

SECTION 2

The Water Supply

DISCOVER

How Does the Water Change?

1. Shine a flashlight through a clear plastic cup of water.
2. Add 6 drops of milk to the water and stir.
3. Shine the flashlight through the cup again. Note any differences.



ACTIVITY

Think It Over

Observing Where in the cup of water is the milk located? Could you easily separate the milk from the water?

How could you determine whether life has ever existed on another planet in the solar system? One piece of evidence scientists look for is the presence of water. This is because water is the most common compound in all living cells on Earth. Water is necessary for life as we know it.

Most of Earth's surface is covered by some form of water. From space you cannot even see many parts of Earth because they are hidden behind clouds of tiny water droplets. Around the poles are vast sheets of ice. Oceans cover nearly three fourths of Earth's surface.

The Water Cycle

Water in Earth's oceans does not remain there indefinitely. Water is constantly recycled through the water cycle. **The water cycle is the continuous process through which water moves from Earth's oceans to the atmosphere, to the land surface, and then returns to the oceans.** The processes of evaporation, condensation, and precipitation make up the **water cycle**. As you read about these processes, follow the water cycle in Figure 8.

GUIDE FOR READING

- ◆ What is the water cycle?
- ◆ Why is fresh water a limited resource?
- ◆ What are the major sources of water pollution?

Reading Tip As you read, identify sentences that support this statement: *Water is a scarce resource that must be protected.*

Key Terms

- evaporation • condensation
- precipitation • groundwater
- drought • water pollution
- sewage • fertilizer • pesticide
- sediment • land subsidence

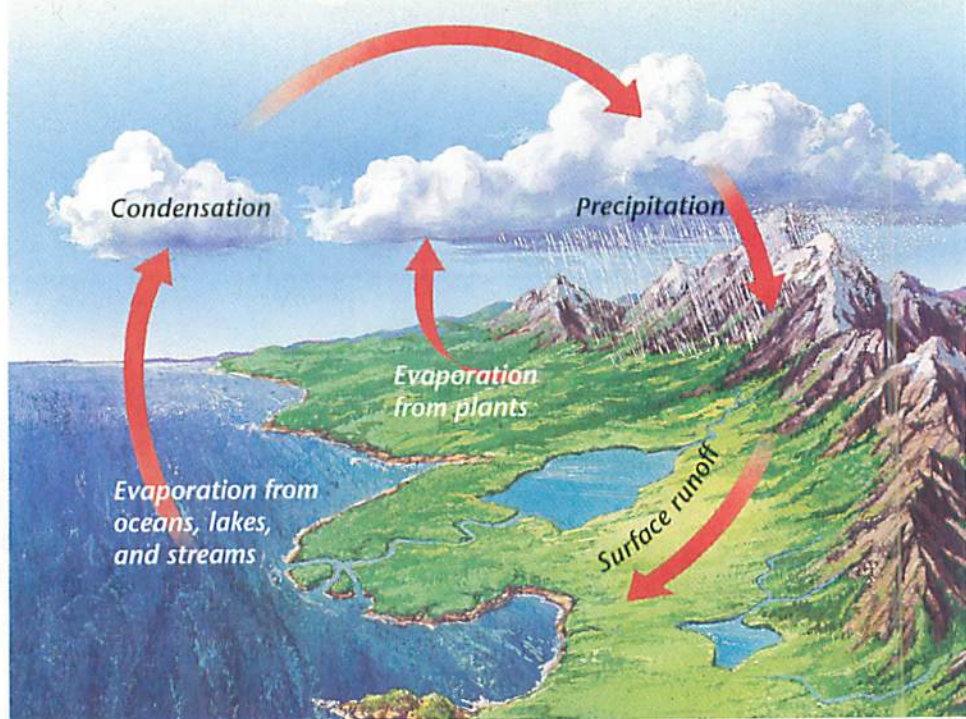
Figure 7 A view from space shows the abundance of water on Earth and in the atmosphere.



Figure 8 In the water cycle, water moves continuously from Earth's surface to the atmosphere and back.

Interpreting Diagrams

In which step of the water cycle does water return to Earth's surface?



TRY THIS

Getting Clean

In this activity you will see how Earth's fresh water is purified in the water cycle. **ACTIVITY**

1. Pour 15 mL of water into a plastic cup.
2. Add a few drops of food coloring and half a teaspoon of sugar. Stir until the sugar is dissolved.
3. Put the cup in the sunlight in a place where it will not be disturbed.
4. Check on the cup twice a day until all the water has evaporated. Observe what remains in the cup.

Making Models What do the *sugar and food coloring* represent? What happens to the water in this activity?

Evaporation The process by which molecules of liquid water absorb energy and change to the gas state is called **evaporation**. In the water cycle, liquid water evaporates from Earth's surface and forms water vapor, a gas, in the atmosphere. Most water evaporates from the surfaces of oceans and lakes. The energy for evaporation comes from the sun.

Some water is also given off by living things. For example, plants take in water through their roots and release water vapor from their leaves. You take in water when you drink and eat. You release liquid water in your wastes and water vapor when you exhale.

Condensation What happens next to the water vapor in the atmosphere? As the water vapor rises higher in the atmosphere, it cools down. When it cools to a certain temperature, the vapor turns back into tiny drops of liquid water. The process by which a gas changes to a liquid is called **condensation**. The water droplets collect around particles of dust in the air, eventually forming clouds.

Precipitation As more water vapor condenses, the drops of water in the cloud grow larger and heavier. Eventually the heavy drops fall back to Earth as a form of precipitation—rain, snow, sleet, or hail. Most precipitation falls back into oceans or lakes. The **precipitation** that falls on land may soak into the soil and become groundwater. Or the precipitation may run off the land, ultimately flowing into a river or ocean once again.

Checkpoint What change of state occurs when water from the surface of the ocean enters the atmosphere as water vapor?



Figure 9 The water cycle constantly moves water between Earth's surface and the atmosphere. As water vapor evaporates from this pond, it condenses in the cool air, forming mist.

The Water Cycle as a System

The water cycle is a complex system driven by energy from the sun and by gravity. The sun's energy is the source of the thermal energy that causes evaporation and lifts water vapor into the atmosphere. Gravity pulls precipitation to the surface and causes runoff to flow downhill.

Presently, the water cycle is in balance worldwide. This means that total precipitation and runoff are about equal to the total amount of evaporation.

A change in one part of the water cycle, however, could affect other parts of the cycle. For example, scientists think that 20,000 years ago, during the last ice age, sea level was about 100 meters lower than at present. Where did this huge volume of water go? Much of it had become frozen in the vast continental glaciers that existed during the ice age. The change in the volume of ocean water affected evaporation and precipitation worldwide.

Human actions can have a local effect on the water cycle. When a forest is cut down, for example, the water that trees would have released as water vapor becomes groundwater or runoff. This increases the flow of streams or rivers in the area. A change in the water cycle thus affects other Earth systems.

A Limited Supply

How can water be scarce when there is so much of it on Earth's surface? **The reason is that most of the water on Earth—about 97 percent—is salt water. Salt water cannot be used for drinking or watering crops.** People need fresh water for these purposes.

In addition, about three quarters of the fresh water on Earth is in the form of ice. This water is not available for people to use. Finally, the supplies of liquid fresh water that do exist are not always close to where people live. For example, many cities in the southwestern United States draw their drinking water from rivers hundreds of kilometers away. About half the people in the United States use **groundwater**, water stored in layers of soil and rock beneath Earth's surface.

Figure 10 People obtain and store water in many ways. At left, a tower holds the water supply of a community in Bucks County, Pennsylvania. At right, women in the Yucatán in Mexico draw water from a well.



Renewing the Supply Fortunately, Earth's supply of fresh water is renewable. Water continually moves between the atmosphere and Earth's surface in the water cycle. Water evaporates from oceans, lakes, and rivers, becoming water vapor in the atmosphere. As the water evaporates, any dissolved substances are left behind. The pure water vapor condenses into tiny droplets which form clouds. When the droplets become large and heavy enough, they fall as precipitation.

Water Shortages Water shortages occur when people use water in an area faster than the water cycle can replace it. This is more likely to happen during a **drought**, a period when less rain than normal falls in an area. During a drought, people have to limit their water use. All unnecessary water uses may be banned. If the drought is severe, crops may die from lack of water.

Due to growing populations, many places in the world never receive enough rain to meet their water needs. They must obtain water from distant sources or by other means. For example, the desert nation of Saudi Arabia obtains more than half its fresh water by removing salt from ocean water.

 **Checkpoint** What is a drought?

Water Pollution

When fresh water supplies are scarce, pollution can be devastating. Any change to water that has a harmful effect on people or other living things is called **water pollution**. Some pollutants, such as iron and copper, make water unpleasant to drink or wash in. Other pollutants, such as mercury or benzene, can cause sickness or even death.

Most pollution is the result of human activities. Many activities—including agriculture, industry, construction, and mining—produce wastes that can end up in water.

If you did the Discover activity, you saw that a few drops of milk quickly spread throughout a cup of water. You could not tell where the milk first entered the water. In the same way, pollutants dissolve and move throughout a body of water. This is how pollution can affect areas far from its source.

Sewage The water and human wastes that are washed down sinks, toilets, and showers are called **sewage**. If sewage is not treated to kill disease-causing organisms, the organisms quickly multiply. If untreated sewage mixes with water used for drinking or swimming, these organisms can make people very ill.

Even treated sewage can pollute. Any remaining wastes in the sewage can feed bacteria living in the water. As the bacteria multiply, they use up the oxygen in the water. Other organisms that need the oxygen, such as fish, cannot survive.

Agricultural Wastes Animal wastes and farm chemicals are also sources of pollution. Two examples are fertilizers and pesticides. **Fertilizers** are chemicals that provide nutrients to help crops grow better. But rain can wash fertilizers into ponds, where they cause algae to grow quickly. The algae soon cover the pond, blocking light from reaching plants in the pond. **Pesticides** are chemicals that kill crop-destroying organisms such as beetles or worms. However, pesticides can also harm other animals such as birds that feed in the sprayed fields.

Because agricultural chemicals are usually spread over a large, open area, it is hard to keep them from polluting nearby water. Even low levels of chemicals in the water can build up to harmful concentrations as they move through the food chain.

TRY THIS

Testing Water

Use a water test kit to analyze tap water samples. **ACTIVITY**

1. Obtain a water test kit and tap water sample.
2. Using the water test kit, perform three tests on the tap water. Test for properties such as pH, hardness, and dissolved oxygen.
3. Record the results of your three tests in a table.

Drawing Conclusions How do you think your tap water would compare with local pond or river water? With your teacher's permission, test samples from local water sources.

Figure 11 This plane is spraying crops with pesticides.

Relating Cause and Effect How might pesticides sprayed on a field affect fish that live in a nearby pond?





Figure 12 Industrial processes and mining are two sources of chemical pollutants. At left, a chemical plant spills wastes into a river. At right, dissolved copper from a mine turns a stream turquoise.

Industry and Mining Chemical plants, paper and textile mills, and factories that use metals produce wastes that can pollute water. Mining sites are another source of metal wastes. Chemicals and metals can harm the living things in the polluted bodies of water. In addition, humans who drink the water or feed on these organisms are exposed to the pollution.

Sediments When water runs off bare ground, it turns a muddy brown color. This color is due to particles of rock, silt, and sand called **sediments**. Water that flows through places where the ground is disturbed, such as building sites and mines, can pick up large loads of sediments.

As sediments wash into bodies of water, the particles cover up the food sources, nesting sites, and eggs of organisms. By blocking sunlight in the water, the sediments prevent algae and plants from growing. This affects other organisms that rely on the algae and plants for food.

Oil and Gasoline One of the most dramatic forms of water pollution is an oil spill. You may have seen news reports showing beaches covered with tarry black oil, or of volunteers cleaning globs of oil from the feathers of birds. It can take many years for an area to recover from such a spill.

Another pollution problem is caused by oil and gasoline that leak out of underground storage tanks. Think of how many gas stations there are in your area. Each one has storage tanks below the street level to hold the gasoline. In the past, these tanks were often made of steel. Over time, they rusted and developed small holes.

As the gasoline leaked out, it soaked into the soil and polluted the groundwater. People are addressing this problem by replacing older underground tanks and cleaning up polluted soil.

It's also important to remember not to dump used oil into storm sewers or on the ground. Such oil should be disposed of properly according to local procedures.

Land Subsidence and Groundwater Withdrawal

Water pollution is not the only environmental problem that can result from people's use of water. As groundwater is pumped out of the ground, land subsidence can occur. The sinking of the land surface that results when water is lost from spaces between loose particles of soil and rock underground is called **land subsidence**. As the water is removed, the particles of soil and rock settle closer together and occupy less space. This causes the land surface above to sink or subside.

Land subsidence due to groundwater withdrawal is a problem in many parts of the United States. In parts of Houston and Galveston, Texas, land subsidence due to groundwater withdrawal has made some neighborhoods more likely to be flooded. To prevent further subsidence, the region has placed limits on the pumping of groundwater.

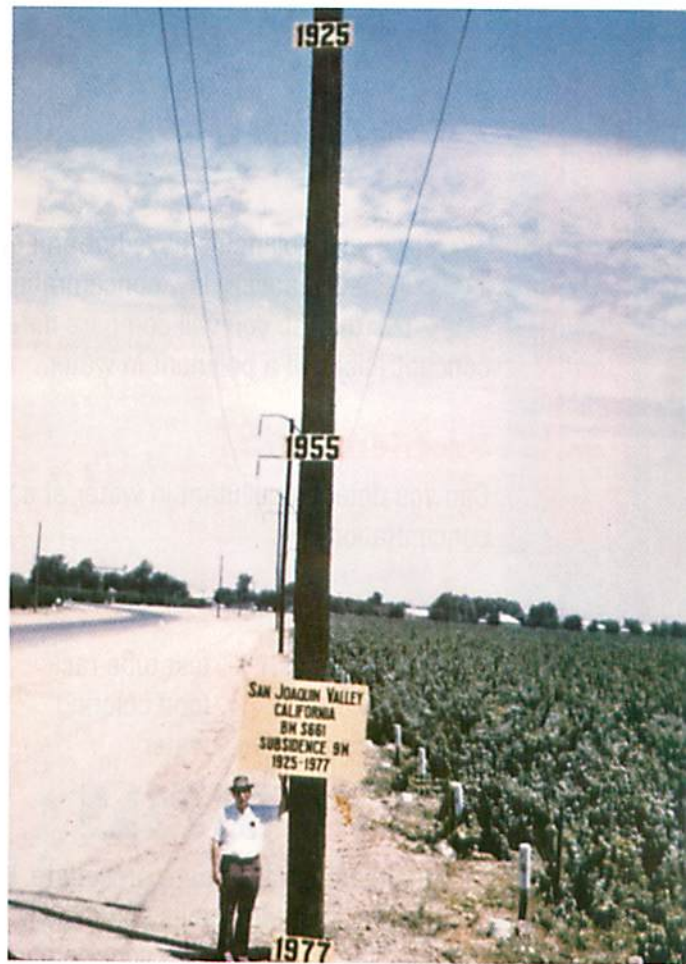


Figure 13 In California's San Joaquin valley, large amounts of water were pumped out of the ground for use in irrigating crops. In parts of the valley, the land subsided by as much as 9 meters.



Section 2 Review

1. Describe the steps in the water cycle.
2. Why isn't most of the water on Earth's surface available for people to use?
3. Name four types of human activities that can be sources of water pollution.
4. Explain why finding the source of water pollution can be difficult.
5. What is land subsidence?
6. **Thinking Critically Relating Cause and Effect** Why should sewage be treated before being released to the environment?

Check Your Progress

CHAPTER PROJECT

By now you should be gathering information to include in your product. Consider including the story of a historical event related to your topic in order to get your audience's interest. As you collect information, begin putting it in a logical order. Using an outline or a storyboard can help you organize your thoughts. (*Hint:* Be sure to keep your topic well focused. Air and water quality are very broad topics! Focusing your topic will help you stay on task and manage your time.)