LESSON 1

The Water Cycle

Applicable TEKS

Science Grade 4	Science Grade 5	Science Grade 6
4.1 B 4.7 A, B, C 4.8 B	5.1 B 5.5 D 5.7 B 5.8 B 5.9 A, B, D	6.1 B

Duration

Three 40-minute lessons

Objectives

Students will grasp the relatively small amount of water that is available for human consumption. Students will understand the water cycle and its nomenclature. Students will also understand a water cycle that includes human activities (watering the lawn, washing your hands, flushing the toilet, etc.).

Prerequisites

None.

Materials

- Glass of water
- Apple and a knife
- *Handout 1—Water Recycles: The Complete Story* (GI-403)
    - You can request free color copies online at <takecareoftexas.org/publications>

Procedure

Introduction

1. Show your students a glass of water. Ask them what they know about water.
2. Review with your students the information in the guide under the section "What Is Water? What Is Water Quality?"—specifically, about water's basic properties and how the water they drink contains dissolved gases, maybe some organic matter, or even suspended particles.
3. Next, ask them where did this water come from. After the class understands that the water came from groundwater or surface water (rivers and lakes), continue to the lesson Earth's Water.

Earth's Water

1. Tell your students that you will show them how much water is on the Earth that is available for human use.
2. Show the apple and tell them that this apple represents all of the water that is on the Earth. Ask them: how much of this water is ocean salt water?
3. Cut a very small slice out of the apple, about 3 percent of the entire apple.
4. Say that this small slice represents freshwater (3 percent) and the rest represents ocean saltwater (97 percent). Let them know that this "freshwater" piece includes water trapped in glaciers and ice caps, but we don't get our water from these sources.
5. Next, cut a third off this small slice.
6. Tell them that the bigger piece is the freshwater trapped in glaciers and ice caps (about 2 percent of the total water on the Earth); the tiny little piece (only 1 percent of the total water on the Earth) represents all of the groundwater and water held in lakes and rivers. Let them know that this is where all of our water comes from, this one tiny, little piece.
7. With the little piece in your hand, point to the peel and say that this represents the water that is in rivers and lakes (only 0.02 percent of the total water on the Earth).
8. Let your students know that the upcoming lessons are about water and protecting our surface drinking water sources, the peel of the tiny little piece.

Handout 1—Water Recycles, the Complete Story

1. Review with your students the information in the guide under "The Water (Hydrologic) Cycle."
2. When ready, have them open up their binder to Handout 1. Discuss the water cycle that includes human consumption, including these points:

a. We get our water from the ground (groundwater) and from the surface (surface water).

b. More than likely, the water that enters your house came from a water-treatment plant. Water-treatment plants prepare the water for human consumption; they might do that by disinfecting and filtering the water.

c. Water that goes down your drains either goes to a wastewater-treatment plant or a septic system; both systems are designed to remove certain pollutants before releasing the water back into the environment as surface water or groundwater.

3. You and your students should work together to complete the water-trivia handout. You might want to give students a word bank for the crossword puzzle, since some of the words in the puzzle are not discussed in this guide.

Crossword Puzzle

DOWN		ACROSS	
1	ESTUARY	4	GROUNDWATER
2	OZONE	6	EFFLUENT
3	POLYMER	9	TURBID
5	RESIDENTIAL	10	CHANNELIZATION
7	HARVESTING	16	RESERVOIR
8	SILVICULTURE	17	AQUIFER
11	AGRICULTURAL	19	AERATION
12	INDUSTRY	20	BIOSOLIDS
13	CHLORINE	21	WETLAND
14	REUSE		
15	EUTROPHIC		
18	POTABLE		

Handout Answers

Fill in the Blanks

1	Rain barrel	4	Precipitation	7	Reuse	10	Condensation
2	Sludge	5	Power plant	8	Surface water	11	Drinking water
3	Infiltration	6	Groundwater	9	Sewage	12	Evaporation

Bonus: The dinosaurs are a reminder that the water on Earth today is the same water that was on Earth a long time ago when the dinosaurs were alive. That means there is a chance that the water you used to wash up this morning may be the same water that a dinosaur once drank. It also means that, a hundred years from now, your grandchildren may wash their hair with the same water that you drink today. That's why it's so important that we take care of the Earth's water; it's the only water we've ever had and the only water we will ever have.

Word Scramble

RAIN	LAKE	RESERVOIR	PLANTS	TAKE CARE OF TEXAS
SNOW	RIVER	FOG	BIOSOLIDS	
HAIL	HARVESTING	BARREL	POWER PLANT	
OCEAN	AQUIFER	SOIL	METHANE	

Water Basics

What Is Water? What Is Water Quality?

The water molecule is …

- the most abundant, unique, and important substance on Earth;
- essential to life;
- an essential part of all living things;
- a universal solvent that makes all biological functions possible;
- the only substance that occurs naturally on Earth in all three physical states (solid, liquid, and gas);
- odorless, tasteless, colorless, and transparent; and
- composed of two hydrogen atoms and one oxygen atom (H_2O).

When you pour a glass of water, what is in that glass of water? It's not pure water because it is virtually impossible to remove all other substances from the water (including any dissolved gases like oxygen). Even if your water comes from a water treatment plant (or even if it's bottled), it probably contains small levels of organic matter, suspended particles, certain elements, or other molecules. If your water contains these substances, you shouldn't have to worry about them if they are at levels low enough to comply with the quality standards established for drinking water.

Water quality comprises the physical, chemical, and biological properties of the water at levels suitable for a particular use. Uses will vary, and so will the water quality standards. In the scenario above, the water treatment plant takes in water (groundwater, surface water, etc.) and prepares it for drinking; since it is being used for human consumption, the water must meet the drinking-water quality standards that are set at levels to protect the health of the general population. For another example, treated effluent (water) from a wastewater-treatment plant that will be used by aquatic life must meet the water quality standards set for that water body so the aquatic life is not affected by the incoming waters.

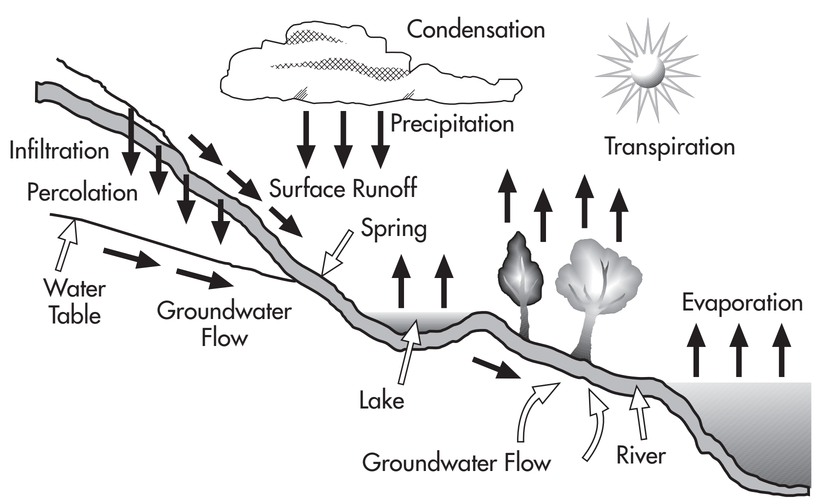
When you study water quality, you must know what the water is being used for to determine which tests you will need and what testing outcomes are appropriate for that water study. As an example, surface water quality might be tested for its:

- **Physical properties:** water temperature, flow, pH, amount of dissolved oxygen, and turbidity (water clarity)
- **Chemical properties:** amount of nutrients and heavy metals
- **Biological properties:** number and diversity of bacteria, plankton, benthic macroinvertebrates, and fish

The Water (Hydrologic) Cycle

The water cycle (also called the *hydrologic cycle*) is a model that describes continuous movement of water between the atmosphere, land, and water bodies. This section explains the water cycle and how some of the water's properties may change during the process. There is no beginning or end to the water cycle since it is a continuous loop; this guide will start with precipitation.

The Hydrologic Cycle



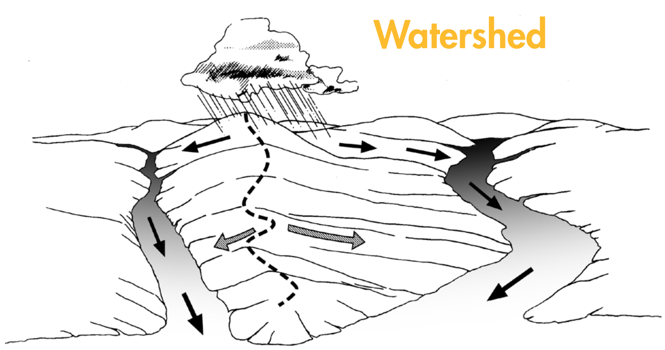
Precipitation

As water vapor moves through the atmosphere, it interacts with other molecules. Water vapor will react with some of the carbon dioxide in the atmosphere to form carbonic acid (a weak acid). If nitrogen oxides or sulfur dioxide are present, the water vapor will mostly likely react with these molecules to form stronger acids. Both nitrogen oxides and sulfur dioxide enter the atmosphere from natural sources (such as volcanoes) and human sources (such as fossil-fuel combustion).

When the water vapor cools, it condenses into clouds and eventually falls to the Earth as precipitation (rain, sleet, hail, or snow). Precipitation is naturally acidic, with a pH greater than 5.6, because it contains carbonic acid. Rainwater with a pH less than 5.6 contains stronger acids and is called ***acid rain***. Rainwater also contains items that are found in the atmosphere, such as pollen and dust.

Watershed

When precipitation hits the ground, it either enters the ground (called *infiltration*, or *percolation*) or drains across the land as surface runoff (called *stormwater*). The stormwater follows the drainage patterns of a *watershed*—a geographic area in which water, sediments, and dissolved materials drain into a common outlet. This outlet could be a stream, lake, reservoir, playa, estuary, aquifer, or ocean. The precipitation that enters the ground (*groundwater*) may eventually drain into a watershed or its outlet.



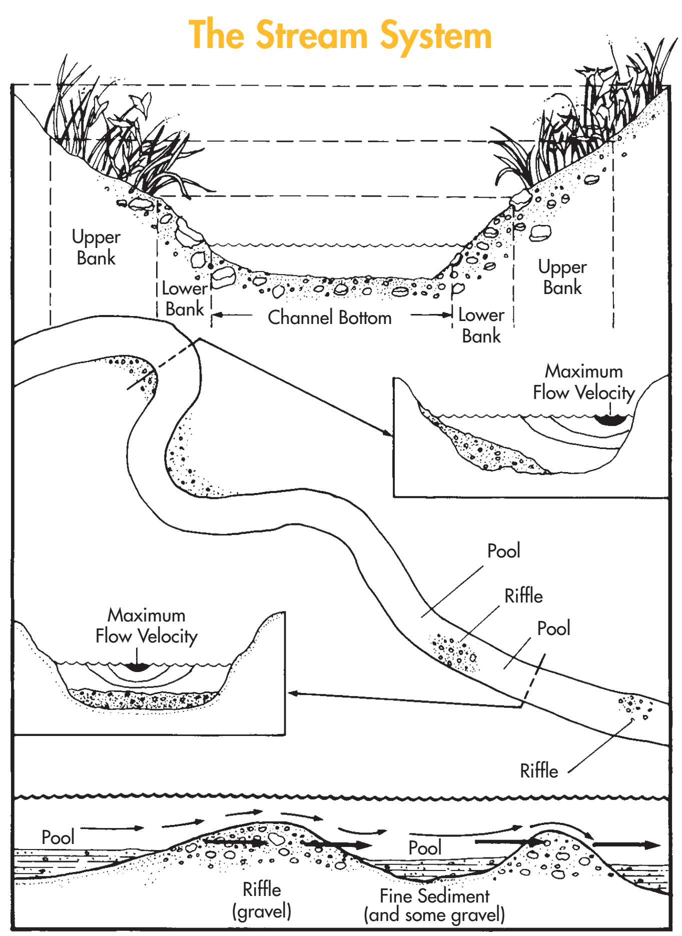
Watersheds are also commonly called *drainage basins* or *drainage areas*. The total area of land that contributes stormwater to the outlet is determined by topographic boundaries. A ridge or other area of elevated land (called a *divide*) separates one watershed from another. A stream on one side of the divide will flow to a different outlet than one that is on the other side of the divide.

In each watershed a variety of factors interact with the water in the system, including the climate, the amount of rainfall, the geology and geography of an area (soil, hills, lowlands, forests, etc.), and human activities (urban or industrial development, agriculture, etc.). Everything that happens in the watershed can contribute to what ends up in its outlet. Impurities such as oil and grease (from roads) or bacteria (from untreated wastewater, leaking septic systems, pet waste, or other sources) can be picked up in the stormwater and deposited into the watershed's outlet.

In natural areas (such as forests), vegetation slows the flow of water over the land, filters some impurities, and decreases erosion. As much as half of all rainfall that falls in these areas is absorbed into the ground. In urban areas, many vegetated surfaces are replaced with impervious cover (like concrete) which does not allow water to enter the ground. Instead, the amount of stormwater increases and it flows more swiftly downhill. This increased flow can lead to flooding, erosion, and additional impurities reaching a watershed's outlet. In many urban areas, less than one-third of all rainfall is absorbed into the ground.

Streams

Stream channels are created as stormwater from the watershed seeks a path of least resistance. If the watershed has a very steep terrain, the resulting swiftly moving water may



The above diagram shows the water flow and major structures of a stream. Notice how the pools and riffles alternate. A major feature of the riffle is that water flows through the gravel as well as over it. This enables small fish and small benthic invertebrates to obtain the oxygen they need while being protected from predation by larger organisms such as fish. *Source: Kentucky Division of Water* cut a deep stream channel and remove sediment from the stream bed. If the topography is flat, the stream may be shallow and meandering with suspended sediment in the water column.

Streams may contain one or more of the following instream habitats: pools, riffles, root mats, aquatic plants, undercut banks, overhanging vegetation, leaf litter, and submerged rocks and logs. These habitats, along with the depth and flow of the water, are key factors in determining the type of aquatic organisms found in a stream. Under natural conditions, a greater variety of combined habitats means a greater diversity of aquatic life. Poor quality instream habitats can often be the root cause of low diversity of aquatic life in streams.

A stream's bank and its associated riparian zone (a vegetated buffer between nearby lands and the stream) serve many functions other than keeping the water in the channel. They are home to many plants and animals. Under natural conditions, they help protect the stream from outside influences. When these areas are covered with trees, shrubs, and herbaceous (non-woody) plants, they provide erosion control, sediment collection, and nutrient absorption.

Rivers

Rivers are large natural streams that carry a considerable volume of water. Rivers serve as a collection point for all the smaller creeks and streams in a watershed and ultimately carry water to coastal areas. They are extremely important water-supply sources for domestic use, agriculture, industry, and generating electricity (hydroelectric power).

The amount of water a river transports is the result of many factors: the size of the watershed, climate, geography, geology, size of the stream channel(s), any stream alterations (channelization, dredging, reservoir construction), and the water table (level of groundwater). A river can receive water from groundwater subsurface flow; thus the water-storing capacity of rocks and soil surrounding a river can strongly influence flow.

Reservoirs

Texas has thousands of reservoirs—artificial lakes whose main function is to stabilize the flow of water from a watershed or to satisfy the varying demands from water consumers. Most reservoirs have a dam and a spillway that limits the maximum water level. Many reservoirs also have outlet structures that allow the controlled release of water. The outlet for a reservoir is an inlet for another water body, such as a river or another reservoir.

Evapotranspiration

Water on the surface of the Earth can change physical states, from liquid to gas (vapor). The amount of water changing into vapor depends greatly on temperature. Generally, the higher the temperature, the higher the amount of water that changes into vapor. This water vapor will rise into the atmosphere and eventually change its physical state back into a liquid (or even become a solid) and become precipitation.

Evapotranspiration refers to the two ways water moves from the land to the atmosphere as vapor. The word *evapotranspiration* is the combination of two words, *evaporation* and *transpiration*. Bodies of water (oceans, lakes, streams, etc.) releasing water vapor is called evaporation. Plants (that have absorbed groundwater) releasing water vapor is called transpiration.