Lesson 1 Part A Introduction -The Saga of Fred the Fish

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Grade Level: 5-8
Lesson Time: Two 45-minute sessions, one 90-minute session.
Suggested Class Structure: Collaborative group work, whole class presentations
Subject Areas: Science, Social Studies, Language Arts

BACKGROUND

Without water, life would be impossible. We use it in many ways--for drinking, bathing, recreation, farming, and manufacturing. We depend on a continuous supply of clean water, yet each time we use it we change it- sometimes by polluting it.

Pollution can be described as substances that are harmful to life. There are a variety of pollutants to be found in freshwater, but here some are classified into commonly seen freshwater problems.

Organic Waste
Sewage or animal waste can come from septic tanks or livestock run-off. Manure contains bacteria and other pathogens, or disease causing organisms, which can be detrimental to aquatic life. There may be chemicals associated with the waste or just the build-up of sediment as it settles out of the water solution to the bottom of a body of water. The end result is a lowering of the oxygen in the water due to the growth of bacteria or algae and a build-up of sediment, which covers organisms and decreases water quality.

Sedimentation
Following a storm, one can observe that streams and rivers will have a brown or reddish color. The coloring of the water is the result of the soil, which is suspended in the water from erosion. Construction sites and agricultural field, any area with low or limited plant growth, are places where water can easily pick up and carry soil into waterways forming pollution. The soil particles that are in the water can cause breathing problems for aquatic organisms due to the blocking of gills and other respiratory structures over a prolonged period. The soils will typically be dropped out of the solution once the water velocity slows, which leads to a covering of the bottom and organisms with find silt, thus killing clams.

Chemical Compounds
Chemical compounds are all around us and provide many useful services. Chemical fertilizers, for example are used for the production of crops and growth of lawns. The excess of N, P and K (nitrogen, phosphorus and potassium), which are not taken in and used by the plants, can erode or leach into the water. Leaching is when elements on the surface are dissolved into water and carried into the ground. They can end up in the groundwater or in ponds and streams.

High levels of NPK in the water can lead to the problem of eutrophication, a situation where excessive algae grows in the body of water. The algae grows on the surface of the water and kills the bottom dwelling plants underneath it, due to a reduced amount of sunlight getting through. The lower number of plants present in the aquatic community lowers the dissolved oxygen level and reduces food available for the food web.

Decomposers that feed on all this dead material further deplete the oxygen. The decaying organic matter builds up on the lake or stream bottom.

Pesticides or Toxic Chemicals

Pesticides are used in farming and to control pests in urban and suburban areas, both indoors and out. Organisms are killed to prevent crop damage, protect food stores, make landscapes more visually appealing, and prevent the spread of disease.

Unfortunately, with the use of most types of pesticides, both the beneficial organisms and the harmful organisms are killed. The pesticides also run off into streams and high levels can kill aquatic organisms. Some pesticides do not break down as part of the natural decomposition process, and can build up in the food web and become concentrated in the tissues of predators.

Some long life pesticides were phased out in the United States due to the harmful effects of bioaccumulation—when toxins build up in body tissues over time. There are still many toxic and persistent chemicals around today, but attempts are being made to strictly regulate how and when people use them. Less toxic alternatives are being sought.

Some pesticides have a limited time span of activity, and become inactive shortly after application. A short-lived pesticide is less likely to build up in the food web and cause permanent damage to a community. But even short-lived pesticides can kill aquatic organisms if they end up in the water in large amounts soon after they have been applied.

GOAL

Students will explore the ways in which water becomes polluted and become familiar with ways in which people attempt to monitor and assess water quality with regards to the presence of major pollutants.

VOCABULARY

Organic – (organic matter)- Chemical compounds of carbon combined with other chemical elements. These compounds are created by the life-processes of plants and animals.

Pathogens – a specific cause of disease, such as a bacterium or virus

Pesticide – any chemical preparation used to control populations of pest organisms.

Respiratory – (Respiration) -- the chemical process which takes place in the cells of plants and animals in which carbohydrates are broken down and energy is released which can be used by the cells to do work. The most common form of respiration involves the use of oxygen and the release of the waste products carbon dioxide and water.

Sediment – loose material such as sand and mud that can be taken up and suspended in water. Sediment often settles on the bottom of a body of water as the water's movement slows down.

Septic tanks – a tank in which bacteria disintegrate the solid matter of sewage.

Solution – a mixture, usually liquid, in which one or more substances are distributed throughout the liquid in the form of separate molecules or ions. Once suspended in solution, substances cannot easily settle out. A solution may appear transparent or it may be colored.

Velocity – quickness of motion, rate of occurrence or action.

MATERIALS

--- Script pages for each group
--- Pair of scissors
--- 9 large index cards for each group
--- Glue stick or some tape
--- Light-colored sponge
--- A yarn needle
--- Small weights (metal nut)
--- String
--- Wide-mouthed jar or large beaker for each group
--- Cold tap water
--- Pencil for each group
--- 5 small paper cups or baby food jars for each group
--- Soil
--- Brown sugar ("fertilizer")
--- Pancake syrup or molasses ("oil")
--- Salt
--- Punched paper dots ("litter")
--- A medium beaker or glass jar
--- Detergent
--- Warm tap water
--- Red food coloring ("sewage")
--- Green food coloring ("toxic waste")
--- Water chemistry sampling kits, (available for loan from Muhlenberg College.)
--- Copies of water chemistry protocols

ADVANCE PREPARATION

- ✓ Copy and cut apart the ten roles from the script titled "The Saga of Fred" in the Lesson Copy Master section, found on pages 7-9. Attach them to large index cards with tape or glue. Make a set for each cooperative group.
- ✓ Cut a fish shape out of the sponge. Use the yarn needle to thread a string through the bottom of the fish, and then attach the weight so that it hangs below the fish.
- ✓ Fill the large glass jar or beaker two-thirds full with cold tap water. Thread another string through the top of the fish, and suspend it in the water by tying it to a pencil positioned across the mouth of the jar. Adjust the length of the string until the fish is suspended midway in the jar of water (see figure 1). Make a fish setup for each group.
- ✓ Number a set of paper cups or baby food jars 1 through 5, then place soil in cup 1, brown sugar ("fertilizer") in cup 2, pancake syrup ("oil") in cup 3, salt in cup 4, and paper dots ("litter") in cup 5. Pour detergent and warm water into the medium-sized jar, and set out red and green food coloring ("sewage" and "toxic waste").
- ✓ Make copies of hydrology investigation protocols, one for each station.
- ✓ Get water sampling kits from Muhlenberg or order for your class from LaMotte.
- ✓ Set up water quality investigation stations with directions, kit, and water samples.

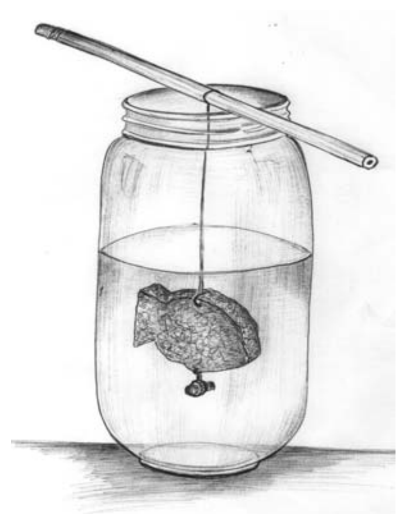


Figure 1 – Fred the Fish

PROCEDURES – Outline and Narrative

Prior to the lesson, divide the class up into two or three cooperative working groups of no more than 10 students. Show the class where all the materials are set up.

Part 1 – *The Saga of Fred* – 30 min.

a) Introduce Fred the Fish to the class. Tell them that he has grown up in a protected stream in a nature preserve, but he is about to leave the preserve and journey down-stream. The class has been invited to share in his adventure.

b) Distribute the script cards, cups filled with "pollution," food coloring, jar of sudsy water, etc. to each group.

c) The students are going to read the adventure of Fred the Fish as a group. The script of the story is numbered from one to nine. As each student reads his or her script card, they should dump the appropriate ingredients into Fred's jar on cue.

d) Every student should write down a different descriptive adjective each time they are asked the question, "Describe Fred's condition?"

Fifth grade students at Ironton Elementary School, Parkland School District, Lehigh County, PA

e) After all the ingredients have been dumped in, lift Fred out of the jar, and discuss the change in his appearance and that of the water. (Someone will probably remark that Fred looks dead).

f) After they have completed the activity, here are some possible discussion questions for the class:
   i) What would happen if a turtle ate Fred after Fred had gone on his adventure downstream?
   ii) If Fred the fish traveled to a clean river after going on his adventure, would he be become completely healthy again?
   iii) Why do you think people put harmful substances in places where they will get washed into the water as runoff?
   iv) Why do you think people might break the law and dump waste or toxic substances into the water, rather than disposing of them properly?
   v) What else can pollution do to a healthy river, besides harming fish and other organisms?
   vi) What are some other types of pollution?

Note: Material for this part of the lesson was adapted with permission from the Kalamazoo Soil Conservation District. Kalamazoo, MI. The original activity, developed by Patricia Chilton and Jan Wolanin, was titled ***A Fish Story*.**

2) *Help for Fred* – 60 min.

a) Have the class brainstorm a list of the pollutants Fred encountered on his trip down the stream.

Fred encountered the following pollutants:

- Acid rain from burning coal
- Soil runoff from erosion
- Fertilizer from fields and lawns
- Oil leaking from cars and being washed into the river
- Salt from treating roads to prevent ice from forming on them.
- Trash and litter
- Pollution from factories
- Sewage from a wastewater treatment plant
- Toxic waste from pesticides, industrial cleaners and paint

b) Brainstorm how concerned citizens could detect these pollutants in the water--what chemical or physical property of water could be measured to detect the presence of these pollutants in the water? Would the presence and behavior of the aquatic life tell us anything?

One idea is doing a **visual inspection** of the stream area and looking for discharge pipes or oil slicks forming on the water. The color and clarity of the water is another visual observation that might indicate problems with sedimentation or other chemicals in the water. The presence of dead fish in large numbers or the absence of any observable animal or plant life might indicate a toxic environment.

Sometimes the **smell** of a body of water can indicate the presence toxins or other pollution problems. The odor of sulfur indicates anaerobic decomposition—bacteria that can break down dead material without needing lots of oxygen give off sulfuric gases as a byproduct of their life processes, hence the stinky smell of water with low levels of dissolved oxygen.

It is probably not a good idea to **TASTE** water to determine its quality. Many diseases, such as cholera, can be traced to people drinking contaminated water.

Some students with pools or aquariums may be familiar with and bring up the idea of **chemical tests**.

c) Tell the students that you are going to show them how to scientifically measure the presence and level of the contaminants that led to Fred's demise. The water quality parameters they will be investigating at Graver arboretum allow them to determine the health of the ecosystem. They are as follows:

pH and Alkalinity – these tests tell how acid the water is, and if it is able to buffer the effects of acid rain.

Turbidity – this test indicates the level of material suspended in the water that make it cloudy. Turbidity tube and Secchi disk.

Excess nutrients, (fertilizer) – although there are many nutrients that make their way into the water, one of the most troublesome is nitrogen, for which we will be testing.

Salt and other ions – It is hard to test for "salt" in the water, since there are many types of salts that could be present. Instead, we will test indirectly for the effects of salt in the water by testing for conductivity. Conductivity indicates the presence of ions in the water.

Ions could be caused by the breakup of salt molecules, or the presence of metal compounds in the water, such as iron and magnesium.

Sewage – There are many ways sewage can affect water quality—there can be harmful bacteria in the sewage, and it can add excessive nutrients into the ecosystem causing an explosion of plant growth and a subsequent explosion of decay using up all the oxygen.

One indicator of sewage getting into the in water is the presence of e. coli bacteria in large numbers. E. coli can be detected by culturing a water sample in a petri dish with some type of medium in the dish that will support the growth of the bacteria. It takes at least a day for the bacteria to show up in measurable amounts if it is indeed present.

For the short term of our visit to Graver, we will be testing for dissolved oxygen, which can indicate whether or not there is an excessive growth of organisms in the water using up all the oxygen.

Since the temperature of the water directly affects how much oxygen the water can hold, we will also take the temperature of the water.

d) Next, students proceed to Part B of this lesson where they will practice using the water testing equipment.

Optional Extensions – *Fred's Saga Continued or "Fred Returns from the Dead!"* – 45-60 min.

- So far, things are looking grim for Fred the fish and the waterways on which he depends. In this part of the lesson, students will explore how people can clean up and preserve good water quality so that Fred's story will have a happy ending.

  Draw pictures in groups depicting what Fred is experiencing at each stage, with each student contributing a panel of the storyboard.

  Decide how the story could have a happier ending and add panels depicting the way in which people contributed to helping Fred survive.

- Utilize a water survey and come up with a picture of how the class uses water.

- Come up with a publicity campaign for individual actions your class can take to reduce nonpoint source pollution in your neighborhood.

- Come up with an action plan for something your class could do in the community to reduce water pollution.

Lesson 1 Part B – Testing Procedures

MATERIALS

---7 jugs of distilled water
---sunglasses
---7 small waste jars and one large
---waste container
---7 rolls of paper towels
---Optional towelettes for cleaning hands
---Container of sand
---Container of potting soil
---Green food coloring
---Optional Secchi disk (for demonstration only)
---Optional e-coli paddle (for demonstration only)
---Jason turbidity tube
---Turbidity meter
---Farenheit and Celsius thermometers
---Unbreakable beakers
---DO test kit
---DO probe
---pH test kit
---pH paper
---pH probe
---vinegar
---antacid
---shampoo (2 kinds)
---household cleaner
---aquarium salt
---Conductivity meter
---Alkalinity test kit
---Alkalinity probe
---Fertilizer
---Nitrate test kit
---Nitrate probe
---Calcium probe
---Five small nalgene waste containers, one for each station, clearly labeled "Waste"
---One large nalgene waste container for the entire class
---Optional hot plate
---Optional beaker
---Three smaller dispensing bottles for distilled water
---Five dispensing bottles for tap water

ADVANCE PREPARATION

Gather the probes and test kits, and various solutions to be tested. Set up the classroom so that there is a circuit of five stations with room to maneuver between them. Set up the stations as follows:

Station 1: DO and temperature: DO test kit, DO probe, Farenheit and Celsius thermometers, instructions and data sheets, waste container, optional hot plate and beaker

Station 2: pH: pH paper, pH probe, pH test kit, instructions and data sheets, waste container, bottles of vinegar, shampoo, household cleaner and peptol bismol

Station 3: Nitrate nitrogen: nitrate test kit, nitrate probe, instructions and data sheets, waste container, bottle of liquid fertilizer

Station 4: Conductivity and turbidity: jug of distilled water, conductivity meter, 2 sample beakers, Jason turbidity tube, jar of soil, jar of sand, jar of salt and bottle of distilled water, sunglasses, green food coloring, instructions and data sheets

Station 5: Alkalinity and calcium: alkalinity test kit, calcium probe, instructions and data sheets, waste container, antacid and bottle of distilled water

PROCEDURES

a) Divide the class into five cooperative learning groups. It may be helpful to assign a task master who is responsible for seeing that all instructions are correctly followed, two materials managers for each group, who are responsible for cleanup, a group communicator who is responsible for directing group questions to the instructor, and a group recorder who is responsible for making sure the results are accurately reported.

b) Assign each group to one of the stations. They are to read the instructions that go with each station, follow the testing procedures, and record their results. Student groups will have 15 minutes at each station, so they must stay on task and immediately begin the procedures for each station.

c) After approximately 13 minutes, give the signal to finish and clean up. At the end of 15 minutes, give a signal for groups to rotate to the next station. Groups may not be able to finish all the testing procedures at each station.

d) At the end of the lesson, debrief with the following questions;
   i) Did all groups achieve the same test results for each station?
   ii) What factors might cause variations in results for different groups?
   iii) What techniques can be used to minimize errors?
   iv) Were some tests more difficult than others?
   v) What were some examples of effective behaviors by student members that contributed to the smooth running of a group?
   vi) What additional information needs or questions came up during the practice session?

e) After debriefing, make sure all materials are cleaned up and returned to their proper storage areas. The data sheets may be saved and displayed on a class bulletin board or poster.

ASSESSMENT

The assessment for this lesson includes a water quality crossword puzzle and a water quality quiz which can be found in the Lesson 1 Appendix.

RESOURCES

LaMotte Test Kits, LaMotte Company, P.O. Box 329, Chesterton, MD 21620, [**http://www.lamotte.com**]

Flyers

ALLARM, The ALLiance for Aquatic Resource Monitoring – ***Nonpoint Source Pollution, How is it affecting our water? What can you do to help?*** For copies, call or write the Dickinson College Environmental Studies Department, P.O. Box 1773, Carlisle, PA 17013, (717) 245-1565, [**www.dickinson.edu/alarm**]

Deleware River Basin Commission, ***Snapshot: A Report Card on the Health of the Delaware River Basin Waterways***, contains a section on “Measuring water quality, The Key Components.” For copies, call or write to the public information officer at P.O. Box 7360, 25 State Police Drive, West Trenton, NJ 08628, (609) 883-9522, [**www.state.nj.us/drbc/public.htm**]

Books for the teacher:

Lind, K. 1991. *Water, Stone, & Fossil Bones.* Washington, D.C.: National Science Teacher's Association.

The Watercourse and Council for Environmental Education (CEE). 1995. *Project WET.* Bozeman, Montana: The Watercourse and Council for Environmental Education (CEE). Web sites**:** Since the Web is constantly changing, check Muhlenberg's Outreach Web site for updated listings. [**http://www.muhlenberg.edu/cultural/graver/**]

Books for the students:

Cherry, Lynne. 2002. *A River Ran Wild: An Environmental History.* New York: Harcourt Trade Publishers.

Cole, Joanna. 1988. *The Magic School Bus: At the Waterworks.* New York: Scholastic, Inc.

Web sites for the teacher:

Northern Virginia Regional Commission – ***Nonpoint Source Pollution Prevention Brochure***
[**http://www.novaregion.org/fourmilerun**] Colorfully illustrated brochure by the planning commission for the Arlington area. You can download a copy of the brochure or write to them to receive a free copy.

U.S. EPA - ***Index of Watershed Indicators***
[**http://www.epa.gov/iwi/**]
This is a compilation of national aquatic health information and resources.

U.S. EPA, Office of Water – ***Classroom Activities and Experiments –***
[**http://www.epa.gov/OGWDW/kids/exper.html**] Includes a PDF version of a water curriculum called the "Water Sourcebook" as well as other lessons on water quality.

Web sites for the students

U.S. EPA Office of Water – *What's Up With Our Nation's Waters?*
[**http://www.epa.gov/owow/monitoring/nationswaters/**] This is a Web site clearinghouse for students with information about water quality. It includes How is the quality of our waters determined? What is the quality of our waters? The three big pollutants, Where are these pollutants coming from? What are wetlands? What is ground water? What can I do? Science Projects, Want to know more? Test your water smarts, Home Survey and A glossary that defines some common terms. You can also order a booklet by the same name from the EPA by calling 1-800-490-9198.

U.S. EPA Office of Water –***Nonpoint Source Pollution Home Page*** **–**
[**http://www.epa.gov/owow/nps/**] This page has an index to other EPA links including laws, government agencies, teachers and kids pages, background information, fact sheets and other publications, what you can do to help, and other topics related to nonpoint source pollution such as wetlands and watersheds.

USGS – *Water Science for Schools* -
[**http://ga.water.usgs.gov/edu/waterquality.html**]
This Web site covers many topics involving water quality including chemical and physical properties, pollution, kid's views, urbanization and water quality, groundwater

quality, water science, special topics like acid rain, water shortages, and much more!

Center for Global Environmental Education – ***Watershed Action Background Information*** **-** [**http://cgee.hamline.edu/watershed/action/background/fact_sheets.htm**] Various fact sheets on different kinds of water pollution.

Building Environmental Education Solutions (BEES) – *Water Quality* - [**http://www.beesinc.org/resource/currenha/watqual.htm**] This Web site discusses various aspects of watersheds, water quality, and provides an activity.

PA Academic Standards for Environment and Ecology Covered by the Lesson:

4.1.7 Watersheds and Wetlands

A. Explain the role of the water cycle within a watershed.

B. Understand the role of the watershed.
- Explain how water enters a watershed.
- Explain factors that affect water quality and flow through a watershed.

C. Explain the effects of water on the life of organisms in a watershed.
- Explain how the physical components of aquatic systems influence the organisms that live there in terms of size, shape and physical adaptations.

E. Describe the impact of watersheds and wetlands on people.
- Explain the impact of watersheds and wetlands in flood control, wildlife habitats and pollution abatement.

4.3.7 Environmental Health

A. Identify environmental health issues.
- Identify various examples of long-term pollution and explain their effects on environmental health.
- Identify diseases that have been associated with poor environmental quality.
- Describe different types of pest controls and their effects on the environment.
- Identify alternative products that can be used in life to reduce pollution.

B Describe how human actions affect the health of the environment.
- Identify land use practices and their relation to environmental health.
- Explain how natural disasters affect environmental health.
- Identify residential and industrial sources of pollution and their effects on environmental health.
- Explain the difference between point and nonpoint source pollution.
- Explain how nonpoint source pollution can affect the water supply and air quality.

4.6.7 Ecosystems and their Interactions

A. Explain how ecosystems change over time.
- Explain change in an ecosystem that relates to humans.

4.7.7 Threatened, Endangered and Extinct Species

A. Explain natural or human actions in relation to the loss of species.
- Identify natural or human impacts that cause habitat loss.

4.8.7 Humans and the Environment

A. Describe how the development of civilization relates to the environment.

- Explain how people use natural resources in their environment.

D. Explain how human activities may affect local, regional and national environments.
   - Describe what effect consumption and related generation of wastes have on the environment.
   - Explain how a particular human activity has changed the local area over the years.

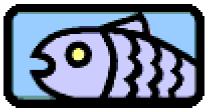
E. Explain the importance of maintaining the natural resources at the local, state and national levels.
   - Explain how human activities and natural events have affected ecosystems.
   - Explain how conservation practices have influenced ecosystems.

Lesson 1 Appendix

Copy Masters for:

The Saga of Fred the Fish
Hydrology Investigation Protocols
Water Quality Crossword
Water Quality Quiz

1. Imagine a clean river as it meanders through a protected wilderness area. In this river lives Fred the Fish. **DESCRIBE FRED'S CONDITION.** Fred has lived in this stretch of the river all his life. But now he is going on an adventure and travel downstream.



2. Fred swims into an area downstream of a coal burning factory, which is releasing nitrous and sulfuric acid into the air and causing acid rain. There is a storm and a heavy downpour fills the stream with acid rain. ***(Dump some acid in Fred's jar)***
DESCRIBE FRED'S CONDITION.

3. Fred swims into farm country. He passes a freshly plowed riverbank. It begins to rain and some soil erodes into the river. ***(Dump some soil into Fred's jar).***
DESCRIBE FRED'S CONDITION.

4. Fred nears a suburban housing development. Some fertilizer from the farms and the lawns washed into the river awhile back. ***(Dump some fertilizer in Fred's jar).*** The fertilizer made the plants in the river grow very fast and thick. Eventually, the river couldn't furnish them will all the nutrients they needed, and so they died and are starting to decay. Their decomposition is using up some of Fred's oxygen. **DESCRIBE FRED'S CONDITION.**

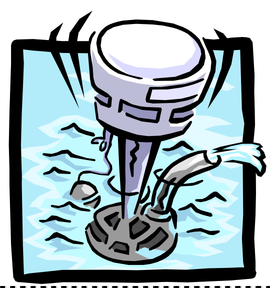
5. Fred swims under a highway bridge. Some cars traveling across it are leaking oil. The rain is washing the oil into the river below. ***(Pour"oil" into Fred's jar).*** **DESCRIBE FRED'S CONDITION.**

6. During a recent cold spell, ice formed on the bridge. County trucks spread salt on the road to prevent accidents. The rain is now washing salty slush into the river. **(Put salt into Fred's jar). DESCRIBE FRED'S CONDITION.**

7. Fred swims past the city park. Some picknickers didn't throw their trash into the garbage can. The wind is blowing it into the river. ***(Sprinkle paper litter into Fred's jar).*** **DESCRIBE FRED'S CONDITION.**

8. Several factories are located downriver from the city. Although the regulations limit the amount of pollution the factories are allowed to dump into the river, the factory owners don't always abide by them. ***(Squirt two drops of "pollution" into Fred's jar).*** **DESCRIBE FRED'S CONDITION.**

9. The city's wastewater treatment plant is also located along this stretch of the river. The pollution regulations aren't as strict as they used to be. Also a section of the plant has broken down. ***(Pour "untreated sewage" into Fred's jar).*** **DESCRIBE FRED'S CONDITION.**



10. Finally, Fred swims past an old dump located on the bank next to the river. Someone dropped off a bunch of old pesticide and paint containers. These rusty barrels of toxic chemicals are leaking. The rain is washing these poisons into the river. ***(For each leaking barrel, squeeze one drop of toxins into Fred's jar).*** **DESCRIBE FRED'S CONDITION.**

Hydrology Investigation

Safety Precautions

A. Read all instructions to get familiar with the test procedure before you begin.

B. Note any safety warnings in the instructions.

C. In the event of an accident or suspected poisoning, immediately call the Poison Center phone number, which should be in the front of your local telephone book. Be prepared to give the name of the reagent.

D. Always dispose of the text chemicals properly. Follow the disposal instructions that come with the text kits.

Proper Analytical Technique

A. Avoid getting any reagents on your skin, eyes, nose, and mouth.

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

C. When dispensing a reagent from a plastic squeeze bottle, hold the bottle vertically upside-down (not at an angle) and gently squeeze it (if a gentle squeeze does not suffice, the dispensing cap or plug may be clogged).

D. Wipe up any reagent spills liquid or powder as soon as they occur. Rinse area with wet sponge then dry.

E. Thoroughly rinse test tubes before and after each test. Dry your hands and the outside of the tube.

F. Tightly close all reagent containers immediately after use. Do not change caps from different containers.

G. Do not set the reagents in direct sunlight.

Hydrology Investigation

Student Activity Sheet

Turbidity/Transparency Station

Background

Transparency is the measurement of water clarity. How clear the water is at your site will depend on the amount of soil particles suspended in the water and on the amount of algae growth at your site. Transparency may change with the seasons and with changes in plant growth rates, in response to precipitation runoff, or for other reasons. The clarity of your water determines how much light can penetrate. Since plants require light, transparency becomes an important measurement in determining the productivity of your water site.

In the field you would measure transparency in one of two ways; with a Secchi disk in deep, still waters or with a turbidity tube or probe if your site has shallow or running water. For the practice station, we will use the turbidity tube.

What To Do and How to Do It

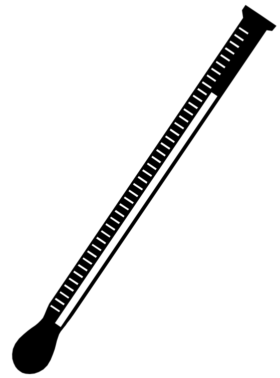
1. Fill the turbidity tube with water until the image disappears. Record the depth of the water in the tube in cm.
2. Compare data from several students or groups at the bottom. Discuss why there are variations in your data.
3. Try the tube again testing variables such as: amount of light, tube in sunlight and shadow, with and without sunglasses, turning the tube to try and detect the image at the bottom, letting the water stand in the tube for 15-20 seconds.
4. Once you have established the depth, pour the water into a beaker and mix a few grams of silt into the water.
5. Fill the turbidity tube with the silty water until the image disappears. Record the depth of the water in the tube in cm. Compare the readings from several students.
6. Put a few drops of green food coloring in the water.
7. Fill the turbidity tube with the colored water until the image disappears.

Turbidity continued . . .

Student/Group Name	Water Sample Tested	JTUs

Why are there variations in the data between students testing the same types of water samples?

Hydrology Investigation



Student Activity Sheet

Temperature Station

Background

Water temperature is the temperature of a body of water such as a stream, river, pond, lake, well, or drainage ditch as it appears in nature. Water bodies can vary greatly in temperature, according to latitude, altitude, time of day, season, depth of water, and many other variables. Water temperature is important because it plays a key role in chemical, biological and physical interactions within a body of water. For example, high temperatures may be an indicator of increased plant production. The temperature of the water determines what aquatic plants and animals may be present since all species have their natural limits of tolerance to upper and lower temperatures. Water temperature can therefore help us to understand what may be happening within the water body without directly measuring hundreds of different things within the body of water.

What To Do and How To Do It

1. Following the steps in the *Water Temperature Protocol*, each member of the group should take a turn measuring the temperature of the **same sample** with the **same thermometer**. Make sure everyone in the group can read the thermometer. Compare your readings. Are they within 0.5° C of each other? Why? Why not? If not, repeat this exercise with another water sample until you are obtaining readings within 0.5° C of each other.
2. Following the steps in the water temperature protocol, measure the temperatures of water from the hot water beaker and cold-water tap.
3. Dip the thermometer in water and wave it around in the air. How does this affect the temperature reading?

Temperature continued . . .

List the things you checked and record the temperatures you obtained for them.

Student/Group Name	Water Sample Tested	Temperature

Hydrology Investigation

Student Activity Sheet

Dissolved Oxygen Station

Background

All living things depend on oxygen to survive. In a water environment, molecules of oxygen gas dissolve in the water. This is called dissolved oxygen (DO). In air, 20 out of every 100 molecules are oxygen. In water, only 1-5 molecules out of every million molecules are oxygen. This is why dissolved oxygen is measured in parts per million (ppm). Different species of aquatic organisms require different amounts of oxygen, but generally aquatic organisms require at least 6 ppm for normal growth and development.

Water temperature and altitude influence how much oxygen water can hold. In general, warmer water cannot hold as much oxygen as colder water. Similarly, at higher altitudes water cannot hold as much oxygen as waters at lower altitudes.

The actual amount of DO in a body of water may be higher or lower than normal at different periods of time. Bacteria in the water consume oxygen as they digest decaying plant or animal materials. This can lower the DO levels of the water. In contrast, algae in lakes produce oxygen during photosynthesis, which can sometimes result in higher DO levels in summer.

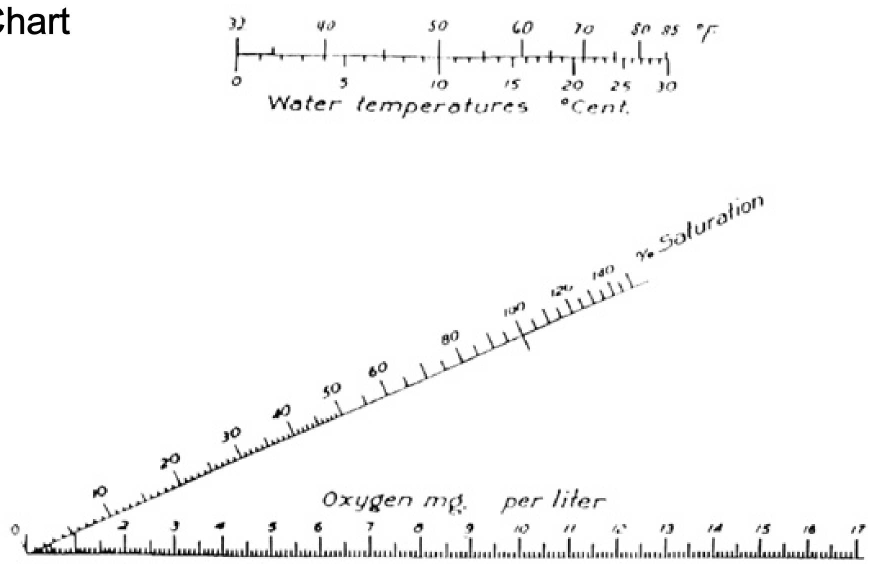
Dissolved Oxygen continued . . .

What To Do and How To Do It

1. Immediately begin the chemical DO test with a sample of tap water.
2. Following the steps in the *Dissolved Oxygen Protocol*, each member the group takes a turn measuring the DO of the same sample with the DO probe. Compare your readings. Are they within 0.2 mg/L of each other? Why? Why not?
3. If your water faucets have aerators on them, test a water sample freshly drawn from the faucet and one that was drawn at the beginning of the day and allowed to sit undisturbed in a bucket. How long has it been since the water was drawn? Compare the readings. Are they different? Why? Why not? What might account for the differences?

Student/Group Name	**Water Sample tested**	DO	**% Saturation**

Saturation Chart



Hydrology Investigation

Student Activity Sheet

pH Station

Background

pH is an indicator of the acid content of water. The pH scale ranges from 1 (acid) to 14 (alkaline or basic) with 7 as neutral. The scale is logarithmic so a change of one pH unit means a tenfold change in acid or alkaline concentration. For instance, a change from 7 to 6 represents a solution 10 times more acidic; a change from 7 to 5 is 100 times more acidic, and so on. The lower the pH the more acidic the water. The pH of a water body has a strong influence on what can live in it. Immature forms of salamanders, frogs, and other aquatic life are particularly sensitive to low pH.

What To Do and How To Do It

1. Following the steps for pH paper in the *pH Protocol*, each member of the group takes a turn measuring the pH of the same sample. Compare your readings. Are they within 1.0 pH units of each other? Why? Why not? If not, repeat this exercise with another water sample until you are obtaining readings within 1.0 pH units of each other.

2. Use the pH test kit and measure the pH of the sample. Compare your reading to the reading you got with the pH paper. Are they the same or different? Why?

3. Take the pH of familiar liquids such as distilled water, vinegar, tap water, milk, juice, soda pop, etc. List the samples you checked and record the pH obtained by the different methods.

4. Create a pH scale and plot the average values obtained for each sample.

pH continued . . .

Sample tested	pH paper	pH Test kit

Low pH
0

Neutral pH
7

High pH
14

pH of Common Substances

1.0 Battery Acid
2.0 Lemon Juice
3.0 Vinegar
4.0 Adult fish die
5.0 Fish reproduction affected
6.0
7.0 Milk
8.0 Baking Soda
9.0 Sea Water
10.0
11.0 Milk of Magnesia
12.0 Ammonia
13.0 Lye
14.0

2-5 Acid Rain
5-7 Normal Rainfall
6-8 Normal Range of Stream pH

Hydrology Investigation

Student Activity Sheet

Electrical Conductivity Station

Background

Electrical conductivity is a measure of the ability of a water sample to carry an electrical current. Pure water is a poor conductor of electricity. It is the impurities in water, such as dissolved salts, that enable water to conduct electricity. Therefore, conductivity is often used to estimate the amount of dissolved solids in the water since it is much easier than evaporating all the water molecules from a sample and weighing the solids that remain.

Conductance is measured in a unit called the microSiemen/cm. Sensitive plants can be damaged if they are watered with water that has electrical conductivity levels above about 2200-2600 microSiemens.

What To Do and How To Do It

1. Following the steps in the *Electrical Conductivity Protocol*, each group takes a turn measuring the conductivity of the same tap water sample. Compare your readings. Are they within 40 μSiemens/cm of each other? Why? Why not? If not, repeat this exercise with another water sample until you are obtaining readings within 40 μSiemens/cm of each other.

2. Measure the conductivity of familiar liquids such as vinegar, drinking water, milk, juice, soda pop, etc. List the samples you checked and record the results.

3. What is the range of conductivity readings? Create a conductivity scale and plot the value obtained for each sample.

Conductivity continued . . .

Water Sample tested	Conductivity
distilled water	
tap water	
salty water	

Low Conductivity

High Conductivity

Hydrology Investigation

Student Activity Sheet

Alkalinity Station

Background

Alkalinity is a measure of the ability of a body of water to resist changes in pH when acids are added. Acid additions generally come from rain or snow, although soil sources may also be important in some areas. Alkalinity is generated when water dissolves rocks such as calcite and limestone. The alkalinity of natural waters protects fish and other aquatic organisms from sudden changes in pH.

What To Do and How To Do It

1. Following the steps in the *Alkalinity Protocol*, each member of the group takes a turn measuring the alkalinity of the same sample of tap water. Compare your results. Are they within one drop or titrator unit of each other? Why? Why not? If not, repeat this exercise with another tap water sample until you are obtaining results within one drop or titrator unit.

2. Test the water samples you have brought to class from other sources. List the source of the water sample and the results obtained. Compare the alkalinity of these samples. What is the range of results? Why are there variations?

3. Create an alkalinity scale and plot the value obtained for each sample.

Alkalinity continued . . .

Student Group	Water Sample tested	Reading

Low Alkalinity

High Alkalinity

____

Hydrology Investigation

Student Activity Sheet

Nitrate Station

Background

Nitrogen is one of the three major nutrients needed by plants. Most plants cannot use nitrogen in its molecular form (N_2). In aquatic ecosystems blue-green algae are able to convert N_2 into ammonia and nitrate (NO_3) which can then be used by plants. Animals eat these plants to obtain nitrogen that they need to form proteins. When plants and animals die, bacteria break down protein molecules as part of the decomposition process. Different bacteria produce different nitrogen compound, such as nitrites (NO_2), nitrates (NO_3), and ammonia. Thus the nitrogen cycle begins again. This is how nature recycles!

Typically nitrogen levels in natural waters are low (below 1.0 ppm nitrate nitrogen). Plants rapidly consume nitrogen released by decomposing animal excretions, dead plants and animals. In water bodies with high nitrogen levels, eutrophication can occur. Nitrogen levels can become elevated from natural or human-related activities. Ducks and geese contribute heavily to nitrogen in the water where they are found. Man-made sources of nitrogen include sewage overflowing into rivers, fertilizer washed into streams or leached into groundwater, and runoff from feedlots and barnyards.

Nitrate levels are measured in milligrams per liter nitrate nitrogen.

Nitrate continued . . .

What To Do and How To Do It

1. Following the steps in the *Nitrate Protocol*, measure the nitrate level of the water sample. Compare the readings of several students. Are they within 0.2 mg/L of each other? If not, discuss possible reasons for error. Repeat the readings until you obtain readings within 0.2 mg/L.

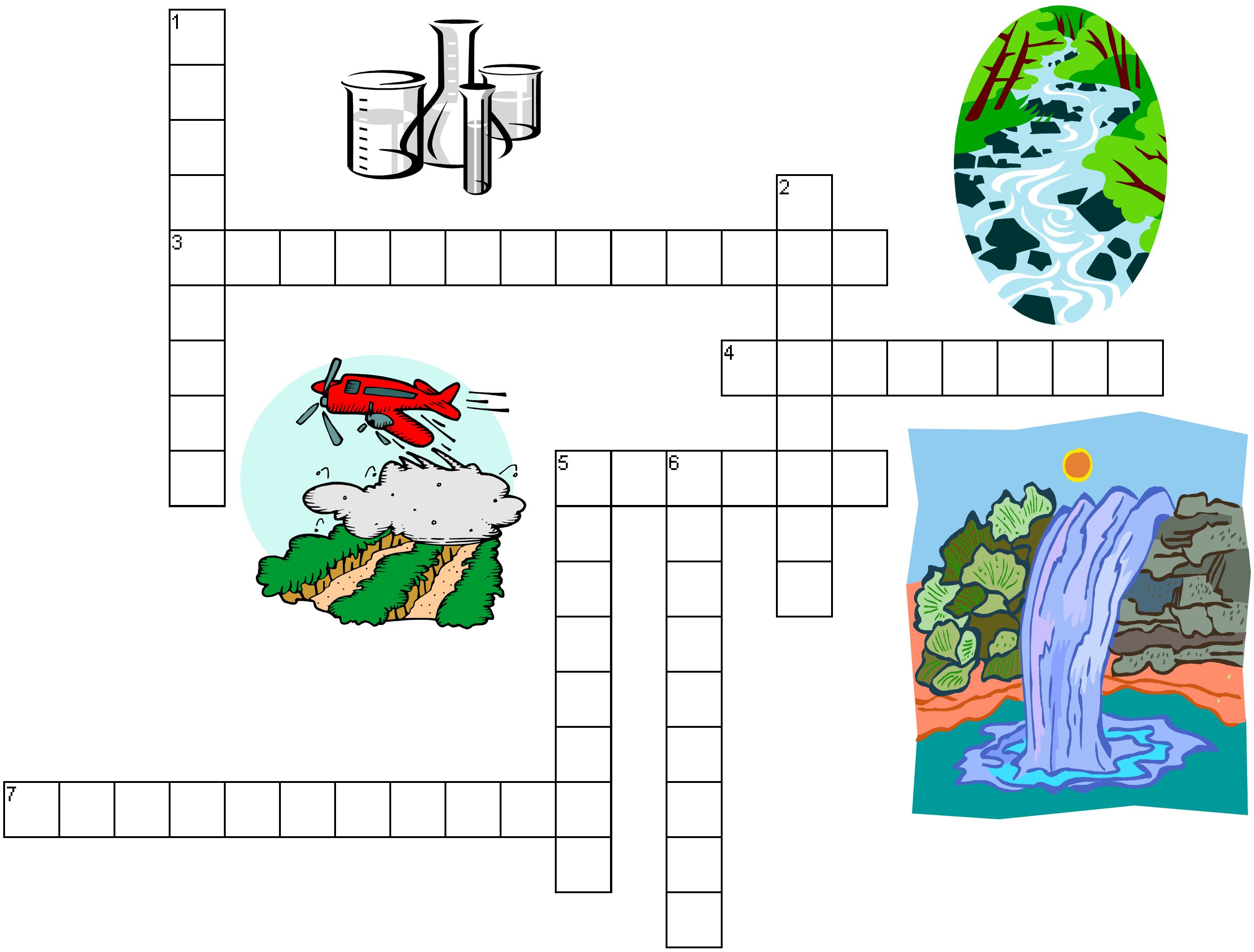
2. Add a few grains of fertilizer to your sample. Test again. What is the difference?

3. Discuss possible sources of nitrogen in your pond or stream water samples.

Water Sample tested	Reading	Student/Group

Water Quality Crossword

Name________________ Date__________________



Across

3. bits and pieces of the remains of plants and animals made up of carbon compounds
4. a mixture that results when particles of a substance are dissolved in a liquid
5. the kind of tank in which the solid matter of sewage is held to be disintegrated by bacteria
7. the chemical process that takes place in the cells of plants and animals in which oxygen is used to break down sugars and release energy

Down

1. specific causes of disease-such as bacteria or viruses
2. quickness of motion-rate at which an action occurs
5. loose material such as sand, silt and mud that washes into a stream or lake
6. a chemical substance used to control or kill pest organisms

Water Quality Quiz

Name:__________________ Date:___________________

Match the words on the left with their definitions on the right by filling the blank with the number that gives the correct definition for each word

_____ organic matter	1) the capability of a solution to neutralize an acid
_____ solution	2) the chemical process that takes place in the cells of plants and animals in which oxygen is used to break down sugars and release energy
_____ pathogens	3) a muddiness created when solid particles are mixed in with water
_____ respiration	4) a chemical substance used to control or kill pest organisms
_____ pesticide	5) bits and pieces of the remains of plants and animals made up of carbon compounds
_____ sediment	6) measure of how acidic or alkaline a solution is (from 0 to 14 where 7 is neutral)
_____ DO	7) Stands for "dissolved oxygen," which is the amount of oxygen that can remain suspended in the water and is needed for aquatic life to survive
_____ Nitrate nitrogen	8) A chemical commonly found in fertilizers
_____ turbidity	9) loose material such as sand, silt and mud that washes into a stream or lake
______ pH	10) measure of how well water can conduct an electrical current depending on how much dissolved salts and other particles are present
______ alkalinity	11) specific causes of disease-such as bacteria or viruses
______ conductivity	12) a mixture that results when particles of a substance are dissolved in a liquid

Water Quality Quiz

Answer Key:

5 - organic matter
12- solution
11 - pathogens
2 - respiration
4 - pesticide
9 - sediment
7 - DO
8 – nitrate-nitrogen
3 – turbidity
6 – pH
1 – alkalinity
10 - conductivity

Water Quality Crossword

Answer Key:

Answers Across:
3. organic matter
4. solution
5. septic
7. respiration

Answers Down:
1. pathogens
2. velocity
5. sediment
6. pesticide