Would You Drink This Water?

Can you safely rely on your eyes, nose, and taste buds to detect polluted water?

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Chapter 3 • Lesson 4

Please note: Academic Standards are updated regularly and our alignments will be updated on the DNR Academic Standards Website at: www.mndnr.gov/education/teachers/edstandards_intro.html

Would You Drink This Water?

Minnesota Academic Standards

◒ Lesson *introduces* this Benchmark.
◍ Lesson *partially* addresses this Benchmark.
● Lesson *fully* addresses this Benchmark.

Language Arts

Grades 3, 4, 5
I. Reading and Literature
B. Vocabulary Expansion:
Benchmark 1—The student will acquire, understand and use new vocabulary through explicit instruction and independent reading. ◍
III. Speaking, Listening, and Viewing
A. Speaking and Listening:
Benchmark 1—The student will participate in and follow agreed-upon rules for conversation and formal discussions in large and small groups. ●

Math

Alignment to the 2007 Minnesota Academic Math Standards coming soon.
Grade 3
II.Number Sense, Computation, and Operations
A. Number Sense:
Benchmark 3—The student will know how fractions are related to the whole, such as four-fourths equals a whole or three fourths equals three of four equal parts of a whole. ◒
Benchmark 4—The student will represent and write fractions with pictures, models and numbers. ◒
V. Spatial Sense, Geometry and Measurement
C. Measurement:
Benchmark 1—The student will select an appropriate tool and identify the appropriate unit to measure time, length, weight and temperature. ◒

Science

Grade 3
I. History and Nature of Science
A. Scientific World View:
Benchmark 1-The student will explore the use of science as a tool that can help investigate and answer questions about the environment. ◍
B. Scientific Inquiry:
Benchmark 1—The student will ask questions about the natural world that can be investigated scientifically. ◍
Benchmark 2—The student will participate in a scientific investigation using appropriate tools. ◍
Benchmark 3—The student will know that scientists use different kinds of investigations depending on the questions they are trying to answer. ◍

Grade 4
I. History and Nature of Science
A. Scientific World View:
Benchmark 1—The student will explore the uses and effects of science in our interaction with the natural world. ◍
B. Scientific Inquiry:
Benchmark 2—The student will collect, organize, analyze and present data from a controlled experiment. ◍
Benchmark 3—The student will recognize that evidence and logic are necessary to support scientific understandings. ◍
III. Earth and Space Science
A. Earth Structure and Processes:
Benchmark 1—The student will identify and investigate environmental issues and potential solutions. ◍
B. The Water Cycle, Weather and Climate:
Benchmark 1—The student will describe the water cycle involving the processes of evaporation, condensation, precipitation and collection. ◍
Benchmark 2—The student will identify where water exists on Earth. ◍

Grade 5
I. History and Nature of Science
B. Scientific Inquiry:
Benchmark 1—The student will perform a controlled experiment using a specific step-by-step procedure and present conclusions supported by the evidence.
Benchmark 2—The student will observe that when a science investigation or experiment is repeated, a similar result is expected.

Environmental Literacy Scope and Sequence

Benchmarks

- Social and natural systems are made of parts. (PreK-2)
- Social and natural systems may not continue to function if some of their parts are missing. (PreK-2)
- When the parts of social and natural systems are put together, they can do things they couldn't do by themselves. (PreK-2)
- In social and natural systems that consist of many parts, the parts usually influence one another. (3-5)
- Social and natural systems may not function as well if parts are missing, damaged, mismatched or misconnected. (3-5)

For the full Environmental Literacy Scope and Sequence, see:
www.seek.state.mn.us/eemn_c.cfm

Chapter 3 • Lesson 4

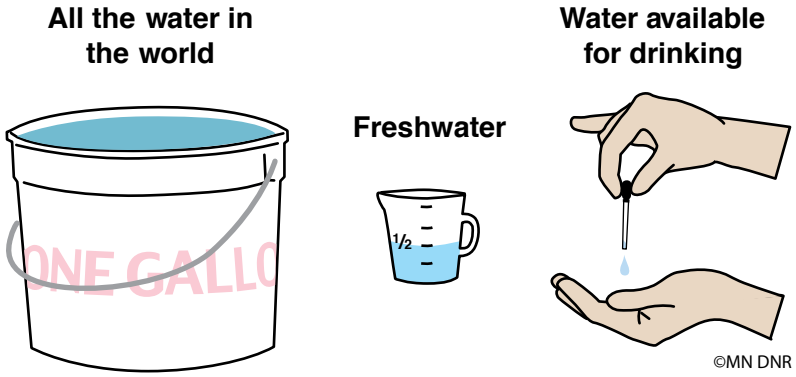
Would You Drink This Water?

Adapted with permission of the author. /What Water Would You Drink?/ 1993. On the Rocks: Earth Science Activities for Grades 1-8. SEPM (Society for Sedimentary Geology), Tulsa, OK. ISBN 1-56576-005-0.

Grade Level: 3-5
Activity Duration: 25 minutes
Group Size: any
Subject Areas: Language Arts, Math, Health & Safety, Science
Academic Skills: comparison, description, drawing conclusions, observation, recording data, small group skills
Setting: indoor or outdoor gathering area with tables
Vocabulary: erosion, evaporation, limited resource, precipitation, suspended sediment, transpiration, water cycle, water pollution
Internet Search Words: drinking water, mercury, water pollution, water quality, water treatment

Instructor's Background Information

Water is an essential resource for life on earth. Water covers approximately 75 percent of the planet's surface—but most of this water is salt water. For every 100 drops of water on earth, less than three drops are fresh, or less than three percent. Fresh water resides in lakes, rivers, underground aquifers, and frozen in ice, but all of this water isn't available for use. Some is trapped in ice, or too deep within the ground to retrieve. Less than one percent of all fresh water can be accessed for consumption. Fresh water is essential to our survival, so how we use and protect water is an important issue.



Water covers 75 percent of the earth. Less than three percent of the water is fresh water, and just one percent of this fresh water is available for use.

Water is considered a **limited resource** because we can't make new water. Just imagine this—the water we drink today is the same water

Summary

A demonstration illustrates the amount of the earth's fresh water available for use. Using their senses of sight, smell, and taste, small groups of students will examine six water samples (five of them "polluted") and decide which samples they would drink based on their observations. Students will discuss the ways in which water can be polluted and how to reduce water pollution.

Student Objectives

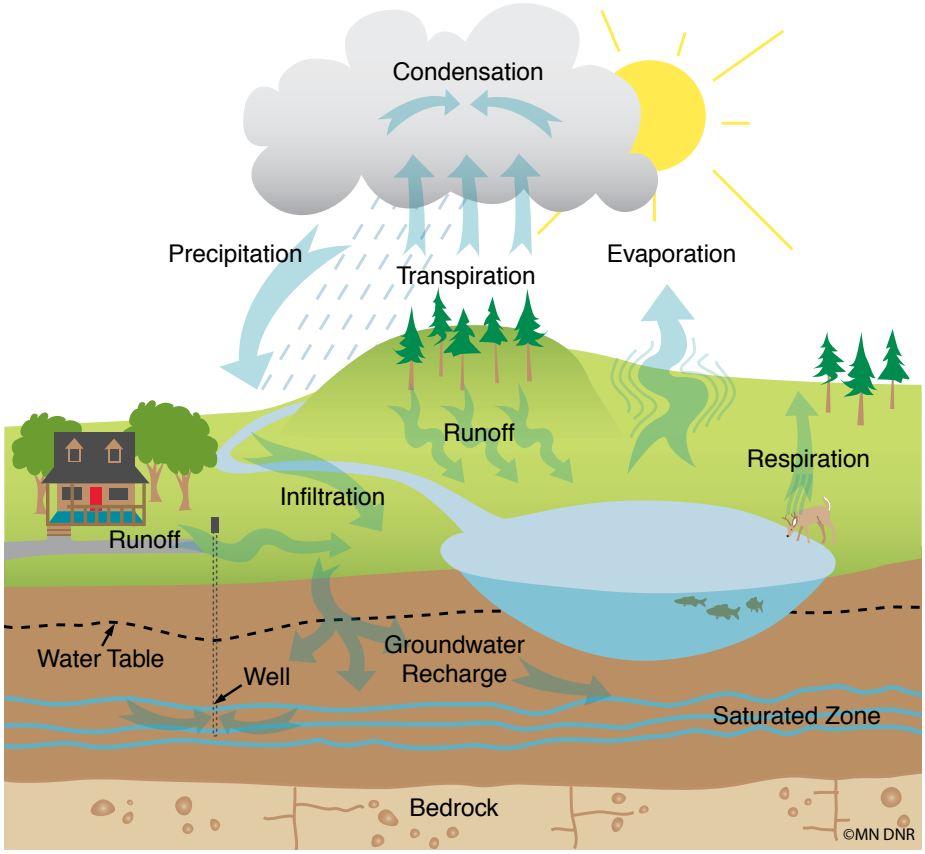
The students will:

1. Know how much of the earth's fresh water is available for use.
2. Evaluate whether or not water is safe to drink by using their senses of sight, smell, and taste.
3. Understand that some pollutants are difficult to detect using their senses alone.
4. Understand that some water that may seem unsafe to drink isn't necessarily polluted.
5. Propose three ways to reduce water pollution.

Materials

- One-gallon ice cream pail
- Paper cups, six for each group of four students
- Clear one-cup measuring cup
- Eyedropper
- Globe
- One 6-pack of bottled drinking water
- Five plastic spoons, for mixing materials into water samples
- Green food coloring
- Instant iced tea mix
- Powdered coffee creamer
- Onion, anise, or peppermint extract
- Salt
- Blindfolds (clean or unused), two for each group of four students
- Permanent marker
- **Would You Drink This Water? Data Sheet**, one per group of four students
- Pens or pencils for each student group

that the dinosaurs slurped! Water is made available for reuse through the water cycle, a process by which water changes states (solid, liquid, gas) and moves throughout the planet. Water falls to the earth in the form of precipitation (rain or snow). It moves to places where it's stored or used by organisms. Ultimately, it returns to the atmosphere through evaporation (the conversion of water into water vapor) or transpiration (evaporation that takes place through plants).



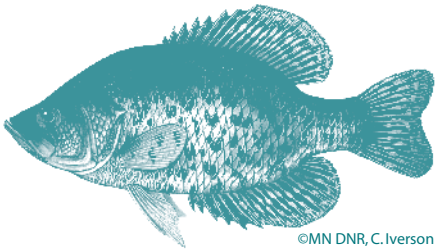
Water is always in motion in the water cycle, which connects clouds, lakes, rivers, groundwater, soil, plants, and animals, including people and fish.

Water Pollution

Protecting our water supply from pollution is essential because water is a limited resource. **Water pollution** is a form of contamination caused by natural or human-made substances that reduce the water's useful qualities, or make it unhealthful for humans or other organisms. Water pollution occurs naturally, such as in the case of a volcanic eruption or an animal carcass decaying in a stream. It also occurs as a result of human activities such as air emissions from vehicles, power plants, failing septic systems, improper disposal of household chemicals, or **erosion**. Erosion is the gradual wearing away of soil and rock surfaces by natural forces such as flowing water, wind, and ice or by human and animal activities that disturb the soil and vegetation that holds the soil in place and can be accelerated by human activities.

Natural processes purify some polluted water as water flows through the water cycle. Some pollutants are filtered from the water as it trickles through the ground. Wetlands and shoreline vegetation buffers trap wastes and decompose some toxic substances, too. Water treatment facilities and water filtration plants clean water, but, unfortunately, not all pollution can be removed by natural or human-designed systems.

People's activities have contributed to water pollution in numerous ways. When vegetation is cleared from the land, for example, a natural water filter is removed from the water cycle. Plants hold soil in place with their roots and prevent sediments from running into water. Without plants, the land becomes more susceptible to erosion, and sediment flows from the land into lakes and streams. Erosion also increases the amount of **suspended sediment** in lakes. (Suspended sediment is present in the water column; it's what makes water appear cloudy.) As suspended sediment settles on the river or lake bottom, it covers fish eggs, depriving them of needed oxygen. Suspended sediment also increases water temperature (sunlight is absorbed rather than reflected from the water), which reduces dissolved oxygen that fish need. Erosion also allows pollutants to flow into lakes and streams. Common pollutants, such as animal waste, pesticides, oil, and household chemicals can be washed into waterways, increasing the water's levels of bacteria and toxic substances. These pollutants may also harm people that drink the water or eat fish from the water.



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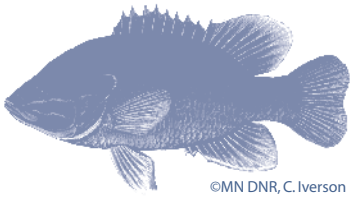
Pollutants released into the air can also make their way into water systems. For example, although mercury occurs naturally, most of the mercury entering the waters comes from coal-burning power plants or from household and industrial wastes that contain mercury. Mercury from the air enters the water cycle when it rains or snows—often hundreds of miles from the emission source. Mercury is converted to methylmercury by bacteria in the water. Fish absorb methylmercury from their food. When ingested, mercury binds to the proteins of all fish tissue, including muscle. You can't see, smell, or taste mercury in the water or in a fish, and no methods of filleting or cooking will remove it.

Mercury in large quantities is a neurotoxin that can be harmful to humans. Small amounts have been found in fish tested from all Minnesota waters. Although mercury levels are usually low in individual fish, consuming large quantities can be harmful. Please refer to the Minnesota Health Department website for fish consumption guidelines specifics. Expectant mothers and youth should stick to recommendations from the Minnesota Health Department. (The amount allowed varies by fish species). For more information on mercury, see **Lesson 6:5—Eating Fish**.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You can obtain updated fish consumption advisories on the Minnesota Department of Health website: www.health.state.mn.us/divs/eh/fish/index.html

The list of potential water pollutants is long. In general, any form of pollution that affects the land or air can also affect water. Pollutants in water can be visible, such as oil spills, excessive algae growth, and litter. Other pollutants may be invisible, yet detectable by smell. For example, waters polluted with animal waste have a distinct odor. Other chemical pollutants, such as pesticides and mercury, aren't easily detectable, and must be identified through water testing. On the other hand, some waters that look or smell polluted or have a "different" taste may actually be harmless. For example, water may be stained brown with iron from the ground or with tannins from the local vegetation. Both are natural conditions, and neither is harmful to humans or aquatic life. Drinking water from a well can taste different than bottled water because it contains naturally-occurring minerals—but these are harmless to consume. Well water can also taste different than "city" water because water from treatment facilities is often treated with chlorine, which you can taste in the water.

Preventing Water Pollution

The cleaning of polluted water can be difficult and expensive. Sometimes, it's not even possible. Although it may be impossible to eliminate all water pollution, we can take action to reduce the amount of pollution entering our waterways. One way to reduce erosion and pollutants in runoff is by preserving native habitat and wetlands, especially around waterways. Wetlands and vegetation around shorelines act as buffers by naturally trapping and filtering sediments. This is why measures should be taken to retain native vegetation and minimize soil disturbance, particularly in sensitive areas such as shorelines and wetlands.

A buffer zone of vegetation along a shoreline reduces erosion and maintains high quality fish habitat.

Another way to reduce water pollution is to conserve water. When people waste water, they expose it to pollutants unnecessarily. Overuse of water also stresses limited water supplies from streams, lakes, and underground. Conserving energy is also extremely critical—even switching off lights when leaving rooms reduces the amount of pollutants emitted from power plants.

Whenever possible, make an effort to use environmentally-friendly products, such as phosphorus-free fertilizers and detergents, organically-grown foods, and nontoxic household cleaners. Properly dispose of unwanted household products such as oil, paints, and pesticides rather than dumping them down the drain. Remember to "Reduce, reuse, recycle."

In the United States, each person uses an average of 80 gallons of water each day!

Procedure

Preparation

1. Fill the ice cream bucket (or another type of one-gallon bucket) with a gallon of water and mark a clear drinking cup with a half-cup line (or use a measuring cup).
2. Prepare "polluted" water samples.
   - Label the six water bottles from 1 to 6
   - "Pollute" the first five of them with a different substance:
     - green food coloring
     - onion extract
     - powdered coffee creamer
     - salt
     - powdered ice tea mix
   - The amount to use will depend on the substance and the size of the water bottle. Pollute lightly at first; you can always add more if the taste or odor is not observable.
   - *One bottle should be left as plain water, and not polluted.*
   - The plain water, onion, and salt should appear clear—shake them if necessary.
   - The food coloring and iced tea will color the water; the coffee creamer will make the water cloudy.
3. For each group of students, use small writing to discreetly label six clean cups from 1 to 6. Fill them three-quarters full of water from the same numbered bottles.
4. Place these cups out of sight for use later in the activity.

Activity

Warm-up

1. Ask the students about the various ways they use water each day. Supplement their responses with some less obvious uses such as growing food, making paper, generating electricity, transportation, and so forth. Then ask them if they have ever put litter into the water or seen someone else littering. How do they suppose the litter affected aquatic animals? Tell the students that water pollution exists in many forms and affects all living things; we all need water to survive.
2. Hold up and spin a globe and ask the students if they know how much of the planet's surface is covered with water. Explain that 75 percent of the earth is covered with water and the remaining 25 percent is land. Represent this amount with the bucket full of water. Tell students that we know the oceans are filled with salt water. Then ask them how much of the water in the one-gallon ice cream bucket represents the world's supply of fresh water. Have a student come to the front of the class and measure one-half cup of water from the bucket to represent all the fresh water in the world (less than three percent). Tell them that the rest of the world's water is salt water, and that we can't drink it.

The instructor could further develop Step 2 to include math skills. Students could determine percentages and fractions as they identify quantities such as the amount of the earth's surface covered by water, the amount of fresh water on earth, and the amount available for human use.

3 Ask students to think about how much of the world's supply of fresh water, represented by the half-cup, is actually available for plants and animals (including people's use). Have a student come to the front of the class and remove one drop of water from the half-cup. This amount represents all of the fresh water available for use! The rest is frozen in icebergs, glaciers, and polar ice caps. Explain that water continuously cycles throughout the world, and that no new supply of water is ever made. It's a limited resource.

Survey the class for any food allergies before this activity.

Lesson

1 Divide students into groups of four. Tell them that they're a team of scientists who have been asked to evaluate the quality of drinking water taken from several locations in their town. Instead of using their scientific equipment to test the samples, they will be using their senses. Their job is to find the clean drinking water. Reassure the students that all the samples are safe to drink, but that some might look, smell, or taste funny.

2 One student in each group should be designated "recorder" to record responses. Give each recorder a **Would You Drink This Water? Data Sheet**. The other students in each group will be "samplers." One should be the designated "looker," another the "smeller," and one as the "taster." Blindfold the smeller and taster and ask them to remain seated until they are called. Each group should be given a set of six cups to evaluate.

3 From a distance, let the looker examine the cups visually. No one but the recorder should be able to see the numbers on the cups. For each cup, lookers should decide whether they would drink the water based on its appearance. *To avoid influencing blindfolded evaluators, lookers should respond nonverbally by nodding "yes" or shaking their heads for "no."* The recorder should note responses on the data sheet.

4 Retrieve the smeller and taster. Remind them that the water is safe to drink and will not hurt them. Tell the tasters to take small sips.

5 In each group, with the recorder's assistance, the smeller and taster should evaluate each of the six samples after being asked, "Would you drink this water?" For each cup, they should nonverbally indicate "yes" or "no" by nodding or shaking their heads. The recorder then records the responses on the data sheet.

6 After all samples have been evaluated, the students may remove their blindfolds. If students detected an odor, taste, or unusual appearance, they may try to guess what it might be. The recorder can note these guesses on the data sheet.

7 When all teams have finished, bring all the students back together as a class. Review each group's results. Ask students to compare the responses. Which samples did the tasters consider fit to drink? The smellers? The lookers? Which was the clean water? Reveal the contents in each of the samples and share with the students that these simulate a variety of water samples, some polluted and some not. For example, green food coloring could represent algae in the water, the odor of the onion might represent a chemical spill, the

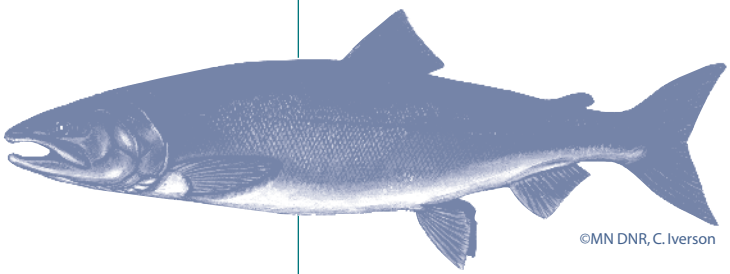
iced tea may represent safe water stained with iron or tannins, and coffee creamer could signify cloudy water containing sediment. The sediment could be due to natural or human causes, and may or may not be safe to drink. Tell students that some pollutants can't be seen, smelled, or tasted. Examples include mercury, high temperature, acidic pH, and low oxygen levels. Scientific tests must be done to see if the water holds pollutants like these.

Wrap-up

Each team should answer the questions on the **Would You Drink This Water? Data Sheet.** Responses can be discussed as a class. Discuss with students that water with some odors, tastes, or appearances may not be harmful to people. For example, an iron flavor or rotten egg odor aren't necessarily harmful, just unpleasant. Other pollutants, such as mercury or toxic chemicals, may not be visible in our water supply but they're harmful. In order to keep drinking water safe and fresh water safe for lake and stream animals, we must perform many chemical tests to evaluate water quality. Students should share their ideas about what they can do to help prevent water pollution.

Assessment Options

1. Collect the **Would You Drink This Water? Data Sheet** from groups and evaluate the worksheets and group participation during the activity to ensure that students are able to define water pollution and that students know:
   - that there are various types of water pollution
   - how the different types of pollution affect fish and aquatic habitats
   - that some pollutants are difficult to detect using our senses alone
   - that not all water that may seem unsafe (by taste, smell or sight) is actually polluted
   - three things individuals can do to keep the water clean
2. Assessment options include the Checklist and Rubric on the following pages.



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Would You Drink This Water? Checklist

Possible Points	Points Earned Student	Points Earned Instructor	
7	_____	_____	Student completes all seven questions correctly.
5	_____	_____	Student demonstrates excellent understanding of contaminants and their effects on fish.
4	_____	_____	Completed worksheet is easy to read and contains no errors.
4	_____	_____	Student follows directions for group work.
4	_____	_____	Student works cooperatively to complete all role duties within the group.
3	_____	_____	Student can explain and give examples of why water that may appear clean isn't necessarily healthful to drink.
3	_____	_____	Student can explain and give examples of why water that looks, smells, or tastes contaminated may be clean and healthful to drink.
2	_____	_____	Student can define *water pollution*.
Total Points			
32	_____	_____	**Score** _____

Checklists are tools for students and instructors. Checklists involve students in managing their own learning. They help students understand and set learning goals before the lesson begins, and help them monitor their progress during the lesson, ensuring that they meet learning goals and objectives by the end of the lesson. Students can also use checklists to discover areas that may need improvement. Checklists help instructors monitor each student's progress throughout the lesson, facilitating appropriate adjustment of instruction to ensure learning by the end of the lesson. The instructor may wish to have students add several of their own learning goals to the checklist to personalize it, and to accommodate varied learning needs and styles.

Grade

30-32points = A
Excellent. Work is above expectations.

27-29 points = B
Good. Work meets expectations.

20-26 points = C
Work is generally good. Some areas are better developed than others.

16-19 points = D
Work does not meet expectations; it's not clear that student understands objectives.

0-15 points = F
Work is unacceptable.

Would You Drink This Water? Scoring Rubric

Sensing Water Quality	4 Excellent	3 Good	2 Fair	1 Poor	0 Unacceptable
Would You Drink This Water? Data Sheet	Completed all eight questions correctly and demonstrated excellent understanding of contaminants and their effect on fish.	Completed six or seven questions correctly and demonstrated an understanding of contaminants and their effect on fish.	Completed five or four questions correctly and described the effects of one contaminant on fish.	Completed three or fewer questions correctly. Didn't demonstrate an understanding of water contaminants and their effects on fish.	Didn't complete questions.
Legibility	Worksheet legible and contained no errors.	Worksheet legible, but contained two or three grammatical errors.	Worksheet was hard to read, with numerous grammatical errors.	Worksheet illegible.	Didn't complete worksheet.
Small group skills	Followed directions for group work. Worked cooperatively and completed all role duties within the group.	Displayed some initial difficulty with following directions. Worked cooperatively but didn't complete all duties effectively.	Didn't follow directions. Displayed initial difficulties with working cooperatively within the group. Didn't complete duties in the group.	Didn't follow directions or work cooperatively.	Didn't participate in group activity.

Score _____ (Calculate score by dividing total points by number of criteria.)

Diving Deeper

Extensions

1. Take a field trip to a local water treatment plant to see how cities clean their water and to talk with experts about local water issues.
2. Have students research the source of their town's water supply—is it a lake, a stream, or the ground? Have them propose some potential sources of pollution that could affect the water at that location.
3. Have students research a recent water pollution incident that happened close to home or elsewhere in the state (such as a chemical spill, feedlot discharge, a beach closing due to bacteria). Have them propose ways to reduce the chances of future incidents.
4. Ask students where they suspect pollution problems exist in their town. Discuss the possible source of these pollutants, the effects they have on the habitat, and how they affect fish that people catch and eat. Make a list of these sites or facilities and select a few to visit. Contact the owner or public relations department to set up a tour of the facility or get permission to visit the site. Have the tour guide explain where they collect the water, how they use it, if they clean it, how they dispose of it, as well as any other things they do to help protect our resources. After the tour, ask students what they themselves, the owner, or the company could do to help make the process less polluting, or to expand their positive efforts to other areas.
5. Have students act the roles of scientists who must invent ways to help people conserve water in their homes. They can describe, in writing or with an illustration, how their inventions help people conserve water.

For the Small Fry

K-2 Option

1. Do the water testing with senses as an entire class while making an effort to actively engage each student. All students get a chance to participate by indicating (silently with raised hands) whether they would drink the water based on its appearance. For each of the six samples, the instructor can ask a different smeller and taster to be blindfolded and evaluate each water sample. Another student or two can record the data (yes or no) on the whiteboard. At the end of the activity, lead a group discussion.
2. Have some samples of actual pollutants in other bottles or buckets. For example, pour soil into some water and discuss how the polluted water could harm fish.

STUDENT COPY

Name(s) _____ Date _____

Would You Drink This Water? Data Sheet

For the looker, smeller, and taster, record YES or NO in the correct box after they indicate whether they would drink the water. After everyone is done and blindfolds are removed, team members may guess what substance, if any, is in each water sample.

	Looker	Smeller	Taster	What's in it?
Cup 1				
Cup 2				
Cup 3				
Cup 4				
Cup 5				
Cup 6				

STUDENT COPY

Name(s) _____ Date _____

Would You Drink This Water? Data Sheet

Part 1: Read the following statements carefully. Circle **True** if the statement is true. Circle **False** if the statement is not true. Explain why the statement is true or false.

1. **True or False** If water has a bad taste, it's always unsafe to drink.

Explain your answer. _____

2. **True or False** Water that smells bad must be harmful to humans.

Explain your answer. _____

3. **True or False** Water that looks clean isn't always safe to drink.

Explain your answer. _____

Part 2: Answer these questions.

1. Define water pollution.

_____

2. List two kinds of pollution we *can* see in a body of water such as a lake or stream.

_____

3. List two kinds of pollution we *can't* see in a body of water such as a lake or stream.

_____

4. How might water pollution affect fish and fish habitat?

_____

_____

_____

_____

5. List three things you can do to reduce water pollution.

_____

_____

INSTRUCTOR COPY

Would You Drink This Water? Data Sheet

Part 1:
1. **False** Water may taste bad to someone, but it could still be safe to drink.

Water with some odors, tastes, or appearances may not be harmful to us. For example, an iron flavor or rotten egg odor are not necessarily harmful, just unpleasant.

2. **False** Water that smells bad is not necessarily harmful to humans.

Water with some odors, tastes, or appearances may not be harmful to us. For example, an iron flavor or rotten eggs odor are not necessarily harmful, just unpleasant.

3. **True** Water that looks clean isn't always safe to drink.

Other pollutants, such as mercury or toxic chemicals, may not be visible in our water supply, but they're harmful.

Part 2:

1. Define water pollution.

Polluted water contains substances or has qualities that make the water unpleasant or unhealthful for humans and other organisms.

2. List two pollutants that we can see in a body of water such as a lake or stream.

Sediment, excessive algae growth, trash, or petroleum film on water

3. List two pollutants that we can't see in a body of water such as a lake or stream.

Mercury, pesticides, bacteria, or nutrients such as phosphorus

4. How might water pollution affect fish and their habitat?

Pollution can make the water cloudy, affecting a fish's ability to breathe and find food; it can make them sick if it accumulates in their bodies; it can kill plants or other animals that the fish depend on for food; it can change the nature of the water (temperature, oxygen content, or acidity) making it uninhabitable; it can change the nature of hiding, feeding, and nesting places.

5. List three things you can do to reduce water pollution.

Conserve water, dispose of waste properly, don't litter, use environmentally-friendly products, reduce-reuse-recycle-renew!