What You’ll Learn
• Why all populations require natural resources to exist.
• How the use of natural resources affects Earth’s land, air, and water.

Why It’s Important
As a result of increasing human population growth, natural resources are being used at increasing rates. The development and use of natural resources may have impacts upon the environment. Humans need to find ways to extract and use natural resources that minimize these impacts.

To learn more about human impact on natural resources, visit the Earth Science Web Site at earthgeu.com
Your everyday activities require resources. In this activity, you will explore the types of resources that you use and some of the global impacts of using them.

1. Make a pile of 10 to 15 items that you brought into the classroom.
2. Combine your pile with those of two or three other students so that you have about 30 different items.
3. In your science journal, make a data table for your items.
4. For each item, record as much of the following information as you can.
   - What resources were used to make the item?
   - Are the resources renewable or nonrenewable?
   - Where was the item made?

**CAUTION:** Always wear an apron and safety goggles in the lab.

**Observe** How many different resources are represented by the items in your collection? What are the percentages of renewable and nonrenewable resources? Where were each of the objects made?

**Suppose you and some of your friends plan to spend a day at the park. Some of your friends start a volleyball game, while others unpack the cooler and light the barbecue. Later on, maybe all of you will go for a bicycle ride. Did you know that in each of these activities you and your friends would be using natural resources?**

**RESOURCES AND ORGANISMS**
Take a deep breath right now, then let it out again. When you inhale, you take oxygen gas out of the air and into the cells of the blood vessels in your lungs. When you exhale, you release oxygen and carbon dioxide gas and water vapor back into the air. Oxygen, carbon dioxide, and water are examples of natural resources that you, as well as many other living things, use every day.

Like all organisms, you need particular natural resources to maintain life, grow, and reproduce. Among the resources that organisms require are air, food, water, and, in some cases, shelter. To meet their...
basic needs, most organisms are adapted to their immediate environment; they live in a balance with the natural resources their environment provides. For example, songbirds live in grassy meadows, forage for grass seeds to eat, weave nests out of dried grasses and twigs, and drink water from ponds or streams nearby. Painted turtles live in ponds, swamps, and slow-moving streams, where they eat aquatic plants, insects, and other small animals.

Other organisms, however, alter their environment to better meet their needs. For example, beavers build dams across streams to create ponds where none previously existed. Such alteration of the environment has both positive and negative impacts: it kills some trees and displaces both aquatic and terrestrial organisms, but at the same time, it creates a new wetland environment for other organisms. Termites in tropical areas also create environments that are favorable to themselves by building tall mounds. Both a beaver dam and a termite mound, shown in Figure 27-1, alter the environment to provide for the basic needs of the organisms that build them. Many other organisms alter their environments to improve their chances of survival. For example, corals build huge, underwater reefs that provide homes for all kinds of marine organisms. Of all organisms, however, humans have an unequaled capacity to modify their environments. This capacity allows us to live in every terrestrial environment on Earth. As a result, humans also have the greatest impact on Earth’s natural resources.

**Figure 27-1** Some organisms alter their environment to better provide for their needs. In the middle of their newly created ponds, beavers build domed lodges where they live, nest, and raise their young (A). Tropical termites are highly social organisms that live in colonies where each termite has an assigned role that helps the society survive (B).
immediate environment. However, if you were in a closed room crowded with people, there would soon be less oxygen and more carbon dioxide than the amount people are used to. If no additional fresh air entered the room, everyone eventually would become uncomfortable and would leave the room. As any population increases, its demand for natural resources increases as well. Figure 27-2 illustrates what happens when an elephant population exceeds the ability of the environment to provide the necessary natural resources.

Population growth is defined as an increase in the size of a population over time. A graph of a growing population resembles a J-shaped curve at first. Whether the population is one of dandelions in a lawn, squirrels in a city park, or herring gulls on an isolated island, the initial increase in population is small because the number of adults capable of reproducing is low. As the number of reproducing adults increases, however, the rate of population growth increases rapidly. The population then experiences exponential growth, a pattern of growth in which a population grows faster as it increases in size. As shown in Figure 27-3, exponential growth results in a population explosion.

**LIMITS TO POPULATION GROWTH**

If the graph in Figure 27-3 was extended for a longer period of time, what do you think would happen to the size of the population? Would it continue to grow exponentially? Many of Earth’s natural resources are in limited supply, and therefore, most populations cannot continue to grow forever. Eventually, one or more limiting factors, such as the

**Figure 27-2** A large elephant population can damage natural resources, such as forests and riverbeds, which other populations depend upon for survival.

**Figure 27-3** This graph shows a rapid increase over time in the population of bacteria after just a few individuals were added to a petri dish full of necessary nutrients.
availability of food, water, or clean air, will cause a population to stop increasing. This leveling-off of population size results in an S-shaped curve, similar to the one in *Figure 27-4*.

The number of organisms that any given environment can support is its **carrying capacity**. When population size has not yet reached the carrying capacity of a particular environment, there will continue to be more births than deaths. If the population size exceeds the carrying capacity temporarily, the number of deaths will increase, or the number of births will decrease, until the population size returns to the carrying capacity. A population that is at the carrying capacity for its environment is in equilibrium. It continues to fluctuate around the carrying capacity as long as natural resources remain available.

**Environmental Limits** Have you ever seen television or newspaper coverage of the aftermath of a tornado or other violent storm? Storms are environmental factors that limit population growth. Environmental factors that affect population growth, such as storms, extreme changes in temperatures, droughts, floods, and pollution, are **density-independent factors**. These factors affect all populations that they come in contact with, regardless of population size. A flood affects not only the humans whose homes are destroyed, but also trees, birds, and many other populations of organisms.

Other environmental factors that affect population growth, such as disease, parasites, and lack of food, are called **density-dependent factors**. Density-dependent factors increasingly affect a population as the population’s size increases. For example, in a large population members may live close together. This enables disease organisms to spread quickly from one member of the population to another. If a population is very dense, disease may wipe out the entire population.
**Human Population Growth**

No matter where you live, you probably have seen an increase during your lifetime in the number of cars, houses, and roads. The human population on Earth is still growing. As shown in Figure 27-5, the growth curve of the human population is still in the J-shaped stage. The human population is expected to continue to grow for at least another 50 years.

Although the human population has not yet reached the carrying capacity of Earth, the current rate of growth clearly cannot continue forever. As the population continues to increase, human demand for natural resources also will continue to increase steadily. Although humans are not the most abundant species on Earth, our use of natural resources has impacted the environment on a global scale.

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**Section Assessment**

1. Why do populations stop increasing when they reach carrying capacity?
2. Explain why a hurricane is a density-independent factor that limits population growth.
3. Suppose that a small population of bacteria is placed in a petri dish with limited nutrients. Predict how the population will change over time.
4. **Thinking Critically** What might happen if a human population temporarily exceeded the carrying capacity of an area?

**Skill Review**

5. **Making Graphs** Make a graph that extends the human-population growth curve shown in Figure 27-5. Base your graph on the assumption that the carrying capacity of Earth for humans will be reached in the year 2150. For more help, refer to the *Skill Handbook*. 

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**Figure 27-5** A graph of human-population growth still shows a J-shaped curve. What does this graph tell you about the growth of the human population on Earth?
27.2 Human Impact on Land Resources

**OBJECTIVES**

- **Describe** the environmental impact of mineral extraction.
- **Discuss** the environmental problems created by agriculture and forestry, and their solutions.
- **Explain** the environmental impact of urban development.

**VOCABULARY**

- reclamation
- biodiversity
- monoculture
- deforestation
- bioremediation

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How much land do you think is necessary to grow the food and provide the other materials that you consume and use? Each year, a typical person in North America consumes resources equal to the renewable yield from approximately 5 ha (about 12.35 acres) of forest and farmland. Through our use of mineral resources, food, lumber, and living space, humans have a significant impact on Earth’s surface.

**Extraction of Mineral Resources**

Do you spend much time talking on the telephone? Perhaps you use a microwave oven to heat up after-school snacks. Many of the materials in telephones and microwave ovens are derived from land. Modern societies require huge amounts of land resources, including iron, aluminum, copper, sand, gravel, and limestone. Unfortunately, the extraction of these resources often disturbs large areas of Earth’s surface. Finding a balance between the need for mineral resources and controlling the environmental change caused by extraction can be difficult.

**Surface Mining**

Mineral and ore deposits found just beneath Earth’s surface, such as iron, bauxite (aluminum ore), copper, coal, and gold, can be extracted through mining techniques that involve removing huge amounts of overlying soil and rock, as shown in Figure 27-6. Unfortunately, extracting land resources in this way completely changes the landscape.

**Figure 27-6** Surface-mining techniques include strip-mining and open-pit mining. In a coal strip-mine, surface material up to 60-m deep may be removed to expose the coal seam below (A). In an open-pit mine, the mineral resources are extracted from the surface downward, and a gaping hole is gouged into Earth’s surface (B).
Underground Mining Underground mining, also called subsurface mining, is used where mineral resources lie deep under the ground. Underground mining is less disruptive to Earth’s surface than surface mining, but it still has impacts on the environment. For example, although the underground mine in Figure 27-7 cannot be seen, the mountains of waste rock dug from under the ground are clearly visible. Rainwater seeping through these piles of mining waste can dissolve toxic metals as well as other chemicals and move them into nearby streams and rivers, where they will cause water pollution. Although many mining companies build large holding ponds to contain polluted water until it can be treated, these ponds sometimes leak.

Responsible mining companies make efforts to protect the land during mining operations. In the United States, the Surface Mining Control and Reclamation Act of 1977 requires mining companies to restore the land to its original contours and to replant vegetation in the process of reclamation. Figure 27-8 shows a strip-mined area both before and after reclamation. Although reclamation repairs much of the damage that surface mining causes, it can be extremely difficult to restore land to its original contours, as you will discover in the MiniLab on the following page.

Figure 27-7 Much of the material brought to the surface of underground mines is waste material that must be removed before miners can extract the mineral resource.

Figure 27-8 Layers of soil and rock have been stripped away to expose the coal in this strip mine (A). During reclamation, soil and rock are replaced and the area is replanted (B).
AGRICULTURE

In natural ecosystems, such as a forest, many species of organisms interact with one another and with their environment to create a stable ecosystem. For example, scientists have identified as many as 300 species of trees on just 1 ha of land in a tropical rain forest. Even city parks can have a wide variety of different species, called biodiversity. In a recent study of a park in Hartford, Connecticut, scientists found and identified a total of 1369 species of organisms in just one 24-hour period. Ecosystems that have high biodiversity are more stable than those with fewer species because they are able to recover more quickly from harmful events such as disease and drought.

Monoculture When land is cleared for food production, a biologically diverse ecosystem is often replaced with a single plant species, such as corn or wheat. The planting of just one species in a field is called monoculture. Growing a monoculture crop makes it easier for a farmer to sow, fertilize, and harvest a crop, but this efficiency also brings risks. For example, in a monoculture of corn, illustrated in Figure 27-9, a fungus or a parasite that destroys corn can spread rapidly and destroy the entire crop. In contrast, in a field that contains several species of crops, disease organisms cannot spread as quickly because they have a more difficult time finding the target species. Even if the entire corn crop in such a field is eventually lost, the farmer can still harvest the other crops growing in the field.

Figure 27-9 Many farmers in the United States grow just one plant species in their fields.
**Pesticides**  A variety of pesticides, including fungicides and insecticides, have played an important role in boosting food production worldwide by eliminating organisms that destroy crops. However, the use of pesticides has drawbacks. Some pesticides remain in the environment for long periods of time. As they slowly accumulate in the food chain, they may harm beneficial organisms, such as fishes and birds. Some pesticides also kill beneficial insect predators along with destructive insects. When pesticides kill decomposers, such as worms, the overall fertility of topsoil deteriorates. In addition, insect populations can quickly develop resistance to an insecticide, causing some farmers to use ever-increasing amounts in an attempt to control pests. Further problems are created when wind and rain carry pesticides away from a farm and cause pollution in nearby waterways.

**Topsoil**  It can take thousands of years for topsoil to form, and thus, once it is lost, it is hard to replace. Erosion of topsoil occurs when forests or grasslands are cleared for the first time, but even established farms can suffer from the loss of topsoil. As shown in **Figure 27-10**, whenever fields are plowed and the plants whose roots hold the soil in place are removed, topsoil becomes vulnerable to erosion by wind and water. The addition of fertilizers helps replace some of the nutrients that are depleted by topsoil erosion, but there are other substances in topsoil that fertilizers cannot provide. Topsoil contains trace minerals as well as organisms such as earthworms, which aerate the soil and provide space for plant roots to grow, and nitrogen-fixing bacteria, which take nitrogen out of the air and make it available to plants. Topsoil also has an abundance of organic matter, including fecal material from organisms that live in the soil and dead and dying organisms such as grasses and insects. As organic matter decomposes, it releases nutrients back into the soil.

**Figure 27-10**  Plowing a field in preparation for planting can result in the loss of topsoil.
Good farming practices can help conserve topsoil. In no-till farming, the crop residue is left on the field after harvest to hold soil in place. In the spring, seeds are planted right through the crop residue (A). To stabilize the soil and replenish nutrients in a field used for monoculture, farmers plant cover crops such as clover every few years (B).

To maintain the fertility of their land, many farmers use methods that help preserve topsoil, such as those shown in Figure 27-11. When fertilizers are necessary, responsible farmers carefully monitor their use to prevent runoff into streams. Because fertilizers are expensive, farmers also save money by using only as much as the plants require. Methods used by farmers to selectively apply fertilizers where they will provide the greatest benefit include soil analysis, careful mapping of fields, and monitoring of plant growth.

**Forestry**

The clearing of forested land is another way in which topsoil is lost. Worldwide, thousands of hectares of forests are cut down annually to meet the demand for firewood, charcoal, paper, and lumber. In many parts of the world, the clearing of forested land results in deforestation, which is the removal of trees from a forested area without adequate replanting. Deforestation often involves clear-cutting, the complete removal of all the trees in an area. Clear-cutting may result in the loss of topsoil through erosion and in the clogging of nearby streams with excess sediment. Fortunately, the negative environmental impacts of deforestation can be minimized through the practices of selective logging, as shown in Figure 27-12, and the retention of buffer zones of trees along streambeds. In selective logging, workers remove only designated trees rather than clear-cutting an entire forest. This practice reduces the amount of ground left bare and thus helps prevent erosion. In the United States, new logging laws require that buffer zones of trees be left along the banks of streams. Buffer zones of trees slow runoff by catching the sediment that has been eroded from bare ground before it reaches streams.
**Urban Development**

Do you live in the country, or in a town or city? As the human population continues to increase, more and more people live in cities and towns. For example, 70 percent of the population in North America now lives in urban and suburban areas, and an estimated 5 billion people worldwide will be living in cities and towns by the year 2025.

The development of land for the growth of urban areas has many impacts on the environment. When towns and cities expand into rural areas, natural habitats are lost as forests are cleared and wetlands are filled to provide land for roads, houses, and other buildings. When land is prepared for construction, erosion of topsoil often increases until new landscaping can be established.

Development also takes land away from agricultural use, which puts pressure on the remaining farmland for increased production. Other problems are created when concrete and asphalt cover large land areas; because there are fewer opportunities for rainwater to soak into the ground, groundwater supplies are not recharged and flooding increases during heavy rains. Increasing urbanization also produces large volumes of solid waste, as illustrated in Figure 27-13.

Each person in the United States generates an average of 1.5 kg of solid waste per day. Where does it all go? Much of it is buried in landfills. People once thought that because buried waste was out of sight, it was no longer a problem. Many old landfills, however, are creating pollution problems as dangerous chemicals leak out and contaminate water supplies.

Additional contamination occurs as a result of industrial processes. Heavy metals, such as lead and mercury, and poisonous chemicals, such as arsenic, are by-products of many industrial processes and can

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**Solid Waste Generated Each Year**

*Finding Percentages*

If 61 million metric tons of the solid waste generated in the United States each year are reclaimed, and if this represents 28 percent of the total solid waste generated, how much total solid waste is generated in the United States each year?

**Figure 27-13** This graph shows the percentage of solid waste generated by various users of natural resources in the United States annually. Municipal wastes are those wastes contributed by homes and businesses.
pollute the soil and groundwater in urban areas. Some of this type of contamination was caused by industries that operated before the dangers of improper waste disposal were known. However, accidental spills and illegal dumping continue to be sources of contamination. Even though it is possible to clean up contaminated sites, the processes involved in doing so are difficult and extremely expensive.

**Solutions** Although urban development can create many environmental problems, most of these problems can be solved. People are becoming aware of the need to protect the environment, and communities are making increased efforts to do so. For example, developers are often required to place barriers, such as those shown in Figure 27-14, around construction sites to catch sediment from increased erosion. In the United States, wetlands are now recognized as valuable ecosystems and are protected from development. In some cases, if developers destroy a wetland area, they are required to build wetlands somewhere else in return.

Problems associated with waste disposal are more difficult, primarily because the volume of trash is so large. Modern landfills, however, are very different from the dumps of the past; they are carefully designed to minimize leakage of toxic liquids. Impermeable clay or plastic layers are placed beneath a landfill, and each day’s trash is compacted by huge machines and buried under a layer of dirt to reduce volume and eliminate wind-blown trash. Ventilation pipes in landfills release methane and other gases that are generated as the garbage decomposes. A diagram of a modern landfill is shown in Figure 27-15.
Several methods are available for cleaning up industrial toxic-waste sites. In one method, all the contaminated soil is removed and incinerated at temperatures high enough to destroy the toxic chemicals. The drawbacks to this method are that it can be very expensive when large volumes of soil are involved and it also produces toxic ash. Another method that shows great promise is bioremediation, the use of organisms to clean up toxic wastes, illustrated in Figure 27-16. In some cases, naturally occurring bacteria can be found that eat toxic materials and convert them to less-harmful substances. This technique has been especially useful for contamination caused by spilled gasoline and oil.

Figure 27-16 In one type of bioremediation, plants that contain bacterial genes are grown in soils contaminated with toxic compounds. The bacterial genes enable the plants to convert these compounds into nontoxic substances, which the plants then release.

1. What are some of the ways in which mining activities affect the land surface?
2. Compare the positive and negative aspects of pesticide use.
3. What are some of the ways in which urbanization affects the local land environment?
4. Thinking Critically If fertilizers cause environmental damage and are expensive, why do farmers use them?

**Skill Review**

5. **Concept Mapping** Use the following terms to fill in the concept map below to organize the major ideas in this section: erosion, topsoil loss, water pollution, waste rock, and mineral extraction. For more help, refer to the *Skill Handbook*.

   ![Concept Map](image)
OBJECTIVES

• Describe the types and sources of air pollution.
• Differentiate between the greenhouse effect and global warming.
• Sequence the reactions that occur as CFCs cause ozone depletion.
• Identify the causes and effects of acid precipitation.

VOCABULARY

smog
ozone
global warming
acid precipitation

Can you see the haze that seems to hover above the buildings in Figure 27-17? This yellow-brown haze is a type of air pollution called smog, which is a photochemical haze caused by the action of solar radiation on an atmosphere polluted with hydrocarbons and nitrogen oxides mostly from automobile exhaust systems. When smog occurs in a city, the air becomes harmful to breathe, especially for those who already have some difficulty breathing. The major chemical in smog is ozone (O₃), a gas molecule made up of three oxygen atoms. Recall that in the upper atmosphere, solar radiation converts oxygen gas into ozone. Ozone in the upper atmosphere is beneficial because it absorbs and filters out harmful ultraviolet (UV) radiation. However, ground-level ozone is produced when combinations of air pollutants, including nitrogen oxides, carbon monoxide, and hydrocarbons, are exposed to sunlight. Ozone irritates the eyes, noses, throats, and lungs of humans, and it also has harmful effects on plants.

Air pollution also occurs in the form of particulate matter. The solid particles of such materials as ash, dust, pollen, and asbestos fibers range in size from microscopic bits to large grains. When humans breathe in particulates, they can lodge in lung tissues, disrupt normal functions, and cause breathing difficulties and lung disease.
GLOBAL IMPACTS OF AIR POLLUTION

Recently, it has become clear that human activities can affect Earth on a global scale. The global atmospheric effects of air pollution include global warming, ozone depletion, and acid precipitation.

Global Warming Recall from Chapter 14 that the greenhouse effect is a natural phenomenon in which Earth’s atmosphere traps heat in the troposphere to warm Earth. A phenomenon related to the greenhouse effect is global warming, which is the increase in Earth’s average surface temperature. Whereas the greenhouse effect is a natural phenomenon, global warming is partly caused by humans. Human activities, especially the burning of fossil fuels by automobiles, are largely responsible for increased levels of carbon dioxide, which is the main greenhouse gas that causes global warming. Fossil fuels contain carbon, and when they are burned, the carbon combines with oxygen to form carbon dioxide. Since the beginning of the industrial revolution, around 1850, humans have been burning fossil fuels at an ever-increasing rate. Figure 27-18 shows how atmospheric carbon dioxide has increased over the past 250 years.

Studies indicate that Earth’s mean surface temperature has risen about 0.5°C in the last century. Some scientists hypothesize that this warming trend is the result of global warming and predict that global warming could raise average temperatures by 1 to 3.5°C in the next 100 years. Although this may not seem like much of a temperature change, the consequences could be extreme. Wind and rainfall patterns might

![Figure 27-18](image)

**Figure 27-18** The amount of atmospheric carbon dioxide has increased greatly since the 1850s.
change and affect the major agricultural belts. If climate patterns change too rapidly, plant and animal species may be unable to adapt and may become extinct. Glaciers and ice caps could melt, raising the sea level and flooding low-lying areas. Other scientists, however, assert that humans have not kept weather records long enough to tell whether the present rate of global warming is an artificial or a natural phenomenon. They argue that the increase in Earth’s temperature could be part of a natural pattern of climatic change.

**Ozone Depletion** Another global change that is a result of human activity involves the ozone layer in the stratosphere. The ozone layer serves as a protective shield as it absorbs and filters out harmful UV radiation, which has been linked to human eye damage and skin cancer, as well as reduced crop yields. In the early 1970s, scientists first suggested that chlorofluorocarbons (CFCs) could destroy ozone in the upper atmosphere. Although CFCs are stable and harmless near Earth’s surface, scientists now know that they destroy ozone molecules when they migrate into the upper atmosphere, as shown in *Figure 27-19*. Since the mid-1980s, atmospheric studies have detected a thinning of the ozone layer, including an extremely thin area over Antarctica that was publicized in the news media as an “ozone hole.” Because all of the CFCs in the atmosphere were released from old refrigerators, cleaning agents, and propellants in aerosol cans, this ozone depletion is entirely a result of human activity.

*Figure 27-19* Just a few chlorine atoms from CFCs can destroy many ozone molecules.
Acid Precipitation Another major air pollution problem is acid precipitation, which is defined as precipitation with a pH of less than 5.0. Recall from Chapter 3 that pH is a measure of the acidity of a substance on a scale of 0 to 14, with 7 being neutral. Natural precipitation has a pH of about 5.0 to 5.6, which is slightly acidic. Acid precipitation forms when sulfur dioxide and nitrogen oxides combine with atmospheric moisture to create sulfuric acid and nitric acid. Acid precipitation includes acidic rain, snow, fog, mist, gas, and dust. Although volcanoes and marshes add sulfur gases to the atmosphere, 90 percent of the sulfur emissions in eastern North America are of human origin. Figure 27-20 shows a comparison of the different sources of acid precipitation.

The type of acid precipitation that has received the most attention is caused by coal-burning power plants in the midwestern United States. These plants burn coal that contains significant amounts of the mineral pyrite (FeS₂) and other sulfur-bearing compounds. When sulfur-rich coal is burned, large amounts of sulfur dioxide are released. The sulfur dioxide generated by midwestern power plants rises high into the air and is carried by winds towards the eastern coast of the United States and Canada. When acids are carried into wet weather, they become part of the rain, snow, or fog that falls to the ground in areas far from their source.

When acid precipitation makes its way into surface waters, such as lakes, streams, ponds, and rivers, it causes damage to aquatic ecosystems and vegetation. Acid precipitation also affects plants and soil. Although trees in areas affected by acid precipitation usually aren’t killed outright, acid precipitation weakens them so that they become...
more susceptible to damage from insect pests and disease. In addition, acid precipitation depletes the soil of some nutrients needed by plants.

Acid precipitation damages stone buildings and statues, as shown in Figure 27-21, especially those made of limestone, by accelerating the rate of weathering. It also can corrode metal structures such as bridges, thereby shortening their life spans and increasing maintenance costs.

**Reducing Air Pollution**

Air pollution is difficult to control because it travels with the wind; pollution produced in one area travels across borders to neighboring regions. Thus, solving air pollution problems requires the cooperation of both state and national governments. In the last decade, the governments of many nations have met several times in an attempt to reduce global air pollution, especially that caused by carbon dioxide

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**Using Graphs**

**Identify changes in air pollutants** The Clean Air Act of 1972 was an attempt to reduce the amount of air pollution in the United States. The emission rates of six major air pollutants are graphed to the right. Use this graph to answer the following questions.

**Analysis**

1. In 1970, the main source of lead (Pb) air pollution was leaded gasoline. What has happened to the amount of lead emitted into the atmosphere since 1970? What do you think may have caused this change?

2. Modern cars emit significantly fewer air pollutants, such as carbon monoxide and nitrogen dioxides, than cars from the 1970s and earlier. How have the emission rates of these two air pollutants changed since 1970?

**Thinking Critically**

3. If modern cars are more efficient and less polluting, how would you explain the small amount of change in the levels of nitrogen dioxides over the years?
and CFCs. In the United States, Congress has passed laws to reduce air pollution. For example, the 1990 Clean Air Act set specific reduction goals and enforcement policies for many types of air pollution. This act called for the United States to reduce its sulfur dioxide emissions to 50 percent of their 1980 levels by the year 2000, and to reduce emissions of nitrogen oxides as well. You will find out how the amount of air pollutants in the United States has changed since the 1970s in the Problem-Solving Lab on the previous page.

Many coal-burning power plants have installed a device such as the wet scrubber illustrated in Figure 27-22 to reduce emissions of particulate matter and sulfur dioxide. In North America and Western Europe, the use of low-sulfur coal and natural gas have helped to reduce such emissions. However, scientists agree that the most effective way to reduce air pollution is to remove older, highly polluting vehicles from roadways. It is estimated that just 10 percent of the motor vehicles in operation produce 50 to 60 percent of the air pollution generated by gasoline-powered engines. Switching to newer cars with more efficient engines could significantly reduce air pollution throughout the world.

**SECTION ASSESSMENT**

1. Name two forms of pollutants found in air. What are some of the natural and human sources of these pollutants?
2. How is global warming related to the greenhouse effect?
3. How do CFCs cause ozone depletion?
4. What are the effects of acid precipitation on ecosystems?
5. Thinking Critically At some point, humans will run out of inexpensive coal resources to burn for fuel. What impact might this have on global warming?

**SKILL REVIEW**

6. Predicting The atmosphere of Venus is 90 percent carbon dioxide. Based on this information, what could you infer about the average surface temperature of Venus? Explain your answer. For more help, refer to the Skill Handbook.
Humans depend on water in many ways. In 1995, the United States consumed 378 billion L of water per day. Since 1960, freshwater use has nearly doubled, and the demand is expected to continue to increase. Most people use freshwater in their homes for bathing, drinking, cooking, and washing. The irrigation of crops also requires water, but much of it is wasted because it often evaporates or seeps into the ground before it can be used by crops. Still, the greatest demand on water supplies comes from industry, including power plants that use water for cooling purposes. Figure 27-23 shows how water supplies in the United States are distributed among users.

Because water supplies are not distributed evenly on Earth, some areas have less water than is needed. When water supplies are limited, conflicts occur between the needs of people and the needs of other users, including wildlife.

**WATER POLLUTION**

Pollution is another area in which humans have an impact on water supplies. Some supplies of water have been polluted by human activities and are no longer usable. Water-pollution sources are grouped into two main types. **Point sources** generate pollution from a single point of origin, such as a sewage-treatment plant or an industrial site, while **nonpoint sources** generate pollution from widely spread areas.

**Vocabulary**

- point source
- nonpoint source

**Figure 27-23** This graph illustrates the percentage of total water supplies used for various purposes in the United States.
**Point Sources** Common point sources of water pollution include bacteria and viruses that enter water systems through improper disposal of sewage, and toxic wastes that enter streams from both illegal dumping and accidental spills. In addition, industries that divert water from streams to use in manufacturing processes may return polluted water to the streams, as shown in Figure 27-24.

**Nonpoint Sources** Rainwater, a nonpoint source of water pollution, absorbs air pollutants and may become acidic itself. Rainwater also dissolves pesticides and fertilizers and carries them into streams as it drains from farms and lawns. Runoff from roads and parking lots that includes oil, gasoline, and other chemicals is another nonpoint source of water pollution.

**Pollution of Groundwater** Leaking chemical-storage barrels, underground gasoline-storage tanks, landfills, road salts, nitrates from fertilizers, sewage from septic systems, and other pollutants can seep into the ground and foul underground water supplies. Polluted groundwater may find its way into the drinking-water supplies of people who rely on wells. Once groundwater is contaminated, the pollutants can be very difficult to remove.

**Pollution in the Oceans** Although human activities have the greatest impact on freshwater supplies, pollution of ocean waters is also a concern. For years, it was thought that the oceans were so big that human activities could not affect them. This may be true for the oceans as a whole, but it is not true for near-shore regions. Nearly 50 percent of the U.S. population lives near coastlines in areas such as San Francisco, shown in Figure 27-25. Pollutants from such cities often end up in estuaries and other near-shore regions.

Sewage water is a major source of near-shore pollution around coastal areas. Even after treatment, human waste-water contains high levels of nitrogen and phosphorus. These nutrients can create blooms of cyanobacteria that later die and use up the oxygen in the water as they decompose. Some coastal cities dispose of their untreated sewage by pumping it through pipelines that run along the ocean floor and extend far out into the ocean. This practice can create large dead zones on the ocean floor where there are no living organisms. You will identify possible types and sources of pollution along a hypothetical coastline in the Mapping GeoLab at the end of this chapter.
REDUCING WATER POLLUTION

In recent decades, many steps have been taken to prevent and reduce water pollution as people have found that it is much cheaper and more efficient to prevent pollution than it is to clean it up later. Two major laws have been passed in the United States to combat water pollution: the Safe Drinking Water Act and the Clean Water Act. The Safe Drinking Water Act of 1974 was designed to ensure that everyone in the United States has access to safe drinking water. Progress is being made, but many water supplies still do not meet the standards consistently. In 1998, 20 percent of public water supplies were in violation of the act at least once in a one-year period. The goal of the Safe Drinking Water Act is to reduce this number to less than 5 percent by the year 2005.

The Clean Water Act of 1972 is the primary federal law that protects our nation’s waters. The act was amended in 1977, 1981, and again in 1987. The two main goals of the Clean Water Act are to eliminate discharge of pollutants into rivers, streams, lakes, and wetlands, and to restore water quality to levels that allow for recreational uses of waters, including fishing and swimming. One positive result of this act is shown in Figure 27-26.

Is the Clean Water Act working? Since 1972, the number of people served by sewage-treatment plants has increased from 85 million to 190 million. During that same time period, the annual rate of wetland losses has decreased from 146,000 ha to about 32,000 ha. Two-thirds of the nation’s waters are now safe for swimming and fishing, compared to only one-third in 1972. However, more improvements must be made; in 1998, 35 percent of U.S. rivers and streams were still in violation of established water-quality levels at some point during that year.

WATER CONSERVATION

When there is not enough water to go around, populations have two choices: decrease demand or develop new supplies. In many cases, new supplies are not readily available or may be too expensive to develop. Therefore, water conservation is the most common solution to excessive demand. Because irrigation can waste so much water, efficient irrigation practices can greatly reduce the demand for water. Landscaping with plants that require less water, as illustrated in Figure 27-27, monitoring soil moisture, improving delivery systems, and raising water prices have all been effective in minimizing the amount of water used for irrigation. Industries can also conserve...
water; many are developing ways to recycle cooling water and wastewater, especially when they are charged high rates for water usage. Manufacturing processes often can use recycled water, or they can be redesigned to conserve water.

Is there a leaky faucet in your home? In the United States alone, 20 to 35 percent of the water taken from public water supplies is lost through leaky pipes, toilets, bathtubs, and faucets. Some cities don’t even have water meters to measure, and thus charge for, the public water that households use. Not surprisingly, when water meters were introduced in Boulder, Colorado, the use of water was reduced by more than 30 percent. People tend to fix leaks and conserve water when they have to pay for it. If every person used a little less water, the water conserved would add up to a large volume. Installing more efficient showerheads, as shown in Figure 27-28, and toilets is just one way to decrease personal water consumption. Consider how you use water. What are some of the ways you might conserve water in your everyday life?

**Figure 27-27** In arid and semiarid areas, landscaping may include plants adapted to a dry climate. This form of landscaping is called xeriscaping, for the Greek word xeros, meaning “dry.”

**Figure 27-28** Many communities offer low-flow showerheads like these to their residents at low cost to help conserve water.

### Section Assessment

1. What are some of the ways in which surface water can be polluted?
2. What are some ways to minimize the need for irrigation?
3. How might residents of a city reduce water consumption?
4. What are some of the positive impacts of the Clean Water Act?
5. **Thinking Critically** Which type of pollution is easier to eliminate, point source or nonpoint source? Give an example of each type and explain how it might be controlled.

### Skill Review

6. **Interpreting Graphs** Based on the graph in Figure 27-23, what percentage of water supplies in the United States is used to provide you with food and the electricity needed to cook it? For more help, refer to the Skill Handbook.
Problem
How can the residents of Iris City identify the source of local water pollution?

Materials
metric ruler
pencil

Preparation

Iris City and the surrounding region are shown in the map on the facing page. Iris City is a medium-sized city of 100,000. It is experiencing many types of environmental impacts. Study the map and the information given to identify these problems and possible solutions.

1. Iris City obtains its drinking water from Opal Lake. Studies of the lake have detected increased levels of nitrogen, phosphorus, hydrocarbons, sewage, and silt. The northwest end of Opal Lake is experiencing increased development, while the remainder of the watershed is a mix of forest and logging clear-cuts.

2. Last spring, blooms of cyanobacteria choked parts of the Vista Estuary Nature Preserve. Commercial shellfish beds in Iris Bay have been closed because of sewage contamination.

3. A natural-gas power plant has been proposed for location A, near the Vista Cutoff, an abandoned channel of the Vista River. The plant would provide jobs as well as generate electricity. The company plans to divert 25 percent of the Vista River down the Vista Cutoff.

4. The Lucky Mine was abandoned 60 years ago. A mining company has applied for permits to reopen the mine. An estimated 1 million ounces of gold can be recovered using modern techniques.

Procedure

1. What are some possible sources of water pollution in Opal Lake? What steps might the residents of Iris City take to protect their drinking water?

2. How are the blooms of cyanobacteria and the closing of the shellfish beds in Iris Bay related?

Analyze

3. What are the positive and negative aspects of diverting water from the Vista River through the Vista Cutoff?

4. If the Lucky Mine is reopened, what effects might it have on the populations of Carlton, Vista, and Iris City?
1. Identify the sources of water pollution in Iris Bay. Are these point or nonpoint sources of pollution?
2. How could you identify the source of pollution causing cyanobacteria blooms in the Vista Estuary?
3. If the Vista Cutoff is used to divert water from the Vista River, how will the aquatic habitats of the river be affected?
4. If the Lucky Mine is reopened, what could the mining company do to minimize negative environmental impacts?
Methane Hydrates: Hope or Hype?

On April 4, 2000, the United States Congress passed a bill providing nearly $50 million for the research of a new fuel. This new fuel has more than twice the energy potential of all other fossil fuels combined. In addition, the new fuel is plentiful throughout the world. This new fuel could allow many countries to reach energy independence in the new century.

This new fuel is called methane hydrate. Methane hydrates are molecules of frozen methane gas captured inside crystals of regular ice. Many methane hydrate deposits are found deep within the permafrost in arctic regions. Methane gas released when dead plants and animals decay becomes frozen within the ice. Larger deposits of methane hydrates are found under the oceans, particularly along the continental slopes. Heat generated by tectonic processes is thought to release methane gas. The gas first rises, then freezes deep beneath the oceanic crust.

Something Old

Geologists have known about methane hydrates for a long time. The crystal structure of methane hydrates is strong, but not stable. When a hydrate bed is disturbed, the crystals break down and the methane is released as a gas. The rapid breakdown of the hydrate bed causes areas above the bed to slump. This phenomenon has been a major problem for offshore oil drilling platforms, which need a stable ocean floor to rest upon.

Something New

What’s new is the idea of mining the hydrates from permafrost or from beneath the ocean floor. Fluctuations in fuel prices have led to an interest in harvesting the energy from this source. Research is underway in Japan, India, Canada, and the United States to develop ways to tap into the methane hydrate beds and remove useful amounts of the fuel. The instability of the hydrates is the biggest stumbling block. The hydrates must either be kept stable and frozen all the way to the processing area to avoid unwanted releases of methane, or the released gas must somehow be captured on-site.

What are the drawbacks to methane hydrates? First, removing hydrates from the seafloor may cause massive slumping along the continental shelves. Second, methane hydrates are fossil fuels, and burning them would cause the same environmental problems as the burning of other fossil fuels. Third, a disruption of the methane hydrate beds might release a large bubble of methane. Scientists have discovered that just such a “big burp” of methane, released 55 million years ago, led to climatic changes and a major extinction of deep-sea species.

Activity

Research and report on the potential advantages and disadvantages of the use of methane hydrates as fuel. Why are scientists interested in using methane hydrates? How might slumping impact the coastal environment?
### Summary

#### SECTION 27.1 Populations and the Use of Natural Resources

**Main Ideas**
- All organisms use resources to maintain their existence. The use of these resources has an impact on the environment.
- As populations increase, the demand for resources also increases. Because resources are limited, populations eventually will reach the carrying capacity of the environment and stop growing.
- At early stages, populations grow exponentially. Earth is currently experiencing a human population explosion.

**Vocabulary**
- carrying capacity (p. 714)
- density-dependent factor (p. 714)
- density-independent factor (p. 714)

#### SECTION 27.2 Human Impact on Land Resources

**Main Ideas**
- Modern societies require large amounts of land resources. The extraction of land resources can disrupt Earth’s surface.
- Growing populations increase the demand for food. Food production can cause habitat loss, erosion, and water pollution.
- Urban development causes habitat loss, increased erosion, and pollution of nearby areas.
- The impact of using land resources can be minimized through the use of modern techniques.

**Vocabulary**
- biodiversity (p. 718)
- bioremediation (p. 723)
- deforestation (p. 720)
- monoculture (p. 718)
- reclamation (p. 717)

#### SECTION 27.3 Human Impact on Air Resources

**Main Ideas**
- Many human activities create air pollution. Air pollution can cause human health problems.
- Humans have affected Earth’s atmosphere on a global scale. Acid precipitation, ozone depletion, and global warming are all caused by human activities.

**Vocabulary**
- acid precipitation (p. 727)
- global warming (p. 725)
- ozone (p. 724)
- smog (p. 724)

#### SECTION 27.4 Human Impact on Water Resources

**Main Ideas**
- Humans require freshwater to live. In some regions, there is not enough freshwater to meet the demand. Conservation of existing supplies is the best way to stretch supplies of freshwater.
- Human activities can pollute freshwater supplies and render them unusable.
- The Safe Drinking Water Act and the Clean Water Act are two sets of laws designed to decrease water pollution in the United States.

**Vocabulary**
- nonpoint source (p. 730)
- point source (p. 730)
1. What is the rapid growth rate of a population after a period of slow growth called?
   a. exponential growth  
   b. overconsumption  
   c. a point source  
   d. the carrying capacity  

2. Which of the following consumes the largest amount of freshwater in the United States?
   a. sewage-waste disposal  
   b. irrigation  
   c. drinking water  
   d. industrial uses  

3. What is the use of organisms to help clean up pollution called?
   a. the greenhouse effect  
   b. reclamation  
   c. recycling  
   d. bioremediation  

4. What type of pollution comes from multiple places?
   a. point source  
   b. nonpoint source  
   c. irrigation  
   d. reclamation  

5. What is the process in which a mining company restores the land after mineral extraction?
   a. bioremediation  
   b. reclamation  
   c. pollution  
   d. open-pit mining  

6. Which of the following is a gas molecule composed of three oxygen atoms?
   a. nitrogen oxide  
   b. ozone  
   c. sulfur dioxide  
   d. smog  

7. Which of the following is the primary source of carbon-monoxide air pollution?
   a. motor vehicles  
   b. volcanoes  
   c. urban development  
   d. power plants  

8. Which of the following gases is (are) responsible for ozone depletion in the upper atmosphere?
   a. chlorofluorocarbons  
   b. carbon dioxide  
   c. sulfur dioxide  
   d. carbon monoxide  

9. What is the variety of species in a habitat called?
   a. biodiversity  
   b. monoculture  
   c. bioremediation  
   d. biology  

Use the following graph to answer questions 10 through 13.

**Solid Wastes Generated Annually in the U.S.**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining and oil and gas production</td>
<td>75%</td>
</tr>
<tr>
<td>Sewage</td>
<td>1%</td>
</tr>
<tr>
<td>Industry</td>
<td>9.5%</td>
</tr>
<tr>
<td>Agriculture</td>
<td>13%</td>
</tr>
<tr>
<td>Municipal</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

10. What activity is the largest producer of solid wastes in the United States each year?

11. What source produces the smallest amount of solid wastes in the United States each year?

12. What is the total percentage of solid waste produced by industry and resource extraction activities in the United States each year?

13. If you wanted to reduce the total amount of solid wastes produced each year, in what area would you concentrate your efforts? Why?

**Test-Taking Tip**

**ROOT WORDS** Use roots to learn. Roots can help you group words together as you learn them. If you learn that *bene-* means “good” as in beneficial, you can then group new words such as benefit, benefactor, and benevolent with beneficial, a word you already know.
Applying Main Ideas

14. What causes populations to experience periods of explosive growth?
15. What will happen to human population numbers as carrying capacity is approached?
16. How do mining companies protect the environment when they extract mineral resources?
17. What are some of the risks of planting a monoculture?
18. What steps are taken in modern landfills to reduce environmental pollution?
19. Explain why a hurricane is a density-independent factor in limiting population size, whereas a new disease such as the Ebola virus is density-dependent.
20. Why do farmers who use chemical pesticides to control pests have to increase the amount applied to their fields each year?

Thinking Critically

21. What are some of the environmental costs involved in developing a new gold mine, and how might this affect the decision to open the mine?
22. Why is ground-level ozone worse on a sunny weekday than on a sunny weekend?
23. If midwestern power plants generate most of the air pollution, why does most acid precipitation fall in the northeastern United States?
24. How does urban development impact coastal waters?
25. What would be some of the positive environmental effects of reducing consumption of electricity?

Standardized Test Practice

INTERPRETING DATA Use the graphic below to answer the following questions.

1. Which area of Brownsville is most likely to have problems with flooding during heavy rains?
   a. I  b. II  c. III  d. IV

2. Which area of Brownsville is most likely to have problems with nonpoint source pollution from fertilizer runoff?
   a. I  b. II  c. III  d. IV

3. If Brownsville County decided to clear area I in order to expand area III, Brownsville might develop problems with topsoil erosion and pesticide pollution. What might be one way to minimize harmful effects?
   a. deforestation  c. monoculture
   b. clear-cutting  d. selective logging

4. What will happen if the size of Brownsville’s human population reaches the carrying capacity for its environment?
   a. There will be more births than deaths.
   b. The death rate will increase and the birth rate will increase.
   c. The population will reach equilibrium.
   d. There will be no more births until the death rate increases.
Resources and the Environment

Earth Resources

Resources Natural resources, which include air, water, land, organisms, rocks, minerals, and nutrients, are resources that Earth provides. Geochemical cycles that move substances through Earth’s hydrosphere, lithosphere, biosphere, and atmosphere are also natural resources. Renewable resources, which include living things, surface water, groundwater, fertile soil, air, solar energy, and elements that cycle such as carbon and nitrogen, are replaced by natural processes at a rate that is at least equal to the rate at which they are used. Nonrenewable resources exist in fixed amounts in Earth’s crust and can be replaced only by geological, physical, or chemical processes that take hundreds of millions of years. Nonrenewable resources include fossil fuels, such as coal and petroleum, and elements such as gold, copper, and silver. Natural resources are not distributed evenly on Earth.

Land Resources Land resources include topsoil, rocks, minerals, and space for agriculture, housing, roadways, and protected areas such as wildlife refuges and national parks. In the United States, 42 percent of the land is protected from some uses. Topsoil is a mixture of decaying organic matter, eroded rock, minerals, nutrients, oxygen, and water. It takes thousands of years for topsoil to form, yet poor farming practices and erosion can lead to its rapid loss and even to the formation of deserts. Bedrock is unweathered parent rock, which is used in buildings and monuments. Aggregates such as sand, gravel, and crushed stone, are used in construction. An ore is a natural resource that can be mined at a profit. Ores may be associated with igneous rocks or formed by processes at Earth’s surface. Some uses of land resources may have negative effects on the environment.

Air Resources Earth’s atmosphere is mostly composed of nitrogen and oxygen, with small amounts of other gases. Early in Earth’s history, its atmosphere had no oxygen; over time, oxygen was provided by photosynthetic organisms. When human activities disrupt the balance of the geochemical cycles in Earth’s atmosphere, pollution results. Both indoor and outdoor pollution are harmful. Outdoors, pollutants can be transported, diluted, transformed, or removed. Indoor air pollutants remain trapped, resulting in “sick” buildings.
**Water Resources**  Only three percent of the water on Earth is freshwater and it is continually recycled through the water cycle. Water has unique properties that allow life to exist on Earth. It is a liquid over a wide range of temperatures, has high heat-storage capacity, dissolves many substances, and expands when it freezes. Because water is not evenly distributed on Earth, water management techniques and plans are developed to ensure a continuing supply. Management methods include building dams and reservoirs, transporting surface water, tapping groundwater, and desalinating seawater.

**Energy Resources**

The Sun is Earth’s primary energy source. The Sun’s energy is transferred from photosynthetic organisms to all other living things. Materials from living things have been used as fuels throughout history. Renewable biomass fuels release energy when they are burned, decomposed, or digested, and thus produce heat and electricity. Wood still serves as a fuel for over half of the world’s population. Field crops such as hay, corn, straw, and sugar cane are also used as fuels. Fossil fuels, such as coal and petroleum, formed from organisms that lived millions of years ago. The burning of fossil fuels releases sulfur into the atmosphere and causes air pollution. As ancient organisms died and settled to the bottom of swamps, their remains partially decayed and formed peat. When the peat was subjected to high temperatures and pressure, coal formed. Types of coal include lignite, bituminous coal, and anthracite.

Natural gas and petroleum formed from accumulations of ancient organic material, primarily plankton, in shallow seas. Refined crude oil yields gasoline, kerosene, fertilizer, plastics, lubricants, and medicines.

**Alternative Energy Resources**

Alternative energy resources are those other than fossil fuels. Solar energy is unlimited, but advances in technology are needed to find better ways to collect and store it. Both passive and active solar techniques are used. Hydroelectric power is derived from the energy of falling or moving water and is commonly used in the production of electricity. In coastal areas, tidal power can be used to produce electricity. Geothermal energy is available in certain areas and is a product of Earth’s internal heat. In areas with consistently strong winds, wind is a source of energy. Nuclear energy results when atoms of radioactive elements emit particles in the process known as fission. Technological advances are needed to dispose of or render harmless the dangerous waste products of nuclear energy. Biomass energy comes from the burning, decomposition, or digestion of organic materials such as wood, crops, and animal-waste material. Alcohols that form from biomass can be mixed with fuels such as gasoline to produce gasohol. Biogas, a mixture of methane and carbon dioxide, forms from the decomposition of animal wastes.

**Conservation of Energy Resources**

Energy resources will last longer if conservation and energy efficiency are further developed, so that fewer resources are used to provide more energy. Making vehicles more fuel efficient and improving efficiency in industry and homes will reduce the rate at which natural resources are used. Achieving sustainable energy use will ensure that current and future energy needs are met while guarding against the degradation of our environment.
Humans and Resources

Populations All organisms use resources to exist and the uses of these resources have an impact on the environment. As populations increase, the demand for resources also increases. At first, populations grow exponentially. But because resources are limited, populations eventually reach the carrying capacity of the environment and stop growing. Earth’s current human population explosion has a huge impact on resources and environments.

Impact on Land, Air, and Water The extraction of the mineral resources that modern societies need can disrupt land surfaces and create toxic chemical wastes. Growing populations may increase the demand for food production, which causes habitat loss, erosion, and water pollution. Urban development also causes habitat loss, erosion, and pollution of nearby areas. Many cities are taking steps to preserve habitats, control erosion at construction sites, and clean up pollution. Air pollution causes human health problems. Ground-level ozone is the major component of smog, a type of air pollution common in cities. Humans affect Earth’s atmosphere on a global scale, as demonstrated by acid precipitation, ozone depletion, and global warming. Controlling air pollution requires government help because wind blows air pollution across state and national boundaries. Conservation of existing supplies is the best way to ensure that freshwater is available in areas where there is not enough to meet human needs. Pollution of freshwater supplies comes from sewage, pesticide and fertilizer runoff, and chemical and oil spills. The Clean Air, Safe Drinking Water, and Clean Water Acts are laws designed to decrease pollution in the United States.

A Sustainable Society When the total environmental cost of developing and using a resource is considered, some resources may be uneconomical to develop. Resources will run out if the current rate of consumption is not decreased. For a society to be sustainable, it must manage its resources to minimize demand and environmental impact. Reducing, reusing, and recycling materials decreases the demand for resources.

FOCUS ON CAREERS

Urban Planner
An urban planner develops ideas for how a city will develop and use its land—now and in the future. He or she works with city leaders to make a plan that meets the needs of all citizens. The urban planner examines the need for greenbelts and parks, and determines how traffic will move through an area. Urban planners usually have bachelor’s degrees, and an advanced degree is sometimes necessary.

Vital Statistics

Most Populous Cities: 2003

<table>
<thead>
<tr>
<th>Rank</th>
<th>City</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Mumbai (Bombay), India</td>
<td>12 383 100</td>
</tr>
<tr>
<td>2</td>
<td>Buenos Aires, Argentina</td>
<td>12 116 400</td>
</tr>
<tr>
<td>3</td>
<td>Karachi, Pakistan</td>
<td>10 537 200</td>
</tr>
<tr>
<td>4</td>
<td>Manila, Philippines</td>
<td>10 232 900</td>
</tr>
<tr>
<td>5</td>
<td>Delhi, India</td>
<td>10 203 700</td>
</tr>
<tr>
<td>6</td>
<td>São Paulo, Brazil</td>
<td>10 195 000</td>
</tr>
<tr>
<td>7</td>
<td>Seoul, South Korea</td>
<td>9 630 600</td>
</tr>
<tr>
<td>8</td>
<td>Istanbul, Turkey</td>
<td>9 419 000</td>
</tr>
</tbody>
</table>
## Understanding Main Ideas

1. What are resources called that are replaced by natural processes at a rate that is at least equal to the rate at which they are used?
   - a. nonrenewable resources
   - b. fossil fuels
   - c. renewable resources
   - d. minerals

2. What type of resources are topsoil, rocks, minerals, and space for agriculture, housing, and roadways?
   - a. land
   - b. air
   - c. water
   - d. solar

3. What causes a building to become “sick”?
   - a. outdoor air pollution
   - b. thinning of the ozone
   - c. indoor air pollution
   - d. acid precipitation

4. What types of methods are building dams and reservoirs, tapping groundwater, and desalinating seawater?
   - a. soil conservation
   - b. water management
   - c. transportation
   - d. cleaning up pollution

5. Which of the following is not a type of coal?
   - a. lignite
   - b. bituminous coal
   - c. anthracite
   - d. peat

6. What is the ultimate source of most forms of energy on Earth?
   - a. fossil fuels
   - b. the Sun
   - c. biomass
   - d. tidal power

7. Which of these is not a property of water?
   - a. liquid over wide temperature range
   - b. high heat storage capacity
   - c. contracts when it freezes
   - d. dissolves many substances

8. What happens when populations reach the carrying capacity of the environment?
   - a. They stop growing.
   - b. They explode.
   - c. They grow exponentially.
   - d. They outgrow cities.

9. Acid precipitation, ozone depletion, and global warming demonstrate what type of effects by humans on the atmosphere?
   - a. local
   - b. regional
   - c. national
   - d. global

10. Which of these is a land resource that can be mined at a profit?
    - a. bedrock
    - b. aggregate
    - c. ore
    - d. topsoil

## Thinking Critically

1. Compare and contrast renewable and nonrenewable resources.

2. Describe how gasoline is derived from living things.

3. Explain why governments get involved in controlling pollution.