


Temperature Procedure



1. Wear protective gloves. At each site, place the thermometer four inches below the water surface for one minute.

2. Remove the thermometer from the water, read the temperature and record the temperature as degrees Celsius.



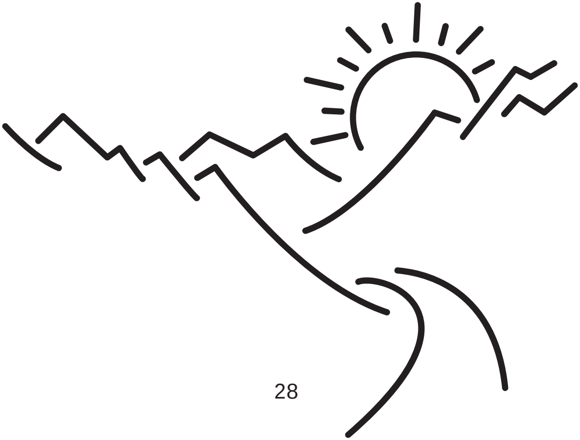
3. Repeat the test approximately 1 km upstream as soon as possible.

4. The difference between the temperature upstream and the temperature at the sampling site is the change in temperature.

pH

pH is a measurement of the acidic or basic quality of water. The pH scale ranges from a value of 0 (very acidic) to 14 (very basic), with 7 being neutral. The pH of natural water is usually between 6.5 and 8.2. Most aquatic organisms are adapted to a specific pH level and may die if the pH of the water changes even slightly.

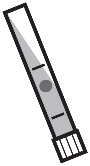
pH can be affected by industrial waste, agricultural runoff or drainage from improperly run mining operations.



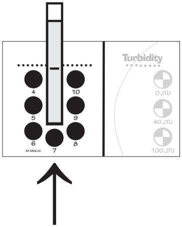
pH Procedure

1. Fill the test tube (0106) to the 10 mL line with the water sample.

2. Add one pH Wide Range TesTab (6459A).



3. Cap and mix by inverting until the tablet has disintegrated. Bits of material may remain in the sample.

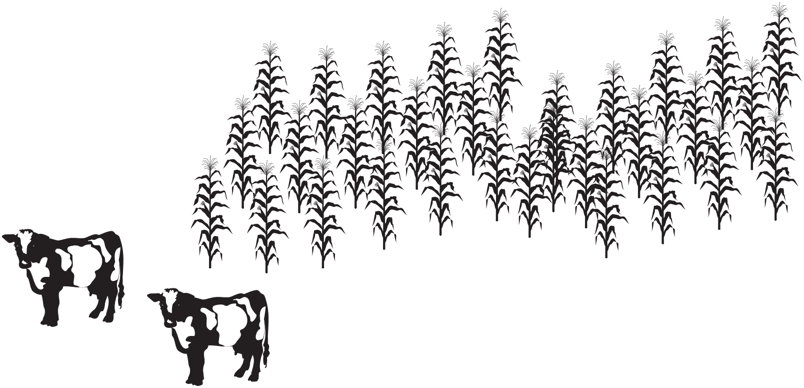


4. Compare the color of the sample to the pH color chart. Record the result as pH.

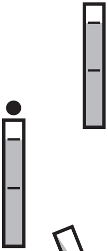
Phosphate

Phosphate is a nutrient needed for plant and animal growth and is also a fundamental element in metabolic reactions. High levels of this nutrient can lead to overgrowth of plants, increased bacterial activity, and decreased dissolved oxygen levels.

Phosphate comes from several sources including human and animal waste, industrial pollution and agricultural runoff.

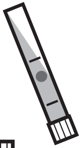


Phosphate Procedure



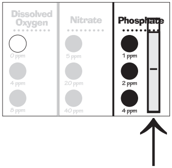
1. Fill the test tube (0106) to the 10 mL line with the water sample.

2. Add one Phosphorus TesTab (5422A).



3. Cap and mix by inverting until the tablet has disintegrated. Bits of material may remain in the sample.

4. Wait 5 minutes for the blue color to develop.



5. Compare the color of the sample to the Phosphate color chart. Record the result as ppm Phosphate.

Nitrate

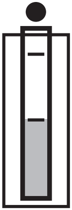
Nitrate is a nutrient needed by all aquatic plants and animals to build protein. The decomposition of dead plants and animals and the excretions of living animals release nitrate into the aquatic system. Excess nutrients like nitrate increase plant growth and decay, promote bacterial decomposition, and therefore, decrease the amount of oxygen available in the water.

Sewage is the main source of excess nitrate added to natural waters, while fertilizer and agricultural runoff also contribute to high levels of nitrate.

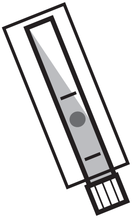
Drinking water containing high nitrate levels can affect the ability of our blood to carry oxygen. This is especially true for infants who drink formula made with water containing high levels of nitrate. ***You should always have a professional lab test your drinking water for the presence of nitrate.***

Nitrate Procedure

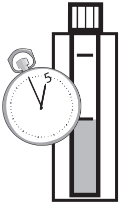
1. Fill the test tube (0106) to the 5 mL line with the water sample.



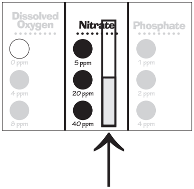
2. Add one *Nitrate Wide Range CTA TesTab (3703A). Immediately slide the test tube into the Protective Sleeve (0106-FP).



3. Cap tube and mix for two minutes to disintegrate the tablet. Bits of material may remain in the sample.



4. Wait 5 minutes for the red color to develop. Remove the tube from the Protective Sleeve.



5. Compare the color of the sample to the Nitrate color chart. Record the result as ppm Nitrate.

NOTE: Nitrate Wide Range CTA TesTabs (3703A) are sensitive to UV light. The Protective Sleeve (0106-FP) will protect the reaction from UV light. If testing indoors, there is no need to use the Protective Sleeve in this procedure.

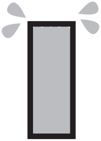
Dissolved Oxygen

Dissolved Oxygen (DO) is important to the health of aquatic ecosystems. All aquatic animals need oxygen to survive. Natural waters with consistently high dissolved oxygen levels are most likely healthy and stable environments, and are capable of supporting a diversity of aquatic organisms. Natural and human-induced changes to the aquatic environment can affect the availability of dissolved oxygen.

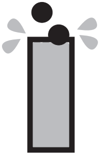
Dissolved Oxygen Percent Saturation is an important measurement of water quality. Cold water can hold more dissolved oxygen than warm water. For example, water at 28°C will be 100% saturated with 8 ppm dissolved oxygen. However, water at 8°C can hold up to 12 ppm of oxygen before it is 100% saturated. High levels of bacteria from sewage pollution or large amounts of rotting plants can cause the percent of saturation to decrease. This can cause large fluctuations in dissolved oxygen levels throughout the day, which can affect the ability of plants and animals to thrive.

Dissolved Oxygen Procedure

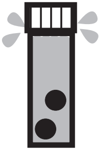
1. Record the temperature of the water sample (see page 25).



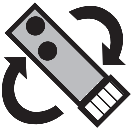
2. Submerge the small tube (0125) into the water sample. Carefully remove the tube from the water sample, keeping the tube full to the top.



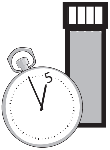
3. Drop two Dissolved Oxygen TesTabs (3976A) into the tube. Water will overflow when tablets are added.



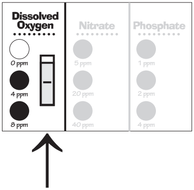
4. Screw the cap on the tube. More water will overflow as the cap is tightened. Make sure no air bubbles are present in the sample.



5. Mix by inverting the tube over and over until the tablets have disintegrated. This will take about 4 minutes.



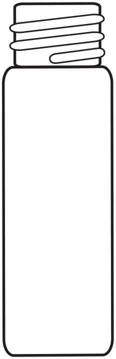
6. Wait 5 more minutes for the color to develop.



7. Compare the color of the sample to the Dissolved Oxygen color chart. Record the result as ppm Dissolved Oxygen.

Percent Saturation**

Temp°C	0 ppm	4 ppm	8 ppm
2	0	29	58
4	0	31	61
6	0	32	64
8	0	34	68
10	0	35	71
12	0	37	74
14	0	39	78
16	0	41	81
18	0	42	84
20	0	44	88
22	0	46	92
24	0	48	95
26	0	49	99
28	0	51	102
30	0	53	106



0125 vial
Actual size

**Calculations based on solubility of oxygen in water at sea level, from Standard Methods for the Examination of Water & Wastewater, 18th edition.

Locate the temperature of the water sample on the Percent Saturation chart. Locate the Dissolved Oxygen result of the water sample at the top of the chart. The Percent Saturation of the water sample is where the temperature row and the Dissolved Oxygen column intersect.

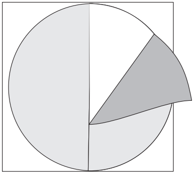
For example: if the water sample temperature is 16°C and the Dissolved Oxygen result is 4, then the Percent Saturation is 41.

Turbidity

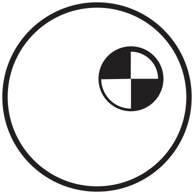
Turbidity is the measure of the relative clarity of water. Turbid water is caused by suspended and colloidal matter such as clay, silt, organic and inorganic matter, and microscopic organisms. Turbidity should not be confused with color, since darkly colored water can still be clear and not turbid. Turbid water may be the result of soil erosion, urban runoff, algal blooms, and bottom sediment disturbances which can be caused by boat traffic and abundant bottom feeders.

Turbidity Procedure

The water testing kit container is used to perform the Turbidity test.

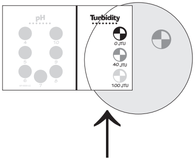


1. Remove the backing from the secchi disk icon sticker.



2. Adhere sticker on the inside bottom of the large white jar (kit container). Position the sticker slightly off center.

3. Fill the jar to the turbidity fill line located on the outside kit label.



4. Hold the Turbidity Chart on the top edge of the jar. Looking down into the jar, compare the appearance of the disk icon in the jar to the chart. Record the result as Turbidity in JTU.

A Jackson Turbidity Unit (JTU) is a unit of measure based on the amount of light from a candle that passes through a turbid sample.

Data Sheet

Make a copies of this Data Sheet for students

Test Factor:	Result:	Rank:	Score (from ranking)
Temperature Change	0 - 2°C	4 (excellent)	
	3 - 5°C	3 (good)	
	6 - 10°C	2 (fair)	
	>10°C	1 (poor)	
pH	4	1 (poor)	
	5	1 (poor)	
	6	3 (good)	
	7	4 (excellent)	
	8	3 (good)	
	9	1 (poor)	
	10	1 (poor)	
Phosphate	1 ppm	4 (excellent)	
	2 ppm	3 (good)	
	4 ppm	2 (fair)	

Test Factor:	Result:	Rank:	Score (from ranking)
Nitrate	<5 ppm	3 (good)	
	5 ppm	2 (fair)	
	20 ppm	1 (poor)	
	40 ppm	1 (poor)	
Dissolved Oxygen Saturation	91-110%	4 (excellent)	
	71-90%	3 (good)	
	51-70%	2 (fair)	
	<50%	1 (poor)	
Turbidity	0 JTU	4 (excellent)	
	Between 0 to 40 JTU	3 (good)	
	Between 40 to 100 JTU	2 (fair)	
	>100 JTU	1 (poor)	

Use the ranked results to track water quality trends over long periods of time, to compare the water quality at different sites along the river, and to investigate how land use affects water quality.

Glossary

Dissolved oxygen (D.O.)	the amount of oxygen dissolved in water.
Eutrophication	the enrichment of water with nutrients, usually phosphorous and nitrogen, which stimulates the growth of algal blooms and rooted aquatic vegetation.
Fecal coliform	bacteria that are found in excrement or sewage contamination, occurring naturally in the digestive tract of human beings and animals to aid in the digestion of food.
Impounded	a body of water that is confined, as if in a reservoir.
Metabolic	the chemical process in living cells by which energy is provided for vital processes and activities.
Nitrate	one form of nitrogen that plants can take up through their roots and use for growth.

Nonpoint source pollution	pollution whose sources cannot be traced to a single point and reach water bodies in runoff.
Organic	a living plant or animal containing carbon compounds.
pH	a measure of the acidity or alkalinity of a solution.
Pathogens	a biological agent (such as a bacterium or virus) that can cause a disease.
Phosphate	an important nutrient for plants to grow and for the metabolic reactions of plants and animals.
Photosynthesis	a process by which chlorophyll-containing cells in green plants convert incident light to chemical energy and synthesize organic compounds from inorganic compounds.

Phytoplankton	microscopic, photosynthetic floating aquatic plants.
Point source pollution	pollution that has discrete discharges, usually from a pipe or outfall.
Turbidity	a measure of the clarity of water.
Watershed	the catchment basin or drainage area (both below and above ground) of an entire river system.

SUM OF THE PARTS, from the Project WET (Water Education for Teachers) Curriculum and Activity Guide is used with the permission from The Watercourse/Montana State University and the Council for Environmental Education (CEE).

For further information about Project WET, contact the national office at: (866) 337-5486 or fax (406) 522-0394.

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