Water Quality

Strand	Living Systems	
Topic	Investigating water quality	
Primary SOL	6.7	The student will investigate and understand the natural processes and human interactions that affect watershed systems. Key concepts include g) water monitoring and analysis using field equipment, including hand-held technology.
Related SOL	6.5	The student will investigate and understand the unique properties and characteristics of water and its roles in the natural and human-made environment. Key concepts include f) the importance of protecting and maintaining water resources.

Background Information

An *ecosystem* is made up of the living community and the nonliving factors that affect the organisms living in it. The nonliving, physical features of the environment are the *abiotic factors*, which determine ecosystem type and its distribution of plants and animals. Abiotic factors include water quality, topography, landforms, geology, climate, soil types, amount of sunlight, and air quality or oxygen availability. The health of an ecosystem is directly related to its water quality.

One thing that all watersheds have in common is people. Human activity can alter abiotic factors and thus accelerate or decelerate natural processes. Human activity can affect water quality in two ways: by changing the ecological processes that naturally purify water, and by adding pollutants. For example, people can affect the rate of natural erosion one way or the other. Plowing cropland can cause greater erosion, while planting trees can lessen it. Preserving or destroying wetlands is another example because wetlands regulate runoff, reduce erosion, purify water by filtering it, and recharge groundwater.

Land-use changes upstream can cause runoff pollution problems for people, plants, and animals downstream that depend on clean, usable water. This form of pollution is called *nonpoint-source* (NPS) *pollution*, because the pollution does not come from a single source, such as the discharge from a sewage treatment plant or a factory. NPS pollution is caused mainly by storm-water runoff. When it rains hard, water runs off farmland, city streets, construction sites, lawns, and driveways, carrying sediment, nutrients, pesticides, oil and gasoline, bacteria, and other pollutants with it. One of water's unique properties is its ability to dissolve a wide variety of compounds. Thus, water-soluble materials easily pollute water, which then carries these harmful substances into our waterways and other bodies of water.

The four primary NPS pollutants are sediment, nutrients, toxic chemicals, and disease-causing pathogens.

- *Sediment* is soil carried by rainwater into streams, rivers, and lakes. It reduces light needed by aquatic plants, blocks up waterways, and covers up aquatic habitat. Often the sediment from farmland also carries pesticides and nutrients.
- *Toxic chemicals,* such as pesticides, herbicides, and oil and gasoline, can damage and/or kill aquatic animal and plant life.

- *Nutrients,* particularly nitrogen and phosphorus, over-enrich bodies of water, causing excessive growth of algae. When algae die, bacteria decompose it, decreasing the water's dissolved oxygen level in the process. Low oxygen can kill or cause distress to aquatic animals. Algae also cloud the water and block much needed sunlight.
- *Pathogens,* which cause disease, enter bodies of water primarily through human or animal waste.

Water-quality monitoring is the collection of water samples in order to analyze chemical and/or biological parameters. Simple parameters include pH, temperature, salinity, dissolved oxygen, turbidity, and the presence of macroinvertebrate organisms.

In the past, streams and rivers were often used to dispose of human waste, and open sewers were common. During the mid-1800s, public health officials recognized the connection between disease outbreaks and contamination of public wells and drinking water. Advances in water treatment and sanitary sewers have helped eliminate diseases associated with human waste.

Materials

- Water-quality field-test kit
- Copies of the attached handouts
- Resource materials (library books, Internet access)

Vocabulary

abiotic, biotic, ecosystem, erosion, nonpoint source (NPS), nutrients, pathogens, pollution, recharge, runoff, sediment

Student/Teacher Actions (what students and teachers should be doing to facilitate learning)

1. Distribute copies of the attached Water-Quality Monitoring and Water Pollutants handouts.
2. Organize students into "base teams" of four students each, and assign two students from each base team to work on water-quality monitoring and the other two to work on water pollutants.
3. Have all water-quality monitoring students group together in an "expert group" and all water pollutants students group together into another "expert group" in order to complete their assigned table. Assign each base team pair in each large expert group a different task.
4. Have expert pairs complete their research and then report back to their expert group. Monitor the sharing of information to ensure that it is correct.
5. Once all expert pairs have completed their tables, tell students to return to their base teams and report back all information that was gathered. Go over the tables to ensure all students have correct information.
6. Have students choose an article from *Virginia's Water Resources* (available online) or related textbook passage to summarize. As an alternative to summarizing, you may wish to have students use one of the reading strategies from the English Enhanced Scope and Sequence. You may wish to have students complete this for homework.
7. As an introduction for the next day's class, have several students report on different articles that they read.

Assessment

- **Questions**
  - What happens to water that runs off our streets and lawns? Where does it go?
  - What are some ways that water can become polluted or contaminated?
  - What are some common point-source pollutants?
  - What are some nonpoint-source (NPS) pollutants.
  - How do we know if our water is safe to drink?
- **Journal/Writing Prompts**
  - Explain where you could get drinking water if you did not have indoor plumbing. Include the ways you would know it was safe to drink.

Extensions and Connections (for all students)

- Follow this lesson with the one entitled "Water Testing."
- Show students a water-quality test kit and equipment. Tell students that before they may use the equipment, they need to learn about the different types of pollutants, what the different tests are, and why they are used.

Strategies for Differentiation

- Have students conduct research and place information with pictures on a wall chart or poster. Have students use this information to complete their individual charts.
- Use the answer keys provided to print and cut out answer cards. Give the cards to students to sort into categories as determined by their charts. Once they have sorted the cards correctly, have them paste the cards to their blank charts.
- For the article summarization activity in step 6, allow students to summarize videos and/or articles.
- Have students search the Internet for articles about water-quality monitoring and water pollutants.
- Have students present findings of their research on water-quality monitoring and water pollutants using electronic presentation software.
- Invite a water quality control tester (e.g., public pool water tester, water treatment plant representative) to speak regarding his/her job responsibilities and the water tests he/she performs.
- Divide students into groups, and give each group the charge to bring in different types of water to be tested by the group. Water samples could include tap water, pond water, lake water, rain water, puddle water, Chesapeake Bay water, river water, etc.

Water-Quality Monitoring

Name: _____ **Date:** _____ **Class:** _____

Test	What/Why	Measuring Method
pH		
Temperature		
Salinity		
Dissolved Oxygen		
Turbidity		
Macroinvertebrates		
Nutrients		

Water-Quality Monitoring Answer Key

Test	What /Why	Measuring Method
pH	Measures how acidic or basic a solution is. Most organisms are adapted to a specific pH level and are highly susceptible to changes.	Test kits or probes. In U.S., pH in most natural water systems is 6.5–8.5.
Temperature	Can influence biological activities and chemical processes of organisms living in water. Can change dissolved oxygen levels	Thermometers or probes
Salinity	The amount of dissolved salts in water. Controls the types of plants and animals that can live in the water	Physical methods: density (hydrometer), conductivity, or refractivity. Chemical method: chloride concentration with test kit
Dissolved Oxygen	Best indicator of water's health. Decrease in level can cause changes in type and number of macroinvertebrates.	Field-test kits with five chemicals that are added to water in prescribed order
Turbidity	Clarity or transparency of water. Suspended particles clog gills of fish, reduce photosynthesis, and impair filter-feeding system of many aquatic animals.	Black-and-white weighted disk (Secchi disk) on measured rope is lowered on shady side of boat, and depth at which it disappears is measured and recorded.
Macroinvertebrates	Bottom-dwelling organisms. Presence or absence of organisms is indicator of water quality.	Kick net or dip net scoop sample from the bottom of stream bed. Net is spread out on white plastic to examine specimens.
Nutrients	Main cause of Chesapeake Bay's poor water quality. Excessive amounts cause algae to grow. Bacteria decompose algae, a process that decreases water's dissolved oxygen level.	Field-test kits measure concentration of nitrates and phosphorus in water.

Water Pollutants

Name: _____ **Date:** _____ **Class:** _____

Category	Examples of Polluting Substances	Examples of Water Pollution	Impact	Tests
Sediment Pollution				
Nutrient Pollution				
Toxic Pollution				
Pathogen Pollution				
Thermal Pollution				

Water Pollutants Answer Key

Category	Examples of Polluting Substances	Examples of Water Pollution	Impact	Tests
Sediment Pollution	Insoluble particles suspended in water	Soil erosion from farmland, lawns, construction sites, and other places	Clogs gills of fish, blocks up waterways, covers up aquatic habitat, disrupts food web, clouds water, and inhibits photosynthesis	Test for turbidity, using a Secchi disk. Observation of macroinvertebrate population
Nutrient Pollution	Primarily nitrates and phosphorus	Industrial discharge, fertilizer runoff, vehicle exhaust, animal and human waste	Causes over growth of plant life, decreases dissolved oxygen level, increases temperature	Test for dissolved oxygen, using chemical field-test kit
Toxic Pollution	Gasoline, oil, pesticides	Industrial discharge, runoff from streets and other impervious surfaces	Threatens human health, harms aquatic organisms	Examination of water for evidence of oil spills. Observation of macroinvertebrate population
Pathogen Pollution	Primarily bacteria	Sewage carrying human and animal waste	Spreads disease-causing micro-organisms that typically cause gastrointestinal problems	Performance of total coliform test or fecal coliform test
Thermal Pollution	Hot water	Water discharge from industrial and power plants, water runoff from extremely hot, paved surfaces	Decreases dissolved oxygen level, influences survival of aquatic organisms, increases rate of bacteria growth	Measurement of temperature, using a thermometer. Observation of macroinvertebrate population. Test for dissolved oxygen, using chemical field-test kit