Lesson 3: Energy and Water Efficiency

OBJECTIVE

Students will understand energy consumption, where water sources in Texas are found, and how they are consumed.

KEY CONCEPTS

- Energy Consumption
- Hydrologic Cycle
- Water Use and Consumption
- Aquifer
- Groundwater
- Subsidence

LESSON RESOURCES

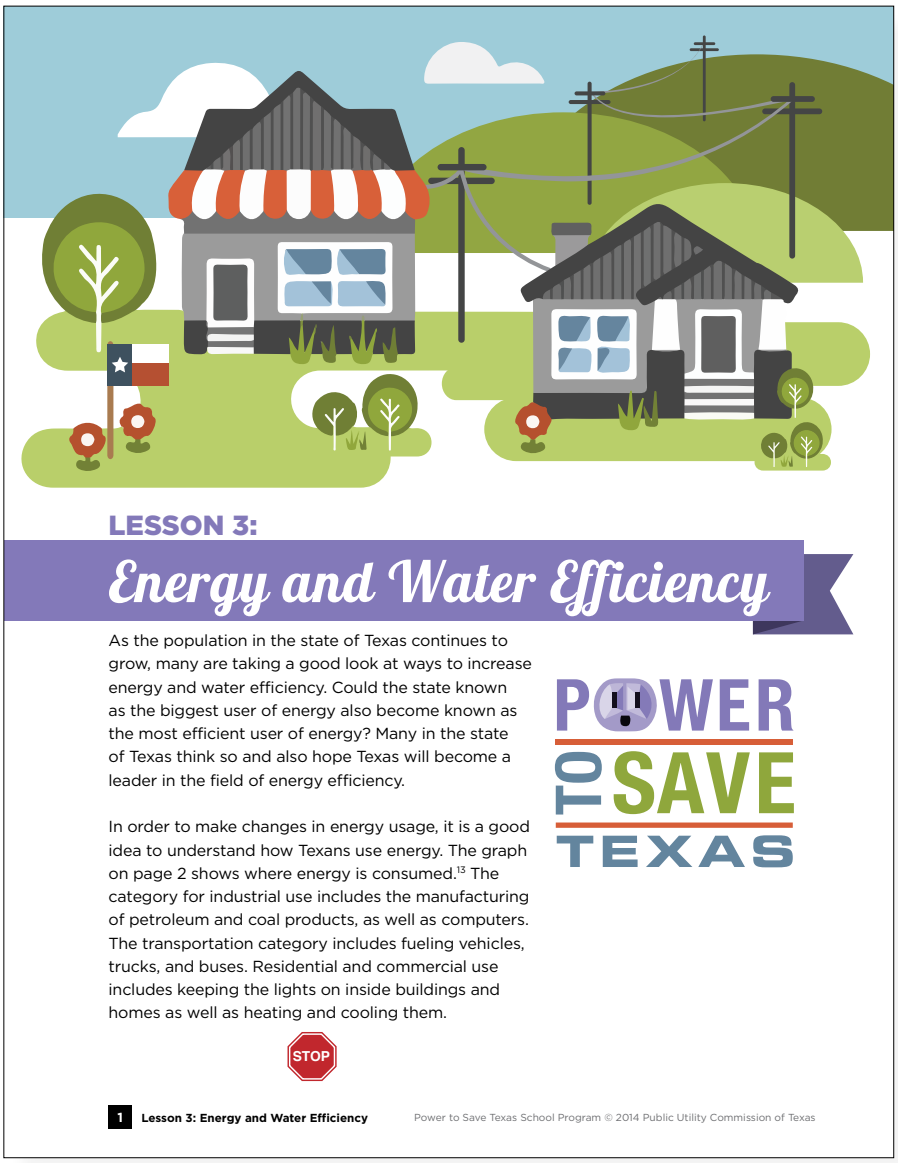
LIMITED ENGLISH PROFICIENT, AT GRADE, AND ADVANCED

In this lesson, there are three versions provided for the Water Works activity. Each version is designed for a particular ability level. The color-coded outlet in the upper right-hand corner indicates the ability level on the activity:

LIMITED ENGLISH PROFICIENT LEVEL

AT GRADE LEVEL

ADVANCED GRADE LEVEL



LESSON 3:

Energy and Water Efficiency

As the population in the state of Texas continues to grow, many are taking a good look at ways to increase energy and water efficiency. Could the state known as the biggest user of energy also become known as the most efficient user of energy? Many in the state of Texas think so and also hope Texas will become a leader in the field of energy efficiency.

POWER TO SAVE TEXAS

In order to make changes in energy usage, it is a good idea to understand how Texans use energy. The graph on page 2 shows where energy is consumed.[13] The category for industrial use includes the manufacturing of petroleum and coal products, as well as computers. The transportation category includes fueling vehicles, trucks, and buses. Residential and commercial use includes keeping the lights on inside buildings and homes as well as heating and cooling them.

LESSON 3 ENRICHMENT

Interactive Links

US Geological Society

This link displays a student-friendly water cycle. It describes how Earth's water is always changing forms between liquid, solid, and gas and also how it is moving on, above, and within the earth.

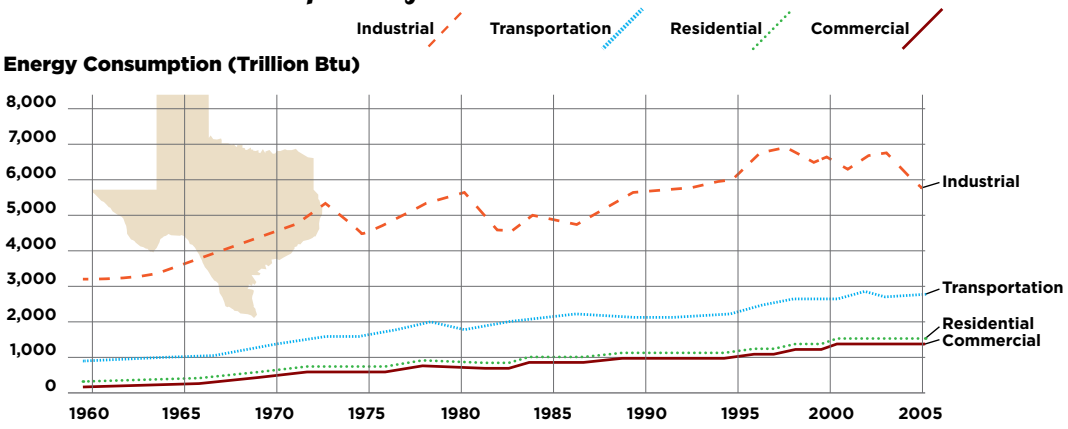
National Geographic

This link identifies the hidden water we use. Students may be surprised to see how much water it takes to bring a hamburger to their plate or to make a T-shirt. Students will see how their everyday choices add up.

Texas Tech Center for Geospatial Technology

This link provides numerous maps from the Ogallala Aquifer Map Series. The research found at this site explores the aquifer in an effort to help students better understand the physical characteristics of the aquifer.

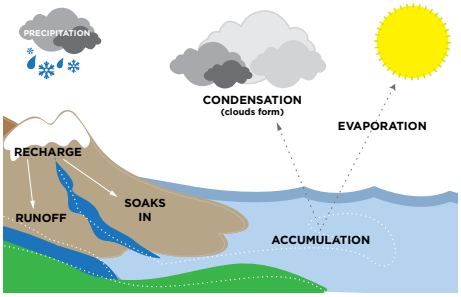
Texas Annual Consumption by Sector



When talking about becoming more energy efficient with the resources in Texas, one resource that probably comes to mind is water. Water is the most important resource on the planet. Without it, there would be no plants, animals, or people. A person can survive for a month or more without eating food, but only for about a week without drinking water. Water must be managed carefully.

It may sound funny, but our water is old! All the water on Earth, the water in your glass, the water with which you brush your teeth, all that water is about 4.4 billion years old. No water is being made or destroyed on the globe. Earth has always held the same amount of water. The water we have today has been used over and over again. Dinosaurs drank the water, and so did George Washington, long before we ever did.

Water is considered a **renewable resource** because it does not disappear, it simply gets moved around in Earth's natural recycling system. This system is called the water cycle, or **hydrologic cycle**. Water is constantly changing through this never-ending process as it moves from the land and ocean to the atmosphere and back. The atmosphere is the entire mass of air surrounding the earth. Water evaporates, condenses (forms clouds), falls back to Earth as precipitation, collects in bodies of water (lakes, rivers, and oceans), and then the cycle begins again. See the picture below.[14]



Water covers about 70% of the earth, yet less than one percent (<1%) of the world's fresh water (~0.007% of all water on

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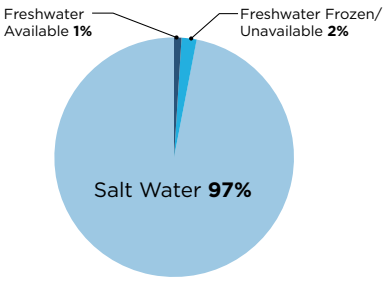
Earth) is available to use. This includes all the water found in lakes, rivers, reservoirs, and even underground water that is shallow enough to be reached. This very small amount of freshwater, replenished by rain and snowfall through the hydrologic cycle, is all there is for us to use.[15]



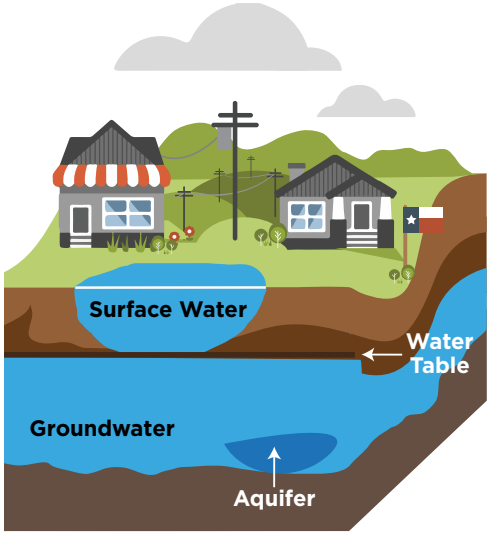
It may be hard to believe there is so much water on our planet, yet so little available to us. Most freshwater returns to the atmosphere by **evapotranspiration**. This simply means that water moves to the air from the earth's surface **(evaporation)**, and the water moves as vapor **(transpiration)** from plants, grasses, and trees. The sum of evaporation plus transpiration equals evapotranspiration. In this part of the water cycle, fresh water we could have used simply returns to the atmosphere.[16]

As the picture to the right shows, water on top of the earth's surface is called **surface water**.[17] Examples of surface water include creeks, lakes, streams, rivers, wetlands, and oceans. When you pass a natural spring and water appears to be flowing as if from nowhere, the source is often groundwater. **Groundwater** is the water that seeps into the earth and is stored in aquifers.

This underground water makes its way into lakes and rivers. Sometimes this water is tapped by wells for drinking or irrigation.

Aquifers are areas of soil, sand, and rock that are able to hold liquid. Groundwater sits in the aquifer and is usually replenished by rain and snow. Groundwater stored in aquifers can be found either close to the earth's surface or hundreds of feet below. As groundwater moves through aquifers, sediment and other particles are trapped within the spaces of aquifer rock. In this way, aquifers act like natural filters to help purify groundwater.

The word aquifer means water-bearing, formed from the Latin "aqua" (water) and "ferre" (to bear). This underground source is in more danger today due to population increases. Even though polluted water from agricultural and



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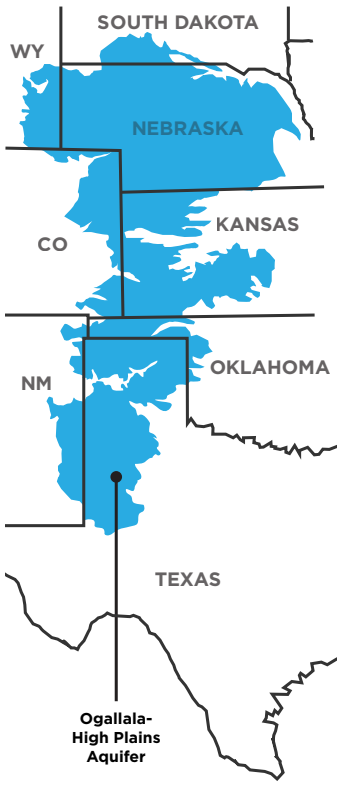
Green Link

Click on the green word "subsidence" in the student lesson to watch a YouTube video showing a vivid animation of land subsidence.



urban runoff seeps into groundwater sources, the biggest threat of this limited resource is overuse.

The Ogallala Aquifer is one of the largest aquifers in the world and is located across eight states in the United States: South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas. Like many aquifer systems throughout the world, the Ogallala Aquifer is shrinking.[18]

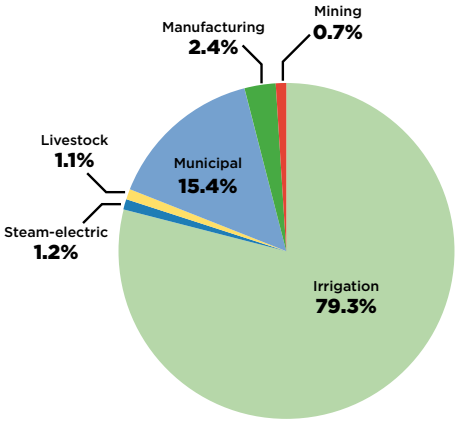
In 2005, the groundwater in the Ogallala Aquifer was recorded at 3,600 cubic kilometers. Between 2005 and 2010, the amount of water in the aquifer reduced by 300 cubic kilometers. One cubic kilometer equals 264 billion gallons!

As the graph on page 5 displays, the biggest use for groundwater in Texas is **irrigation**.[19] Although other sources of groundwater usage exist, the irrigation of crops like corn and cotton is especially heavy in West Texas and South Texas. Farming and ranching make up about 10 percent of the state's economy, and this translates into jobs for many Texans.

When considering the 300 cubic kilometers of groundwater lost by the Ogallala Aquifer, you might wonder how the land above the aquifer changed. One result is a lowering of the ground's surface, or **subsidence**. The basic cause of land subsidence is a loss of support below ground. When too much water is taken out of the soil, the soil collapses, compacts, and drops. Land subsidence leads to many problems including changes in elevation, flooding, and sinkholes.

NOTES:

In some of the land areas along Galveston Bay, the land surface has sunk as much as 10 feet since 1906. Flooding becomes a concern because the land is lower, drier, and usually compacted from shrinking. One hundred years of intense groundwater pumping in the Houston area has collapsed the layers of the Gulf Coast Aquifer, causing the land above it to sink. These changes in elevation can cause major damage to buildings, roads, and bridges.[20]



Sources: Texas Water Development Board and Texas Comptroller of Public Accounts

As we study using and valuing water, it is good to know that water use is described in two ways: water withdrawal and water consumption. There is a big difference between the two terms. **Water withdrawal** refers to water that is redirected or withdrawn from its source – surface water or groundwater. **Water consumption** refers to water withdrawn from its source permanently; it is no longer available for other uses because it has evaporated, been used by plants, or consumed by people or livestock. Once consumed, the water needs to be treated before it can be used again.

People commonly think of water use and water consumption together. However, this is not accurate because water withdrawal refers to water that can be used over and over again, as in the case of a hydroelectric power plant. Water is used temporarily to cool the power plant, then is returned to its original location, perhaps a reservoir. The next lesson will discuss this concept in more detail. Understanding how water is used, or more specifically, how water is withdrawn or consumed, is key to using it more wisely.[21]

The idea of land subsidence and depleting aquifers may start you thinking about becoming more efficient with your water use. Wasting water just doesn't make sense. Even so, the average American wastes thousands of gallons of water each year. Gallons of water are wasted during daily activities, such as taking long showers, running the hose while washing the car, or simply letting the water run straight down the drain.

In America, our water consumption has increased 127% from 1950, while much of the world lives off 3 gallons of water per day or less. To put that into perspective, we can waste 3 gallons of water with one flush of the toilet.[22] That's a lot!

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Easy Changes to Start Making Today

1	Throw used tissue into the wastepaper basket rather than the toilet.
2	Keep an eye out for leaky faucets.
3	When brushing your teeth, pour some water in a cup to use for rinsing instead of letting the water run.
4	When trying to get the faucet water warm or cold, catch the running water for plants or animals in or around the home.
5	Time yourself when taking a shower.
6	Run the dishwasher only when you have a full load. The same is true for washing clothes in the washing machine.
7	If you wash dishes by hand, don't leave the water running.
8	Use a broom for sweeping the driveway or sidewalk, not water from the hose.
9	Keep a bottle of drinking water in the fridge; it will always be cold.
10	Water lawns and shrubs early in the day when the air is still cool, and the wind is usually calm.[23]

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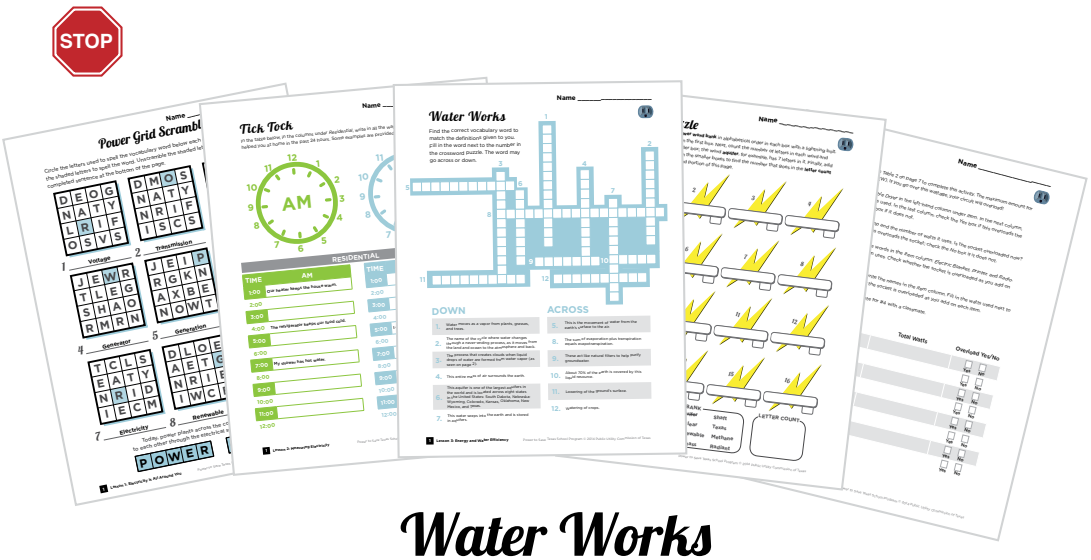

Water Works

Ask your teacher for the Water Works activity. You will receive one of three versions. Water Works uses vocabulary words to match definitions, complete a traditional crossword, or create definitions.

Long-Term Savings for Homes Tips

ELECTRIC WATER HEATER

- Repair leaks on warm-water faucets. These leaks just drain your water heater, which means it has to heat more water. That process costs you more.
- Drain your hot water tank regularly to remove sediment.
- If buying a new water heater, consider a tankless unit. These systems are 35-45% more efficient. Plus, you'll never run out of hot water.

See more at www.powertosavetexas.org.

Scan this QR Code with your smartphone to visit the program website.

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Focus on 5

Use these five questions for reflective journaling, short paragraph essays, or class discussion:

Reflective Journaling

1. List at least three positive attributes about this career that you found interesting or appealing.

2. List at least three negative attributes about this career that you thought did not apply or appeal to you.

Short Essays

3. Why do you think the future of this job is predicted as it is shown?

4. In your city, who would be an employer you could contact to ask for more information about this career choice?

Class Discussion

5. Why do you think this job was featured as a part of this lesson?

Career Connection | Job Profile:

Are you interested in how machines work?
Do you like using math?
Are you good at following rules and laws?

If you answered, "Yes," to these questions, you might like to be a water treatment plant operator. These workers run plants that treat water so it is safe to drink. They also treat water after it is used so it is safe for it to go back into rivers, lakes, and the ocean.

As a water treatment plant operator, you would:

- Use machines to clean water, remove sewage, and make power.
- Check equipment to make sure it works correctly.
- Use tools to maintain and repair machines.
- Use chemicals to clean water.
- Test water samples to make sure it is clean.
- Use tools to clean and maintain water tanks and filters.
- Keep daily records of the work at the plant.
- Manage other plant workers.

Will There Be Jobs in the Future?

In Texas, this occupation has high growth potential. Nationally, this occupation is growing at an average rate.

Education Required:

To work as a water treatment plant operator, you typically need to:

- Have a high school diploma or GED; and
- Complete long-term, on-the-job training; and
- Pass state or local licensing exams.

Provided courtesy of: www.onetonline.org

NOTES:

Focus on 5

Use these five questions for reflective journaling, short paragraph essays, or class discussion:

Reflective Journaling

1. List at least three positive attributes about this career that you found interesting or appealing.

2. List at least three negative attributes about this career that you thought did not apply or appeal to you.

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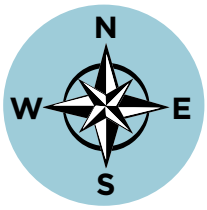

Are you good at reading maps?
Do you like using a computer?
Are you interested in where people live?

If you answered, "Yes," to these questions, you might like to be a geographer. Geographers study the features of the earth and how people use the land they live on. They often use special computer software called GIS (geographical information systems) to do tasks. Many geographers work for the federal government. Others work for private companies or colleges and universities.

As a geographer, you would:

- Study the earth and its people on a local or global scale.
- Collect data from maps, satellite photos, and from trips to sites.
- Study land features of an area, such as the plants, rocks, and climate.
- Study the culture of a group of people in a region.
- Use GIS to create maps, graphs, or diagrams.
- Give GIS data to companies that need it.
- Keep GIS software and devices in good working order.
- Give advice on issues such as where to put a new shopping center.
- Write reports and give talks about research findings.
- Teach courses to college students.

Will There Be Jobs in the Future?

In Texas and nationally, this occupation is growing at an average rate.

Education Required:

To work as a geographer, you typically need to:

- Have a high school diploma or GED; and
- Have at least a bachelor's degree in geography.

Provided courtesy of: www.onetonline.org

NOTES:

GO BACK TO PAGE 1

Stop Directions - Page 1

Objective:

Students will become acquainted with new vocabulary through the introduction of information or data in a variety of mediums.

Instructions:

Direct students to the following page (page 2) to review the Texas Annual Consumption by Sector graph. Once students are familiar with the information displayed, ask them to reflect on the following questions.

- When was energy consumption at its highest for the industrial sector?
- What do you think is the reason for the drop since that time?
- Why do you think the other three categories continue to increase?

To enhance the lesson, include a math component and represent the same information in a pie chart and bar graph. Ask students to select a particular year from the base of the graph. Once the year is selected, students will be asked to display four sectors in a pie chart, bar graph, or both, when appropriate. Students may also state their preference for the graph that best represents the information.

For example, should students select the year "1985," the answers would be as follows:

Industrial	5,000 (Trillion Btu)
Transportation	2,000 (Trillion Btu)
Residential	1,000 (Trillion Btu)
Commercial	750-1,000 (Trillion Btu)

For reference, the definition for a British Thermal Unit is provided below:

British Thermal Unit – This is a unit of power for heating and cooling systems. It is measured by the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit at a specified temperature (such as 39°F or 60°F). This is abbreviated as Btu or BTU.

GO BACK TO PAGE 5

Stop Directions - Page 5

Objective:
Students will learn how quickly water was drained from the Ogallala Aquifer over a five-year span and increase their awareness of this precious resource (water).

Instructions:
Discuss the Ogallala Aquifer. Once the discussion is finished, ask students to reflect on the information presented thus far with the **Learn and Know** questions below. The reflection may take place in written or group discussion format. Then, ask students to study and reflect on the map on page 4 and contribute their thoughts in a journal or as a member of a class discussion.

Learn and Know
Q: What is the percentage of the decline in the Ogallala Aquifer between 2005 and 2010?

A: Nearly 10%

Q: If one cubic kilometer equals 264 billion gallons, how many gallons were lost during that period?

A: 79,200 billion gallons (300 x 264 billion gallons)

Reflective Journal Prompts:
- After seeing this aquifer map, do you think it is accurate to say we are living on water?

- Even as we study water and learn about using it wisely, it is good to remember that nearly one billion people around the globe do not have access to clean water.

- The following passage is from a poem titled "The Rime of the Ancient Mariner." The poem was written by Samuel Taylor Coleridge and published in 1798. The story tells of the experiences of a sailor who had just returned from a long sea voyage.

  "Water, water, everywhere
  And all the boards did shrink;
  Water, water, everywhere,
  Nor any drop to drink."

GO BACK TO PAGE 7

Stop Directions - Page 7

Visit the Teacher Portal to access all three versions of the Water Works activity to distribute to your students. Directions for this activity are listed below.

Objective:

Students will become acquainted with the definitions of the new vocabulary words associated with using and consuming water. Student knowledge is enhanced based on their ability (see below) by manipulating the vocabulary to correctly complete the crossword puzzle.

Instructions:

Provide each student with one version of the Water Works activity. Distribute the appropriate level(s) for your class.

Limited English Proficient
Find the correct vocabulary word to match the definitions given to you. Fill in the word next to the number in the crossword puzzle. The word may go across or down.

At Grade Level
The vocabulary words for the crossword puzzle are already provided for you. Write out the definition or clue for each word below.

Advanced Grade Level
Vocabulary words from Lesson 3 will fit in each of the rows and columns of blank spaces provided above. Discover which words fit where, then write the definitions below.

GO BACK TO PAGE 7

Stop Directions - Page 7 (continued)

Water Works Activity

Aquifer – These act like natural filters to help purify groundwater.

Atmosphere – This entire mass of air surrounds the earth.

Condensation – This is created when liquid drops of water are formed from water vapor (as seen on page 2).

Evaporation – This is the movement of water from the earth's surface to the air.

Evapotranspiration – This is the sum of evaporation plus transpiration.

Groundwater – This water seeps into the earth and is stored in aquifers.

Hydrologic – This is the name of the cycle where water changes through a never-ending process, as it moves from the land and ocean to the atmosphere and back.

Irrigation – This is the watering of crops.

Ogallala – This aquifer is one of the largest aquifers in the world and is located across eight states in the United States: South Dakota, Nebraska, Wyoming, Colorado, Kansas, Oklahoma, New Mexico, and Texas.

Subsidence – This is the lowering of the ground's surface.

Transpiration – As water is warmed, it moves away from plants, grasses, and trees and becomes vapor released into the atmosphere.

Water – About 70% of the earth is covered by this liquid resource.