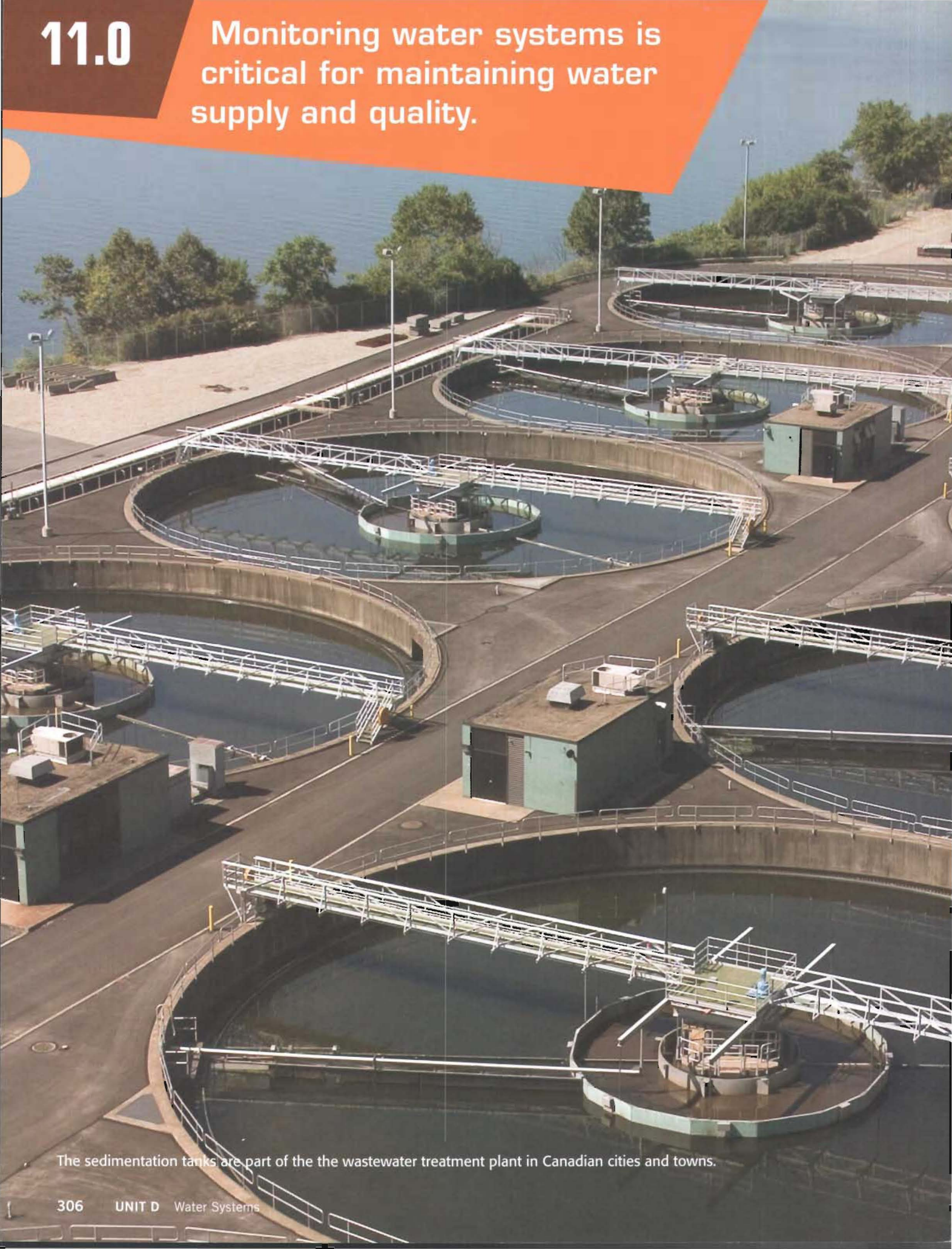
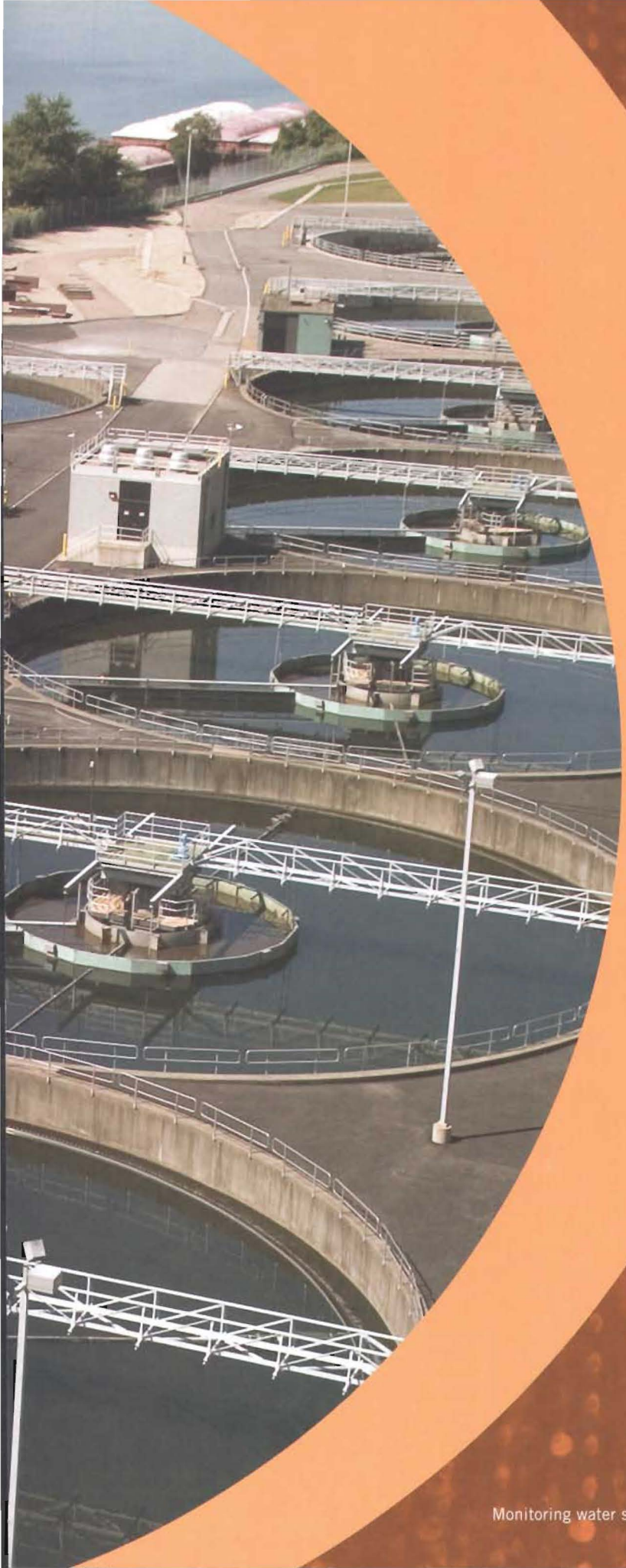
11.0

Monitoring water systems is critical for maintaining water supply and quality.



The sedimentation tanks are part of the the wastewater treatment plant in Canadian cities and towns.



What You Will Learn

In this chapter, you will:

- explain how natural events and human activities can change the water table and affect our water supply
- explain the stages involved in processing drinking water and treating waste water
- design and build a water filter and test its efficiency
- analyze a local water issue and develop a plan of action

Skills You Will Use

In this chapter, you will:

- follow established safety procedures when using apparatus
- design, build, and test a water filtration device
- test water samples for a variety of chemical characteristics

Why This Is Important

Regularly monitoring our water systems enables us to ensure that our water is clean and safe to drink now and in the future.

Before Reading

Thinking Literacy

Asking Questions

Science inspires readers to be curious. Think about the title for Chapter 11. Then, use the 5Ws and "How" to turn parts of the title into questions. For each question, indicate whether the answer would require the reader to (1) have a fact or knowledge or (2) form an opinion or make an evaluation.

Key Terms

- chlorine
- contaminants
- recharge
- septic tank
- discharge

Monitoring water systems is critical for maintaining water supply and quality.

11.0 Getting Started

Figure 11.1 This kind of *Escherichia coli* bacterium can make us very ill if it is in our food or our water (magnification of 50 000×).

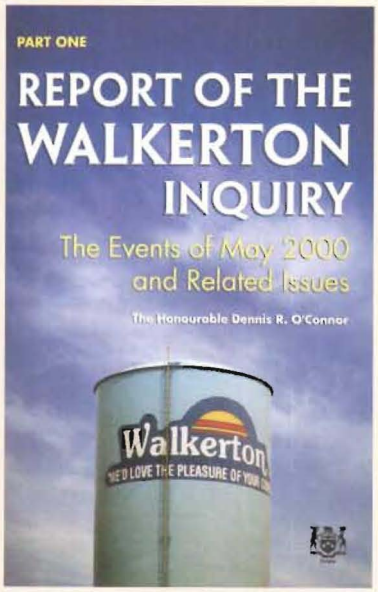


Figure 11.2 The tragedy in Walkerton, Ontario, reminded everyone about the serious consequences of unsafe drinking water.

You read in Chapter 10 that whatever happens in one part of a watershed can influence its other parts, affecting the health of forests, wildlife, and people. In May 2000, the people of Walkerton, Ontario, learned this first-hand (Figure 11.2).

Walkerton is a rural community of about 5000 people near the city of Owen Sound. Three large wells supply drinking water to the people living there. In the spring of 2000, the drinking water in one of the wells became contaminated because three things happened at the same time.

- A normal farming activity (spreading cow manure on a field as fertilizer) resulted in bacteria seeping into the ground and washing into the well water.
- The amount of chlorine usually added to treat the water in the well was not being monitored. **Chlorine** is a chemical used to disinfect (meaning kill organisms in) water. If enough chlorine had been added to the well water, the bacteria would have been killed.
- Testing and reporting of the well's water quality was not being done properly.

As a result of these three things, the residents of the area who drank this contaminated, improperly chlorinated water became ill. Seven people died and more than 2000 others became ill.

As you may recall from previous studies, bacteria exist all around us. Some can harm humans. The bacterium that contaminated the Walkerton well water is called *Escherichia coli* O157:H7 (Figure 11.1). This is the same bacterium that can be found in uncooked ground beef. There are many, many other kinds of *Escherichia coli* (*E. coli* for short), but not all are harmful. *E. coli* bacteria are found in the intestines of mammals. A lot of them are present in your intestines right now, helping to keep them functioning normally. The O157:H7 kind, however, can make us very ill or even kill us. Cows, on the other hand, are not affected by it. *E. coli* O157:H7 can live in a cow's intestines and a farmer would not know it.

The sad story of Walkerton's contaminated water supply reminds us of the importance of checking to see that our drinking water is safe. Even water that looks clear and clean may contain harmful bacteria and other microorganisms that are invisible except under a microscope. For this reason and many others, it is critical that our water systems be monitored.

WORDS MATTER

A bacterium is a type of micro-organism. The plural of bacterium is bacteria.

D20 Quick Lab

Dissecting a Water Filtering Device — Teacher Demonstration

Many people use small purchased water filtering devices in their homes. These are designed to filter out some heavy metals that might get into tap water from old pipes. Your teacher will cut a filter apart so that you can see what is inside.

Materials & Equipment

- 1 water filter
- hacksaw

CAUTION: The hacksaw blade is very sharp. Use the saw with care.

Procedure

1. Watch as your teacher opens up the side of the water filter.

Questions

2. Draw a diagram of the cross-section of the opened water filter.
3. What is the filter capable of removing from the water?

11.1 Natural and Human Factors Affecting Our Water Supply

Here is a summary of what you will learn in this section:

- Natural occurrences such as flooding, droughts, and earthquakes can cause changes in the height of the water table.
- Overuse of wells has the potential to alter groundwater supplies permanently.
- How much water we take from our environment and how we alter it before disposing of it can affect both the supply and the quality of water.

Imagine that you have a large rain barrel filled with water. Every time you need to use water outside, it must come from the barrel. That includes watering plants and washing the car. The barrel can only recharge after a rainfall. **Recharge** means refill. Therefore, if you were to use water faster than the supply in the barrel could recharge, you would soon run out.

Like the rain barrel, a watershed receives only a certain amount of water each year. That water recharges above-ground reservoirs, such as rivers and lakes, and underground reservoirs, such as aquifers. Because most of the fresh water in Canada lies below the surface, we need to pay attention to natural and human factors that can affect our groundwater supply.

D21 *Starting Point*

Skills P C

Nature and the Water Table

Draw a three-column K-W-L chart.

- In the first column, write down three statements that you know about nature's water table. At the top of the column, put K ("What I know").
- In the second column, write down three questions that you would like to have answered about the water table. At the top of the column, put W ("What I want to learn").
- As you are studying this section, fill in the third column with statements describing what you learned about the water table. At the top of the column, put L ("What I learned").

The Rising and Falling Water Table

The rain barrel described earlier is a lot like a watershed. If more water leaves a watershed than enters it, a shortage will result. The usual water levels in lakes and rivers will start to drop. Below ground, the level of the water table will drop as the amount of ground water decreases (Figure 11.3).

On the other hand, if more water fills a watershed than can leave it, a different problem occurs. When it rains, water soaks into the ground, filling up the layers of soil and aquifers. If the rain continues, the top of the water table will rise closer to the ground's surface. In low-lying areas, this means that the water table might reach the surface and lead to flooding (Figure 11.4). Flooding may not only damage property but also cause drinking water to become contaminated. For example, when flooding occurs in saltwater areas, the water table may become contaminated with salt, making it unsuitable for drinking.

Both natural factors and human activities can affect our water supply by changing the water table. The result can be a scarcity of water for consumption or too much water, which can lead to flooding and possibly contamination.

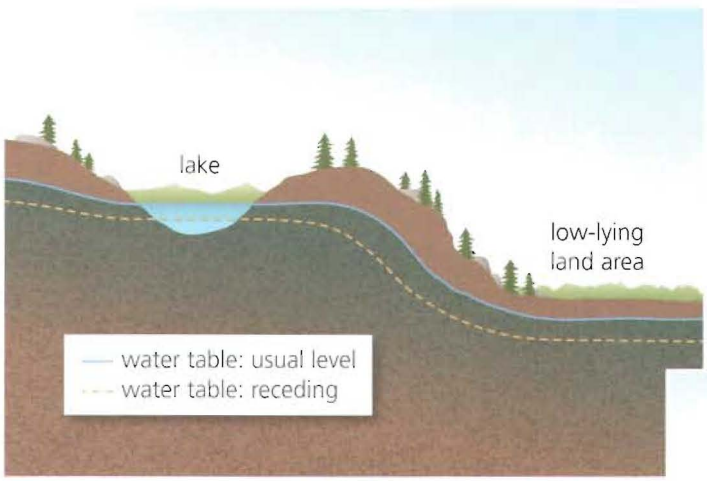


Figure 11.3 The results of a falling water table

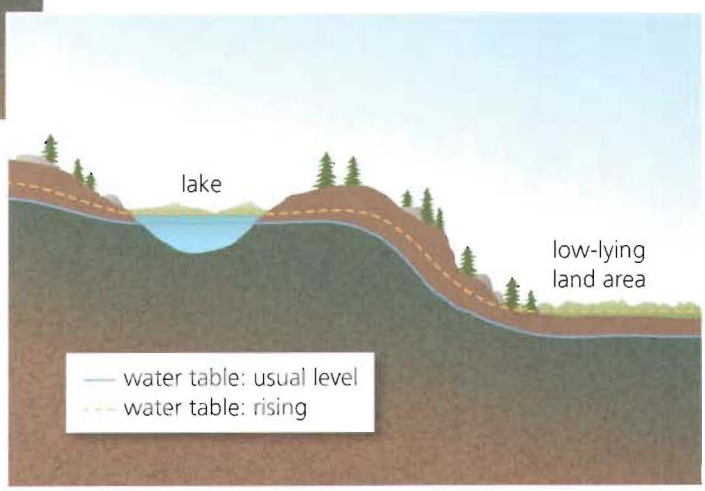


Figure 11.4 The results of a rising water table

Figure 11.5 Many streets and basements filled with water during the 2004 flood in Peterborough, Ontario

Natural Water Table Changes

On July 15, 2004, Peterborough, Ontario, received 200 mm of rain (Figure 11.5). Basements flooded and waste water backed up in pipes. People with drilled wells were told to boil their drinking water. Floods are natural occurrences within a watershed.

As water cycles from water bodies to the atmosphere and back again, water levels naturally rise and fall. Droughts and earthquakes are other natural occurrences that affect water supply.

Flooding

Flooding can be brought on by heavy rainfall, ice-jams, sudden spring thaws, and storms. Flash floods are floods that come without much warning. They are caused by heavy, concentrated rainfall such as the kind you would see during a thunderstorm. The rain flows rapidly across bare ground and paved surfaces, causing the water level in storm drains to rise, overflow, and back up. Surface flooding then occurs.

Drought

Canada's Prairies have been experiencing drought conditions in recent years. Droughts are long periods of little or no precipitation. The result is that a watershed gradually starts to lose water. Lakes and rivers may experience falling water levels. As less ground water collects, the upper surface of the water table gradually drops. Communities must restrict water use during these drought periods.

Earthquakes

Although earthquakes are not that common in central Canada, they can affect the water table directly. In earthquake-prone areas of the world, scientists have noticed a drop in the water table by as much as 1 m after a quake. This affects the ability of wells to draw water. Such a disruption in the water table can also cause ground water to become cloudy, affecting its potability.

Suggested Activity
D23 Problem-Solving Activity
on page 315

D22 Learning Checkpoint

Your Water Table K-W-L Chart

Referring to the reading that you have just completed on natural water table changes, add two sentences about what you learned to the third column (column L) in your K-W-L chart.

Human Causes of Water Table Changes

Human activities can also affect the water supply. For example, flooding may occur if a dam or other human-made water reservoir collapses. Most often, however, it is our overuse or misuse of water that hurts the supply.

Overuse of Wells

More than 25 percent of Canadians rely on ground water for their water needs. Most of these users live in rural areas. As you read in Chapter 10, wells are drilled into aquifers to obtain the water (Figure 11.6).

The water cycle naturally recharges our groundwater supply. An unusually dry summer or a winter with little snow results in less water sinking into the ground and collecting in aquifers. Because we cannot do anything about a dry cycle in nature, it is important that users of wells be aware of the reduced precipitation and draw less water from the ground. Overuse of wells can deplete underground aquifers, often for long periods.

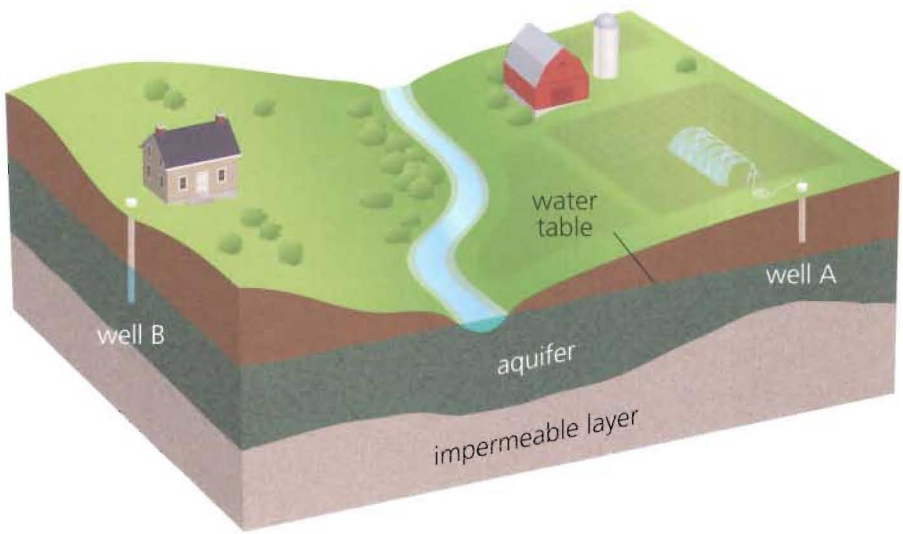


Figure 11.6 This cross-section of ground shows two wells. Well A has run dry because the depth of the water table has fallen below it. Well B is continuing to produce water because the well still reaches the aquifer.

Farming and Industry Practices

Many large-scale farms and industries need immense quantities of water in their operations. That is one reason why many industrial plants are located beside a river or lake. After the water is used, it is discharged back into the environment. **Discharge** means to release or pour out. The used water may be discharged directly into a water body, the atmosphere, a wastewater drainage system, or a ground filtration system. Often, the water that is put back is not as clean as it was when it was taken out of the environment. Also, sometimes less water is put back into the natural system than was removed.

Figure 11.7 Producing electricity in nuclear power plants, such as this one at Pickering, Ontario, uses a great deal of water.

Figure 11.8 The mining and petroleum industries use large volumes of water. In Alberta's Athabasca River basin, hot water is used to separate the oil from the oil sands deposits.

Examples of large-scale water use include crop irrigation, power generation other than hydroelectric (Figure 11.7), and industries such as pulp and paper production and mining. The oil sands development in northern Alberta's Athabasca River basin is of particular concern because of the enormous effect it is having on the supply and quality of fresh water in the region (Figure 11.8).

Water Diversion and Export

The bottled water industry also removes large quantities of water from our water supply. The majority of Canada's bottled water industries are in Ontario, Quebec, and British Columbia. Millions of litres of water are removed from a variety of sources, including springs, municipal water treatment systems, aquifers, and glaciers. If more water is removed than replaced, the height of the water table will be affected. Also, water may be pumped out of one location and shipped to another province or country. When this happens, the water is not returned to the watershed from where it was extracted.

SKILLS YOU WILL USE
- Identifying possible solutions
- Designing, building, and testing

Clearing Muddy Waters

Recognize a Need

Events such as flooding can cause soil to dirty well water. The first step in bringing this water back to a usable condition is to filter out the soil. In this activity, you will design, build, and test a device for filtering soil sediment out of water.

Problem

What is the best way to filter muddy water?

Materials & Equipment

- one 2-L plastic pop bottle
- scissors
- 1 L muddied water (from your teacher)
- coarse, dry sand
- cotton balls
- 2 sheets of paper towel
- approximately 250 mL of pebble-sized gravel

Criteria for Success

Your water filter must:

- allow at least 250 mL of the muddy water to pass through it without clogging up.
- remove enough of the soil particles so that the water that has passed through the filter is noticeably clearer.

Brainstorm Ideas

With a partner, discuss how you might use the materials provided to create a filter. In a design brief, write down all your ideas.

Make a Drawing and Build a Prototype

1. Decide on the best idea for your filter. Make a drawing first of the outside of your filter structure and then of the inside of the filter, showing the layers.
2. Build your water filter.

Test and Evaluate

3. Obtain the sample of muddy water from your teacher. Test your filter by *slowly* pouring the muddy water into the filter.
4. Observe what happens to the water as it passes through the filter layers. Record your observations on your design brief.
5. Suggest one improvement that you could make to the water filter you designed.

Communicate

6. Present your results to the class, including how they met the two design criteria set out.
7. How did the construction of your filter compare with that of other groups in your class? Which group's filter removed more of the soil particles than other filters did? Why?
8. As water moves through the ground layers on Earth, it is naturally filtered. How does your water filter compare with Earth's natural water filter in cleaning our ground water?
9. Think back to what you learned about the Walkerton tragedy at the start of this chapter. Even though you have removed soil from the muddy water, is it safe to drink? Explain your answer.

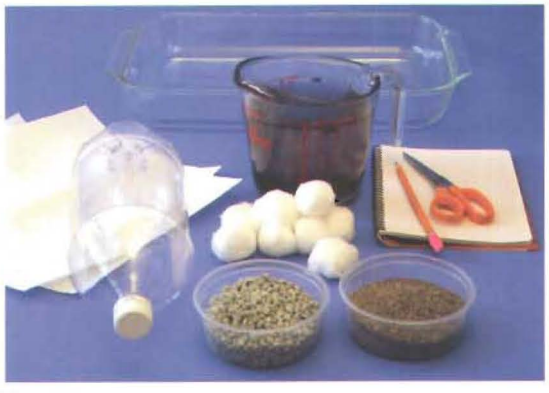


Figure 11.9 The design materials

11.1 CHECK and REFLECT

Key Concept Review

1. Why does heavy rainfall sometimes result in flooding?
2. (a) Name two large user groups of our freshwater supplies.

   (b) Explain how each group's actions can affect our water supply.
3. Describe two ways in which humans have negatively affected ground water.

Connect Your Understanding

4. A bottled water company wants to set up a plant in your community. What are two concerns that your community might have?
5. Flood water can be contaminated with chemicals, salt, and unsafe levels of microorganisms. Explain why this should be a concern to the people in the community.

Practise Your Skills

The table below contains data on some historical floods in Canada. Use the information to answer question 6.

Date	Location	Cause	Estimated Property Damage (year 2000 dollars)
Sept. 1999	Maritime provinces	Heavy rainfall (Tropical Storm Harvey and Hurricane Gert)	$12.0 million
April 1999	Melita, MB	Flooding of Souris River	$103.0 million
May 1997	Manitoba	Flooding of Red River and Assiniboine River valleys	$815.0 million
July 1996	Québec	Flooding of Saguenay River valley	$1.5 billion
May & June 1974	Québec	Excessive snow melt and higher-than-normal rainfall	$359.0 million
Oct. 1954	Toronto area, ON	Heavy rainfall (Hurricane Hazel)	$1.0 billion

6. Create a graph to display the property damage figures for the flood events shown in the table.

For more questions, go to ScienceSource.

D24 *Thinking about Science, Society, and the Environment*

Competing for Water Use

Most golf courses require large amounts of water to keep their fairways green. In communities where the supply of fresh water is already at low levels, some groups have argued that using a limited natural resource for a recreational activity should not be allowed. What do you think about this? Should recreational businesses have the same access to water resources as industries, farm operations, and public facilities such as hospitals do?

What to Do

1. Discuss the issue as a class. Make a list of the social, economic, and environmental consequences of both sides of the argument.
2. Think of what actions could be taken to help resolve the concerns on both sides.

11.2 Obtaining Water Quality

Here is a summary of what you will learn in this section:

- Water quality can be affected by physical, biological, or chemical contaminants.
- We obtain the water we need from underground and aboveground sources.
- Water that is removed from our water systems must be treated and tested before it is safe to drink.

You have learned how important having a steady supply of water is to us and to our environment. Just as important is the quality of our water systems, because they provide us with drinking water. Our drinking water must be clean and free from harmful organisms and chemical substances (Figure 11.10). To ensure that it is, we treat it.

We have a responsibility not to take our treated water for granted. More than one billion people in the world do not have access to clean drinking water. Many developing countries cannot afford to build facilities to treat or test drinking water. People wash and drink directly from the same river water where human and animal wastes have been discharged. Illnesses caused by contaminated water kill thousands of people in these countries every year.

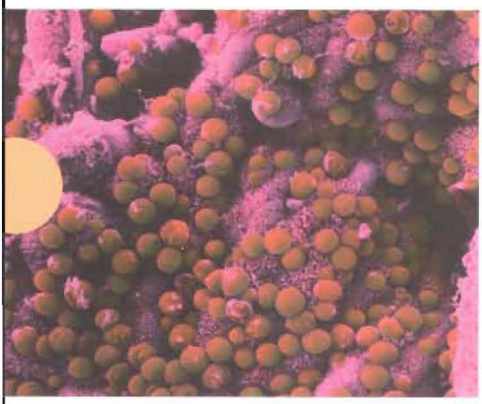
Figure 11.10 The water we drink and even the water we play in needs to be clean and free from harmful chemicals and from organisms that can cause disease.

D25 Starting Point Skills A C

How Much Do You Know about Your Drinking Water?

Answer the following questions orally with a partner to determine how much you know about the water you drink.

1. What is the source of the drinking water (for example, the name of a lake or river) in your home?
2. Is your drinking water chlorinated?
3. What water storage facilities (for example, water tower) exist in your community, and where are they located?



(a) *Cryptosporidium parvum* (greatly magnified)

(b) Chemical pesticides

(c) Visible sediment (on the left)

Figure 11.11 Examples of water contaminants: (a) biological, (b) chemical, and (c) physical

Factors Affecting Water Quality

The water that flows into your sink or bathtub has flowed through your local watershed. Therefore, whatever human activities or natural events affect the water systems in your watershed will affect the water that reaches your home.

You might think that a factory 50 km away that discharges harmful chemicals into a nearby river has nothing to do with you or with your community's health. Yet, the factory's actions do affect you because that river is likely part of your watershed. The same is true if home gardeners and golf course operators near you are using harmful chemicals that can seep into the water system. All of these actions are connected to you because they all have the potential to contaminate your community's water supply. **Contaminants** are contents that are harmful to humans, other animals, and the environment.

The contents of water are typically categorized into three types:

- biological: both visible (such as zebra mussels) and microscopic organisms (such as bacteria and viruses)
- chemical: dissolved substances that come from natural processes (such as dissolving limestone) or human activity (such as dissolved road salt)
- physical: all materials that do not dissolve in water (such as animal waste and plant debris)

Not everything that water contains is harmful. Figure 11.11, however, shows examples of contents that are. When water is removed from the environment for drinking, it must be treated and then tested to ensure that contaminants do not harm our health.

Treating Groundwater Sources

For the many Canadians who get their water from a well, the water is usually filtered before drinking to remove contaminants. The water must also be tested regularly to ensure that it is safe to drink. Samples of the water can be sent to laboratories for testing.

Canada has some very large aquifers that supply ground water to industry and municipalities. One such aquifer in the Kitchener-Waterloo area of Ontario provides much of that region's water.

Treating Aboveground Water Sources

We generally cannot drink the water as it exists in our freshwater systems. As you have learned, water in our streams, rivers, and lakes can contain harmful organisms and substances that can be hazardous to our health. The water from aboveground water sources needs to be treated before it becomes drinking water. Boiling water before drinking it will kill harmful organisms, but it will not remove chemical or physical contaminants.

Most Canadians obtain their drinking water from a lake, river, or reservoir. The water is treated and distributed by the town or city where they live so that it is safe to drink. The type and amount of treatment the water receives depends on the condition of the water at its source. Polluted sources require more treatment than cleaner sources. Water treatment is very expensive, however. This is another reason to keep our water supply clean.

The Water Treatment Plant

Imagine standing on a steel floor grid with water churning and bubbling beneath your feet. Behind you is the lake where the water came from. In that lake, at least 0.5 km from shore, is the opening of the intake pipe that brings the water to this building, a water treatment plant (Figure 11.12).

A first stage in the treatment process is to pass the raw water through extremely fine membrane filters to remove contaminants. The filters are so fine that they can remove an organism called *Giardia*, which causes an illness called "beaver fever." *Giardia* is a microscopic parasite often found in the feces of beavers and other animals. If it gets into drinking water, it can make people very ill.

Figure 11.12 Inside a water treatment plant, you would see a complicated system of pipes and controls such as the ones shown here.

Most of us in Canada rely on a water treatment facility such as this to purify our water so that it is safe to drink. Not all cities use the same treatment method. Figure 11.13 shows the basic treatment stages that are typically followed.

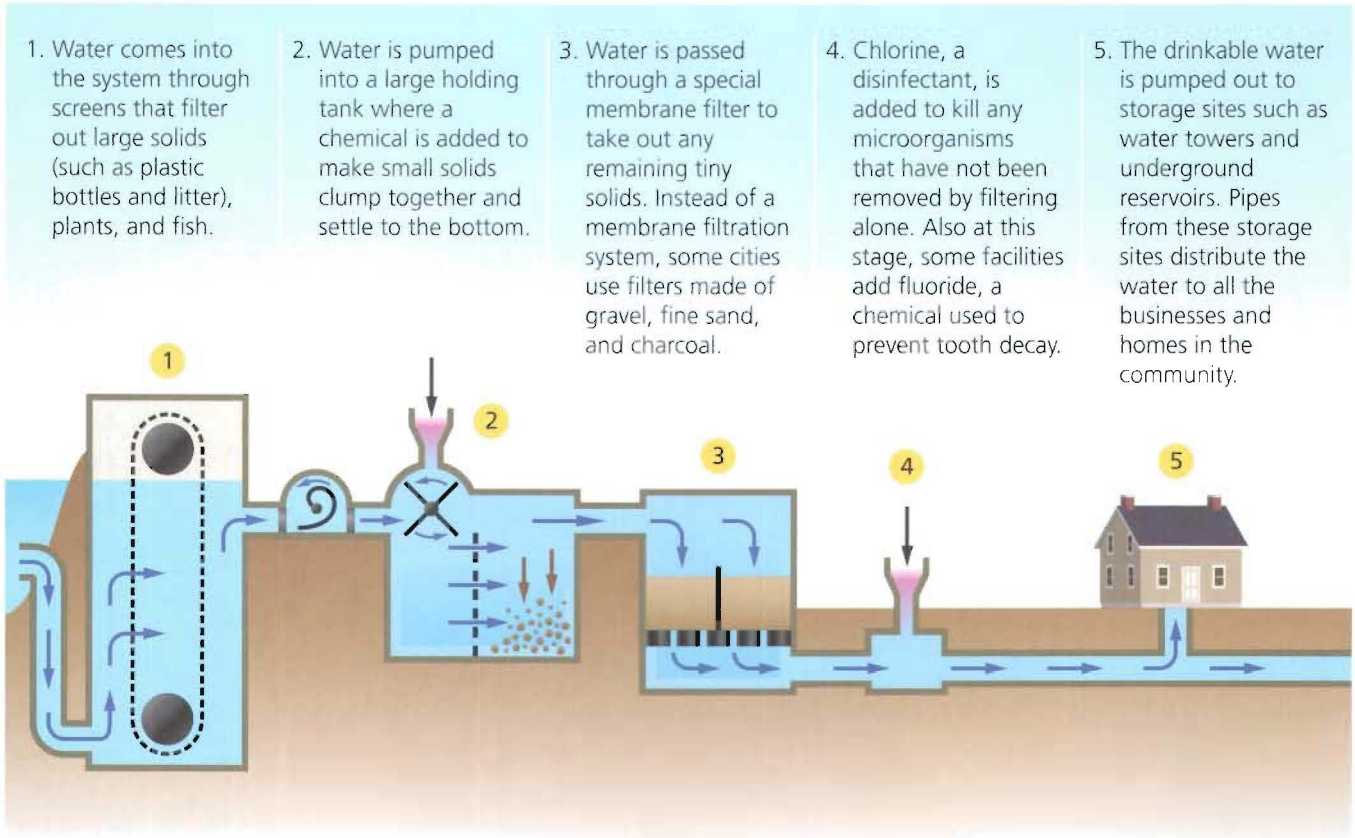


Figure 11.13 The basic stages in the water treatment process

Water treatment plants are very sophisticated and expensive facilities. They use a computerized system of checks, rechecks, monitors, and alarms to ensure that no step in the treatment process fails. Samples are tested often to show that everything is working properly and that the finished water does not have harmful concentrations of such things as bacteria and a broad range of chemicals. The people who monitor the system are highly trained to recognize problems immediately.

D26 Learning Checkpoint

The Water You Drink

1. Give one reason why it is important to keep our supply of drinking water clean.
2. What causes "beaver fever," and how is water treated to prevent this illness?
3. Why is chlorine sometimes added in the water treatment process?

Testing Water Quality

In past centuries, before technology such as the microscope was invented, no one knew why people could sometimes become ill or die from drinking water. Today, we have the knowledge and the equipment to detect microscopic contaminants even after the water is treated so that we can be sure it is truly safe to use.

Water samples from treatment plants are sent to scientists in laboratories to test. In larger communities, the tests might be done inside the water treatment plant itself. Biological, chemical, and physical tests are performed (Figure 11.14).

Drinking water samples are also taken from sites that receive the processed water, such as hospitals and schools. If an abnormal test result is obtained, the cause is investigated. Sometimes the pipes that transport the water may have caused the problem. Action is always taken immediately to repair any problems found.

Suggested Activity
D27 Inquiry Activity on page 322

In addition to biological testing for the presence of harmful bacteria, our drinking water is tested for harmful chemical substances (such as lead and nitrates) and radioactive matter. Test results are compared with government standards for safe limits. Contamination that is above the acceptable standards means that the water must not be consumed.

Figure 11.14 This microbiologist is analyzing a drinking water sample.

D27 *Inquiry Activity* Toolkit 2

SKILLS YOU WILL USE
- Measuring
- Drawing conclusions

Be a Water Quality Inspector

In this activity, you will measure the pH and salt and chlorine content of four sources of water.

Question

Which water sample will have the highest and which will have the lowest values for each test?

Materials & Equipment

- a chart for recording test results
- water-soluble marking pen
- 4 water samples to test, collected in clean 250-mL containers: tap water, rain water, bottled water, and water from a river, stream, or pond
- pH test strips
- clock or watch that reads seconds
- 4 microscope slides
- four 1-mL dropper pipettes
- light source
- 4 test tubes
- silver nitrate (1 percent weight per volume solution) in a dropper bottle

CAUTION: Do not taste any of the water samples. Follow your teacher's instructions for handling and disposing of chemicals.

Hypothesis

Write a separate hypothesis for each of the three tests you will peform. Refer to all four water samples.

Procedure

Part 1 — Measuring pH

1. Put a separate pH test strip into each sample of water for about 10 s. Remove the test strip and wait 1 min.
2. Note the colour change (the pH value) and compare it with the values shown on the test kit. Write the pH value in your chart.

Part 2 — Measuring Salt Content

3. Put a clean pipette into each water sample and leave it there for the remainder of the tests.
4. With the marking pen, label each microscope slide with one of the four water sources. With the pipette, drop 1 mL of each water sample onto its labelled slide. Place the slides under the light until they dry.
5. Examine each slide for salt residue and record your observations.

Part 3 — Measuring Chlorine Content

6. Label each test tube with one of the four water sources. With the pipette, drop 5 mL of each water sample into its labelled test tube.
7. Add four drops of silver nitrate solution to each tube.
8. Examine each tube for a change and record your observations.

Analyzing and Interpreting

9. Compare your test results with your hypotheses. Did any result surprise you? If so, which one?
10. For each water sample, explain the results that you observed for pH, salt, and chlorine.

Skill Builder

11. Why must you add the same amount of silver nitrate to the same amount of each water sample tested?

Forming Conclusions

12. (a) Would you ever expect to find salt in rainwater? Explain your answer.
    (b) What could be a source of salt in a pond water sample?

11.2 CHECK and REFLECT

Key Concept Review

1. Name four sources of drinking water for Canadians.
2. Explain what is meant by the term "water treatment."
3. (a) How are the contents of water categorized?

   (b) When are those contents of concern to scientists who test our drinking water?

Connect Your Understanding

4. You have learned from previous studies of water that it is an excellent solvent. Explain how this property of water contributes to drinking-water contamination.

Practise Your Skills

5. For each item in the list below, indicate whether it should be classified as a biological, chemical, or physical contaminant of a freshwater system. Explain your decision.
   (a) dissolved fertilizer from a riverfront golf course
   (b) spill of gasoline while refuelling a motorboat
   (c) lawn clippings from storm drain run-off
   (d) dog waste washed into the lake from a nearby campsite
   (e) smoke from a smokestack in an industrial plant
   (f) chlorine bleach used in household laundry

For more questions, go to ScienceSource.

D28 *Thinking about Science, Society, and the Environment*

Down the Drain

Many people are unaware of what gets poured down the drains in their home or school. When cleaning products, laundry detergents, medicines, hair dye, and many other products are disposed of in this way, it is easy to think they have just disappeared. This is not the case, of course. The products flow into septic tanks or wastewater pipes. Regardless of treatment, the risk of our water supply becoming contaminated is always a concern.

What to Do

1. For the next week, keep a small notebook in the kitchen of your home. Every day, record all the things that you and other family members wash down the drains in your house. (You do not need to record food items or human waste.)
2. At the end of the week, analyze your results. If you have questions about the contents of certain products, do some research to find answers. Begin at ScienceSource.
3. Propose a plan of action that would enable your family to improve the quality of the water disposed of down the drains in your home.

11.3 Managing Our Water Systems

Here is a summary of what you will learn in this section:

- How we dispose of our waste water affects the quality of our water systems.
- Protecting our water systems is important to maintaining safe drinking water sources.

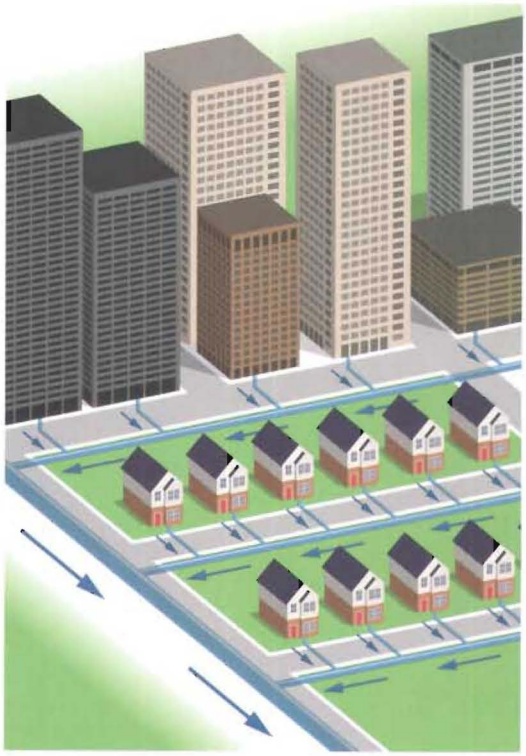


Figure 11.15 All of the waste water in your home goes into an underground collection system of pipes.

When we turn on a tap to get water, we usually give little thought to where the water is coming from. The same holds true when we flush a toilet. We are fortunate to be able to do this. Most of us in Canada obtain water from a municipal water supply like the one you just read about in section 11.2.

Municipalities also manage the removal of waste water. The sink drains and toilets in urban homes and businesses are connected to a pipe. The pipe joins a large system of underground pipes (Figure 11.15). Pumping stations send all that waste water to a treatment plant, where chemical contaminants and harmful microorganisms are removed. After that, the water is discharged to a nearby stream, river, lake, or ocean.

Treating our waste water is part of an overall plan to manage our water systems and keep them healthy.

D29 Starting Point

Skills A C

How Much Do You Know about Waste Water?

Answer the following questions orally with a partner to determine how much you know about the waste water that leaves your home.

1. Where does the waste water in your home go? If it goes to a treatment plant, where is the plant located?
2. What body of water receives the treated waste water that leaves the plant?

Treating Waste Water

Every day, we get rid of water that we have finished using or that we no longer need. Water is emptied down the drains in our homes and businesses and flushed down the toilet. With it go substances such as soap, food residue, human waste material, rags, and anything else that can accidentally or intentionally get flushed into the system.

If we were to put this waste water directly back into our rivers and lakes, we would be contaminating our drinking water supply and the water used by other animals. We therefore treat our waste water before letting it re-enter the natural environment. Several treatment methods exist. They are described below.

Septic Systems

WORDS MATTER

The word septic comes from a Greek word meaning to putrefy (decay).

The rural home that gets its drinking water from a well probably disposes of its waste water in a septic system. A septic system is a self-contained wastewater treatment facility. Waste water from all indoor sources such as toilets, sinks, and bathtubs enters the **septic tank**. Immediately, bacteria in the tank begin to break down the waste (Figure 11.16). Solid material settles to the bottom. Lighter materials such as kitchen grease float to the surface. The liquid layer in between flows into pipes that lead out from the tank. This waste water contains organic matter and nutrients such as nitrogen.

The pipes leading from the septic tank are perforated on the bottom. This means they have small holes that allow the water to seep into the soil. Once the water is in the soil, more bacteria digest and break down the organic waste. Eventually the liquid returns to the groundwater supply.

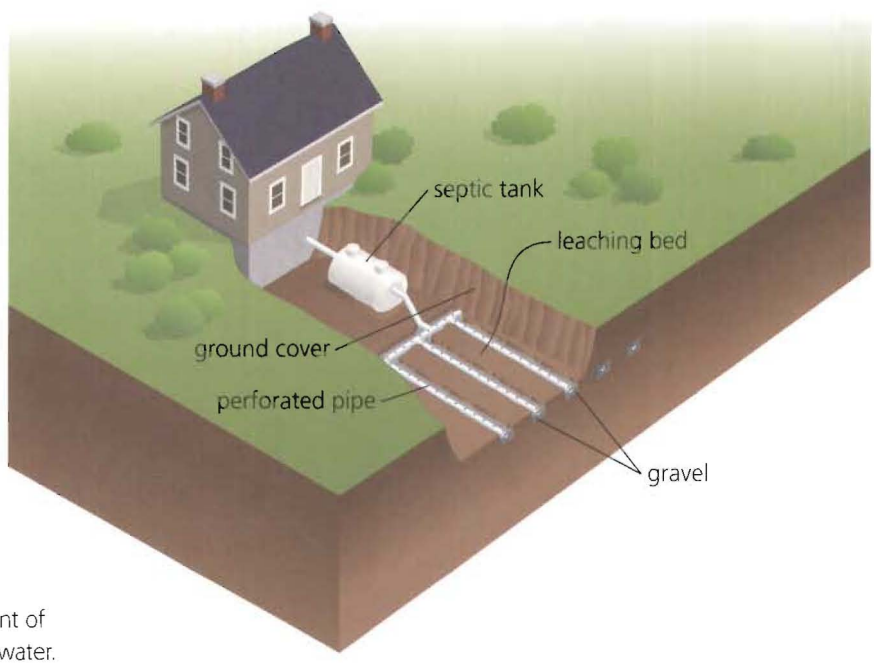


Figure 11.16 A septic system. About 25 percent of Canadians use this method to treat their waste water.

Figure 11.17 Instead of making expensive renovations to enlarge its existing treatment system, the Kortright Conservation Centre in Kleinburg, Ontario, constructed a wetland to treat its waste water.

Wetland Technology

A wetland, such as a marsh or swamp, is land that is saturated with water for long periods of time. Water-loving plants that grow in wetlands can filter and purify water. Scientists have combined knowledge of the filtering ability of natural wetlands with human technology to construct wetlands for wastewater treatment. Many smaller communities and businesses use this enhanced natural method. Some of these human-made wetlands even look like natural marshes (Figure 11.17). Just as they do in a natural setting, the plants and microorganisms in a human-designed wetland remove and recycle nutrients. Roots and soil filter out contaminants.

The Wastewater Treatment Plant

If someone asked you to name the most expensive facility in your community, you might answer that it is the new sports complex and ice arena, or the performing arts centre with the up-to-date acoustics. It is unlikely that either of those answers is correct. The most expensive facility in any community is usually the wastewater treatment plant. It costs millions of dollars to construct. For example, for a city with a population of about 50 000, a wastewater treatment facility may cost over $40 million to build and maintain.

The treatment of our waste water involves the physical plant and the network of underground pipes that gets the waste to the plant. Figure 11.18 shows the route waste water takes from your home before being released back into the natural environment.

D30 *Learning Checkpoint*

Treating Waste Water

1. What is waste water?
2. Why is it not a good idea to put waste water directly back into the environment?
3. Name three methods of wastewater treatment that Canadians use.

1. Waste water leaves your home through an underground system of pipes. It is pumped to the treatment plant.
2. Waste water passes through screens to remove large particles such as garbage.
3. Waste water enters the grit chamber. Small particles such as sand and coffee grounds settle to the bottom.
4. Waste water passes into a primary treatment tank. Heavy solids settle to the bottom, forming sludge. Material that floats gets skimmed off the top.
5. The grey effluent enters the aeration tank. It contains micro-organisms such as bacteria and protozoa that digest the organic wastes. Oxygen is added to supply the microorganisms with the environment they need.
6. The waste water passes into another settling tank. This time, the microorganisms settle to the bottom as sludge. Some of this sludge is returned to the aeration tank for reuse.
7. Harmful microorganisms can still be in the waste water, so the final treatment is usually disinfection with chlorine. Most of the chlorine is allowed to get used up before Stage 8.
8. Cleaned and treated water is discharged back into the environment.

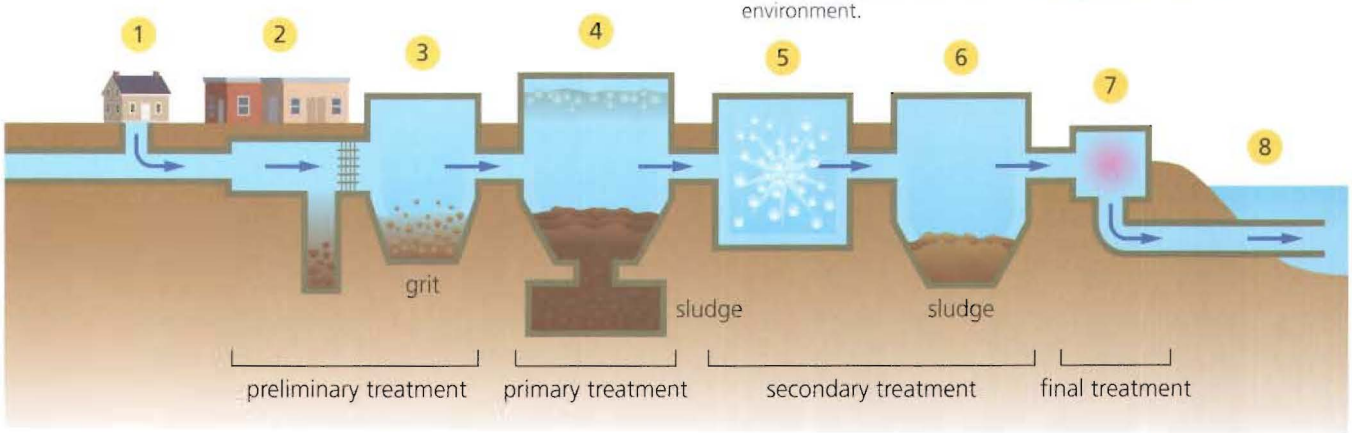


Figure 11.18 The basic stages in the wastewater treatment process

Protecting Drinking Water Sources

It costs a lot of money to treat our water so that it is safe to drink and use for other purposes. Therefore, it makes sense to prevent our rivers and lakes from becoming contaminated in the first place. The less contaminated they are, the less they need to be treated to become drinking water. Also, because not all chemical contaminants can be removed from water, it makes sense to avoid putting them there to begin with (Figure 11.19).

Protecting our drinking water sources is not only better for us, but healthier for other animals and the plants that also depend on them.

All human activities that affect our water systems affect the sources that supply our drinking water (Figure 11.20). The combined effects of these actions can make a body of water so polluted that it is unsuitable for human use.

Figure 11.19 Read product labels to find out whether special disposal is needed. Many cleaning products should not simply be poured down the drain.

Protecting Our Drinking Water Starts at the Source

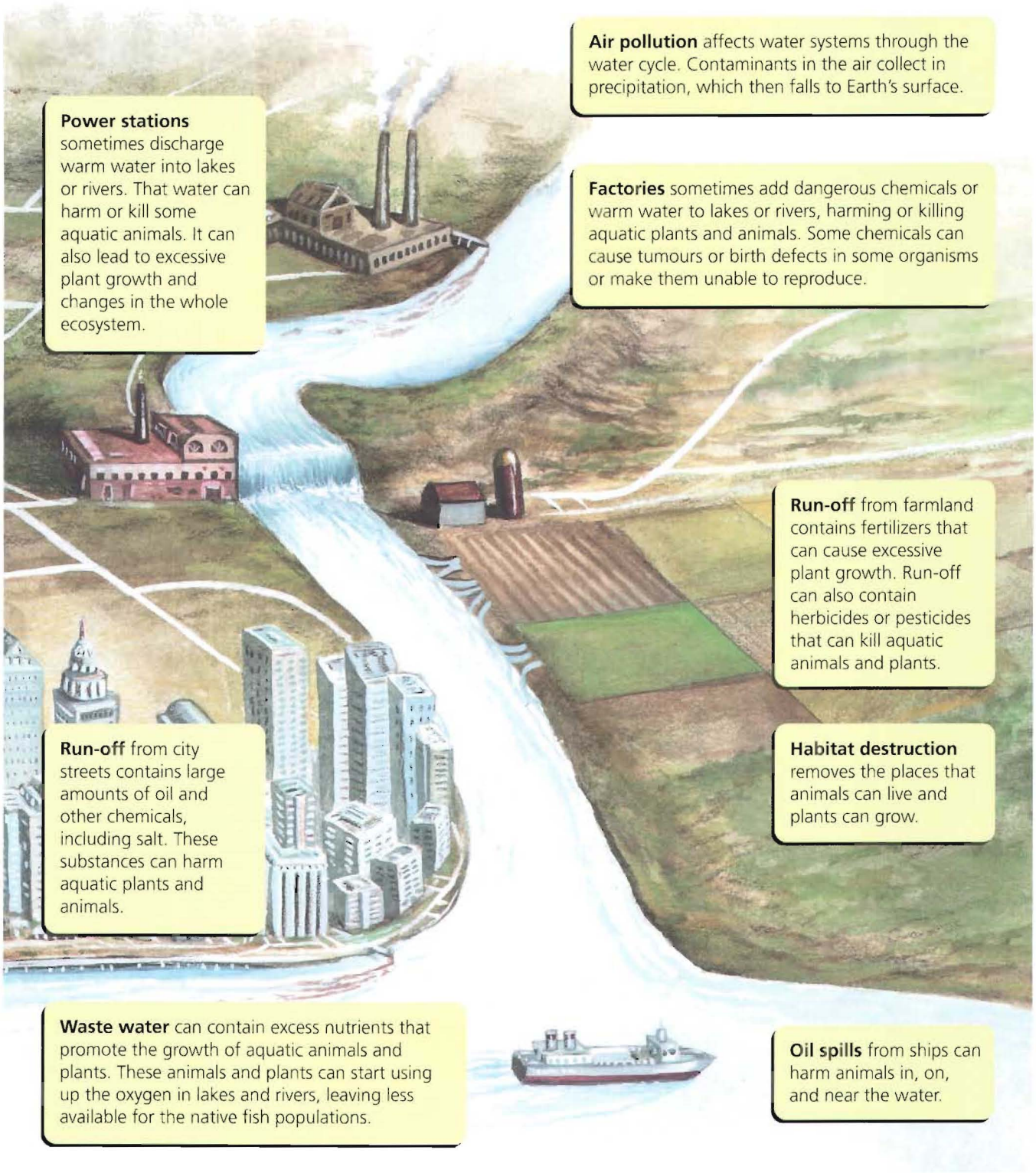


Figure 11.20 Human activities and their effects on water systems

The Yellow Fish Road Program™

If you see storm drains near your home or school marked with yellow fish symbols, you will know that the Yellow Fish Road Program™ has been to your neighbourhood. The program reminds people of the connection between our storm drains and our water systems (Figure 11.21).

As Figure 11.20 notes, city run-off may pick up many contaminants. People have even intentionally disposed of chemical products by pouring them down storm drains.

Since the Yellow Fish Road Program™ began, thousands of students have helped paint yellow fish symbols next to storm drains. Volunteers also distribute brochures to homes, educating people about the dangers that aquatic animals, plants, and our drinking water face when materials are dumped down our storm drains.

Figure 11.21 A storm drain with the Yellow Fish Road symbol

Who Manages Our Water?

All levels of government — federal, provincial, territorial, and municipal — help to manage Canada's water systems (Figure 11.22). Responsibility for a water body depends on many factors, such as where the water flows. Managing our water systems is a shared responsibility.

Suggested Activity
D33 Decision-Making Analysis on page 331

Your community has bylaws that manage the local water supply. An example of this is restricting lawn watering in the summer. The Ontario Water Resources Act sets out rules that apply to many water-related activities, such as the transfer of water from the Great Lakes, the construction of wells, and the operation of wastewater treatment plants.

Ontario also has laws to protect our province's drinking water specifically. These laws, made under the Clean Water Act, require communities to identify how the quality of their drinking water might be threatened and to make an action plan to reduce or remove those threats.

Figure 11.22 The Canadian Coast Guard has an oil spill clean-up program that can be put into action even in remote parts of Canada's offshore areas.

D31 During Reading

Thinking Literacy

The Question-Answer Relationship

The Question-Answer Relationship strategy helps a reader identify four types of questions to ask about a text and to identify where the answers might be found. The first two types of questions are "Right There Questions" and "Here and There Questions." Answers to these are likely to be in one or more places in the text. The other two types of questions are "Author and Me Questions" and "Just Me Questions." Answers to these require the reader to use prior knowledge and to look at other details in the text. Not all answers to a reader's questions will be found in the text.

Think of questions based on the title of the Quick Lab below. Identify the type of question you have created and where you expect to find the answer. Confirm this Question-Answer Relationship by reading the lab. What kinds of questions are included at the end of the lab? Where will you find these answers?

D32 Quick Lab

How Phosphates Affect Our Water Supply

You might have seen the words "phosphate free" on detergent boxes. Detergents and soaps that contain phosphates upset the natural balance of our lakes and rivers. Removing phosphates from these products protects our water supply.

Purpose

To investigate why phosphates contribute to pollution

Materials & Equipment

- 1 L pond water
- 2 transparent 500-mL containers
- small beaker
- tap water
- 2 measuring spoons, 5 mL and 15 mL
- 1-mL dropper pipette
- 5 mL detergent containing phosphates
- stirring spoon

Procedure

1. Fill each of the 500-mL containers two-thirds full with pond water.
2. Fill the beaker with 45 mL of tap water and add 5 mL of detergent. Stir.
3. With the pipette, add 1 mL of the detergent solution to one of the pond water samples.
4. Set both containers of pond water on a windowsill.
5. In your notebook, record what you observe about the two samples every day for five days.

Questions

6. Why did you add the detergent solution to only one pond water sample?
7. Describe the difference you observed between the two samples.
8. By preventing phospate contamination of our water supply, how could we benefit the environment?

SKILLS YOU WILL USE
- Gathering information
- Summarizing information

Managing Small Sound's Water Supply

Issue

The town of Small Sound, where you live, is proposing to install a very expensive storm sewer pipe to handle an increase in storm water run-off from its streets. In addition to being very costly, the pipe will extend into the bay that is the source of the town's drinking water. You have gathered a group of friends to propose an alternative plan because you know that storm waters contain many contaminants. You do not want more of this entering your drinking water supply and the waters where you swim and kayak.

Background Information

Your community has noticed an increase in the number of extreme weather events in the past five years. Two major storms produced above-average rainfall, and in one of those storms, flooding occurred because the storm drains could not handle the run-off from the streets. They backed up and overflowed. This cost more than $1 million in property damage.

Figure 11.23 Think of Small Sound as looking something like this.

Analyze and Evaluate

Your task is to come up with a plan that will reduce the amount of run-off on Small Sound's streets. You will present your plan to town council. Part of your plan involves educating residents about the contaminants present in surface run-off.

Begin developing your plan, using the following information to guide you.

1. Go to ScienceSource to search for information on using native plants instead of paved boulevards to reduce surface run-off.
2. Look in print materials such as newspapers and books for information on how plants can protect water supplies.
3. Investigate ways in which individual home-owners can reduce surface run-off from their roofs and driveways.
4. Summarize the information you find in a short report for presentation to town council. Include only information that supports your viewpoint or refutes the proposed pipe plan.
5. Prepare a flyer for local residents that includes:
   (a) information on the kind of contaminants that can be present in surface run-off that enters a drinking water supply
   (b) an explanation of ways to reduce surface run-off on their own property

11.3 CHECK and REFLECT

Key Concept Review

1. What methods are used for the treatment of waste water?
2. What is added to waste water during the aeration part of its treatment?
3. Give two reasons why it is necessary to protect our drinking water sources.

Connect Your Understanding

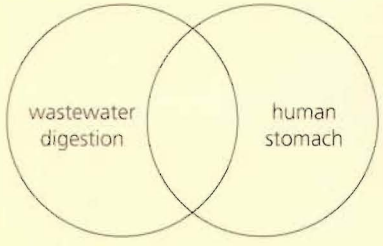
4. Why is the chlorine that is added to final, treated waste water allowed to get used up before it is discharged into a river or lake?

Practise Your Skills

5. Several of the main stages in how our bodies digest food are listed in the next column. Copy the diagram shown here into your notebook. Using the diagram, compare the stages in food digestion with the stages in wastewater treatment.

Stages in Food Digestion

- The stomach provides a site for temporary food storage.
- The stomach mechanically breaks down food.
- The stomach chemically breaks down some foods, such as protein.
- Stomach contents are transferred into the small intestine, which is the main site for food digestion.
- The intestines contain bacteria that work to break down food further.



Use this Venn diagram to show how the human digestive system is like a wastewater treatment plant.

For more questions, go to ScienceSource.

D34 *Thinking about Science, Society, and the Environment*

Educating the Community

You read about the Yellow Fish Road Program™ in this section. This is one way to raise awareness about the risk of run-off contaminating local lakes, rivers, and streams.

What to Do

1. As a class, think of a project you could do together to educate your community about the harmful effects that run-off can have on local water systems. Participating in the Yellow Fish Road Program™ is one option, but there are many others as well.
2. Develop a plan and schedule to carry out your project and then take action.

Consider This

3. Think of ways to evaluate how effective your project has been. How could you find out, for example, how many people heard or read your message? How could you learn whether your project influenced them to change their behaviour?

Career: Public Health Inspector

Figure 11.24 Becky Hester taking a water sample for testing

When you turn on your taps to fill a glass with drinking water, you can thank people such as Becky Hester for their role in keeping it safe. Hester is a senior public health inspector (Figure 11.24). Her job is to prevent water-borne illnesses in our community. Her work is guided by the provincial standards.

On the wall in Hester's office is her framed certificate indicating that she is well qualified to help manage our water. After studying environmental health at university, Hester passed oral and written exams and a 12-week practical session to become a certified public health inspector.

"My job has a lot of variety," says Hester. "I am never bored. I deal with numerous aspects of public health, including monitoring drinking water test results, promoting well water safety, sampling beach water, and investigating the effects of a water main break."

Hester is also an educator and promoter of public health programs. "I enjoy presenting at community events," she explains. "I have spoken on such topics as how to maintain, disinfect, and treat wells, and even on how our beaches get polluted. I have also had the opportunity to work on a lot of exciting projects, such as the York Children's Water Festival" (Figure 11.25).

Questions

1. How is a public health inspector involved with people who obtain their drinking water from underground sources?
2. Why would regular tests be taken on beach water in the summer?
3. Describe three ways in which you can show respect for our water and the people like Becky Hester who help manage it.

Figure 11.25 These children are at a water festival. Learning about water systems helps children make wise choices about using them.

11.0 Chapter Review

Assess Your Learning

Key Concept Review

1. Explain the statement, "The water that flows into your sink or bathtub has flowed through your local watershed." K

2. (a) Explain the importance of the chlorination step in drinking water treatment. K

   (b) Why is chlorination usually also a final treatment step in the treatment of waste water? K

3. Give an example of each type of drinking water contaminant: biological, chemical, or physical. C

4. The waste water that enters a treatment plant is 98 percent water. The other 2 percent is removed during preliminary treatment. What might the other 2 percent contain? C

5. Describe four threats to our drinking water sources. K

Connect Your Understanding

6. A company wanting to extract ground water for use in a bottled water plant must first obtain a licence from the province. Explain why this licence helps to manage our freshwater supplies. C

7. In desert areas, such as the Los Angeles region of California, hot, dry summers have led to a lot of water being pumped from underground aquifers for use by the large population.

   (a) If annual rainfall is not enough to recharge these aquifers, how would the water table be affected? C

   (b) Describe two ways in which the government of California could manage the drinking water supply. K

8. When water is withdrawn from natural water systems to irrigate crops, much of it is returned to the environment in a more contaminated state.

   (a) Explain what this statement means. C

   (b) What kind of contaminants might be of concern? K

After Reading Thinking Literacy

Reflect and Evaluate

Science is about inquiry and asking questions. Have all your original questions from the beginning of the chapter been answered? Use the following organizer to summarize what you have learned about the value of asking questions as you read:

3-2-1 Review

3 things I learned about the strategy of "asking questions."
2 ways this strategy helps me as a reader.
1 question I still have.

ACHIEVEMENT CHART CATEGORIES
K Knowledge and understanding C Thinking and investigation C Communication A Application

Practise Your Skills

9. Each circle below represents a step in the treatment of drinking water in a typical water treatment plant. Copy the diagram into your notebook.

(a) Label each step in the correct order, choosing from the list provided. (K)

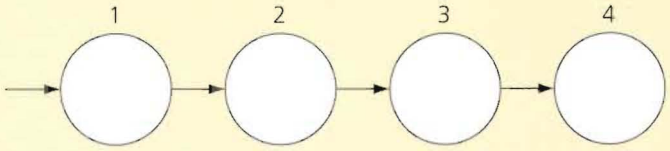
(b) Describe what happens after step 4. (K)

filtration through a membrane or sand and gravel

addition of chlorine to kill microorganisms

screening out of large solids

addition of chemical so solids clump and settle out



Unit Task Link

If you lived in the African country of Sierra Leone, your supply of water would be limited. What personal behaviours would you need to change immediately?

D35 Thinking about Science, Society, and the Environment

Lessons Learned

At the beginning of this chapter, you read about how, even in a country such as Canada, we cannot take having clean, safe water for granted. Maintaining water quality is a responsibility we all share.

What to Do

Working with a small group, reread the Walkerton story at the beginning of the unit. Then discuss the following points.

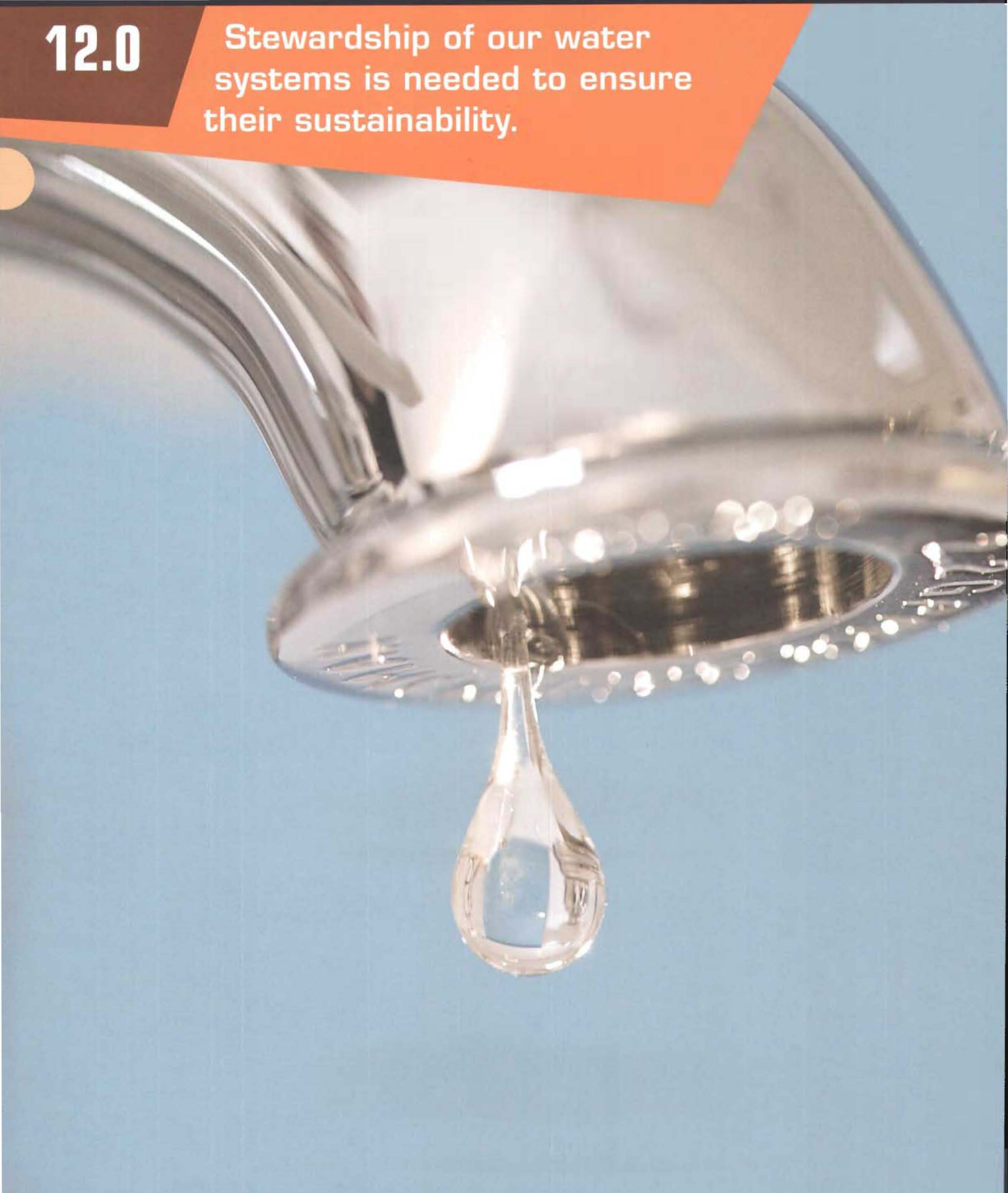
1. What three things happened at the same time that led to the tragic outcome?
2. Identify two ways in which the outcome could have been prevented.

Consider This

The events at Walkerton, Ontario, led to a public inquiry. An inquiry is a formal and detailed examination by government of what went wrong in a situation and why. At the Walkerton inquiry, many scientists were asked to give their expert opinion about water contamination and water treatment methods.

3. Can knowledge of science alone prevent a similar event like Walkerton from happening in another town or city? Discuss your answer to this question with your group.

12.0 Stewardship of our water systems is needed to ensure their sustainability.



Water is a precious resource that we all have a role in caring for. As an old proverb says, "We never know the worth of water until the well is dry."

What You Will Learn

In this chapter, you will:

- compare your personal water consumption with that of others in the world
- use critical thinking to assess how issues related to water systems are reported by media sources
- analyze the impact of some scientific discoveries and technological innovations on water systems

Skills You Will Use

In this chapter, you will:

- use a variety of forms to communicate with different audiences for a variety of purposes
- test a method of desalinating water
- use appropriate science and technology vocabulary in oral communication

Why This Is Important

Understanding how valuable water is enables us to better understand the importance of working individually and together to protect and manage our water systems for current and future needs.

Before Writing

Thinking Literacy

Descriptive Writing Tells Us...

This chapter describes what stewardship and sustainability mean in relation to water systems. Predict one thing that you will learn about these terms. Scan the next page to check your prediction. Why are stewardship and sustainability "hot topics" for writers these days?

Key Terms

- stewardship
- sustainability
- bias
- bioremediation
- desalination
- impartial

12.0 Getting Started

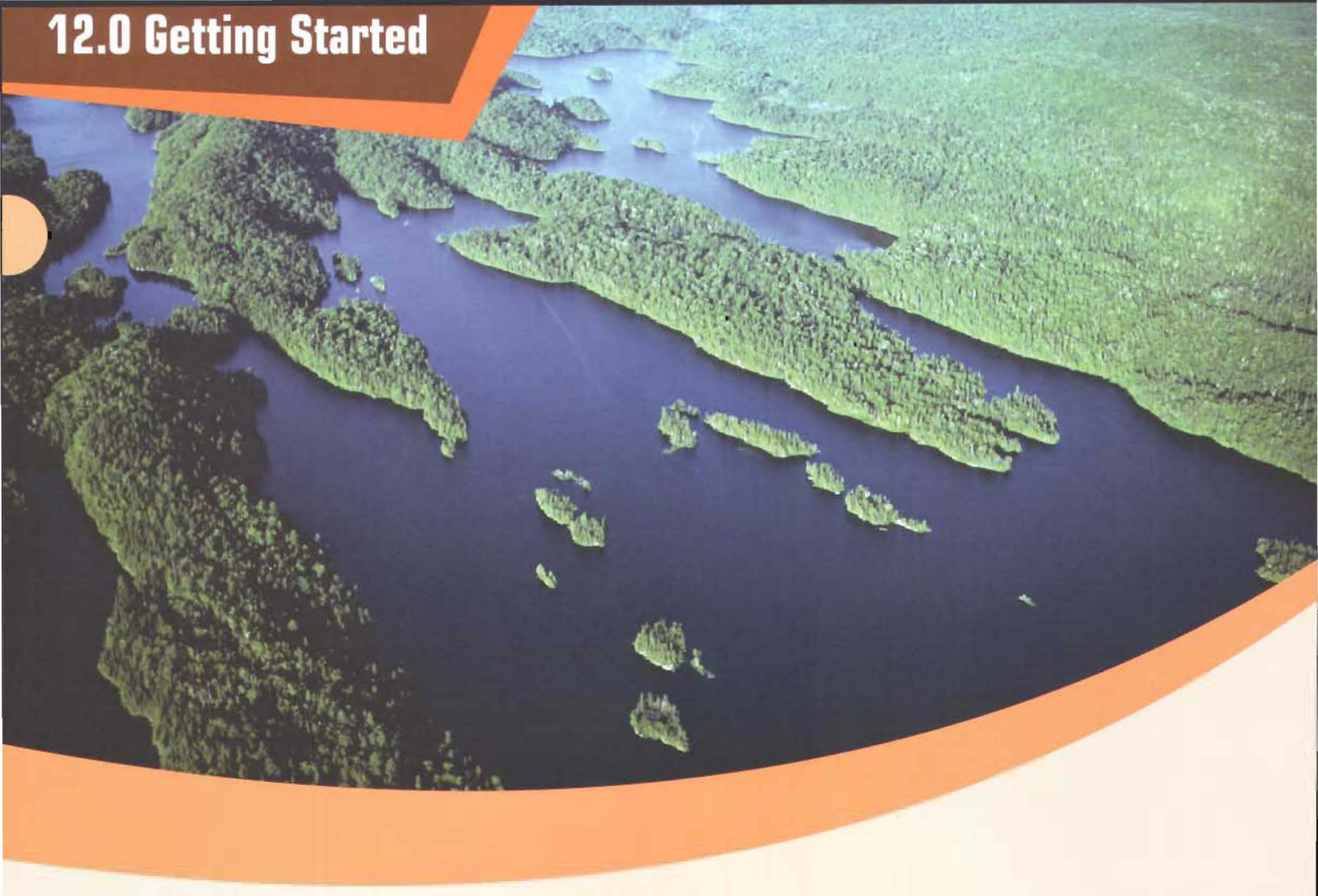


Figure 12.1 In Canada, where we have so much fresh water, it is easy to think that our water supply is limitless.

We are fortunate to live in one of the most water-rich countries on Earth (Figure 12.1). You have learned, however, that there are many reasons for us to be concerned about both our supply of water and our water quality. Natural events such as droughts and human activities such as farming and industrial development remind us that the supply of water is not endless. At the same time, the Walkerton story reminds us of how critical it is to safeguard the quality of our water.

For these reasons, taking action to protect our water systems is something we should all care about. We can do this by practising **environmental stewardship**. This means taking action to manage and maintain the environment to protect its well-being for current and future generations. At the same time, we need to use our water systems in a way that keeps them sustainable.

Sustainability is the ability of something to exist or be used at the same level for a long period of time without being

damaged, harmed, or reduced for future use. Therefore, when we develop our water systems to meet today's needs, we must do so in a way that protects the quality and supply of water for generations to come.

Niagara Falls is a good example of this. When the rushing water of the falls started being used to produce electricity, Canada and the United States realized that regulations were needed to protect this natural resource (Figure 12.2). Without such protection and concern for sustainable development, the supply of water for electricity production in the future could be affected.

Figure 12.2 Canada and the United States must share the resources of Niagara Falls.

D36 Quick Lab

What Does Stewardship of Water Systems Look Like?

The schools and communities that take part in the Yellow Fish Road Program™ are helping to maintain a healthy watershed. They are practising environmental stewardship.

Purpose

To identify ways in which we can be stewards of our water systems.

Procedure

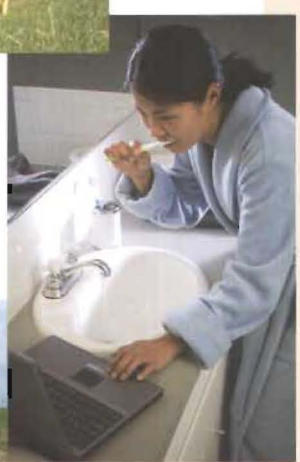
1. Working with a partner, look at the three photographs in Figure 12.3.
2. Consider how each photograph involves our water systems.

Questions

3. You are part of a stewardship group.
   (a) Does your group identify any concerns for water systems in the photographs? Explain.
   (b) Suggest one corrective action that your group recommends for any concern identified.

(a)

(b)



(c)

Figure 12.3 Watching out for our water systems

12.1 Stewardship through Water Conservation

Here is a summary of what you will learn in this section:

- Canadians are large consumers of water, on average, compared to people in other developed countries.
- Actions taken today to conserve water will protect our future supply.
- Individual actions add up, so what you do matters.

Researchers have estimated that Canadians each consume, on average, 335 L of water a day. This is water consumed for a variety of purposes, not just for drinking (Figure 12.4).

Figure 12.4 Almost half of the water that Canadians use in the summer is sprayed onto lawns.

There are many ways in which we all use water during a day, often without really being aware of it. Try to imagine how it would be possible to shower, flush a toilet, brush your teeth, cook, and wash dishes and clothes if you did not have access to water.

Only in the United States is daily water consumption per person higher than it is in Canada. This is not something to be proud of.

Our water use per person in Canada has also changed over time. Today, each of us is consuming, on average, six times more water daily than people in this country did 100 years ago.

D37 Starting Point

Skills P C

Daily Water Use in an Average Canadian Home

Table 12.1 lists typical Canadian indoor activities that use water daily. The average consumption rate of 335 L per person per day is also shown.

1. Look at each activity. Think about your own water use. Then guess how many litres of water, out of the 335 L daily total, a person in Canada consumes for that activity.
2. Compare your guesses with the figures your teacher provides. Do any surprise you?

Table 12.1 Daily Water Use in an Average Canadian Home

Activity	Amount of Water Used (L per person per day)
bathing and showering	
using the toilet	
laundry	
kitchen activities (for example, drinking and cooking)	
cleaning	
TOTAL	335

Thinking Literacy

Gathering Information in a Web

When writers want to explain something, they may use a "descriptive organizational pattern" to write some of the topic's main features in chunks.

In section 12.1, you will read about water consumption and conservation. As you read, create a web to record what the writer tells you about the benefits of water conservation and how we can reduce our water consumption. Once you have gathered information from the text, add to the web your own personal reasons and ideas for conserving water. Did you find any specific "signal words" for this pattern of writing?

Comparing Water Consumption

The way water is distributed in many Canadian communities (removed from a water body, treated, stored, and sent to homes and businesses in pipes) does not happen everywhere else in the world. As Canadians, we are also fortunate to pay much less for treated water than the true cost of treating it. Compared to people living in other developed countries, we pay very little for the water that comes out of our taps. For these reasons and others, water use in other parts of the world is much lower than it is in this country (Figure 12.5).

Country	L/Day
Israel	135
France	150
Sweden	200
Italy	250
United States	380
United Kingdom	200
Mozambique	10

Figure 12.5 Comparison of water consumption rates per person in several countries

The Benefits of Water Conservation

A family that draws water from a well and disposes of waste water in a septic system knows the two main benefits of water conservation. One benefit is having enough water when they need it. The other is not contaminating their water supply with an over-used septic system. Well-users pay attention to activities that remove a lot of water from their underground source, such as doing many loads of laundry in a day or letting lawn sprinklers run for hours. They are also careful not to dispose of harmful products down their drains.

People living in communities with a municipal water distribution system often pay less attention to water usage than well-users do. The city or town water supply is often taken for granted and activities that consume a lot of water are often not given any thought. However, conserving water in these communities also offers many benefits, including the following.

Figure 12.6 As our population grows, so does our demand for water. However, our supply is limited to how much clean water treatment plants can produce.

- Ensuring water supply: Our supply of water is limited by how much our treatment plants can produce and the distribution system can store (Figure 12.6). Water conservation allows our treatment plants to work efficiently and allows our groundwater sources to recharge.
- Putting less demand on water distribution and collection systems: The pipes beneath our streets are as old as the communities themselves. Many underground pipes are in need of repair (Figure 12.7).
- Saving money: In some communities, homes and businesses are now being charged for the amount of water they use. Using less water means having a lower water bill to pay.

Reducing Water Consumption

Knowing *why* to conserve water and finding ways to inform others about the issues is the first step in reducing how much water we use. Learning *how* to conserve water is the next step. There are many ways in which individuals and communities can accomplish this.

Adopting Improved, Water-Efficient Machines and Devices

Appliances such as dishwashers and washing machines have been redesigned in recent years to operate with less water. Shower heads that reduce the rate of flow of water can save as much as 60 L of water in a typical shower. New technology in toilets uses as little as 3 L of water per flush compared to more than 13 L of water per flush in older models.

Figure 12.7 Repairs to aging water distribution pipes and wastewater collection pipes are extremely expensive and disruptive.

Most farms and golf courses use automated sprinkler systems for watering. These systems can be programmed to turn on early in the morning or late at night and will shut off after a set period. The sprinklers also often work by dripping the water onto the ground instead of spraying it overhead (Figure 12.8). As well, technology exists for automated carwashes, public laundry facilities, and industries to recycle their water by filtering and re-using it.

Figure 12.8 Drip irrigation means that less water is lost to evaporation and more goes into the soil.

Changing How We Pay for Water

In most Canadian municipalities, households and businesses pay the same amount (called a flat rate) for water use, no matter how much or how little they consume. Many other municipalities, however, have installed water meters on homes and businesses. These meters keep track of exactly how much water a household or business consumes. The users then pay for that amount. This means that what people pay for water might start being closer to what it actually costs to provide treated water.

A study of water use in Canadian homes found that when water use is monitored with meters, people use one-third less water a day than when water use is not metered (Figure 12.9).

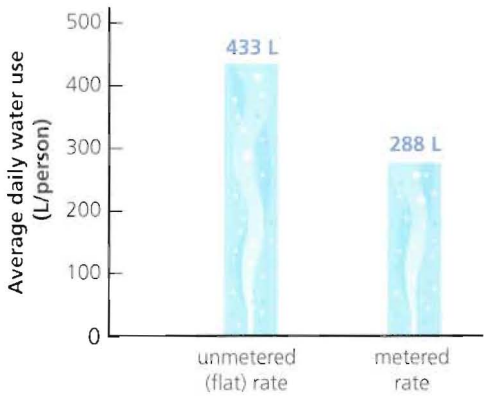


Figure 12.9 Environment Canada reports that when people know they have to pay for the volume of water they use, the consumption rate drops significantly.

Taking Direction from Government

Numerous government regulations and programs are aimed at protecting water resources. For example, many building codes (the rules for how someone builds a house or an office tower) now require that only water-efficient toilets be installed in new buildings. Some municipalities, such as the City of Toronto, also offer home-owners a rebate if they replace old toilets in already existing homes. This means that if a home-owner purchases one of the water-efficient toilets from a certain list, the city will refund the person part of the purchase cost.

As well, many municipalities have bylaws restricting water use during drought periods.

Take It Further

How does a meter measure water consumption? How does a municipality calculate a water bill? Find out at ScienceSource.

D39 *Inquiry Activity* Toolkit 2

SKILLS YOU WILL USE
- Recording and organizing data
- Analyzing patterns

Be a Water Watchdog

In the Starting Point activity on page 340, you examined the daily water consumption of Canadians. Now it is time to evaluate how much water you personally consume in one day.

Question

Why is it important to evaluate your personal water use?

Materials & Equipment

- observation sheet from your teacher
- 5-L bucket
- watch or clock with a second hand
- 1-L container

Procedure

1. Choose one 24-h period on a weekend, when you will be at home to carry out this investigation. On that day, you are going to record how much water you use for every activity you do that requires you to run water.
2. Showering: Holding the 5-L bucket up to the shower head, turn on the cold water for 1 min at the pressure you would normally use to shower. Turn off the water and measure how much water has filled the bucket. Multiply this amount by the number of minutes of your usual shower.
3. Toilet flushing: If your home has an older-model toilet, multiply the number of times you flush it by 13.5 L. Otherwise, if you know the actual volume of water your toilet uses, multiply by that figure.
4. Cooking: For anything that is cooked with water (for example, hot cereal, pasta, rice, soup), measure how much water is used.
5. Drinking: Measure all the water you drink in the 24-h period.
6. Dishwashing: If you wash dishes by hand, fill the 5-L bucket first before pouring the water into the sink or washbasin. Measure how much water in total you use (you may need more than 5 L or less). If you have a dishwasher, look in the operating manual to see how much water it uses per load. For either case (handwashing or using the dishwasher), divide the amount of water required by the number of people in your household to get your individual use figure. Multiply that figure by the number of times dishes are washed that day.
7. Teeth brushing: Put the 1-L container under the sink faucet when you brush your teeth. Do not let the container overflow. Measure the total amount that ran until you finished brushing.

Analyzing and Interpreting

8. Look at the data your teacher gave you in the Starting Point activity. Explain how your water use compared per activity and per day with the average Canadian's water use.
9. What other activities using water that involve you indirectly were not counted in this activity?

Skill Builder

10. List two sources of error that affected how you determined your water use.

Forming Conclusions

11. Write a sentence explaining why it is important to evaluate your personal water use.
12. Make a two-step plan of action to reduce your personal water consumption.

Key Concept Review

1. (a) How does Canada rank compared to the rest of the world in terms of daily water consumption per person?

(b) Give two reasons why Canada has this ranking.

Connect Your Understanding

2. Give a "water-wise" alternative to each activity below.

(a) hosing off a driveway to clean it

(b) watering outdoor plants with a hose

(c) letting the tap run to get cold water

Practise Your Skills

The table in the next column shows the amount of water it takes to produce 1 kg of four common products. Use the information to answer the next two questions.

Product (1 kg)	Water (L)
steel	95
paper	324
potatoes	1 000
beef	99 980

3. How much more water does it take to produce:

(a) 1 kg of paper than 1 kg of steel?

(b) 1 kg of potatoes than 1 kg of paper?

(c) 1 kg of beef than 1 kg of potatoes?

4. Explain why so much more water is needed to produce beef than potatoes.

For more questions, go to ScienceSource.

D40 *Thinking about Technology, Society, and the Environment*

You and Your Water Bill

How much does your water cost? It is hard to know because we do not have to pull money out of our wallets to pay every time we turn on a tap in our kitchen or bathroom.

What to Do?

1. Your teacher will give you a copy of his or her home water bill or that of the school and will show you how to read it. Your teacher will also give you a price list of bottled water products of different sizes.

2. As a class, figure out a way to compare the cost of regular municipal tap water with the cost of bottled water. Calculate the average cost of each for a standard volume.

Consider This

3. Many people feel that Canadians pay too little for municipal water. Think about how our behaviour might change if the price we had to pay for tap water doubled. Brainstorm a list of the advantages and disadvantages of such an increase in municipal water charges.

12.2 Issues Relating to Water's Sustainability

Here is a summary of what you will learn in this section:

- People hold very differing opinions about how human activities affect water systems.
- Media such as newspapers, television, radio, and the Internet often present information about water issues from a biased viewpoint.
- Thinking crtically about water issues is necessary if we are to make good decisions about managing our water systems.

Imagine that you and your classmates are asked to come up with a plan for improving your school building. Do you think you would all start with having exactly the same ideas about what is needed? It is not likely. We all bring our own unique ideas and values to any topic or issue.

This is the case with the management of water resources. Different groups have very different opinions about how water should be managed, protected, and shared so that water's sustainability is assured. They also hold different views about how human activities could affect local, national, and even international water systems.

Bottled Water vs. Tap Water

Consider the issue of removing and selling water from freshwater systems. As you learned in Chapter 11, this is what the bottled water industry does (Figure 12.10). The growing export of our water resources has created great controversy. A controversy is a disagreement that goes on for some time.

Figure 12.10 Those plastic or glass containers of water you see everywhere are part of a multibillion-dollar industry.

Many people against the use of bottled water point to several facts. One is that bottled water costs about $1 for a 500-mL container. Tap water costs just pennies a litre. It would take a lot of increase in the price of municipal water to reach the price of bottled water. Another fact is that the treated tap water across Canada is of good quality and can be consumed safely.

Those people in favour of bottling water point to other facts. One is that the industry creates many jobs. Another is that bottled water can be shipped to areas that do not have treated water supplies. Furthermore, bottled water can be life-saving in emergencies when a supply of safe drinking water is not available.

When you read or hear facts like these in a newspaper, on an Internet website or blog, or on a radio or television report, you might not be able to tell whether the media source is in favour of bottling water or not. The viewpoint or opinion of the person providing the news report may not be evident. On the other hand, that person may present the news with a clear bias. A **bias** is an obvious opinion about an issue. By knowing what biases a reporter or broadcaster might have, you can better judge the content of the information presented.

If facts about an issue are presented in a fair and unbiased way, we say that the speaker is being **impartial**.

D41 Starting Point

Skills A C

Finding Messages behind Words

When people write or speak about a subject, you can often tell a lot about whether they are for or against something by their choice of words. Read the three statements below and then answer the questions that follow.

(a) "Our town doesn't need to worry about conserving water. After all, there is a huge lake right in our backyard!"

(b) "Some people get all excited because they think a few litres of water disappearing is a big deal."

(c) "The study carried out by the government found that 6000 L more water than the standard rate is being removed from the reservoir."

1. Suppose these sentences were spoken by a news reporter. Which one or ones show that he or she:

   (a) has a bias? Explain.

   (b) is impartial? Explain.

2. (a) Which statements show that a message is implied (that is, meant but not stated) in the words?

   (b) What is the message that you think is being implied?

Figure 12.11 Always ask yourself if the media source you are listening to or reading might be biased in how it addresses water issues.

Bias behind the Reporting of Issues

Media sources such as newspapers, magazines, television, radio, and websites often contain biased information on an issue. It is helpful to know who wrote an article that you are reading so that you can determine whether the information discussed might be biased. For example, a report about the bottled water industry written by the president of MegaBlue Bottled Water may not tell you the same information as a report written by the president of the local "Don't Sell Our Water!" association. Each source would want to convince you that its viewpoint is the right one, and that would influence the information provided.

The same is true when you watch a television documentary or listen to a radio program about a topic (Figure 12.11). It is important that you know who is behind the information before you evaluate its meaning.

Issues Involving Water Systems

Removing and selling water from freshwater systems has become the topic of a national and international debate. However, it is just one of many issues related to the sustainable development of our water systems.

Another example is the world's largest hydroelectric dam project, Three Gorges Dam. It is built across the Yangtze River in China (Figure 12.12). It has received much global attention. If you were to read only reports by the Chinese government about the project, you might think that the benefits of the hydroelectric power generated at the dam were a good use of technology. Yet, you would be getting only part of the story. Other media sources report how the project has forced nearly 1.5 million people to move, flooded dozens of towns and villages, destroyed animal habitat, and threatened important archaeological sites.

Figure 12.12 The damming of the Yangtze River in China is an issue because many people have different viewpoints about its benefits.

Closer to home, the impact of human activities on the long-term health of the Great Lakes has been debated for decades (Figure 12.13). One issue is the destruction of Great Lakes coastal wetland habitats. Across southern Ontario, development for housing and agriculture has reduced or altered wetlands by approximately 70 percent. In the past, people viewed swamps and marshes as wastelands and did not understand their importance (Figure 12.14). Today, pro-development and anti-development groups continue to express their viewpoints about which activities near the Great Lakes should be permitted.

All issues relating to our water systems — whether they affect the local, national, or global community — require careful and critical thinking. We must reason through all issues by asking questions, separating facts from opinions, and examining viewpoints.

Figure 12.13 How to maintain the health of the Great Lakes and their shorelines (such as Lake Superior's, shown here) is a hotly debated issue.

Figure 12.14 When wetlands become filled up and built on, the habitat they provide for wildlife is destroyed.

Take It Further

There are national standards for how drinking water should be monitored and managed in First Nations communities. Learn the various viewpoints about these guidelines. Begin your research at ScienceSource.

D42 *During Writing*

Thinking Literacy

Writers Make Decisions with RAFTS

RAFTS is a writing strategy that writers use to remind themselves of several decisions they need to make as they begin the writing process. The letters stand for **R**ole of writer, **A**udience, **F**ormat, **T**opic, and **S**trong verb.

Using the information on your water consumption and conservation web, write a description of five behaviours people could change to reduce their water consumption. Use the RAFTS strategy to finish making your writing decisions. Then complete your writing piece.

SKILLS YOU WILL USE
- Selecting media
- Determining bias

Exploring a Great Lakes Issue

More and more people in Ontario are concerned about the quality and supply of water in the Great Lakes. In this activity, you will look critically at how an issue involving the Great Lakes is reported by a range of media sources.

Issue

The impacts of rising and falling water levels in the Great Lakes

Background Information

The level of water in the Great Lakes rises and falls all the time. This has been happening since the glaciers receded after the last ice age. Most changes in Great Lakes water levels occur naturally. If the water flowing into them equals the water flowing out of them, then levels remain the same. Usually, however, changes in evaporation, precipitation, and spring run-off cause the water levels to change. Human activities such as diverting water in and out of locks and canals also change water levels.

High water levels are a concern for many reasons, including increasing the chances of flooding. Concerns over low water levels include difficulty securing boats to high docks and loading and unloading a ship's cargo (Figure 12.15).

Figure 12.15 Companies that use ships to transport products such as road salt from one port to another on the Great Lakes are very concerned about water levels.

Analyze and Evaluate

1. Working with a small group, find at least five different reports, articles, or radio or television programs about the water levels in the Great Lakes–St. Lawrence River basin. Make sure that you choose a range of media types and sources.
2. As you read, listen to, or watch the information presented, make notes about the facts that are given.
3. Answer the following questions to evaluate the viewpoints or opinions of your media sources.
   (a) What is the main purpose of the piece? For example, is it to provide facts or to put blame on something?
   (b) Who is the main audience or group of readers that the piece is directed to? Examples include scientists and researchers, the general public, schoolchildren, or special interest groups.
   (c) How does the information in each of the sources compare with the others?
4. Explain why one media source would take a different position from that of another media source.
5. Think of the issue of changing water levels in the Great Lakes. Has your research found any decisions that have been made? Explain.

12.2 CHECK and REFLECT

Key Concept Review

1. Why is it important to question what you read, watch, or listen to in the media?
2. What is the difference between a fact and an opinion?

Connect Your Understanding

3. Suppose you belong to a stewardship group looking at ways to improve the health of your local watershed. What media sources might you access for information on the subject?

Practise Your Skills

4. Many coastal communities depend on tourism to provide income and jobs to its citizens. Describe what viewpoint the following individuals might have.
   - the mayor of a coastal city
   - members of an environmental group

For more questions, go to ScienceSource.

D44 *Thinking about Science, Society, and the Environment*

Mini Media Analysis

Water-related topics are written about and reported on every day. Many are about controversies over who has the right to use water when, why, for how long, and in what amount. When we read, watch, or hear media stories, it can be difficult sometimes to know whether the information we are getting is based on facts, opinions, or personal interests.

What to Do

1. Choose a water-related issue that has made headlines recently. Then find at least three different media sources that have reported on the matter.
2. Read, watch, or listen to each report critically. Analyze the way that each source has presented the information. For example, ask yourself:
   - Does the information provided in the report seem accurate? If science or technology information is provided, where can I check to see if it is factual?
   - Does the source seem impartial or biased? What evidence makes it seem that way?
3. Write a summary of your media analysis, stating your conclusions about how balanced each report's presentation was.
4. Think about everything else you read, watch, and listen to in the media daily. Is it only about water issues that biased reporting might occur? Explain your answer with several examples.

12.3 Water Sustainability through Science and Technology

Here is a summary of what you will learn in this section:

- Using our water systems in a sustainable way will enable us to protect our natural ecosystems and protect the quality and supply of water for future generations.
- Science and technology offer solutions to many water-related problems, but the impact of any innovation on local and global water systems must always be assessed.

The connection between land and water reminds us that stewardship of one must involve stewardship of the other if our water systems are to be sustainable. Many organizations, government departments, businesses, farmers, waterfront owners, and individuals just like you are working together to improve water quality and protect our supply so that it is sustainable.

D45 *Starting Point*

Skills A C

Looking More Closely at Solutions

Scientific and technological solutions to problems often create a new set of issues. Therefore, when we are trying to solve a problem in one part of the environment and society, it is important to consider how that might affect other parts.

With a partner, think about the problem below and the two proposed solutions shown in the table. For each solution given, list in your notebook what needs to be considered for all parts of (a) the environment and (b) society.

Problem:
A company discharges wastes from manufacturing processes as smoke through a tall chimney called a stack. Chemicals in the smoke are creating acid rain, which, in turn, is killing fish in a nearby lake.

Proposed Solution	Environmental Considerations	Societal Considerations
1. Update the stack with new technology that reduces the amount of chemicals released by 75 percent. This technology is very expensive.		
2. Install a much taller stack that discharges the smoke higher into the atmosphere and lets the smoke spread out over a larger area. This technology is less expensive than Proposed Solution 1.		

One place where we can look to see examples of sustainable practices is in our farming communities. Farmers use land and water management techniques and participate in programs that protect and enhance our watersheds. For example, the Ontario Environmental Farm Plan educates farmers in using plants along streams (Figure 12.16). These plants reduce the amounts of chemicals and nutrients produced by farm practices entering the local watershed.

Ongoing research in science and technology continues to offer solutions to many problems involving our water systems. However, a solution to any problem must always be assessed in terms of how it affects the environment and society.

Figure 12.16 A strip of plants between the stream and the nearby farm helps to filter contaminants and reduce pollution in the watershed.

Sustainability Solutions Using Bioremediation

The technique of using living organisms to clean up contamination in land and water is called **bioremediation**. A subset of bioremediation is phytoremediation, which is the technique of using plants as environmental clean-up remedies (as discussed in the farm example, above). Scientists often use the term bioremediation to apply specifically to clean-up remedies involving microorganisms.

WORDS MATTER

"Bio" is a prefix meaning life. "Phyto" is a prefix meaning plant. The word "remediation" comes from "remedy," which is something that corrects.

Bacteria are the microorganisms most often used in cleaning up problems with our water systems. For instance, the petroleum industry employs bacteria to clean up after oil spills and leaks have occurred. Some types of bacteria use the petroleum chemicals as food. These chemicals can harm people and animals, but oil-loving bacteria break down the chemicals into natural substances, including carbon dioxide gas, a type of alcohol, and water (Figure 12.17).

Bioremediation, while safe, relies on the natural processes of bacteria. Therefore, one disadvantage of this technology is that it takes a long time to complete. Another is that scientists who are knowledgeable about the technology are needed to carry out the remediation. This can mean hiring the services of someone to do the work. For some small companies, that can be expensive.

Figure 12.17 Bioremediation at work cleaning toxic waste in soil to protect ground and surface water

Stewardship of our water systems is needed to ensure their sustainability.

Water Supply Solutions Using Desalination Technology

Maybe you have heard the lines "Water, water everywhere, Nor any drop to drink." They are from the poem "The Rime of the Ancient Mariner" by 19th century poet Samuel Taylor Coleridge. If you can imagine being far out at sea without fresh water to drink, you will know what Coleridge's mariner meant by those words. However, many countries with a scarce supply of fresh water are today using technology to turn ocean water into drinking water. **Desalination** is the process of removing salt from water.

Desalination plants operate in many parts of the world (Figure 12.18). Ocean-going ships also have desalination equipment on board. Desalination can be accomplished in several ways. One way is illustrated in Figure 12.19.

Figure 12.18 Africa's largest desalination plant is in Algeria. It can produce 200 000 m^3 of drinking water daily from the Mediterranean Sea.

As with any technological solution, desalination does have some disadvantages. The waste water from a desalination plant contains a heavy concentration of salt, which is discharged back into the ocean. This unusually high concentration of salt can be toxic even to saltwater organisms if they are exposed to it for long periods. The waste water that flows out of the desalination plant and into the ocean also contains chemicals that are toxic to marine life.

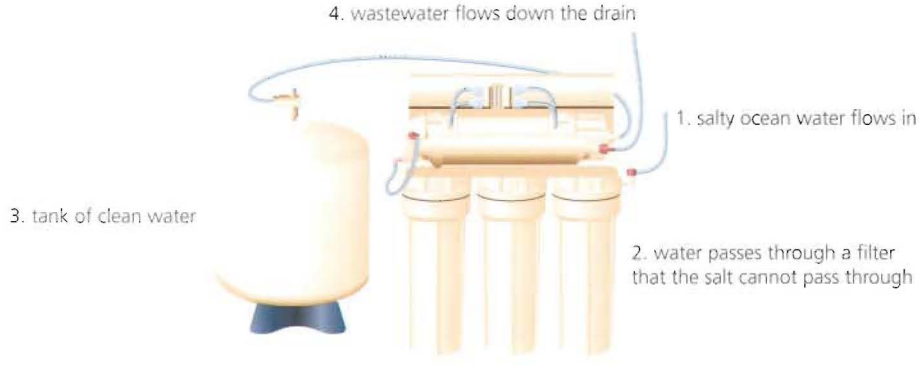


Figure 12.19 Reverse osmosis. In this set-up, salt water is pushed through a membrane or filter that the salt cannot get through. This is one way to desalinate water.

Take It Further

What other parts of the world use desalination technology? Begin your research at ScienceSource.

SKILLS YOU WILL USE
- Predicting
- Drawing conclusions

Changing Salt Water into Fresh Water

In this activity, you will model a simple method of desalinating water.

Question

How can fresh water be made from salt water?

Materials & Equipment

- 1-L container of salt water (35 mL of salt dissolved in 1 L of fresh water)
- 2 pans: 1 wide and flat, 1 smaller to fit inside the wide pan
- plastic wrap
- tape
- small rock
- 2 medicine droppers
- 2 glass slides

Procedure

1. Set the smaller pan in the larger one. Pour the salt water into the bottom pan so that the water surrounds the smaller pan but does not spill into it.
2. Cover the whole set-up with one large piece of plastic wrap. Tape the edges to the pan. Place the small stone on the plastic over the smaller pan to make a small depression.
3. Set the pans in a sunny location in the classroom (Figure 12.20). Predict what will happen to the salt water in the large pan.
4. Make a chart and record your observations daily for the next week.
5. After one week, take samples of the water. Use one medicine dropper to place two drops of water from the large pan onto a glass slide.

Figure 12.20 Lab set-up

Do the same for the water sample from the small pan, using the other medicine dropper and glass slide. Allow the two samples to dry and record your observations.

Analyzing and Interpreting

6. Explain how the dried samples on the slides differed.
7. How did what happened to the salt water compare with your prediction?
8. What purpose did the depression in the plastic serve?

Skill Builder

9. Why were you instructed to dissolve 35 mL of salt in 1 L of water? What did this concentration represent?

Forming Conclusions

10. Describe how fresh water was made from salt water. Use the following words in your explanation: evaporation, condensation, salinity, desalinate.

12.3 CHECK and REFLECT

Key Concept Review

1. When assessing solutions to problems involving our water systems, what needs to be considered?
2. Give one advantage and one disadvantage of bioremediation.
3. (a) Define the word "desalination."
   (b) Describe one desalination method.

Connect Your Understanding

4. The desalination plant in Algeria shown in Figure 12.18 on page 354 cost an estimated $250 million to build. Why would the country have spent so much money to build this structure?
5. The term "brownfields" is used to describe unused properties in urban areas that have been contaminated by hazardous materials such as petroleum. What is one way in which municipalities could clean up brownfields? Explain.

Practise Your Skills

6. Bioremediation offers many possibilities for decontaminating water and land sites in a watershed. Cleaning sites contaminated with petroleum is just one use. Think about how this technology could be applied more widely. What other problems can you think of where bioremediation might offer a possible solution? Make a chart listing your ideas and the societal impacts of each.
7. You have been given two unmarked containers. In one is a sample of salt water and in the other a sample of fresh water. You are asked to identify which is which, without tasting them. Explain the procedure you would use to do this.

For more questions, go to ScienceSource.

D47 *Thinking about Technology, Society, and the Environment*

Fog Water

In some parts of the world, polluted ground water and little precipitation mean that potable water is in short supply. Thanks to the work of many scientists and technologists, however, ways of collecting water from the air have been developed. "Fog catchers" are large screened panels that are installed outside like big sections of fencing. When fog or mist blows against them, the water droplets in the air condense, drip down the panels into pipes, and collect in storage tanks. These systems are fairly simple and inexpensive to build and operate.

1. Consider this scenario: A community has been using 12 fog catcher panels for a year, but now decides it could get much more water by increasing the number of panels across its area to 100.
2. Think about the intended and unintended consequences that such a step might have. Make a list of both. Then explain whether you feel the advantages of expanding this technology's use outweigh the disadvantages for the community.

Making Connections

Jay Ingram

Jay Ingram is an experienced science journalist and is the host of *Daily Planet* on Discovery Channel Canada.

A Tea Cup of Storm Clouds

If you have tea-drinkers in your house, you have a good opportunity to see a fascinating display of miniature weather.

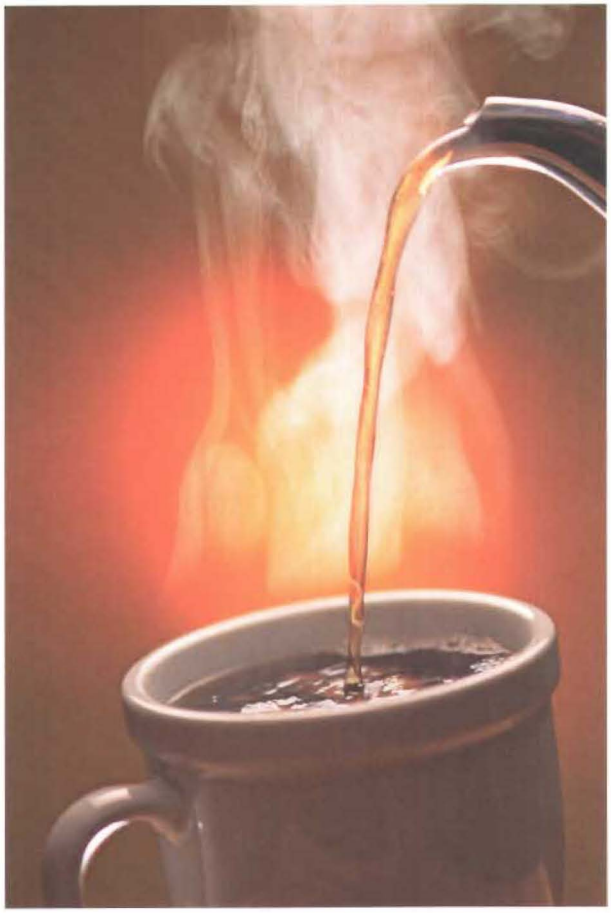
First, you need a cup of very hot tea with no milk or sugar. Sit the cup under a bright light bulb or on a table or counter in the early morning sun. Watch carefully and you will see a pattern on the surface of the tea. The pattern will be made up of irregular white patches separated by thin black lines. These patches will change their shape from moment to moment.

The whitish areas you are seeing are places where hot tea is rising to the surface. The black lines are where cooler tea is sinking beneath the surface.

Why, you might ask, would warm tea be a different colour than cold tea? In fact, there is no colour difference in the tea. The whitish areas are not tea at all, but droplets of water suspended in the air.

When hot tea rises and reaches the surface, individual molecules of water from the tea evaporate, breaking away and rocketing into the air. These molecules are much too small to see, but there are millions of them. They do not go far. They cool quickly, slow down, and collect together to form tiny but visible droplets of water. Normally, these droplets would be pulled right back down into the tea by gravity. However, all the other molecules that are still evaporating from the surface keep the droplets suspended about a millimetre above the tea. So, what you are seeing in the whitish areas are really miniature clouds that are floating above the tea.

Eventually, as the tea cools, the clouds disappear. Imagine if you were miniaturized and floating in a nano-boat on the tea. It would be as if the storm had passed and the sky had cleared.



Unstable weather above a cup of hot tea

12.0 Chapter Review

Assess Your Learning

Key Concept Review

1. Describe one thing you can do in your home, in your school, and in your community to reduce your personal water consumption. (K)

2. Identify the following statements as being true or false. If a statement is false, rewrite it so that it is true. (K)

   (a) Ontarians live in one of the richest water areas on Earth, so our water supply is not threatened.

   (b) We pay about the same price for treated tap water as it costs to produce.

   (c) Judging the content of information on our water issues is easier when you know what biases the writer might have.

   (d) All scientific discoveries and technologies developed to help clean up our water systems are always safe.

3. For each word below, write a sentence that uses the word and shows its meaning. (K)

   (a) controversy

   (b) viewpoint

   (c) critical thinking

4. Explain what bioremediation is and how it works. (K)

Connect Your Understanding

5. Do you think that the price we pay for our water should cover the costs to produce it? Give reasons for your answer. (A)

6. Name five behaviours that people could change in order to reduce their personal water consumption. (A)

7. All kinds of cargo are transported by ship along Canadian waterways each year. Explain why a reliable water level in our Great Lakes is important to the shipping industry. (A)

After Writing — Thinking Literacy

Reflect and Evaluate

Exchange your writing piece on reducing water consumption with a partner. How did knowledge of the "descriptive organizational pattern" for writing help you when you were reading your partner's work? Was this pattern an easy way to organize and present your information? What other organizational pattern did you use or could you have used? Share your experiences and ideas with the class.

ACHIEVEMENT CHART CATEGORIES
(K) Knowledge and understanding (T) Thinking and investigation (C) Communication (A) Application

8. Look back at Figure 11.17 on page 326, which shows the human-made wetland at the Kortright Conservation Centre. Explain the technology behind this solution to waste water treatment. a

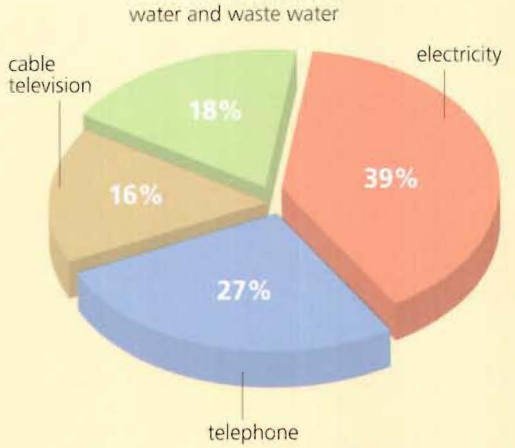
9. Many groups, such as conservation authorities, provide stewardship education.
   (a) What educational messages about our water systems might they give? t
   (b) How does educating the public help to protect and preserve our water systems? a

Unit Task Link

How would acting out a part of life in an African village that is short of water help you to understand water's value?

Practise Your Skills

10. The pie chart on the right shows a breakdown of monthly household expenses for an average Canadian family. From the data in the pie chart, explain why households are more interested in saving electricity than in saving water. Use figures from the graph to support your answer. t



Comparison of some monthly household expenses for an average family

D48 Thinking about Society and the Environment

Group Actions

Even though many separate actions can bring about a change, it often takes the actions of individuals and groups working together to create a sustainable solution to a problem with our water systems.

Think of an example that illustrates what this statement means. Your example can be one from your local area or one that applies provincially, nationally, or internationally.

Consider This

1. Group action is necessary to bring about change. At the same time, however, the greater the number of people involved in solving an issue, the harder it can be to reach a solution that will make everyone happy. Working with a partner, discuss why you think this is the case.
2. What are some ways that people can work together to resolve differences of opinion?

UNIT D Summary

10.0 Water on Earth exists in different states and is always moving and changing.

KEY CONCEPTS

- Water on Earth exists in three states: liquid, solid, and gas.
- In a watershed, water from all sources on the land drain to one main water body.
- Activities in one part of a watershed affect all living things downstream.
- Water influences our climate and creates our weather.

CHAPTER SUMMARY

- Water in all three states covers approximately 70 percent of Earth's surface and cycles constantly between the surface and the atmosphere.
- Of the two kinds of water on Earth, salt water is more abundant, but humans can drink only fresh water.
- Large water bodies influence the climate of coastal areas.
- Glaciers and ice sheets are affected by changes in temperature and precipitation. In turn, changes to glaciers and ice sheets influence water systems.

11.0 Monitoring water systems is critical for maintaining water supply and quality.

KEY CONCEPTS

- Our supply of water on Earth is limited.
- The supply and quality of our water is threatened by natural events and human activity.
- Our sources of drinking water must be protected.

CHAPTER SUMMARY

- Proper management of our water supply is needed so that there is enough for all living things and for the future.
- Canadians obtain drinking water from below- and aboveground sources, and it must be treated and tested before it is safe to drink.
- Protecting our drinking water sources from pollution and overuse is the first step in ensuring water's sustainability.
- Treating water and waste water is expensive and does not remove all contaminants.

12.0 Stewardship of our water systems is needed to ensure their sustainability.

KEY CONCEPTS

- Sustainable water systems provide the quality and supply of water for the future.
- Through stewardship action, our water systems can be properly managed, maintained, and enhanced.
- Issues involving our water systems must be examined critically.

CHAPTER SUMMARY

- Canadians are large consumers of water, and conservation is necessary to protect our future supply and Earth's ecosystems.
- Thinking critically about water issues involves asking questions, separating facts and opinions, and examining viewpoints for biases.
- Science and technology offer solutions to problems involving our water systems, but their impact on the environment and society must be assessed.

UNIT D Task

The Worth of Water

Getting Started

The United Nations considers access to clean drinking water to be a fundamental human right. Yet this is not the reality for more than one billion people worldwide. We rarely have to think about putting a value on water. One way to do it, however, is to measure the time and effort needed to gather and store it for our use.

Your Goal

Using a simulation, you will share the experience of a student your age who lives in rural Sierra Leone, in western Africa. Your task will be to supply your family with enough water for their daily routine, collecting that water from the community well.

What You Need to Know

Your teacher will help you research (1) the volume of potable water that a family of four in a rural west African country uses in a day, and (2) how much water a young person might carry per trip to the well. You will then use appropriate sizes of containers to represent your home cistern (storage container) and the container you will carry.

Your teacher will also set a distance in your schoolyard to represent the distance between your village and the well. The well will be represented by an outdoor hose. A pathway will be laid out for you to follow as though you were travelling to and from the well.

Steps to Success

1. With a team of three or four, walk from your "home" to the well along the set path, each carrying a water container. At the well, fill your container.
2. Return home along the same path. Empty your container into the cistern and return to the well for a refill. Repeat as often as it takes to fill the cistern.
3. When finished, sit down with your team to discuss the activity. Was it physically difficult? What would it feel like if you had to do this every day?
4. On your own, compose a first-person story as though you are a student in Sierra Leone describing the responsibility of taking water to your family. Include events that might occur during the travel to and from the well and your feelings about how you view this duty.
5. With your whole class, consider the information you learned in this unit about the volume of water required for a family's use in Canada. Develop a graphic organizer to contrast the information about family water consumption in Sierra Leone to that in Canada.

How Did It Go?

6. Suppose that your family in Canada had access only to the same amount of water per day as the family in Sierra Leone. Examine your graphic organizer. What water use habits are you prepared to change?
7. Examine the length of the path set out by your teacher. How long would it take your team to get the required volume of water if the path were 1 km? What if it were 5 km?
8. International organizations such as OXFAM and UNESCO work to bring low-technology wells to villages in the developing world. What might be the effect on a community if the water supply was located only a short distance from the homes?

UNIT D Review

Key Terms Review

1. Create a concept map that illustrates your understanding of the following terms. (K)

- aquifer
- bias
- bioremediation
- chlorine
- contaminants
- desalination
- discharge
- groundwater zone
- heat capacity
- impartial
- polar ice-cap
- potable water
- recharge
- salinity
- septic tank
- stewardship
- sustainability
- water table

Key Concept Review

10.0

2. Match the definition in Column A with the term in Column B. (K)

Column A	Column B
(a) a long, hollow shaft drilled into an aquifer	(i) oceans
(b) massive bodies of surface water that are referred to as Earth's water reservoirs	(ii) water table
(c) natural, underground freshwater reservoirs	(iii) river
(d) a large body of flowing fresh water that usually leads to a lake or ocean	(iv) aquifer
(e) the upper surface of the groundwater zone	(v) well
(f) land that is permanently or seasonally covered by shallow water	(vi) groundwater zone
(g) the underground water storage zone	(vii) wetland

3. Draw a diagram of the water cycle and label it with the following words. (K)

- evaporation
- transpiration
- precipitation
- condensation
- surface run-off
- ocean
- lake
- river
- ground water
- clouds
- atmosphere

4. Complete the following sentences by filling in the blanks with a word or words from this unit. (K)

(a) The line created by the Rocky Mountains in North America that separates the direction of water flow is known as the _____.

(b) An area with a small, localized climate is called a _____.

(c) The _____ of a substance describes its ability to absorb heat.

5. Write down whether each of the following statements is true or false. Give one piece of evidence from this unit to support your answer. (K)

(a) Large bodies of water have a moderating effect on the climate of a nearby region.

(b) Water takes the same amount of time to absorb heat as soil does.

(c) Rising temperatures and an increase in precipitation over a long period of time have a minimal effect on massive ice formations.

ACHIEVEMENT CHART CATEGORIES
(K) Knowledge and understanding (T) Thinking and investigation (C) Communication (A) Application

11.0

6. Describe three natural events that can affect the depth of the water table. K

7. (a) Explain how overuse of water threatens drinking water supplies. K

(b) Describe two human activities that contribute to overuse. K

8. What three tests are regularly carried out on drinking water to ensure that it is safe? K

9. The following steps are part of the treatment process for municipal waste water. Place them in the sequence in which they occur. C

(a) Clean water is returned to the river or lake.

(b) Waste water from homes and businesses is sent to the treatment plant through underground pipes.

(c) In the aeration tanks, micro-organisms digest the organic wastes.

(d) A coarse screen removes large debris such as toys, false teeth, and rags.

(e) Settling tanks separate the floaters and the sinkers. The remaining liquid is sent to the aeration tanks.

(f) Liquid from the secondary tanks can contain harmful microorganisms, so it is usually disinfected with chlorine.

10. Which of the following statements about wetlands are true and which are false? Rewrite the false statements to make them true. K

(a) Wetlands have no impact on our drinking water.

(b) Marshes and swamps are both types of wetlands.

(c) Wetlands are not important ecosystems.

12.0

11 Explain the term "sustainable development" as it applies to our water systems. K

12. Give one example of a biased statement and one of an impartial statement. C

13. Copy the following table into your notebook. In the Positive column, list benefits of the technology. In the Negative column, list drawbacks to the technology. In the third column, note interesting facts or comments about each technology. C

Examining Technological Innovations Using Water Systems

Technology	Positive	Negative	Interesting Fact
1. bioremediation			
2. desalination			

Connect Your Understanding

14. The large amount of snowfall in areas near the Great Lakes is often referred to as "lake effect snow." Explain why that term is used. C

15. The owners of a small hotel that draws water from a well submit a water sample for testing. The test result indicates the presence of *E. coli*, so the public health department issues a Boil Water Advisory. This tells the hotel owners to boil their water before consuming it. Answer the following questions about this situation.

(a) Why is drinking water tested for bacteria such as *E. coli*? K

(b) What is the purpose of boiling the water? T

(c) What could an unsatisfactory test result indicate? T

(d) What further investigations are necessary? A

16. Swimming pool water contains chlorine. Why should backyard swimming pools not be emptied down storm drains? T

17. Some bottled water companies remove water from municipally treated supplies. They are required to have a permit to remove the water. Do you think they should also pay for the treatment that the water received? Explain your answer. T

18. In the washrooms of some facilities such as airports, train stations, and shopping malls, water taps operate on sensors. Putting your hands under them starts the water flow. When you remove your hands, the water shuts off. Explain the benefit of this technology in terms of our water systems. T

19. Reflect back on all you have learned in this unit.

(a) List five things that you did not know before about Earth's water systems. C

(b) Beside each of the things you noted in (a), describe one way that this new knowledge will affect your actions and attitude from now on. A

Practise Your Skills

20. The map below shows the Niagara Peninsula watershed.

(a) Into which large waterfall does most of this watershed's water drain? K

(b) Does the rain that falls during a thunderstorm over Welland reach the ground water of Hamilton? Explain. T

(c) To what major ocean watershed does all water from this smaller watershed drain? A

21. Imagine that you are camping in the woods with friends. You brought enough drinking water with you, but you need to use lake water to wash your dirty dishes.

ACHIEVEMENT CHART CATEGORIES
K Knowledge and understanding T Thinking and investigation C Communication A Application

Write a plan for:

(a) the safe use of lake water for washing dishes.

(b) disposal of dish water so that there is minimal impact on the environment.

Revisit the Big Ideas

22. Weather is an important part of our lives. Read the following statements about weather. Explain how water systems are involved in each one.

(a) Weather forecasts explain how the weather will change over a short period of time.

(b) Cloud types and patterns can be used to interpret the weather.

(c) In the daytime, air rises over warmer land and cooler air moves in from the nearby water.

23. You have learned that water is an important five-letter word. For each letter, write down the name of something that depends on a sustainable use of water.

24. How crucial is water to our lives? Write a one-page essay to answer this question. First, write down all the responses you can think of. Then organize these ideas into a logical point-form outline. Finally, develop your ideas into sentences and paragraphs that describe how crucial water is to our lives.

D49 *Thinking about Science, Technology, Society, and the Environment*

S T S E

Water for All

Each photograph in Figure 12.21 shows one or more ways that water plays a role in supporting the world around us.

1. How are human lives dependent on or improved by each use shown?
2. What competing water uses could harm or disrupt the existing uses shown in each photograph? Would the impacts be social, cultural, political, environmental, or a combination of these? Explain.

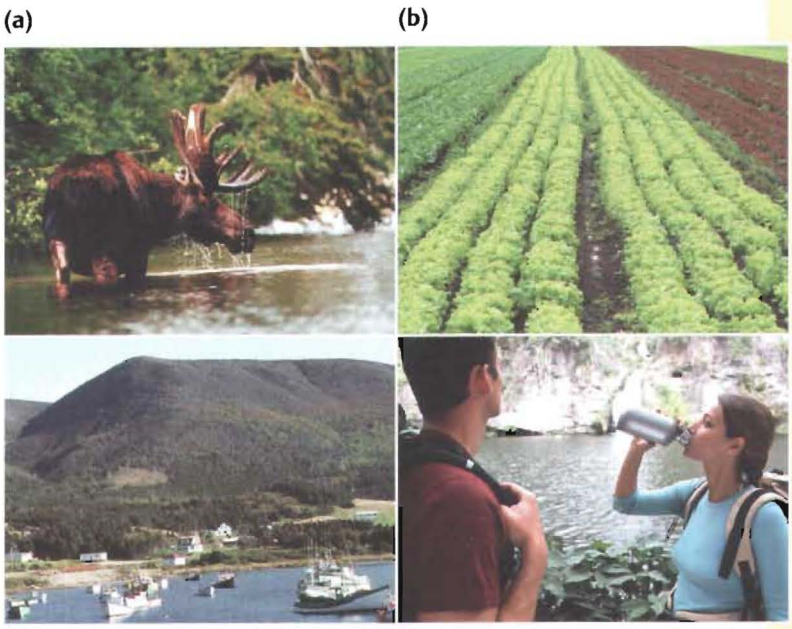


Figure 12.21 Water everywhere