

# HOW IS THIS HOUSE SAVING OUR PLANET?



## What can people do to use resources wisely?

Have you ever thought of ways to reuse something you would normally throw away? This home is made from the shipping containers you see transporting goods on ships and trucks. These containers would have been thrown away but an architect thought of a new way to use them.

**Infer** How can reusing shipping containers and other objects help our planet?


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Watch the **Untamed Science** video to learn more about reusing resources.

# Land, Air, and Water Resources

TN



CHAPTER

10

## Tennessee Academic Standards for Science

- 6.LS4.2** Design a possible solution for maintaining biodiversity of ecosystems while still providing necessary human resources without disrupting environmental equilibrium.
- 6.ESS3.1** Differentiate between renewable and nonrenewable resources by asking questions about their availability and sustainability.
- 6.ESS3.2** Investigate and compare existing and developing technologies that utilize renewable and alternative energy resources.
- 6.ESS3.3** Assess the impacts of human activities on the biosphere including conservation, habitat management, species endangerment, and extinction.

# Getting Started

## Check Your Understanding

1. **Background** Read the paragraph below and then answer the question.

On a lazy summer day, Mia pours water on the hot sidewalk and imagines where the water will go as it travels through the **water cycle**. After the water **evaporates**, it may float through the **atmosphere** and fall as rain in faraway lands or the ocean.

- What makes the water cycle a *cycle*?

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The **water cycle** is the continuous process by which water moves from Earth's surface to the atmosphere and back.

**Evaporation** is the process by which molecules of liquid water absorb energy and change to a gas.

The **atmosphere** is the envelope of gases that surrounds the planet.

## Vocabulary Skill

**Prefixes** Some words can be divided into parts. A root is the part of the word that carries the basic meaning. A prefix is a word part placed in front of the root to change the word's meaning. The prefixes below will help you understand some of the vocabulary in this chapter.

Prefix	Meaning	Example
<b>bio-</b>	life	biodegradable, <i>adj.</i> describes a material that can be broken down and recycled by bacteria and other decomposers
<b>photo-</b>	light	photochemical, <i>adj.</i> describes a chemical reaction that occurs in the presence of light

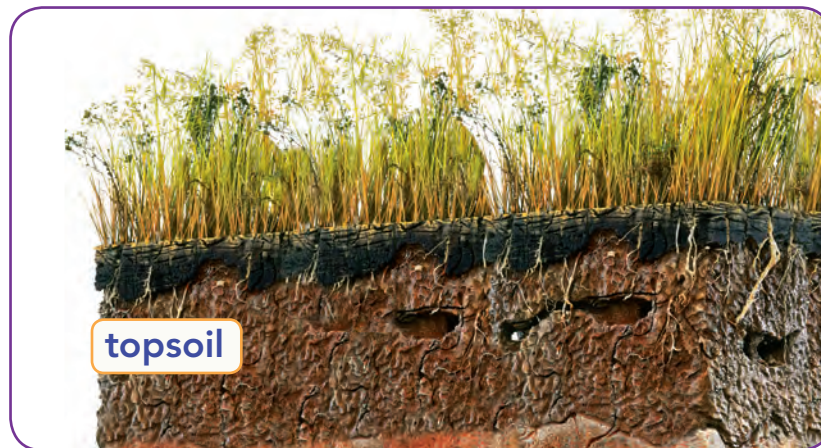
2. **Quick Check** In the definitions of the example words in the table, circle the part that includes the prefix meaning.



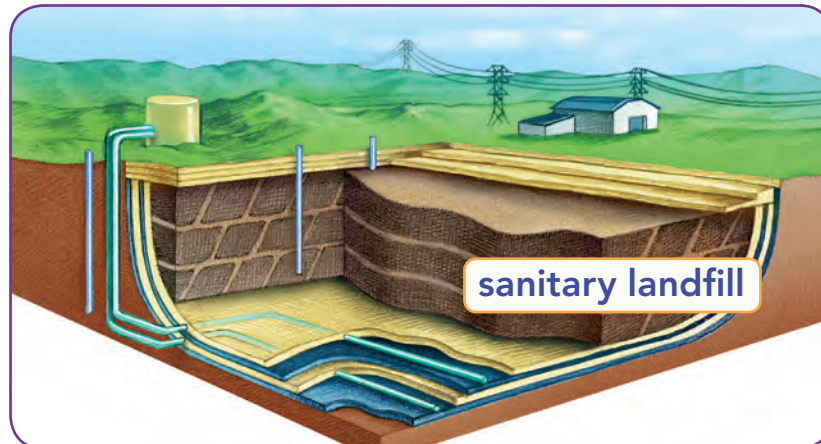
**pollution**



**nonrenewable resource**



**topsoil**



**sanitary landfill**

## Chapter Preview

### LESSON 1

- natural resource
- pollution
- point source
- nonpoint source
- environmental science

🎯 Relate Cause and Effect

▲ Draw Conclusions

### LESSON 2

- renewable resource
- nonrenewable resource
- sustainable use
- ecological footprint
- conservation

🎯 Relate Text and Visuals

▲ Calculate

### LESSON 3

- litter
- topsoil
- subsoil
- bedrock
- erosion
- nutrient depletion
- fertilizer
- desertification
- drought
- land reclamation

🎯 Relate Cause and Effect

▲ Infer

### LESSON 4

- municipal solid waste
- incineration
- pollutant
- leachate
- sanitary landfill
- recycling
- biodegradable
- hazardous waste

🎯 Compare and Contrast

▲ Graph

### LESSON 5

- emissions
- photochemical smog
- ozone
- temperature inversion
- acid rain
- radon
- ozone layer
- chlorofluorocarbon

🎯 Relate Text and Visuals

▲ Communicate

### LESSON 6

- groundwater
- pesticide
- sewage
- sediment

🎯 Outline

▲ Design Experiments

**CCC: Stability and Change**


## It's All Water Under the Dam SEP: Developing and Using Models

People build dams for many reasons, such as to produce electricity or to control flooding. No matter what the use, dams function by blocking the flow of water in a river.

Dams affect the local ecosystem. Not only is the river valley above the dam flooded, but the water flow in the river below the dam also is changed. Organisms adapted to a fast-flowing stream may no longer be able to live in the river. The elimination of a single species in a habitat disrupts the entire food web for that ecosystem.

In this activity, you will build a model dam and experiment with water flow and depth to observe the effect on upstream and downstream land areas. From your observations, you will infer how changing water flow may affect the organisms that live in the area.

### Identify the Problem

1. Suppose you are an engineer designing a dam that will provide flood control on a river with minimal effect on the ecosystem. A model will help you study the effects of the dam. What problem(s) will your design help solve? 

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### Do Research

Examine the photos and diagrams of dams provided by your teacher.

2. What are the key features of a dam, and how do they function to control the flow of water?

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Examine the stream table on which you will build your model.

3. How does the stream table function? How does the stream table's design make it appropriately suited as the basis for your model? \_\_\_\_\_

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Go to the materials station(s). Examine the materials. Think about which materials may be useful for your model. Leave the materials where they are.



- 4.** What are your design constraints? \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Develop Possible Solutions

- 5.** Describe two ways that you could construct the physical land features (topography) of a river valley.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- 6.** Identify two ways you could represent organisms in your model.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

- 7.** Explain how you will add a dam to your river in order to observe the effects of changed water flow.  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## Choose One Solution

Answer the following questions on a separate sheet of paper.

- 8.** List the material(s) you will use for the river valley, the organisms, and the dam in your model.
- 9.** Draw your designs. Show the original river valley in one diagram; show the valley with the dam in a second diagram. Label all parts.
- 10.** Describe how you will build your model. Distinguish the stages before and after the construction of the dam. Write your descriptions below your diagrams.
- 11.** Describe how your model will function both before and after the dam construction.

## Design and Construct a Prototype

Have your teacher review and approve your design. Then, gather the materials you need to build your model. Build your prototype, the first working version of your design. If you can, document your construction process by taking photos or recording video.

- 12.** Construct your river valley. On a separate sheet of paper, draw a detailed diagram of the river before the dam is built. Include measurements of the river's width and depth at different points. Flow water through your river and observe what happens to the land around the river. Note where the water flows quickly and where it flows more slowly. Estimate the percentage of the ground surface covered by river water. Explain how you made your estimate.
- 13.** Construct the dam. On a separate sheet of paper, draw a detailed diagram of your completed prototype. Label the parts.

## Test the Prototype

Test your prototype. Produce a flow of water through the prototype. Answer these questions on a separate sheet of paper.

- 14.** Describe water flow and the effect on the land with the dam gate fully open.
- 15.** Describe water flow and the effect on the land with the dam gate partially closed.
- 16.** Describe water flow and the effect on the land with the dam gate almost closed.
- 17.** Draw a detailed diagram of your river valley after the formation of the reservoir. Estimate the percentage of the ground surface now covered by water. Explain how you made your estimate. Measure the depth of the water in the lake at several points. Include information on water flow below the dam.

## Communicate Results

- 18.** Collect the materials that document the design, construction, and testing of your prototype. Assemble a portfolio that includes the diagrams of your river valley, your photographs or video of the process, and your test results. Use at least one chart, graph, or data table in the representation of your results.
- 19.** Prepare a computer slide show or a video presentation showing how you built your prototype, how it performed, and why your results were significant. Include your conclusions on how the changes in the river valley would affect organisms living there. Deliver the presentation to your class.

## Evaluate and Redesign

- 20.** Evaluate your prototype using the following rubric. Check one answer for each question.

Does the prototype...	Very Much	Somewhat	Not At All
fit onto the stream table?			
form a reservoir upstream of the dam?			
allow the adjustment of water flow?			
show the effects of the dam on a river valley?			

- 21.** Compare your results with your classmates. Did your prototypes function in similar ways? Explain.



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- 22.** What changes could you make to your prototype to make it more effectively show the effects of a dam on upstream and downstream ecosystems?

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6.ESS3.1, 6.ESS3.2

# Introduction to Environmental Issues



- What Are the Types of Environmental Issues?
- How Are Environmental Decisions Made?

## my planet DiARY

## CAREER

### How Do You Feel About Nature?

You have probably heard of scientists who study animals, plants, rocks, and everything else in an ecosystem. Social scientists study an often-overlooked but very important part of any ecosystem—the people who use it! These scientists study how people value nature. They study how much people would be willing to pay to preserve nature. They also study how different age groups, genders, races, and social groups use nature. For example, a scuba diver wants coral reefs to remain beautiful and full of all kinds of organisms to enjoy in future dives. A commercial fisherman cares more about a coral reef supporting the kind of fish he wants to catch. You might care about coral reefs because you want to visit one someday.

**Communicate** Discuss the question with a group of classmates. Then write your answer below.

Do you think it is important to consider how people value nature? Explain.



Do the Inquiry Warm-Up  
How Do You Decide?

## Vocabulary

- natural resource
- pollution
- point source
- nonpoint source
- environmental science

## Skills

- 🌀 Reading: Relate Cause and Effect
- 📌 Inquiry: Draw Conclusions

# What Are the Types of Environmental Issues?

Here is a riddle for you: what place is bigger than the United States and Mexico combined? This place is covered with ice more than two kilometers thick. It is a habitat for many animals and is a source of oil, coal, and iron. Stumped? The answer is Antarctica. Some people think of Antarctica as a useless, icy wasteland, but there are unique wildlife habitats in Antarctica. There are also valuable minerals beneath its thick ice.

What is the best use of Antarctica? Many people want access to its rich deposits of minerals and oil. Others worry that mining will harm its delicate ecosystems. Some people propose building hotels, parks, and ski resorts. Others think that Antarctica should remain undeveloped. Who should decide Antarctica's fate?

In 1998, 26 nations agreed to ban mining and oil exploration in Antarctica for at least 50 years. As resources become more scarce elsewhere in the world, the debate will surely continue.

Antarctica's future is just one environmental issue that people face today. 🗝️ **Environmental issues fall into three general categories: population growth, resource use, and pollution.** Because these three types of issues are interconnected, they are very difficult to study and resolve.

FIGURE 1 .....

### Arguing Over Antarctica

Some people want to leave Antarctica wild. Others want it developed.

✍️ **Summarize** Fill in the boxes with points outlining each argument.

#### Argument One: Keep Antarctica Wild

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#### Argument Two: Develop Antarctica

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**Vocabulary Identify Related Word Forms** The word *conflict* means a disagreement between people, ideas, or interests. What causes conflicting opinions about natural resource use?

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**Population Growth** The human population grew very slowly until about A.D. 1650. Around that time, improvements in medicine, agriculture, and waste disposal led to people living longer. The human population has been growing faster and faster since then.


When a population grows, the demand for resources also grows. Has your town or city ever experienced a water shortage? If so, you might have noticed that people have been asked to restrict their water use. This sometimes happens in areas with fast-growing populations. The water supplies in such areas were designed to serve fewer people than they now do, so shortages can occur during unusually dry weather.

**Resource Use** Earth provides many materials people use throughout their lives. Anything that occurs naturally in the environment and is used by people is called a **natural resource**. Natural resources include trees, water, oil, coal, and other things. However, people do not use resources in the same way. In some areas of the world, people use a wide variety of resources. In other areas, people have little or no access to certain natural resources. For example, people in central Asia live too far away from ocean waters that provide fish and other resources. This difference in access to natural resources also leads to differences in technology uses and limitations for people in various regions of the world. Conflict arises when a natural resource is scarce or used in a way that people feel is unfair.

FIGURE 2 .....

### Everyday Natural Resources

We use natural resources many times a day without even realizing it! A trip to the beach uses land, water, fuel, and many other resources.

 **List** On the journal page, list all the ways you have used natural resources so far today. For example, this book is made of paper that started as a tree.

### My Resources Journal

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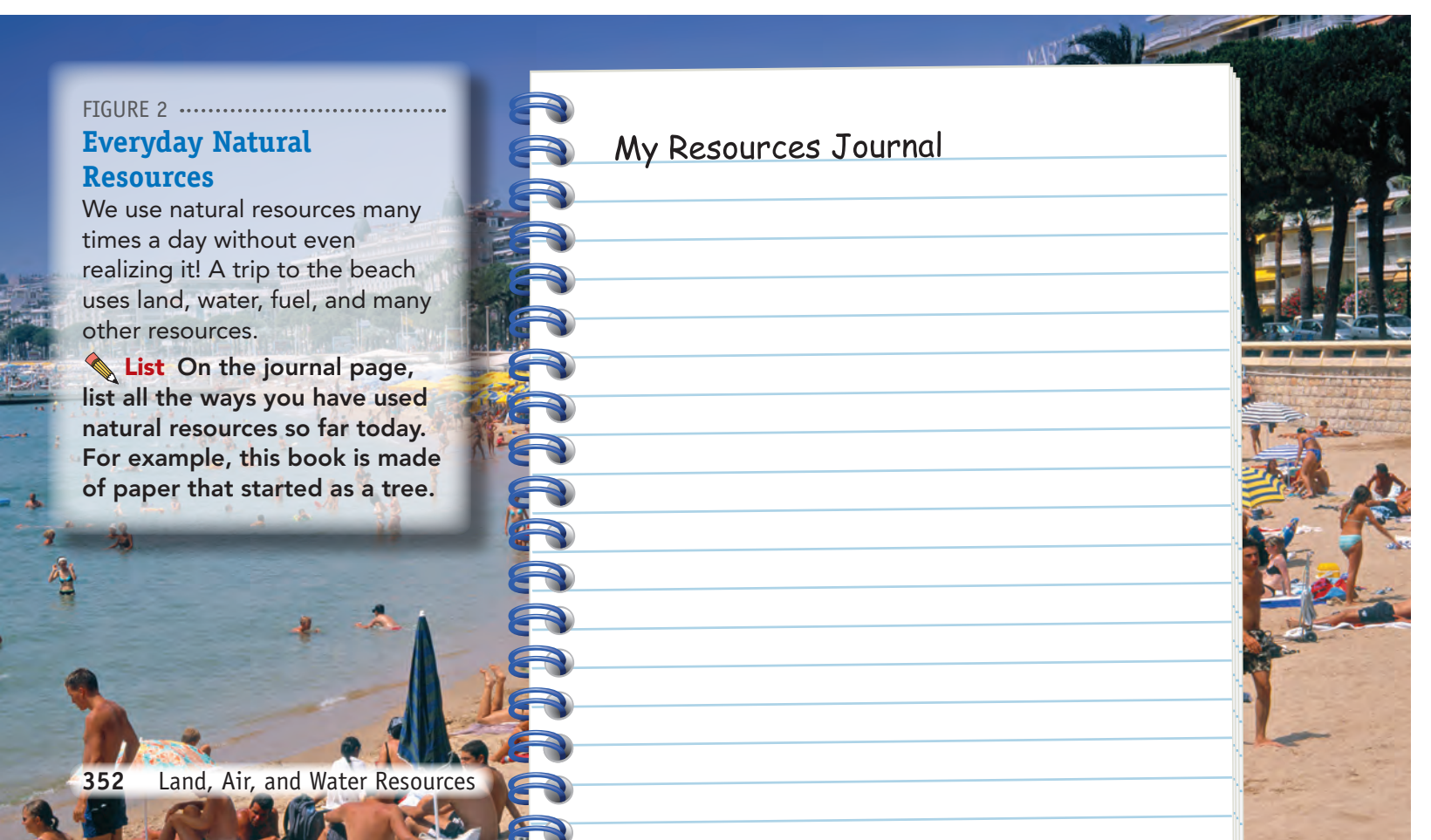
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**Pollution** Many environmental factors can contribute to less than ideal conditions on Earth for people or other organisms. The contamination of Earth's land, water, or air is called **pollution**. Pollution can be caused by wastes, chemicals, noise, heat, light, and other sources. Pollution can destroy wildlife and cause human health problems.

Pollution is usually related to population growth and resource use. As you probably know, the burning of gasoline releases pollutants into the air. With more cars on the road, more gasoline is used, so more pollutants are released into the air. As populations grow and more people need to be fed, more fertilizers and other chemicals may be used to produce that food. As these chemicals run off the land, they can pollute bodies of water.

Pollution sources can be grouped into two categories. A **point source** is a specific pollution source that can be identified. A pipe gushing polluted water into a river is an example of a point source. A nonpoint source of pollution is not as easy to identify. A **nonpoint source** is widely spread and cannot be tied to a specific origin. For example, the polluted air that can hang over urban areas comes from vehicles, factories, and other polluters. The pollution cannot be tied to any one car or factory.



**Relate Cause and Effect**  
Use what you have read about pollution so far to fill in the boxes below.

**Some Causes of Pollution**

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**Some Effects of Pollution**

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**Lab zone** Do the Quick Lab Environmental Issues.

**Assess Your Understanding**

**1a. Define** What is a natural resource?

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**b. Make Generalizations** How is population growth related to resource use and pollution?

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**got it?** .....

I get it! Now I know that the types of environmental issues are \_\_\_\_\_


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I need extra help with \_\_\_\_\_

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## How Are Environmental Decisions Made?

Dealing with environmental issues means making decisions. Decisions can be made at many levels. Your decision to walk to your friend's house rather than ride in a car is made at a personal level. A town's decision about how to dispose of its trash is made at a local level. A decision about whether the United States should allow oil drilling in a wildlife refuge is made on a national level. Decisions about how to protect Earth's atmosphere are made on a global level. Your personal decisions have a small impact. But when the personal decisions of millions of people are combined, they have a huge impact on the environment.

**Balancing Different Needs** Lawmakers work with many groups to make environmental decisions. One such group is environmental scientists. **Environmental science** is the study of natural processes in the environment and how humans can affect them. Data provided by environmental scientists are only part of the decision-making process. Environmental decision making requires a balance between the needs of the environment and the needs of people.  **To help balance the different opinions on an environmental issue, decision makers weigh the costs and benefits of a proposal for change before making a decision.**

### apply it!

Suppose you are a member of a city planning board. A company wants to buy a piece of land outside the city and build a factory on it. When you go into work one day, you are met by protesters demanding that the land be turned into a wildlife park.

**1 Solve Problems** How should you decide what to do with the land?

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**2 CHALLENGE** What are some ways you could find out people's opinions about the issue?

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**Types of Costs and Benefits** Costs and benefits are often economic. Will a proposal provide jobs? Will it cost too much money? Costs and benefits are not measured only in terms of money. For example, suppose a state must decide whether to allow logging in a certain area. Removing trees changes the ecosystem, which is an ecological cost. However, the wood and jobs provided by the logging are economic benefits.

It is also important to consider the short-term and long-term costs and benefits of an environmental decision. A plan's short-term costs might be outweighed by its long-term benefits.

Costs of Offshore Drilling	Benefits of Offshore Drilling
<ul style="list-style-type: none"> <li>• Setting up sites is expensive.</li> <li>• Transporting the oil is risky and expensive.</li> <li>• Oil supply is limited and will not meet energy demands.</li> <li>• Oil spills and leaks harm marine organisms and the environment.</li> </ul>	<ul style="list-style-type: none"> <li>• Creates jobs</li> <li>• A larger oil supply lowers oil prices.</li> <li>• Provides new oil supply to fight shortages</li> <li>• Reduces dependence on foreign oil</li> </ul>

FIGURE 3 .....  
**Weighing Costs and Benefits**

Once you have identified the potential costs and benefits of a decision, you must analyze them.  **Draw Conclusions** Read the chart. Based on these costs and benefits, write a brief letter to your senator explaining your opinion either in favor of or against offshore drilling.

Handwriting practice area with a vertical red margin line on the left and horizontal blue lines for writing.

 **Assess Your Understanding**

**got it?** .....

I get it! Now I know that environmental decisions are made by \_\_\_\_\_

I need extra help with \_\_\_\_\_



Do the Quick Lab  
*Comparing Costs and Benefits.*



6.ESS3.1, 6.ESS3.2

# Introduction to Natural Resources



What Are Natural Resources?

Why Are Natural Resources Important?

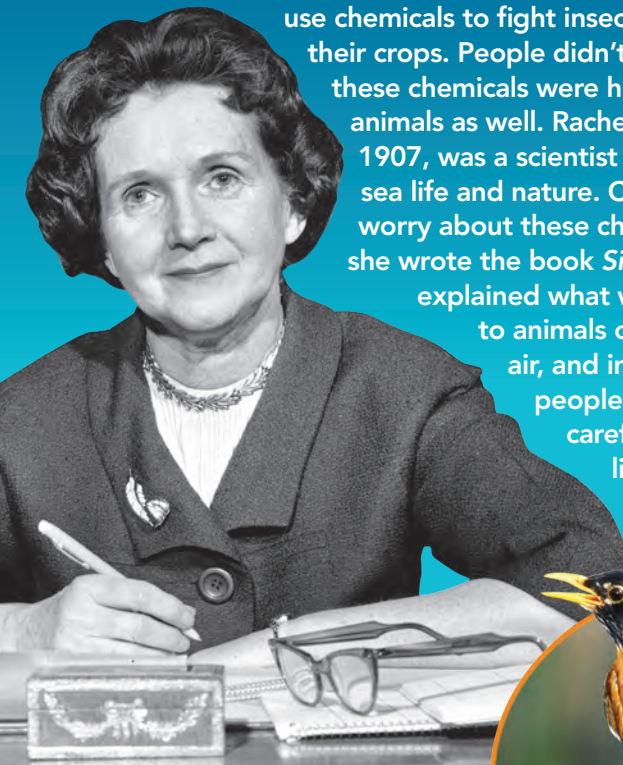


## my planet DiARY

*"It was a spring without voices. On the mornings that had once throbbed with the dawn chorus of robins . . . there was now no sound; only silence lay over the fields and woods and marsh."*

—Rachel Carson

In the twentieth century, farmers began to use chemicals to fight insects that killed their crops. People didn't realize that these chemicals were hurting other animals as well. Rachel Carson, born in 1907, was a scientist who wrote about sea life and nature. Carson began to worry about these chemicals. In 1962, she wrote the book *Silent Spring*. She explained what was happening to animals on land, in the air, and in the sea. Today, people are more careful to protect living things.



## VOICES FROM HISTORY

Write your answers below.

1. What dangers did Rachel Carson warn people about?

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2. Do you think the spring Carson wrote about would look different now that some harmful chemicals are banned? Why or why not?

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Do the Inquiry Warm-Up  
Using Resources.

## Vocabulary

- renewable resource
- nonrenewable resource
- sustainable use
- ecological footprint
- conservation

## Skills

- 🔗 Reading: Relate Text and Visuals
- 📐 Inquiry: Calculate

# What Are Natural Resources?

Did you turn on a light or use an alarm clock today? Flush a toilet or take a shower? Ride in a car or bus? Eat some food? Use any paper—other than this page that you are reading right now? All of these things—and so much more—depend on Earth’s resources.

Recall that anything that occurs naturally in the environment and is used by people is called a natural resource. 🗝️ **Natural resources include organisms, water, sunlight, minerals, and oil.**

**Renewable Resources** A **renewable resource** is either always available or is naturally replaced in a relatively short time. Some renewable resources, like wind and sunlight, are almost always available. Other renewable resources, like water and trees, are renewable only if they are replaced as fast as they are used.



🔗 **Relate Text and Visuals** The trees in the first diagram are being harvested for wood. The landowner tells you the trees are a renewable resource. Based on the number of trees being harvested and replanted, is the landowner right? Why?

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**Nonrenewable Resources** Over millions of years, natural processes changed the remains of organisms into the substances now called oil and coal. Today’s world—including the use of technologies—is powered by these fuels. Humans use these resources much faster than they are naturally replaced. Resources that are not replaced in a useful time frame are **nonrenewable resources**. Metals and minerals are also nonrenewable. Remember that some resources, such as trees, may be renewable or nonrenewable, depending on how quickly they are replaced.

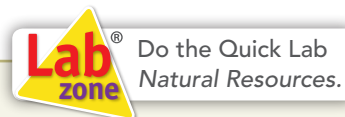
FIGURE 1 .....

**Categorizing Resources**

Resources are grouped into two main categories: renewable and nonrenewable. Gold, shown above, is nonrenewable.

 **Summarize** Use what you have read to fill in the table comparing renewable and nonrenewable resources.

Renewable Resources	Nonrenewable Resources	Both
Replaced in a short time or always available	Not replaced in a useful time frame	Fits both natural resource categories
Examples: _____ _____ _____ _____	Examples: _____ _____ _____ _____	Examples: _____ _____ _____ _____



 **Assess Your Understanding**

1a. **Define** What is a renewable resource?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

b. **Compare and Contrast** Sunlight and trees are both natural resources. How are they different?

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**got it?** .....

I get it! Now I know that natural resources include \_\_\_\_\_

\_\_\_\_\_

I need extra help with \_\_\_\_\_

\_\_\_\_\_

# Why Are Natural Resources Important?

Humans cannot live without some natural resources, such as sunlight and fresh water. Others, such as metals, are necessary to sustain modern life. 🗝️ **Humans depend on Earth's natural resources for survival and for development.**

**How People Use Resources** Around the world, people rely on natural resources for the same basic needs. Not all resources are equally available in all parts of the world. In some areas, there is a plentiful supply of clean fresh water. In other areas, water is scarce. In some places, pollution threatens the water supply.

Globally, fuels are used for cooking, heating, and power. Different fuels are common in different parts of the world. Coal is plentiful in some areas of the world and oil is plentiful in others. See **Figure 2**. In some areas, wood is the main fuel, not coal or oil.

FIGURE 2 .....

## Resources Around the World

People use natural resources in different ways around the world.

✎ **Describe** In the blank box below, draw or describe one way you use natural resources.



In Sierra Leone, entire communities get their drinking water from a main well.



In China, coal is delivered to homes by bicycle to be burned for heat.



In Iceland, most homes get hot water and heat from the energy of the hot, liquidlike rock under Earth's surface.

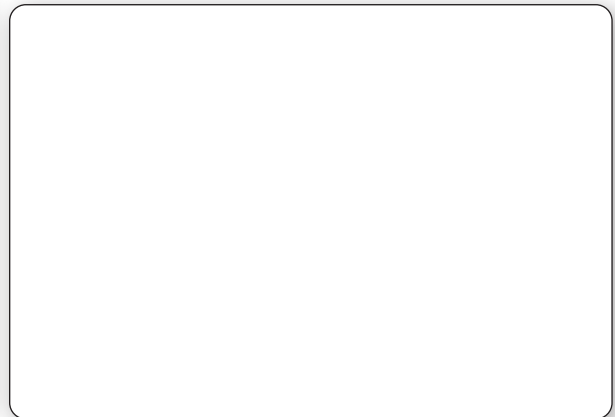
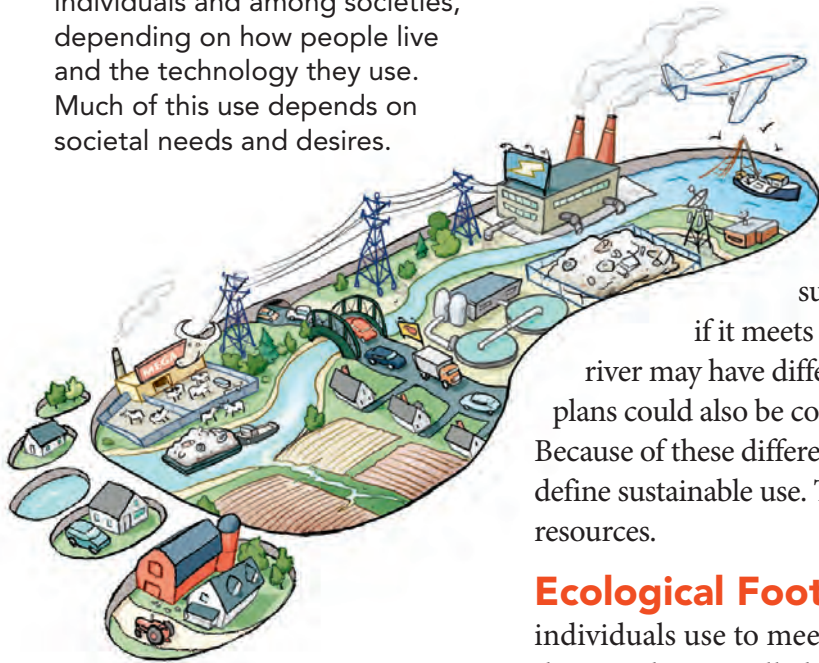


FIGURE 3 .....

## Ecological Footprint

Everything you do contributes to your ecological footprint: how you travel, the food you eat, the home you live in. Ecological footprints vary among individuals and among societies, depending on how people live and the technology they use. Much of this use depends on societal needs and desires.



**Sustainable Use** How long a resource lasts depends on how people use it. **Sustainable use** of a resource means using it in ways that maintain the resource at a certain quality for a certain period of time. For example, a city may want to manage a river. Does the city want the water to be clean enough to drink or clean enough to swim in? Does the city want the water to be clean for fifty years, two hundred years, or indefinitely? The answers to these questions define what would be considered sustainable use of the river. However, it may not be sustainable from an ecological perspective even if it meets human needs. Other cities farther down the river may have different answers to those questions, but their plans could also be considered sustainable if they met their goals. Because of these differences, policymakers and lawmakers struggle to define sustainable use. The struggle adds to the challenge of regulating resources.

**Ecological Footprint** The amount of land and water that individuals use to meet their resource needs and absorb the waste they produce is called an **ecological footprint**. A high level of resource use means a larger footprint. A low level of resource use means a smaller footprint. Refer to **Figure 3**.

## apply it!

The chart below gives the average ecological footprints for the people of several countries. It also gives the footprint for each country as a whole. Ecological footprints are measured in global hectares. A global hectare (gha) is a unit of area. It is adjusted to compare how much life different places on Earth can support.

Country	Average Ecological Footprint (gha/person)	Total Ecological Footprint (million gha)
United States	9.6	2,819
United Kingdom	5.6	333
Germany	4.5	375
Mexico	2.6	265
China	1.6	2,152

**1 Interpret Tables** Which country has the largest ecological footprint? \_\_\_\_\_

**2 Calculate** About how many times larger is the average ecological footprint per person in the United States than per person in Mexico?

**3 CHALLENGE** China has a smaller ecological footprint per person than the United Kingdom, but a much larger total ecological footprint. Why?

**Conservation** While we cannot avoid using resources, there are better ways to use them. Resource **conservation** is the practice of managing the use of resources wisely so the resources last longer. Conservation cannot make resources last forever, but it can make resources last longer.

Governments and industries greatly affect resource conservation. Even individuals can make a difference. Walking, riding a bike, or riding the bus conserves fuel resources. People can also conserve resources when they turn off lights and unplug equipment that they are not using. Taking shorter showers saves water. When many people make small changes, the results can be huge.



**did you know?** .....

If everyone on Earth lived like the average American, it would take the resources of five planets to support us!

### Resource Conservation at My School

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FIGURE 4 .....

### Conserving Resources at School

Students like you can take action to conserve natural resources.

 **List** On the notebook paper, write ways your school can conserve resources.



Do the Lab Investigation *Recycling Paper.*

### Assess Your Understanding

2a. **Review** Resources (are/are not) equally available around the world.

b. **Summarize** What two factors determine whether or not a resource is being used sustainably?

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c. **Evaluate the Impact on Society** As the human population continues to grow, how do you think it will affect the use of natural resources?

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**got it?** .....

I get it! Now I know that natural resources are important because \_\_\_\_\_

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I need extra help with \_\_\_\_\_

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6.ESS3.3

# Conserving Land and Soil



 How Do People Use Land?

 Why Is Soil Management Important?



## my planet DiARY

### Land Inspiration

Conservation is a state of harmony between men and land.

—Aldo Leopold

Aldo Leopold spent his life in beautiful landscapes. He was so inspired by what he saw that he sought to better understand it. Leopold realized that land and all it contains—living and nonliving—are connected. He believed people should use land in a way that protects it for all living things as well as for future generations. Leopold called his idea the “land ethic.” He wrote several books on conservation using this philosophy, including his most famous book, *A Sand County Almanac*.

## VOICES FROM HISTORY

**Communicate** Discuss this question with a group of classmates. Write your answer below.

How do you think land should be used?

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Do the Inquiry Warm-Up  
How Does Mining Affect  
the Land?

## How Do People Use Land?

Less than a quarter of Earth’s surface is dry, ice-free land. All people on Earth must share this limited amount of land to produce their food, build shelter, and obtain resources. As the American author Mark Twain once said about land, “They don’t make it anymore.”

People use land in many ways.  **Three uses that change the land are agriculture, mining, and development.** See Figure 1.

## Vocabulary

- litter • topsoil • subsoil • bedrock • erosion
- nutrient depletion • fertilizer • desertification
- drought • land reclamation

## Skills

- 🎯 Reading: Relate Cause and Effect
- 🔺 Inquiry: Infer

**Agriculture** Land provides most of the food that people eat. Crops such as wheat require lots of fertile land, but less than a third of Earth's land can be farmed. The rest is too dry, too salty, or too mountainous. New farmland is created by clearing forests, draining wetlands, and irrigating deserts. Land can also be used to grow food for animals, to provide grazing for livestock, or to grow crops such as cotton.

**Mining** Mining is the removal of nonrenewable resources from the land. Resources just below the surface are strip mined. Strip mining removes a strip of land to obtain minerals. The strip is then replaced. Strip mining exposes soil, which can then be blown or washed away. The area may remain barren for years. Resources can also be removed from deeper underground by digging tunnels to bring the minerals to the surface.

**Development** People settled in areas that had good soil near fresh water. As populations grew, the settlements became towns and cities. People developed the land by constructing buildings, bridges, and roads. In the United States, an area half the size of New Jersey is developed each year.

FIGURE 1 .....

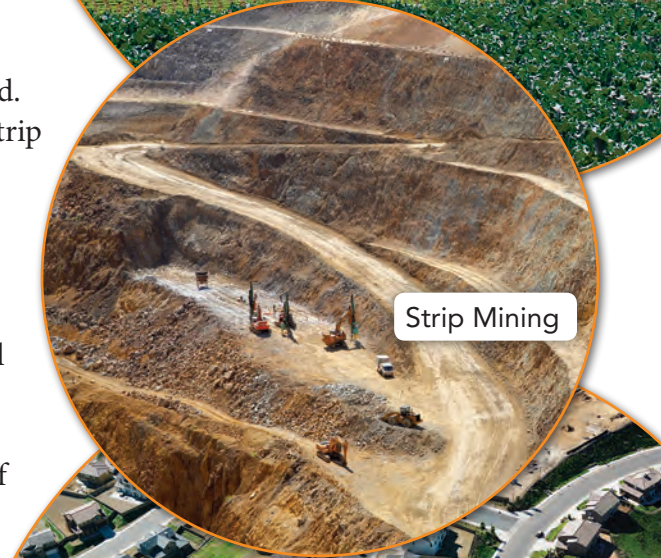
### Land Use

The ways that people use land vary greatly. For example, about 93 percent of land in Nebraska is used for agriculture, while just over 40% of land in Tennessee is used for agriculture.

 **Describe** How is land used in your area?

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Do the Quick Lab  
Land Use.

## Assess Your Understanding

got it? .....

I get it! Now I know the ways people use and change land include \_\_\_\_\_

I need extra help with \_\_\_\_\_


## Why Is Soil Management Important?

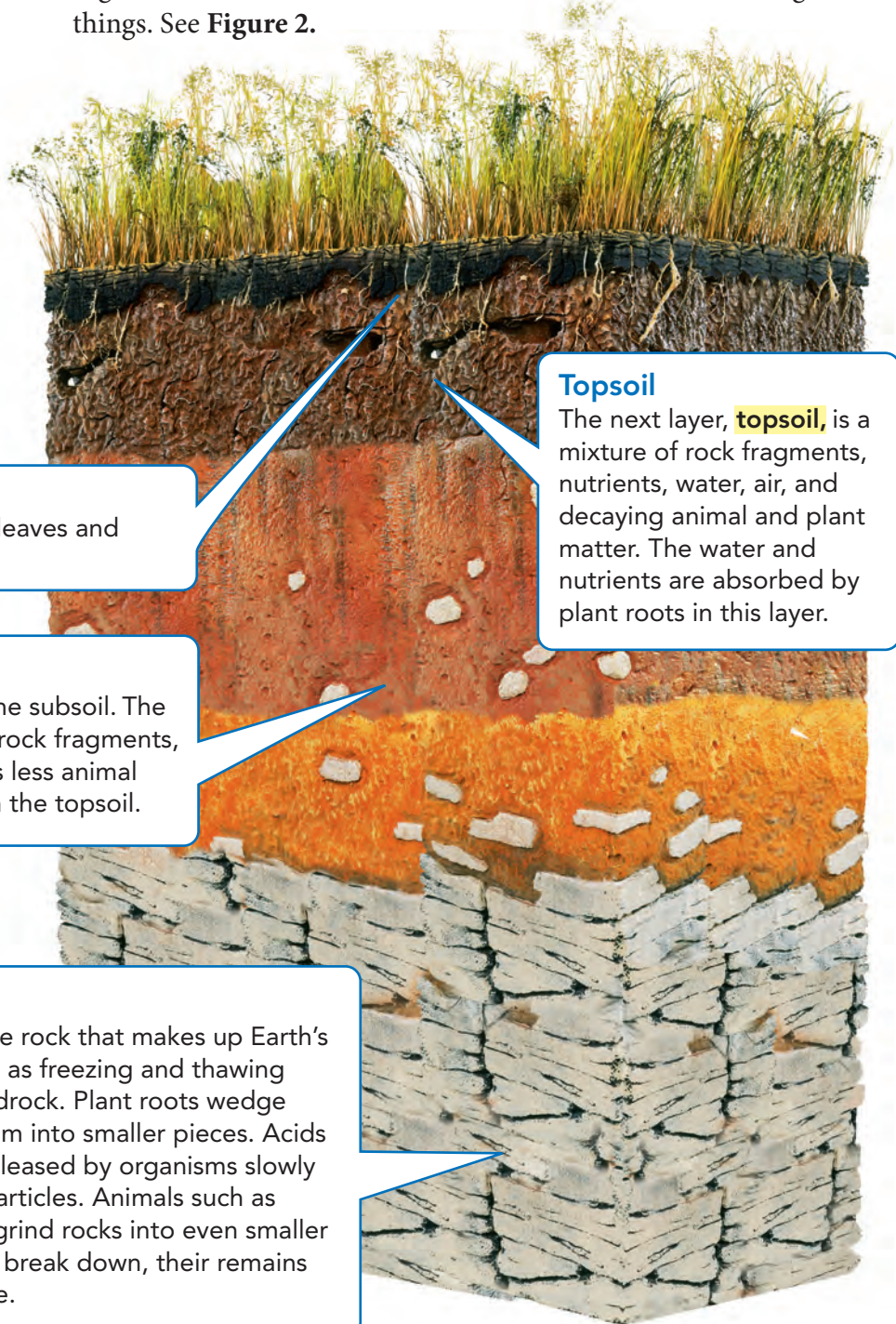
To understand why soil management is important, you need to know about the structure and function of fertile soil. It can take hundreds of years to form just a few centimeters of new soil. Soil contains the minerals and nutrients that plants need to grow. Soil also absorbs, stores, and filters water. Bacteria, fungi, and other organisms in soil break down the wastes and remains of living things. See **Figure 2**.

FIGURE 2 .....

### Structure of Fertile Soil

Fertile soil is made up of several layers, including litter, topsoil, and subsoil.

 **Identify** Underline the organisms that make up or play a role in each soil layer.



#### Litter

The top layer of dead leaves and grass is called **litter**.

#### Subsoil

Below the topsoil is the subsoil. The **subsoil** also contains rock fragments, water, and air, but has less animal and plant matter than the topsoil.

#### Bedrock

All soil begins as **bedrock**, the rock that makes up Earth's crust. Natural processes such as freezing and thawing gradually break apart the bedrock. Plant roots wedge between rocks and break them into smaller pieces. Acids in rainwater and chemicals released by organisms slowly break the rock into smaller particles. Animals such as earthworms and moles help grind rocks into even smaller particles. As dead organisms break down, their remains also contribute to the mixture.

#### Topsoil

The next layer, **topsoil**, is a mixture of rock fragments, nutrients, water, air, and decaying animal and plant matter. The water and nutrients are absorbed by plant roots in this layer.

**Soil Use Problems** Because rich topsoil takes so long to form, it is important to protect Earth's soil. 🗝️ **Without soil, most life on land could not exist. Poor soil management can result in three problems: erosion, nutrient depletion, and desertification.** Fortunately, damaged soil can sometimes be restored.

**Erosion** Normally, plant roots hold soil in place. But when plants are removed during logging, mining, or farming, the soil is exposed and soil particles can easily move. The process by which water, wind, or ice moves particles of rocks or soil is called **erosion**. Terracing, one farming method that helps reduce erosion, is shown in **Figure 3**.

✎️ **Relate Cause and Effect** In the text, underline the causes and circle the effects of two soil use problems.



**Nutrient Depletion** Plants make their own food through photosynthesis. Plants also need nutrients such as the nitrogen, potassium, and phosphorus found in soil to grow. Decomposers supply these nutrients to the soil as they break down the wastes and remains of organisms. But if a farmer plants the same crops in a field every year, the crops may use more nutrients than the decomposers can supply. The soil becomes less fertile, a situation called **nutrient depletion**.

When soil becomes depleted, farmers usually apply **fertilizers**, which include nutrients that help crops grow better. Farmers may choose other methods of soil management, too. They may periodically leave fields unplanted. The unused parts of crops, such as cornstalks, can be left in fields to decompose, adding nutrients to the soil. Farmers also can alternate crops that use many nutrients with crops that use fewer nutrients.

FIGURE 3 .....

**Terracing**

✎️ A terrace is a leveled section of a hill used to grow crops and prevent erosion. The flat surfaces allow crops to absorb water before the water flows downhill.

1. **Interpret Photos** Draw the path of water down the first hill and the terraced hill.
2. **Infer** Why do you think terracing helps prevent erosion?

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**Desertification** If the soil in a once-fertile area becomes depleted of moisture and nutrients, the area can become a desert. The advance of desertlike conditions into areas that previously were fertile is called **desertification** (dih zurt uh fih KAY shun).

One cause of desertification is climate. For example, a **drought** is a period when less rain than normal falls in an area. During droughts, crops fail. Without plant cover, the exposed soil easily blows away. Overgrazing of grasslands by cattle and sheep and cutting down trees for firewood can cause desertification, too.

Desertification is a serious problem. People cannot grow crops and graze livestock where desertification has occurred. As a result, people may face famine and starvation. Desertification is severe in central Africa. Millions of rural people there are moving to the cities because they can no longer support themselves on the land.

## apply it!

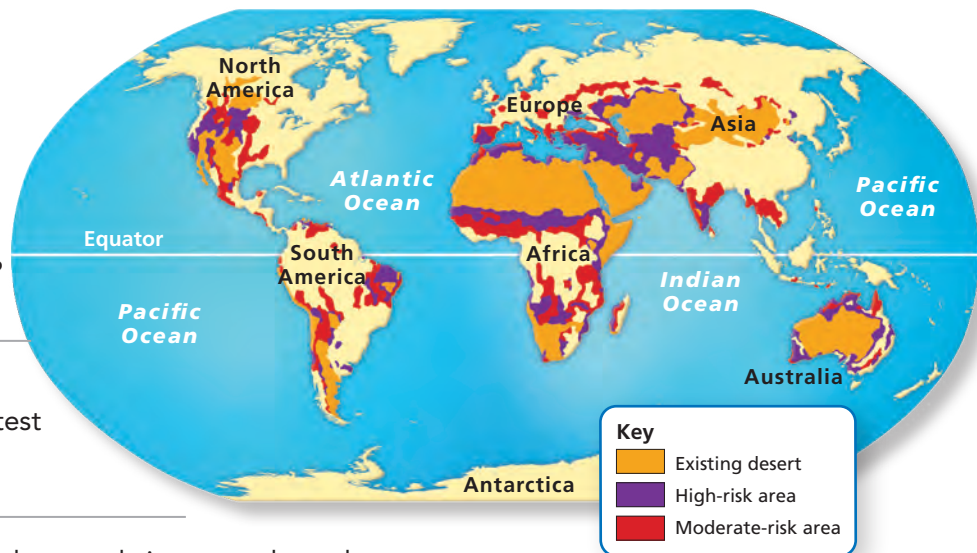
Desertification affects many areas around the world.

**1 Name** Which continent has the most existing desert?

**2 Interpret Maps** Where in the United States is the greatest risk of desertification?

**3 Infer** Is desertification a threat only in areas where there is existing desert? Explain. Circle an area on the map to support your answer.

**4 CHALLENGE** If an area is facing desertification, what are some things people could do to possibly limit its effects?



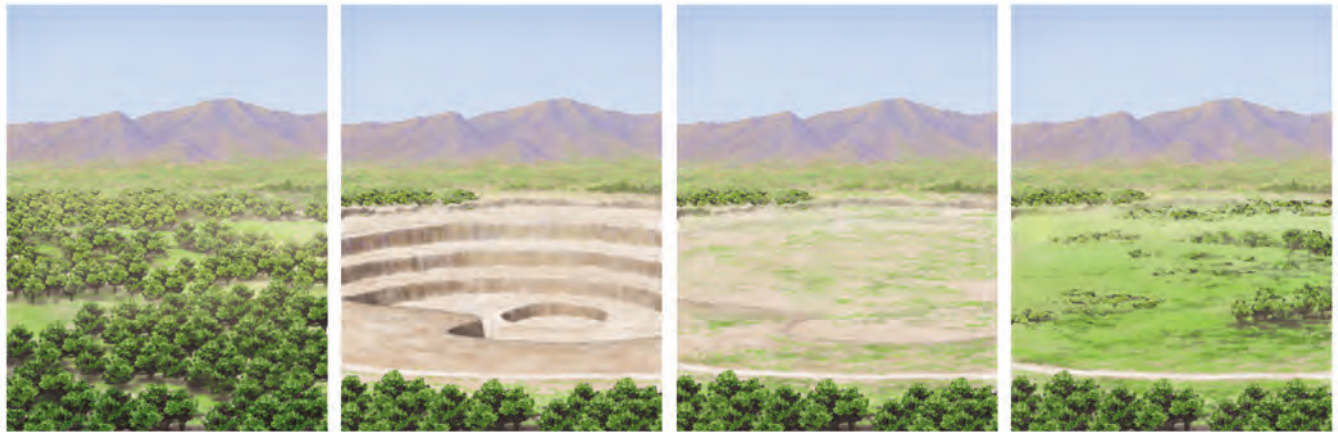
**Land Reclamation** Fortunately, it is possible to replace land damaged by erosion or mining. The process of restoring an area of land to a more productive state is called **land reclamation**. In addition to restoring land for agriculture, land reclamation can restore habitats for wildlife. Many different types of land reclamation projects are currently underway all over the world. But it is generally more difficult and expensive to restore damaged land and soil than it is to protect those resources in the first place. In some cases, the land may not return to its original state.

FIGURE 4 .....

**Land Reclamation**

These pictures show land before and after it was mined.

 **Communicate** Below the pictures, write a story about what happened to the land.




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Do the Quick Lab  
Modeling Soil Conservation.

 **Assess Your Understanding**

- 1a. **Review** Subsoil has (less/more) plant and animal matter than topsoil.
- b. **Explain** What can happen to soil if plants are removed?

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- c. **Apply Concepts** What are some problems that could prevent people from supporting land reclamation?

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**got it?** .....

I get it! Now I know that soil management is important because \_\_\_\_\_

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I need extra help with \_\_\_\_\_




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6.ESS3.3

# Waste Disposal and Recycling



-  What Are Three Solid Waste Disposal Methods?
-  What Are the Major Categories of Recycling?
-  How Are Hazardous Wastes Safely Disposed Of?



## my planet DiARY

### Trash Talk

Here are some interesting facts about trash:

- Every hour, people throw away 2.5 million plastic bottles.
- Recycling one aluminum can saves enough energy to run a TV for three hours.
- Americans create two kilograms of trash per day. That trash could fill 63,000 garbage trucks each day!
- In 2005 the U.S. government recorded the first-ever drop in the amount of trash produced from the previous year. Trash declined by 1.5 million metric tons from 2004 to 2005, partly due to an increase in recycling.

## SCIENCE STATS

**Communicate** Discuss these questions with a group of classmates. Write your answers below.

1. Do you think the amount of trash we produce will increase or decrease in the future? Explain.

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2. What can you do to reduce the amount of trash you create?

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Do the Inquiry Warm-Up  
What's in the Trash?

## Vocabulary

- municipal solid waste • incineration • pollutant
- leachate • sanitary landfill • recycling
- biodegradable • hazardous waste

## Skills

- 🔄 Reading: Compare and Contrast
- 📊 Inquiry: Graph

# What Are Three Solid Waste Disposal Methods?

People generate many types of waste, including empty packaging, paper, and food scraps. The wastes produced in homes, businesses, schools, and in the community are called **municipal solid waste**.

Other sources of solid waste include construction debris, agricultural wastes, and industrial wastes. 🔑 **Three methods of handling solid waste are burning, burying, and recycling.** Each method has its advantages and disadvantages.

**Incineration** The burning of solid waste is called **incineration** (in sin ur AY shun). The burning facilities, or incinerators, do not take up much space. They do not directly pollute groundwater. The heat produced by burning solid waste can be used to produce electricity. Incinerators supply electricity to many homes.

Unfortunately, incinerators do have drawbacks. Even the best incinerators create some air pollution. Although incinerators reduce the volume of waste by as much as 90 percent, some waste still remains and needs to be disposed of somewhere. Incinerators are also expensive to build.

## apply it!

What happens to all the trash?

1 📊 **Graph** Use the data in the table and the key to fill in the bar graph. The graph represents the methods of municipal waste disposal in the United States in 2007. Give the graph a title.

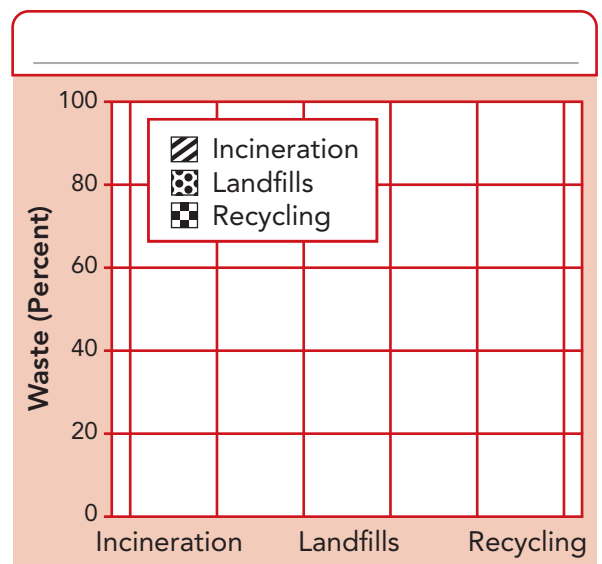
Disposal Method	Waste (Percent)
Incineration	13%
Landfills	54%
Recycling	33%

2 **CHALLENGE** Why do you think incineration is the least popular method of solid waste disposal?

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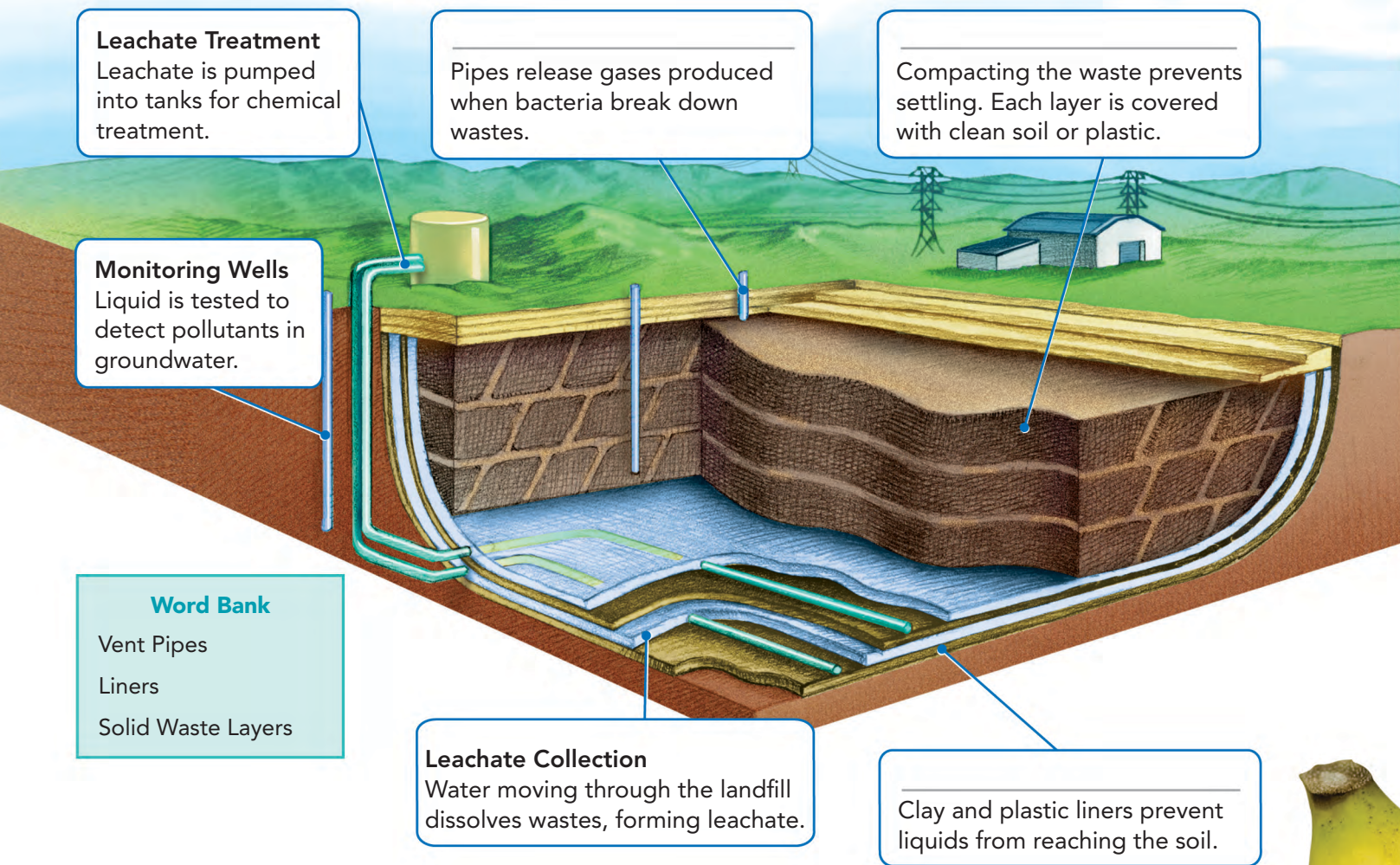



FIGURE 1 .....

### Sanitary Landfill Design

Sanitary landfills are designed to protect the surrounding area.

 **Interpret Diagrams** Use the terms listed in the word bank to fill in the missing labels on the diagram. Why is it important for landfills to be carefully designed?

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**Landfills** Until fairly recently, people disposed of waste in open holes in the ground called dumps. Some of this waste polluted the environment. Any substance that causes pollution is a **pollutant**. Dumps were dangerous and unsightly. Rainwater falling on a dump dissolved chemicals from the wastes, forming a polluted liquid called **leachate**. Leachate could run off into streams and lakes, or trickle down into the groundwater.

In 1976, the government banned open dumps. Now much solid waste is buried in landfills that are built to hold the wastes more safely. A **sanitary landfill** holds municipal solid waste, construction debris, and some types of agricultural and industrial waste. **Figure 1** shows the parts of a well-designed sanitary landfill. Once a landfill is full, it is covered with a clay cap to keep rainwater from entering the waste.


Even well-designed landfills can pollute groundwater. Capped landfills can be reused as parks and sites for sports arenas. They cannot be used for housing or agriculture.

**Recycling** You may have heard of the “three R’s”—reduce, reuse, and recycle. *Reduce* refers to creating less waste from the beginning, such as using cloth shopping bags rather than disposable ones. *Reuse* refers to finding another use for an object rather than discarding it, such as refilling reusable bottles with drinking water instead of buying new bottled water.

The process of reclaiming raw materials and reusing them to create new products is called **recycling**. You can recycle at home and encourage others to recycle. You can buy products made from recycled materials. Your purchase makes it more profitable for companies to use recycled materials in products.

Another way to reduce solid waste is to start a compost pile. The moist, dark conditions in a compost pile allow natural decomposers to break down grass clippings, leaves, and some food wastes. Compost is an excellent natural fertilizer for plants.



 **Compare and Contrast**  
In the table below, write one pro and one con for each of the three solid waste disposal methods.

	Incineration	Sanitary Landfills	Recycling
Pro	_____ _____ _____	_____ _____ _____	_____ _____ _____
Con	_____ _____ _____	_____ _____ _____	_____ _____ _____



Do the Lab Investigation  
Waste, Away!

 **Assess Your Understanding**

1a. **Define** What is incineration?

\_\_\_\_\_

b. **Design a Solution** What could be some possible uses for the space over a landfill once it is capped? \_\_\_\_\_

\_\_\_\_\_

c. **Make Judgments** Which solid waste disposal method do you think is best? Why?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**got it?** .....

I get it! Now I know solid waste can be disposed of through \_\_\_\_\_

\_\_\_\_\_


I need extra help with \_\_\_\_\_


\_\_\_\_\_

## What Are the Major Categories of Recycling?

Recycling reduces the volume of solid waste by reusing materials. Recycling uses energy, but it also saves the energy that would be needed to obtain, transport, and process raw materials. Recycling is also cheaper than making new materials. Additionally, recycling conserves nonrenewable resources and limits the environmental damage caused by mining for raw materials.

Materials that can be broken down and recycled by bacteria and other decomposers are **biodegradable** (by oh dih GRAY duh bul). Many products people use today are not biodegradable, such as plastic containers, metal cans, rubber tires, and glass jars. Instead, people have developed different ways to recycle the raw materials in these products.

A wide range of materials can be recycled.  **Most recycling focuses on four major categories of products: metal, glass, paper, and plastic.**

 **Vocabulary Prefixes** The prefix *bio-* means “life.” A material is biodegradable if it can be broken down and recycled by living things such as

Material	Recycling Process	Products Made From Recycling
Metal	Metals are melted in furnaces and rolled into sheets.	Cars, cans, bicycles, jewelry, office supplies, house siding
Glass	Glass pieces are melted in furnaces and cast into new glass.	Bottles, floor tiles, countertops, jewelry, jars
Paper	Paper is shredded and mixed with water to form pulp. The pulp is washed, dried, and rolled into new sheets.	Toilet paper, notebook paper, paper cups, paper plates, napkins, envelopes
Plastic	Plastic containers are chopped, washed, and melted. The molten plastic is turned into pellets that can be heated and molded.	Picnic tables, park benches, speed bumps, recycling bins, playground equipment, deck lumber, fleece (see girl's jacket at left)




Is recycling worthwhile? Besides conserving resources, recycling saves energy. Making aluminum products from recycled aluminum rather than from raw materials uses about 90 percent less energy overall. For certain materials, recycling is usually worthwhile. However, recycling is not a complete answer to the solid waste problem. For some cities, recycling is not cost-effective. Scientists have not found good ways to recycle some materials, such as plastic-coated paper and plastic foam. Some recycled products, such as low-quality recycled newspaper, have few uses. All recycling processes require energy and create pollution. The value of recycling must be judged on a case-by-case basis.




FIGURE 2 .....

### Like New

Did you know that old tires can be made into belts? Or jeans into insulation?

 **Apply Concepts** Besides the examples shown, name other objects that could be made from these recyclables.

 Do the Quick Lab  
It's in the Numbers.

## Assess Your Understanding

2a. **Explain** How does recycling save energy?

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b. **Solve Problems** How could your community solve its solid waste problem?

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### got it?

I get it! Now I know recyclable materials are categorized as \_\_\_\_\_

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I need extra help with \_\_\_\_\_

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## How Are Hazardous Wastes Safely Disposed Of?

Many people picture hazardous wastes as bubbling chemicals or oozing slime. Any material that can be harmful to human health or the environment if it is not properly disposed of is a **hazardous waste**.

**Types of Hazardous Wastes** Toxic wastes can damage the health of humans and other organisms. Explosive wastes can react very quickly when exposed to air or water, or explode when dropped. Flammable wastes easily catch fire. Corrosive wastes can dissolve many materials. Everyday hazardous wastes include electronic devices, batteries, and paint.

Other wastes that require special disposal are radioactive wastes. Radioactive wastes give off radiation that can cause cancer and other diseases. Some radioactive waste can remain dangerous for millions of years.

**Health Effects** A person can be exposed to hazardous wastes by breathing, eating, drinking, or touching them. Even short-term exposure to hazardous wastes can cause problems such as skin irritation or breathing difficulties. Long-term exposure can cause diseases such as cancer, damage to body organs, or death.

FIGURE 3 .....

### Sort It Out!

Wastes can be thrown away, recycled, or disposed of as hazardous waste.

 **Summarize** Draw a line from each object to its appropriate disposal container.






FIGURE 4 .....

### Hazardous Wastes

Hazardous waste can be harmful if improperly handled.

 **Review** What is the best way to manage hazardous wastes?

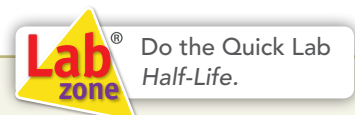
- Store waste in small facilities.
- Produce less waste to start.
- Incinerate waste.

**Disposal Methods** It is difficult to safely dispose of hazardous wastes. Hazardous wastes are most often disposed of in carefully designed landfills. The landfills are lined and covered with clay and plastic. These materials prevent chemicals from leaking into the soil and groundwater.  **Hazardous wastes that are not disposed of in carefully designed landfills may be incinerated or broken down by organisms. Liquid wastes may be stored in deep rock layers.**

Scientists are still searching for methods that will provide safe and permanent disposal of radioactive wastes. Some wastes are currently stored in vaults dug hundreds of meters underground or in concrete and steel containers above ground.

**Disposal Sites** It is a challenge to decide where to build hazardous waste disposal facilities. In general, people would prefer to have a single large facility located in an area where few people live. However, it may be safer, cheaper, and easier to transport wastes to small local facilities instead.

**Reducing Hazardous Waste** The best way to manage hazardous wastes is to produce less of them in the first place. Industries are eager to develop safe alternatives to harmful chemicals. At home, you can find substitutes for some hazardous household chemicals. For example, you could use citronella candles instead of insect spray to repel insects.



### Assess Your Understanding

**3a. Name** What are some negative health effects of exposure to hazardous wastes?

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**b. Make Judgments** Do you think hazardous wastes should be disposed of at one large central facility? Explain.

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### got it? .....

I get it! Now I know that hazardous wastes are disposed of by \_\_\_\_\_

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I need extra help with \_\_\_\_\_




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6.ESS3.2, 6.ESS3.3

# Air Pollution and Solutions



-  What Causes Outdoor and Indoor Air Pollution?
-  What Causes Damage to the Ozone Layer?
-  How Can Air Pollution Be Reduced?



## my planet DiARY

## PROFILE

### Drawing for a Difference

Some people may think that kids can't help the environment. Kids in the San Joaquin Valley of California know better! Each year, students enter their drawings into a contest for a Clean Air Kids Calendar sponsored by the San Joaquin Valley Air Pollution Control District. Lisa Huang and Saira Delgada are two middle school students whose work was chosen to be a part of the 2008 calendar. Their drawings show people why healthy air is important. Every time people looked at the calendar, the drawings reminded them of the simple ways they can help the planet.

**Communicate** Discuss the question with a group of classmates. Then, write your answer below.

How could you raise awareness about air pollution in your community?

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Do the Inquiry Warm-Up  
*How Does the Scent Spread?*



## Vocabulary

- emissions
- photochemical smog
- ozone
- temperature inversion
- acid rain
- radon
- ozone layer
- chlorofluorocarbon

## Skills

- 🎯 Reading: Relate Text and Visuals
- 📌 Inquiry: Communicate

# What Causes Outdoor and Indoor Air Pollution?

You can't usually see it, taste it, or smell it, but you are surrounded by air. Air is a mixture of nitrogen, oxygen, carbon dioxide, water vapor, and other gases. Almost all living things depend on these gases to survive. Recall that these gases cycle between living things and the atmosphere. These cycles guarantee that the air supply will not run out, but they don't guarantee that the air will be clean.

**Outdoor Air Pollution** What causes air pollution? Until the mid-1900s in the United States, factories and power plants that burned coal produced most of the pollutants, or **emissions**, that were released into the air. 🗝️ **Today, a large source of emissions resulting in air pollution outdoors comes from motor vehicles such as cars and trucks.** There are also some natural causes of air pollution. Methane released from animals such as cows also sends pollutants into the atmosphere.

Air pollution sources can be grouped as point or nonpoint sources. A point source is a specific source of pollution that is easy to identify, such as a smokestack. A nonpoint source is a source that is widely spread and cannot be tied to a specific origin, such as vehicle emissions. So the pollution cannot be traced to any specific vehicle.

FIGURE 1 .....

### Volcanoes and Air Pollution

Not all air pollution is caused by people. Gases released by volcanic eruptions can also harm the atmosphere.

✎ **Infer** In the text, underline one natural source of air pollution. Name at least one other natural source of air pollution.

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FIGURE 2 .....

### Temperature Inversion

Normally, pollutants rise into the atmosphere and blow away. During a temperature inversion, warm air traps the pollution close to the ground.

 **Interpret Photos** On the photo above, label the warm air, cool air, and polluted air.

**Smog** Have you ever heard a weather forecaster talk about a “smog alert”? A smog alert is a warning about a type of air pollution called photochemical smog. **Photochemical smog** is a thick, brownish haze formed when certain gases in the air react with sunlight. When the smog level is high, it settles as a haze over a city. Smog can cause breathing problems and eye and throat irritation. Exercising outdoors can make these problems worse.

The major sources of smog are the gases emitted by cars and trucks. Burning gasoline in a car engine releases gases into the air. These gases include hydrocarbons (compounds containing hydrogen and carbon) and nitrogen oxides. The gases react in the sunlight and produce a form of oxygen called **ozone**. Ozone, which is toxic, is the major chemical found in smog. Ozone can cause lung infections and damage the body’s defenses against infection.

Normally, air close to the ground is heated by Earth’s surface. As the air warms, it rises into the cooler air above it. Any pollutants in the air are carried higher into the atmosphere and are blown away from the place where they were produced.


Certain weather conditions can cause a condition known as a temperature inversion. During a **temperature inversion**, as shown in **Figure 2**, a layer of warm air prevents the rising air from escaping. The polluted air is trapped and held close to Earth’s surface. The smog becomes more concentrated and dangerous.



FIGURE 3 .....

### Acid Rain

Acid rain harms plants, animals, buildings, and statues.

 **Review** In the text, underline the cause of acid rain.

**Acid Rain** Precipitation that is more acidic than normal because of air pollution is called **acid rain**. Acid rain can also take the form of snow, sleet, or fog. Acid rain is caused by the emissions from power plants and factories that burn coal and oil. These fuels produce nitrogen oxides and sulfur oxides when they are burned. The gases that are released react with water vapor in the air, forming nitric acid and sulfuric acid. The acids dissolve in precipitation and return to Earth's surface.

As you can imagine, acid falling from the sky has some negative effects. When acid rain falls into a pond or lake, it changes the conditions there. Many fish, particularly their eggs, cannot survive in more acidic water. When acid rain falls on plants, it can damage their leaves and stems. Acid rain that falls on the ground can also damage plants by affecting the nutrient levels in the soil. Whole forests have been destroyed by acid rain. Fortunately, some of the effects of acid rain are reversible. Badly damaged lakes have been restored by adding lime or other substances that neutralize the acid.

Acid rain doesn't just affect living things. The acid reacts with stone and metal in buildings and statues. Statues and stonework damaged by acid rain may look as if they are melting, as seen in **Figure 3**. Automobiles rust more quickly in areas with acid rain. These effects are not reversible and the damage can be costly.

## apply it!

You are a scientist called to testify before Congress about acid rain. The government is proposing putting limits on emissions that lead to acid rain.

**1 Communicate** Some of the members of Congress do not think acid rain causes real damage. What do you tell them?

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**2 Explain** Is rain the only form of precipitation you would identify as being potentially acidic? Explain.

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**3 CHALLENGE** What could you tell a company that was unwilling to reduce its emissions because the initial cost was high?

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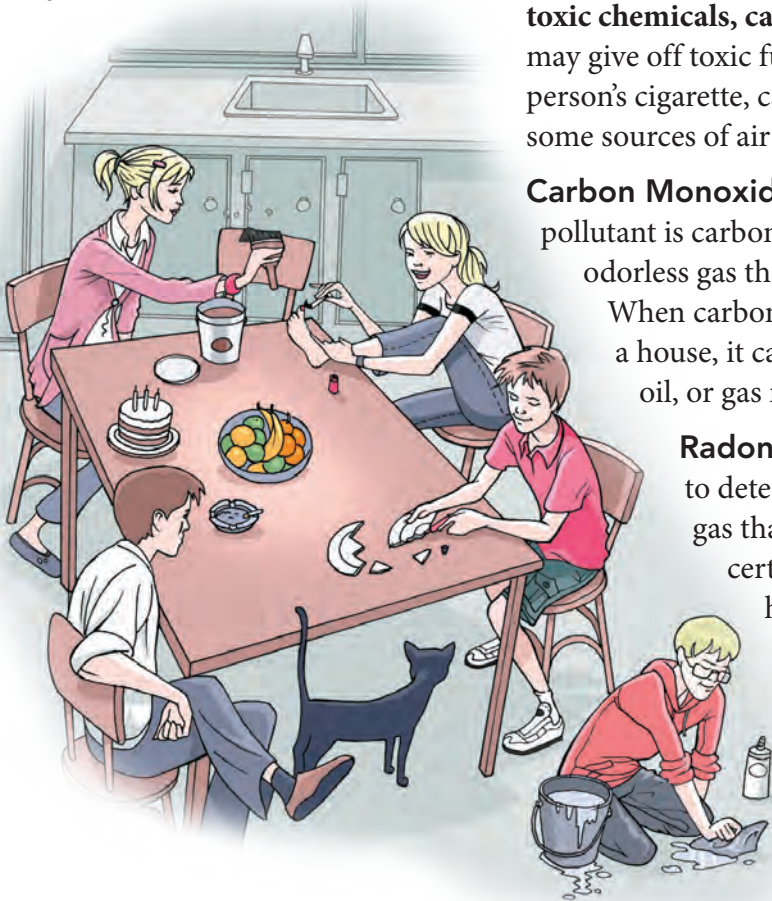
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FIGURE 4 .....

### Indoor Air Pollution

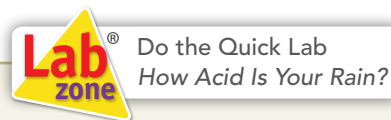
Indoor air pollution has many sources.  **Identify** Circle the sources of indoor air pollution in this room.



**Indoor Air Pollution** You might think that you can avoid air pollution by staying inside. The air inside buildings can be polluted, too.  **Some substances that cause indoor air pollution, such as dust and pet hair, bother only those people who are sensitive to them. Other indoor air pollutants, such as toxic chemicals, can affect anyone.** Glues and cleaning supplies may give off toxic fumes. Cigarette smoke, even from another person's cigarette, can damage the lungs and heart. **Figure 4** shows some sources of air pollution that can be found in homes.

**Carbon Monoxide** One particularly dangerous indoor air pollutant is carbon monoxide. Carbon monoxide is a colorless and odorless gas that forms when fuels are not completely burned. When carbon monoxide builds up in an enclosed space, like a house, it can be deadly. Any home heated by wood, coal, oil, or gas needs a carbon monoxide detector.

**Radon** Another indoor air pollutant that is difficult to detect is radon. **Radon** is a colorless, odorless gas that is radioactive. It is formed naturally by certain rocks underground. Radon can enter homes through cracks in basement walls or floors. Breathing radon gas over many years may cause lung cancer and other health problems. Homeowners can install ventilation systems to prevent radon from building up in their homes.



### Assess Your Understanding

- 1a. **Name** (Photochemical smog/Methane) is a thick, brownish haze formed when gases in the air are exposed to sunlight.
- b. **Make Judgments** Do you think the government should regulate sources of air pollution such as factory and car emissions? Explain.

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### got it? .....

- I get it! Now I know outdoor air pollution is caused by \_\_\_\_\_  
\_\_\_\_\_
- and indoor air pollution is caused by \_\_\_\_\_  
\_\_\_\_\_
- I need extra help with \_\_\_\_\_  
\_\_\_\_\_

# What Causes Damage to the Ozone Layer?

If you have ever had a sunburn, you have experienced the painful effects of the sun’s ultraviolet radiation. But did you know that sunburns would be even worse without the protection of the ozone layer? The **ozone layer** is a layer of the upper atmosphere about 15 to 30 kilometers above Earth’s surface. The amount of ozone in this layer is very small. Yet even this small amount of ozone in the ozone layer protects people from the effects of too much ultraviolet radiation. These effects include sunburn, eye diseases, and skin cancer.

Because you read earlier that ozone is a pollutant, the fact that ozone can be helpful may sound confusing. The difference between ozone as a pollutant and ozone as a helpful gas is its location in the atmosphere. Ozone close to Earth’s surface in the form of smog is harmful. Ozone higher in the atmosphere, where people cannot breathe it, protects us from too much ultraviolet radiation.

**The Source of Ozone** Ozone is constantly being made and destroyed. See **Figure 5**. When sunlight strikes an ozone molecule, the energy of the ultraviolet radiation is partly absorbed. This energy causes the ozone molecule to break apart into an oxygen molecule and an oxygen atom. The oxygen atom soon collides with another oxygen molecule. They react to form a new ozone molecule. Each time this cycle occurs, some energy is absorbed. That energy does not reach Earth’s surface.

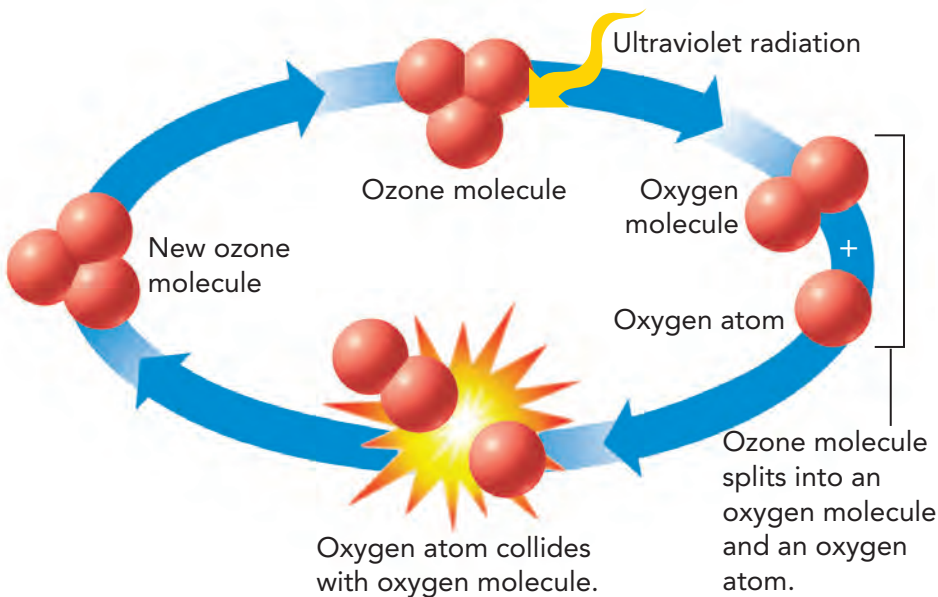


FIGURE 5 .....

## Ozone Cycle

The ozone cycle prevents harmful ultraviolet radiation from reaching Earth’s surface.

 **Sequence** Explain the ozone cycle in your own words.

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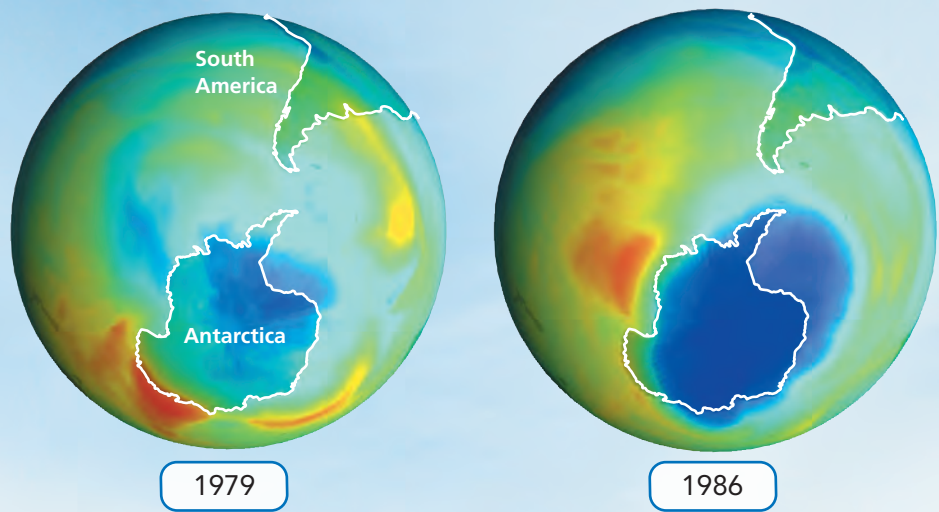
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FIGURE 6 .....

### Ozone Hole

The ozone hole (shown in blue) is over Antarctica. The hole has grown over time, but it varies seasonally and from year to year.



**The Ozone Hole** In the late 1970s, scientists observed from satellite images that the ozone layer over Antarctica was growing thinner each spring. The amount of ozone in the ozone layer was decreasing. This caused an area of severe ozone depletion, or an ozone hole. In **Figure 6**, you can see the size of the ozone hole in five selected years.



What is to blame for the ozone hole?  **Scientists determined that the major cause of the ozone hole is a group of gases called CFCs.** CFCs, or **chlorofluorocarbons**, are human-made gases that contain chlorine and fluorine. CFCs had been used in air conditioners, aerosol spray cans, and other household products. CFCs reach high into the atmosphere, and react with ozone molecules. The CFCs block the cycle in which ozone molecules absorb ultraviolet radiation. As a result, more ultraviolet light reaches Earth's surface.

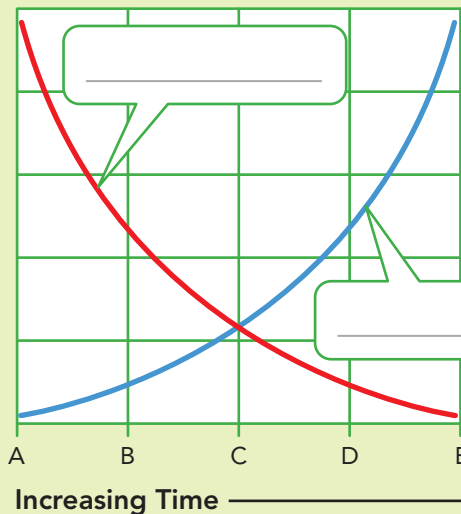
FIGURE 7 .....

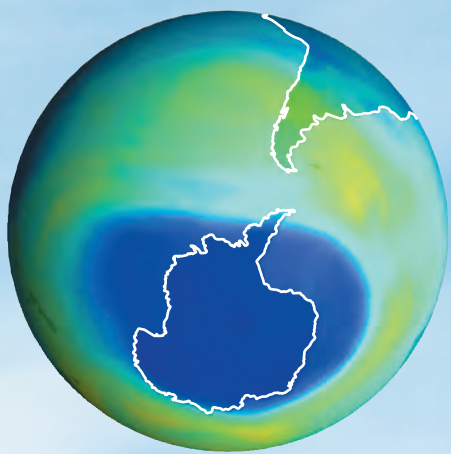
### Ozone and Ultraviolet Radiation

 The amount of ozone in the atmosphere and the amount of UV radiation reaching Earth are linked.

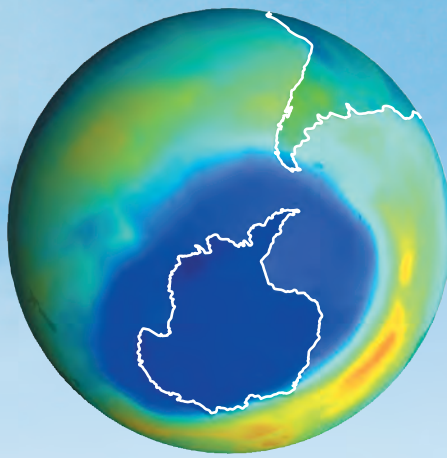
- 1. Read Graphs** Label the curve on the graph representing ozone and the curve representing UV radiation.
- 2. Summarize** Explain the graph in your own words.

### Ozone and UV Radiation Resulting From CFCs

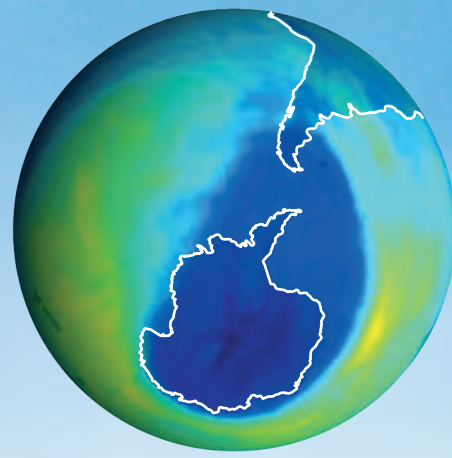




1993




2000



2004

**What's Being Done** In 1990, many nations signed an agreement to eventually ban the use of ozone-depleting substances, including CFCs. Most uses of CFCs were banned in 2000. Some uses of CFCs are still allowed, but compared to the 1970s, few CFCs now enter the atmosphere. Unfortunately, CFC molecules remain in the atmosphere for a long time. Scientists predict that if the ban on ozone-depleting substances is maintained, the ozone layer will gradually recover.

When scientists discovered that CFCs were harming the atmosphere, they immediately began to search for substitutes. Refrigerators and air conditioners were redesigned to use less-harmful substances. Most spray cans were either replaced by pump sprays or redesigned to use other gases. Researchers developed new ways to make products such as plastic foam without using CFCs. As a result of this research and the development of CFC substitutes, far less CFCs now enter the atmosphere.

 **Relate Text and Visuals**  
Based on the photos, describe what happened to the hole in the ozone layer before CFCs were banned. What do you think could happen if the ban is maintained and enforced?

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 **Assess Your Understanding**

**2a. Explain** How can ozone be both a pollutant and something beneficial to Earth?

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**b. Solve Problems** What can countries do to help the ozone layer recover?

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**got it?** .....

I get it! Now I know the ozone layer was damaged by \_\_\_\_\_

I need extra help with \_\_\_\_\_

 Do the Quick Lab Analyzing Ozone.

# How Can Air Pollution Be Reduced?

Air pollution can be reduced if we examine the sources.  **The key to reducing air pollution is to control emissions.** In the United States, laws such as the Clean Air Act regulate the amount of certain pollutants that can be released into the air. Laws also encourage the development of new technology that reduces air pollution. Reducing emissions also requires your efforts.

**Controlling Emissions From Factories** At one time, industries dealt with emissions by building tall smokestacks. The stacks released wastes high into the air where they could blow away, but the pollutants still ended up somewhere. Now factories remove pollutants from their emissions with devices known as scrubbers that release water droplets. Pollutants dissolve in the water and fall into a container. The use of scrubbers explains why “smoke” from factories is white—it’s not smoke, it’s steam.

**Controlling Emissions From Vehicles** Cars and trucks now contain pollution-control devices. A catalytic converter is a part of the exhaust system that reduces emissions of carbon monoxide, hydrocarbons, and nitrogen oxides. This device causes the gases to react, forming less-harmful carbon dioxide and water. Laws can ensure that people use pollution-control devices. For example, in many states, cars must pass emissions tests to be allowed on the road.

**What You Can Do** You may not think there is much you can do to reduce air pollution. However, even small changes in your behavior can make a big difference.

You can help reduce air pollution by reducing certain types of energy use. Much air pollution is a result of burning fuels to provide electricity and transportation. Using less energy conserves fuel resources and reduces emissions. Turning off lights, computers, and televisions in empty rooms uses less energy and reduces emissions. When you take public transportation, carpool, walk, or ride a bicycle, there are fewer cars on the road. This means there are less emissions that contribute to air pollution.

FIGURE 8 .....

## Your Solutions

 **Communicate** With a partner, list ways you can reduce air pollution in your everyday life.

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# Apple Imports

Apples are grown in an orchard in Chile.



Trucks carry apples from the orchard to the airport.




Airplanes carry the apples from Chile to the United States.



More trucks bring the apples from the airport to shipping centers and grocery stores around the country.

FIGURE 9

## Where Does an Apple Really Come From?

Many things in our everyday lives, even where food comes from, can contribute to air pollution.  **Analyze Costs and Benefits** Read the comic strip above. Then, fill in the boxes with pros and cons of buying apples that were grown locally instead of those grown in another country.

**Pros**

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**Cons**

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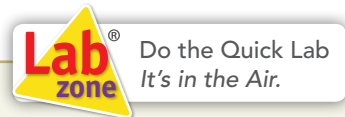
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### Assess Your Understanding got it?

I get it! Now I know the key to reducing air pollution is \_\_\_\_\_




I need extra help with \_\_\_\_\_



6.ESS3.2, 6.ESS3.3

# Water Pollution and Solutions



-  Why Is Fresh Water a Limited Resource?
-  What Are the Major Sources of Water Pollution?
-  How Can Water Pollution Be Reduced?

## my planet DiARY

### A Flood of Sludge

In December 2008, over 4.5 billion liters of polluted water flooded the area around Kingston, Tennessee. A nearby coal-powered electric plant produced polluted water containing arsenic, lead, and other toxic chemicals. The toxic chemicals and coal ash mixed with water in a holding pond to form a thick sludge. When the dam holding back the pond broke, the water poured into rivers. The sludge water spilled over the land, damaging trees, homes, and other buildings.

Local residents feared the flood would be dangerous to their health as well.

## DISASTERS

**Communicate** Discuss the question with a group of classmates. Then write your answer below.

Is water pollution a problem in your community? Why or why not?



Do the Inquiry Warm-Up  
How Does the Water Change?

## Why Is Fresh Water a Limited Resource?


Most of Earth's surface is covered by some form of water. Oceans cover nearly three fourths of Earth's surface. Around the poles are vast sheets of ice. From space you cannot even see many parts of Earth because they are hidden behind clouds of tiny water droplets. There seems to be so much water—it's hard to believe that it is a scarce resource in much of the world.

## Vocabulary

- groundwater
- pesticide
- sewage
- sediment

## Skills

- 🎯 Reading: Outline
- 🔺 Inquiry: Design Experiments


How can water be scarce when there is so much of it on Earth's surface?  **Water is scarce on Earth because most of it—about 97 percent—is salt water.** Salt water cannot be used for drinking or watering crops. Also, about three quarters of the fresh water on Earth is ice. Most liquid fresh water is **groundwater**, water stored in soil and rock beneath Earth's surface. People use groundwater for drinking, but it is not always found near where people live. Cities in dry areas may draw their drinking water from hundreds of kilometers away.

**Renewing the Supply** Fortunately, Earth's fresh water is renewable. Remember that water continually moves between the atmosphere and Earth's surface in the water cycle. Even though fresh water is renewable, there is not always enough of it in a given place at a given time.

**Water Shortages** Water shortages occur when people use water faster than the water cycle can replace it. This is likely to happen during a drought when an area gets less rain. Many places never receive enough rain to meet their needs and use other methods to get water. Desert cities in Saudi Arabia get more than half of their fresh water by removing salt from ocean water, which is very expensive.

FIGURE 1 .....  
**Water**

Most of Earth's surface is covered with water, but fresh water is still a limited resource.

 **Identify** Reread the text. Then, underline the reasons why fresh water is scarce.

## Assess Your Understanding

got it? .....

I get it! Now I know that fresh water is limited on Earth because \_\_\_\_\_

I need extra help with \_\_\_\_\_



Do the Quick Lab  
Where's the Water?

## What Are the Major Sources of Water Pollution?

Since fresh water is scarce, water pollution can be devastating. 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 water pollution is the result of human activities. Wastes produced by agriculture, households, industry, mining, and other human activities can end up in water.** Water pollutants can be point or nonpoint pollution sources, classified by how they enter the water. A pipe gushing wastewater directly into a river or stream is an example of a point source. The pipe is a specific pollution source that can be easily identified. Nonpoint pollution sources include farm, street, and construction site runoff. The exact pollution source is hard to trace and identify.

FIGURE 2 .....

### Farm Pollution

This scene may show common things found on a farm, but even common things can lead to water pollution.

 **Relate Text and Visuals**

Circle the potential sources of water pollution in this scene.

**Agricultural Wastes** Animal wastes, fertilizers, and pesticides are also sources of pollution. **Pesticides** are chemicals that kill crop-destroying organisms. Rain washes animal wastes, fertilizers, and pesticides into ponds, causing algae to grow. The algae block light and deplete the oxygen in the pond.

**Household Sewage** The water and human wastes that are washed down sinks, showers, and toilets are called **sewage**. If sewage is not treated to kill disease-causing organisms, the organisms quickly multiply. People can become ill if they drink or swim in water containing these organisms.




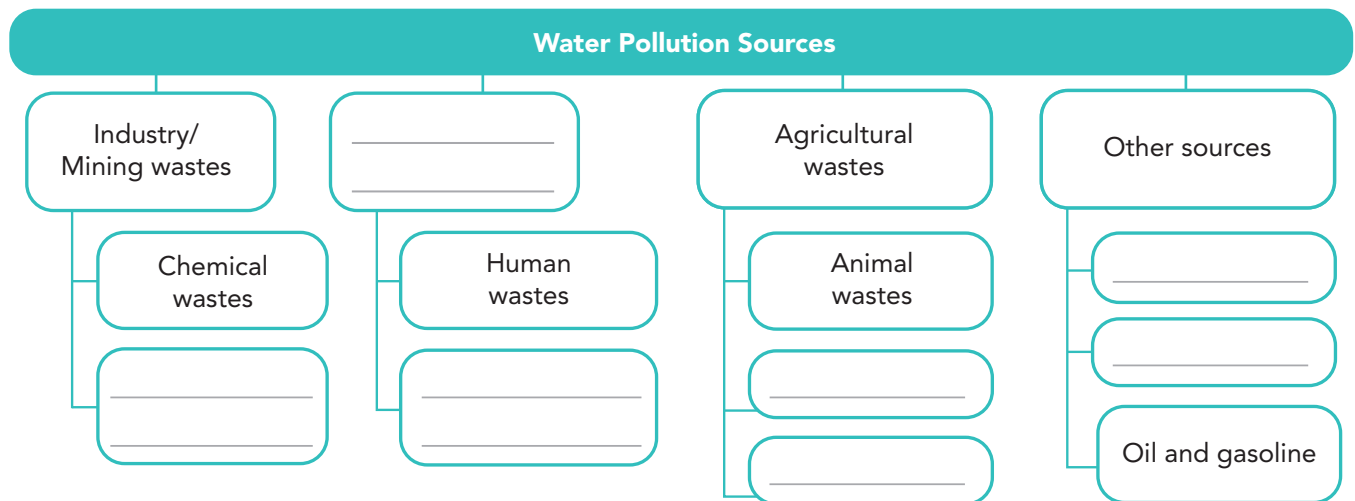
**Industry and Mining Wastes** Some plants, mills, factories, and mines produce wastes that can pollute water. Chemicals and metal wastes can harm organisms that live in bodies of water. Animals that drink from polluted bodies of water or eat the organisms that live in the water can also become ill.

**Sediments** Water that causes erosion picks up **sediments**, or particles of rock and sand. Sediments can cover up the food sources, nests, and eggs of organisms in bodies of water. Sediments also block sunlight, preventing plants from growing.

**Heat** Heat can also have a negative effect on a body of water. Some factories and power plants release water that has been used to cool machinery. This heated water can kill organisms living in the body of water into which it is released. This type of pollution is also known as thermal pollution.

**Oil and Gasoline** An oil spill is a very dramatic form of water pollution. It can take many years for an area to recover from an oil spill because the oil floats on water and is difficult to collect. Another water pollution problem is caused by oil and gasoline that leak out of damaged underground storage tanks. The pollution can be carried far away from a leaking tank by groundwater.

 **Outline** Look back in the text and fill in the graphic organizer below to outline causes of water pollution.



Do the Quick Lab  
Cleaning Up Oil Spills.

 **Assess Your Understanding**

**got it?** .....

I get it! Now I know that the major sources of water pollution include \_\_\_\_\_

I need extra help with \_\_\_\_\_



# How Can Water Pollution Be Reduced?

By working together, governments, industries, and individuals can improve water quality. Federal and state laws in the United States regulate the use of certain substances that can pollute water.

**🔑 The keys to keeping water clean are effective cleanup of oil and gasoline spills, proper sewage treatment, and reduction of pollutants.** There are also some important ways that people can reduce water pollution at home.

**Cleaning Up Oil and Gasoline Spills** Nature can handle oil in small amounts. A natural cleaning process slowly takes place after oil spills. Certain bacteria living in the ocean feed on the oil. Of course, oil can cause much damage to an area in the time it takes the bacteria to work, so people often help clean up large spills. The hard work of many scientists and volunteers can minimize environmental damage from large spills.

Gasoline or oil that leaks from an underground tank is hard to clean up. If the pollution has not spread far, the soil around the tank can be removed. But pollution that reaches groundwater may be carried far away. Groundwater can be pumped to the surface, treated, and then returned underground. This can take many years.

FIGURE 3 .....

## Wastewater Treatment

There are several steps to proper sewage treatment.

**✎ Sequence** Put the steps of proper sewage treatment in order by writing the numbers one through four in the circles.

○ Bacteria break down wastes.

○ Water is filtered to remove solids.

○ Water is treated with chlorine.

○ Heavy particles settle in tank.



**Reducing Pollutants** Instead of releasing wastes into the environment, industries can recycle their wastes. Once such programs are underway, companies often find they save money as well as reduce pollution. Other companies change their processes to produce less waste or less-harmful waste by using fruit acids as cleaning agents instead of toxic chemicals.

**What You Can Do** It is easy to prevent water pollution at home. Some common household water pollutants are paints and paint thinner, motor oil, and garden chemicals. You can avoid causing water pollution by never pouring these chemicals down the drain. Instead, save these materials for your community's next hazardous waste collection day.

did you know?

The Exxon Valdez oil tanker spilled 40.9 million liters of oil into the Pacific Ocean on March 24, 1989. The oil eventually covered 28,000 square kilometers of ocean!

**apply it!**

Bacteria can be used to clean up oil spills. Some companies specialize in creating bacteria for cleaning up oil.

**1 Analyze Costs and Benefits** Fill in the boxes with some pros and cons of using bacteria to clean oil spills.

Pros

Cons

**2 Design Experiments** If you were creating bacteria for cleaning oil spills, what characteristics would you want to test the bacteria for? \_\_\_\_\_

# Pollution and Solutions



What can people do to use resources wisely?

FIGURE 4 .....  
All living things depend on land, air, and water. Conserving these resources for the future is important. Part of resource conservation is identifying and limiting sources of pollution.

 **Interpret Photos** On the photograph, write the letter from the key into the circle that best identifies the source of pollution.

## Land

Describe at least one thing your community could do to reduce pollution on land.

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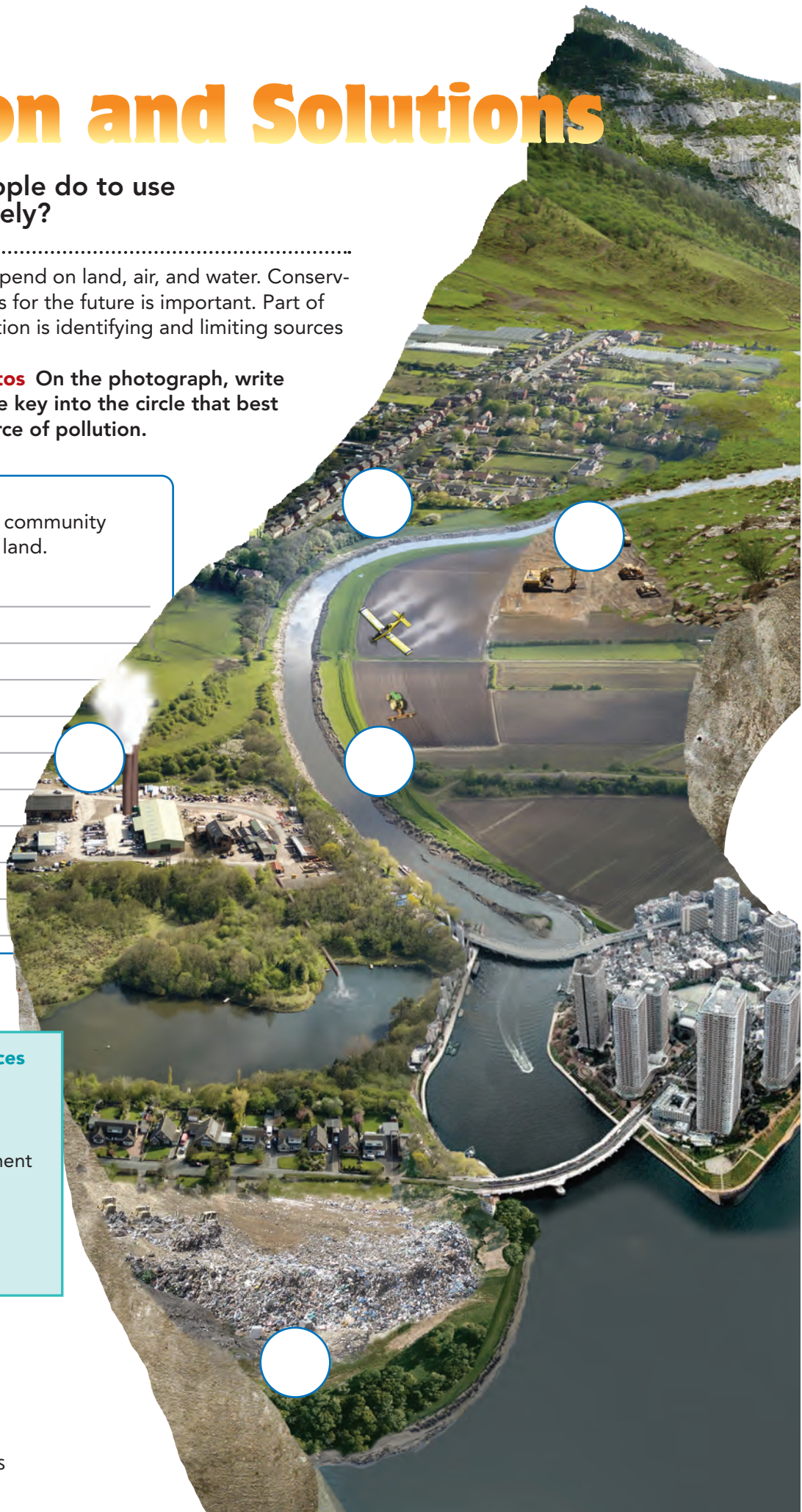
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### Key of Pollution Sources

- A. Sediments
- B. Municipal solid waste
- C. Runoff from development
- D. Emissions
- E. Oil and gasoline
- F. Agricultural wastes



 **Assess Your Understanding**

1a. **Define** What are sediments?

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b. **Explain** How can bacteria help clean an oil spill in the ocean?

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c.  What can people do to use resources wisely?

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d. **CHALLENGE** Why might a company not want to recycle the waste they produce even if it would reduce water pollution?

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**got it?** .....

I get it! Now I know that water pollution can be reduced by \_\_\_\_\_

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I need extra help with \_\_\_\_\_

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**Air**  
Describe at least one thing your community could do to reduce air pollution.

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**Water**  
Describe at least one thing your community could do to reduce water pollution.

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# Study Guide



To use resources wisely, people can reuse or \_\_\_\_\_ materials and they can properly dispose of hazardous wastes and other \_\_\_\_\_.

## LESSON 1 Introduction to Environmental Issues

Environmental issues fall into three main categories: resource use, population growth, and pollution.

To balance opinions, decision makers weigh the costs and benefits of a proposal.

### Vocabulary

- natural resource
- pollution
- point source
- nonpoint source
- environmental science

## LESSON 2 Introduction to Natural Resources

Natural resources include organisms, water, sunlight, minerals, and oil.

Humans depend on Earth's natural resources for survival and for development.

### Vocabulary

- renewable resource
- nonrenewable resource
- sustainable use
- ecological footprint
- conservation

## LESSON 3 Conserving Land and Soil

Three uses that change the land are agriculture, mining, and development.

Without soil, most life on land could not exist. Poor soil management results in three problems: erosion, nutrient depletion, and desertification.

### Vocabulary

- litter
- topsoil
- subsoil
- bedrock
- erosion
- nutrient depletion
- fertilizer
- desertification
- drought
- land reclamation

## LESSON 4 Waste Disposal and Recycling

Solid waste is burned, buried, or recycled.

Recycling categories include metal, glass, paper, and plastic.

Hazardous wastes are stored depending on the type and potential danger.

### Vocabulary

- municipal solid waste
- incineration
- pollutant
- leachate
- sanitary landfill
- recycling
- biodegradable
- hazardous waste

## LESSON 5 Air Pollution and Solutions

A major source of outdoor air pollution is vehicle emissions. Indoor air pollution has a variety of causes.

The major cause of the ozone hole is CFCs.

Reducing air pollution requires reducing emissions.

### Vocabulary

- emissions
- photochemical smog
- ozone
- temperature inversion
- acid rain
- radon
- ozone layer
- chlorofluorocarbon

## LESSON 6 Water Pollution and Solutions

Earth's water is about 97 percent salt water.

Most water pollution is caused by human activities.

The keys to keeping water clean include cleaning oil spills, proper sewage treatment, and the reduction of pollutants.

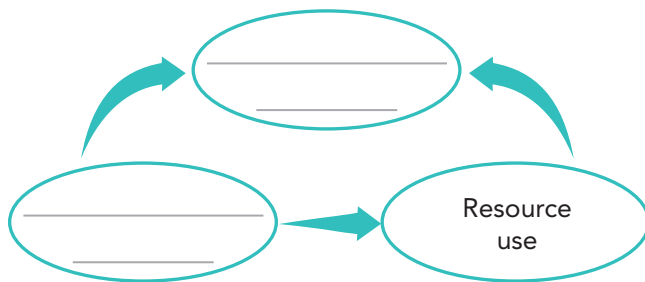
### Vocabulary

- groundwater
- pesticide
- sewage
- sediment

# Review and Assessment

## LESSON 1 Introduction to Environmental Issues

- Coal and sunlight are examples of
  - environmental sciences.
  - pollution.
  - natural resources.
  - extinction.
- \_\_\_\_\_ can take many forms, including chemical wastes, noise, heat, and light.
- Relate Cause and Effect** Fill in the blank circles with the other main categories of environmental issues. How are they related?



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- Write About It** Suppose your town is considering building a new coal-burning power plant. The benefits of the new facility include providing power and jobs for the town's growing population. What are some of the costs of this project? What do you think your town should do?

## LESSON 2 Introduction to Natural Resources

- Which of the following actions can increase an individual's ecological footprint?
  - riding a bicycle more often
  - reducing the use of plastic bags
  - reusing materials before disposal
  - turning on the air conditioner
- Like oil, metals are an example of \_\_\_\_\_
- Apply Concepts** When is water a renewable resource? When is it nonrenewable?

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## LESSON 3 Conserving Land and Soil

- What is an agricultural use of land?
  - growing crops on land
  - collecting water from land
  - building structures on land
  - removing minerals from land
- Plant roots absorb nutrients and water from the layer of soil called \_\_\_\_\_.
- Relate Cause and Effect** What type of land use can result in nutrient depletion? Explain.

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# Review and Assessment

## LESSON 4 Waste Disposal and Recycling

11. What is one benefit of recycling?
- It increases the volume of solid waste.
  - If it is recycled, a material won't biodegrade.
  - It conserves resources and energy.
  - It uses more raw materials that need to be mined.
12. A \_\_\_\_\_ is a waste that can be harmful to human health or the environment.
13. **Write About It** How could your school reduce the amount of municipal solid waste it produces? Include where you think the most waste is produced in your school and propose at least two ways to reduce it.



## LESSON 5 Air Pollution and Solutions

14. Which of the following describes a pollutant that has been released into the air?
- sewage
  - leachate
  - sediment
  - emissions
15. The \_\_\_\_\_ in the upper atmosphere prevents some of the sun's ultraviolet radiation from reaching Earth.
16. **Predict** Do you think the hole in the ozone layer will increase or decrease in size? Why?

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## LESSON 6 Water Pollution and Solutions

17. Why is fresh water a limited resource?
- because most water on Earth is in lakes
  - because most water on Earth is in clouds
  - because most water on Earth is in the ground
  - because most water on Earth is salt water
18. A \_\_\_\_\_ is a chemical that kills crop-destroying organisms.
19. **Draw Conclusions** Rain may wash fertilizers into bodies of water, such as ponds. How might fertilizer affect a pond?

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## What can people do to use resources wisely?

20. Every individual, including young people, can make decisions to use resources wisely. Use the terms *reduce*, *reuse*, and *recycle* to explain how the students in the picture below can help minimize solid waste.




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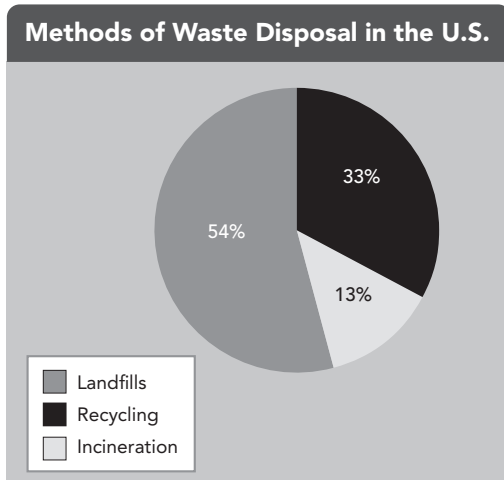
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# TNReady Prep

**6.ESS3.1, 6.ESS3.2, 6.ESS3.3**

Read each question and choose the best answer.

1. According to the circle graph, what is the most common method of waste disposal in the United States?



- A composting      B recycling  
C incineration      D landfills

2. In which layer of soil would you expect to find rock fragments, nutrients, and decaying plant and animal matter?

- A litter              B topsoil  
C subsoil            D bedrock

3. What types of materials could be broken down in a compost pile?

- A all recyclable materials  
B biodegradable materials  
C all materials that can be incinerated  
D glass, metal, and other raw materials

4. How can sediments negatively affect an aquatic ecosystem?

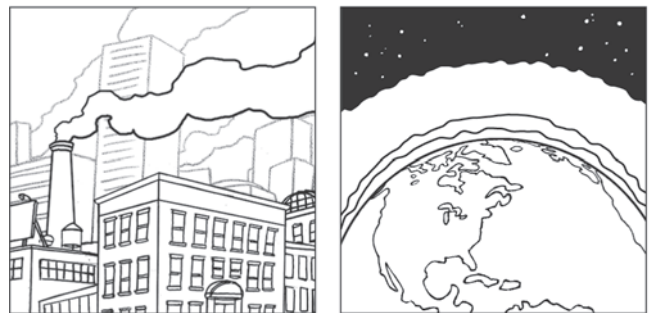
- A by blocking sunlight  
B by causing algae to grow  
C by causing plants to grow  
D by changing the water temperature

5. What are the main sources of ocean pollution?

- A upwellings  
B natural causes  
C human activities  
D waves of sunlight reacting with water

## Constructed Response

Use the diagram below and your knowledge of science to help you answer Question 6. Write your answer on a separate sheet of paper.



6. Compare and contrast the role of ozone in each of the images shown above.



# Please Don't Pass the Plastic!

An ecosystem includes all the plants, animals, and nonliving resources in a given area. The organisms interact with each other and with all the nonliving components of their ecosystem. The flow of nutrients and energy through food chains and food webs is part of how the organisms and nonliving materials interact. But when did plastic—a nonliving, chemical-based, human-made material—enter the food chain?

Only since the 1940s have plastics become part of our everyday life. Today, large numbers of plastic bags, bottles, caps, and other trash end up in streams, rivers, ponds, landfills, and the ocean. Researchers exploring the remotest areas of Antarctica and the deepest sea trenches have found plastic litter and fragments!

Scientists have identified over 180 species that ingest plastic debris. Birds, fish, crustaceans, turtles, mollusks, plankton, and marine mammals are most susceptible to ingesting different-sized pieces of plastic, from large to microscopic. Many more species are at risk of absorbing harmful chemicals that have leached from plastics. Plastic debris may remain undigested inside an animal—filling the stomach or blocking digestive passages, and contributing to illness or even starvation. Organisms may also be choked or injured by getting tangled in plastic bags or strapping.

**Model It** Research how waste plastics spread and build up in different ecosystems and in the food chain. Make models of two ecosystems in different locations, comparing and contrasting the organisms in each model that plastic waste may affect. Suggest ways that humans can keep plastics out of the world's environments.



# THE CONSERVATION PRESIDENT

In 1901, if you wanted to go camping or hiking, you might run into a mine or a logging site. Although a lot of natural space existed in the United States when Theodore Roosevelt became president, the country had only five national parks. Years of uncontrolled mining, logging, and hunting threatened many of the country's natural areas. Roosevelt, at left in the photograph, was a passionate conservationist. He signed laws that protected over 93 million hectares of land in the United States. Today, the area of the United States that is protected as wilderness is greater than the area of France, Belgium, and the Netherlands combined!



**Map It** Create a map of national parks in your state or region. Your map should include interesting details about each park.

Science and History

## Environmental Lawyer



◀ Environmental lawyer Melissa Scanlan finds inspiration from her childhood home in Wisconsin.

As a child, Melissa Scanlan loved boating on the Fox River with her family. As she grew older, she learned that the river was polluted with industrial and agricultural chemicals. Scanlan went to law school and became an environmental lawyer. As a lawyer, she formed Midwest Environmental Advocates—a law firm that helps midwestern communities work with industries and the government to find solutions to local environmental problems. Scanlan says that seeing her work affect the world around her “is like dropping a pebble into water and seeing the rings echo out.”

**Debate It** Research an environmental issue in your region. Choose a possible solution and stage a class debate. Make sure you support your opinion with facts and evidence from your research.

Careers