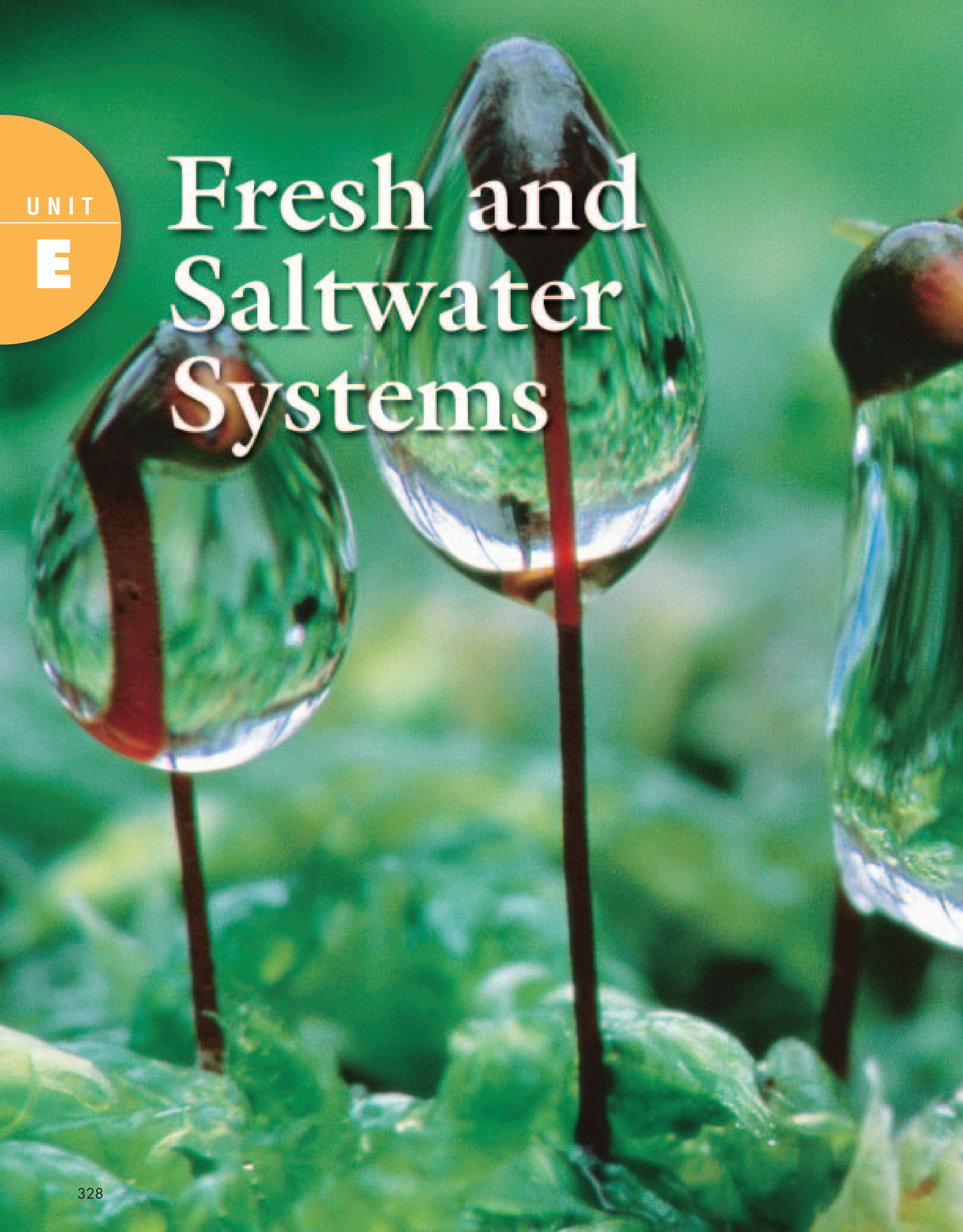
UNIT E

Fresh and Saltwater Systems



In this unit, you will cover the following sections:

1.0 **Humans depend on water supply and quality.**

1.1 The Distribution of Water on Earth

1.2 Water Quality

2.0 **Water in its various states affects Earth's landforms and climate.**

2.1 Waves and Tides

2.2 Erosion and Deposition

2.3 Processes That Shape Ocean Basins and Continental Drainage

2.4 Water and Climate

3.0 **Living things in aquatic environments are affected by many factors.**

3.1 The Diversity of Organisms in Salt and Freshwater Systems

3.2 Populations in Fresh and Salt Water

3.3 Water Quality and Living Things

4.0 **Human activities affect aquatic environments.**

4.1 How Humans Use Water

4.2 Measuring Impacts

Exploring

Rain is just one of the ways that we experience Earth's water systems.

When you think of water, what comes to mind? Perhaps you think of drinking it, cooking with it, or washing in it. You might think of sailing on a lake, or skiing down a snow-covered hill. Water is all that and more. Living systems—including you—need it to survive. Ecosystems depend on it. The land is changed by it. Industry uses large amounts of it. Climate and weather are determined by it.

In this unit, you will explore fresh and saltwater systems. You will investigate how water quality influences living things, and how water affects landforms and climate. You will discover how human activities and needs have changed our planet's water supplies and the environments that depend on them.

Because you live in Canada, you see water in the environment all the time—in lakes, rivers, and streams, and falling from the sky. Canada is a water-rich country. Most countries in the world have much less fresh water than we do. In fact, in some areas of the world, it hasn't rained in years! But even in Canada, water isn't always where we need it when we need it.

In the 1930s, farmers in Alberta struggled to keep their farms going during the severe drought.

Coping with a Dry Climate

In the 1930s, much of Alberta and Saskatchewan was in the grip of a long drought. Lake and river levels dropped significantly. Small streams, sloughs, and ponds simply dried up. The water in the soil evaporated into the dry air. Topsoil turned to dust and blew away. Farming became almost impossible.

Today, southern Alberta is a very different place from the "dust bowl" of the 1930s. Large irrigation projects have brought water from the foothills of the Rockies to these dry areas. Crops can now be grown in areas where only grasses and cacti once lived. Such irrigation projects have also changed parts of southern Saskatchewan and British Columbia.

The rich crops of southern Alberta today rely on irrigation to ensure a steady supply of water.

Human Water Use

Irrigation is only one of the many ways that humans use Earth's water supply. In agriculture, in industry, and in our personal uses, we use water every day. And in our many uses, we affect the other organisms on Earth that depend on water as well. Can you think of any living thing on this planet that does not require water in some way to survive?

Give it a TRY — **ACTIVITY**

Your Water Use

Water is essential to life—your life as well as that of all other organisms on the planet. Fresh water is especially important to humans. We think we have lots of water, but even in our water-rich country, the amount of clean, fresh water we want isn't always available. As you saw from the effect of a severe drought on Alberta, lack of water can be a serious problem. Can individuals like you help to conserve water?

- In what ways do you use precious water? With a partner, brainstorm all of the ways you can think of that you use water. Look over the items on your list, and identify the ones where you might be wasting water. For example, do you leave the tap running while you brush your teeth?
- For each item on your list, suggest a way that you could reduce your water use. Add your ideas to a class suggestion board on how to reduce water consumption at home.

Using Water Indirectly

When you use water for brushing your teeth or drinking or washing dishes, you are using water directly. But all day long, you're also using water indirectly. Every food you eat, every item of clothing you wear, every vehicle that you travel in—everything you use involves water in some part of its production. Water for irrigation is important in growing fruit and other crops. In manufacturing jeans, water is used for washing fabrics and dyeing. In making soft drinks, water is an ingredient, as well as part of the cleaning process for bottles.

All of these uses can have negative impacts on Earth's water. It's up to all of us to understand Earth's water system—what it is, how it works, and how we affect it—so we can keep our planet healthy.

Focus On — Social and Environmental Context

As you work through this unit, you will learn about the science of water systems and the social and environmental importance of water. Think about the focussing questions below as you perform activities and answer questions throughout the unit.

1. **What are the characteristics of fresh and saltwater systems?**
2. **How do these water systems function?**
3. **How do fresh and saltwater systems interact with Earth and its atmosphere?**
4. **How do the actions of humans affect these water systems?**

Thinking about these questions will help you understand the importance of water to all life on Earth—including our own. They will also help you understand how science and technology help us meet our needs for water.

In the project at the end of this unit, you will consider the effect of human activity on the water we drink. This project will give you an opportunity to use the research, thinking, and decision-making skills you practise in this unit. You will also be able to use the scientific knowledge about water systems that you learn here.

1.0 Humans depend on water supply and quality.

Key Concepts

In this section, you will learn about the following key concepts:

- water quality
- human impact

Learning Outcomes

When you have completed this section, you will be able to:

- describe the distribution of water on Earth
- recognize that fresh and salt water contain other materials
- define water quality
- describe tests for water quality
- describe methods for making fresh water from salt water

When astronauts first viewed Earth from space, they were impressed by its beautiful blue and white colour. Earth is unique among the planets because 74% of its surface is covered with water. It is often called the "water planet" or the "blue planet." Yet, parts of Earth are so dry that they are deserts. In other areas, there is enough water, but people may not be able to drink it because of minerals that give it an unpleasant taste and odour. These are all natural variations in Earth's water supply.

The water supply can also be affected by human activities. Industries might pollute the water in lakes and rivers. Overuse by people in cities might reduce the amount of water available in an area.

An important first step in managing our water supplies is to understand how and where water occurs on Earth and what water quality means to humans and other living things. Let's begin by exploring fresh water, salt water, and water quality.

For Web links relating to 1.0, visit **www.pearsoned.ca/scienceinaction**

1.1 The Distribution of Water on Earth

Our planet has more water than any other planet in the solar system. Our water also exists in different forms. It isn't all frozen the way water on Mars is. But is it evenly distributed all over Earth? Where is the water on Earth, and what kind of water is it?

Think about a map of the world and what you know about water already. Draw a circle. The whole circle represents the total amount of water on Earth. If the circle was a pie, how big a piece of this pie do you think would represent all the drinking water available in the whole world? Draw that slice of pie on your circle. Keep your prediction handy so you can refer to it later in this subsection.

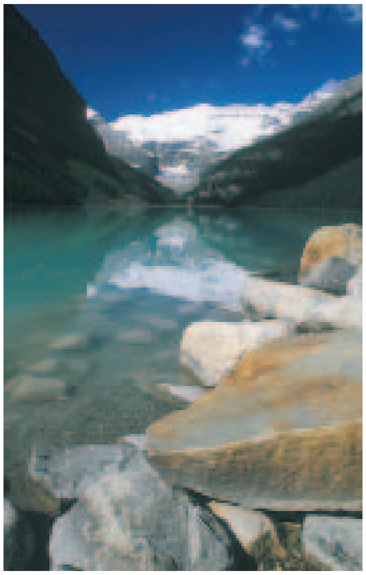


Figure 1.1 How many different states of water can you see at this lake?

Drinking Water for Humans

Humans, and many other animals, would die if they had only salt water to drink. Drinking water must be fresh water, not salt water. However, not all fresh water is drinkable. Think about the water that collects in puddles on the street after a summer rainstorm. Would you drink that? Why not? Or the water that runs in ditches along country roads in the spring—would you drink that? Both of these are examples of fresh water, but you shouldn't drink them. Water that humans can drink safely is called **potable water**. Only a tiny amount of water on Earth is potable.

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Water in Alberta

Alberta is fortunate to be a water-rich province with large rivers, huge lakes, and gleaming glaciers. However, most of our major rivers are far from the large urban centres of Edmonton and Calgary, which need a lot of water. Some of Alberta's largest rivers, such as the Hay, Peace, and Athabasca, drain to the north. The Bow and Elbow rivers, and the North Saskatchewan River all have reservoirs for water storage and management. A *reservoir* is an artificial lake. A reservoir may be used for drinking water, irrigation, or generation of hydro-electricity.

Alberta's major rivers and lakes

Inquiry Activity

WATER, WATER EVERYWHERE

The Question

How much water on Earth is available for humans to drink?

Procedure

Part A Using a Model of Earth's Water

1. Fill a 1000-mL graduated cylinder with water. This represents all the water on Earth.
2. Predict the amount of this 1000 mL that you will use to represent the amount of drinkable water on Earth.
3. Pour 30 mL of this into a 100-mL graduated cylinder. This 30 mL represents the total amount of fresh water on Earth.
4. Use the balance to measure out 29 g of salt. Dissolve the salt in the 970 mL of water remaining in the 1000-mL graduated cylinder. This represents the amount of water in all the oceans. It is too salty to be drinkable. Put it aside.

Materials & Equipment

Part A

- 1000-mL graduated cylinder or beaker
- 100-mL graduated cylinder
- salt
- balance
- 10-mL graduated cylinder
- freezer
- eyedropper

Part B

- graph paper or graphing software

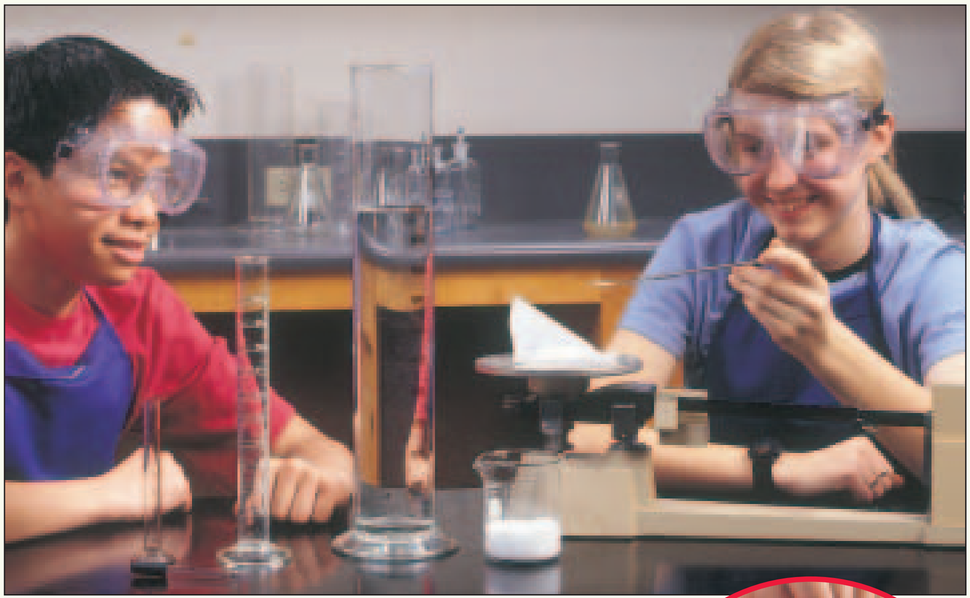

Figure 1.2 In this activity, you are creating a model of the distribution and characteristics of water on Earth.

5. Now pick up the 100-mL graduated cylinder containing the 30 mL of fresh water. Pour 6 mL into the 10-mL graduated cylinder. Take the 100-mL graduated cylinder that now contains only 24 mL of water, and put it in the freezer. This represents the amount of fresh water that is frozen in glaciers and icecaps.

6 You now have 6 mL of water left in the 10-mL graduated cylinder. Use an eyedropper to remove a small amount of water. Let one single drop fall into your palm. This one drop represents all the fresh water on Earth that is available for people to drink! It is about 0.003% of the total amount of water on Earth.

Here's what you've learned about the distribution of water on Earth:

- Of all the water on Earth, 97% is salt water in the oceans, and 3% is fresh water.
- Of the fresh water (3% of the total water), 77% is ice, 22% is groundwater, and 1% is in lakes, rivers, and wetlands.

Part B Graphing the Distribution of Water on Earth

7 Another way to represent Earth's water supply is to graph it. Either by hand or using graphing software, draw two separate circle graphs, one for each of the statements about water shown in the box.

- Remember to be accurate when graphing. If you are doing it by hand, make sure to convert the percentages to degrees, and use a protractor to measure the angles accurately.
- Colour your graphs, and give each one a title and a legend.

Analyzing and Interpreting

8 In this activity, you used two different methods of presenting information about the distribution of water on Earth. What were the two methods? What were the benefits of using each method? What were the drawbacks to each method?

Forming Conclusions

9 Using words, pictures, or both, describe how much water is available to humans as drinking water, compared with the rest of the water on Earth.

Applying and Connecting

While you were doing this activity, water was evaporating from your samples into the air. About 0.0009% of all the water on Earth is a gas in the atmosphere at any one time. In some places in the world, water in the atmosphere is the only fresh water that's available for people to drink. How can they drink water from the air? A village in the desert on the north coast of Chile uses special web collectors to gather water from the fog that forms early every morning. In Peru, Ecuador, Namibia, and Oman, people are also using this technology.

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Canada's Water Riches

Canada is awash with water. We are bounded on three sides by oceans. We have 9% of all the world's fresh water. We have over 2 million lakes. And we have large reserves underground as well. Should we share our fresh-water riches with the United States and other countries? Use the Internet to learn more about this issue. Decide for yourself what Canada's policy on water exports should be.

Water on Earth

Earlier in this subsection, you learned that humans can drink only fresh water. From the information above, it looks as if there's plenty of water for us to drink. But most of the fresh water is locked in icecaps and sea ice in the Arctic and the Antarctic far from population centres. And not all of the water underground, and in lakes, rivers, and wetlands is accessible. In fact, only about 0.003% of all the water on Earth is available for humans to drink. The remaining fresh water may be too far below Earth's surface or in places where humans don't live.

Imagine that you had 1000 glasses of water in front of you, representing all the water on Earth. You would be able to drink less than one-third of one glass! Figure 1.3 is another way of illustrating the amounts of salt water and fresh water on Earth.

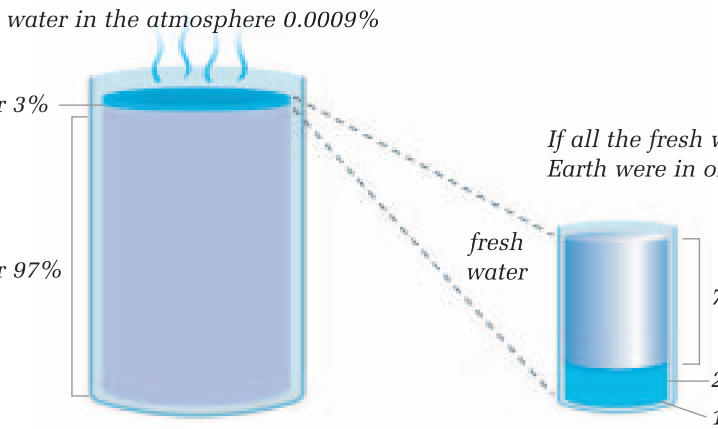

Figure 1.3 Most of the water on Earth is in the salty oceans. Most fresh water is frozen solid.

Check and Reflect

1. a) Where is most of the fresh water on Earth?
   b) Is it readily available for humans to use? Why or why not?
2. a) How much of all the water on Earth is available for humans to drink?
   b) Find the circle graph that you drew at the beginning of this subsection predicting the amount of drinking water compared with the total amount of water on Earth. Was your prediction close? Why or why not?
3. We know that Earth's population is increasing. Do you think enough drinking water will be available for future generations? Why or why not?

1.2 Water Quality

When you turn on your tap, you expect your glass to fill up with clear water that has no unpleasant odour or taste. In Canada, we expect the quality of our water to be good all the time. **Water quality** describes how pure the water is. You can determine water quality by measuring the amount of substances besides water that are in a water sample.

Water in nature is never pure—it always contains organisms, organic material, minerals, and other chemicals. You are about to explore water quality in more detail. To prepare for your exploration, start a concept map with the phrase *water quality* in the centre. Build your concept map as you read about and investigate water quality. See Toolbox 9 for information on creating concept maps.

Substances Dissolved in Water

Many different substances are dissolved in both fresh and salt water. Most of these substances are called *salts*. The most common salt dissolved in water is sodium chloride—the same mineral we use for table salt. The total amount of all salts dissolved in water is called its **salinity**. Seawater (water in the oceans) has a much higher salinity than fresh water. Seawater's average salinity is 3.5%. Seawater also contains many other substances in much smaller amounts. It even contains gold and silver! But you would have to process an enormous amount of seawater to obtain even a small amount of gold.

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Unsafe Water

Over 1 billion people drink dirty water every day because they can't get clean water. Worldwide, 3 to 5 million people die each year from unsafe water. Most of them die from diseases carried by the local water supply. The diseases may be caused by bacteria, viruses, or small parasites in water. Most of these diseases are spread by drinking water contaminated by feces of infected animals or people.

Why is this water unsafe for human use?

math Link

Seawater is a solution containing 96.5% water and 3.5% dissolved salts. The following substances make up these salts:

sodium	30.6%
chloride	55.0%
sulphate	7.7%
magnesium	3.7%
calcium	1.2%
potassium	1.1%
other	0.7%

Which substance makes up the largest percentage of dissolved salts? What percentage of seawater is this substance?

Hard Water

Fresh water can be found both on Earth's surface and underground. As it flows, it dissolves minerals from the soil and rocks it passes through. One of these minerals is salt. Fresh water contains much less salt than seawater does. But in some places, the salinity of fresh water is high enough that you can taste it. In Canada, salty fresh water can be a problem in places on the Prairies. Other substances can also be a problem. In some places in Ontario, water contains so much iron that it affects the taste.

Many areas across the country have **hard water**. Hard water contains a high concentration of the minerals calcium and magnesium. You can tell that you have hard water if soap doesn't lather properly. Hard water also leaves mineral deposits in appliances such as kettles and hot water heaters.

Figure 1.4 Hard water causes mineral deposits called *scale* to form on the inside of pipes. The scale clogs up the pipes.

Organisms in Drinking Water

Fresh water also contains organisms and other organic matter. Some of the substances and organisms that may be found in water are harmful and some are not. Most minerals are not a serious health problem, but some organisms that may be found in fresh water can be. For example, *Escherichia coli*, known as *E. coli*, is a type of bacteria that can cause sickness and even death. Usually, our water treatment processes prevent these organisms from becoming a problem.

Water Quality Testing

If you get your water from a well, your family probably doesn't have the water tested very often. Because the water comes from deep underground, it is protected from most pollutants—both natural and human-made. But most cities and towns get their drinking water from surface sources, either lakes or rivers. They then filter this water and treat it with chemicals. This processing brings it to a level of quality that is safe for human use. Such water must be tested regularly to make sure that it is potable.

Figure 1.5 A scientist tests water quality. Water quality is important to all living things. Different organisms can withstand different levels of water quality. The close-up shows the parasite *Giardia*. It causes intestinal problems in humans.

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Community Water Processing

Getting good quality water to people, businesses, and other users is a big effort. Water from a source such as a lake, river, or groundwater is pumped into a treatment plant. There it passes through a series of stages that gradually make it cleaner and cleaner until it is safe to drink. Find out how water treatment is done in your community.

Inquiry Activity

Testing the Waters

Materials & Equipment

- 1 500-mL sample of tap water in a beaker
- 2 500-mL samples of untreated water from 2 different sources (provided by your teacher)
- filter paper (or white paper coffee filters)
- funnel
- 250-mL beaker
- graduated cylinder
- 3 test tubes
- silver nitrate (1% solution)
- 3 Erlenmeyer flasks
- soap flakes (not detergent)
- 1-mL measuring spoon
- 3 stoppers for flasks
- bromothymol blue

Caution!
Do **not** taste any of the water samples at any time during this activity.

Caution!
Always follow your teacher's instructions in handling and disposing of chemicals.

The Question

Are there physical and chemical differences between treated water and untreated water?

The Hypothesis

Write a hypothesis about the differences you would expect to find between treated and untreated water.

Hint: Think about their appearance and what substances they might contain.

Procedure

Checking for Clarity

1. Observe the samples in their beakers. Record their appearance, including colour.
2. Read the next step and predict what you will see after filtering each water sample.
3. Place a filter paper cone in a funnel and place the funnel in the empty beaker. Using the graduated cylinder, pour 100 mL of one water sample through the filter paper. Wait until the water has drained through the filter entirely. Observe the filter paper and the water in the beaker. Record your observations.
4. Repeat step 3 for each of the other two water samples.

Testing for Chlorine

5. Predict which water sample will contain the most chlorine.
6. Pour a small amount from each water sample into separate test tubes. Add 5 drops of silver nitrate solution to each test tube. Record any changes you see in the water in the flasks. Wash your hands.

Testing for Hardness

7. Use the graduated cylinder to measure 100 mL of each sample into 3 separate Erlenmeyer flasks. Label each flask.
8. Add 1 mL of soap flakes to each flask and put the stoppers in the flasks. Shake each flask vigorously for 30 s. Observe the soap froth in each flask. Record your observations.

Testing for Living Organisms

9. Thoroughly wash out, rinse, and dry the 3 Erlenmeyer flasks and rubber stoppers. Pour 125 mL of the tap water into a clean Erlenmeyer flask. Put the same amount of each of the other samples in separate flasks. After you measure each sample, make sure to clean the measuring container thoroughly with soap and water. Then rinse and dry it carefully before using it for the next sample.

10 Add 5 drops of bromothymol blue to each flask. Tightly stopper the flasks and label them. Record the colour of the solution in each flask. Place all the flasks in a warm, dark place where they won't be disturbed for 24 h. Wash your hands. After 24 h, remove the flasks from the dark and record the colour of the solution in each one.

11 Wash your hands after you have completed all the tests and cleaned up your equipment.

Collecting Data

12 Record your observations in a table similar to the one below.

Purpose of Test	Appearance of Sample before Test	Appearance of Sample after Test	What the Test Indicated

Analyzing and Interpreting

13 Explain any differences you observed in the appearance of the filter papers used for the water samples.

14 Which sample contained the largest amount of chlorine? Why?

15 Which sample contained the hardest water? How do you know?

16 When you were preparing the test for living organisms, you had to clean the graduated cylinder between water measurements. You also had to make sure the Erlenmeyer flasks were clean. Why did you have to be so careful?

17 Which sample contained the most living organisms? Do you think it would be safe to drink? Remember: Do **not** taste any of the water samples.

18 Which sample had the least number of living organisms? Why?

Forming Conclusions

19 Are there differences between treated water and untreated water? Summarize the results of your tests to support your conclusion.

Applying and Connecting

For years, the Cree community of Split Lake, Manitoba, had suffered health problems because of poor water quality. They went to Environment Canada for help and then linked up with the International Development Research Centre (IDRC) in Ottawa. IDRC had been working on low-cost water-testing kits for developing countries. The Split Lake community used the IDRC technology to prove that people in isolated areas could do their own water testing and take action to improve their water quality.

Figure 1.6 Step 3. Pour 100 mL of one water sample through the filter.

Figure 1.7 Step 6. Add 5 drops of silver nitrate solution to each test tube.

Water Testing Criteria

Figure 1.8 Which glass of water is safe to drink? Maybe neither of them is!

One of the first things that a technician does when testing water is to look at it. Look at the two glasses of water in Figure 1.8. Which one of these glasses of water would you be more likely to drink? Another step in water quality testing is smelling the water. Does it have any unpleasant odours? For example, in some areas, dissolved hydrogen sulphide gas can give water a rotten egg smell. And it's not only the smell that is bad. Hydrogen sulphide is unsafe for human consumption.

Always remember, however, that clear water is not a sign of clean water. Ocean water can be very clear, but we can't drink it because of the high salt content. Similarly, a stream in the woods may look clear, but it may contain organisms or chemicals that are dangerous to humans. In order for us to be sure that our water is safe to drink, it must be tested regularly. After testing, the water is filtered and treated with chemicals, such as chlorine, to kill any dangerous organisms.

These are some of the items that drinking water is tested for:

- taste and odour
- turbidity (cloudiness) and colour
- toxic substances and other pollutants
- bacteria
- hardness or mineral content
- pH (how acidic or basic the water is)
- dissolved oxygen
- solids, including floating materials
- dissolved solids

Changing Salt Water to Fresh Water

As you learned in subsection 1.1, most of the water on Earth is in the salty oceans. Much of the fresh water is locked up in icecaps and glaciers. Only a small percentage of liquid fresh water is available for drinking. In some areas of the world, very little fresh water is available, but there is lots of salty water. Is there a way to use salty water for drinking? Salt water must be processed to remove the salt to make the water potable. The two most common processes used for producing fresh water from salt water are distillation and reverse osmosis.

Distillation

Distillation equipment produces pure water (distilled water) from water that may contain minerals, such as salt, and other substances. In **distillation**, the solution is boiled so that the water evaporates and leaves the salt behind. Liquid fresh water is then formed from the water vapour.

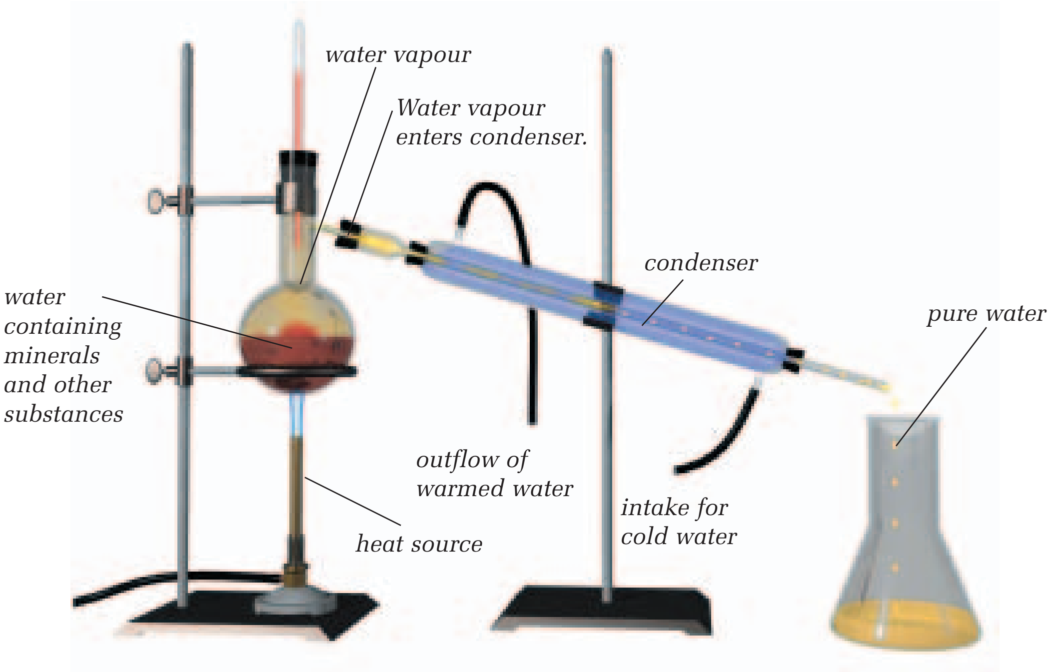

Figure 1.9 This simple lab apparatus can create pure water.

Reverse Osmosis

Reverse osmosis operates by forcing salt water through a filter or membrane with holes too small for the salts to pass through. *Osmosis* is the movement of water particles through a membrane. The particles move from an area of higher water concentration to one with a lower water concentration. In reverse osmosis, the water moves from an area of lower water concentration to one of higher water concentration. In this way, the water leaves behind the unwanted dissolved substances.

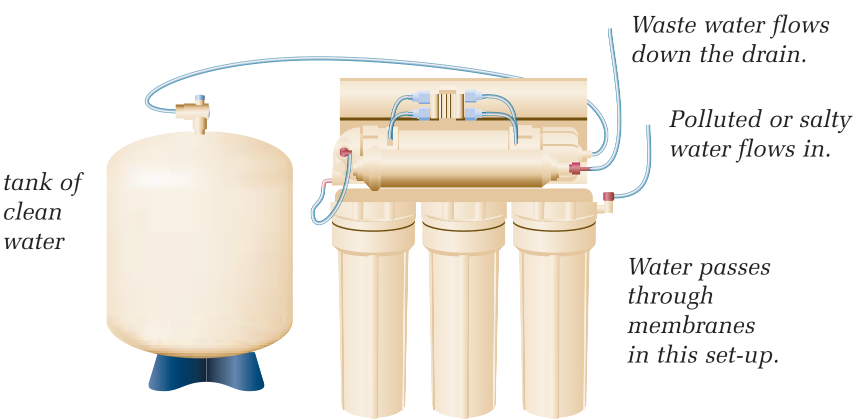

Figure 1.10 This reverse osmosis set-up can also create pure water from salty or polluted water.

Check and Reflect

1. You are walking along a dry, dusty road in summer. Feeling really thirsty, you stop by a clear, running stream. Would you drink the water? Why or why not?
2. Some cities and towns take their drinking water from rivers and lakes. Sometimes their water quality changes during the year. What do you think might cause these changes? Suggest an example of the difference in water from a lake between summer and winter.
3. Saudi Arabia is a desert country with very little fresh water. However, it has a long coastline along the Red Sea and the Persian Gulf. Large commercial desalination operations in Saudi Arabia produce fresh water from salt water. The availability of inexpensive fuel in the form of oil makes these huge operations possible. One of the reasons Canada does not have huge desalination operations is the high cost of fuel to heat the water. Can you think of any other reasons why we don't use distilled water?

TRY This at Home — ACTIVITY

Salt Water into Fresh Water

You can turn salty or dirty water into drinkable fresh water simply by using the sun. After all, it's the sun's energy that converts the salty water of the oceans into the fresh water of the rain. All you need is a clean, clear plastic bag, a twist-tie to close the bag, some table salt, and a cereal bowl of water.

- Dissolve a tablespoon of salt in the bowl of water. Taste the water by touching it and tasting it off your fingertip. It should taste very salty.
- Place the bowl inside the plastic bag and close the top of the bag tightly with the twist-tie.
- Set the bag and bowl next to a sunny window, and leave it there for 24 h.
- After 24 h, open the bag, and touch the liquid collected on the inside of the bag. Taste it. Is it still salty?
- Explain what happened to the salty water.

Figure 1.11 Set-up for activity

Assess Your Learning

1. Explain what potable water is. If all the water on Earth is represented by a 1000-L tank, how many millilitres of that would represent potable water?
2. Do you think there are reserves of fresh water that have yet to be used by humans? Explain your answer.
3. What chemical is usually added to water that will be piped to households? Why?
4. What is hard water? What do you think soft water is?
5. If you haven't already done so, add information on water quality and testing to your concept map. Keep your concept map so you can add to it later in this unit when you learn how water quality can affect organisms.

Focus On — Social and Environmental Context

Science and technology have contributed to human well-being. Think about what you learned in this section.

1. How have water quality testing techniques improved people's lives?
2. Why do you think more and better water desalination technology is being developed?
3. What did you learn about water quality in this section that helped you understand the importance of protecting our sources of drinking water?

Desalination plant

2.0 Water in its various states affects Earth's landforms and climate.

Key Concepts

In this section, you will learn about the following key concepts:

- water-borne materials
- erosion and deposition
- stream characteristics
- continental drainage systems
- ocean basins
- climate
- glaciers and icecaps

Learning Outcomes

When you have completed this section, you will be able to:

- describe the causes of waves and tides
- describe erosion and deposition and their causes
- identify stream characteristics
- describe processes that shape ocean basins and continental drainage
- identify factors that affect glaciers
- recognize evidence of glacial action
- describe the link between water and climate

Water exists in many different forms on Earth. You can find it in all three states—solid, liquid, and gas. You can find it underground, on the surface, and in the air. Because there is so much of it, water affects both the living and non-living parts of Earth's environment. Waves and tides erode shorelines and influence the kinds of animals and plants that live there. On land, moving water in streams and rivers, and moving ice in glaciers change the geography of continents. And water—or the lack of it—determines climate and weather around the world. In this section, you will learn more about how fresh and saltwater systems interact with the atmosphere and Earth's surface.

For Web links relating to 2.0, visit www.pearsoned.ca/scienceinaction

2.1 Waves and Tides

In Figure 2.1, waves splash onto the ocean's shore at low tide. Above the line of waves, you can see another line on the shore where the waves hit at high tide. Waves and tides are two examples of ways in which water moves.

Waves are movements on the surface of the water. Tides are the regular rising and falling of very large bodies of water. You can also see in Figure 2.1 evidence of erosion caused by the waves. Make a sketch of what you see in Figure 2.1. Label it to show where the waves are coming from, the effect they have had on the shore, high tide level, and low tide level. As you read through this subsection, add information on waves and tides to your diagram.

What Is a Wave?

If you have ever been to the ocean or a lake, you know that the water's surface is constantly moving. On calm days, waves lap along the shore. On stormy days, they crash against it. But even small bodies of water—right down to puddles—have waves sometimes. How do these waves form?

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Boats and Shore Erosion

A large cruiser travelling at 8 knots (14.8 km/h) will cause a wash big enough to sink small boats, damage moored ones, and contribute to shore erosion. In waterways where major bank erosion is occurring, you may see "NO WASH" signs displayed. This means that boat drivers must slow down so that no waves are created that could damage the shore.

Boats create waves called "wash" that can affect other boats and the shore.

Figure 2.1 Waves and tides both affect the shape of the shoreline.

Inquiry Activity

Making Waves

Materials & Equipment
- deep, flat baking pan
- water
- 1 cork

The Question

How does the movement of waves affect objects floating on the water?

The Hypothesis

Write a hypothesis to explain how the movement of waves affects objects floating on the water.

Procedure

1. Fill the baking pan three-quarters full of water, and place it on a desk or table. Wait for the surface to be calm.

Figure 2.2 Set-up for making waves

2. Create waves by blowing across the water's surface.
3. Take turns trying to produce different kinds of waves. See if you can change the height of the waves.
4. Place a cork on the water, and wait for the water to calm. Predict what will happen if you blow on the water and not on the cork. Blow on the water to make waves, but do **not** blow directly on the cork.

Collecting Data

5 Draw labelled diagrams of the different waves you make and the cork's movement.

Analyzing and Interpreting

6 Were you able to change the heights of the waves you created? If so, how did you do it?

7 Were you able to move the cork across the pan? Explain why or why not.

Forming Conclusions

8 Using words and pictures, create a summary of what you know about waves.