Monitoring to Protect Water Quality

Town and city water supplies have to be monitored regularly to ensure that the quality of the water remains high. Water technicians regularly measure the chemicals and organisms in the water and observe how it looks and smells. In this way, they can identify possible problems and adjust the water treatment to eliminate them.

Similarly, research scientists use monitoring techniques to protect the environment. Monitoring also helps them develop appropriate technologies to help protect the environment. Think back over what you have learned about aquatic environments. You can probably list several things that scientists would monitor in a lake, slough, river, or stream. The presence of toxic chemicals in the water is one of these. Another one is the diversity of organisms in the environment.

Figure 4.14 Logging roads built in wilderness areas can threaten streams. Scientists monitor the quality of the water to make sure no damage is done to the stream or its inhabitants. What do you think should be done if a logging company's activities affect a stream?

Ongoing Monitoring

Ongoing monitoring of a site helps scientists observe change. As you saw earlier, a change in the number of species in a lake indicates that the environment has changed. This, in turn, would be compared with other monitoring information to see what else might have changed. For example, the amount of sediment in the water might have changed because of road-building along the water's edge. The water becomes cloudy. Animals and plants that cannot tolerate this condition disappear from the lake. In turn, those animals that fed on them no longer have enough food. The information from this kind of monitoring can then be used to develop regulations and technology to protect the environment.

Figure 4.15 To develop effective clean-up technology, scientists must monitor the environment. They need information on how oil affects the shoreline and how long these effects last.

Decision Making Activity

Chlorine and the Environment

The Issue

Spring runoff is a problem for many Canadian cities. Large amounts of organic material, such as leaves, collect in their watersheds during the winter and enter the waterways when the ice and snow melt. Organic matter can affect the colour and the taste of water. Additional chlorine is usually required in the spring to ensure that the water is safe from bacteria and other disease agents. Should the amount of chlorine in our water be increased at certain times of the year?

Figure 4.16 By monitoring water throughout the year, technicians in this water treatment plant know when they have to add more chlorine.

Background Information

1. Scientists have studied the influence of chlorine on organic materials in water supplies. Some of the chlorine reacts with this organic material to form chloroform and other chlorine-containing chemicals. Research has shown that some chlorine-containing chemicals can increase the risk of cancer.
2. Working with your group, find out more about the benefits and costs of using chlorine in the water supply. Have each member of your group research information on one of the following:
   a) the risk to health of not treating water supplies with chlorine
   b) the risk to health of using chlorine in water treatment
   c) alternatives to using chlorine for water treatment
   d) scientific research underway on chlorine use
   e) what (if anything) is used to treat your local water supply

Support Your Opinion

3. When you have finished your research, share your information with your group. Design a presentation to summarize your group's findings. Be prepared to share your group's findings with the rest of the class.
4. Do you think that the amount of chlorine in our water should be increased at certain times of the year? Give reasons to support your opinion.

Problem Solving Needs More Than Science and Technology

In the *info*BIT at the beginning of subsection 4.1, you read about the changes to the Aral Sea in Russia. Over the years, human uses have drained a huge amount of water from the sea. Docks that once lined the shore are now far from the water's edge as the sea shrinks. A once rich fishing industry has been destroyed. The problems with the Aral Sea cannot be solved by science and technology alone. Scientists have studied the effects of the human impact on the sea. The technology exists to solve many of these problems. What more is needed?

Problem solving requires a strong commitment from people. People must decide what needs to be done and how to do it. In many cases, they must find the money to help carry out the solutions.

reSEARCH

Protecting Watersheds

Contact the environment ministry to find out what kind of monitoring they do in your local watershed. See if you can arrange to go with a scientist on a monitoring field trip. Prepare a field trip report for presentation to your class.

A Success Story

Can huge problems in aquatic environments be solved? A good example of a success story is the famous Thames River in England. In London, the Thames used to be an open sewer. For hundreds of years, the city dumped sewage into it. Industry along its shores dumped toxic waste directly into it. Dead animals floated in it. Just the smell of the water made people sick.

Today, the Thames is so clean and clear that types of fish that had disappeared from it years ago are starting to reappear. Scientists knew for years what was wrong with the river—pollution. They also knew how to fix it—stop the pollution. The river only started to become cleaner in the 20th century. In this case, science and technology alone could not fix the problem. People finally organized and became committed to creating a solution. In this case, the reason was public health. The Thames was a hazard to people's health.

Figure 4.17 The Thames River was once so polluted that the smell of it could make you sick.

People Working Together

Think about environmental problems in water systems in your area or elsewhere. It's likely that scientific studies have been done on these problems. The technology may exist to help solve these problems. Or perhaps the technology does not exist or is too expensive. Science and technology alone cannot do what is necessary. People have to work together and look at different ways to approach problem solving.

Check and Reflect

1. Why is monitoring an important technique in environmental protection?
2. Why can't science and technology alone solve all our environmental problems?

TRY This at Home

Activity

Pollution Dilution

Many years ago, there was a slogan that said, "The solution to pollution is dilution." Some people thought that if you diluted a pollutant enough, it would no longer be harmful to the environment. You will use a non-toxic substance to represent a pollutant such as oil. Follow the instructions here, and see if that old slogan is true.

- Arrange the cups in a row on a table or counter. Put 50 mL or 1/4 cup of water into each cup. Add 1 drop of food colouring to the first cup and mix it well.
- Take 1 tsp. (5 mL) of this solution and pour it into the second cup. Mix it well.
- Take 1 tsp (5 mL) of this solution and pour it into the third cup. Mix it well.
- Continue this process up to the last cup.
- Put the 5 samples on the sheets of paper so you can see their colour more easily.
- How many dilutions did you have to do before you could no longer see any colour difference?
- Do you think the first colourless sample would be safe to drink if the food colouring was oil?
- Is it a good idea to depend on the dilution of pollution when we dispose of wastes?

Materials & Equipment

- 5 small clear containers (cups or glasses)
- measuring cup
- water
- food colouring
- stirrer
- teaspoon
- plain white paper

Caution!
Never taste water that you use in science experiments.

Assess Your Learning

1. Think about the different ways that water is used in your community. Describe two uses other than water use in the home. Do you think less water could be used in the situations you describe? How?
2. Most treatment facilities add chlorine to their water. Explain why this is a necessary step in water treatment.
3. Describe two types of water pollution that can result from industrial development.
4. Scientific research has helped us understand what causes pollution and how it affects Earth's water systems. Through technology development, devices and techniques exist to prevent polluting activities. Use your "+/–" chart from this section (page 393) to help you explain why pollution continues to occur. Think of as many reasons as you can.
5. How can ongoing monitoring of a river help scientists determine if a change in a population of fish is caused by natural events or human activities?

Focus On Social and Environmental Context

Science and technology have both intended and unintended consequences for humans and the environment. ("Intended" means "planned." "Unintended" means "unplanned.") Think back to what you learned in this section.

1. In this section, you learned that the largest use of water worldwide is in irrigation. Why do farmers use irrigation technology? (This is an intended consequence or result of the technology.) Describe two unintended consequences (results) of using irrigation technology.
2. If you did the Decision Making Activity on chlorine, did you have any difficulty finding reliable information? Do you think some of the publications or Web sites were biassed (supported one side more than another)? How do you know? Does that mean that their information is not usable?
3. Think ahead to your water e-zine/magazine project on logging in community watersheds. What did you learn in this section that you could use in advising a community on how to identify possible unintended consequences of logging?

SCIENCE WORLD

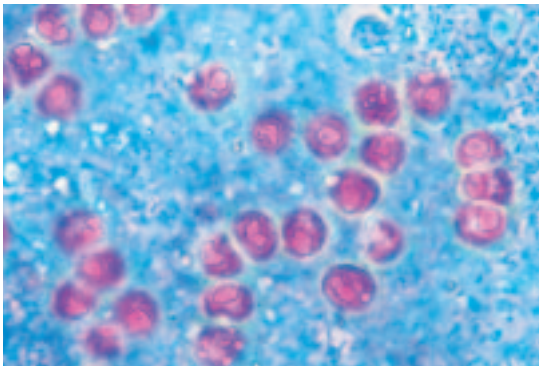
Case Study

Chemicals in Our Water Supply

The Issue

The town of Retaw is debating whether to stop adding water-softening chemicals to its water supply. Dissolved calcium and magnesium minerals are normally found in most water supplies. In some areas, like Retaw, the concentration of these minerals is so high that the water is hard. Retaw uses lime (calcium hydroxide) to soften its water. The lime reacts with the calcium and magnesium minerals so that they settle out. They can then be easily removed.

Should Retaw continue to add chemicals to soften its water supply? Look at the arguments below for and against adding chemicals to soften water.



The micro-organism *Cryptosporidium*. Water softening can make it more difficult to remove this organism from the water supply.

Retaw should continue to add chemicals to soften its water supply.	Retaw should not add chemicals to soften its water supply.
Soap works better in soft water. It creates suds more easily.	**Some soaps work in hard water.**
Soft water eliminates the problem of mineral deposits called *scale* in equipment. Kettles, hot water heaters, and other equipment can be seriously damaged by mineral buildup from hard water.	**Treating water with lime to soften it increases the cost of treating it with other chemicals.** More alum (aluminum sulphate) is needed because the lime reduces the alum's effectiveness. Alum helps remove small particles and organisms. So more chlorine is needed to kill organisms.
Soft water protects us from possible health problems associated with hard water. High levels of calcium in hard water may contribute to the development of kidney stones.	**Adding more alum and chlorine may be harmful to human health.** Aluminum in drinking water may be related to Alzheimer's disease. Chlorine compounds have been linked to increased risk of cancer.

Go Further

Now it's your turn. Look into the following resources to help you form your opinion.

- Look on the Web: Check out water softening on the Internet.
- Ask the Experts: Try to find an expert on water softening. Experts can be found in all sorts of places: your community's water department, universities, and government agencies.
- Look It Up in Newspapers and Magazines: Look for articles about water softening or chemicals in our water supplies.

In Your Opinion

Write up your point of view on water softening as one of the following:

- a letter to the editor of the Retaw newspaper
- a letter of concern to the Retaw town council
- a statement that you could read at a public forum on this issue

Unit Summary: Fresh and Saltwater Systems

Key Concepts	Section Summaries
1.0 • water quality • human impact	**1.0 Humans depend on water supply and quality.** • Most of Earth's water is in the salty oceans that cover much of the planet's surface. Of the remaining fresh water, most of it is locked in icecaps and glaciers all over the world. Our drinking water comes from groundwater and rivers and lakes. • Water in nature contains a wide range of materials including minerals, microscopic organisms, and other organic material. Water quality testing ensures that the water we use from nature is safe to drink.
2.0 • water-borne materials • erosion and deposition • stream characteristics • continental drainage systems • ocean basins • climate • glaciers and icecaps	**2.0 Water in its various states affects Earth's landforms and climate.** • Waves and tides are different types of water movement that interact with the shoreline of bodies of waters, eroding and depositing sediment. • Understanding stream and river characteristics helps us understand how erosion and deposition shape Earth's surface. • Two other important processes that shape Earth's surface are plate tectonics and glaciers. Plate tectonics resulted in the ocean basins and helped to shape the continental drainage system of North America. Glaciers have further eroded that drainage system into the distinctive pattern we see today. • Water interacts with Earth to produce the great variations in climate we experience, from desert climates to rainy ones.
3.0 • water quality • adaptations to aquatic ecosystems • human impact	**3.0 Living things in aquatic environments are affected by many factors.** • In the same way that we are affected by the air around us, living things in aquatic environments are affected by the water they live in. • The variety of organisms found in an aquatic environment depends on the water conditions of light, temperature, and depth of the water. Oceans support a greater diversity of life than freshwater systems because they contain a greater range of environments. • A population is a group of individuals of one species living in a particular area. A change in a population indicates that something in its environment has changed. • Each aquatic species is adapted to a certain quality of water. Some need very clean water with a high level of oxygen. Others can survive in murky water. No matter what their preference, a change in that quality can seriously affect them.
4.0 • water quality • human impact	**4.0 Human activities affect aquatic environments.** • Humans use water in many ways—for work, for play, for survival. Even when we aren't using water directly, we can have an effect on aquatic environments. • Our greatest use of water is in irrigation for agriculture. The next largest use is for industry. Domestic use (in the home) is third. All these uses have both intended and unintended results. Many of the unintended results are harmful to aquatic environments. • Monitoring aquatic environments helps us to understand the effects of human activities. It also helps us to develop technologies that will make our activities less harmful. • Science and technology alone cannot solve problems. People must take action and be committed to solutions.

PROJECT

To Log or Not to Log

Getting Started

You have learned in this unit that water is one of our most important resources. Here in Canada, as in other places in the world, we depend on a continual supply of fresh water. We expect clean, safe drinking water, and our agriculture and other industries depend on having large amounts of fresh water.

Our natural environment also depends on water. Our forests act as reservoirs that purify and store water. When the snow and rain fall on our watersheds, they are trapped by this ecosystem. Over time, they are slowly released into the streams and rivers that supply us with water. The trees and other organisms in these environments are affected by many factors including wastes and pollutants.

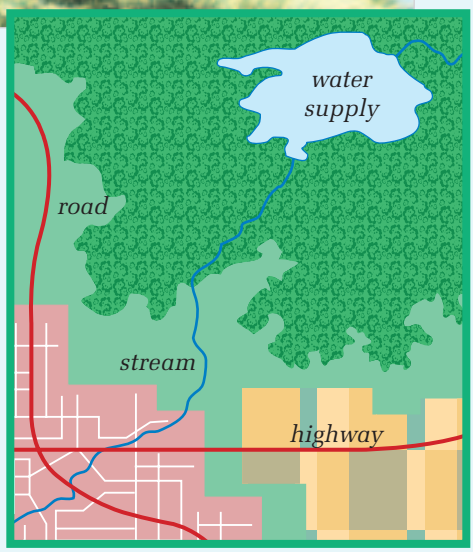
You learned that our activities directly influence water quality and availability. It is important to understand the impact that technological development has on them.

Clearcutting is the most common forestry technology used in Canadian logging.

Logging is one such activity that often stirs controversy. Wood and wood fibre are important components of many things we use. Much of northern Alberta and the eastern slope of the Rocky Mountains are heavily forested. The trees they contain are a valued source of lumber and a potential source of wood pulp for paper manufacture. But many people object to clear-cut logging, the most common logging technology. It is unsightly and can have environmental consequences, such as excessive erosion. Some people would prefer to see logging greatly reduced, but the forest industry is a major employer in Canada. In certain areas, it is almost the only employer.

In some communities, the debate about logging focusses on water quality. Should logging be allowed at all near any body of water (lake or river) that is the source for a community's drinking water? Is there some way to balance employment, environmental, and human safety considerations?

How do we protect our water supplies?



Valuable timber surrounds this community's water supply.

Your Goal

Your class will work together to design and publish a water e-zine electronically or a paper magazine that presents information and points of view about logging in a community watershed.

What You Need to Know

For the purpose of this project, assume that your community takes its drinking water from a lake surrounded by commercially valuable forests, like the one in the photograph. One of the main industries in your community and the surrounding area is forestry.

Steps to Success

1. Your class will divide up into groups to collect information, prepare articles and photos, and design and publish your e-zine/magazine. Publishing will mean either putting up a Web site or putting together a printed paper document. Articles could include news items, human interest stories, poems, fictional stories, or photo essays. Some of the topics you should cover include:
   - where your drinking water comes from
   - why water quality is important
   - how logging might affect your drinking water
   - logging technologies—clearcutting and alternatives
   - watershed protection activities
   - how logging might affect watershed ecosystems
   - importance of logging to the community's economy
   - how logging and environmental protection may be able to co-exist
   - any other related topic you think is important
2. Have other students in the school read your e-zine/magazine. If it's an e-zine, they can post their comments electronically. If it's a paper magazine, you could set up space on a bulletin board where they could post their comments on the issue.

How Did It Go?

3. Summarize the types of comments you received from other students about your e-zine/magazine. Which comments would help you improve your publication? Why?
4. If you were to produce an e-zine/magazine on another issue, what would you do differently?

Unit Review: Fresh and Saltwater Systems

Unit Vocabulary

1. Write a short story about Earth's fresh and saltwater systems using the following terms:

potable water
water quality
salinity
waves
tides
stream characteristics
watershed
glaciers
climate
diversity
populations
monitor

Check Your Knowledge

1.0

2. a) Where is most of the water on Earth located?

b) Is this water useful to humans? Explain your answer.

c) Describe the differences between the water in a lake and the water in the ocean.

3. What is the difference between salinity and hardness in water?

4. Even when water appears to be clear and clean, it may not be safe enough to drink. Describe two things that could make it unsafe for human use.

5. A friend of yours has moved out to the country but she doesn't like the well water there because it has a salty taste. What would you suggest your friend's family do to improve the quality of their water?

2.0

6. How do waves affect a coastline?

7. A wave is travelling at 50 km per hour across the ocean. As the wave passes your sailboat, you drop a toy boat onto it. How far will the toy boat travel in a day? Explain your answer.

8. What is the difference between a current and a tide?

9. a) What is the Continental Divide?

b) How is it related to the watershed that you live in?

10. a) What is a glacier?

b) How do glaciers affect the environment?

11. What effects does a large body of water have on the climate of a city on its shore?

3.0

12. Which water environment would you go to if you wanted to study as many different types of aquatic organisms as possible? Why does it have so many different types of organisms?

13. Define the term *adaptation* in your own words. Give two examples of adaptations that fish have to living in water.

14. Describe three types of human activities that can affect aquatic organisms.

4.0

15. a) Describe three major ways that people use water worldwide.

b) For each one, give an example of how this use might affect water in the natural environment.

16. What is indirect water use? Give some examples to support your explanation.

17. Agree or disagree with the following statements. Give evidence to support your decisions.

a) Because water is recycling itself all the time, we don't have to conserve it.

b) Only human activities can have negative effects on aquatic animals.

Connect Your Understanding

18. Look around your community. What evidence do you see that human activities might be harming the local water supply? What evidence do you see that efforts are being made to conserve or protect water in your area?

19. A new oceanside resort trucks in tonnes of fine, clean sand to create a beach along a rocky shoreline. In what ways could this change to the rocky shore affect the animals that live there? How do you think the wave action on the ocean's shore might affect the new beach?

20. You are out for a drive in the country, and you notice some unusual-looking hills. They are rounded and tapered at one end. You also notice snake-like ridges of gravel and sand. What is each feature called? Explain the relationship between these geological features and glaciers that covered the province in the past.

21. Imagine a glacier high up in the mountains. What do you think would happen to the glacier in each of the following situations?

a) Winter temperatures are higher than normal for 10 years.

b) Winter temperatures are lower than normal for 10 years.

c) Two winters where the same amount of snow and ice melts from the front of the glacier as falls on it farther up.

22. Ten years ago, there was only one house beside a lake. Today, there is a small community, including a marina and a campground. (A marina is a place on the waterfront where people can park their boats in the water.) Ten years ago the fishing was good here, but now very few fish are caught.

a) What factors do you think affected the fish population? (Think about factors other than overfishing.)

b) What effect do you think the change in the fish population might have on the other animals in the lake? Hint: Think about micro-organisms as well as other, large animals.

Practise Your Skills

23. Imagine that you are a journalist who will be interviewing the head of a mining company that is about to develop

a mine in a wilderness area of the province. Make a list of questions you will ask about how the development will affect water in that area.

24. Plan an experiment to determine which of three water samples is safest to drink. Hint: Limit your testing to suspended solids and organisms.

a) What are your major variables?

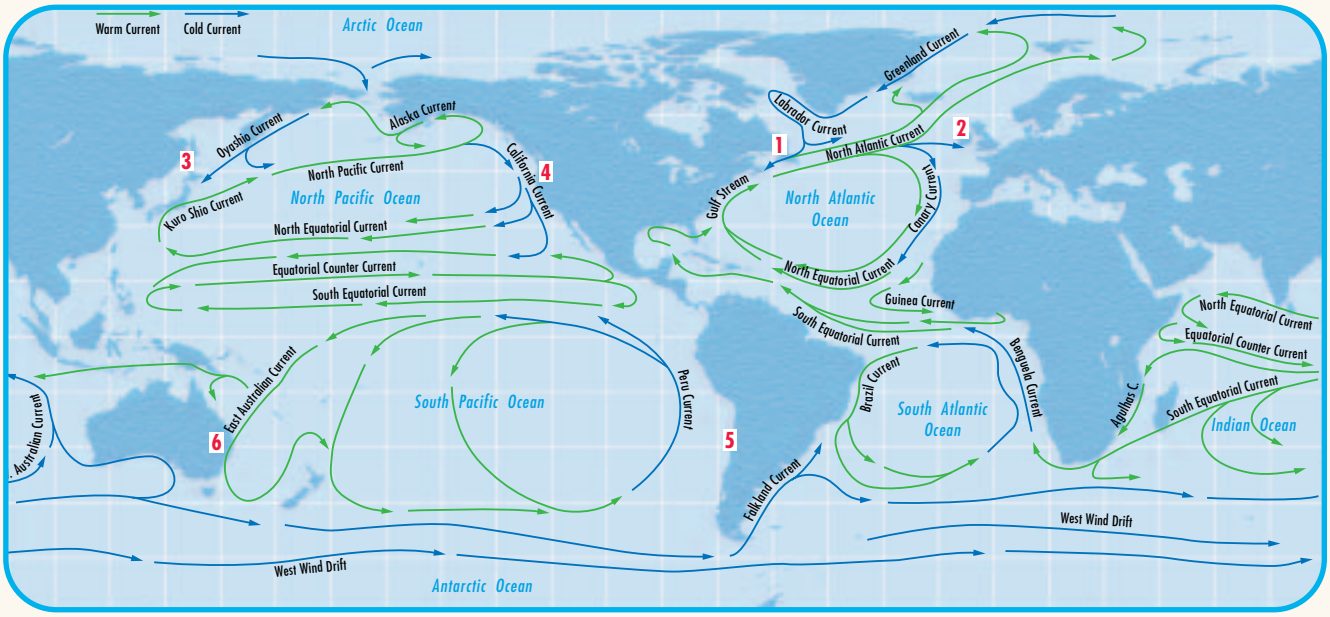
b) What materials would you need?

c) What procedure would you use?

25. On the map shown below, six cities are shown and the ocean currents that pass near them. Compare the following pairs of cities:

- (1) St. John's, Newfoundland, and (2) Dublin, Ireland
- (3) Sapporo, Japan, and (4) Vancouver, British Columbia
- (5) Santiago, Chile, and (6) Sydney, Australia

For each pair, predict which one will have a warmer climate and which one will have more rain. Explain your predictions for each one. Check your predictions by using reference books and the Internet.



Question 25. Which cities have warmer climates? Which cities have more rain?