Watery Earth

Student Reference Book

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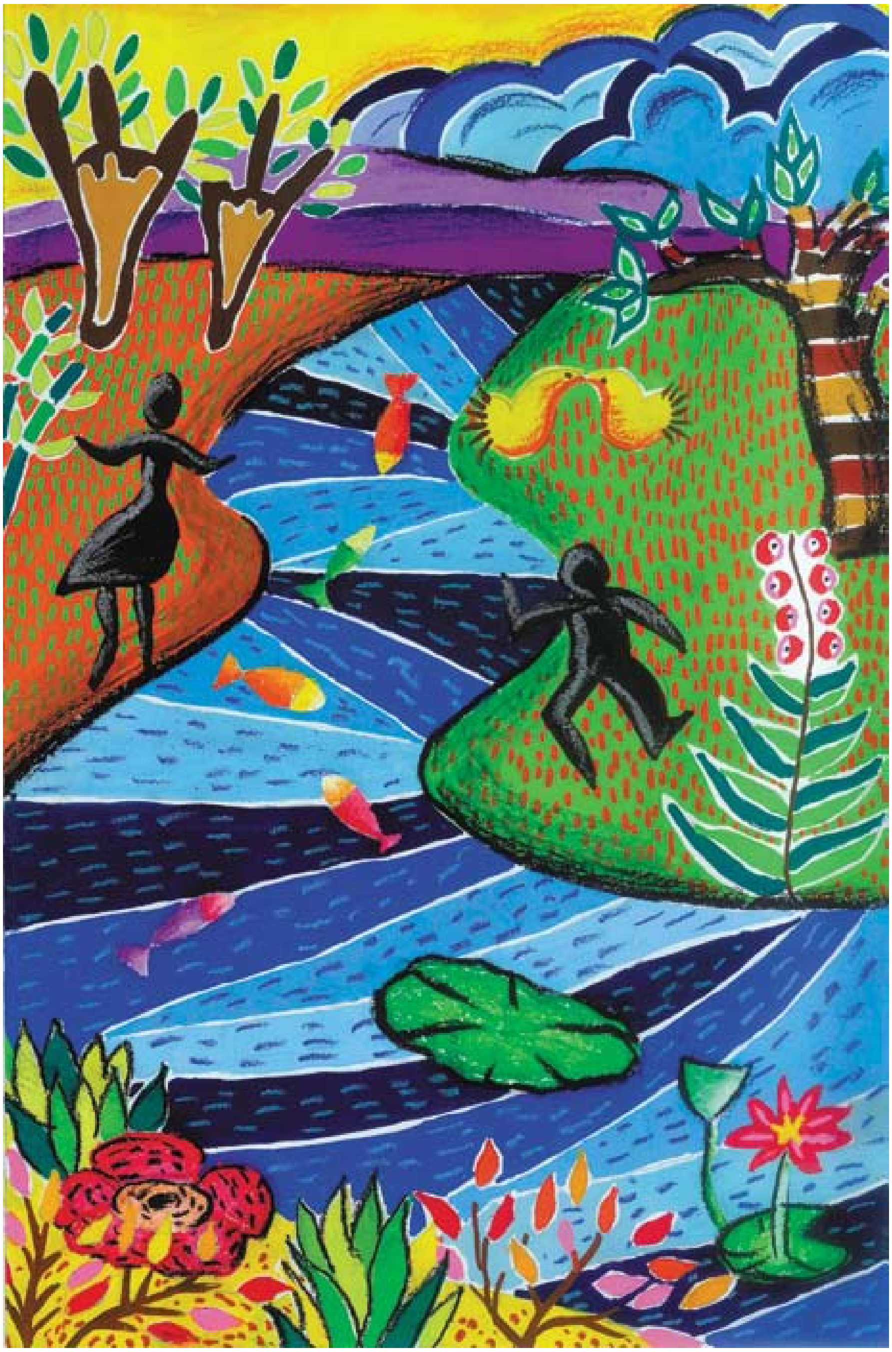


Lim Yi Fan, age 11
Perak, Malaysia

1

The Wonder of Water

Water.

Right now, it's all around you. It's in the air you breathe. It's in your skin and blood, your brain and bones. It's in the food you eat and the juice you drink. It's in the ground beneath your feet, and in the sky above you.

It falls as rain or snow. It flows over the land as rivers and streams. It fills up lakes and ponds, and when we look closely at a globe, it seems like it covers our whole planet.

Water is everywhere, yet we don't think about it much. We don't worry about where it comes from, or how clean it is.

But for many people around the world, water is as rare and precious as gold. Without it, they would not be able to grow crops or raise their farm animals. They could not cook food or clean their bodies. They could not even get a drink when they are thirsty.

In these pages you will make your own discoveries about water. You'll learn how humans and animals need water to live. You'll explore how water moves around the planet, from the sky to the earth's surface, and back again. You'll see how important it is to protect our water.

After making these discoveries, you will notice water everywhere. You will also understand that in many ways it is rare and precious.

Water Inspires Proverbs

All through history, water has inspired people to create art, literature, and music. Just like you have your own stories about water, people all over the world like to share their ideas and experiences with water.

Sometimes people use proverbs to share their thoughts. A proverb is a short saying that expresses a well-known truth or a common experience among people. The proverbs below reflect how different cultures view water. Can you see how these different cultures share similar ideas about water?

Water always finds a way out.

—Cameroon, West Africa

For the benefit of the flowers, we water the thorns, too.

—Egypt, North Africa

Two waterfalls do not hear each other.

—Kenya, East Africa

The horse that arrives early gets good drinking water.

—South Africa

Do not insult a crocodile while your feet are still in the water.

—South Africa

Heaven is dark and yet out of it streams clear water.

—Afghanistan, Southwestern Asia

Elizabeth Au, age 13
Hong Kong, China

In shallow waters, shrimps make fools of dragons.

—China, Asia

No one can see their reflection in running water. It is only in still water that we can see.

—Taoist, East Asia

A coconut shell full of water is a sea to an ant.

—India, South Asia

Any water in the desert will do.

—Saudi Arabia, Middle East

We never know the worth of water till the well is dry.

—France and Ireland, Western Europe

Even hard rocks can be drilled by persistent soft drops of water.

—Portugal, Western Europe

Pardis Sohouli, age 10
Tehran, Iran

La gota de agua cava la piedra. (The drop of water digs the stone.)

—Mexico, North America

Don't spit in the well. You may need to drink from it!

—Russia, Eastern Europe

The water that has passed by does not turn the millstone.

—Mexico, North America

Fine water removes the thorn.

—South America

Source: "International Year of Freshwater 2003." United Nations Educational, Scientific, and Cultural Organization. Water Proverbs. http://www.wateryear2003.org/en/

The water art in this chapter is provided by **River of Words**. Each year, in affiliation with The Library of Congress Center for the Book, **River of Words** conducts a free international poetry and art contest for children on the theme of watersheds. For more information, visit their website: www.riverofwords.org.

Water Inspires Poetry

Some people have proverbs about water. Other people write stories about water. Still other people like to write poetry.

The poems below tell about water in different parts of nature. After reading the poems, you might think about your favorite watery place and write a poem about it.

Mustafayeva Heyran, age 11
Baku, Azerbaijan

Song for the Rainy Season

Elizabeth Bishop

Hidden, oh hidden
in the high fog
the house we live in,
beneath the magnetic rock,
rain-, rainbow-ridden,
where blood-black
bromelias, lichens,
owls, and the lint
of the waterfalls cling,
familiar, unbidden.

In a dim age
of water
the brook sings loud
from a rib cage
of giant fern; vapor
climbs up the thick growth
effortlessly, turns back,
holding them both,
house and rock,
in a private cloud.

. . . .

Once by the Pacific

Robert Frost

The shattered water made a misty din.
Great waves looked over others coming in,
And thought of doing something to the shore
That water never did to land before.
The clouds were low and hairy in the skies,
Like locks blown forward in the gleam of eyes.
You could not tell, and yet it looked as if
The shore was lucky in being backed by cliff,
The cliff in being backed by continent;
It looked as if a night of dark intent
Was coming, and not only a night, an age.
Someone had better be prepared for rage.
There would be more than ocean-water broken
Before God's last "Put out the light" was spoken.

Where Go the Boats? (from *A Child's Garden of Verses*)

Robert Louis Stevenson

Dark brown is the river,
    Golden is the sand.
It flows along for ever,
    With trees on either hand.

Green leaves a-floating,
    Castles of the foam,
Boats of mine a-boating—
    Where will all come home?

On goes the river
    And out past the mill,
Away down the valley,
    Away down the hill.

Away down the river,
    A hundred miles or more,
Other little children
    Shall bring my boats ashore.

Lakshmi Shree, age 9
Bangalore, India

The Old Pond

Matsuo Basho

An old silent pond...
A frog jumps into the pond,
splash! Silence again.

Yanbo Li, age 9
West Lafayette, Indiana

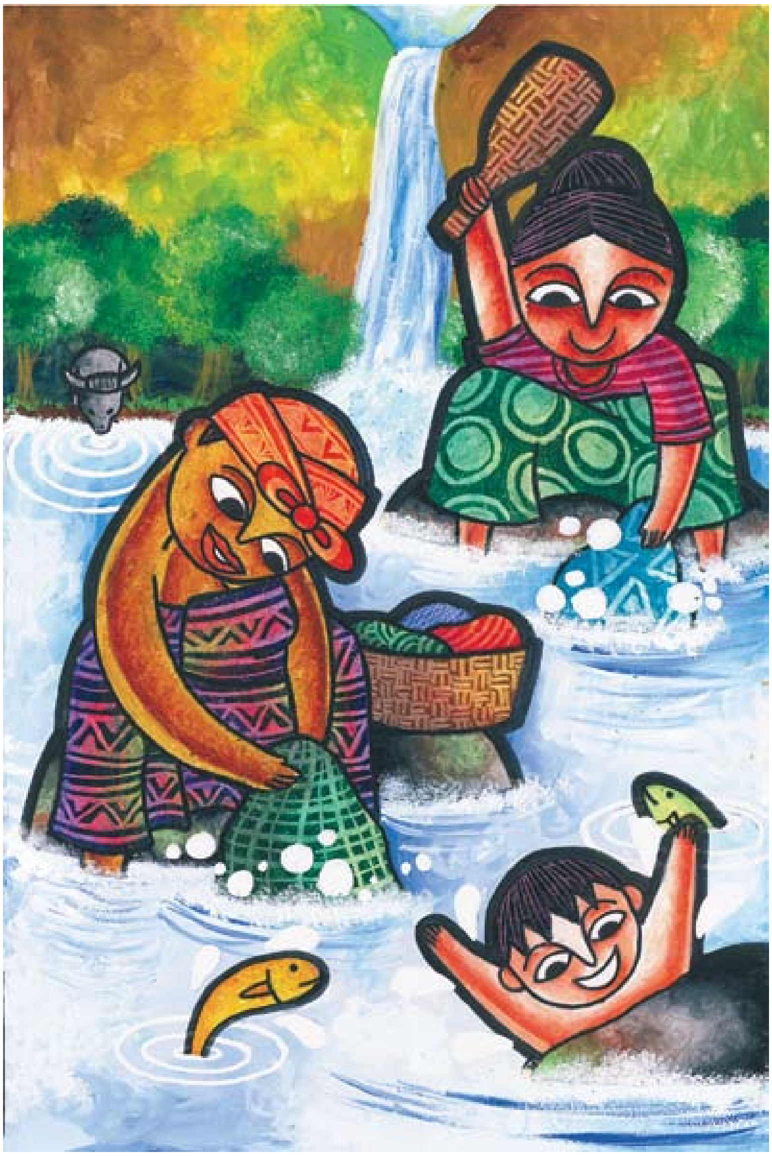
Awake at Night

Matsuo Basho

Awake at night—

the sound of the water jar

cracking in the cold.



Jeane Renee T. Nubla, age 14
Manila, Philippines

The Pike

Amy Lowell

In the brown water,
Thick and silver-sheened in the sunshine,
Liquid and cool in the shade of the reeds,
A pike dozed.
Lost among the shadows of stems
He lay unnoticed.
Suddenly he flicked his tail,
And a green-and-copper brightness
Ran under the water.

Out from under the reeds
Came the olive-green light,
And orange flashed up
Through the sun-thickened water.
So the fish passed across the pool,
Green and copper,
A darkness and a gleam,
And the blurred reflections of the willows on the opposite bank
Received it.

Water Inspires Discovery

Water makes people think about all kinds of things. Sometimes people have questions about water, and want to learn more about it. People who ask questions about the world, and use careful methods for answering those questions, are called scientists.

There are many different kinds of scientists who are curious about water. Each of them asks different kinds of questions and uses different tools to help them answer those questions. But all of them are interested in learning more about water, how people use it, and how we can protect it. These are the names of some of the kinds of scientists who study water:

Biologists want to understand how living things work. Since all living things need water to survive, these scientists need to know how water affects life on earth. One kind of biologist is called an **ecologist**. These scientists study how the environment changes. They might look at how the amount of rain or snowfall affects how plants live in a certain area. Or they might look at how the water flowing from a city into a lake affects the fish living there.

Chemists put chemicals together and take them apart to create new substances or solve problems. While most chemists work in a laboratory, some of them also work outside. One kind of chemist who studies ways to keep our world from being polluted is called an environmental chemist. They test the water to judge how clean it is and make suggestions about how to keep it safe for use by living things.

Chemists study water and other kinds of matter.

Geologists study the earth's changing surface. One of the most powerful forces that shapes the land is water. Over a very long time, water and ice break down rock and carry it away. Understanding how water and ice change rock and sculpt the earth is part of the work of geologists. They observe how water carries small bits of rock that wear down larger rock over time. They look at how rivers carve valleys, and also study glaciers to understand how these large rivers of ice create interesting landforms.

These geologists are using an airboat to take river measurements.

Geographers study the details of the land around us. They are interested in where features like rivers and oceans are located. But they also want to know how the land affects humans and animals. Geographers are interested in how floods bring nutrients to the land, which helps farmers raise crops. They are also interested in how droughts cause deserts to increase in size.

People Doing Science

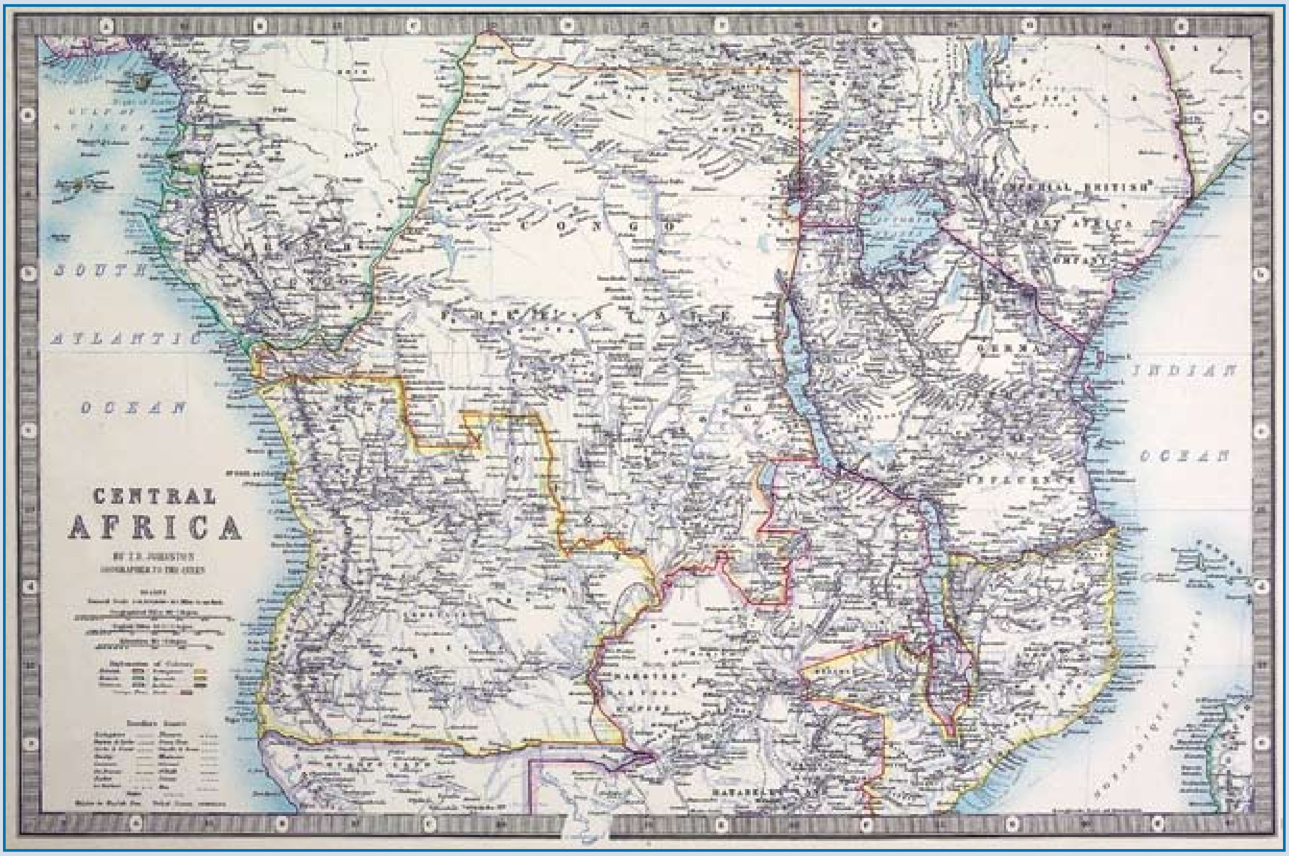
One of the most dramatic moments in the history of geography was the discovery of the source of the Nile River in Africa. 150 years ago, Europeans had not yet explored a large part of Africa. Most maps of the continent showed a blank area in the center. In 1856, the British Royal Geographic Society decided to send an expedition to find the place where the world's longest river began.

The next year, John Hanning Speke (1827–1864) joined an expedition with Sir Richard Burton (1821–1890) to discover the source of the Nile River. They began at the east coast of what is today Tanzania. The native people who lived there told them about some huge lakes to the west.

They were the first Europeans to explore the giant Lake Tanganyika. The people who lived nearby told them of another lake to the north, but Burton was too sick to travel. Speke went on alone and in August, 1858, he became the first European to discover Lake Victoria, which he named after the Queen of England.

But Speke did not locate the exact spot where the water flowed out of the lake. Some people, including his friend Richard Burton, still did not believe that he had found the true source of the Nile. Speke had to return on another expedition to find more evidence.

Almost four years later, in July 1862, he located the waterfalls that led from Lake Victoria, and proved that this lake was the place where the water of the Nile River began its long journey north, to the Mediterranean Sea.



This map of Africa was drawn a few years after Burton and Speke made their journey. Can you find Lake Victoria and the Nile River?

Hydrologists are the only scientists with the word "water" in their name. "Hydro" is the Latin word for water. Hydrologists are interested in answering these questions:

- What are the properties of water?
- Where is it found on earth?
- How do people use water?
- How does water move from the air to the surface of the earth, beneath the earth's surface, and back into the air?

Meteorologists aren't just the people you see giving the weather report on television. In fact, nine out of ten meteorologists are scientists who work behind the scenes to observe, understand, explain, and predict the **weather**. Some meteorologists look at information collected from measuring devices like rain gauges and barometers. Others study pictures taken by satellites circling the earth. Still others fly high in the air, using instruments that collect data about the atmosphere.

This Department of Fish and Wildlife Service scientist gets to work outside on the water.

Oceanographers study the ocean, its water, and the environment that surrounds it. They combine the skills of many scientists, including biologists, chemists, and engineers. They try to answer questions like:

- How can the oceans help feed people?
- How can we protect the waters near the coasts where people live?
- What role do the oceans play in creating storms and other weather events?
- How can understanding the ocean help us understand global warming?

Engineers use science and mathematics to figure out practical ways to solve problems. These people design structures that control water, like dams and canals. They plan ways to clean dirty water, and design systems that generate electricity from water.

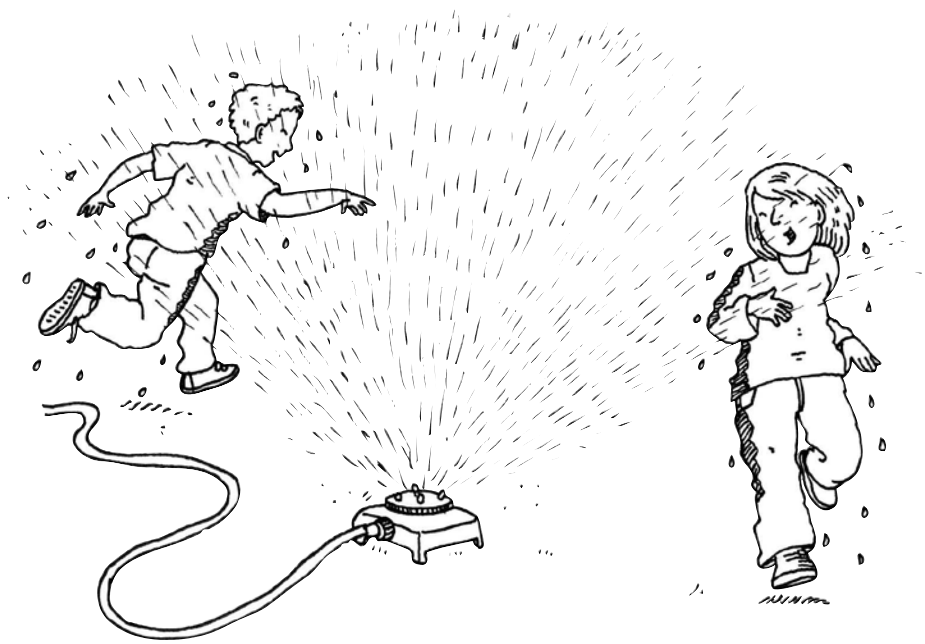
These engineers are discussing a flood control project.

2

Using Water

Who Uses Water?

You use water. Your family and friends use water. All the plants and animals that live around you use water. Even a pesky mosquito uses water. In fact, all living things on Earth need and use water.



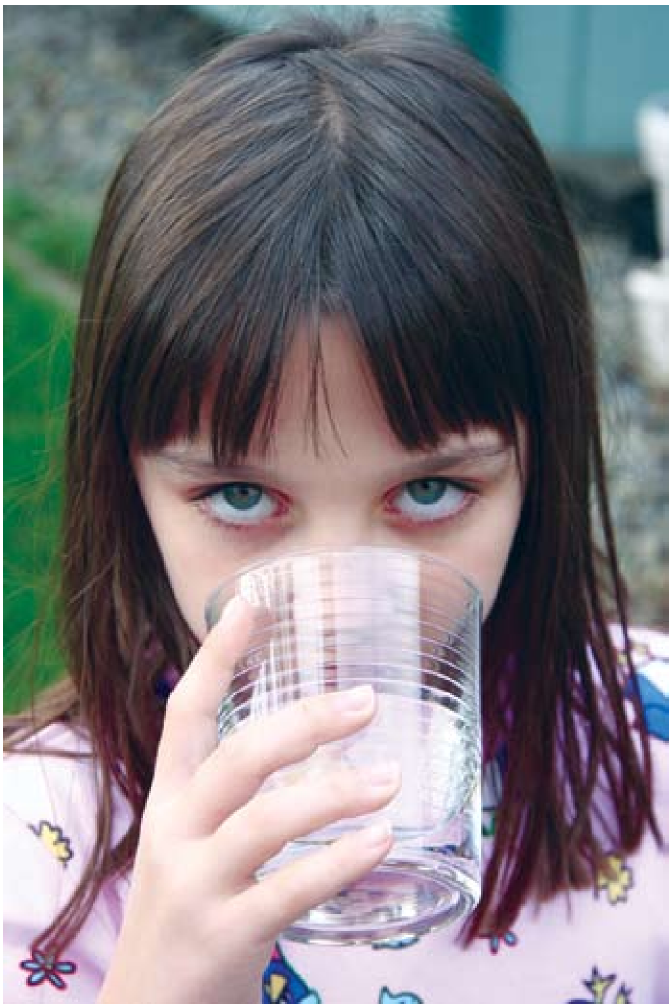
Do you ever play in the water?

Watery Earth Fact

Many of the foods you eat have a lot of water in them. For example, a chicken is 75 percent water, a pineapple is 80 percent water, and a tomato is 95 percent water.

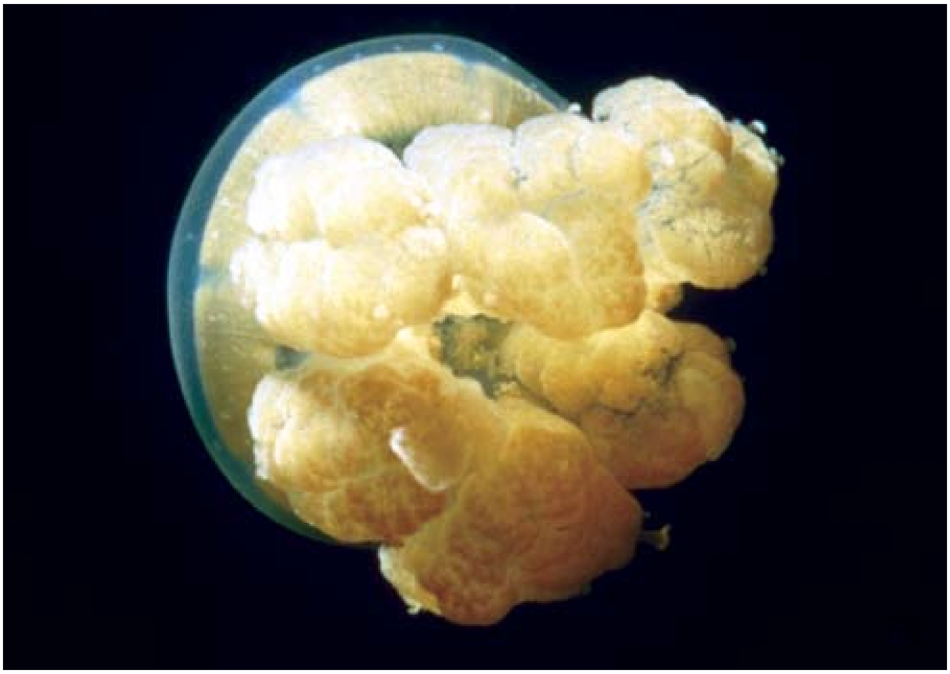
Think about the ways you use water each day. You drink it, you bath in it, you brush your teeth with it, and you use it for household chores. If you have pets, you need to make sure they have enough to drink too.

Some of the water you use is necessary for your health and survival. You need about 2.4 liters (10 cups) of water a day to stay healthy. And it can be life threatening to go without water for even two or three days! The water you need can come in different forms. It can simply be water. Or it can come from juice, milk, or some other drinkable liquid. It can also come from the food you eat.



How much liquid do you drink every day?

Humans and animals consume a great deal of water. In fact, about ¾ of a child's body weight is water. Some animals have even more water within them. A jellyfish can be up to 95 percent water!



The body of a jellyfish is up to 95 percent water.

This camel is taking a well earned break.

Watery Earth Fact

Camels store water in their humps. They can live three months without a drop of water. That's why they are the perfect animals for desert travel. When camels get thirsty they can drink 120 liters (30 gallons) of water at a time.

Water Is a Natural Resource

A resource is something we use in our daily lives. We rely on some resources, such as food and water, for our survival. Many other resources, such as bicycles, books, games, and computers can make our lives more interesting, but are not necessary for our survival.

Many of the resources that we use are produced by humans. For example, the bicycles, books, games, and computers mentioned above are all human-made resources. A few of the resources that we use, however, are not made by humans. These resources come straight from nature and are called natural resources.

Just about everything you use is either a natural resource or was made from a natural resource. For example, some of the food you eat, like fruits and nuts, come straight from the natural world. Other food, like hotdogs and candy bars are human made, but some of the materials that go into them are natural.

Oranges are a natural resource.

Many of our clothes are made from cotton, a natural resource.

Think of the other natural resources you use on a daily basis. The pencil you use at school is not a natural resource, but it is made from trees and graphite, which are natural resources. The bicycle you ride is not a natural resource, but part of it is made from iron, which is a natural resource. The gasoline that fuels your family's car is not a natural resource, but it is made from oil, which is a natural resource.

This girl's baseball glove is made from leather, a natural resource.

The steel frame and other parts on this boy's bicycle are made from natural resources.

Water is one of the most important natural resources available to us. Water comes from nature and cannot be made by humans. Water is necessary for the survival of all plants and animals in the world. Therefore we must take care of water to make sure there is enough of it available for the world's living things.

Humans

Of all creatures on Earth, humans consume the most water by far. We drink a very small amount of water compared to the total amount of water we use. Most of the water we use is for sanitation. This includes keeping things like ourselves, our clothes, and our dishes clean. We also use water to prepare our food, to keep our plants alive, and to wash our cars.

Watery Earth Facts: Water and the Human Body

- A child’s body is approximately 75 percent water.
- The human brain is about 75 percent water.
- About 83 percent of our blood is water. Water helps to digest our food, transport waste, and control body temperature.
- Each day, humans must replace 2.4 liters (10 cups) of water, some through drinking and the rest taken in by the body from foods eaten.
- While the human body can live for weeks without food, it can only survive a few days without water.
- About 50 liters (12.5 gallons) of water per person are needed for drinking, cooking, and basic cleanliness each day.

Sources: World Bank, United Nations *Chronicle*, Canadian Department of the Environment.

Other Mammals

Mammals use water in a variety of ways. Like humans, other mammals need a certain amount of water each day to stay healthy. So even though most cats don’t like to go near water, they still need to drink it. And when cats and other animals lick themselves, they are using their saliva, which is mostly water, to keep clean.

Even tigers spend a lot of time grooming themselves.

Other animals spend time playing in and around the water. For example, many dogs like to chase sticks and frolic in the water.

This dog loves to play in the water.

Mammals such as bears spend a lot of time near the water because fish, one of the mainstays of their diet, live in the water. Other mammals such as seals, otters, and beavers, not only drink water, but they spend most of their time living in or near the water, and get most of their food from water.

This grizzly bear cub will learn how to fish by watching its mother.

Seals spend much of their lives in water.

River otters eat fish and other smaller animals.

Birds

> **Watery Earth Fact**
>
> Many water birds, such as ducks and seagulls, have special oils on their feathers to keep their feathers from soaking up too much water. The special oils help water slide off of the bird's wings. Some birds, like the cormorant, do not have these oils, so they need to dry their wings in the air.

Many species of birds make their homes close to water. Ducks, geese, and other birds use water like an airplane uses a landing strip: for take-offs and landings. Birds also spend a lot of time preening in the water. Preening is when birds use their beaks or bills to clean their feathers. If a bird's feathers don't stay clean, it can be difficult for them to fly.

This mallard duck is getting ready to land on a quiet pond.

Ducks will often rise up out of the water and flap their wings.

This red-winged blackbird hides in a rain-drenched thicket.

Fish

Fish and their offspring, known as fry, spend their entire lives in water. They are born in the water, live in the water, lay their eggs in water, and die in the water. They also drink water, get their food from the water, and get their air from the water. They even get rid of their body's waste in water.

Some fish live in oceans, while others live in lakes and rivers. A few special kinds of fish, like salmon and sturgeon, spend different parts of their lives in rivers and in the ocean.

This colorful parrot fish lives near reefs in tropical waters.

Plants

Plants also need water to survive. For example, water carries much needed nutrients to a tree. The water acts almost like a tree's blood and flows upward to all living parts of the tree.

Water also helps support the leaves and branches of a plant. Think about an empty balloon. Without air or water, it is limp. But when you fill it with water, it is more rigid and keeps its shape. In the same way, a plant needs water to help it keep its form and stay upright.

Trees and other plants have different ways to get the water they need. Most often they have roots, which go into the ground to find water.

The saguaro cactus can survive in areas that only a get few centimeters of rainfall each year.

Watery Earth Fact

A desert plant, such as a cactus, can live for months without water because it can store a tremendous supply of water. When a big rainstorm comes to the desert, the cactus sucks up the water like a sponge and stores it for later use.

Some rain forests can get 1,000 centimeters of rainfall each year.

Some plants, like eel grass, live under the water.

3

Thinking About Precipitation

Water from the Sky

A raindrop falls from the sky and lands in a puddle. Where did the raindrop come from? What will happen to it next?

These raindrops are falling on a pond.

Word Connection

precipitation—Water in clouds that falls to the ground as rain, snow, or hail.

Rain, snow, hail, and other kinds of **precipitation** come from clouds. Clouds contain millions of tiny droplets of water. During stormy weather, the wind may blow clouds around. As clouds travel, their droplets of water or pieces of ice may collide with and join with others. Then the water droplets or ice pieces may get bigger. Once they get too big and heavy, they fall to the earth as precipitation.

Different Kinds of Water

Below are a few of the many different kinds of water that come from the air and sky:

- **Snow**—Crystals of ice that form when water freezes. They usually form as six-sided (hexagonal) or six-pointed crystals.
- **Hail**—Pellets of ice that form when water freezes. Individual balls of hail are called hailstones. Hailstones can be as small as a tiny pebble and as large as a baseball.
- **Sleet**—A mixture of rain and snow or hail.
- **Freezing rain**—Rain that freezes when it hits the ground or other surfaces on Earth.
- **Downpour**—A very heavy rain.
- **Drizzle**—A very light, gentle rain.
- **Mist**—Very fine droplets of water. Lighter than drizzle.

This field looks like it will get rained on soon.

If the air around the water droplets isn't too cold, the drops will fall as rain. If the air around the water droplets is very cold, the drops may fall as frozen water. Sometimes this frozen water drifts down as light, fluffy snowflakes. Under some conditions, it falls as balls of ice known as hail.

Hailstones this large can break car windows.

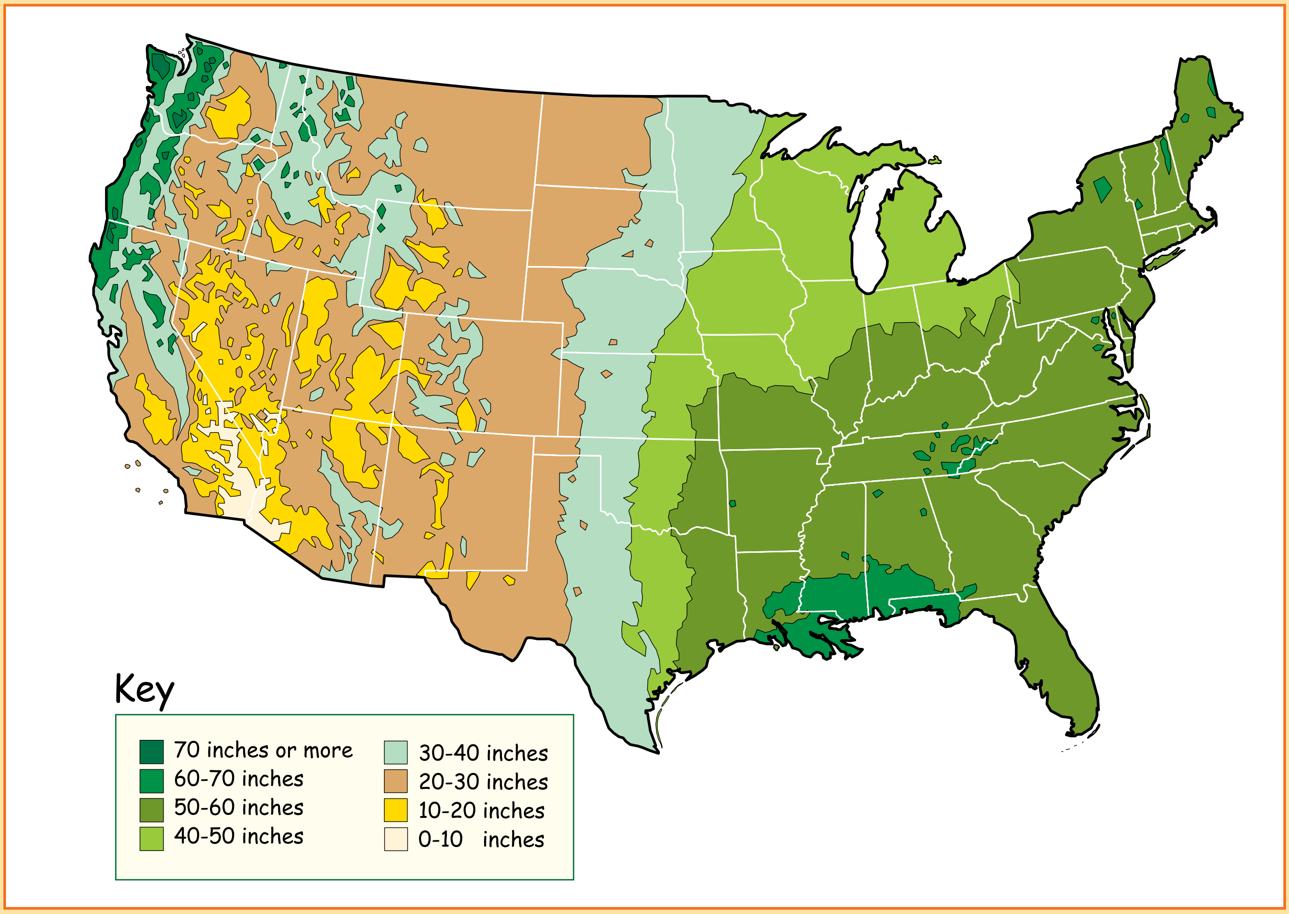
Snow is very cold, but lots of fun to play in.

This snowplow clears away fallen snow.

When precipitation reaches the earth, there are a number of things that can happen to it. It may land in water, such as in a puddle or a lake. It may land on a part of the earth, such as a snowy mountain or a grassy field. Or, it may land on a human-made object such as a sidewalk or a building. Who knows? During a snowfall, precipitation may even land on your outstretched tongue. When the water reaches the earth, there is no telling where it will end up.

Precipitation

The map below shows the amount of precipitation that falls each year in the United States.



4

Surface Water

The Ocean

Although oceans cover much of Earth's surface, many people have never smelled, touched, or even seen one. If we could build our homes on the ocean waves, we could easily feel how it moves. If we could live in the ocean, like fish, we could easily smell it. If we could fly over the oceans, like birds, we could see it. But, since we live on land, many of us miss out on the opportunity to experience the ocean firsthand.

If you've seen the ocean, or felt the power of an ocean wave, consider yourself very lucky. If you haven't had these experiences yet, be thankful that you are still very young and have plenty of time to explore this incredible part of the planet we live on.

Oceans are important because they contain most of the surface water on Earth. The four major oceans are the **Arctic**, **Atlantic**, **Indian**, and **Pacific**. But the oceans aren't the only places to find surface water on the earth.

Watery Earth Facts

The Pacific Ocean is the largest and deepest body of water on Earth. It covers about a third of Earth's surface and contains nearly half of all water on Earth. It covers more area than the world's entire land surface put together.

The Atlantic Ocean is half the size of the Pacific. The Arctic Ocean is the smallest, with less than five percent of the Earth's water.

Ocean waves breaking on the shore.

Common Bodies of Surface Water

The following are descriptions of some of the more well-known bodies of surface water:

Sea—A large expanse of water usually connected to an ocean. Seas are much smaller than oceans. A few bodies of water known as seas, such as the Caspian Sea in Asia, are actually salty lakes.

Mediterranean Sea off the coast of Italy.

The Dead Sea lies between Jordan and Israel.

Watery Earth Fact

The Dead Sea is surrounded by Jordan, Israel, and the West Bank. It is the saltiest sea in the world. The Dead Sea is about five times as salty as the average ocean. Some creatures can live in the very salty water of the Dead Sea, but no fish are able to survive in it.

Lake—A body of water surrounded by land. Most lakes contain fresh water. Some lakes, like the Great Salt Lake in Utah, contain salt water.

Pond—A still body of water that is smaller than a lake. Most ponds contain fresh water.

Cattails grow along the shore of a small pond.

Reservoir—A body of fresh water that is collected and stored in a natural or human-made lake or pond. Reservoirs are often used to store water for a neighboring city or town or to generate electric power.

River—A body of moving water that flows into an ocean, valley, lake, or another river.

Watery Earth Fact

The Amazon River drains about 40 percent of the entire continent of South America.

A lot of water flows through this river.

Some rivers, like the Yellowstone, have picturesque waterfalls.

Stream—A body of flowing water that is smaller than a river and larger than a creek.

Rivers, streams, and creeks are often good places to fish.

Creek—A small stream. Streams and rivers often have many creeks that flow into them.

This small creek runs through a forest.

Other Bodies of Surface Water

The following are descriptions of some less common bodies of surface water:

Bay—A body of water surrounded by land on three sides.

Estuary—A place where salt water and fresh water meet. This may be where the **mouth** of a river meets with an ocean or sea. Or it could be a part of sea that extends inland to meet with the mouth of a river.

Lots of birds are flocking near this estuary.

Gulf—A large area of an ocean or sea that is partly surrounded by land. The Gulf of Mexico, off the coasts of Texas, Louisiana, Mississippi, Alabama, and Florida, is a well known gulf.

Inlet—A stream or a bay that is leading toward the land from an ocean or sea.

Marshes and swamps—Areas of land that are usually soft and wet. Some marshes and swamps have areas of grassy vegetation while others have small trees and shrubs. During rainy seasons, the land is often flooded. During dry seasons, the land dries out.

This marsh may dry up when the rainy season ends.

Salt and Fresh Water

Try This!

Try making saltwater at home. You need to know that 35 g of salt equals about 6 teaspoons. How many teaspoons of salt would you need to add to a cup of fresh water to make a cup of salt water?

Word Connection

dehydration—To lose too much water from the body to stay healthy.

The water contained in various bodies of water comes in different forms. Over 97 percent of the water on Earth's surface is **salt water**. Scientists call water "salt water" when there is at least 35 grams (6 teaspoons) of salt dissolved in each liter (pint) of water. The majority of salt water is located in the world's oceans and seas. A few lakes also contain saltwater. Salt water lakes are often in hot, dry climates, where fresh water evaporates quickly. As the fresh water evaporates, the remaining water is more salty. These lakes usually don't have an outlet, so the salty water stays within the lake.

A tiny fraction of the water on Earth's surface is **fresh water**. Fresh water is very important for life on earth because it is the only water that humans and many other organisms can safely drink. If we drank only salt water, we would die of dehydration.

Lakes, rivers, and streams contain most of the fresh surface water in the world.

An even smaller part of the water on Earth's surface is known as **brackish water**. Brackish water is a mixture of salt water and fresh water. Brackish water is usually found where the freshwater at the mouths of rivers and streams flows into and mixes with the saltwater of oceans and seas.

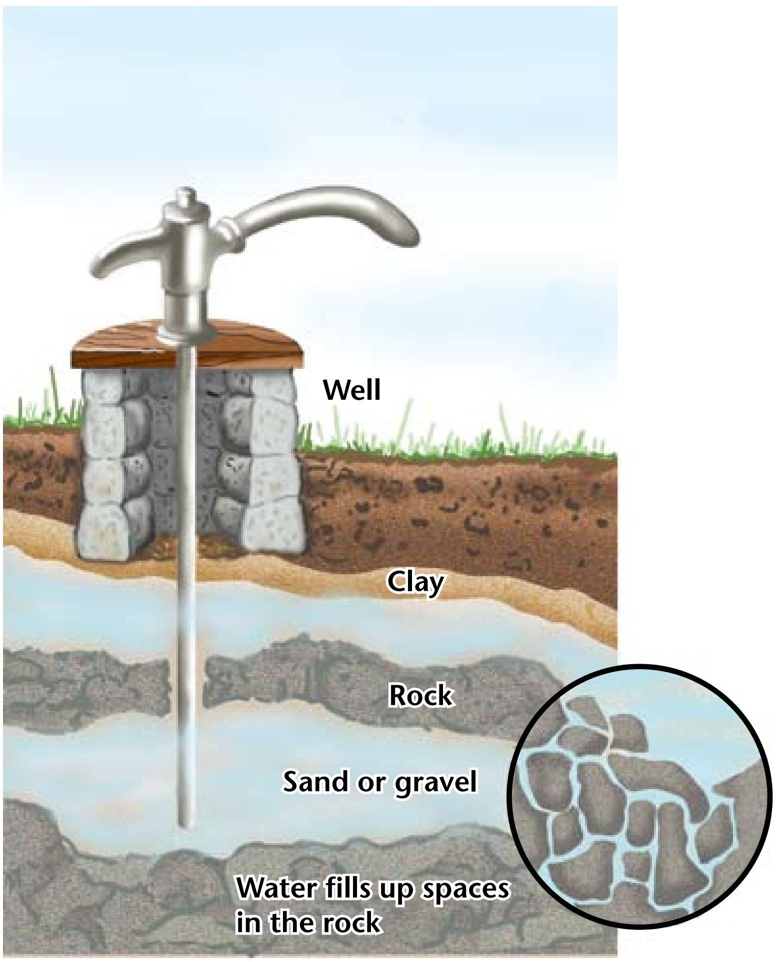
Where Does the Salt Come from?

The salt in ocean and sea water is a lot like the salt you might find in your kitchen. In fact, some of the salt that people use is produced through the evaporation of ocean or sea water. Although the water in the ocean is salty now, when the earth first formed, it was fresh. The salt in the oceans gradually built up over the billions of years that the earth has been around.

The salt in the water originally came from minerals on or near the earth's surface, or from materials on the ocean floor. As rivers and streams drain into the oceans and seas they carry small amounts of dissolved minerals with them. Over billions of years, these minerals have collected in the oceans and have made the water salty.

5

Groundwater



Groundwater Is Important

Watery Earth Fact

The U.S. Geological Survey estimates that there is more than 30 times as much water underground as there is in all the world's lakes, streams, and rivers.

What is groundwater?

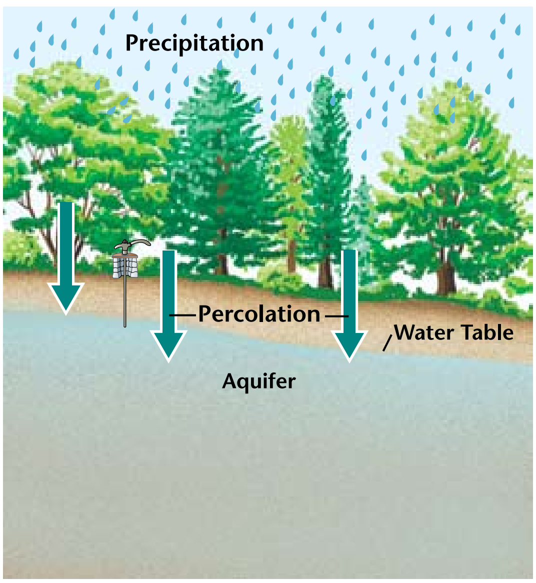
How does it get underground?

Once water lands on the ground, it either flows on the surface into a creek, stream, or river, or it slowly soaks into the ground. As a matter of fact, most water that falls on land ends up as groundwater.

Groundwater is freshwater that fills the spaces between rocks, sand, and soil underground. After rain or snow falls to the ground, gravity moves this water down through the tiny spaces in the earth.

It is difficult to picture water beneath the surface of the earth. Some people think that groundwater is stored in underground lakes, or that it flows in rivers beneath the earth's surface. Actually, groundwater looks very different from this.

The ground below the earth's surface is not just solid rock. In fact, much of it has lots of tiny spaces filled with air or water, like a sponge. Something with lots of tiny spaces that allows liquid to move through it is called **porous**. When water moves through the earth, the process is called **percolation**. Water percolates through the porous layers of the earth until it reaches a layer that it cannot pass through.



Water moves through the earth in a process called percolation.

What Is an Aquifer?

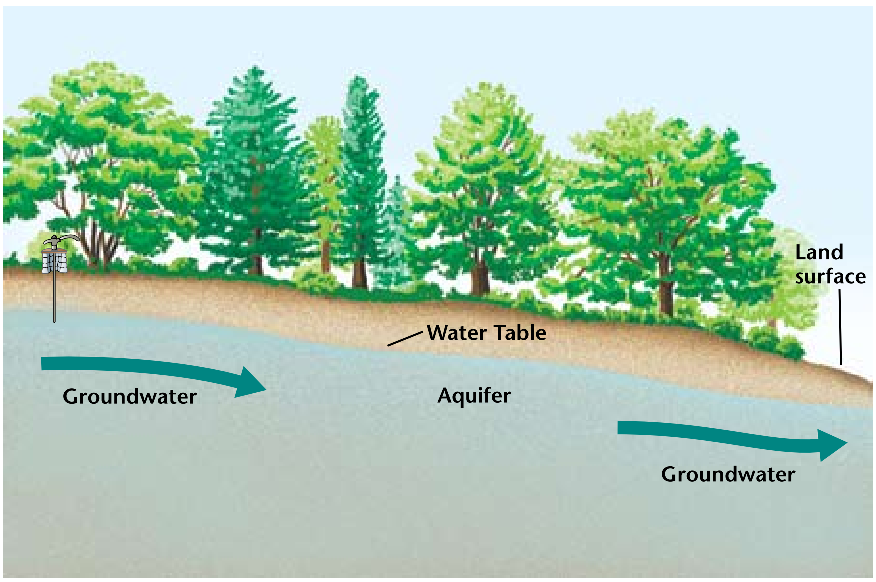
The porous underground layer of earth where groundwater is stored is called an **aquifer**. As water soaks into the ground, the aquifer fills, just like your bathtub fills with water. Just like your filled bathtub has a surface area on top that is at a certain level, the water in an aquifer fills to a level, called the **water table**. The layer of earth above the water table may be damp, but it is not completely filled with water. But, the earth below the water table fills up with water, so there are no empty spaces.

The amount of water in an aquifer does not always stay the same. If there is a lot of rain, for example, the aquifer can fill and the water table can rise. If there is a long period without rain, the aquifer might lose water, and the water table may fall.

Below the water table, the openings between the rocks, sand, and soil are full of water that moves through the aquifer to streams, springs, or human-made wells. Aquifers refill as gravity slowly causes new water to percolate down through porous rock to the water table.

Try This!

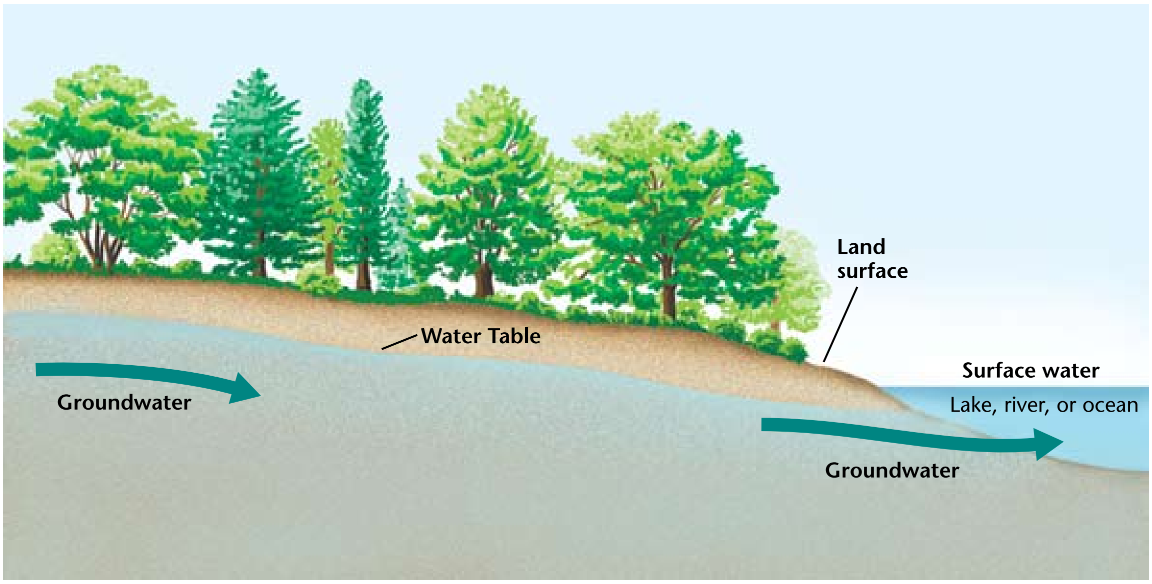
Sponges get bigger or smaller depending on how wet they are. Let a sponge dry out completely and see if you can tell how much it shrinks. Get it wet and watch it expand. Once it is soaked, can you get it to absorb more water?



Groundwater fills the spaces in the earth below the water table.

Groundwater and Surface Water Are Connected

Because of gravity, water almost always flows downward. Some groundwater moves through an aquifer until it comes to a place where the aquifer meets a river, stream, or other body of surface water. The groundwater flows into the body of water.



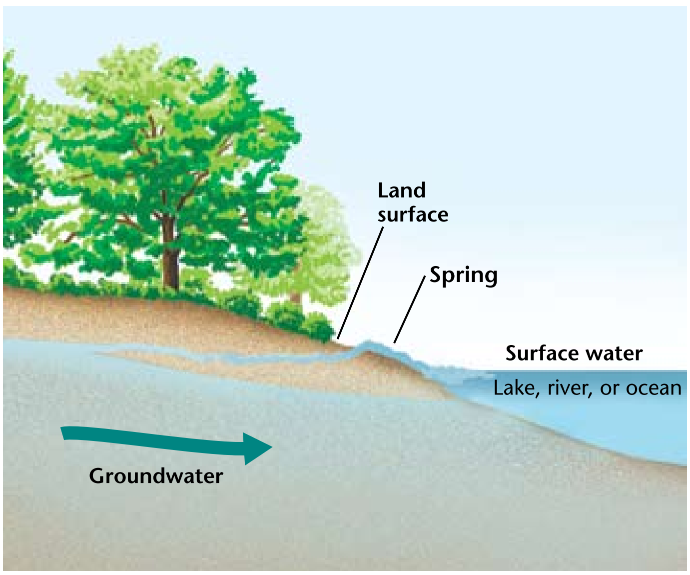
Groundwater can flow into different types of surface water.

When water moves from an underground aquifer into surface water, it usually happens below the surface of the water, so you can't see it. Sometimes you can feel the water bubbling up, though.

In other places, a river can supply the groundwater in the aquifer. That doesn't mean that it flows underground, but water can percolate from the bottom of the river into the ground below it.

Water flows from an aquifer to the earth's surface at Thunder Springs, in the Grand Canyon, Arizona.

Sometimes the water from an aquifer flows from the side of a hill as a **spring**. A spring is like a newborn stream. Often this water is very cold and clean, after being cooled and filtered by layers of rock. Many animals and birds use springs as watering holes. Sometimes springs fill up a large pool big enough for people to swim in.



Groundwater flows from a spring and becomes surface water.

Aquifers refill very slowly because water percolates very slowly from the surface of the earth. Scientists estimate, for example, that if the aquifer that lies below parts of West Texas and New Mexico was emptied, it would take centuries for it to refill. This is because there is very little rain to replenish the aquifer. In other places, where there is lots of rain or snow, the water table is closer to the earth's surface and the aquifer might never dry up.

Using Groundwater

Watery Earth Fact

About half of all the people in the United States depend on groundwater for their drinking water. Almost everyone (99 percent of people) who live in rural areas in the United States use groundwater. In Great Britain, only about 20 percent of people use groundwater for their drinking water.

Humans need fresh water to drink, but the amount of fresh water on Earth's surface is very limited. So, people in many areas rely on groundwater for their water supplies. This is especially true in areas that are not near a body of drinkable surface water. Groundwater is also used to water, or irrigate, crops in many places.

In areas with little surface water, people pump groundwater from aquifers. This windmill uses the power of the wind to pump water to a storage tank.

How do we get water out of an underground aquifer so we can use it? The most common way is to dig or drill a hole that reaches to the layer where water is stored. Water can then be pumped out of the hole to the surface. These holes are called **wells**. (The diagrams on pages 101–105 show how wells and community water systems supply water to residents.)

Watery Earth Fact

In some places in the United States, people use groundwater about 100 times faster than rainfall can replace it.

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Where Is Frozen Water?

On a hot summer day, you might think about frozen water when you want to cool a drink with ice. In the winter, you might see ice in nature. In some places you can skate on a frozen pond or build a snowman. When spring comes, the ice and snow melt and the water flows into streams and rivers, or soaks into the ground. But in some places frozen water is present all year long.

Watery Earth Fact

About two percent of all water is found in glaciers and polar ice caps. About 75 percent of all the earth's fresh water is located in these frozen sources.

When you look at this photograph of Earth from space, you will notice that the top of the planet is covered in ice. If you could fly over the world's tallest mountains, even in summer, you would notice that they also had a lot of snow and ice.

What are these areas of frozen water?

Why do scientists study them?

The Earth from space.

Glaciers

Almost ten percent of the earth's surface, mostly **Greenland** and **Antarctica**, is covered with slow-moving rivers of ice, called glaciers. A **glacier** is a huge mass of moving ice that is so big and thick it does not change much during the seasons.

Gravity and a glacier's immense weight cause glaciers to move downhill or outward in all directions. Though it may still flow and move downhill, if more ice melts from the lower part of a glacier than is replaced from above, the glacier appears to shrink.

A glacier flowing between snow covered mountains.

Thousands of years ago, there were many more glaciers than there are today. When the planet's climate was colder, during periods called **ice ages**, they covered huge areas of the earth's surface.

Word Connection

ice age—A period of hundreds to thousands of years when the climate on the earth becomes colder and wetter and much of the earth's northern hemisphere is covered by glacial ice. There have been several ice ages in the earth's history. The most recent ice age is often referred to with capital letters as the Ice Age. It began about two million years ago and ended about 12,000 years ago.

Today, glaciers are found on top of high mountains, like those in the Rocky Mountains, and the Sierra Nevada and Cascade ranges of the western United States. Glaciers are found on high mountains on every continent in the world, even Africa. When mountain glaciers melt, the run-off water can be an important source of freshwater for animals and humans living downstream.

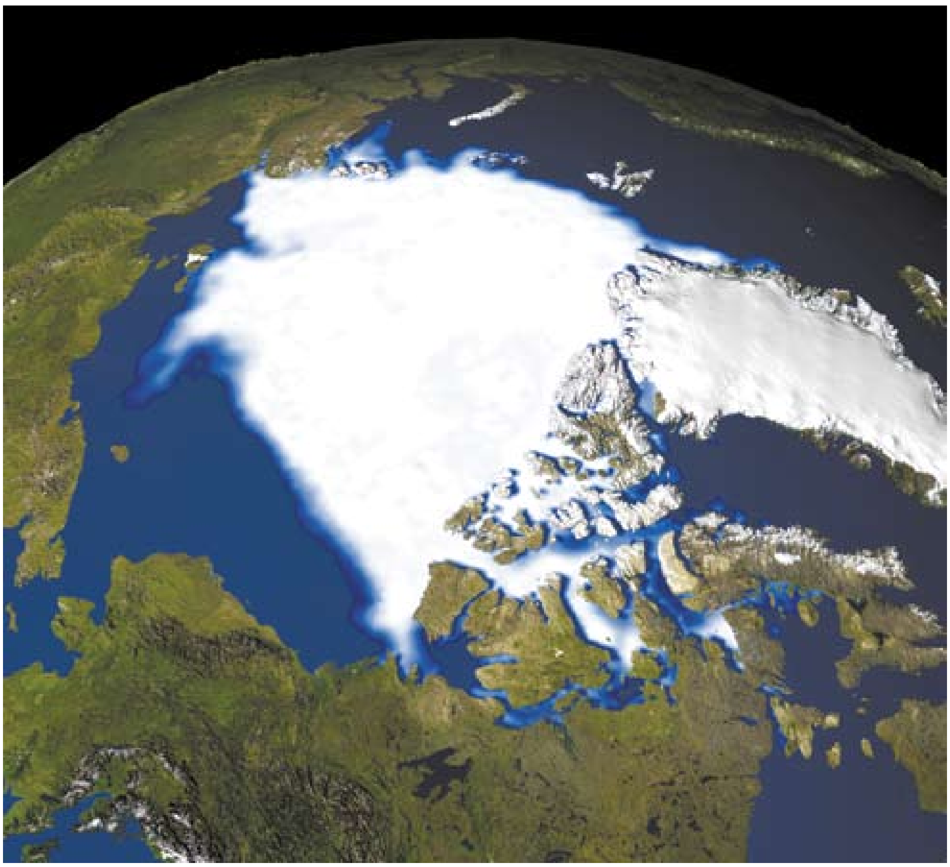
Polar Ice Caps

Watery Earth Fact

Earth is not the only planet with frozen water. Mars also has polar ice caps. Scientists studying these ice caps believe that they are made mostly of water, along with some other frozen substances.

The areas at the two poles are covered by ice caps, areas of permanent frozen water. But the ice cap at the North Pole is very different from the one that covers the South Pole.

If you look closely at the earth's northern ice cap, you'll notice that it is made up of several different parts. The largest ice cap in the north covers about 80 percent of the huge island of Greenland. On average, that ice cap is nearly 1,500 meters (5,000 ft) thick. That's as tall as four Empire State Buildings stacked on top of each other! In some places the ice is 4,300 meters (14,000 ft) thick, which is more than two and a half miles.



This computer-generated image shows the ice caps of the northern polar region and Arctic Ocean sea ice in 2004.

Although many people think the North Pole is on Greenland, it is actually located further north of the island, on a huge sheet of sea ice in the middle of the Arctic Ocean. There is no land under that ice, only frigid salt water. **Sea ice** (also called pack ice) is a thin, fragile solid layer of water that forms in the polar oceans. As the ice floats on the liquid seawater, it bumps and grinds against itself, forming ridges or breaking into smaller rafts of ice, called floes.

Watery Earth Fact

Sea ice is not as salty as the ocean water beneath it because when the water freezes, the tiny particles of salt are pushed out of the ice. So if you were trapped on arctic sea ice, as long as you had a stove to melt ice chunks, you would have a supply of fresh water to drink.

A ship floats through sea ice while the sun sets over the Bering Sea.

The South Pole is found on Antarctica, a huge land continent that is bigger than Mexico and the United States combined. Antarctica is different than the north polar ice cap because the continent is almost completely covered by a glacier. In some places, the ice sheet is as thick as 4.3 kilometers (2.7 miles) thick.

The environment in Antarctica is very harsh. It is the coldest place on earth, and winds have been recorded there as fast as 320 kilometers per hour (200 miles per hour). Yet even in this harsh environment, marine animals, like penguins and seals, live along some of Antarctica's coastal areas where there is no ice.

A tracked vehicle travels over the endless ice of Antarctica.

Glaciers and Ice Caps Change Over Time

Word Connection

climate—The average weather conditions in a region over a number of years.

The frozen water in glaciers and ice caps is affected by the **climate**. If the environment heats up, ice melts. If the environment gets really cold, water freezes.

The earth's climate is always changing. Some of these changes happen very slowly. Over the years, there have been many warm periods, such as when the dinosaurs lived (about 100 million years ago).

Other climate changes happen more quickly, so that we can notice them if we look at nature. One kind of fast change is the annual cycle of climate change we know as the seasons. When summer comes to the polar regions, some snow and ice melts, but when winter returns, so does the snow and ice.

View from space of winter in Iceland.

View from space of summer in Iceland.

Why Scientists Study Frozen Water

To learn more about the effects of human activities on our planet, scientists try to understand the connection between the earth's climate and frozen water.

Over the past few decades, glaciers all over the world have begun to melt. This concerns both scientists and officials who plan for water use by people. If all the glaciers melt away, there may be less fresh water available for people and animals.

For a long time scientists believed the ice at the North Pole never melted, but recently they have noticed changes to the sea ice. Data collected by U.S. Navy submarines tells scientists that the ice draught (the amount of ice below the surface of the water) in the Arctic has thinned by more than 40 percent over the past 40 years.

Scientists aren't sure what these changes may mean, but they collect data about the polar ice caps and sea ice in order to understand how the climate changes, and to discover whether human activities might cause those changes.

Glacier and Polar Ice Cap Facts

- Glaciers cover about 11 percent of all land on earth.
- Antarctica contains almost 90 percent of the earth's ice; Greenland contains almost 10 percent. The rest is found in glaciers and snow packs around the world.
- According to the National Snow and Ice Data Center (NSIDC), if all glaciers melted today the oceans would rise about 70 meters (230 feet).
- During the last ice age (when glaciers covered more land area than today) the sea level was about 120 meters (400 feet) lower than it is today. At that time, glaciers covered almost one-third of the land.
- During the last warm spell, 125,000 years ago, the oceans were about 5.5 meters (18 feet) higher than they are today. During another warm spell, about three million years ago, the oceans could have been up to 50 meters (165 feet) higher.
- The Emmons Glacier has the largest surface area (11 square kilometers or 4.3 square miles) of any glacier in the United States outside of Alaska. It is located on Mt. Rainier in Washington State.

Icebergs

Water Fact

In the Arctic, the biggest iceberg thus far recorded was estimated to be about 11 kilometers (7 miles) long and 5.5 kilometers (3.5 miles) wide. This giant was spotted near Baffin Island in 1882.

Near the very cold polar regions, glaciers can advance all the way to the sea without melting. When they reach the sea, the action of waves and tides strikes the front edge of the glacier, breaking off chunks. The chucks of ice, called icebergs, float out to sea where they are pushed around by winds and ocean currents.

Although icebergs can come from any glacier that reaches the sea, like those in Alaska, Canada, and Norway, most icebergs begin their journey from the giant polar ice sheets covering Greenland and Antarctica. Up to 10,000 to 50,000 icebergs sheer away from the Greenland ice cap each year, and about 100,000 icebergs break off and float away from Antarctica.

Icebergs come in many shapes and sizes. Greenland's icebergs have an average area of 1.6 square kilometers (.6 square miles) and a height of 300 meters (975 feet). Those from Antarctica can be ten times as large as that. Large icebergs can travel many thousands of miles before warmer sea water, sunshine, and salt cause them to melt into the ocean.

A partially melted iceberg.

Science and Technology: Using Icebergs for Drinking Water

Since the snow that formed the ice that becomes an iceberg was mostly clean and pure, and since it is fresh water, some people have thought about using icebergs as a resource for human needs. According to NASA scientists, an iceberg the size of a city block could provide a source of clean drinking water for a city of 50,000 people for perhaps ten years or more. People have proposed different ideas for towing huge icebergs to areas where fresh water is scarce. Unfortunately, so far these ideas have been difficult to carry out, or they would cost too much money.

In March of 2000, a large piece of ice broke off from Antarctica's Ross Ice Shelf. Officially named Iceberg B-15A, it was nearly the size of Texas. This photograph is a view from space of the Ross Ice Shelf and some of the nearby icebergs that broke from it. Can you find Iceberg B-15A?

Icebergs Pose a Danger

Word Connection

density—How heavy something is for its size.

Have you ever heard the expression, "That's just the tip of the iceberg"? Most of an iceberg is submerged below the waterline. Usually only about 1/8 of an iceberg can be seen above the surface of the water. This is because ice is only slightly less **dense** than water, so it floats with most of its **icy bulk** below the surface. A piece of cork, for example, is much less dense than water, so most of it sticks out of the water when it floats.

One reason icebergs are dangerous to vessels at sea is because only a small part of an iceberg is above water. Most ships are not strong enough to withstand a direct hit by an iceberg, because the ice is strong enough to tear through steel.

Try This!

Fill a tall drinking glass halfway with water. Drop in a piece of a carrot and watch what happens. Now add an ice cube. The carrot sinks because it is denser than water, but the ice cube floats because it is slightly less dense than water. Try a cork to see how much higher it floats in the water than the ice.

The part of the iceberg that is underwater is bigger than the part in the air.

One of the most famous disasters at sea—the sinking of the **Titanic** on the night of April 14–15, 1912—was caused by a drifting iceberg. About 1500 people lost their lives after the iceberg gashed the steel hull of the ship, causing it to sink.

In response to this tragedy, the **International Ice Patrol** was set up in January, 1914. Its mission is to observe and track icebergs, and to warn ships about dangerous icebergs.

Most people might think that large icebergs are the most dangerous, but that is not the case. Big icebergs are easier to spot by people or radar. The smaller icebergs can hide in the waves, making them difficult to see and more dangerous. These small icebergs are called "growlers" because of the sound made by trapped air that escapes as the ice melts. It sounds like the growl of an animal. **Growlers** come in sizes anywhere between a car and a house. The smallest icebergs are known as "bergy bits," and these also pose a danger to ships, especially smaller fishing boats with thinner hulls.

7

Water in the Air

Evaporation and Condensation

When a raindrop falls from the sky many things can happen to it. It may percolate into the ground. It may land on surface water. Or, the raindrop may **evaporate**—especially if the sun comes out again. Once it evaporates, the water from the raindrop is in the air. It is no longer liquid though. Now it is a gas called **water vapor**.

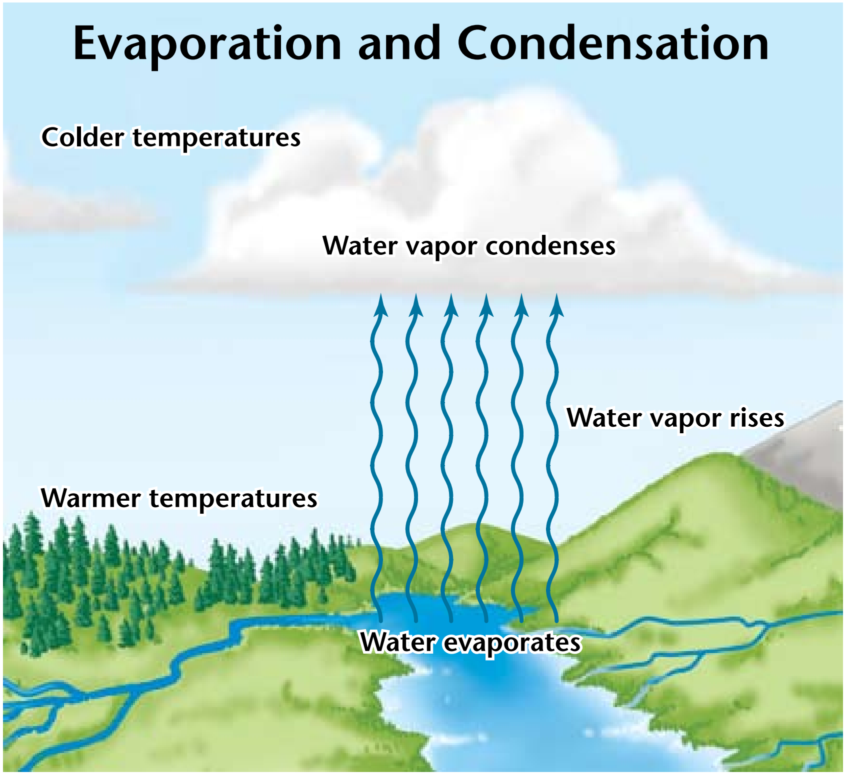
Word Connection

evaporate—To change from a liquid to an invisible gas. When water evaporates it becomes an invisible gas called water vapor.

Watery Earth Fact

Once water evaporates, it can exist as water vapor in air for about ten days before it condenses and then falls back to the ground as precipitation.

The water vapor rises through the air. The higher above the earth the water vapor travels, the colder the air is. When the air is cold enough, the water vapor in the air **condenses**. This means the water in the air changes from a gas back to a liquid.



Water evaporates at warmer temperatures and condenses at cooler temperatures.

Tiny liquid drops of water that have condensed out of the air stick onto tiny bits of dust and form clouds. There are millions of water droplets in a cloud!

The wind may blow the cloud a long distance. As the cloud travels, the water droplets in the cloud collide and merge with other droplets and get bigger. Once the water droplets get big and heavy, they fall to the earth as precipitation.

These dark clouds are letting loose with a rainstorm.

Now there is a drop of water on the ground again (unless of course it fell into a body of water)! Perhaps it will percolate into the ground and find its way to an aquifer for a while.

Or, perhaps the water will fall as snow on top of a large mountain. When the weather warms, maybe it will melt and flow down to a river, which will carry it to the ocean. Then again, maybe it will land in a puddle and evaporate back into the air within an hour or two.

What do you think might happen to it? If you were the raindrop, which journey would you want to take?

Looking at Water in the Air

Sometimes you can see water in the air and sometimes you can't. The photos below show some of the ways you can see water in the air.

This is one form of steam you may have seen before.

This steam forms in the air in Yellowstone National Park.

Fog is very common in marine areas.

Water Vapor and Humidity

The air all around us contains water vapor. In some regions of the world there is a large amount of water vapor in the air. When there is a lot of water vapor in the air, we say that the humidity of the air is high.

Word Connection

humidity—The amount of moisture, or water vapor, in the air.

The air in hot, wet areas is often bursting with water vapor. In a tropical rainforest, for example, it rains a great deal. When the sun comes out after a rainstorm, it causes the water to evaporate quickly. As the large amount of water from the rainfall evaporates, the amount of water vapor in the air builds up quickly.

In other regions of the world, there is very little water vapor in the air. The air in dry areas usually has very little water vapor in it. In a desert or around the polar regions, for example, there is very little precipitation. So there is generally a small amount of water vapor in the air. When there is little water vapor in the air, we say that the humidity of the air is low.


In the arctic, where this bear lives, the humidity is often very low.

What is the humidity like where you live? Check the weather page in your local newspaper to find out. If you live in a Southwestern state, such as Arizona, New Mexico, or Western Texas, the humidity is likely to be relatively low. This is because those areas get little precipitation during the year. If, however, you live in a Southeastern state like Florida, Mississippi, or South Carolina, the humidity is likely to be high.

Except during the monsoon season in summer, the humidity in the Sonoran Desert is very low.

The heavy rainfall in this forest leads to lots of green and high humidity.

Some areas in Hawaii, like this coastline, can be very humid.

Types of Condensation

Dew

Have you ever woken up on a cool, clear morning and seen droplets of water outside on the grass or shrubs? You may have wondered where the droplets of water, called dew, came from. The sky is clear. It hasn't rained. So how did the dew mysteriously appear?

Dew is formed from the water vapor in the air. For dew to form, the air temperature must drop low enough for the water vapor in the air to condense. If the temperature of the air is above freezing, then when the water vapor condenses, it becomes liquid. We call the liquid water dew.

Dew collects in droplets on this grass.

This spider web can hold a lot of dew.

Frost

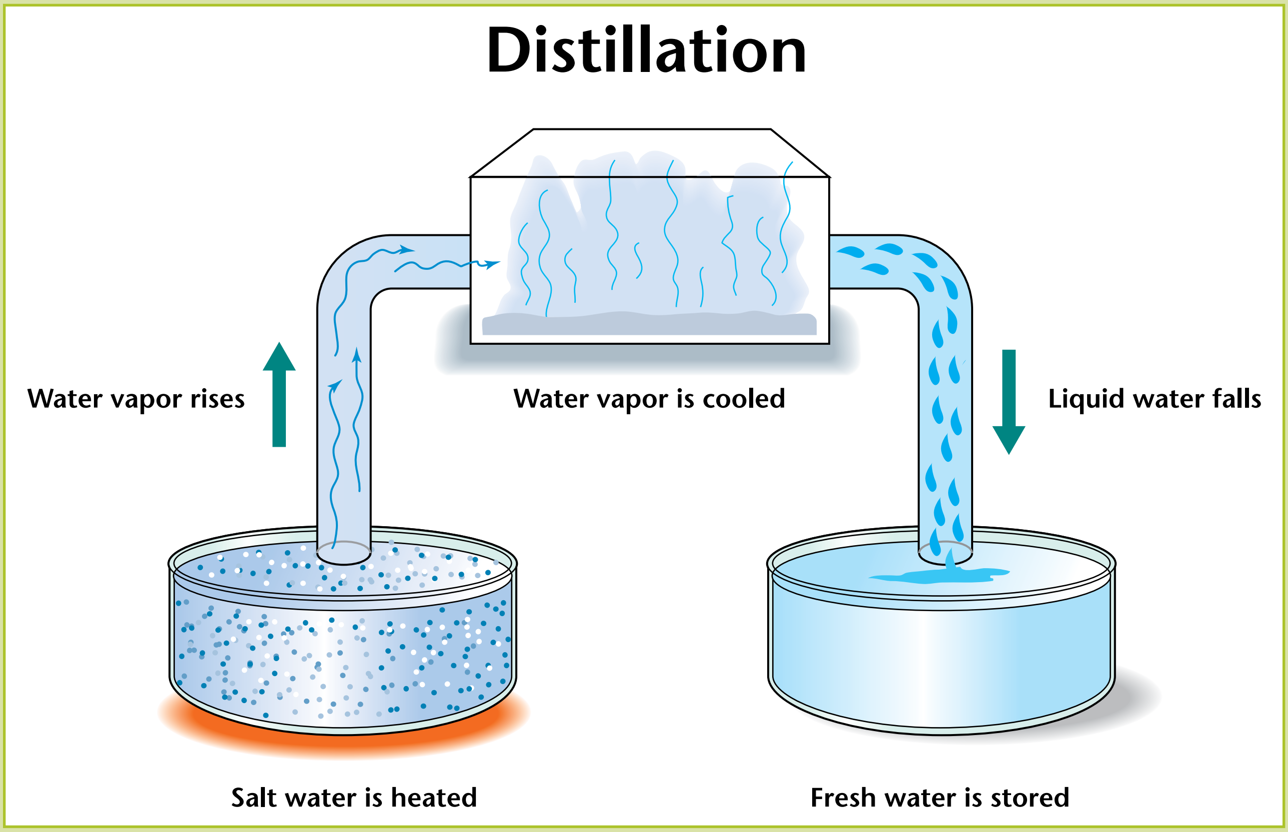
Have you ever looked outside on a freezing, clear morning and seen a layer of ice on a car window or the leaves of a plant? Layers of ice, know as **frost**, form when water vapor condenses. Like dew, frost forms when the air temperature drops low enough for the water vapor in the air to condense. If the temperature of the air is below freezing, then when the water vapor condenses, it becomes icy frost.

On a freezing morning, frost collects on these Oregon grape leaves.

Desalination

In some regions of the world, there is not enough fresh surface water or groundwater to meet the needs of the population. Saudi Arabia, for example, does not have enough fresh water for its inhabitants. However, since Saudi Arabia borders the Red Sea and the Persian Gulf, the people there have access to a huge supply of salt water. In these areas, desalination is sometimes used to provide drinking water supplies.

Although humans can't safely drink salt water, it is possible to use evaporation and condensation to take the salt out. Desalinating (taking out salt) salt water creates fresh water for drinking, as well as for agricultural and other uses.



Desalination using the process of distillation creates fresh drinking water.

Desalination is a process that removes minerals, including salt, from salt water, brackish water, and even waste water. Scientists and engineers have developed several methods to remove salt from water. One of these methods is called distillation. During **distillation**, liquid water is heated until it evaporates to become water vapor. Unlike the salty liquid, the water vapor is fresh water. When this salt-free water vapor cools, it condenses back into liquid water. The fresh water that was collected is then safe to drink.

Word Connection

desalination—A process that removes minerals, including salt, from salty or brackish water.

8

The Water Cycle

It's the Same Water

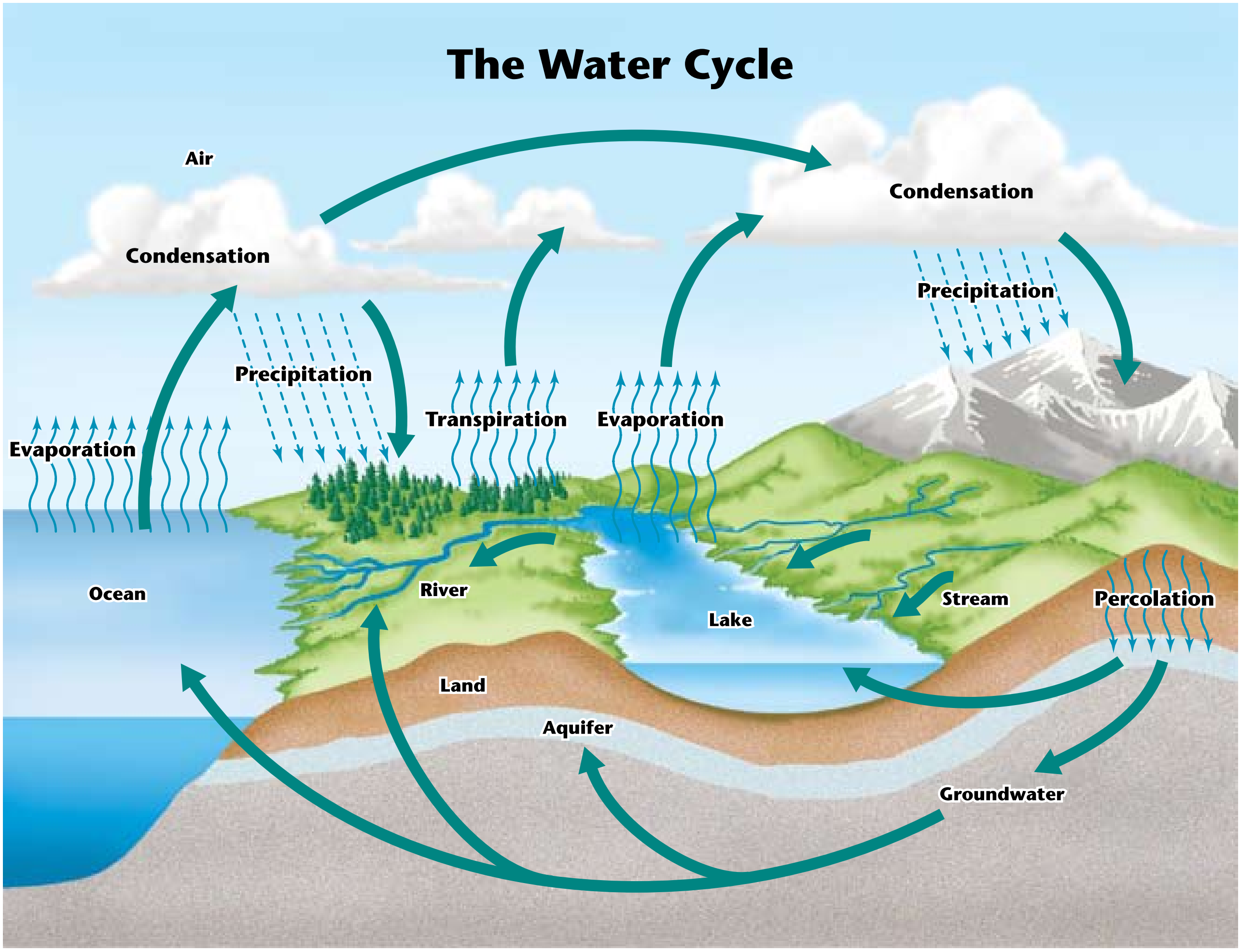
The water you used to brush your teeth this morning might have been part of a cloud last week. It might have been part of the ocean, or stored underground in an aquifer, last year. Your grandparents might have used the same water to bathe your mother or father when they were babies. And long, long before that, a dinosaur mother may have brought her baby to drink from a puddle containing the very same water.

We don't know the exact history of each drop of water that we use, but we do know that almost all of the water on Earth has been around for billions of years. The water has changed forms and locations many, many times, but none of it has disappeared, and almost no new water has been added either. So, the water that we use today is the same water that people used long ago. It is the same water that prehistoric plants and animals used before people were alive.

Watery Earth Fact

Icy comets occasionally collide with the earth, bringing small amounts of "new" water with them.

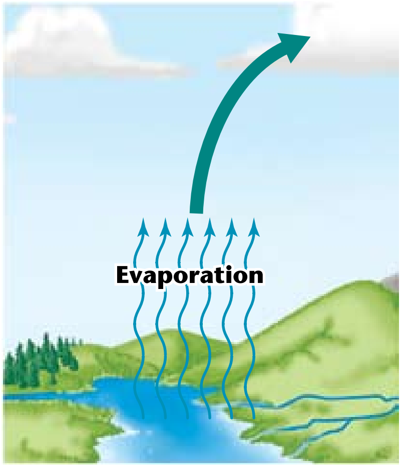
Each drop of water follows a different path, but all of this water circulates around the earth as part of a never-ending process called the water cycle, which is shown on the diagram below.



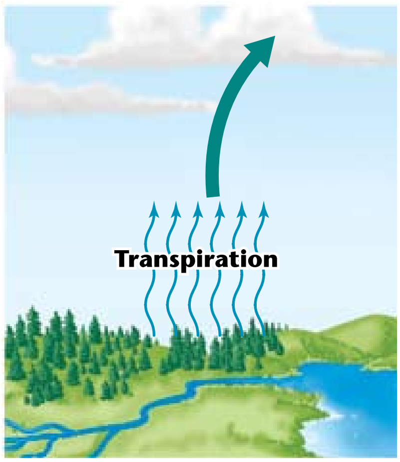
How Does the Cycle Work?

The water cycle works because of many natural processes that go on all the time. You have already learned about many of the processes described below:

- **Evaporation** brings water into the air (as water vapor) from surface bodies of water (lakes, oceans, rivers, etc.), the land, or even underground. Heat energy, like warmth from the sun, can cause evaporation.



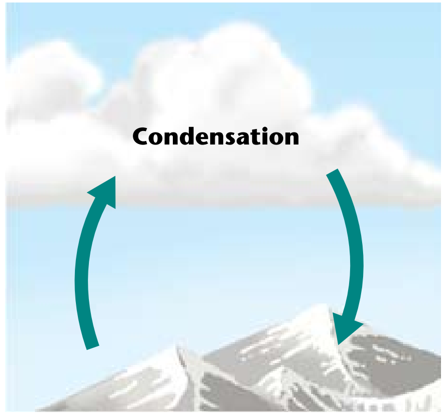
- **Transpiration** is related to evaporation; it's one of the ways that water can move from underground into the air. It happens when trees and other plants give off water vapor from their leaves. Water in the ground moves up from the roots of trees and plants. It travels all the way through the plant, and eventually evaporates from the leaves into the atmosphere.



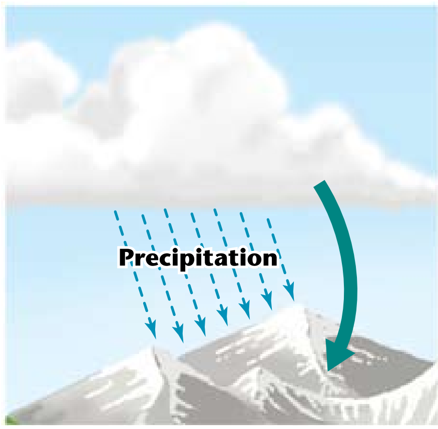
Watery Earth Fact

Some large trees can add 70 or more gallons of water to the air per day through transpiration!

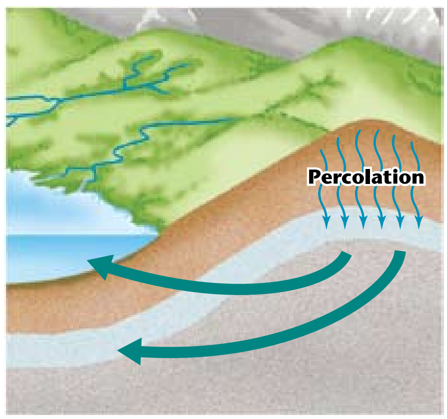
- **Condensation** causes water vapor in the cool air that is high in the sky to form clouds and, eventually, to fall back to land as precipitation. The wind often carries clouds long distances before they produce rain, snow, or hail.



- **Precipitation** is the water vapor in clouds that condenses and falls to the ground as rain, snow, or hail.



- **Percolation** describes the process of water moving underground from the Earth's surface. Much of this groundwater is stored in aquifers.



There are also things in nature that help drive the water cycle.

- **Gravity** is also an important mover of water. Gravity causes percolation. It causes surface water to flow downward from streams and rivers to the ocean, and it carries melting snow or ice, or runoff, down the slopes of mountains. It also plays a role in moving water underground between surface bodies of water and aquifers. And gravity is what makes rain, snow, and hail fall downward towards the Earth.
- **Temperature** changes cause evaporation and condensation. Heat energy from the sun affects the Earth's temperature, which causes water to change forms as it moves through the water cycle. At warmer temperatures, water evaporates; at cooler temperatures, it condenses.

The result is that water is always moving and changing. These processes can happen in many different orders, and all of them are happening somewhere on Earth at the same time. This is why every drop of water follows its own unique path around the water cycle.

How Long Does the Cycle Take?

Water has been moving through the water cycle for all of Earth's history. But the length of time a drop of water might spend on each part of its "journey" around the water cycle varies widely. For example, a drop of water that falls to the sidewalk as part of a short rainfall will probably evaporate very quickly and become water vapor in the air within hours.

Watery Earth Fact

Glacier ice more than 100,000 years old is found at the base of many polar ice caps.

From there, it is likely to become part of a cloud and fall back to the ground again within a couple of weeks. If it falls into a river, it may make it to the ocean within a month or so. If it percolates underground, it may stay there for a very long time, or it may be pumped to the surface and used by humans very quickly. If it lands on a glacier, it may remain frozen there for thousands of years.

Think About It!

You have now learned some facts about water:

- All living things need water to survive.
- All water on Earth is connected by the water cycle.
- We can't make new water.

As you continue your exploration of watery Earth, think about why it is important to take care of water resources.

9

Water Systems

Where Does Water Come From?

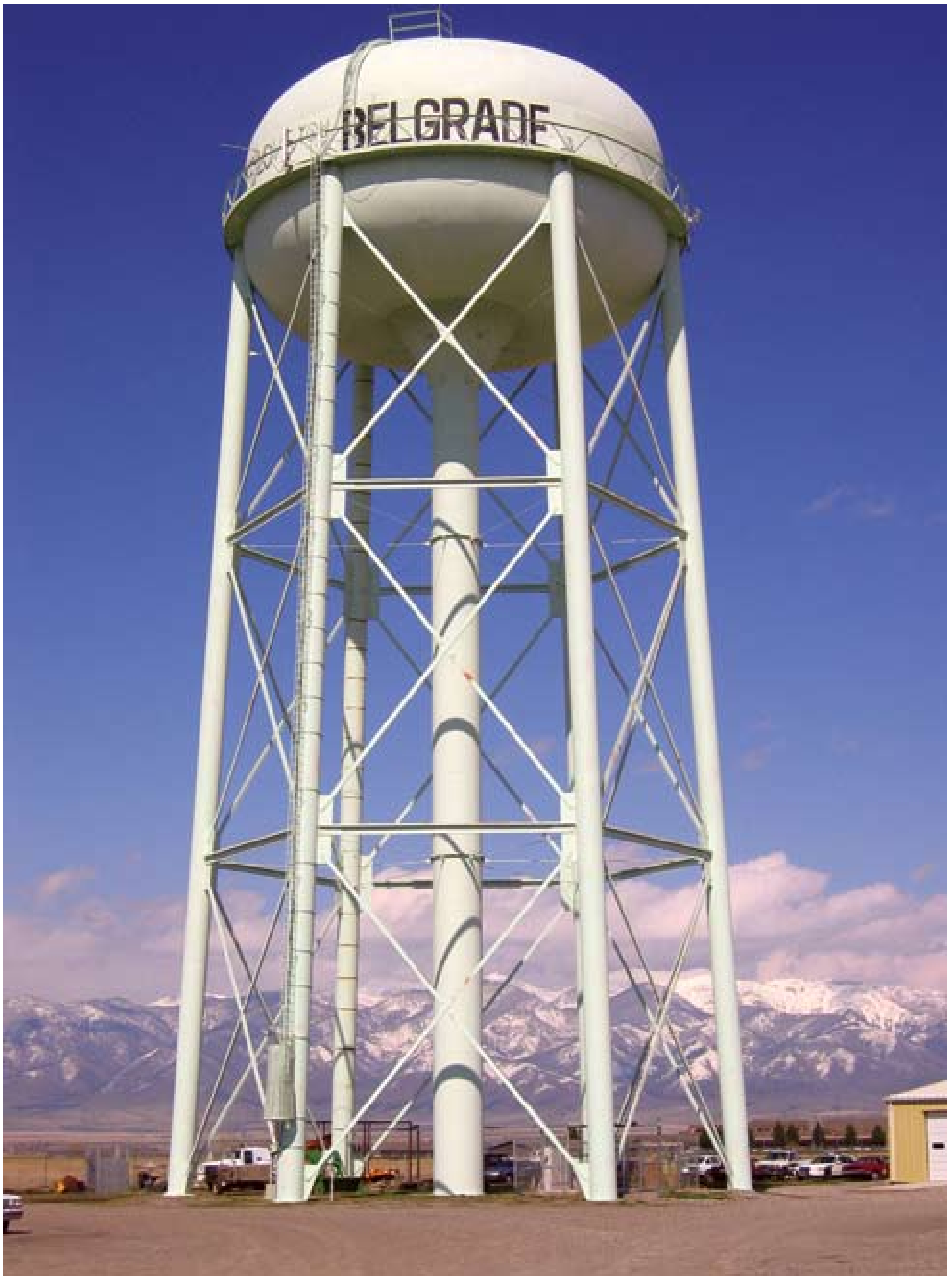
When most of us want clean, clear water, all we have to do is turn on a faucet. In a typical community, such as a city, county, or town, there is usually an agency that is responsible for your water supply. People pay the agency a fee and the agency provides them with the water they want and need.

The people who work at your water supply agency are in charge of a many things. They must find a source for the water. They make sure that the water source will be able to satisfy the community's water needs. The community may be close to the water source or it may be far away from the source. Either way, the water supply agency needs to pump and pipe the water to the community.

Word Connection

agency—A business or service group whose job is to help others.

In a typical water supply system, the source of water is either an above ground reservoir or an aquifer.



Many communities, like this one in Montana, have above ground water storage tanks.

Watersheds

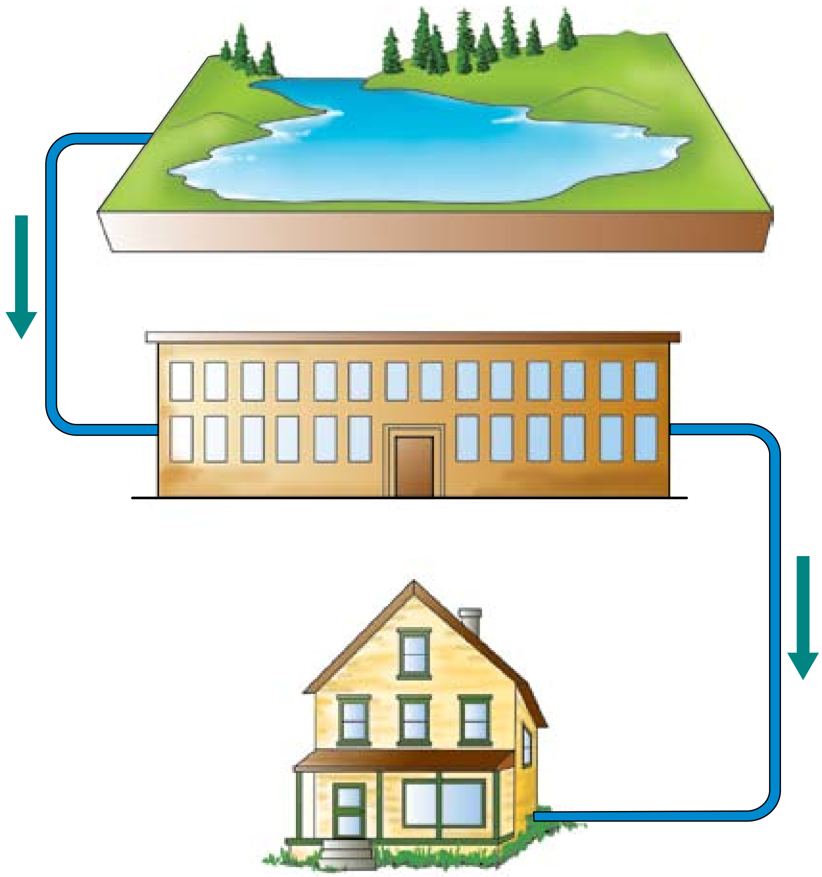
The source of a community's water is usually a watershed. A **watershed** is a land area that drains to a waterway such as a stream, river, lake, marsh, or the ocean. Our actions in a watershed can directly affect the quality of the water that flows from it.

Large watersheds, such as the Mississippi river basin, may contain thousands of smaller watersheds. These smaller watersheds provide water to a number of different communities.

Treating and Delivering Water

The water supply agency must also ensure that the water is ready for use. The agency often designs and builds a water treatment plant to clean and disinfect the water. Usually the treatment plant has filters that remove large objects like sticks and leaves. There are also areas in the treatment plant that can remove small particles such as dirt. Also, the plant must be able to disinfect the water by removing harmful chemicals and by killing harmful microorganisms. Finally, the water supply agency must have a way to deliver the clean water that each home or business depends on.

The following diagram shows and explains how a typical water supply agency might find, clean, and deliver water to the community:



1. The water comes from a reservoir or aquifer. The reservoir or aquifer if filled by precipitation and run-off.
2. The water is filtered and disinfected to make it drinkable.
3. The water flows to your household.

Technology and Innovations: Wells

A long time ago when people wanted water, they had to go to a river or lake and carry the water away. One day, someone noticed a place where water was bubbling up from a spring. An artesian spring occurs when water in an aquifer cannot easily flow through the rock. This water is under pressure, like the water that comes out of an eyedropper or a squirt gun, and it flows naturally.

Maybe you've seen advertisements for bottled "artesian-well drinking water." Is this the same as water that comes from a spring?

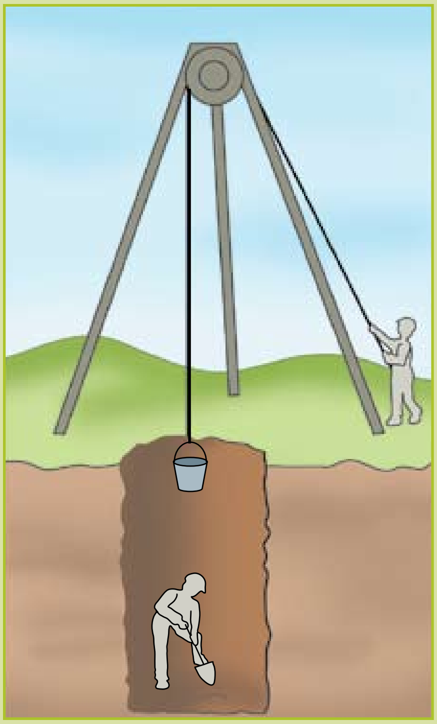
The water may be the same, but the way it comes to the earth's surface is different. This water is also in an aquifer, but there is no place for the water to flow from the aquifer. Because new water can still be added, it is also under pressure, but unless a hole is drilled into the aquifer, the water does not go anywhere.

A long time ago, humans figured out that if they dug a well, they might find this pressurized water in an aquifer. Instead of having to live near a river or lake, people could live in other places, as long as there was an aquifer that could be reached by a well. (Sometimes aquifers are too deep or hard to reach, and humans cannot reach the water.)

People dig three main kinds of wells.

The oldest kind of well is called a **dug well**, because people used to dig them with their hands, a pick and shovel, and a bucket. They would dig and dig until they reached the water table and found water.

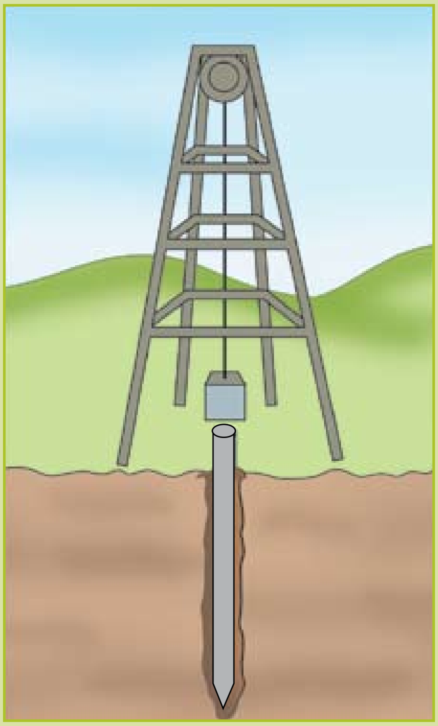
A dug well works if the ground is soft and the water table is close to the surface. They are often lined with stones to prevent the sides of the hole from falling in. They cannot be dug much deeper than the water table. Have you ever tried to dig a hole at the beach? It keeps filling up with water.



Can you imagine how hard it would be to dig a well with a shovel?

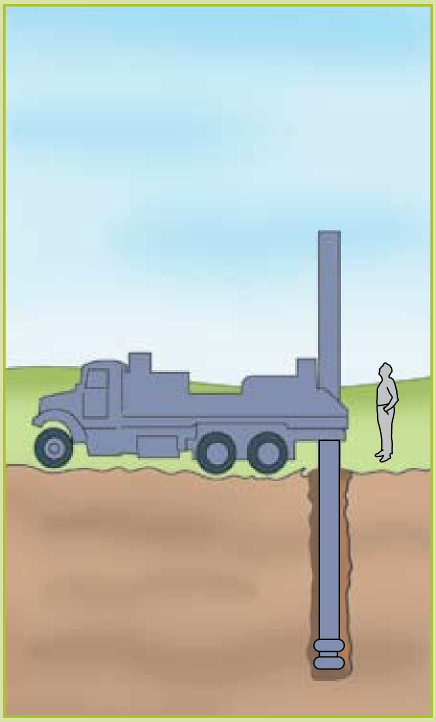
Modern wells are made with large machines that can reach deeper than a dug well. There are two main types of modern wells: driven wells and drilled wells.

Driven wells are built by pounding a narrow pipe into soft earth, such as sand or gravel. A screen usually covers the bottom of the pipe to filter out sand and other particles. These wells cannot be very deep because the water table must be close to the surface.



Driven wells are best when the water table is close to the surface

Drilled wells can be drilled deep into the ground, more than 900 meters (3000 feet) deep. But they use fairly complex machine called a **drill rig**. Drill rigs can be mounted on big trucks. Depending on the type of rig, drill rigs use a drill bit that smashes or chews away at the rock. Once the hole is made, a pump can be placed at the bottom to bring the water up to the surface.

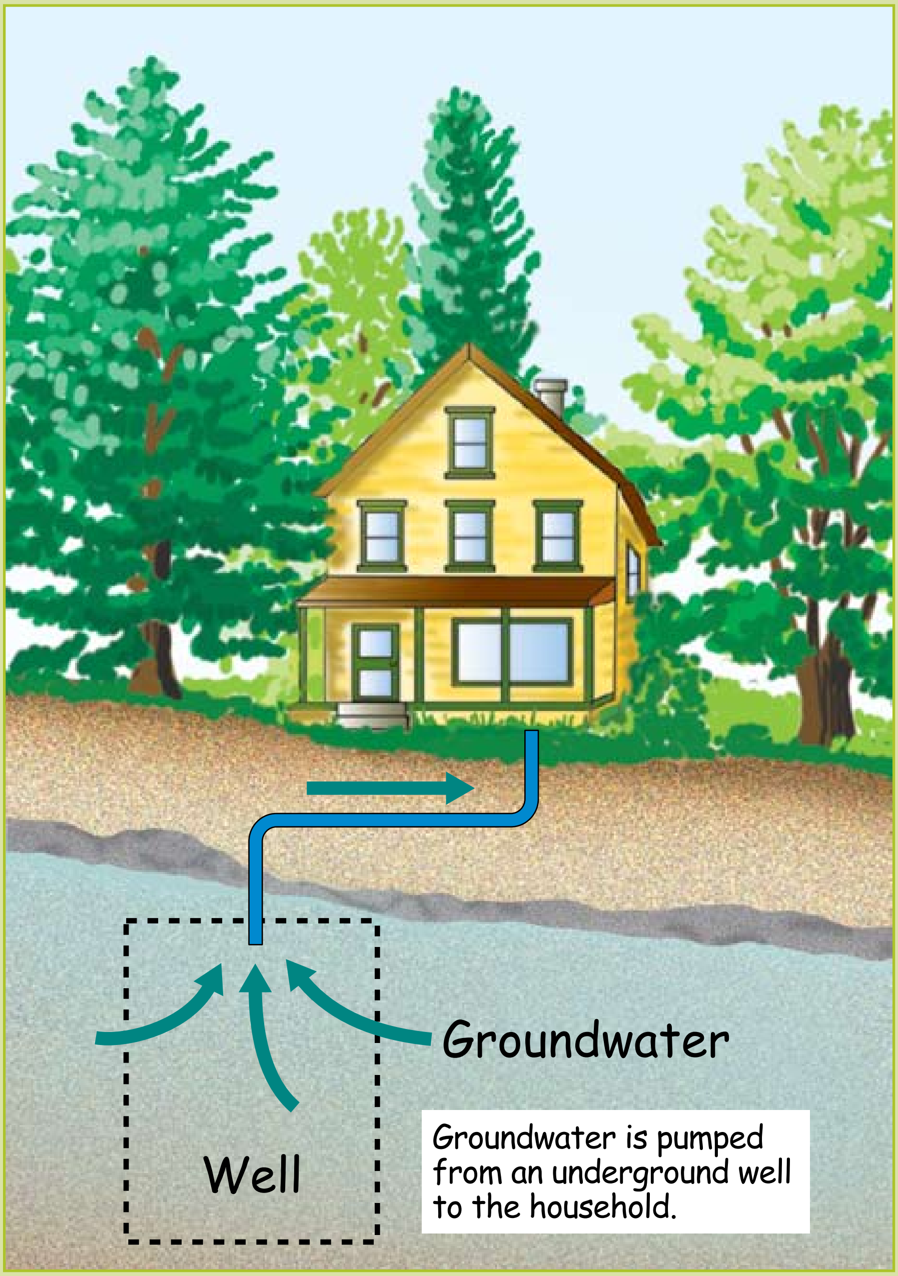


Drilled wells can go very deep into the ground.

Wells are extremely important all over the world. In many places they give people a steady supply of water to use at home, to water crops, or for factories. Where surface water is scarce, such as in deserts, people usually can't survive without groundwater brought to the surface by a well.

Do you get your water from a well?

The picture below shows how groundwater gets from a well to a home.



What Happens to Water After Use?

We don't often think about what happens to water when we're finished using it. Do you know the answers to these questions?

- When you finish your bath and the tub drains, what happens to the water?
- When you brush your teeth and water flows down the drain, where does that water flow to?
- When you flush the toilet, where does that waste and water go?
- When you finish washing your clothes, what happens to the water that drains out of the washing machine?

Word Connection

wastewater—Water that has been used and needs to be cleaned.

In many communities, there is a public agency that thinks a lot about these questions. Sometimes, the agency responsible for your **wastewater** system is different from the one in charge of your water supply system.

The people who work at your wastewater agency are in charge of a number of things. They design and build systems that handle our wastewater and they keep those systems working properly. They make sure your wastewater gets from your household to the treatment plant. There, they treat the wastewater and release it back into the local environment.

This manhole cover is a doorway to the sewer pipes below this street.

The following are some of some typical steps in wastewater treatment:

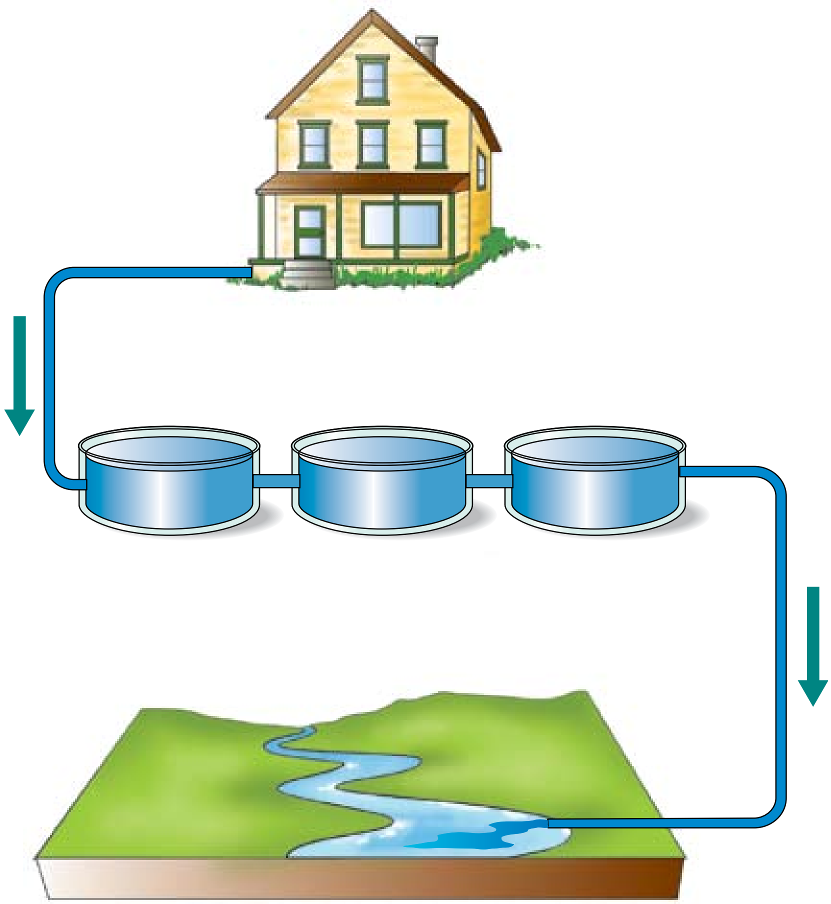
- Wastewater flows through filters that remove large objects such as toilet paper.
- Wastewater flows to large tanks. Materials in the wastewater are allowed to sink to the bottom of the tanks.
- Bacteria digest remaining material in the wastewater.
- Bacteria settle to bottom of the tanks.
- Chlorine is used to disinfect the wastewater.
- Wastewater is pumped out of treatment plant and into nearby body of water, or onto land. In some areas, the water is used to water crops.

Word Connections

bacteria—Microscopic living things that can feed on dead organisms. (The singular form is bacterium.)

chlorine—A chemical used to clean water.

The following diagram shows and explains how a typical community might treat and dispose of wastewater.



1. The water flows from your household.
2. After use, the water is piped to a wastewater treatment facility. It is filtered and disinfected.
3. The treated water is released back into the water cycle.

Technology: Septic System

You've learned that many communities depend on public or private agencies to deliver their water and to dispose of their wastewater. Other households rely solely on themselves for their water and wastewater needs. For example, a small percentage of households in the U.S have a well and **septic system**.

After use, the wastewater flows to an underground storage tank. The solid wastes, including toilet paper, sink to the bottom of the tank. Bacteria are often added to the tank to help digest the solid wastes. When the tank is full of solids, it is pumped and taken to a water treatment plant.

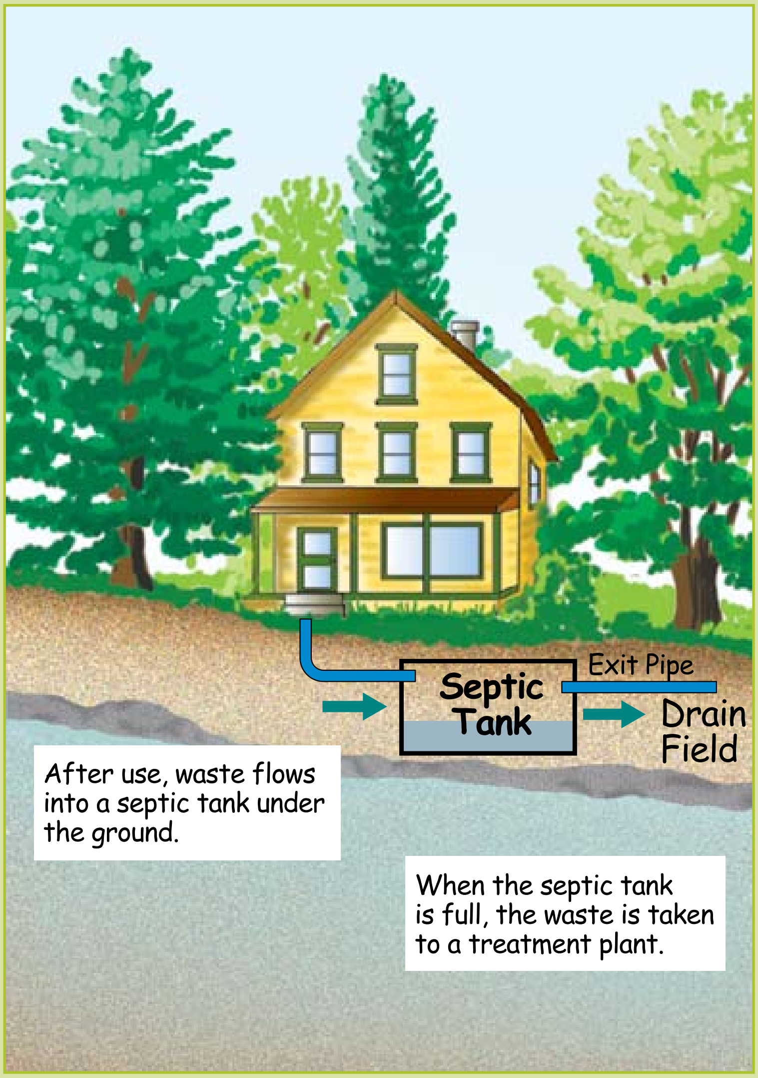
Meanwhile, the excess water flows through an exit pipe in the tank into a drain field. Drain fields are a system of pipes, surrounded by crushed stone, that allows water to drain over a large area. This helps to keep pollutants from building up too much in one place.

Does your home have a septic system?

This picture shows what happens to wastewater with a septic system.

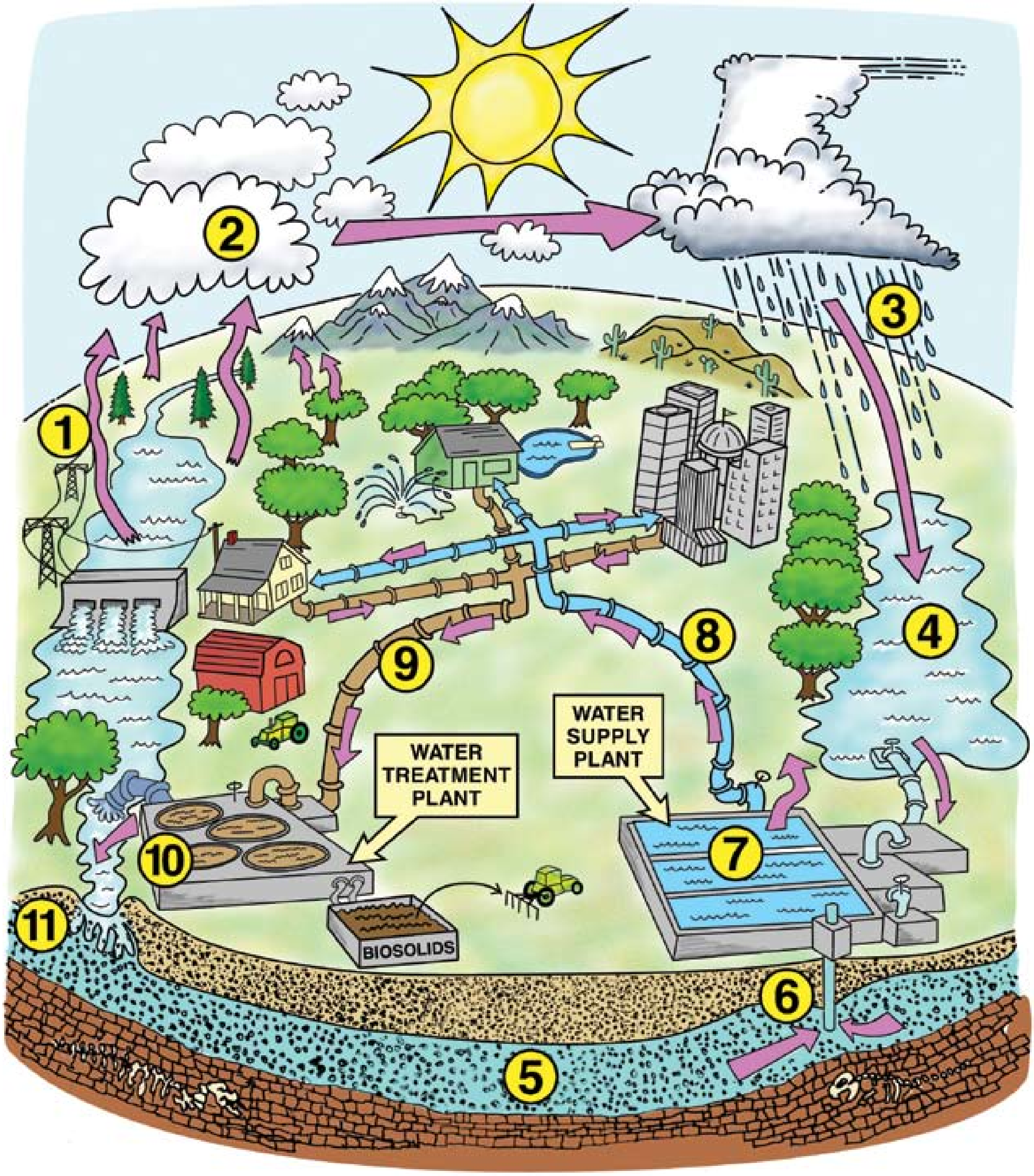
Watery Earth Fact

Ninety percent of urban sewage in the world's poorer countries is released into rivers, lakes, and coastal waterways without any treatment.



The Big Picture

Follow the numbers in the community below to see how water makes its way around it.



10

Conserving Water Resources

Not Enough Water

In Chapter 2, you read about how animals, plants, and people need water to survive. We drink water, use it to grow our food, and pour it in a dish for our pets.

What happens when there isn't enough water for these uses?

When a natural resource is in short supply, we say that there is a shortage, or that the resource is scarce. Water, like any natural resource, can be scarce if there isn't enough to meet the needs of humans, animals, or plants.

If the amount of water on Earth always stays the same, how can water become scarce?

There are many reasons why water resources might become scarce. Some of these shortages occur naturally, and some of them are caused by human activities.

Natural Water Shortages

Although the amount of water on Earth stays the same, the amount of available water can be different, depending on where you are. For example, deserts are dry places that receive less rain than tropical rainforests. The amount of rain that falls in a certain place depends on many things, but one of the most important is the **climate**. If an area has a wet climate, there is more water available. If the climate is dry, less water falls to the ground.

The amount of precipitation that falls can have a dramatic effect on the land.

Sometimes the climate in a certain area changes for a few months or years. The changes might mean that more or less rain falls to the ground. If there is more rainfall, there might be flooding and other problems. But if there is less rainfall than normal, then there may be a **drought**.

Watery Earth Fact

The worst drought in 50 years affected at least 35 states during the long hot summer of 1988. In some areas the lack of rainfall dated back to 1984. In 1988, rainfall totals over the Midwest, Northern Plains, and the Rockies were 50–85 percent below normal.

A **drought** is a period of very dry weather that lasts long enough to cause serious problems such as crop damage or water supply shortages. A drought can cause a decrease in the amount of water resources available to people. Scientists and other experts use the word drought to describe several kinds of water shortages:

- Sometimes a drought can mean that there is not enough rainfall in a certain location. For example, if an area is used to getting 150 cm (60 in) of rain in a year, but it only gets 75 cm (30 in), it might be described as a drought. But people in another place, like a desert, might find that 75 cm (30 in) of rainfall in a year is a lot of water. So whether or not there is a drought depends on the location.
- Farmers use the word drought to describe a situation where there is too little moisture in the soil to meet the needs of a particular crop. Some crops, like cotton and rice, need a lot of water. Other crops, like wheat and small vegetables, use less water.
- Geologists and other scientists might use the word drought to describe the situation where supplies of surface water and groundwater are below normal.

Home Water Use Around the World

People around the world use different amounts of water. The table below shows estimates of how much water one person uses for household purposes each day in a different country.

Country	**Estimated Domestic Water Use (liters per day, per person)**
Argentina	255
Armenia	410
Brazil	150
Canada	790
Chile	270
China	75
Costa Rica	85
Denmark	195
Egypt	150
El Salvador	45
Germany	175
Ghana	35
Guatemala	35
Honduras	35
India	50
Iran	150
Kenya	45
Malaysia	485
Morocco	60
Mozambique	12
Peru	155
Philippines	335
Saudi Arabia	610
South Africa	165
Spain	255
United Kingdom	115
United States	665
Venezuela	450
Zimbabwe	50

Sources: WaterPartners International; World Resources Institute, *A Guide to the Global Environment*. Washington, D.C.: World Resources Institute, 1999.

Humans Can Cause Water Shortages

Young people like you use water everyday to brush their teeth, flush their toilets, and wash their hands. These everyday activities are part of how we live. And no single activity causes water to be in short supply.

But when many people use water in so many different ways, they can cause this precious resource to become scarce. Let's take a look at how large numbers of people can affect water resources.

Watery Earth Fact

According to the Environmental Protection Agency, the average American uses over 380 liters (100 gallons) of water each day. The average household uses over 380,000 liters (100,000 gallons) during a year.

Using surface water

Sometimes people move into an area that does not have enough water to supply all the needs of the people living there. As you already read in Chapter 9, people develop water systems to collect and transport water for use. They might build a dam to collect surface water and store it in a reservoir to use throughout the year.

Sometimes people collect surface water from an area with a large water supply and transport it to a place with few water resources. One example of this is in Los Angeles, California.

Two hundred years ago, Native Americans and a few Spanish settlers populated this region. But over the years, millions of people have been attracted to its warm, mild climate. Today, about ten million people live in Los Angeles County, but the region receives an average of only 38 centimeters (15 inches) of rain a year. For comparison, Kansas City, Missouri receives about 93 centimeters (37 inches) of rain a year.

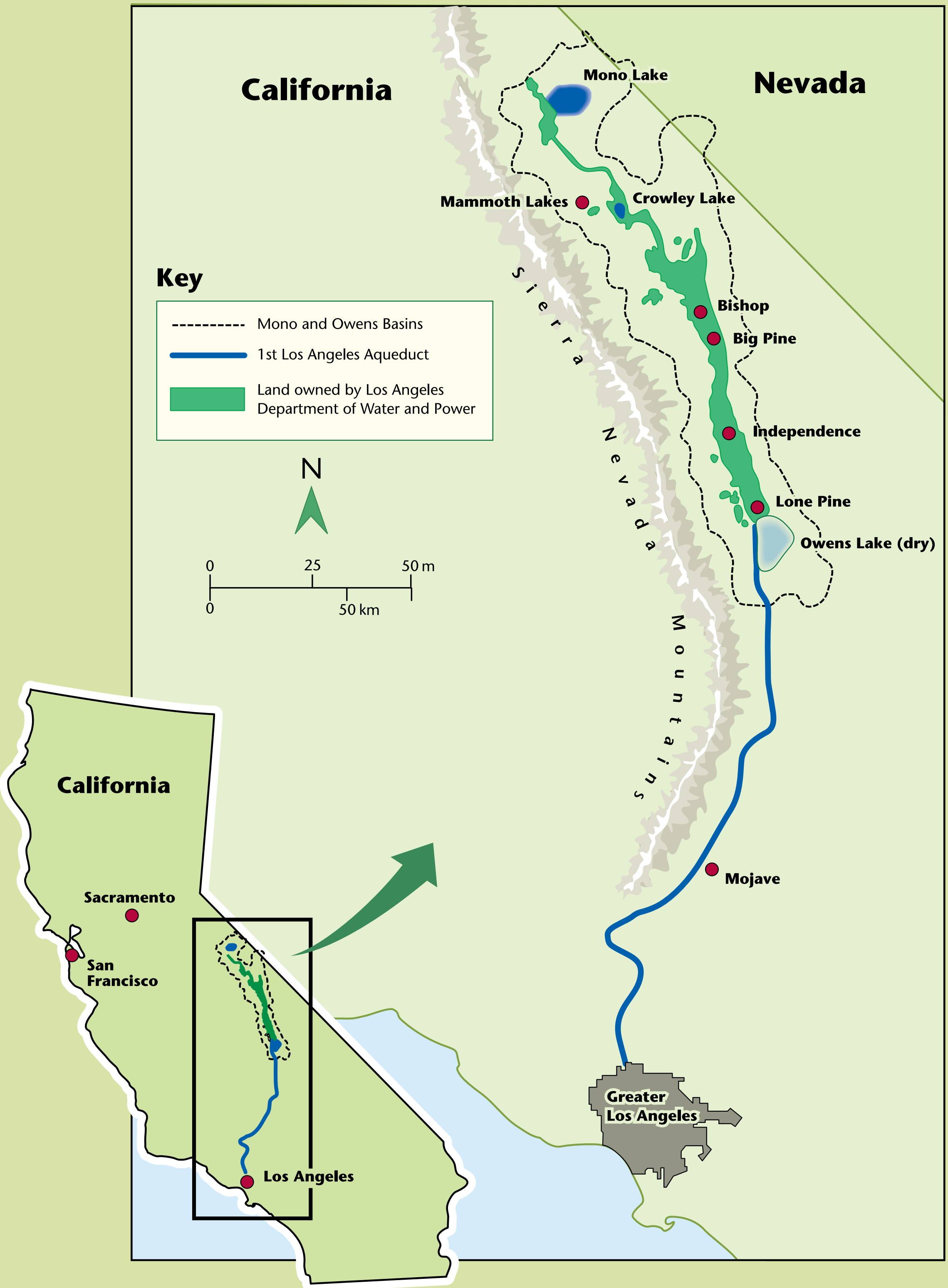
The people in Los Angeles County get most of their water from surface water that falls as rain and snow hundreds of miles away. Some water comes from as far away as the state of Colorado, flowing down the Colorado River to the border with Arizona where it is collected and then pumped to Los Angeles.

Word Connection

aqueduct—A large pipe or channel for moving water across a great distance. Aqueducts can be buried underground, built as open channels, or constructed like a bridge to carry a canal of water across a valley. The word *aqueduct* comes from the Latin roots *aqua*, meaning "water," and *ductus*, which means "the act of leading something."

Transporting Water: The Case of Owens Valley, California

In the early 20th century, city planners in Southern California built an aqueduct to bring water from the Owens Valley to the fast-growing young city of Los Angeles. Though hot and dry, the Owens Valley received ample water supplies from melting snows in the nearby Sierra Nevada mountains. There were thriving farms and a lake 32 kilometers (20 miles) in length. But the city of Los Angeles bought the rights to transport the water, and in 1913 opened an aqueduct that was 400 kilometers (250 miles) long to bring the water to the city. The Owens Valley farms lost their source of water and by 1924 the lake dried up.



In 1913, the city of Los Angeles spent $23 million to build the Los Angeles Aqueduct. This aqueduct still transports the waters of the Owens River to support a growing population to the south.

Using groundwater

Humans can also cause water shortages in aquifers. In some places, people use groundwater faster than rainfall or snowmelt can replace it. If this happens for a long period of time, people who rely on groundwater will not have enough. Sometimes the land above an aquifer can actually sink if too much water is pumped without being replenished. In the worst case, the rock can collapse and destroy the aquifer.

Sometimes people can build things that affect the amount of water that reaches the ground. Water flowing onto land covered with soil and trees refills the aquifer. Bogs and swamps may absorb and store water that later slowly drains into aquifers. When humans replace these naturally wet areas with buildings, parking lots, and highways, less water can reach the aquifer.

How would rainfall percolate into the aquifer in this scene?

Conserving Water

One of the best ways to lessen the need for water resources is to practice conserving water. Wherever people live, they can change their habits to cut down on the amount of water they use. Whether their water comes from surface water sources or groundwater, you can help protect water resources by thinking about how you use water. You can do your part by practicing good water habits that use less water at home, at school, and at play.

Watery Earth Fact

On average, 50–70 percent of household water is used outdoors in such activities as watering lawns and washing cars.

Water Conservation Tips

Now that you have a better idea of how much water is used during different activities, think about these conservation tips suggested by the Metropolitan Domestic Water Improvement District in Tucson, Arizona.

Word Connection

conserve—To use something carefully so it is not wasted.

Ways to Save Water Outdoors

Did you know that nearly half of people's water usage occurs outdoors, and that more than half occurs during the summer (at least in warm, arid regions like Tucson, Arizona)?

- Try watering lawns and plants less. Most can survive with less water than you think.
- Water the lawn late in the day, so less evaporation will occur. And set up sprinklers so you're watering the lawn only—not the sidewalk.

- Plant trees, shrubs, and plants that use less water. Use mulch around the base to slow evaporation.
- Use a broom, instead of a hose, to sweep driveways, sidewalks, and steps.
- Wash your car less frequently. When you do wash it, don't run the hose while soaping it.

Ways to Save Water Indoors

- Keep a pitcher or bottle of drinking water in the refrigerator, so you don't need to run the tap and wait for cool water.
- Load your dishwasher and washing machine all the way before running them.
- If you wash dishes by hand, don't leave the water on for rinsing. Rinse them all together at the end.
- Don't keep the water running for tasks such as washing vegetables, brushing your teeth, or washing your face.
- Check your toilets, faucets, and pipes for leaks.
- Take shorter showers or shallower baths.
- Install water-saving showerheads.
- When old appliances wear out, replace them with water-efficient ones.



11

Water Pollution

What Is Water Pollution?

Water becomes polluted when enough harmful materials build up to make it unhealthy for plants, animals, or their environments.

Imagine you are swimming in a lake and you look down at its bottom. What types of **pollutants** do you think you might see? Chances are you would see a glass bottle or two, some metal cans, or some plastic.

Word Connections

pollutant—Something that contaminates air, soil, or water.

contaminate—To make dirty or unclean.

Now imagine you're wearing "pollution goggles" that allow you to see even the tiniest pollutants. What pollutants do you think you might see now? You might see little drops of oil. You might see tiny specks of chemicals. Or you could even see harmful bacteria.

Unfortunately, pollution goggles haven't been invented yet. If we had them, it would be easy to identify pollutants. Since we don't, scientists must work really hard to determine when water is polluted.

Causes of Water Pollution

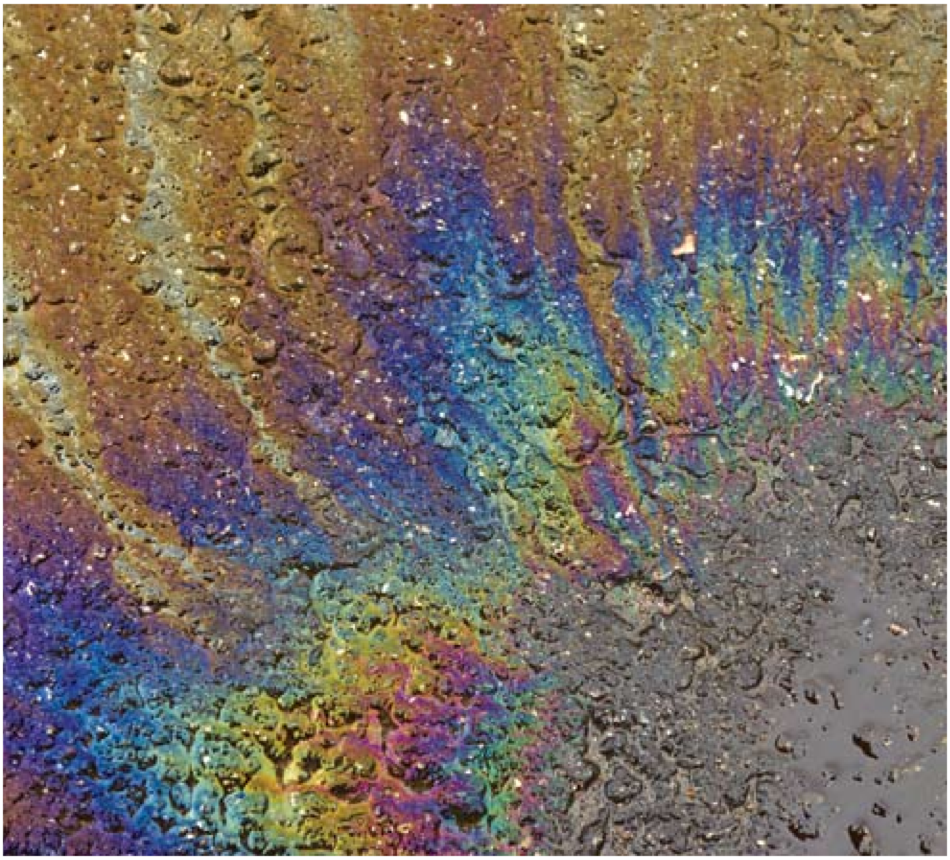
A number of human activities cause water pollution. For example, we pollute water when we throw our cans, bottles, plastic bags, paper wrappers, and other waste directly into surface water. We can also pollute water when we litter on land. During rainfall, litter on land may wash away into nearby bodies of surface water.

Many places charge fines for littering.

Our automobiles also cause water pollution. For example, automobile engines leak gas and oil onto roads and parking lots. Rain can wash these pollutants into local bodies of water or onto land where they can contaminate groundwater.

Watery Earth Fact

One liter (about one pint) of oil can contaminate up to 2 million liters of water.



Oil has leaked onto this pavement.

Products that we use at home can also contribute to water pollution. People often use chemical pesticides and herbicides in their yards. They also may use chemicals to clean and fix up their homes. These chemicals can wash into bodies of surface water, or contaminate groundwater supplies.

Electronic products, such as computers, batteries, and cell phones can add pollution to the water cycle. Electronic equipment sometimes contains materials, such as heavy metals, that can be very harmful to organisms that live in or around the water. When the electronic gadgets break open, these harmful materials are released into surface water or groundwater.

This computer equipment can break apart and contaminate the water supply.

A number of these pollutants can enter the water cycle via storm drains. In many cities, water drains directly into bodies of water with little or no treatment. During periods of heavy rain, storm drains can overflow. The overflowing water can flow down the street, picking up pollutants, and enter either the groundwater or local bodies of water. In areas where there are no storm drains, such as rural areas, rainwater can pick up pollutants and flow directly into local bodies of water.

Any polluted water that flows through this drain goes directly to a stream.

What do you think would happen to these fish if they lived in polluted water?

Since groundwater can become polluted in a number of different ways, people who use it for drinking must have their water tested from time to time to make sure it is clean and healthy. Also, if polluted groundwater travels through an aquifer, it can then pollute a river or stream, a lake, or even the ocean. Animals and humans can come in contact with dangerous waste that may have entered the water cycle many miles away.

Industries Cause Water Pollution

Industries can release toxic chemicals into surface water, onto the land, or into the air. Chemicals released into surface water can damage the habitats of the animals that live there. Chemicals dumped onto land can seep into the ground and contaminate groundwater. Toxins released into the air can enter the water cycle by combining with the water that is in the air. When these chemicals fall to Earth as precipitation they can enter and contaminate bodies of surface water or ground water.

The air pollution from this oil refinery can eventually lead to water pollution.

Many factories are located near bodies of surface water.

Farms Cause Water Pollution

Our farms can cause water pollution by releasing toxic pest- and weed-control chemicals into the environment. These chemicals sometimes end up in nearby surface water. They can also soak into the ground and contaminate groundwater. If the chemicals build up too much in one spot, they can cause harm to organisms that depend on the water.

"Crop-dusters" spray pest and weed control chemicals on many farms.

Farms also accumulate bodily waste from cattle, pigs, and other livestock. The waste can end up in nearby surface water. When it builds up too much in one spot, it can release dangerous chemicals and bacteria into the water. These chemicals can harm organisms that depend on the water.

How Harmful Is Water Pollution?

It is not easy to figure out how harmful a pollutant is to the water supply. Some pollutants, such as glass, do very little damage to water. Other pollutants, such as heavy metals, can do much more damage. Here are the ways that some of the major types of pollution are harmful:

- Paper, most metal, glass: These pollutants are not normally too harmful to the water supply. They are not likely to be harmful to most organisms.
- Plastic: Plastic litter breaks into smaller and smaller pieces in lakes and oceans, but does not completely decay. Some drifting plastic looks like food and is mistakenly eaten by animals. Other drifting plastic can entangle marine animals and kill them.
- Automobile leaks: This pollution is easy to see but hard to clean up. The more pollutants that build up, the more harmful it is to the water supply. Exhaust from cars can also cause rain water to pollute the water supply.
- Chemicals: Fertilizers and chemical pest and weed killers are difficult to see and remove from water. If a large amount of one chemical builds up in the water supply, it can be harmful to an organism or its environment.
- Electronic waste: Batteries, old computers, cell phones, and other electronic equipment contain certain types of metals that can be harmful to living organisms if concentrations are high enough. The materials need to break open in order for their dangerous contents to be released. Once this happens, the hazardous materials are very difficult to observe and remove. In high concentrations, they can pose great risk to an organism or its environment.

How Can We Prevent Water Pollution?

One simple thing you and your families can do to reduce water pollution is to dispose of waste in its proper place. The following are suggestions for disposing of a few common types of waste.

- Paper, plastic, most metal, or glass—Recycle if possible, otherwise put it in with regular garbage

Many paper products, such as these flattened cardboard boxes, can be recycled.

- Chemicals—Always dispose of them at a special hazardous waste site and never dump down storm drains
- Electronic waste—Recycle if possible. If not, dispose of it at a special hazardous waste site and never dump in or near the water.
- Pet waste—Pick it up from outdoor areas so its bacteria doesn't enter a body of water.

Another important way to reduce pollution is to develop good water habits. For example, you and your families should try to reduce the use of herbicide and pesticides, or search for less toxic natural alternatives. You might also replace your household cleaning products with less toxic varieties.

12

Water Resources Case Studies

Conserving Water Resources: Case Study 1

The Ogallala Aquifer, High Plains States (United States)

The **Ogallala aquifer** is the largest groundwater system in North America. It covers an area that is about 1300 kilometers (800 miles) north to south, and about 650 kilometers (400 miles) east to west. This aquifer stores groundwater beneath parts of South Dakota, Wyoming, Nebraska, Colorado, Kansas, New Mexico, Oklahoma, and Texas.

Farmers began using this groundwater for their crops in the early 1900s. Since groundwater is more reliable than rainfall, farmers have been very happy to have access to this store of water, especially in times of drought. More than 90 percent of the water that is pumped out of the Ogallala is used to **irrigate** farmlands.

The Ogallala Aquifer is one of the world's largest aquifer systems.

Although the Ogallala aquifer holds an enormous amount of water, it does not have as much as it once did. This is because water is being taken out of the aquifer at a faster rate than water is collecting in it. Because of geologic changes over time, many of the original sources of water for the aquifer (such as snowmelt from the Rocky Mountains and water from various rivers) no longer add water to it. Little rainfall and fast rates of evaporation are both common in this region. This makes the problem of refilling water in the aquifer even worse.

For a long time, people thought that the water in this aquifer could never run out. Now people are very worried about the problem of using the water faster than it can be replaced. To respond to the problem, people in many parts of the High Plains are trying to conserve water and use it more carefully. For example, fewer acres of farmland are being irrigated. In addition, more and more farmers are using irrigation techniques that provide more water directly to the crops and lose less water to evaporation. Government officials in the affected states have also developed policies to help protect the groundwater resources.

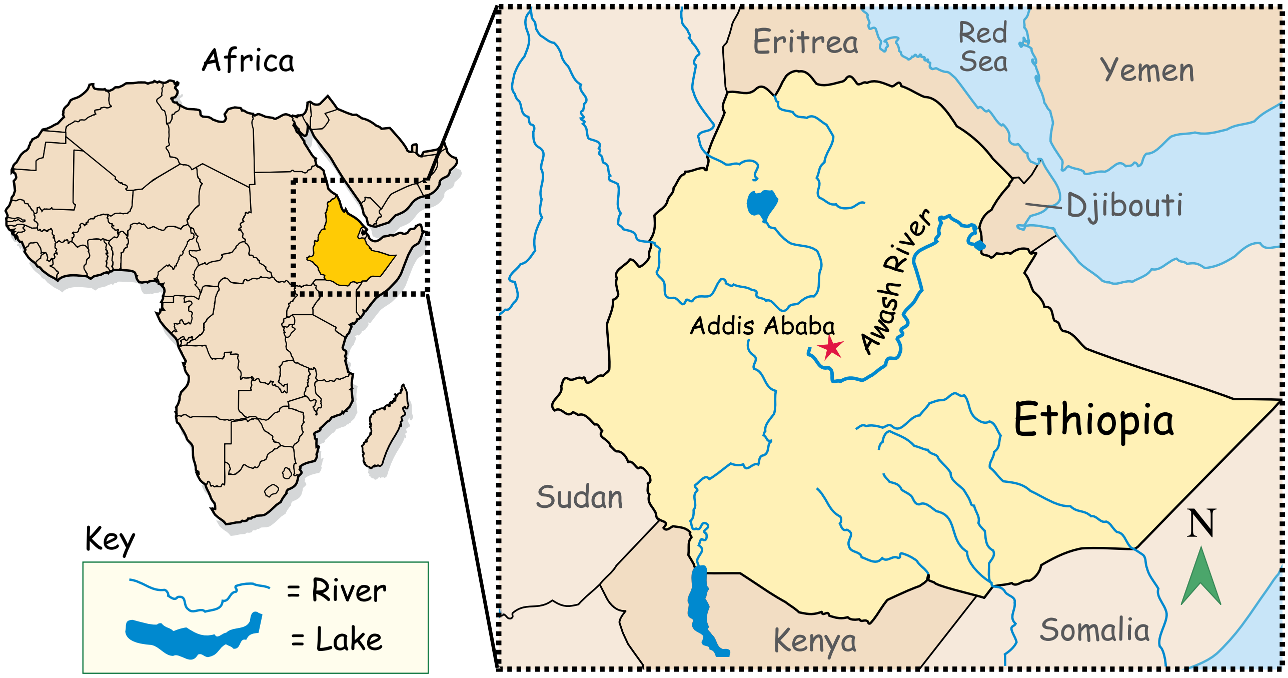
Although the problem of overusing water from the Ogallala aquifer has not been solved, it is a problem that people are now aware of and trying to address in various ways to conserve this important water source for the future.

Protecting Water Resources: Case Study 2

The Awash River, Ethiopia

People who live in the Awash-Malkasa area of Ethiopia in Africa rely on the Awash River for their drinking water. But, the water of the Awash River is polluted with lots of harmful bacteria. The bacteria are probably the result of many things, including human and animal waste entering the river. Drinking the polluted water can make people very sick or even kill them.

The United Nations Children's Fund (UNICEF) arranged for the government of Norway to donate **water purification** equipment to Awash-Malkasa, as well as to several other areas of Ethiopia. The donated systems are not very big and are not difficult to use. They can last for about 10 years. The equipment pumps water from the river into a container where water purification tablets are added. Then the water is filtered and **chlorinated** in another part of the machine. Finally, it is moved to two large tanks. People in the villages get clean drinking water from these tanks.



The water purification system can process from 200 to 4000 liters (50–1000 gallons) of water per hour, depending on how polluted the water is. It can provide enough clean water for about 5000 people per day. This has been a huge help for the people in the Awash-Malkasa region, who are experiencing fewer **waterborne diseases** as a result of the clean water.

Watery Earth Fact

More than five million people die each year from diseases caused by unsafe drinking water, lack of sanitation, and insufficient water for hygiene. More than two million deaths occur each year from water-related diarrhea alone.

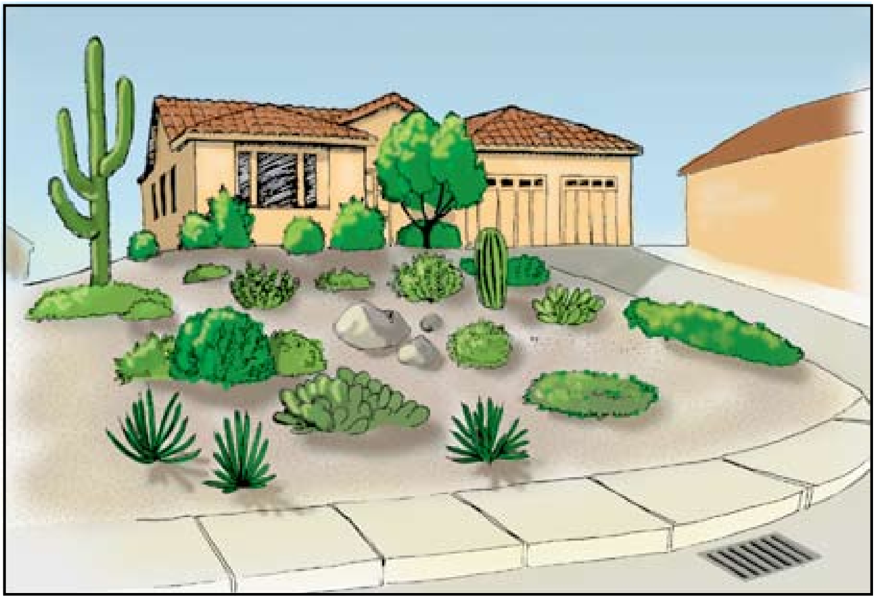
Conserving Water Resources: Case Study 3

Tucson, Arizona (United States)

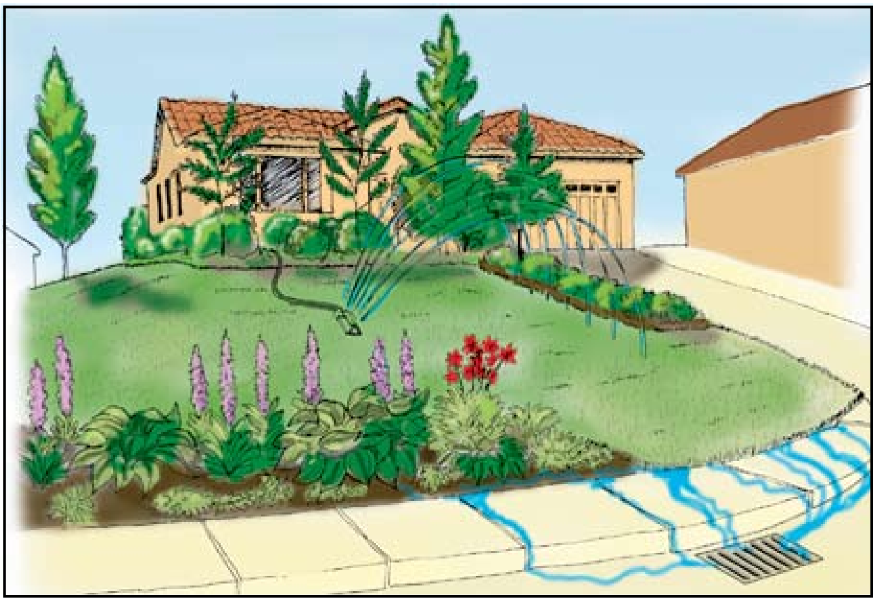
The city of Tucson, Arizona relies mostly on groundwater for its water supply. (Recently, it has also been able to use some water from the Colorado River.) Tucson is surrounded by desert and gets less than 12 inches of rain each year. This is not enough rainfall to replenish the water that residents use from the underground aquifer. In addition, Tucson's population is growing rapidly. The city gets thousands of new residents each month, all of whom take from the same limited supply of water.

Beginning in the 1970s, the local government, water suppliers, and community **activists** in Tucson began wide-scale efforts to encourage residents to use less water. In some cases, new rules were put into place. For example, people who use lots of water are charged higher rates on their water bills. Also, if people want to build a golf course in Tucson, they can only water the grounds with **reclaimed sewage water**, not with fresh water that is safe for drinking.

There have been a variety of other ways to get people in Tucson to use less water. For example, the Tucson Metro Water District offers a 50 dollar rebate for people who replace an old toilet with a new toilet that uses much less water per flush. People are also encouraged to replace grassy lawns with desert plants (such as cacti) in their yards. The desert plants require much less water than grass, trees, and other common yard plants do.



Water-Conserving Yard



Water-Guzzling Yard

Children are learning about conservation, too. Many students in Tucson schools take part in education programs that teach them about water resources, water shortages, and water conservation. As part of one program, students measure the **flow rate** of their showerheads at home. Students who report high flow rates receive a free water-saving showerhead. Tucson residents (old and young) also regularly see television ads that give tips for saving water.

As a result of these efforts and others like them, water use in Tucson has dropped quite a bit. Although exact numbers differ (depending on the source), in 2003 each person in Tucson used about 140 gallons of water per day. This is about 20% less than they used before the water conservation efforts began in the 1970s.

Protecting Water Resources: Case Study 4

The Nashua River, Massachusetts and New Hampshire (United States)

Adapted from A River Ran Wild*, by Lynne Cherry. (Gulliver Green/ Harcourt Brace & Company, 1992.)*

The Nashua River of New Hampshire and Massachusetts was originally called the "Nash-a-way" which means "River with the Pebbled Bottom." It was named by the chief of a Native American tribe who chose to settle by the banks of its crystal clear water. For hundreds of years, Native Americans fished from the Nash-a-way, and had great respect for the abundance of plant and animal life that depended on the river to survive.

When European colonists began to settle in the Nashua River Valley, the conditions of the river began to change. Over time, the colonists cleared the land around the river for farms and created **dams** along the river to collect the water for people to use.

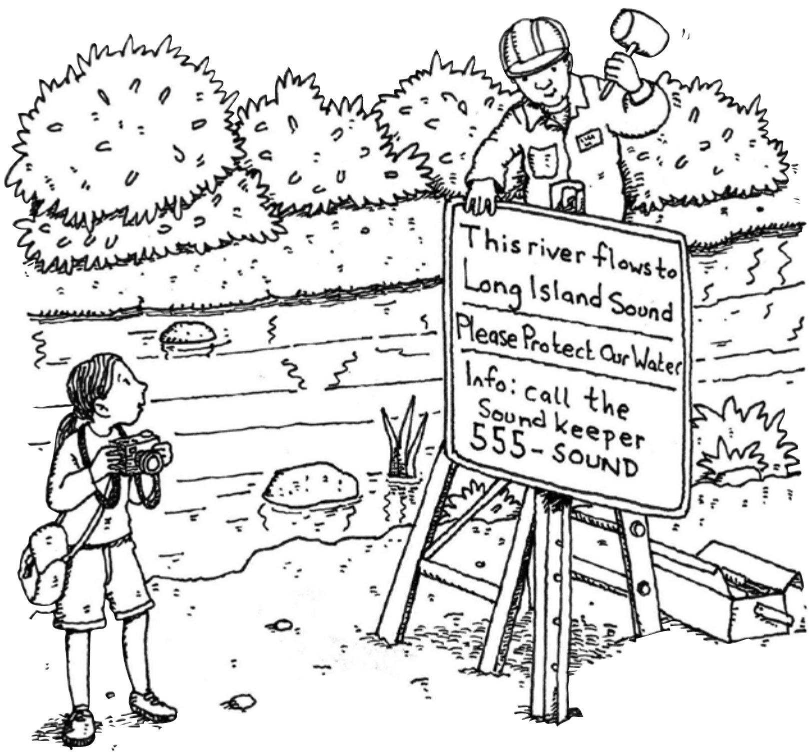
In the 1850s, people started to build factories along the river. Many of the first factories were paper and fabric mills. Later on, new factories that made things out of plastic were built. For a long time the people who owned these factories dumped their used paper pulp, color dyes, and chemicals in the river. Eventually the Nashua was so polluted that fish couldn't survive in it, birds and mammals stayed away from its banks, and the people who lived nearby couldn't stand the smell of the polluted water. The river flowed very slowly because the waste from factories clogged it up.

Finally, in 1962, a woman named Marion Stoddart organized the Nashua River Cleanup Committee. She, and her helpers, convinced the state government to pass laws making it illegal to dump pollutants in the river. The mills and factories found ways to collect and process their waste. Over time, as people cleaned up the old pollution and stopped adding new pollution, the health of the river began to improve. Today, people can canoe on the Nashua River and enjoy all the animal and plant life that thrives in the clean water.

13

Children Protecting Water Resources

Protecting a River from Pollution



Think About It!

How can you make a difference to protect water resources around your home, school, community, or the world?

As part of a school water study, students in Connecticut learned that many companies and individuals continue to dispose of harmful materials in the water. They discovered that people dump pollutants into the water because it was easier and less expensive than removing them properly. One student became so frustrated by this practice that she decided to find a way to make a difference.

She knew that all the bodies of water on Earth are connected and if you pollute one, the pollutants will eventually reach others. She wanted to remind the people in her town that by keeping the local streams clean, they would also be helping to improve the water quality of the ocean.

She contacted her community water agency, explained her concerns, and asked if a sign could be posted by the road alongside the river. The agency agreed and posted a permanent sign that read, “This River Flows to Long Island Sound. Please Protect Our Water.” At the bottom of the sign was a phone number where people could find out more about how to stop water pollution. Everyone in town read the sign as they passed by and it reminded them to take care of the water.

She took pictures of the new sign, shared them with her class, and read the thank-you letter she wrote to the people who helped her at the water authority.

Water Awareness Day

Students were surprised to discover that not every class at school studied water. They thought it was important that all their schoolmates learn about how to protect water resources. After the teacher explained that different teachers focused on different areas of science, the students decided they wanted to share what they had learned with the entire school during a Water Awareness Day.

The class divided into small groups and each group chose a different topic. One group decided to have a demonstration, similar to a science fair, to show how difficult it is to get polluted water clean. Another group made a list of all the sources of pollution around the school and turned that list into a poster. Other children created brochures that explained how people can save water at home.

During the Water Awareness Day, other classes came to see the exhibits and posters. Students gave tours of the pollution sites around school or talked about ways that everyone can conserve water. They read stories about water to younger classes and taught songs that reminded people how special water is in their lives. The entire school took part in an exciting day of activities and learned many ways to conserve and protect water.

The Wetlands Gazette

Students noticed that their local wetlands were being polluted by garbage and worried that birds and animals could be harmed. They visited the wetlands and looked at what kinds of objects made up the trash. There were several newspapers, some debris tossed from cars onto the nearby road, and bottles left behind by weekend picnickers. Students decided that the people using the wetlands and living in the surrounding area were not aware that this was an important habitat that should be kept clean.

They chose to write and print a short newspaper, The Wetlands Gazette, to make people aware of the wetlands and some of the pollution issues there. Some of the articles talked about what students learned about wetlands, while others highlighted the different ways the wetlands were polluted. Students also publicized a wetlands clean-up project organized by another class at their school.

A Compromise for Beavers

A family of beavers blocked the water flowing in a small brook and created a large pond. After a particularly rainy spring, the water level in the beaver pond rose and flooded the nearby road. Town officials decided that the beaver dam would have to be taken apart and the beavers trapped and relocated.

A group of students were very concerned about this decision. They were worried that the beavers might be hurt in the removal process, and that the other animals who had come to depend on the pond would no longer have a home. They contacted a local animal protection group to see if there was a better solution. There was.

People from the animal protection group worked with the town crew to build a “beaver baffler.” They installed wide, plastic pipes through the beaver dam so water could pass through. The pipes are surrounded by large, metal cages so the beavers can’t plug them up with more branches. The students helped the workers prepare the baffler materials and observed them while they worked. They also took photos of the project and later shared what they learned at a class meeting.

After a few days, the water level in the beaver pond went down. The road was clear, and the beavers got used to the new pipes running through their dam. The habitat was saved and the problem was solved.

School Clean-up Day

A group of students were shocked by the amount of trash they found during their pollution walk. It was the first time many of them had noticed the waste. They decided to do something about the problem by organizing a school clean-up day.

To plan the event, students met with the principal and talked with the school’s teachers. To promote interest in the event, they presented the idea to each class. They scheduled the clean-up day for April 22nd (Earth Day) and advertised the event by placing flyers around the school.

They decided to turn the event into a way to raise money for the school. They asked for donations from community businesses for each kilogram of trash that they picked up. Next, they found parent volunteers to donate trash bags and take the refuse to the landfill.

When all was said and done, the students discovered that trash can be treasure, as they picked up more than 200 kilograms (440 lbs) of refuse and raised $252 for the school. To broadcast the event's success, they wrote an article for the school newsletter.

A

Home Water Use

The table below shows estimates of how much water is used for a number of common household activities. The estimates are based on data collected by scientists who study people's water use behavior.

Activity	Estimated Water Use
Drinking Water	1 liter per person per day
Flushing a Toilet	15 liters per flush (older model) 6 liters per flush (newer model)
Taking a Shower	20 liters per minute
Taking a Bath	120 liters
Washing Dishes in a Dishwasher	80 liters per load (older model) 30 liters per load (newer model)
Washing Clothes	120 liters per load (older model) 80 liters per load (newer, front-loading model)
Washing a Car	100 liters
Watering a Lawn	900 liters each 30 minutes for an average sized lawn

Sources: U.S. Department of the Interior, U.S. Geological Survey, Denver Water Department, Colorado River Water Conservation District

B

Which Family Uses Less Water?

Each year, a town chooses families that try to conserve water to show ways local people can also save water. The lucky winners become the "Water Conservation Family of the Year."

Each family answered questions about their water use. There are two final contestants in the "Family of Five" category, the Garcia family and the Knox family.

Family Survey Information

- Water both families drink each day: Each person drinks the same amount
- Toilet use per day for both families: 4 times per person
- All showers are ten minutes long

Family 1: The Garcia Family	
Number in Family: Adults: 2 Children: 3	
Toilet(s):	We replaced our two toilets with new models.
Shower/Bath:	Each person takes four baths and three ten-minute showers in a week.
Dishwashing:	We wash a full load in a newer dishwasher five times a week.
Washing Clothes:	We own a newer washing machine and wash six full loads a week.
Washing a Car:	We own one car, and one adult takes the bus to work. We wash the car once a week.
Watering a Lawn:	Last year, we replaced our lawn with drought-tolerant plants that rely on rain. In the hottest days of summer we water sparingly, using 100 liters of water a week.

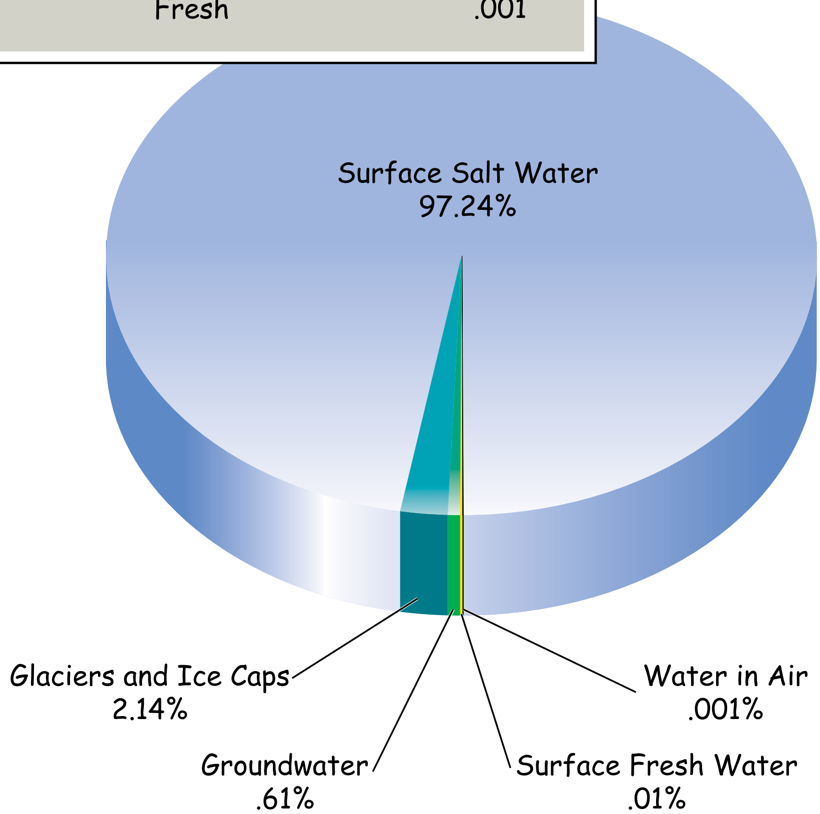
Family 2: The Knox Family	
Number in Family: Adults: 2 Children: 3	
Toilet(s):	We have three old toilets.
Shower/Bath:	Each person takes a ten-minute shower every day. Both adults also take a bath once a week.
Dishwashing:	We wash a full load in and older dishwasher seven times each week.
Washing Clothes:	We own an older washing machine and wash ten half-full loads a week.
Washing a Car:	We wash our two cars once a week.
Watering a Lawn:	We water our average size lawn twice a week, 30 minutes each time.

C

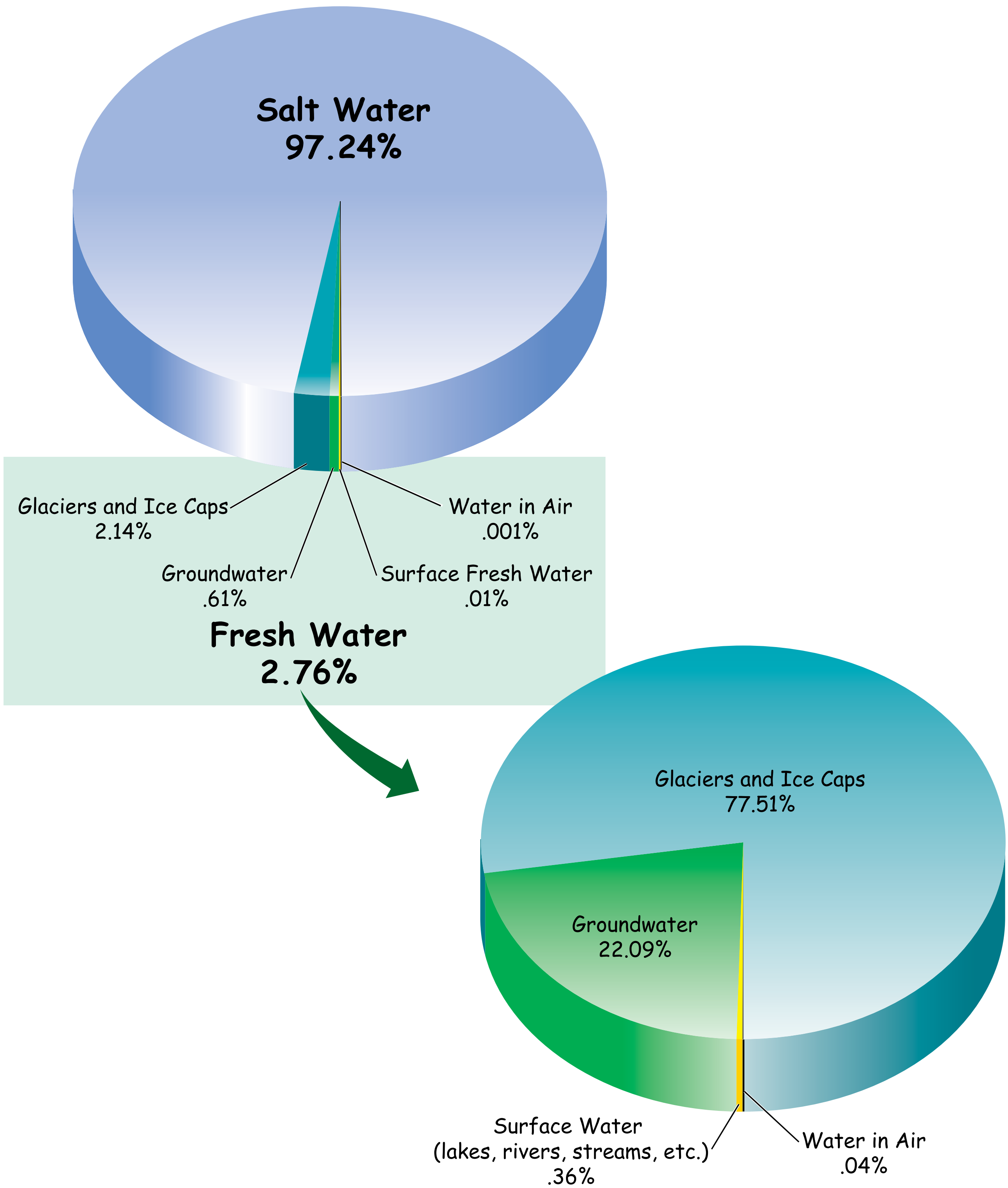
Location of Water on Earth

WHERE IS EARTH S WATER?

Location of Water	Salt or Fresh Water	Percent of Earth's Water
Surface Water (oceans, seas, etc.)	Salt	97.24
Surface Water (lakes, rivers, etc.)	Fresh	.01
Glaciers and Ice Caps	Fresh	2.14
Groundwater	Fresh	.61
Water in Air	Fresh	.001



AMOUNT OF SALT AND FRESH WATER ON EARTH



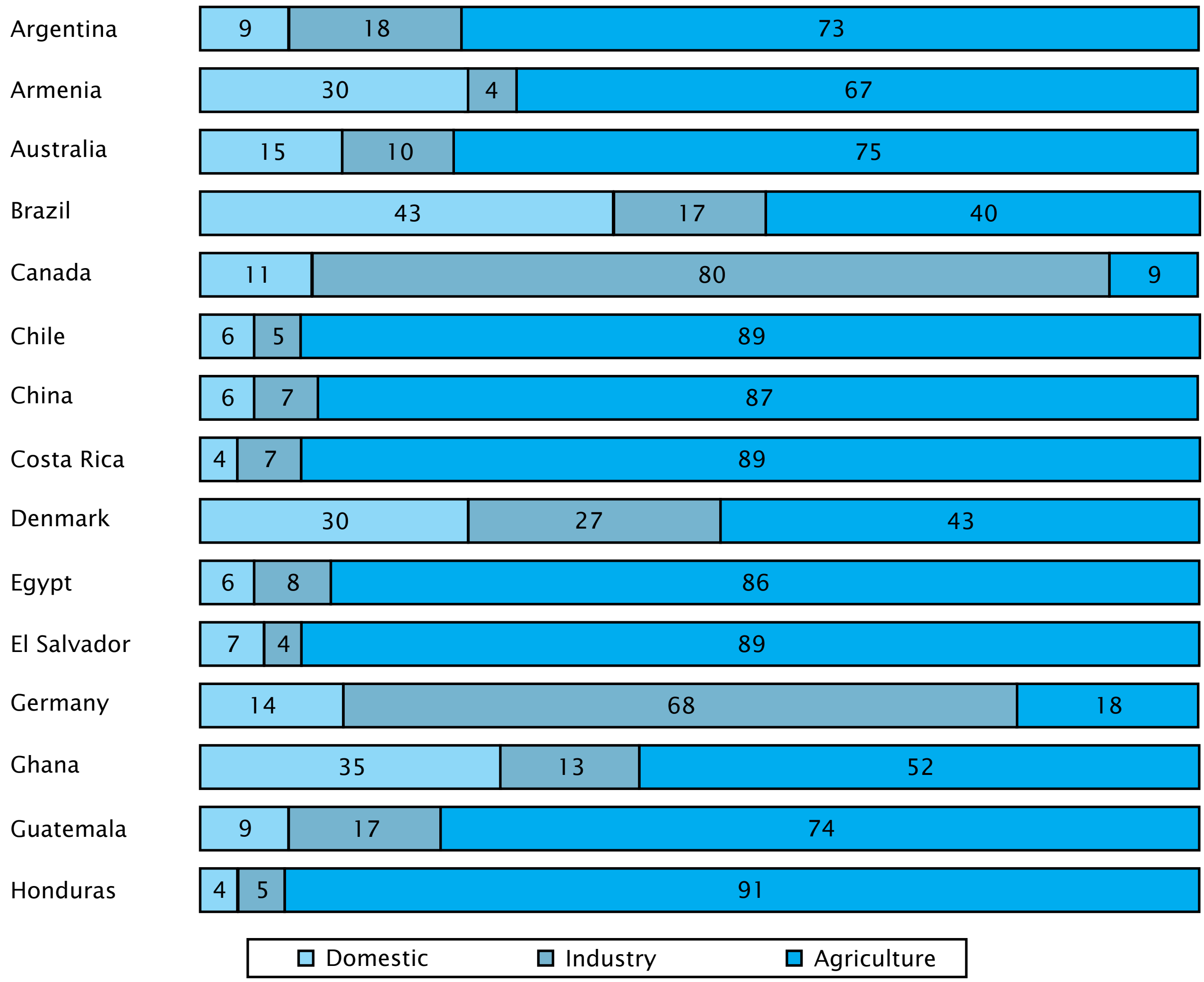
D

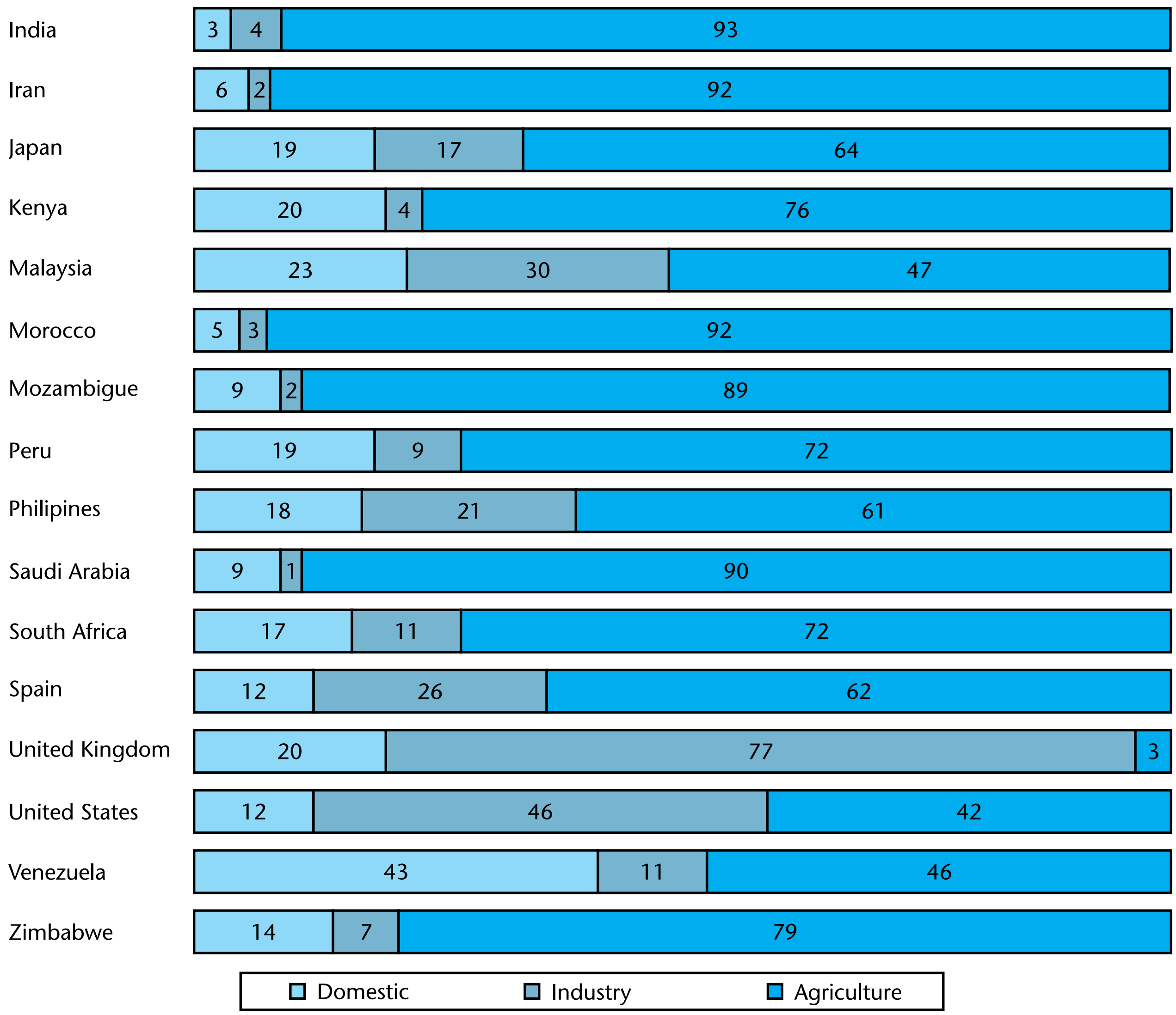
Water Use Around the World

People in different countries use different amounts of water. The table on the following pages shows estimates of how much fresh water is used for agriculture (farming), industry (making items), and domestic (household) use each year.

(Note: The estimates for agricultural use do not include rain that falls on crops, just the amounts of groundwater and surface water that are used.)

Percentage of Water Used by Activity





Source: Gleick, Peter H. *The World's Water: The Biennial Report on Freshwater Resources.* Washington, D.C.: Island Press, 2003.

Glossary

activist
A person who takes action in order to make a change.

agency
A business or service group whose job is to help others.

air
A mixture of gases that surround the earth.

Antarctica
A huge continent at the South Pole. It is larger than Mexico and the United States combined and is almost completely covered by ice. It contains almost 90 percent of the earth's ice.

Arctic Ocean
The smallest of the four oceans in the world. Located north of Alaska, Canada, and Siberia.

Atlantic Ocean
One of four oceans in the world. Located between the east coasts of North and South America and the west coasts of Europe and Africa. The North Atlantic extends all the way to Greenland while the South Atlantic extends all the way to Antarctica.

aquifer
A porous underground layer of rock, sand, or soil in which water is stored.

bacteria
Microscopic living things that can feed on dead organisms.

body of water
Surface water that has collected in a lake, river, stream, or other area.

brackish water
Water with some salt in it. Brackish water has more salt than fresh water and less salt than salt water. Found where a body of fresh water and a body of salt water meet, such as where a river drains into an ocean.

chlorinated
Treated with chlorine.

chlorine
A chemical used to clean water.

climate
The average weather conditions in a region over a number of years.

cloud
A mixture of tiny particles of water, dust, and sometimes ice, floating in the air.

condensation
The change of a gas into a liquid when the gas is cooled.

conserve
To use something carefully so it's not wasted.

contaminate
To make dirty or unclean.

cycle
A repeating pattern of events.

dam
A barrier built across a waterway to control the flow of the water.

dehydration
To lose too much water from the body to stay healthy.

density
How heavy something is for its size.

dew
Droplets of water that form when water vapor in the air condenses on cool surfaces.

disinfect
To kill harmful bacteria, viruses, and other organisms.

dissolve
When a solid, such as salt, mixes with and becomes part of a liquid, such as water.

drought
A period of very dry weather that lasts long enough to cause serious problems such as crop damage or water supply shortages.

environment
Everything that surrounds a living thing.

essential
Needed for survival.

estimate
A best guess.

evaporation
The process of a liquid changing into an invisible gas.

filter
A device that blocks some pollutants from getting into water or removes some pollutants from water.

flow rate
How fast or slow water comes out of a faucet or shower.

fresh water
Water with little or no salt dissolved in it. Found in rivers, streams, and most lakes.

frost
Layers of ice that form when water vapor in the air condenses on cold surfaces.

glacier
A large, long-lasting mass of moving ice and snow.

glacial meltwater
Water that flows out from the front (downhill) edge of a melting glacier.

gravity
The downward pull on all objects toward the center of the earth.

Greenland
A large island located between the North Atlantic and Arctic Oceans. Greenland contains almost 10 percent of the earth's ice.

groundwater
Water that is stored in porous layers beneath the earth's surface.

herbicide
A chemical used to kill unwanted plants.

human-made
Produced by humans.

humidity
The amount of moisture, or water vapor, in the air.

ice age
A period of many years when the Earth's climate becomes colder and wetter and a large part of the earth's surface is covered by glacial ice.

iceberg
A chunk of ice that breaks off from a glacier flowing into the sea.

Indian Ocean
The third largest ocean on Earth. It is connected with the Pacific Ocean to the southeast and the Atlantic Ocean to the southwest.

irrigate
To provide water for crops.

matter
Anything that takes up space and has weight. Something that can be held in a container and released in another place.

mean
A typical, or middle, value for a set of numbers. Calculate the mean by adding the numbers in the set and dividing the sum by the number of numbers. It is often referred to as the average.

mental model
A model someone is thinking about in their mind.

mist
Tiny droplets of water condensed in the air or on a surface.

model
A representation of something that is similar to the real thing in many ways, but different in some ways.

mouth
Where a river meets a lake, valley, or ocean.

natural
Existing in or formed by nature; not made by humans.

natural resource
Things we use that are found in nature, such as water, air, land, forests, oil, and minerals.

need
Something an organism must have in order to stay alive.

Ogallala Aquifer
The largest groundwater system in North America.

Pacific Ocean
The largest and deepest body of water on Earth. It covers about a third of Earth's surface and contains nearly half of all water on Earth. It covers more area than the world's entire land surface put together.

percolation
To move slowly down through the earth's layers.

pesticide
A chemical used to kill unwanted pests, usually insects.

physical model
A three-dimensional model of something.

pictorial model
A two-dimensional model of something.

polar ice cap
The thick layers of ice covering the North and South Poles.

pollutant
Something that contaminates air, soil, or water.

pollution
A harmful change in the natural environment caused by pollutants.

porous
Having many small spaces or holes.

precipitation
Condensation that forms in clouds and falls to the ground as rain, snow, or hail.

reclaimed sewage water
Wastewater that has been treated and reused to water plants or for some other purpose.

reservoir
A place the community water supply system uses to store water before sending it to homes or businesses.

resource
Things we use that meet our needs and wants. They may be human-made or natural.

salt water
Water with salt dissolved in it. Found mainly in oceans and seas.

sea ice
A layer of ice formed when seawater freezes. In some places, like the North Pole, this ice is frozen all year. Also called "pack ice." This ice is not considered part of Earth's frozen water; it is part of Earth's surface water.

septic system
Usually a tank under the ground that holds wastewater. Some wastewater is eaten by bacteria, some goes out into the ground through pipes and gets cleaned as it filters through the soil, and some is pumped back out of the tank.

spring
A natural flow of groundwater on Earth's surface.

storage tank
A tank where the community water supply is stored before it is sent to homes or businesses.

surface water
Liquid water on the surface of the earth, not underground or in the air.

temperature
A measure of how hot or cold something is.

transpiration
The process where water evaporates from the leaves of plants.

value
A number that represents the amount of something.

variable
Any factor in an experiment that can be changed.

want
Something an organism would like to have, but can survive without.

wastewater
Water that has been used and needs to be cleaned.

wastewater treatment plant
A place where wastewater is filtered and cleaned before going back into the water cycle.

water
A liquid that makes up oceans, rivers, lakes, etc., and falls from the clouds as rain. It is essential for all living organisms. In its solid state, water is called ice. When it is a gas, water is called water vapor.

waterborne diseases
Diseases that people get when surface water is contaminated.

water cycle
The way water always circulates between the air, the earth's surface, and underground aquifers.

water pollution
The addition of harmful substances that causes water to become unhealthy.

water purification
A process of cleaning water to make it drinkable.

water table
The top level of water in an aquifer. Below the water table the earth fills completely with water. Above the water table, the earth is damp, but there are still spaces with no water.

water treatment plant
A place where fresh water is filtered and cleaned before going to a community for its water supply.

water vapor
The state of water when it is an invisible gas.

well
A hole dug in the ground so that groundwater can be pumped out of an aquifer.

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