## 14 Water Resources

*Before you read the chapter, answer each question with information you know. After you complete the chapter, re-answer the questions using information you learned.*

### BIG QUESTION

**Why Are We Running Out of Water?**

<table>
<thead>
<tr>
<th>What I Know</th>
<th>What I Learned</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>14.1</strong> Where is all of our water?</td>
<td><strong>Sample answer:</strong> Rivers, lakes, streams, ponds, and rain</td>
</tr>
<tr>
<td><strong>14.2</strong> How can we change the way we use water?</td>
<td><strong>Sample answer:</strong> We can use less water in our daily lives. For example, we can turn off the faucet when we brush our teeth.</td>
</tr>
<tr>
<td><strong>14.3</strong> How does water pollution affect humans and ecosystems?</td>
<td><strong>Sample answer:</strong> Water pollution harms humans and ecosystems.</td>
</tr>
</tbody>
</table>
14.1 Earth: The Water Planet

Key Concepts
- As a natural resource, freshwater is renewable. However, quantities of fresh water on Earth are limited.
- Surface water is contained within watersheds.
- Groundwater can be accessed by wells.

**SKILL BUILDER** Vocabulary Preview

Define each vocabulary term in your own words. Then, write yourself a quick note on how you will remember each. One term has been done for you.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>How I Remember</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh water</td>
<td>Water that is mostly pure, with few dissolved salts</td>
<td>Accept all reasonable responses for How I Remember. A few samples are provided.</td>
</tr>
<tr>
<td>Surface water</td>
<td>Water found on Earth’s surface</td>
<td>Surface is what we see when we look at the face of Earth.</td>
</tr>
<tr>
<td>Runoff</td>
<td>Water that flows over land and has not been absorbed into the ground</td>
<td>Water that runs off land and into water bodies is runoff.</td>
</tr>
<tr>
<td>River system</td>
<td>A network of connected rivers and streams</td>
<td></td>
</tr>
<tr>
<td>Watershed</td>
<td>All the land area that drains into a river system</td>
<td></td>
</tr>
<tr>
<td>Groundwater</td>
<td>Fresh water found below Earth’s surface</td>
<td></td>
</tr>
<tr>
<td>Permeable</td>
<td>Soil and rock layers with spaces for water to pass through</td>
<td>The P in permeable has a hole in the letter, like pores in soil.</td>
</tr>
<tr>
<td>Impermeable</td>
<td>Soil and rock layer with few or no spaces for water</td>
<td>The I in impermeable does not have holes.</td>
</tr>
</tbody>
</table>
Where Is Our Water?

For Questions 1–5, complete each statement by writing the correct word or words.

1. Fresh water is a renewable _________.
2. Another name for the water cycle is the _________.
3. About 97.5% of Earth’s water is _________.
4. _________ is water that is relatively pure, with few dissolved salts.
5. More than three quarters of the fresh water on Earth is _________, the rest is liquid.
6. Fresh water is distributed _________ in both time and space.
7. Explain why liquid fresh water is considered a limited resource.

Only a small amount of Earth’s water is both liquid and fresh. So, it is a limited _________.

8. Explain why the available amount of water per person differs between countries.

Some countries have many people, but not a lot of water. Others have plenty of _________, but few people. Also, the amount of water available at a certain time may vary drastically between seasons and regions.
Surface Water

For Questions 9 and 10, circle the letter of the correct answer.

9. Water that flows over land and has not been absorbed into the ground is called
   A. ocean water
   B. runoff
   C. groundwater
   D. a tributary

10. All of the land area that supplies water to a particular river system is called a
    A. glacier
    B. river
    C. watershed
    D. tributary

11. Why does effective watershed management require the cooperation of everyone in the watershed?

    Watersheds are interconnected. When people pollute their area or take too much water from a river or stream, their actions can directly affect the people and ecosystems downstream.

Groundwater

12. Complete the following paragraph with terms from the word bank.

    Water trickles down through the soil and rock to become groundwater. As water is pulled down by gravity, it passes through layers of soil and rock. These permeable layers have spaces, or pores, for water to pass through. When the water reaches an impermeable layer, it becomes trapped. It cannot move any deeper. The water then begins to fill up the spaces above. This underground layer of rock, sand, or gravel that holds water is called an aquifer.

13. What is a recharge zone?

    A recharge zone is an area where surface water soaks into the ground and reaches an aquifer below.

14. What happens when the water table drops below the depth of a well?

    The well dries up.
15. Label the diagram using terms from the word bank.

Aquifer · Impermeable layer · River · Water table · Well

EXTENSION On the diagram, draw a well that is dry, and a tributary to the river.

Check student’s drawings.

14.1 SELF-CHECK

Answer the questions to test your knowledge of lesson concepts. You can check your work using the answers on the bottom of the page.

16. What is a watershed? ____________________________

_____________________________________________________________________

17. What is groundwater? ____________________________

_____________________________________________________________________

16. All the land area that drains water into a river system.

17. Water found below Earth’s surface.
14.2 Uses of Fresh Water

Key Concepts
- Fresh water is used for agriculture, industrial, and personal activities.
- Because of overuse, surface water resources are being depleted.
- Groundwater is being used, primarily for irrigation, faster than it can be replenished.
- Addressing freshwater depletion will largely depend on strategies that decrease water demand.

**SKILL BUILDER Vocabulary Preview**

Define each vocabulary term in your own words. Then, write yourself a quick note on how you will remember each. One term has been done for you.

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>How I Remember</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water diversion</td>
<td>Moving water from its source to where humans use it</td>
<td>Accept all reasonable responses for How I Remember. A few samples are provided.</td>
</tr>
<tr>
<td>Dam</td>
<td>An obstruction placed in a river or stream to block its flow</td>
<td></td>
</tr>
<tr>
<td>Reservoir</td>
<td>Lakes that store water for human use</td>
<td>I see reservoir and think to reserve, or store.</td>
</tr>
<tr>
<td>Salinization</td>
<td>The buildup of salts in the surface layer of soil</td>
<td>When I see sal, I think salt. Salinization is to add salt</td>
</tr>
<tr>
<td>Desalination</td>
<td>Removing salt from seawater</td>
<td>When I see desal, I think de-salt or to take away salt.</td>
</tr>
<tr>
<td>Xeriscaping</td>
<td>Landscaping using plants adapted to arid conditions</td>
<td></td>
</tr>
</tbody>
</table>
How We Use Water

1. **Organize Information** Fill in the cluster diagram with short descriptions of the ways we use water.

   - **Agriculture** Farmers and ranchers use water to grow crops and raise their livestock.
   - **Industry** Companies use water to make and transport their products. Power plants use water for cooling purposes.
   - **Personal** Individual people use water in many ways including cooking, doing laundry, and flushing the toilet.

2. Why does it make sense that 40 percent of the water used by the United States is for industrial uses?

   _The United States has a lot of industry, so it makes sense that the U.S. uses a large portion of its water in this way._

Using Surface Water

For Questions 3–6, write True if the statement is true. If the statement is false, replace the underlined word or words to make the statement true. Write your changes on the line.

- **True** 3. The process of moving water from its source to places where humans use it is called water diversion.
- **True** 4. Dams can help regulate river flow.
- **reservoirs** 5. Lakes that store water for human use are called dams.
- **depletion** 6. Drought and overuse have caused significant surface water reservoirs.

7. What are some of the benefits and costs of dams?

   _The benefits of dams include preventing floods, facilitating irrigation, and generating electricity. Some of the costs of dams include harming aquatic ecosystems and the fact that they can fail._

8. Why is the Colorado River a good example of surface water depletion?

   _The Colorado River’s water is so heavily diverted that it sometimes runs dry before reaching the Gulf of California._
Using Groundwater

For Questions 9–11, circle the letter of the correct answer.

9. The buildup of salts in the surface layers of soil is called
A. agriculture.  C. salinization.
B. irrigation.  D. waterlogging.

10. Groundwater mining is the process of
A) withdrawing groundwater faster than it can be replaced.
B. replacing groundwater faster than it can be withdrawn.
C. withdrawing groundwater and replacing it with surface water.
D. withdrawing groundwater and replacing it with ocean water.

11. Which of the following is NOT an example of the effects of groundwater depletion?
A. sinking cities  C. dried up wetlands
B. depleted aquifers  D. rising water tables

12. What is groundwater mostly used for in the United States?

13. What is waterlogging?

Waterlogging occurs when soil becomes saturated with water to the point that oxygen no longer gets in.

Solutions to Freshwater Depletion

14. Fill in the table with solutions that increase supply and reduce demand.

<table>
<thead>
<tr>
<th>Solutions that Increase Supply</th>
<th>Solutions that Reduce Demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water diversion</td>
<td>Water conservation</td>
</tr>
<tr>
<td>Desalination</td>
<td>Efficient irrigation, such as drip irrigation</td>
</tr>
<tr>
<td></td>
<td>Growing climate-appropriate plants</td>
</tr>
<tr>
<td></td>
<td>Recycling water and wastewater</td>
</tr>
<tr>
<td></td>
<td>Xeriscaping</td>
</tr>
</tbody>
</table>

15. Which solutions to freshwater depletion do you think are most sustainable? Explain your thinking.

Answers will vary. Accept all reasonable responses.
16. Fill in the cluster concept map with terms from the word bank.

agriculture  decrease demand  groundwater depletion  increase supply  industry

**Uses of Fresh Water**

- include
- lead to

**agriculture**  **industry**  **personal**

- surface water depletion
- groundwater depletion

- solutions include

- increase supply
- decrease demand

17. Why is groundwater mining causing groundwater depletion in some areas?

Since groundwater mining withdraws water faster than it can be replaced, it can reduce the amount of stored groundwater in the area.

18. Why is drip irrigation an example of a solution that reduces the demand for water?

Drip irrigation uses less water than traditional irrigation methods, since it delivers water directly to the roots of plants rather than being lost to evaporation.
Lake Powell

In this activity, you will determine if Lake Powell is gaining or losing water each year. To start, find the actual annual inflows, or the amount of water flowing into the lake, for 2000–2007. Then, compare these inflows to the minimum outflow, or the minimum amount of water that is being taken out of the lake.

Finding Annual Inflows

Use 12 million acre-feet (maf) as 100% of inflow. To find out how much water the percentages in the graph represent, use the percent formula.

\[
\frac{\text{part}}{100} = \frac{x}{12 \text{ maf}}
\]

The calculation for 2000 is modeled below:

\[
\frac{62}{100} = \frac{x}{12 \text{ maf}}
\]

\[
0.62(12 \text{ maf}) = x
\]

\[
7.44 \text{ maf} = x
\]

Calculate the inflows for 2001–2007. Write your answers in the table.

<table>
<thead>
<tr>
<th>Year</th>
<th>Inflow</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>7.44 maf</td>
</tr>
<tr>
<td>2001</td>
<td>7.08 maf</td>
</tr>
<tr>
<td>2002</td>
<td>3 maf</td>
</tr>
<tr>
<td>2003</td>
<td>6.36 maf</td>
</tr>
<tr>
<td>2004</td>
<td>6.12 maf</td>
</tr>
<tr>
<td>2005</td>
<td>12.6 maf</td>
</tr>
<tr>
<td>2006</td>
<td>8.76 maf</td>
</tr>
<tr>
<td>2007</td>
<td>8.16 maf</td>
</tr>
</tbody>
</table>

Comparing Inflow and Outflow

According to the Colorado River Compact, the minimum outflow of Lake Powell is 8.23 maf each year. Assuming only 8.23 maf flowed out, calculate if there was a net gain or loss of water each year. Write your answers in the table below.

The calculation for 2000 is modeled at the right:

\[
7.44 \text{ maf } - 8.23 \text{ maf} = -0.79 \text{ maf}
\]

Lake Powell had a net loss.

<table>
<thead>
<tr>
<th>Year</th>
<th>Inflow</th>
<th>Outflow</th>
<th>Net Gain/Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>-0.79 maf</td>
<td>loss</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>-1.15 maf</td>
<td>loss</td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td>-5.23 maf</td>
<td>loss</td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td>-1.87 maf</td>
<td>loss</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>-2.11 maf</td>
<td>loss</td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td>4.37 maf</td>
<td>gain</td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>0.53 maf</td>
<td>gain</td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>-0.07 maf</td>
<td>loss</td>
<td></td>
</tr>
</tbody>
</table>
14.3 Water Pollution

Key Concepts

- There are many different kinds of water pollution, each with their own sources and effects.
- It can take decades to clean up groundwater pollution, so every effort should be made to prevent it from occurring.
- Oceans are polluted with oil, toxic chemicals, and nutrients that run off land.
- Government regulation and water treatment are two ways of decreasing the effects of water pollution.

**SKILL BUILDER Vocabulary Preview**

Define each vocabulary term in your own words. Then, write yourself a quick note on how you will remember each. One term has been done for you.

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<thead>
<tr>
<th>Term</th>
<th>Definition</th>
<th>How I Remember</th>
</tr>
</thead>
<tbody>
<tr>
<td>Point-source pollution</td>
<td><em>Pollution from discrete locations</em></td>
<td>Accept all reasonable responses for How I Remember. A few samples are provided.</td>
</tr>
<tr>
<td>Nonpoint-source pollution</td>
<td>Pollution from many sources spread over a large area</td>
<td>Nonpoint-source pollution comes from many sources. I could not point at just one.</td>
</tr>
<tr>
<td>Cultural eutrophication</td>
<td><em>Eutrophication caused by human nutrient pollution</em></td>
<td></td>
</tr>
<tr>
<td>Wastewater</td>
<td><em>Water that has been used by humans</em></td>
<td></td>
</tr>
<tr>
<td>Algal bloom</td>
<td><em>Sudden explosion of algal growth</em></td>
<td></td>
</tr>
<tr>
<td>Pathogen</td>
<td><em>Disease-causing agent</em></td>
<td>If pathogens are in my water, I might have to follow a path straight to the doctor.</td>
</tr>
<tr>
<td>Red tide</td>
<td><em>Algal bloom of a marine algal species that produces reddish pigments</em></td>
<td></td>
</tr>
<tr>
<td>Septic system</td>
<td><em>Method of wastewater disposal that runs wastewater from a building to an underground tank</em></td>
<td>Septic Systems Store Sewage.</td>
</tr>
</tbody>
</table>
### SKILL BUILDER  Reading Strategy

As you read the lesson, complete the main ideas and details chart.

<table>
<thead>
<tr>
<th>Main Ideas</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types of water pollution</td>
<td><strong>Sample answers appear below.</strong></td>
</tr>
<tr>
<td></td>
<td><em>Point-source pollution comes from discrete locations. Non-point source pollution comes from many places spread over a large area.</em></td>
</tr>
<tr>
<td></td>
<td><em>Types of water pollution include nutrient pollution, toxic chemical pollution, sediment pollution, thermal pollution, and biological pollution.</em></td>
</tr>
<tr>
<td>Groundwater pollution</td>
<td><em>Sources of groundwater pollution include surface pollutants that leach through soil and seep into aquifers as well as pollution from improperly designed wells and leaky storage tanks.</em></td>
</tr>
<tr>
<td></td>
<td><em>Because groundwater pollution is difficult to clean up, efforts to reduce groundwater pollution focus on prevention.</em></td>
</tr>
<tr>
<td>Ocean water pollution</td>
<td><em>Oil pollution comes from both natural and human sources.</em></td>
</tr>
<tr>
<td></td>
<td><em>Other types of ocean pollution include mercury and nutrient pollution.</em></td>
</tr>
<tr>
<td>Controlling water pollution</td>
<td><em>The Clean Water Act made it illegal to release point-source pollution without a permit, set surface water pollution standards, and funded sewage treatment plant construction.</em></td>
</tr>
<tr>
<td></td>
<td><em>Public drinking water is treated before it reaches your tap and wastewater is treated after it leaves homes and buildings.</em></td>
</tr>
</tbody>
</table>
Types of Water Pollution

For Questions 1–5, match each type of pollution with the statement that best describes it.

- d 1. nutrient pollution a. includes disease-causing agents in the water
- e 2. toxic chemical pollution b. caused by erosion
- b 3. sediment pollution c. raises the temperature of the water
- c 4. thermal pollution d. can cause cultural eutrophication
- a 5. biological pollution e. includes heavy metals and toxic organic chemicals

6. **Organize Information** Fill in the flowchart with the terms *increase(s)* and *decrease(s)* to model the process of eutrophication.

```
Water nutrient levels
increase
→ Aquatic plant growth
increase
→ Decomposition
increase
→ Dissolved oxygen levels
decrease
```

Groundwater Pollution

For Questions 7–11, write **True** if the statement is true. If the statement is false, replace the underlined word or words to make the statement true. Write your changes on the line.

- **difficult** 7. Groundwater pollution is *easy* to monitor and clean up.
- **True** 8. Groundwater pollution as a result of human activity is *widespread*.
- **aquifers** 9. Pollutants leach through soil and seep into *storage tanks*.
- **True** 10. It can take *decades* for groundwater to get rid of its contaminants.
- **True** 11. Most efforts to reduce groundwater pollution focus on *prevention*.

Ocean Water Pollution

12. Why is it important to minimize the amount of oil released into the ocean?
   
   *It is important to minimize oil pollution because petroleum can harm marine life.*

13. What is the largest source of oil in the oceans?
   
   *Naturally occurring deposits on the sea floor, called oil-seepage*

14. Why is mercury contamination in the ocean a concern?

   *Mercury collects in the tissues of animals. If humans consume too much mercury, it can cause neurological damage, especially in fetuses and children.*
15. What causes red tides?

_Nutrient pollution in the ocean causes algal blooms. Some of these algal species produce reddish pigments. Blooms of these species are called red tides._

For Questions 16–19, write True if the statement is true. If the statement is false, replace the underlined word or words to make the statement true. Write your changes on the line.

True

16. Most oil pollution in the oceans comes from small, nonpoint sources.

True

17. Marine organisms at higher trophic levels contain higher levels of mercury.

_nitrogen_

18. Of the nutrients phosphorus and nitrogen, phosphorous causes the most damage to oceans.

_nutrient runoff_

19. Reducing oil seepage into coastal waters can lessen the frequency of algal blooms.

**Controlling Water Pollution**

_Complete each statement by writing the correct word or words._

20. The Clean Water Act made it illegal to release _pollution_ from a point source without a permit.

21. Drinking water suppliers _treat_ water with chemicals and run it through filters before sending it to your tap.

22. _Wastewater_ includes water from showers, toilets, dishwashers, as well as water used by industry to cool power plants.

**14.3 SELF-CHECK**

_Answer the questions to test your knowledge of lesson concepts. You can check your work using the answers on the bottom of the page._

23. List two types of water pollution.

24. Describe how The Clean Water Act has reduced point-source pollution in the U.S.
Chapter Vocabulary Review

Match each term with its definition.

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>h</td>
<td>b. water that flows over land and has not yet been absorbed into the ground</td>
<td>a. water that has been used by people in some way</td>
<td>c. removing salt from seawater</td>
<td>d. pollution that comes from a discrete location</td>
<td>e. water that is relatively pure, with few dissolved salts</td>
<td>f. the area of land that drains water into a river system</td>
<td>g. the buildup of salts in the surface layers of soil</td>
<td>h. a lake that stores water for human use</td>
<td>i. a hole dug into an aquifer to reach groundwater</td>
<td>j. spongelike formation of rock, sand, or gravel that holds water</td>
<td>k. water found on Earth’s surface</td>
<td>l. pollution that comes from many sources</td>
</tr>
</tbody>
</table>

Use each vocabulary term in a sentence.

13. Water diversion  Sample answer: The new channel is a water diversion that routes river water right by my house.

14. Water table  Sample answer: The water table was so close to the surface that we could reach it by digging with a shovel.

15. Algal bloom  Sample answer: Nutrient pollution in a nearby pond caused a large algal bloom.

EXTENSION  Write a paragraph that correctly uses five or more vocabulary terms from the chapter. Answers will vary.
The Law of the River

Defining Colorado River water rights has been—and still is—a fluid process. In 1922, the Colorado River Compact attempted to divide the waters of the Colorado River between seven states: Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming. But, rather than allocate water to each state, the compact divided the entire river basin into two halves: an upper and lower basin. The states in each basin were given rights to 7.5 million acre-feet of water per year to divide among themselves.

Since this compact was signed, additional treaties, compacts, acts, and legal decisions have helped further define who gets to use the river’s waters…and how much they get. This cumulative body of laws and court cases is known as the Law of the River. The timeline below summarizes a few of the major components of the Law of the River.

1922
The Colorado River Compact
Divides the Colorado River basin into an upper and lower basin. The states in each basin get rights to 7.5 million acre-feet of water per year.

1944
Water Treaty with Mexico
Mexico is given rights to 1.5 million acre-feet of water each year.

1948
Upper Colorado River Basin Compact
Defines how much of the upper basin’s water each state has rights to: Colorado, 51.75%; New Mexico, 11.25%; Utah, 23%; and Wyoming, 14%. The small part of Arizona in the upper basin is also given 50,000 acre-feet per year.

2003
Colorado River Water Delivery Agreement
Specifies how California’s portion of Colorado River water is allocated.

The Colorado River Basin Salinity Control Act of 1974
Aims to control and improve the salinity of Colorado River water.
Use the information in The Law of the River to answer the questions below.

1. List the seven states that signed the Colorado River Compact.
   
   Arizona, California, Colorado, Nevada, New Mexico, Utah, and Wyoming

2. Describe the outcome of the Boulder Canyon Project Act.
   
   The water rights of the lower basin were divided among California (4.4 million acre-feet), Arizona (2.8 million acre-feet), and Nevada (300,000 acre-feet).

3. Describe the outcome of the Upper Colorado River Basin Compact of 1948.
   
   The water rights of the upper basin were divided among Colorado (51.75%), New Mexico (11.25%), Utah (23%), and Wyoming (14%). The small part of Arizona in the upper basin was also given 50,000 acre-feet per year.

4. Do you think the Law of the River will change in the future?
   
   Sample answer: Yes. As the water needs of different states change, the laws will likely change as well.

5. How does the changing nature of water rights relate to the Big Question: “Why are we running out of water?”
   
   Answers will vary. Accept all reasonable responses. Sample answer: The laws and court cases dealing with water rights make it clear that water is a critical resource that people rely on and compete for.

21st Century Skills

Gather into small groups to research the compacts, acts, and court decisions that have helped define water rights to the Colorado River. Compile the results of your research, using a group wiki if possible. Then, present your research to the class.

The 21st Century Skills used in this activity include Communication and Collaboration, Initiative and Self-Direction, and Productivity and Accountability.

Log on for more information and activities on the Central Case, Looking for Water...In the Desert.