

3.2

KEY CONCEPT

Society depends on clean and safe water.

Sunshine State STANDARDS

SC.D.2.3.2: The student knows the positive and negative consequences of human action on the Earth's systems.

BEFORE, you learned

- Water supports life
- Water is used in many ways

NOW, you will learn

- How drinking water and wastewater are treated
- How fresh water can become polluted
- How water pollution can be prevented

VOCABULARY

concentration p. 91

sewage system p. 93

septic system p. 94

point-source pollution p. 94

nonpoint-source pollution p. 94

EXPLORE Concentration

What is one part per million?

PROCEDURE

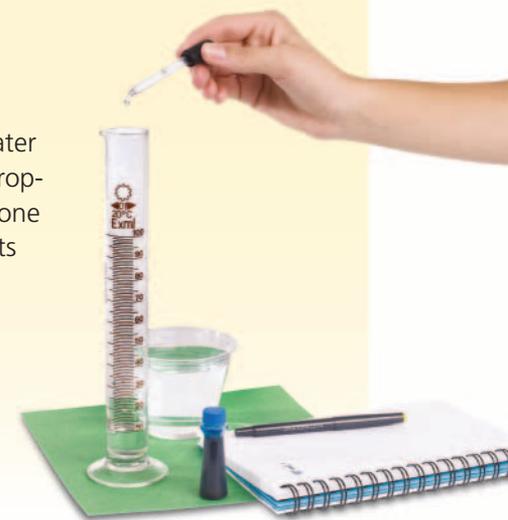
- 1 Pour 50 mL of water into the graduated cylinder. This is equal to 1000 drops of water.
- 2 Add one drop of food coloring to the water in the cylinder. This represents one drop of food coloring to 1000 drops of water, or one part per thousand.
- 3 Fill the eyedropper from the cylinder.
- 4 Empty the cylinder and pour 50 mL of new water into the cylinder. Add one drop from the eyedropper to the cylinder. The mixture now contains one part food coloring per thousand parts water, or one part per million (ppm).

MATERIALS

- water
- graduated cylinder
- eyedropper
- food coloring

WHAT DO YOU THINK?

The amount of sodium found in clean spring water is five parts per million. How would you conduct this experiment to make a mixture of food coloring in water of five parts per million?



SUPPORTING MAIN IDEAS

Remember to start a new chart for each main idea.

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Treatment makes water safe for drinking.

When you wash your face or brush your teeth, do you ever wonder where the water comes from? It depends on where you live. In many places, water is pumped from a nearby well dug into an underground aquifer. If you live in a big city such as New York City or San Francisco, the water may travel a great distance to arrive at your sink. It is piped to the city from reservoirs that may be many miles away. Then it is stored in tanks or in a local reservoir before flowing through pipes to your home.

Water comes from many different sources, so it may contain impurities or organisms that cause disease. For this reason, drinking water in larger systems is cleaned, or treated, before people can drink it.

Quality Standards

Fresh water can contain a variety of harmful substances and organisms. Certain substances and organisms may be present naturally, but others get into water because of pollution from human activity. Some of the impurities in water are safe for humans to drink in small quantities. However, when impurities reach high concentrations, they can harm people. A **concentration** is the amount of a substance that is in another substance. For example, soft drinks have a high concentration of sugar in water. Concentrations are often expressed in parts per million.

A government agency called the Environmental Protection Agency (EPA) sets standards for safe, clean drinking water. The EPA standards are guidelines for the protection of our natural water sources and the quality of the water that reaches our homes. Government agencies in states and local communities enforce laws based on the EPA standards.

The EPA lists standards for harmful organisms that can cause disease. It also lists safe levels for copper and certain other metals that can be found in water. In addition, the EPA checks for a variety of chemicals and harmful radioactive materials.

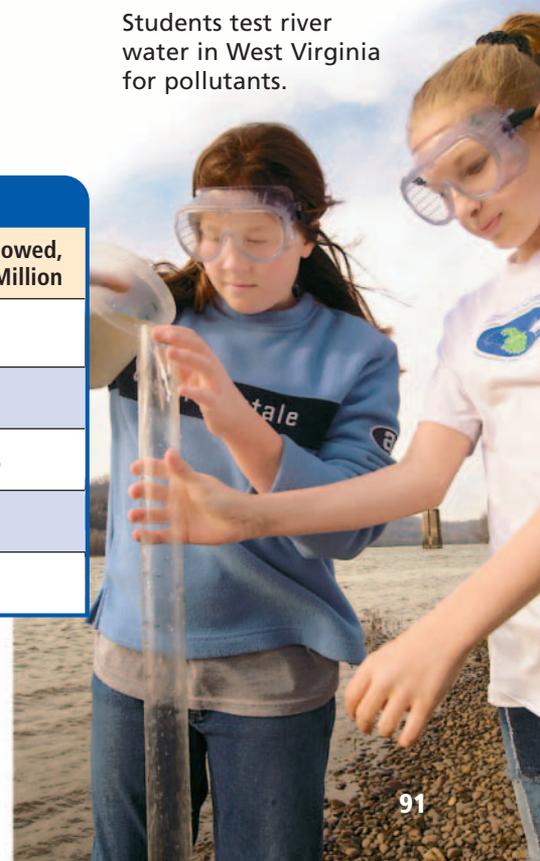
Your local water provider regularly tests the water to make sure it meets the EPA requirements. If any concentrations are higher than the EPA standards, the water must be treated. As a result, the United States has one of the safest, cleanest water supplies in the world.

CHECK YOUR READING

How does a water provider know that it must treat water?

Students test river water in West Virginia for pollutants.

EPA Standards for Substances in Water		
Substance	Common Source	Maximum Allowed, in Parts per Million
Copper	Natural deposits; household pipes	1.3
Cyanide	Various factories	0.2
Lead	Natural deposits; household pipes	0.015
Mercury	Natural deposits; refineries and factories; landfills; crop fields	0.002
Nitrite	Water running off fertilized fields; sewage leaks; natural deposits	1



Treatment of Drinking Water



See a water treatment plant in action.

In a water treatment plant, thousands of gallons of water flow through a series of tanks, where the water is filtered and treated with chemicals to remove harmful substances and kill organisms. The major steps are chemical disinfection and the removal of dirt.

Water Treatment and Distribution

Water Source

- 1 Water in a river or lake is piped to the treatment plant.

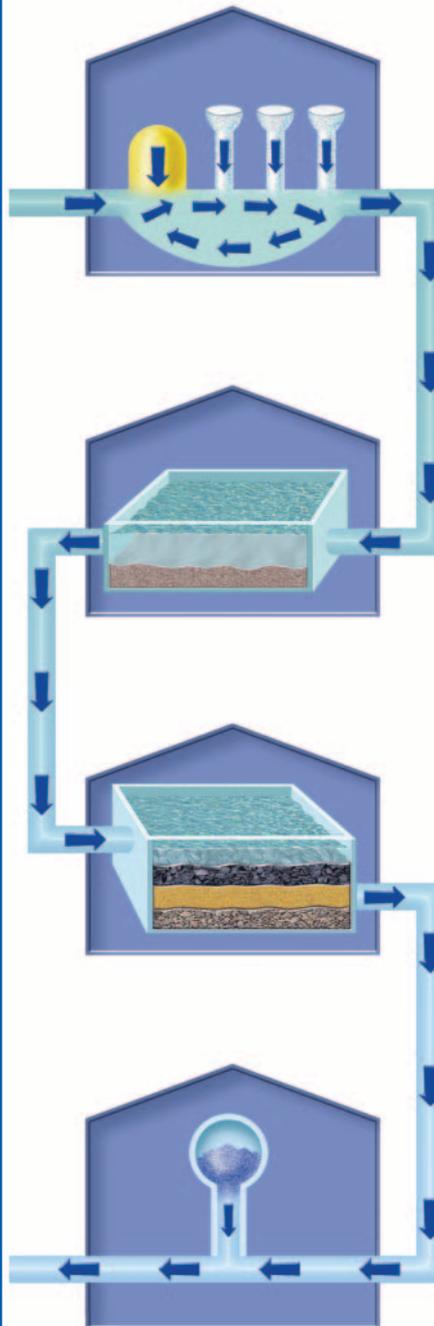


Storage and Distribution

- 6 The treated water leaves the plant. It is stored in huge water tanks so that there is plenty of water available when people need it.



Water Treatment Plant



- 2 The water flows through mixers, where clumping agents and disinfecting chemicals are added. A clumping agent is a substance that makes dirt and bacteria clump together.
- 3 The water flows into a clarifying pool so that it can clarify, or become clearer. Here, the heavy lumps of dirt sink to the bottom and are scraped away.
- 4 Water flows through layers of coal, sand, and gravel, which filter out tiny particles of dust and dirt.
- 5 Now the water looks clear and clean. Chlorine is added to kill the last of the bacteria.

Wastewater is treated and released.

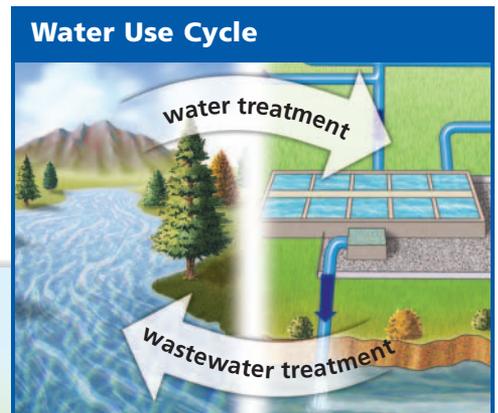
Wastewater is the water that runs down the drain. Before wastewater can be released back into the environment, it needs to be treated. Sewage and septic systems are two ways of treating wastewater.

Sewage System

A **sewage system** is a system that collects and treats wastewater from a city or a town. Sewage pipes carry wastewater from homes and businesses to a water treatment plant.

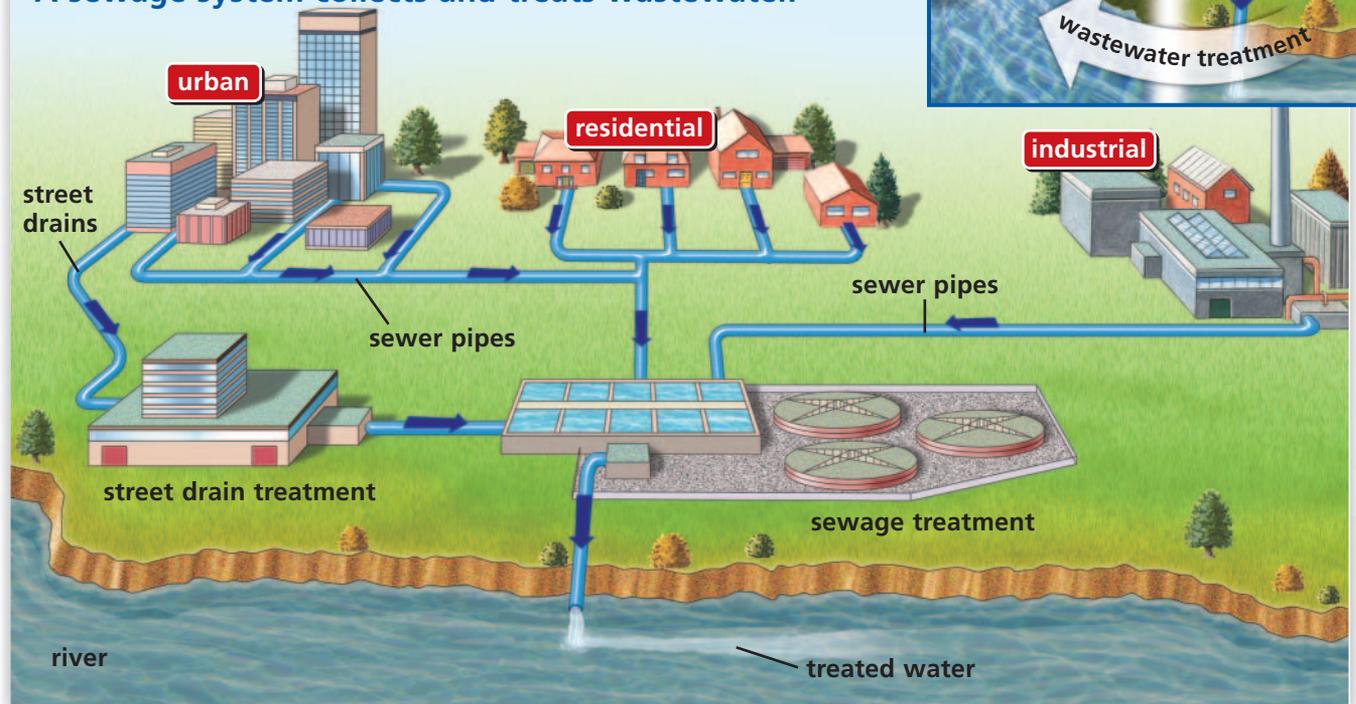
In the first part of treatment, wastewater is strained to remove large objects. Then the water is pumped into a tank, where it sits until the heaviest sludge sinks to the bottom. The sludge is taken away to decompose in another tank. Then chlorine is added to the water to kill the harmful bacteria. This process removes about half of the pollutants.

During the second part of the process, extra oxygen is pumped into the wastewater. The oxygen causes certain kinds of bacteria to grow in great numbers. These bacteria consume much of the sludge and oil that is still in the water. In other words, these tiny organisms help clean the water. More sludge also settles out, and grease is skimmed off the top. Chemicals clean the water one more time and remove any extra chlorine.



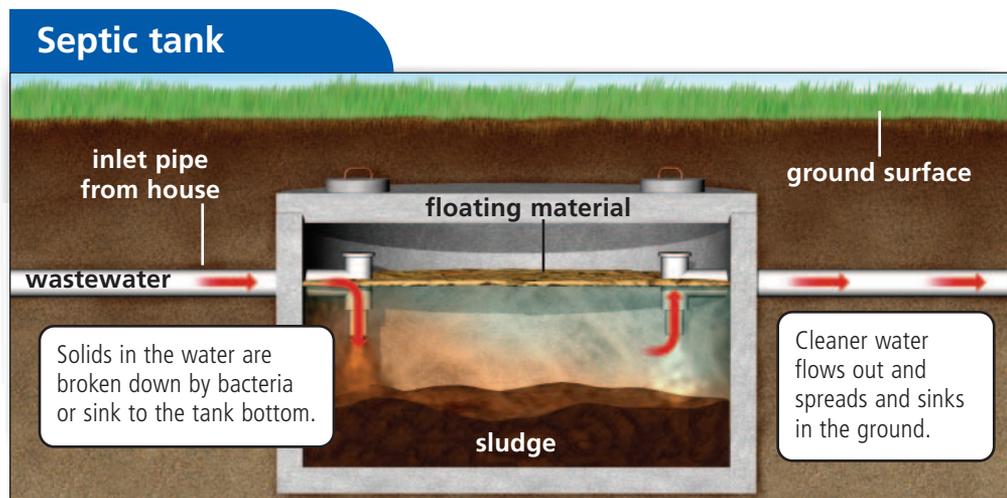
Wastewater Treatment

A sewage system collects and treats wastewater.



Septic System

A **septic system** is a small wastewater system used by a home or a business. Septic systems are more common in lightly populated areas that do not have central sewage treatment centers. In a house with a septic system, wastewater is carried out through a pipe to an underground tank away from the house. The sludge, or thicker material, in the wastewater settles to the bottom. Much of this sludge is consumed naturally by bacteria, just as in the large sewage treatment plants. Sludge that remains has to be removed from the tank every few years.

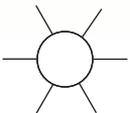


Water pollution comes from many sources.

You have learned how fresh water is treated before we drink it. Unfortunately, treatment only works for water that has fairly low concentrations of harmful substances. Sometimes human activities add far too many minerals, chemicals, or organisms to a water supply. Then a lake or a river becomes polluted. No amount of treatment can make the water safe to drink. Pollution can come from one known source, or point, or it can come from many points.

VOCABULARY

Add a description wheel for *point-source pollution* to your notebook.



- **Point-source pollution** is pollution that enters water from a known source. It might be sewage flowing from a pipe or chemicals spewing out of a factory. This pollution is easy to spot, and laws can be enforced to stop it.
- **Nonpoint-source pollution** is pollution whose source is hard to find or is scattered. Rain and gravity cause water to wash off streets, lawns, construction sites, and farms. This water, called runoff, can carry oil, gas, pesticides, chemicals, paints, and detergents into storm drains or over land and then to rivers and lakes. If you don't know exactly where pollution comes from, it is hard to enforce laws against it. For this reason, nonpoint-source pollution causes most water pollution.

Sources of Water Pollution

Human activity can pollute the water supply.

Homes

- Improper disposal of household batteries, chemicals, and motor oil
- Use of fertilizers and pesticides
- Poorly functioning septic systems

Cities

- Illegal dumping of toxic chemicals
- Water and pollutants running off from streets
- Unsafe disposal of motor oil and other products

Sewage

- Improper disposal of factory wastewater
- Poorly functioning sewage systems
- Dumping of raw wastewater when sewage systems cannot handle heavy rainfall

Farms

- Heavy use of fertilizers and pesticides
- Leaks and spills of animal waste
- Animals grazing near rivers and lakes

Shipping, Boating, and Oil Transport

- Spills of oil or other cargo from barges and ships
- Fuel spills and leakage from small boats
- Illegal dumping
- Illegal release of sewage

READING VISUALS

Identify three examples of point-source pollution.

Water pollution can be prevented.

Water pollution is a serious problem because water is a limited resource. When water is polluted, there is less water available for use. Water pollution can also endanger people's health. People and businesses can do a number of things to prevent or reduce pollution of water.

Industry and Transportation Operators of factories and of vehicles that haul cargo can take a number of steps to prevent or reduce water pollution. For example, factories can maintain their pipelines and equipment to ensure that harmful chemicals are not leaking into the ground and contaminating groundwater. Transportation companies can inspect and repair their trucks, planes, and ships to prevent oil and fuels from leaking onto pavement or into water.

Industry can prevent or reduce pollution by reducing the amount of toxic waste it generates. Factories can reuse and recycle chemicals and materials used in manufacturing. Companies can also provide ways for their customers to recycle or return certain products—such as used motor oil or batteries—that can pollute water if they are disposed of improperly.

In the construction industry, builders can design their projects to reduce the pollution that new construction can cause. Builders can use less pavement when they build parking areas for malls and office buildings. Less pavement reduces the amount of water that may run off and carry pollutants from cars and other sources to rivers and lakes. And measures to preserve open land, especially wetland areas, can protect a natural water cleansing system and reduce runoff.

READING TIP

A toxic substance is one that is capable of causing harm to health.

CHECK YOUR READING

How does pavement contribute to water pollution?



Pollution can make a lake or river dangerous or unusable. In many places, people are cleaning up and restoring freshwater resources.

Agriculture Farming generates chemical and natural waste that can contaminate water. Farmers can follow practices that prevent or reduce pollution from agriculture. On farms with livestock, pastures used by cows and other grazing animals can be fenced off to keep animals away from streams and lakes. Keeping livestock away from water reduces pollution from animal waste. Farms that keep animals in structures can keep waste out of the water supply by storing and disposing of manure properly.

New techniques in farming can reduce pollution. Many farmers grow food without pesticides, which can be toxic and pollute water. The farmers fight insects and other pests by bringing in their natural enemies, such as ladybugs. To fertilize soil, the use of natural substances and the planting of certain crops can take the place of manufactured chemicals. Farming that does not use such chemicals is known as organic.

At home There are a number of things most people can do in their daily lives to prevent or reduce water pollution. People can take their old household chemicals to hazardous waste collection sites. Toxic chemicals should not be poured down the drain or onto the ground. Proper disposal and recycling of electronic devices such as computers can prevent toxic metals contained in them from reaching the water supply.

In shopping for food, consumers can choose organic products to support farming methods that don't use toxic pesticides. People can try to use nontoxic products in their homes. They can also stop using toxic pesticides and weed killers, as well as chemical fertilizers, on lawns and gardens.



These farmers in Vermont use organic methods to produce milk and ice cream.

3.2 Review

KEY CONCEPTS

1. How are EPA standards used to ensure a clean, safe supply of water?
2. What are two ways that wastewater is treated before it can be released?
3. What is the difference between point-source pollution and nonpoint-source pollution?

CRITICAL THINKING

4. **Compare and Contrast** How are sewage systems and septic systems alike? How are they different?
5. **Categorize** Categorize the following as point- or non-point-source pollution: small boat leaking oil; fish farm releasing wastes into a river; person dumping motor oil onto the ground.

CHALLENGE

6. **Compare** What parts of sewage and septic systems are similar to the way water is naturally cleaned by Earth's water cycle?