CHAPTER 7

Global Water Resources and Use

IN THIS CHAPTER

Summary: Water is critical for life. Although much of the world's land has available water, as many as 1 billion people do not have access to safe water. Conservation and distribution of water resources is important to the future of agriculture and the well-being of the world's human and animal inhabitants.

Keywords

✪ Hydrology, reservoir, conservation, residence time, groundwater mining, runoff, infiltration, salinity, soil porosity, watershed, aquifer, water table

Global Water

Although humans live mostly on land, the Earth is a water planet with nearly 72% of its surface covered by 1.3 billion km^3 of water. Deep oceans give us food, trade items, trade routes, recreation, and entertainment. Our bodies are made up of 66% water and require more water daily. We developed in amniotic fluid and can't last over 2 to 3 days without water. We wash ourselves and nearly everything else in water, get much of our food from water (oceans), and travel on water.

> *Hydrology* is the study of the occurrence, distribution, and movement of water on, in, and above the Earth.

Since the beginning of time, the Earth's water has been used over and over. The water you drink today may have once been part of a tropical cove with a *Brachiosaurus* family on the beach nearby. Thanks to water circulation that same water has probably been liquid, solid, and gas many times over geological time.

The Water Cycle

The oceans hold over 97% of the Earth's water, the land masses hold 3%, and the atmosphere holds less than 0.001%. Freshwater is stored in ice caps, glaciers, groundwater, lakes, rivers, and soil. Yearly global precipitation is estimated at more than 30 times the atmosphere's total ability to hold water. Water is quickly recycled between the Earth's surface and the atmosphere. Table 7.1 shows how long water stays in different locations before being recycled.

The oceans are a source for the atmosphere's evaporated moisture. Around 90% is returned to the oceans through rainfall. The remaining 10% is blown across land masses where temperature and pressure changes cause rain or snow. Water, not lost through evaporation and rainfall, balances the cycle through runoff and groundwater flowing back to the seas.

Atmospheric water is thought to be replaced every 8 days. Water in oceans, lakes, glaciers, and groundwater is recycled slowly, often over hundreds to thousands of years.

KEY IDEA

A water *reservoir,* in the atmosphere, ocean, or underground, is a place where water is stored for some period of time.

Some water resources (like groundwater) are being consumed by humans at rates faster than can be resupplied. When this happens, the water source is said to be *nonrenewable.*

Table 7.1 Water is stored for different time periods in different places.

WATER SOURCE	VOLUME (thousands of km^3)	TIME IN LOCATION (average)
Atmosphere	13	8–10 days
Rivers and streams	1.7	16 days
Swamps and marshes	3.6	Months to years
Soil moisture	65	14 days–1 year
Biological moisture in plants and animals	65	1 week
Snow and glaciers	29,000	1–10,000 years
Freshwater lakes	125	1–100 years
Saline lakes	104	10–10,000 years
Shallow groundwater	4,000	Days to thousands of years
Oceans	1,370,000	3,000–30,000 years
Aquifers and groundwater	4,000	10,000 years

Salinity

Salinity levels are written in parts per thousand (ppt) with 1,000 grams salt/1 kg of water. It's estimated that if all the oceans' water were drained, salt would cover the continents 1.5 meters deep. Ocean salinity is about 35 ppt and varies (32 to 37 ppt) as rainfall, evaporation, river runoff, and ice formation affects it. For example, the Black Sea is so diluted by river runoff its average salinity is around 16 ppt.

TIP

When salt water moves into the polar regions, it cools and/or freezes, getting saltier and denser. Since cold, salty water sinks, ocean salinity increases with depth.

Freshwater salinity is usually less than 0.5 ppt. Water between 0.5 and 17 ppt is called *brackish.* The salt content is too high to be drinkable and too low for seawater. In areas such as estuaries, where fresh river water joins salty ocean water, the water is brackish.

Ocean Circulation

Wind pushing the ocean's surface contributes to ocean currents. Differences in water density, salinity, and temperature also augment ocean circulation. Huge currents, called *gyres,* carry water north and south, redistributing heat between the lower and higher latitudes. For example, current flowing south from Alaska keeps San Francisco, California, and the northern Pacific coast cool and misty much of the year.

Redistribution of ocean water is also seen in the Gulf Stream, which carries warm Caribbean water north past Canada's eastern coast to northern Europe. This current contains around 800 times the volume of the Amazon, the world's largest river. When the warm Gulf Stream water gets to Iceland, it cools, evaporates, becomes denser and saltier, and then sinks, creating a deep, powerful, southbound current, which completes the cycle back to the Gulf.

Groundwater

Water found below the Earth's surface is known as *groundwater.* This water fills subterranean spaces, cracks, and mineral pores. Depending on the geology and topography, groundwater is either stored or flows toward streams.

It is sometimes easy to think of groundwater as all the water that has been under the land's surface since the Earth was formed; but remember that nearly all water is circulating through the hydrologic cycle. We will take a closer look at this in Chapter 10.

TIP

The *residence time,* or length of time that water spends in the groundwater portion of the hydrologic cycle, differs a lot. Water may spend as little as days or weeks underground, or as much as 10,000 years. Residence times of tens, hundreds, or even thousands of years are not unknown. Conversely, average river water turnover time, or the time it takes a river's water to completely replace itself, is roughly 2 weeks.

Groundwater is found in one of two soil layers. The layer closest to the soil's surface is called the *zone of aeration,* where spaces between soil particles are filled with both air and water.

Under this surface layer lies the *zone of saturation,* where all the open spaces have become filled with water. The depth of these two layers is often dependent on an area's topography and soil makeup.

KEY IDEA

> The *water table* is found at the upper edge of the zone of saturation and the bottom edge of the zone of aeration.

The water table is the boundary between these two layers. As the amount of groundwater increases or decreases, the water table rises or falls accordingly. Figure 7.1 shows the location of the water table line in relation to other ground layers.

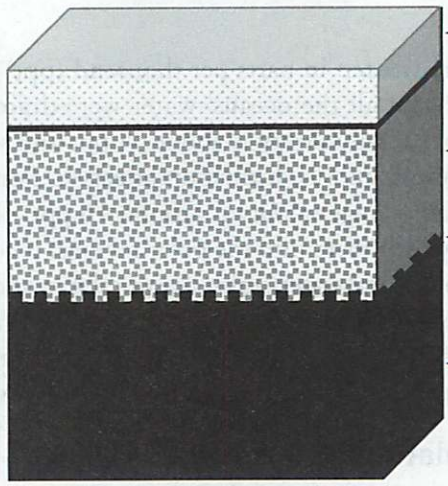

Figure 7.1 The water table is found below the surface between the aerated and saturated zones.

TIP

The amount of open space in the soil is called *soil porosity.* A highly porous soil has many gaps for water storage. The rate at which water moves through the soil is affected by *soil permeability.* Different soils hold different amounts of water and absorb water at different rates.

Hydrologists monitor soil permeability to predict flooding. As soil pores fill, more and more water is absorbed and there are fewer places for the extra water to go. When this happens, rainwater can't be absorbed by otherwise thirsty soil and plants and adds to flood waters. Flooding often happens in the winter and early spring, since water can't penetrate frozen ground. Rainfall and snow melt have nowhere to go and become runoff.

Watersheds

Streams and rivers get their water from hills, valleys, and mountains. The water runs downhill through streams or river beds. During hot months, these beds dry out, but are refilled by rain or melting snow later in the season.

KEY IDEA

> The geographical region from which a stream gets water is called a *drainage basin* or *watershed.*

The boundary between two watersheds is called a *divide.* The Continental Divide in North America is the high line running through the Rocky Mountains. Rainfall and streams on the east side of the Rocky Mountains drain to the Atlantic Ocean or Gulf of Mexico, while flowing water from the western slopes of the Rocky Mountains runs to the Pacific Ocean.

Drainage basins are complex structures with thousands of streams and rivers draining from them, depending on their geographical size. Streams are described by the number of tributaries (other streams) that drain into them. Most streams follow a branching drainage pattern, which is known as *dendritic drainage.*

The United States Geological Survey (USGS) is the main federal agency that keeps records of natural resources and has counted approximately 1.5 to 2 million streams in the United States. These streams have increasingly larger areas of drainage and flow rates. A river is a wide natural stream of fresh water. The Mississippi River, a 10th-order stream, drains 320 million km^2 of land area.

A hydrologist determines flow rates for rivers and streams. This information, important in the design and evaluation of natural and constructed channels, bridge openings, and dams, is a critical factor in understanding water availability and drainage issues.

Aquifers

Groundwater is stored in *aquifers.* Aquifers are large underground water reservoirs. There are two main types of aquifers, *porous media aquifers* and *fractured aquifers.*

Porous media aquifers are made up of individual particles such as sand or gravel. Groundwater is stored in and moves through the spaces between the individual grains.

Permeable soil like sandstone includes lots of interconnected cracks or spaces that are large enough to let water move freely. In some permeable materials, groundwater moves several meters a day, while in other regions water flows just a few centimeters in 100 years.

Fractured aquifers, as the name implies, are made up of broken rock layers. In fractured aquifers, groundwater moves through cracks, joints, or fissures in otherwise solid bedrock. Fractured aquifers are often made of granite and basalt.

TIP

Rainfall soaks into the soil and moves downward until it hits impenetrable rock, at which time it turns and begins to flow sideways. Aquifers are often found in places where water has been redirected by an obstacle such as bedrock.

Groundwater in soil or rock aquifers within the saturated zone adds up to large quantities of water. Aquifers that form a water table separating unsaturated and saturated zones are called *unconfined aquifers* since they flow right into a saturated zone.

Groundwater doesn't flow well through impermeable matter such as clay and shale. Some aquifers, however, lie beneath layers of impermeable materials like clay. These are known as *confined aquifers.* These aquifers do not have a water table separating the unsaturated and saturated zones.

Confined aquifers are more complex than unconfined aquifers that flow freely. Water in a confined aquifer is often under pressure. This causes well water levels to rise above the aquifer's water level. The water in these reservoirs rises higher than the top of the aquifer because of the confining pressure. When the water level is higher than the ground level, the water flows freely to the surface forming a flowing artesian well.

A *perched water table* occurs when water is blocked by a low-permeability material below the aquifer. This disconnects the small, perched aquifer from a larger aquifer below. They are separated by an unsaturated zone and a second, lower water table.

Groundwater returns to the surface through aquifers that empty into rivers, lakes, and the oceans. Groundwater flow, with speeds usually measured in centimeters per day, meters per year, or even centimeters per year, is much slower than runoff.

KEY IDEA

> When water flowing from an aquifer gets back to the surface, it is known as *discharge.*

Groundwater flows into streams, rivers, ponds, lakes, and oceans, or it may be discharged in the form of springs, geysers, or flowing artesian wells.

Water Consumption

Although many people act as if there is an unlimited amount of water available, supply in urban areas can get overloaded from increasing population needs. Withdrawal exceeds local supply, and existing water is often polluted or heated from industrial processes.

KEY IDEA

> *Consumption* is the amount of withdrawn water lost in transport, evaporation, absorption, chemical change, or otherwise made unavailable as a result of human use.

As the global population has increased, human water demand has nearly doubled, especially in developing countries. Average worldwide water use is nearly 650 m^3 (175,000 gallons) per person per year. However, location is everything. In countries like Canada and Brazil with relatively low populations, the withdrawal rate is less than 1% of their annual renewable supply. In the United States, about 40% of the total annual renewable supply is withdrawn, while countries with relatively few freshwater resources like Israel withdraw 100% of their available supply each year.

Groundwater Mining

One issue concerning hydrologists is the depletion of water from aquifers faster than they can be refilled naturally. Humans are the main culprits in aquifer depletion, called *groundwater mining.* Huge volumes of groundwater are pumped out of aquifers for drinking water or irrigation. In fact, over 85% of withdrawn water is used for human and animal consumption in some areas, while 60% of withdrawn water is used for crop irrigation in others. In India, for example, over 90% of withdrawn water is for agricultural use.

When an aquifer is severely depleted in regions with few water resources, water must be rationed. Nonessential water use like lawn watering must be eliminated, and only water for consumption and hygiene allowed so that everyone has enough water to drink.

Aquifer Recharge

When water enters an aquifer, it is said to *recharge.* Groundwater often discharges from aquifers to replenish rivers, lakes, or wetlands. An aquifer may receive recharge from these sources, an overlying aquifer, or from rainfall or snow melt followed by infiltration.

Infiltration takes place when precipitation soaks into the ground and is strongly affected by soil porosity. Once in the ground, infiltrated water becomes groundwater and is stored in aquifers. However, if it is quickly pulled up to the surface, the levels can't build up.

KEY IDEA

> An *aquifer recharge zone,* either at the surface or below ground, supplies water to an aquifer and/or most of the watershed or drainage basin.

Groundwater discharge adds considerably to surface water flow. During dry periods, streams get nearly all their water from groundwater. Physical and chemical characteristics of underground formations have a big effect on the volume of surface runoff.

While the rate of aquifer discharge controls the volume of water moving from the saturated zone into streams, the rate of recharge controls the volume of water flowing across the Earth's surface. During a rainstorm, the amount of water running into streams and rivers depends on how much rain an underground area can absorb. When there is more water on the surface than can be absorbed by the groundwater zone, it runs off into streams and lakes.

Runoff

Permeability is the measure of how easily something flows through a material. The higher the soil permeability, the more rain seeps into the ground. However, when rain falls faster than it can soak into the ground, it runs off.

KEY IDEA

> *Runoff* is made up of rainfall or snow melt that has not had time to evaporate, transpire, or move into groundwater reserves.

TIP

Water always takes the path of least resistance, flowing downhill from higher to lower elevations, eventually reaching a river or its tributaries. All the land from which water drains to a common lake or river is considered to be part of the same watershed or runoff zone. Watershed drainages are defined by topographic divisions, which separate surface flow between two separate water systems.

Water runoff flows over land into local streams and lakes; the steeper the land and less porous the soil, the greater the runoff. Rivers join together and eventually form one major river, which carries the subbasins' runoff to the ocean.

Overland runoff also occurs in urban areas. Land use activities in a watershed affect the quality of surface water as contaminants are carried away by runoff and groundwater, especially through infiltration of pollutants. Because of this, hydrologists are concerned about surface pollutant runoff making its way into underground aquifers. Understanding factors affecting the rate and direction of surface and groundwater flow helps hydrologists determine where good water supplies exist and how contaminants migrate.

Agricultural, Industrial, and Domestic Use

Land use and soil treatment are linked with human activity. Pesticides and fertilizers used on crops affect water purity when runoff joins with surface and/or groundwater. Industrial water use is linked to the processing of hazardous chemicals. These may also impact streams or underground aquifers. Unfortunately, most water quality problems come from populated areas and improper land use.

Building and construction sites also contribute to runoff. Site preparation for new buildings and roads produce loose sediment. If not contained, this soil is washed away in a heavy rainfall along with pesticides, sewage, and industrial waste.

Additionally, septic systems, dumps, and landfills also bring pollutants into the overall water cycle. The United States has spent over $300 billion in the last 30 years on pollution control. However, there are still a lot of heavily polluted streams, rivers, and lakes.

Water is critical to life. Too much or too little water can have tremendous consequences. In the next 1,000 years, conservation and an acute understanding of the way planetary water is transported and stored will be essential.

Conservation

Water management and conservation are important in making water available for everyone. Environmentally frugal technology like low-water toilets, low-volume shower heads, reduced-use campaigns, and flood regulation can lower withdrawal and consumption. Planting native and drought-resistant landscapes and lawns lowers watering needs. A waterless toilet has been developed in Sweden that produces compost from human and kitchen waste. In 1998, cities such as Los Angeles, California; Austin, Texas; and Orlando, Florida, required all new building construction to have water-saving toilets to conserve water resources.

Large amounts of water can be reclaimed from treated wastewater and sewage. In California, over 30% of reclaimed water comes from treated sources. Purified and reclaimed water is being used for everything from crop irrigation to toilet flushing. Currently, California uses nearly 600 million m^3 of recycled water each year. Los Angeles uses roughly two-thirds of that amount for its annual water consumption.

TIP

Globally, better farming techniques, irrigation canals, and preventable runoff and evaporation may reduce water requirements by 70%. Industrial water use such as engine and turbine cooling can be lowered or eliminated by installing dry cooling systems. As with other conservation and environmental concerns, cost is a factor. Some countries can't afford to change existing technology or pass costs on to local users as is done in industrialized countries.

Water is becoming limited for recreational use and wildlife as well. This is yet another aspect of a complex and important issue.

Science Community

Many scientists are concerned that changes in ocean ecosystems brought about by overexploitation, physical alteration, pollution, introduction of alien species, and global climate change are outpacing study efforts.

The scientific community's concern for our oceans compelled more than 1,600 marine scientists to sign the *Troubled Waters* statement in 1998. This statement, a project of the *Marine Conservation Biology Institute* in Washington, D.C., explains the problems involving oceans to policy makers and the public. It describes massive damage to deep-sea coral reefs from bottom trawling on continental plateaus and slopes, seamounts, and mid-ocean ridges. Complex ecosystems with thousands of marine species are destroyed by bottom trawling. Continued bottom trawling offers slim to no chance of recovery.

The *Troubled Waters* statement explains:

> To reverse this trend and avert even more widespread harm to marine species and ecosystems, we urge citizens and governments worldwide to take the following five steps:
>
> 1. Identify and provide effective protection to all populations of marine species that are significantly depleted or declining, take all measures necessary to allow their recovery, minimize bycatch, end all subsidies that encourage overfishing and ensure that use of marine species is sustainable in perpetuity.
> 2. Increase the number and effectiveness of marine protected areas so that 20% of Exclusive Economic Zones and the High Seas are protected from threats by the Year 2020.
> 3. Ameliorate or stop fishing methods that undermine sustainability by harming the habitats of economically valuable marine species and the species they use for food and shelter.
> 4. Stop physical alteration of terrestrial, freshwater and marine ecosystems that harms the sea, minimize pollution discharged at sea or entering the sea from the land, curtail introduction of alien marine species and prevent further atmospheric changes that threaten marine species and ecosystems.
> 5. Provide sufficient resources to encourage natural and social scientists to undertake marine conservation biology research needed to protect, restore, and sustainably use life in the sea.

Population Impact

Although population growth also has a big impact on the oceans, it's tough to change in the short term. Efforts aimed at reversing population growth and human impacts on marine systems include:

- Encouragement of sustainable use of ocean resources
- Policies and new technologies to limit pollution
- Creation and management of protected marine regions
- Education on ocean preservation and health and its human impacts

The oceans unite the people and land masses of the Earth. In fact, one in every six jobs in the United States is thought to be marine-related and attributed to fishing, transportation, recreation, and other industries in coastal areas. Ocean routes are important to national security and foreign trade. Military and commercial vessels travel the world on the oceans.

To highlight the world's oceans, the United Nations declared 1998 the International Year of the Ocean. This helped organizations and governments increase public awareness and understanding of marine environments and environmental issues.

❯ Review Questions

Multiple-Choice Questions

1. Groundwater is stored in

(A) porous rocks
(B) snow
(C) glaciers
(D) aquifers
(E) all the above

2. The layer closest to the surface, where spaces between soil particles are filled with both air and water, is called the zone of

(A) aeration
(B) hydration
(C) precipitation
(D) consolidation
(E) acclimation

3. Infiltration takes place when

(A) streams overflow their banks
(B) plants use water during photosynthesis
(C) deserts get drier and drier
(D) rainfall soaks into the ground
(E) snow melts

4. When water changes from a liquid to a gas or vapor, the process is called

(A) aeration
(B) conservation
(C) precipitation
(D) withdrawal
(E) evaporation

5. The study of the occurrence, distribution, and movement of water on, in, and above the surface of the Earth is called

(A) microbiology
(B) ecology
(C) hydrology
(D) botany
(E) aquaculture

6. A place where water is stored for some period of time (e.g. atmosphere, ocean, or underground) is called a

(A) dam
(B) stream
(C) lock
(D) reservoir
(E) diversion

7. The oceans hold approximately what percent of the Earth's water?

(A) 45%
(B) 62%
(C) 75%
(D) 80%
(E) 97%

8. Aquifers that form a water table separating unsaturated and saturated zones are called

(A) unconfined aquifers
(B) confined aquifers
(C) lakes
(D) closed aquifers
(E) saturated aquifers

9. The water found in subterranean spaces, cracks, and open pore spaces of minerals is called

(A) watershed
(B) groundwater
(C) snow melt
(D) runoff
(E) evapotranspiration

10. Rainfall or snow melt that has not had time to evaporate, transpire, or move into groundwater is known as

(A) transpiration
(B) an aquifer
(C) consumption
(D) runoff
(E) conservation

11. All the following are important water conservation methods except

(A) better farming techniques
(B) oscillating sprinkler systems
(C) dry cooling systems
(D) preventable runoff
(E) irrigation canals

12. The area at the surface or below ground that supplies water to an aquifer and/or most of the watershed or drainage basin is called

(A) an aquifer
(B) an unconsolidated aquifer
(C) a drainage zone
(D) an aquifer recharge zone
(E) a surface discharge

13. The amount of open space in the soil is called

(A) crystal structure
(B) sedimentation
(C) soil porosity
(D) granite
(E) soil salinity

14. Under surface soil, where all the open spaces have become filled with water, lies the zone of

(A) sedimentation
(B) saturation
(C) equalization
(D) salination
(E) diffusion

15. Pesticide and fertilizer use on crops affects water purity when

(A) evaporation is increased by heat
(B) it is used sparingly
(C) there is too little rainfall
(D) it is used in proper amounts
(E) runoff joins with surface and/or groundwater

16. The depletion of water from aquifers faster than they can naturally be refilled is called

(A) aquifer saturation
(B) groundwater mining
(C) flooding
(D) runoff
(E) the water table

17. The amount of withdrawn water lost in transport, evaporation, absorption, chemical change, or is otherwise unavailable as a result of human use is known as

(A) withdrawal
(B) conservation
(C) consumption
(D) discharge
(E) runoff

18. When water is blocked by a low-permeability material below the aquifer, it is known as

(A) an unconfined aquifer
(B) a perched water table
(C) a watershed
(D) a zone of aeration
(E) a diverted stream

❯ Answers and Explanations

1. E—Groundwater is stored in a variety of reservoirs for different amounts of time.

2. A—This zone, closest to the surface, contains gaps between soil particles filled with air or water.

3. D—Infiltration occurs when water molecules fill openings between soil particles.

4. E—Water goes from the liquid to the gaseous or vapor phase in evaporation.

5. C—The prefix *hydro* means "water" in Latin, (*–ology* means the "study of").

6. D—A reservoir holds collected water in its different forms: solid, liquid, and gas.

7. E—Nearly all (97%) of the Earth's total water is held in its oceans.

8. A—Aquifers form a water table; those separated into unsaturated/saturated zones are called unconfined aquifers since they flow right into the saturated zone.

9. B—Groundwater is defined as water found below the land's surface.

10. D—Water, affected by surface conditions and flow rate, needs time to evaporate or sink into the ground or it just runs off the land.

11. B—Oscillating sprinkler systems, which lose lots of water to evaporation, are not efficient.

12. D—When water enters an aquifer, it is said to recharge.

13. C—Loosely packed soils have lots of openings or pores between mineral grains. How tightly minerals are packed is known as porosity.

14. B—A material is saturated when no water or other substance can fill the open spaces.

15. E—Excess pesticides run off the land and may end up in streams or groundwater.

16. B—Extracting water before it can be replenished parallels the extraction of metals and mineral resources in mining.

17. C—When water withdrawal exceeds local supply, it is consumed or unusable for an extended time.

18. B—When a small, perched aquifer is disconnected from a larger aquifer below, it is separated by an unsaturated zone and a second, lower water table.

Free-Response Questions

1. Aquifers are often found in various places. Hydrologists are concerned about surface pollutant runoff making its way down into underground aquifers. Some aquifers form a water table that separates saturated and unsaturated zones. Some aquifers, however, lie beneath layers of impermeable materials like clay. Confined aquifers are more complex than unconfined aquifers that flow freely.

   (a) Can groundwater pollution affect the integrity of aquifers? Explain.
   (b) What is the difference between confined and unconfined aquifers?
   (c) Where are aquifers generally found?

2. Use the chart in Figure 7.2 to answer the following questions.

   (a) What activity uses the most water in the United States?
   (b) What actions should cities take to conserve water resources?
   (c) How can individuals reduce water use in their daily routines?

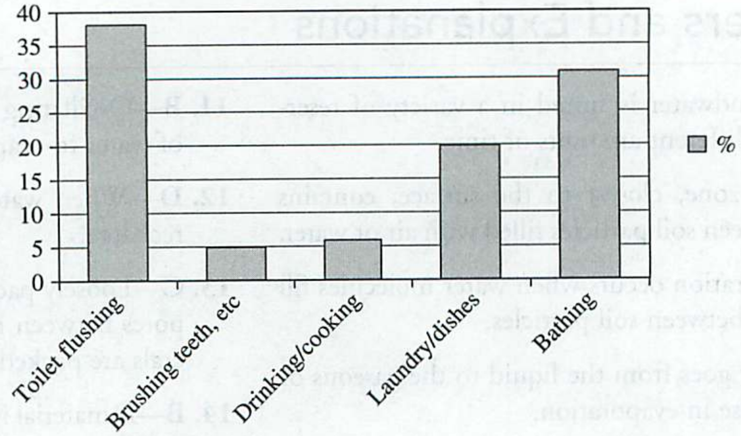

Figure 7.2 Percentage of water usage for an individual's activities.

Free-Response Answers and Explanations

1.

a. Yes. Because water flows with gravity and the path of least resistance; whatever is not soaked up by the ground finds its way elsewhere. In some cases polluted groundwater can make its way into an aquifer and dramatically affect the quality of the stored water. To be used, the water in the aquifer must undergo treatment at a high economic cost.

b. Unconfined aquifers are those that form a water table that separates the unsaturated and saturated zones since they flow right into the saturated zone. The water table of confined aquifers does not separate the two layers. Further, confined aquifers are most commonly under pressure causing water in some spots, like wells, to rise above the groundwater table.

c. Aquifers are generally found in areas where water has been redirected by an obstacle.

2.

a. Toilet flushing.

b. Mandate low-water toilets, scheduled lawn watering, and fines for water wastefulness, especially in the summer when aquifers are low.

c. Turn off running water when brushing teeth, doing dishes, and soaping up in the shower.

› Rapid Review

- Water shortages affect at least one-third of the world's population, with regional shortages being an issue.
- Aquifers are large underground rock formations that store water in reservoirs.
- Recharge zones allow water to enter aquifers.
- Water withdrawal refers to the total amount of water taken, while consumption refers to water lost to direct use, evaporation, and ground seepage.
- Runoff is made up of rainfall or snow melt that has not had time to evaporate, transpire, or move into groundwater locations.

- The geographical region from which a stream gets water is called a drainage basin or watershed.
- Evaporation is water to vapor; condensation is the reverse, vapor to liquid (water).
- Nearly all (97%) of the Earth's total water is contained in its oceans.
- Soil or rock is saturated when no water or other substance can fill the open spaces.
- Aquifers that form a water table that separates the unsaturated and saturated zones are called unconfined aquifers since they flow right into the saturated zone.
- Oscillating sprinkler systems lose a lot of water to evaporation and are not particularly efficient.
- The Gulf Stream current is about 800 times the volume of the Amazon, the world's largest river.
- Water table levels fall during times of low rainfall and high evapotranspiration.
- Aquifer recharge zones, either at the surface or below ground, supply water to an aquifer and/or most of the watershed or drainage basin.
- Porous media aquifers are made up of combined individual particles such as sand or gravel where groundwater is stored or moves between individual grains.
- The boundary between two watersheds is called a divide.
- Scientific concern about increasingly impacted oceans compelled more than 1,600 marine scientists to sign the 1998 *Troubled Waters* statement to raise public awareness.