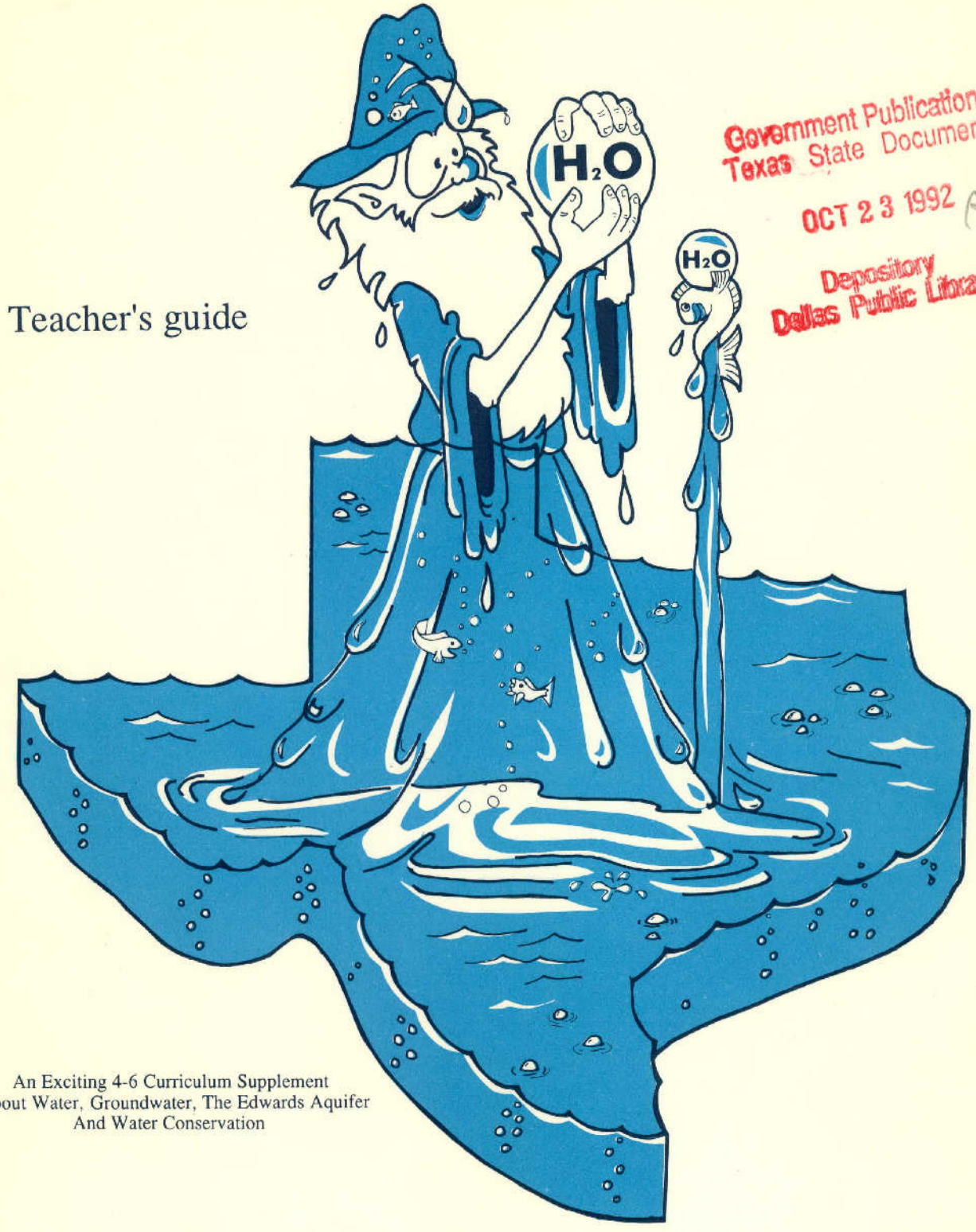
WATER WIZARDS



Teacher's guide

An Exciting 4-6 Curriculum Supplement
About Water, Groundwater, The Edwards Aquifer
And Water Conservation

EDWARDS UNDERGROUND WATER DISTRICT

INTRODUCTION

Water Wizards is the first in a series of curriculum supplements to be generated and distributed to schools in the Edwards Aquifer region. This publication is an interdisciplinary collection of activities created to provide intermediate level (4-5-6) students with a greater understanding of the importance of water and the Edwards Aquifer.

Residents of the Edwards Aquifer area are becoming increasingly aware that wise and successful management of this resource is necessary. Providing students with information about the physical and chemical properties of water, the hydrologic process, the geographic, geologic and hydrologic dynamics of the Edwards Aquifer, and the social and economic implications of its use will help them make wise decisions regarding water management.

The Edwards Underground Water District was created in 1959 to conserve, preserve and protect the Edwards Aquifer. The District believes that one of its most important goals is to inform the public about the underground water supply. Understanding the Edwards Aquifer is the first step towards preserving it.

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OVERVIEW

The lessons in this guide are designed to be used as an interdisciplinary supplement to existing district curriculum. Lessons are targeted to grade levels 4-5-6, but teachers of lower elementary grades or junior high can use the guide with simple modifications.

The emphasis in the lessons is on hands-on, minds-on activities, with maximum student involvement and minimum teacher direction. In an effort to enhance student curiosity and involvement, all activities are written along the guidelines of ***Project 2061's 5-E Instructional Model:***

Engagement - Mentally engages and motivates students with an event or a question.

Exploration - Hands-on/minds-on activities.

Explanation - Helps students to provide reasonable solutions and answers. Encourages them to listen and to further question.

Elaboration - Events that help students apply the newly learned concept. Activities are used as vehicles to probe other unique situations.

Evaluation - Students demonstrate an understanding of the concept or skill. Events help students to continue to elaborate on their understanding.

The activities are grouped into four separate lessons. Each lesson can be used independently, but comprehension and retention would be significantly higher with the sequential presentation of all four lessons.

LESSON I - The Water Puzzle - Importance and Properties

Activity 1 - What Is It? To reinforce the three forms of water.

Activity 2 - Why Is It So Important? To help students understand the necessity of water to all life forms.

Lesson II - The Water Cycle: How Groundwater Fits In

Activity 1 - Water: The Never Ending Cycle. To demonstrate groundwater's role in the water cycle.

Activity 2 - How Does Groundwater Fit In? The Water Table. To help students understand how water soaks through permeable layers of the earth and collect to form groundwater and the water table.

Lesson III - Our Water Source: The Edwards Aquifer

Activity 1 - Where Is It? Location and Description of the Edwards Aquifer Region. To identify the location of and name the three zones of the Edwards Aquifer.

Activity 2 - How Does It Work? Dynamics of a Confined Artesian Aquifer. To reinforce the dynamics of the Edwards Aquifer system and highlight the possibility of contamination.

Lesson IV - Water Usage and Conservation

Activity 1 - Wow! Do We Really Use That Much? To identify activities using water at home, and the amount of water used.

Activity 2 - Water Conservation - Every Drop Counts! To learn to recognize good and bad water use habits.

ESSENTIAL ELEMENTS CORRELATION

Subject: Science

Essential Element	Grade Level	Subelement	LESSON I			LESSON II		LESSON III		LESSON IV	
			Activity 1	Activity 2	Activity 3	Activity 1	Activity 2	Activity 1	Activity 2	Activity 1	Activity 2
Manipulative Laboratory Skills **1**	4	c) use metric balances		✔							
		e) use comparators: mass, volume		✔	✔		✔	✔			
	5	b) construct models	✔			✔	✔	✔	✔	✔	
The use of skills in acquiring data through the senses **2**	4	a) observe phenomena and apply knowledge of facts and concepts	✔			✔	✔		✔		
	5	a) observe phenomena of natural cycles				✔	✔		✔		
	6	a) observe phenomena and apply knowledge of facts, theories, laws, structures, concepts	✔			✔	✔		✔		
The use of classification skills in ordering and sequencing data **3**	4, 5, 6	a) classify organisms, objects, actions or events according to similarities and differences	✔	✔	✔				✔	✔	✔
	6	b) classify variables as being constant, manipulated, or responding	✔	✔					✔	✔	✔
Experience in oral and written communication of data appropriated form **4**	4	b) describe the changes that occur in weather and their effects				✔					✔
		c) describe information obtained from charts, graphs, histograms			✔					✔	
	5	b) interpret meaningful arrangements of data		✔						✔	✔
	6	c) describe the patterns of data									
		e) describe the sequence of events in an investigation				✔	✔				

ESSENTIAL ELEMENTS CORRELATION

Subject: Science

Essential Element	Grade Level	Subelement	LESSON I			LESSON II		LESSON III		LESSON IV	
			Activity 1	Activity 2	Activity 3	Activity 1	Activity 2	Activity 1	Activity 2	Activity 1	Activity 2
Experience in concepts and skills of measurement using relationships to standards **5**	5	a) collect information by measuring and recording data on graphs and tables			✔					✔	✔
	6	a) collect information by measuring and recording data on graphs, diagrams, and other visual materials			✔	✔		✔		✔	✔
The use of skills in drawing logical inferences, predicting outcomes, and forming generalized statements **6**	5	a) predict an outcome from a trend in data					✔		✔		✔
		b) predict cause-and-effect relationships	✔			✔		✔	✔		✔
	6	a) predict an outcome from trends in data					✔		✔		✔
		c) deduce from given information the cause and effect relationships	✔			✔		✔	✔		✔
Experience in skills relating objects and events to other objects and events **7**	4, 5	a) compare objects according to motion, mass, volume		✔	✔		✔	✔			
Experience in applying defined terms based on observations **8**	4	a) apply knowledge of facts and concepts in explaining observations in experimental and controlled situations				✔	✔		✔	✔	✔
	5, 6	a) state the differences between objects and events using an operational definition			✔				✔		
Experience in identifying and manipulating the conditions of investigations **9**	5,6	a) identify the variables being manipulated and the variables responding in an investigation				✔	✔		✔		✔
	6	b) design and conduct an investigation				✔	✔			✔	

ESSENTIAL ELEMENTS CORRELATION

Subject: Math

Essential Element	Grade Level	Subelement	LESSON I			LESSON II		LESSON III		LESSON IV	
			Activity 1	Activity 2	Activity 3	Activity 1	Activity 2	Activity 1	Activity 2	Activity 1	Activity 2
Concepts and skills associated with understanding of numbers (whole, integer, and non-negative rational) and the place value system **1**	4, 5	a) compare and order								✔	
	4	d) use decimals		✔							
	5	e) use decimals		✔							
	6	e) find relationships between fractions, decimals, percents, ratios		✔							
The basic operations on numbers (addition, subtraction, multiplication, division), their properties and their uses **2**	4	a) add and subtract whole numbers and decimals b) multiply whole numbers c) divide whole numbers		✔						✔	✔
	5	a) add, subtract, multiply, and divide whole numbers		✔						✔	✔
	6	a) add, subtract, multiply, and divide integers		✔						✔	✔
Experience in solving problems by selection and matching strategies to given situations **3**	4, 5, 6	b) use basic operations with whole numbers, fractions and decimals		✔						✔	✔
		d) use charts and graphs		✔						✔	✔
Measurement concepts and skills using metric and customary units **4**	4, 5, 6	a) measure (using measuring instruments)		✔						✔	✔
The use of probability and statistics to collect and interpret data **7**	4, 5, 6	a) collect data and use to construct graphs		✔						✔	✔
	5, 6	a) interpret and construct charts and graphs		✔						✔	✔

ESSENTIAL ELEMENTS CORRELATION

Subject: Theater Arts			LESSON I			LESSON II		LESSON III		LESSON IV	
Essential Element	Grade Level	Subelement	Activity 1	Activity 2	Activity 3	Activity 1	Activity 2	Activity 1	Activity 2	Activity 1	Activity 2
Expressive use of the Body and Voice	4	express concepts using interpretive movement	✔								
Creative Drama	5	improvisation	✔								
	6	situation role-playing	✔								✔
Subject: Art Ideas											
Elements are principles: creating art	4, 5, 6	create art that demonstrates an understanding of design principles	✔			✔		✔			
		selectively use the elements and principles of art to achieve planned effect	✔			✔		✔		✔	
		use elements and principles of design to compose original artworks in two- and three-dimensional formats						✔		✔	

ESSENTIAL ELEMENTS CORRELATION

Subject: Social Studies			LESSON I			LESSON II		LESSON III		LESSON IV	
Essential Element	Grade Level	Subelement	Activity 1	Activity 2	Activity 3	Activity 1	Activity 2	Activity 1	Activity 2	Activity 1	Activity 2
Personal, social, and civic responsibilities **1**	5	c) follow standards of ethical and moral conduct							✔		
	6	a) explain the role of compromise as a method of resolving conflict									✔
The American economic system **2**	4	d) identify major economic resources of regions of Texas		✔	✔			✔			
	5	b) explain why conservation of economic resources is important			✔						✔
Historical data about Texas, the United States, and the world **3**	4	a) describe the influence of geography on the history of Texas						✔		✔	

ESSENTIAL ELEMENTS CORRELATION

Subject: Social Studies

Essential Element	Grade Level	Subelement	LESSON I			LESSON II		LESSON III		LESSON IV	
			Activity 1	Activity 2	Activity 3	Activity 1	Activity 2	Activity 1	Activity 2	Activity 1	Activity 2
Local, state, national, and world geography **5**	4	a) describe how the various geographical regions of Texas, U.S., and the world are similar and different						✔			
	4	b) understand how people adapt to their physical environment								✔	
	4	d) describe landforms of various regions of Texas						✔			
	4	e) locate major geographical features of Texas on maps and globes						✔			
	5	d) describe the landforms of various regions of the U.S.						✔			
	5	e) locate major geographical features of the U.S. on maps and globes						✔			
	6	c) describe the impact of physical features on selected cultures, past and present								✔	✔
	6	d) locate and describe landforms and climates of various regions						✔			
Psychological, sociological, and cultural factors affecting human behavior **6**	6	c) describe how written and unwritten laws and rules of a society affect individual and group behavior									✔
Social studies skills **7**	4	b) interpret visuals (pictures, charts, graphs, tables)			✔	✔	✔	✔	✔	✔	✔
	5	b) located information in reference work (atlas, almanac, encyclopedia, etc.)						✔			
	6	b) compare and contrast opposing viewpoints									✔

ESSENTIAL ELEMENTS CORRELATION

Subject: English/Language Arts

Essential Element	Grade Level	Subelement	LESSON I			LESSON II		LESSON III		LESSON IV	
			Activity 1	Activity 2	Activity 3	Activity 1	Activity 2	Activity 1	Activity 2	Activity 1	Activity 2
Speaking Developing fluency in using oral language to communicate effectively **1**	4, 5, 6	a) engage in creative dramatic activities and nonverbal communication	✔								✔
Listening Developing skill in attending to, responding to, and analyzing oral communication	4, 5, 6	a) employ active listening in a variety of situations				✔					
Reading Developing vocabulary to understand written material **2**	4, 5, 6	c) understand content area vocabulary		✔		✔		✔	✔		
Using comprehension skills to gain meaning from whatever is read **3**	5, 6	b) predict probable future outcomes or actions								✔	✔
Applying reading skills to a variety of practical situations. **4**	4, 5, 6	a) follow directions	✔	✔	✔	✔	✔	✔	✔	✔	✔
	4	e) use graphic sources for information simple maps, globes, pictures, diagrams, and bar graphs		✔	✔	✔	✔	✔	✔	✔	✔
	5	b) use graphic source for information tables and lists, charts and graphs, maps and globes, timelines, pictures and diagrams, scale drawings, and transportation schedules		✔	✔	✔	✔	✔	✔	✔	✔

ESSENTIAL ELEMENTS CORRELATION

Subject: English/Language Arts			LESSON I			LESSON II		LESSON III		LESSON IV	
Essential Element	Grade Level	Subelement	Activity 1	Activity 2	Activity 3	Activity 1	Activity 2	Activity 1	Activity 2	Activity 1	Activity 2
Reading Applying reading skills to a variety of practical situation **4**	6	c) compare the information on charts and graphs, tables, and lists		✔	✔					✔	✔
Writing Using a variety of techniques to select topics and to generate material to write about those topics **1**	4, 5	a) use ideas and information from sources other than personal experiences for writing					✔				
	6	a) generate material for writing independently and in a variety of ways					✔				
Applying the convention of writing to produce effective communication **3**	4, 5	e) join related sentences into paragraphs					✔				✔
	6	e) include in paragraphs a variety of kinds of complete sentences		✔			✔				✔
	5, 6	b) spell increasingly complex words						✔	✔		

TAAS Objectives

A few of the activities in the Water Wizards curriculum supplement can be used to reinforce selected TAAS objectives as indicated below.

	Lesson I			Lesson II		Lesson III		Lesson IV	
	Act. I	Act. 2	Act. 3	Act. 1	Act. 2	Act. 1	Act. 2	Act. 1	Act. 2
Grade Levels 5 and 7: English Language Arts									
Objective 2: The student will organize ideas in a written composition on a given topic					✔				✔
Objective 3: The student will demonstrate control of the English language in a written composition on a given topic					✔				✔
Grade levels 5 and 7: Mathematics									
Objective 5: The student will demonstrate an understanding of probability and statistics			✔					✔	✔
Objective 6: The student will use the operation of addition to solve problems								✔	✔
Objective 7: The student will use the operation of subtraction to solve problems									✔
Objective 8: The student will use the operation of multiplication to solve problems		✔						✔	✔
Objective 9: The student will use the operation of division to solve problems		✔						✔	✔
Objective 12: The student will express or solve problems using mathematical representation			✔					✔	✔

Lesson I:
The Water Puzzle
Importance and Properties

Background Information:

Water is all around us. The Earth is called "The Water Planet". But what is water? Water is the only substance that naturally occurs in these three states:

Liquid - Saltwater oceans (over 97% of all water on earth)
Freshwater- lakes, rivers, streams (approximately .01% of all water on earth), and groundwater (0.6% of all water on earth)

Solid - Glaciers, icebergs, and snow (almost 2% of all water on earth)

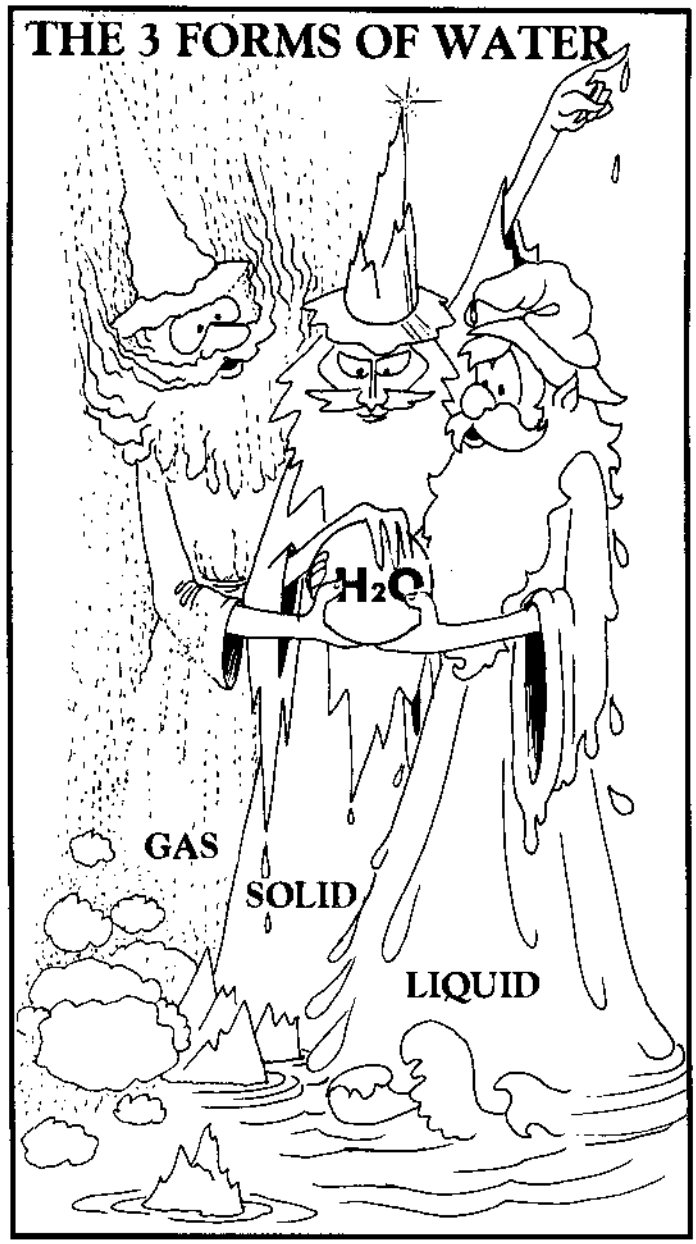
Gas - Vapor in clouds and air

Water becomes a solid (ice) at below 32°F (0°C), a liquid between 32°F and 212°F (0° and 100°C) and a vapor (gas) above 212°F (100°C).

All plants and animals need water to live. Our bodies require water to function properly. Our bodies may feel solid, but we are actually about 65% water. If you were to lose 20% or more of this water you would die.

The Earth is called **The Water Planet.** But how much of the water on this planet is available for life? Seventy-five percent of the planet is water. Over 97% of that is saltwater, useless for plant and animal consumption. Of the remaining water, 2% is frozen, leaving less than 1% usable liquid freshwater.

Freshwater takes on many forms: rivers, lakes, reservoirs, glaciers and even groundwater. Only 0.6% of the water on the earth is groundwater. Although this is a small percentage, millions of people on earth, including people who live in the south central area of Texas, rely primarily on groundwater.



LESSON PLAN

This lesson includes activities focusing on the necessity of water, a demonstration of the amount of water on the earth's surface, and a description/demonstration of the three properties of water.

Concepts:

1. Water is found on the earth in three forms.
2. Water is required for healthy plants and animals.
3. The earth has only a small supply of freshwater.

Objectives:

Students will recognize the importance of water to all forms of life.

Knowledge - Students will be able to describe
* the three forms of water
* how plants and animals must have water to survive
* how much of the earth's water can be used for the purpose of sustaining life

Skill - Students will be able to define
* the basic vocabulary: solid, liquid, gas, saltwater, freshwater, surface water, groundwater

Attitude - Students will become
* aware of the necessity of water to sustain life
* aware of the scarcity of fresh water on the planet

TEACHING TIPS

Preparation:

1. Make student copies of:
   Reading 1: The Importance of Water
   Make group copies of :
   Investigation 3: How is Water Distributed on Earth
2. Make transparencies of:
   Investigation 2: How Much Water Does Your Body Hold?
3. Materials needed:
   Activity 1: water, clear container, food coloring, toothpicks, ice, hotplate, boiling pan, construction paper, markers, glue, plastic cups.
   Activity 3: globe or poster of Earth (a world map will be sufficient).
   Every group will need: 10 cups of water, clear container, measuring cups, 1 quart container, 1 tablespoon, 3 smaller clear containers (one with rocks in it), spoon, eyedropper.
4. Set up for Activities 2 and 3 in advance.

Procedures:

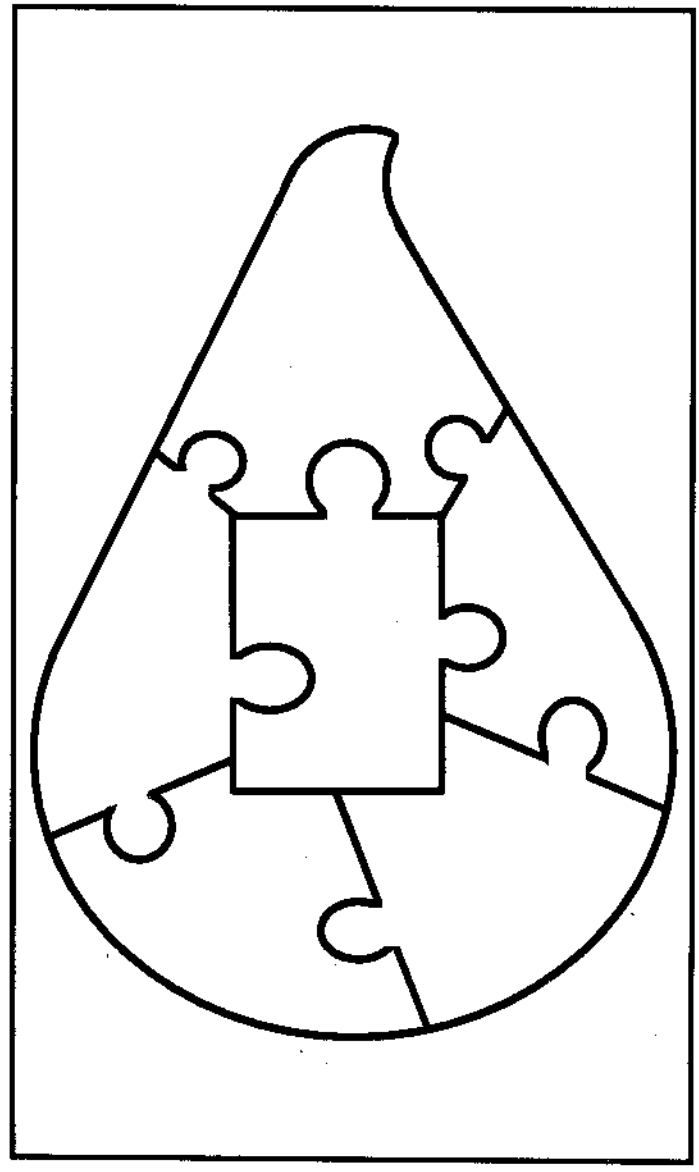
1. Use Activity 1 to explore the three forms of water.
2. Use Activity 2 to introduce important water facts and to identify how much water is in your system. Set up ahead of time.
3. Use Activity 3 to identify how much of the earth's water is freshwater, how much is saltwater. Set up ahead of time.

Major ideas:

* Water occurs in three forms: solid, liquid, gas.
* Living things are made up mostly of water.
* Living things cannot live without water.
* Less than 3% of the earth's water is freshwater. Of this, 2% is frozen in glaciers. Only 0.6% is groundwater.

Vocabulary:

solid	freshwater	saltwater
liquid	groundwater	
gas	surface water	



ACTIVITY 1: WHAT IS IT?

Goal: To reinforce the concept of the 3 forms of water - solid, liquid, gas.

Curricula areas: Science, Art, Theater Arts

Materials: Water in a clear container, food coloring, toothpicks, ice, hot plate, boiling pan, construction paper, markers, glue, plastic cups.

Procedures:

Engagement - Break students into groups of 6 at tables, or have them rearrange their desks to form a hexagon. Give each group one container of water. Instruct the students to discuss what is in the container:

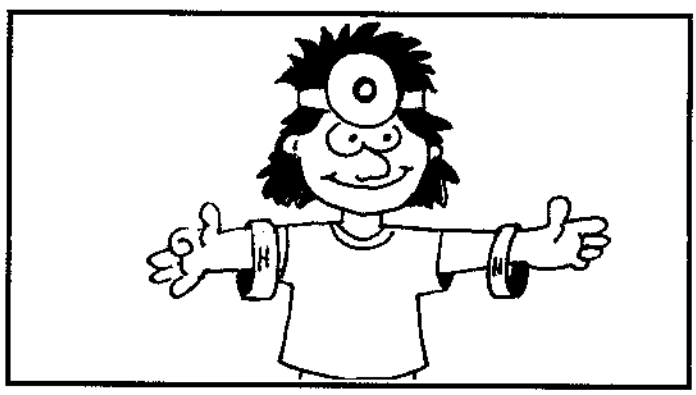
Does the substance appear to be one thing?
Can you see any smaller pieces?

Instruct students to reach into the container, wet their hand, and shake drops on table. Students should then use toothpicks to separate into smaller and smaller droplets.

Is there any limit to how far it can be divided?
Are the droplets still water? WHY?
What are the forms of water?
WHAT IS THE SMALLEST PIECE OF WATER
(THAT IS STILL WATER)
CALLED?
A WATER MOLECULE.

Exploration - Preparation for role-playing:

1. Make an oxygen atom hat - label it O.
2. Make 2 hydrogen rings - label them H.
3. Students will place the hat on their head, and rings around their arms. Their arms will be the bands that connect hydrogen atoms to oxygen atoms. Students are now set to pretend they are water molecules.



Explanation - Complete *Investigation 1.*

Note: Question for students to ponder while taking part in Investigation 1 - What connections will you have with other water molecules as water changes from one physical property to another? (Students need to seriously VISUALIZE themselves as water molecules.)

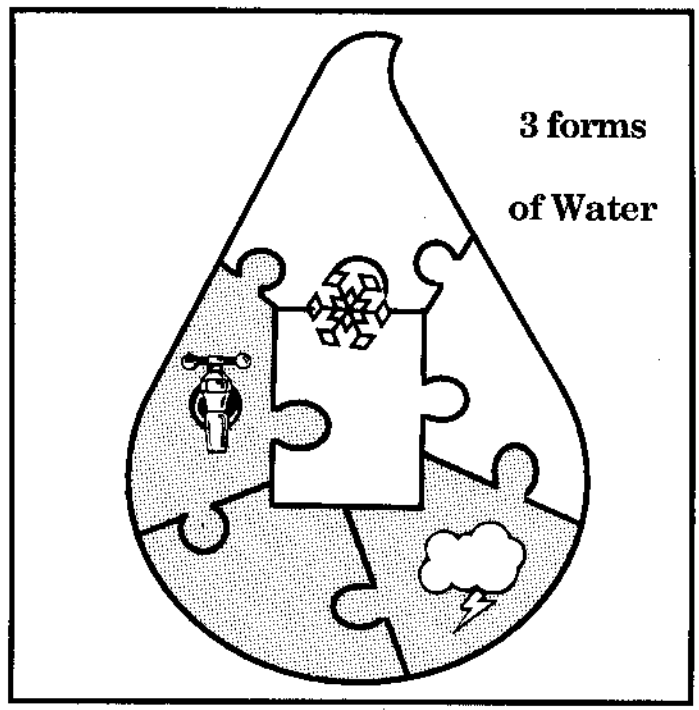
Elaboration - Give each group a stack of magazines to look for and clip pictures of solid, liquid, and gaseous water. Trade photos with other groups so that one has all pictures of solids (snow, ice), one has all liquids (salt and freshwater), and one has pictures of all gases (fog, clouds, etc.). Instruct each group to make a collage of the pictures to put on a bulletin board. Put a drawing of a thermometer across the bottom of the bulletin board.

solid..... 32°F ..... liquid ..... 212°F .....gas .....
0°C 100°C

Evaluation -

Have students tell you what they know about water:

1. How many atoms are in a water molecule? Specifically oxygen? Hydrogen?
2. What are the three physical forms of water?
3. At what temperature (°F) can we see a change from liquid to solid? From liquid to gas?
4. How do water molecules react when subjected to cold temperatures? To heat?



ACTIVITY 2: WHY IS IT SO IMPORTANT?

Goal: To help students understand the necessity of water to all life forms.

Curricula areas: Science, Math

Materials:
Student copies of: *Reading 1: The Importance of Water.* Student copies or transparency of: *Investigation 2: How Much Water Does Your Body Hold?*, balance scale, fresh fruits and vegetables.

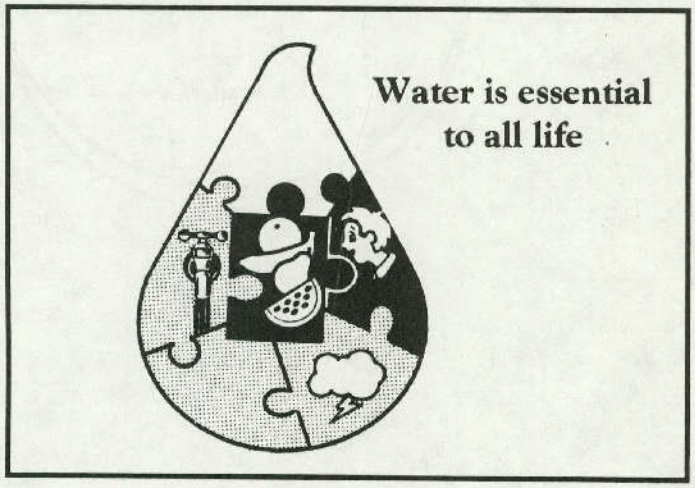
Procedures:
Engagement - Have students brainstorm this question: How much (what percentage) of your body is water? List guesses on board.

Exploration - Using a balance scale, have students compare and chart weights of the following:

dried fruits vs. fresh fruits
beef jerky vs. fresh hamburger
garlic powder vs. garlic clove

NOTE: Have students bring in fruits and vegetables. Mash one of each; refrigerate one of each. Teacher can take home and dehydrate the mashed fruits or vegetables. Students can then weigh one of each dehydrated and one of each fresh and discover the difference between the two. (Use metric measures if possible!)

Explanation - Read orally and discuss - *Reading 1: The Importance of Water*



Elaboration - Complete *Investigation 2* (details given on separate handout - can be worked from an overhead transparency).

Evaluation - Observe students' reactions to investigation. Check answers for understanding.

Extension - *Charting a Comparison: (see handout)* Construct a bar graph showing how much water different food products contain. Start with the food that contains the least amount of water, progressing to the food that contains the largest amount of water.

ACTIVITY 3: WHERE IS IT? HOW MUCH OF IT CAN WE USE?

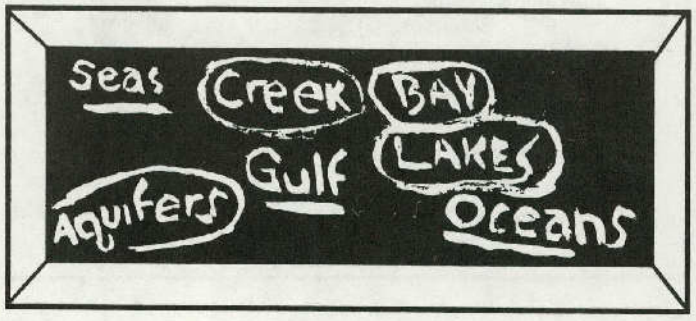
Goals: To demonstrate the limited amount of usable water on earth. To describe how much of the world's water is groundwater.

Curricula areas: Math, Science, Social Studies

Materials: A globe or a poster of the Earth (a world map would be sufficient); Group copies of: *Investigation 3*. *Investigation 3* requires that every group be supplied with the following: 10 cups of water, clear container, measuring cups, 1 quart container, 1 tablespoon, 3 clear containers (one with rocks in it), spoon, eyedropper.

Procedures:
Engagement - Using a map of the Earth, or a globe, discuss the following with the students:

*How much of the earth's surface is water?
*What type of water bodies are found? (list on board)
*Which water bodies are saltwater? (underline)
*Which bodies are freshwater? (circle)



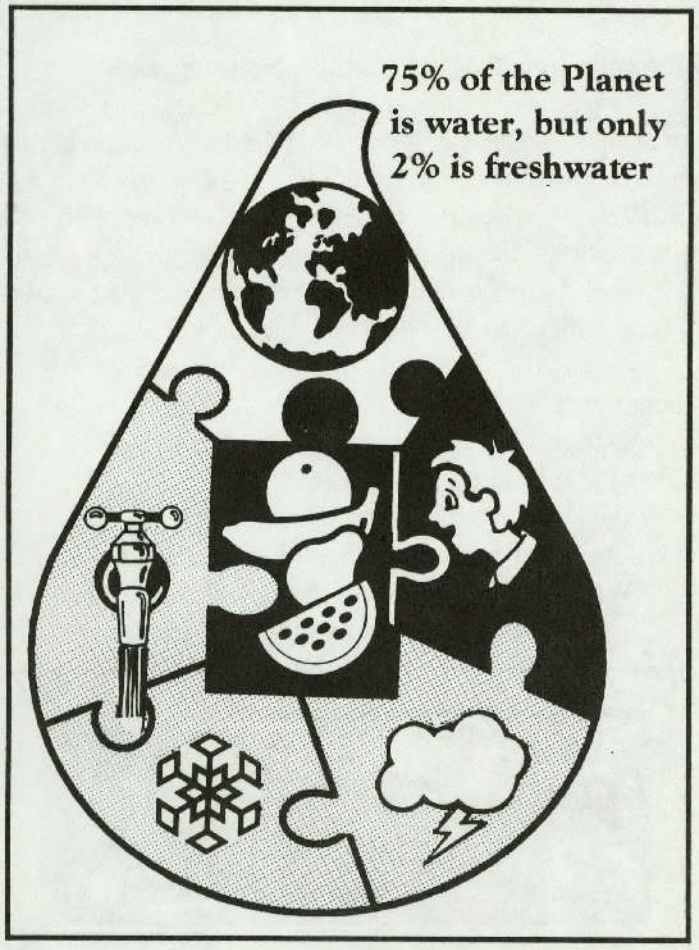
Exploration - Break students into groups of 3-5. Begin with 10 cups of water in one clear container (representing all water on the earth's surface) for each group. Ask students to write down guesses as to what percentage of it they think represents freshwater and what percentage represents saltwater. Teacher should list students' guesses on the board.

In groups, students complete *Investigation 3: How is Water Distributed on Earth?* (details given on separate handout).

Elaboration -

Discussion questions for oral or written purposes:

1. How much saltwater verses freshwater is there on the earth's surface?
2. What is water needed for?
3. Why is freshwater so important?
4. Where can freshwater be found?
5. Where does your freshwater come from?
6. What would happen if people in this area could not rely on the freshwater underground for drinking?
7. How should we treat the freshwater underground?



Explanation -

Provide students with the following statistics concerning the amount of water found on Earth.

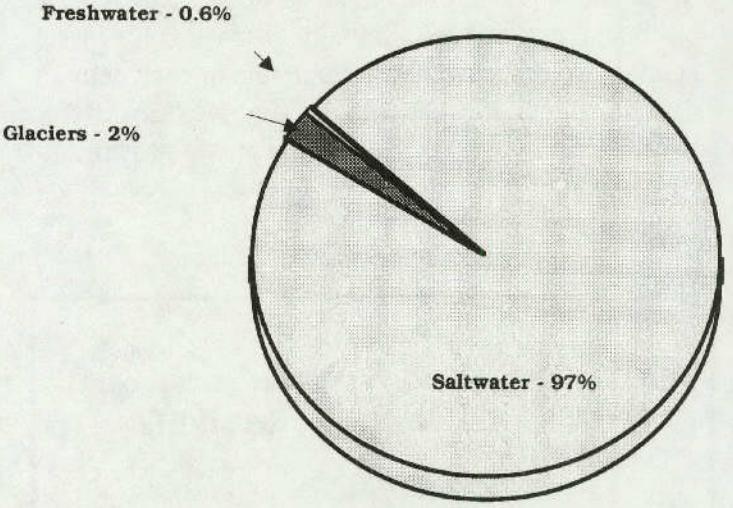
Water Type	Approx. Amount (%)
Oceans	97.2
Ice caps/glaciers	2.0
Groundwater	0.62
Freshwater lakes	0.009
Inland seas/salt lakes	0.008
Atmosphere	0.001
Rivers	0.0001
Total	99.8381

Have students list as many names for each type of water bodies as they can!

Evaluation -

Given information in the chart, have students create a pie graph and fill in estimates:

Saltwater (97%)
Glaciers (2.0%)
Freshwater (0.6291%)



Lesson II:
The Water Cycle
How Groundwater Fits In

Background Information:

Groundwater is not a mysterious substance that magically appears underneath the surface of the earth. It is part of a process called the Water Cycle.

The Water Cycle is a continuous cycle through which water travels from the ground up into the air and back to the ground again. The sun is the powerful force that keeps water moving through this circular path.

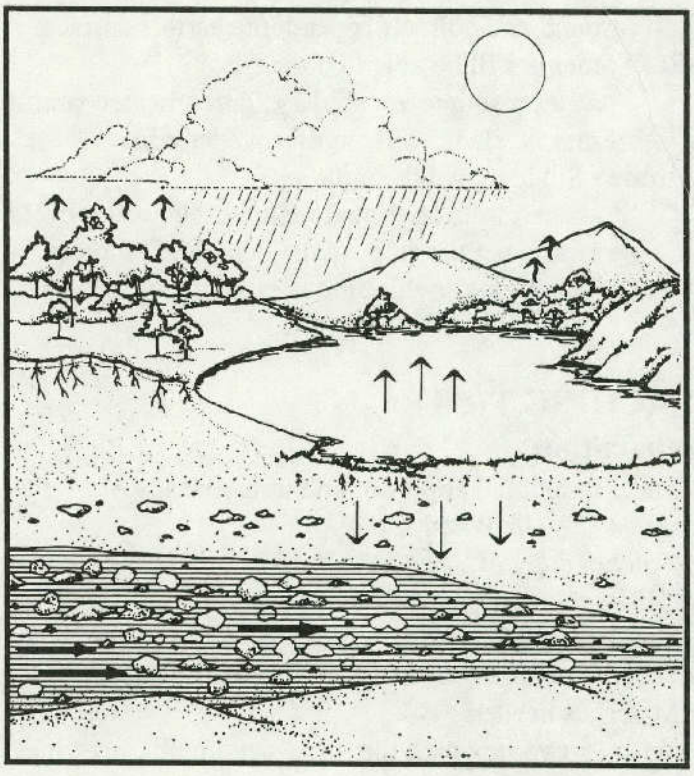
The water in the air falls as precipitation (rain, sleet, snow, hail). The most common of these in our area is rainwater. Several things may happen to precipitation after it falls. About 50% of rain and snow become runoff which flows downhill following the surface features of the land. The water then converges into streams or rivers and then runs into lakes, or it flows underground, Eventually, most of the water flows into the ocean.

Some of the rain falling over land percolates into the ground until it reaches an impermeable rock formation. A rock formation beneath the earth's surface that contains water, is called an aquifer. This water is referred to as groundwater, which is different from surface water (rivers, lakes, streams, etc.) formed from runoff.

Also, some of the rainwater that soaks into the ground is drawn up into the roots of plants and trees and is then released into the atmosphere again as water vapor. This process is referred to as transpiration.

Some of the precipitation that falls to the ground and into bodies of water evaporates back into the air as water vapor. Water molecules travel upwards, cool down, and form clouds. This process is called condensation. Clouds then produce precipitation, thus completing the cycle and starting all over again.

A watershed is a natural division of land divided by hills and other high areas. The rainwater that falls on a watershed typically drains as runoff into rivers and streams. Sometimes water supplies are created by building a dam which stops the flow of a river, and forms a reservoir of water. In South Central Texas, many of these rivers and streams disappear underground and help to recharge, or fill up, our groundwater source. Groundwater can be tapped by drilling wells to pump water to the earth's surface.



LESSON PLAN

This lesson includes a demonstration of the water cycle, an investigation of percolation rates, a model aquifer, water table concepts, and water resource vocabulary.

Concepts:

1. Water that flows through our faucets and pipes is part of the natural water cycle. It may come from either lakes and rivers, or from underground.
2. Reservoirs can collect runoff, and wells enable us to draw on groundwater.

Objectives:

To increase students' recognition of the importance of water in their lives and of the role of the water cycle in our water supply system.

Knowledge - Students will be able to describe
* how the water cycle works in a continuous cycle
* how water percolates, or soaks through the ground and collects beneath the earth's surface

Skill - Students will be able to define
* water resource vocabulary: groundwater, runoff, reservoir, dam, well, aquifer, water table

Attitude - Students will become
* aware of the continual nature of the water cycle
* aware that the sole source of water for most people living in this area is groundwater

TEACHING TIPS

Preparation:

1. Make individual copies of and transparency of: *Diagram 1 - The Water Cycle.*
2. Teacher copy of: *Reading 2 - Water Goes Around and Around.*
3. Group copies of: *Investigation 4 - Build Your Own Terrarium*; and *Investigation 5 - The Water Table.*
4. Materials needed -

Activity 1: two jars with the same size mouth, masking tape, mirror, water, rock, direct sun, 2 sponges, tagboard, paints or markers, food coloring.

Activity 2: one liter plastic soda bottles, cheesecloth, rubber bands, fine sand, gravel, top soil, clear plastic cups, small aquarium or similar container, clay, food coloring, soup cans with holes, or spray bottle.

5. Set up for Activity 2 in advance.

Procedures:

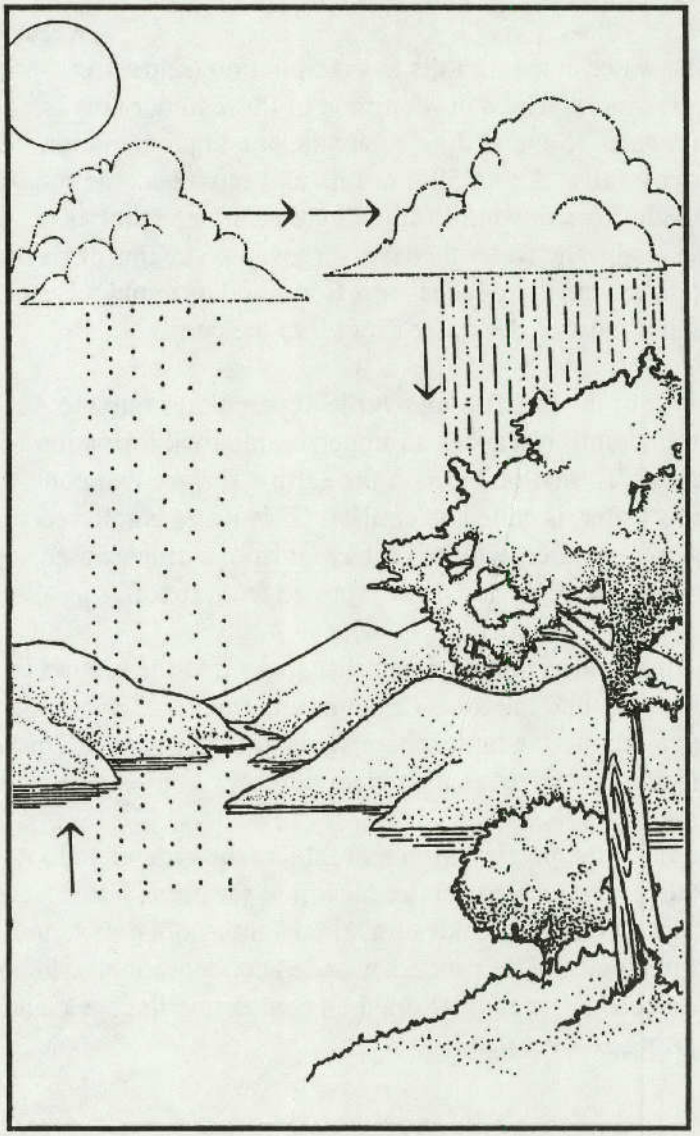
1. Use Activity 1 to introduce and reinforce the water cycle concept.
2. Use Activity 2 to demonstrate how water percolates, or soaks into the ground, and collects as groundwater.

Major ideas:

* Water is recycled continuously in the water cycle.
* Water can change form and have movement.
* Man can build structures to collect rainwater to provide a water supply.
* Man can drill into the ground to tap the groundwater for a water supply.

Vocabulary:

evaporation	groundwater
watershed	condensation
rainwater	dam
precipitation	water cycle
well	transpiration
aquifer	water table



ACTIVITY 1: WATER ~ THE NEVER-ENDING CYCLE

Goal: To demonstrate groundwater's role in the water cycle, including evaporation and condensation, through exploratory activities and the construction of a model.

Curricula areas: Science, Art, Language Arts

Materials: 2 jars, tape, mirror, water, rock, direct sun, 2 sponges, tagboard, paints or markers, food coloring.

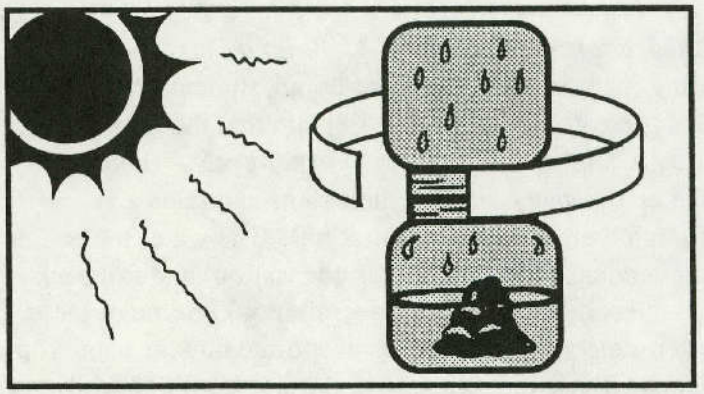
Students provide for *Elaboration* Activity:
*Large (2 or 3 liter) plastic soda bottles with black bottom removed
*gravel, peat moss, potting soil
*two or more types of plants - such as mosses, ivy, ferns, philodendrons, begonias, etc.

Transparency and student copies of: *Water Cycle Diagram (Diagram 1).*
Teacher copies of: *Reading 2: Water Goes Around and Around.*
Group copies of: *Investigation 4: Build Your Own Terrarium; Investigation 5: The Water Table.*

Procedures:
Engagement - To illustrate the concept of water vapor, have 1 or 2 students exhale on the blackboard so that moisture from their breath forms a dark, wet spot. Trace the spots with chalk and ask why it is darker than the rest of the board. Where did the moisture come from? Fan the spot so that it disappears. Write the word evaporation under it. Discuss the meaning of the root word "vapor".

Exploration - To initiate the lesson, ask the students where their water comes from (groundwater). But how does the water get underground? Where does the water come from before it goes underground?

Demonstration - Make a small water cycle model by pouring 1 inch of colored water in one jar. Place the rock in the center. Invert the other jar over it and tape closed with masking tape. Place the jars in a warm, lighted place. Observe the containers over several hours.



Discussion:
*What collects on the sides of the jars?
(condensed moisture)
*Where did it come from?
(evaporated water)
*What does this model represent?
(jar of water, rock, air = water, land, air)
(heat and light = sun's energy)
(moisture on sides of jar = rain and other precipitation)

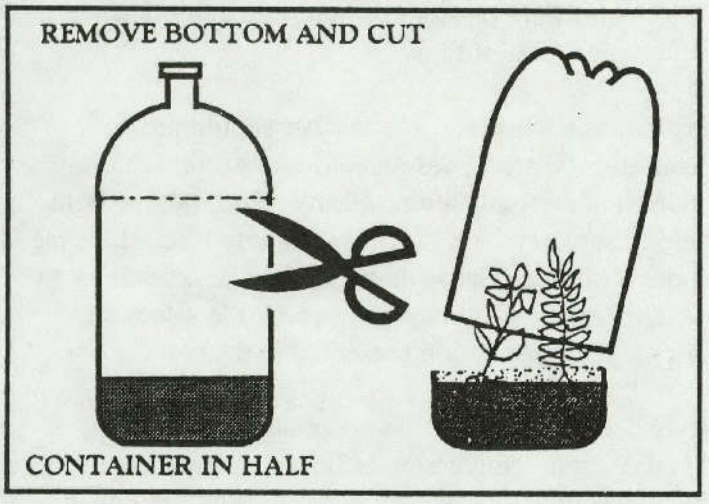
Explanation - Initially, the teacher should present *Reading 2: Water Goes Around and Around* to the students in a visualization activity. Turn out the lights, making sure you have sufficient light to read. Have the students put their heads down on their desks and try to visualize water's journey as you read the selection. Discuss the information presented in the reading.

Second, define and discuss vocabulary:
*Evaporation - conversion of liquid water to water vapor (examples in natural world: water boiling, shallow pan of water in sun, wet clothes hung outside in sun to dry)
*Transpiration - process in which water is absorbed by the root system of plants, passes through their living structure, then evaporates into the atmosphere
*Condensation - conversion of water vapor to liquid drops of water (examples in natural world: clouds, fog, dew)
*Precipitation - dew, rain, sleet, hail, snow
(after it falls to earth, it either infiltrates the surface and becomes groundwater, or becomes runoff to surface waters, or evaporates or transpires back to start the cycle again)

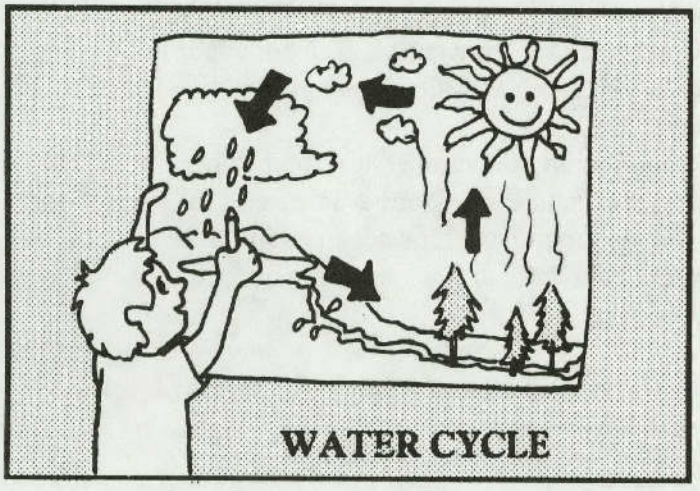
Finally, students should complete *Diagram 1*, using vocabulary words.

Elaboration - Investigation 4: Build a Terrarium
Using materials brought from home, students can build a living, breathing terrarium. Explain that the terrarium is actually a model of the natural water cycle. The plants take up the water through their roots and release it through their leaves (transpiration). The water molecules will condense on the glass (condensation) and fall back into the soil just like rain (precipitation). Some of these water molecules will also be evaporated by the sun. The plants will use the moisture in the soil for photosynthesis, a process that occurs in the plants' cells and provides energy for the plants' growth.

You may want to make this activity a competition between groups. Challenge them by telling them that they can present their terrarium to school staff (principal, secretaries, librarians), or take the terrarium home to give as gifts to parents.



Evaluation - As a class project, create and complete a mural of the water cycle, including groundwater. Display the mural in the cafeteria, library, or hallway.



ACTIVITY 2 : HOW DOES GROUNDWATER FIT IN? THE WATER TABLE

Goal: To help students understand how water soaks through permeable layers of the earth and collects to form groundwater and the water table. Groundwater is an important part of the water cycle.

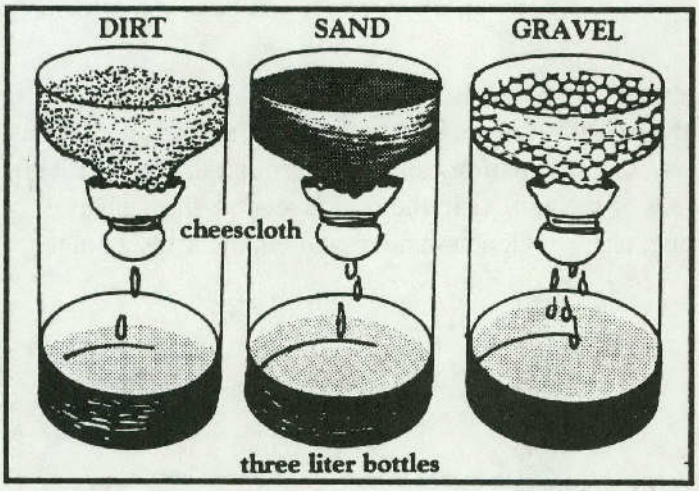
Curricula area: Science

Materials: 20 oz. or 1 liter plastic soda bottles, cut in half, cheesecloth, rubber bands, fine sand, gravel, topsoil, clear plastic cups, group copies of *Investigation 5*, small aquarium or clear plastic box, clay, food coloring, water, soup can with holes or spray bottle.

Procedures:

NOTE: Water stored in the spaces between particles of rock and soil is called groundwater, The zone or rock formation holding the water is called an aquifer and the surface of the saturated zone is called the water table. Water is added to the aquifer by: 1) precipitation percolating downward, 2) water moving horizontally by capillary action, or 3) pressure from water moving from above (infiltration).

Engagement - Cut the bottoms from three 20 oz. or 1 liter soda bottles and use the bottles as funnels. Cover the mouths of the bottles with cheesecloth or tulle, securing it with a rubber band. Fill each of the funnels with a different kind of material (sand, small gravel, loam). Have students speculate as to which one of the three materials will allow water to pass through the fastest. Pour 1 cup of water into each funnel, one at a time. Record the time it takes for the water to flow through the sample. Begin timing when all the water has been poured and stop timing when the stream coming out of the bottom of the funnel becomes a drip. Compare the times. Which was the fastest? How does the time compare to the students' projections?



Exploration - Groundwater is stored in either rock or sand aquifers. There are two types of aquifers: artesian (confined) and water table (unconfined). Although the Edwards is an artesian aquifer, the remainder of this activity focuses on water table aquifers. A water table aquifer is an easier example to use when explaining how water enters and is stored underground.

Group activity:

1) Divide students into groups and hand out cups containing gravel and one cup of water. Ask students to examine the material in their cup and describe where the water fits in between gravel particles.

2) Have each group find the top of the water in the cup, and using a crayon or piece of tape, mark it on their cup. Explain that this is the water table.

3) Distribute one cup of sand, and one cup of water to each group. Have students examine the sand for things like particle size, color, texture, etc.

4) Students should slowly pour the water into the cup of sand. Those not pouring should be carefully observing where the water goes. (It fills the spaces between the sand particles.) They should also look for the telltale bubbles of air that may form as air is being forced out of the spaces between particles by the incoming water.

5) Ask students to mark the water table in the cup of sand and water with a crayon or tape.

6) Instruct one student in each group to make a hole in the sand with their pencil. A small pool of water will form in the hole. The top surface of the water in this pool is the water table.

7) Instruct one student in each group to make a hole in the rocks with their pencil. Does the water table change as a result of this?

Explanation - Discussion:

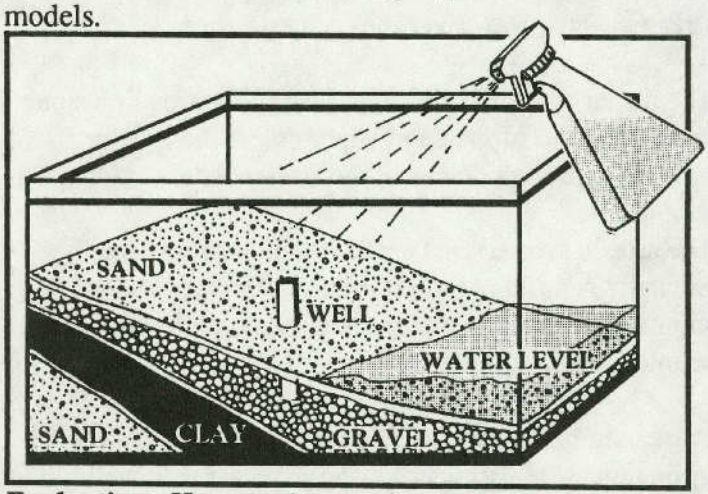
* What was between the sand or gravel particles before water was poured into the cups? (air)
* What was between sediment particles if there is no water there? (air, which is displaced by water)
* Which of these two substances takes in the water more readily? (stone)
* Which would probably give it up more readily? (stone)
* How far underground is the water table?
(The depth of the water table varies with each area.)
* Why is a water table important to life on Earth?
(People use wells to reach the water table and draw up water.)

Explain to the students that some precipitation that falls to the earth goes underground, where it is stored in aquifers, before it has a chance to evaporate or transpire. This water eventually finds its way back to the water cycle through the pumping of water out of the ground, or through the natural discharge of springs, or if the water table is at the surface.

Elaboration -

Complete *Investigation 5: The Water Table*

Either build this model for the students as a demonstration, or have students work in groups to build their own models.



Evaluation - Have students write a narrative story from the point of view of a drop of water that has fallen over South Central Texas. Instruct them to incorporate the water cycle (precipitation, evaporation or transpiration, condensation) and groundwater into their story.

Lesson III:
Our Water Source
The Edwards Aquifer

Background Information:

Groundwater is a precious natural resource. Approximately 50% of the people in the U.S. depend upon groundwater for daily consumption. In South Central Texas, six counties rely primarily on the groundwater of the Edwards Aquifer. San Antonio is the only major city in the U.S. that relies solely on groundwater.

The Edwards Aquifer is a confined, or artesian aquifer. This means that water is confined between layers of porous rock (specifically the Edwards limestone) and trapped between layers of impermeable rock, thus putting the water under pressure.

The Edwards Aquifer region encompasses land in 13 counties. The three zones of the Edwards area are: the Drainage area, the Recharge zone and Artesian or Reservoir area.

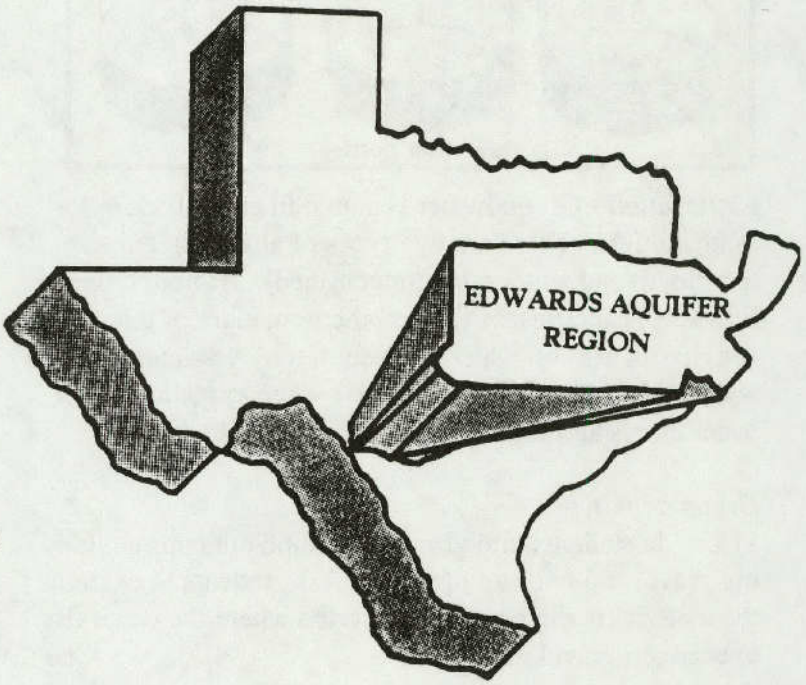
The drainage area takes in the upper watersheds in the hill country where rainwater runs off into creeks and streams which flow over the recharge zone.

The recharge zone is the area where Edwards limestone is exposed at the surface and water enters the aquifer, primarily through cracks in the streambeds.

The artesian (reservoir) area is the area where the Edwards Aquifer is buried in the subsurface and is fully saturated with water under pressure. It underlies and supplies water to six counties.

Water can be discharged from the Edwards Aquifer through natural springs or through man-made wells. The waters of the Edwards Aquifer are crystal clear. It is one of the purest artesian aquifers in the nation. Protecting the quality of water in the Edwards Aquifer is a major concern of the Edwards Underground Water District.

Despite these efforts, one of the greatest concerns the Edwards Aquifer region faces in the future is contamination. Contamination can occur through the unconfined areas of the aquifer in the drainage area and recharge zone, or through abandoned wells in the artesian area.



LESSON PLAN

This lesson includes activities identifying the location of the Edwards Aquifer, and the three zones that make up the system; a model of the Edwards Aquifer including recharge and discharge, and a discussion/demonstration of the possibilities of contamination.

Concepts:

1. The Edwards Aquifer system encompasses parts of 13 counties in South Central Texas.
2. The Edwards Aquifer system is split into three zones, with each playing an equally important role.
3. Water stored in the Edwards Aquifer is pristine.
4. Contaminants can enter the Edwards Aquifer, primarily through the recharge zone.
5. The Edwards Aquifer is a confined artesian aquifer.

Objectives:

Students will understand that the Edwards Aquifer is the primary, if not sole source of water for their community, therefore we need to take steps to ensure its protection.

Knowledge - Students will be able to identify
* the location of the Edwards Aquifer in Texas
* the three zones of the Edwards Aquifer region
* where pollutants could enter the Edwards Aquifer

Skill - Students will demonstrate
* how rainwater interacts with the surface in the drainage area (Hill Country watersheds) and enters the confined aquifer through the recharge zone
* that water cannot enter into the aquifer in the artesian area because of its confined nature

Attitude- Students will recognize
* the importance of preserving and protecting the Edwards Aquifer

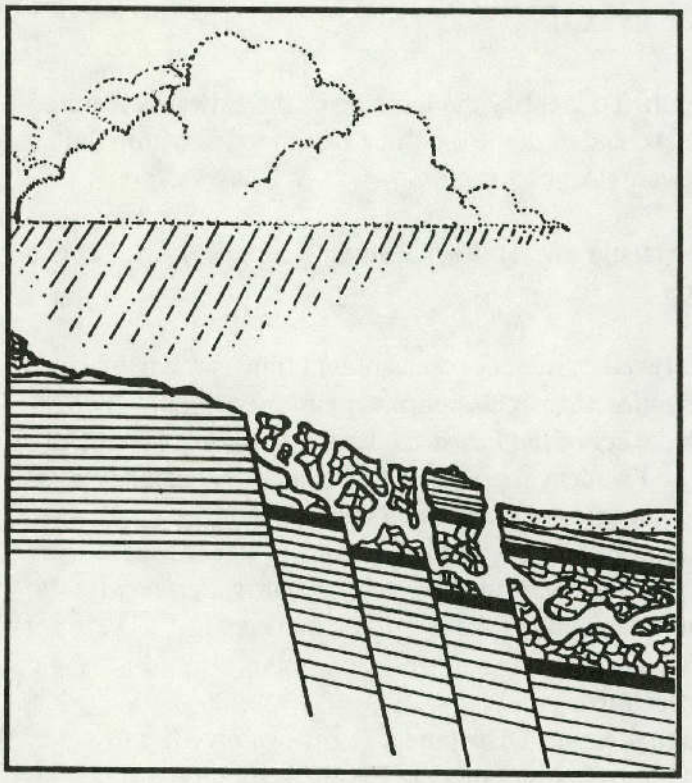
TEACHING TIPS

Preparation:

1. Make student copies of: *Texas County Map*
Diagram 2 - The Edwards Aquifer;
Diagram 3 - Cross-Section of the Edwards Aquifer.
2. Make groups copies of: *Investigation 6: Modeling the Edwards Aquifer.*
3. Make transparencies of: *Diagrams 2 and 3.*
4. Materials needed: Activity 1- newspapers cut into strips, flour, water, bowls, tempura paints or water colors, markers.
Activity 2- clear plastic cups, plastic flower pots or hanging basket pots, glossy paper from newspapers, junk mail or magazines, loaf of uncut bread, water, eye dropper, plastic boxes (shoe boxes) or old aquariums, clay, sand, gravel, clear straws, green felt or astroturf, water, model houses, etc.
5. Accumulate materials from students, and set up for Activity 2 in advance.

Procedures:

1. Use Activity 1 to find the location of the Edwards Aquifer and identify the three zones of the Edwards Aquifer.
2. Use Activity 2 to discover how recharge occurs through the Edwards Aquifer system (a confined aquifer), and how pollution could enter.
3. Use Activity 2 to model the Edwards Aquifer and identify 2 ways water can make its way to the surface.



Major ideas:

* The Edwards Aquifer region is located in South Central Texas.
* The Edwards Aquifer system is composed of three zones.
* The Edwards Aquifer is a confined aquifer.
*Water enters the artesian area through the recharge zone.
* Pollutants could also enter through the recharge zone.

Vocabulary:

artesian aquifer	discharge
porous	confined aquifer
permeable	limestone
recharge	impermeable
spring	drainage area
recharge zone	artesian (reservoir) area

ACTIVITY 1: WHERE IS IT? LOCATION AND DESCRIPTION OF THE EDWARDS AQUIFER REGION

Goal: To identify the location of the Edwards Aquifer in Texas, and to name the three major zones within the Edwards Aquifer region.

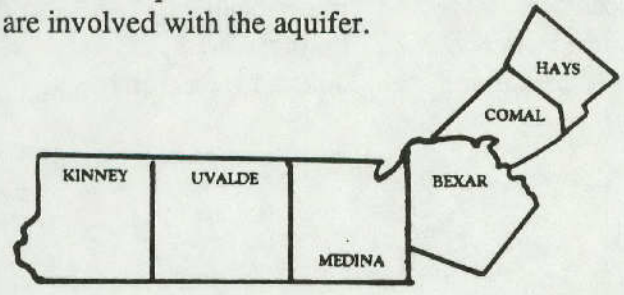
Curricula areas: Social Studies, Science, Art, Language Arts

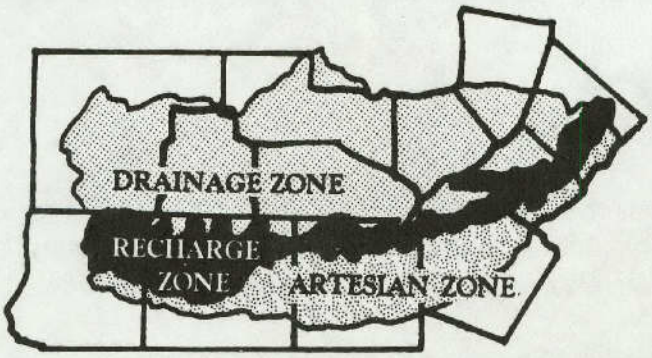
Materials: Student copies of and transparency of *Texas Counties Map*, classroom copy of poster map: *"Water Resources of the Edwards Aquifer Region"*, transparency of and student copies of *Diagram 2*, transparency of and group copies of *Diagram 3* (blown up to 11 x 14), map colors, student copies of *Reading 3*. Paper Mache activity: newspapers cut into strips, flour, water, bowls, tempura paints or water colors, markers.

Procedure:

Engagement - Distribute a *Texas County Map* to students. Instruct them to lightly shade in the area where they think the Edwards Aquifer is located. When students are finished, put the same map on the overhead and outline Kinney, Uvalde, Medina, Bexar, Comal, and Hays counties. Explain that these are the areas in which people rely either primarily or solely on groundwater from the Edwards Aquifer. Check to see whether any of the students were close when trying to estimate the location of the Edwards Aquifer, then have students outline the six counties on their map.

Second, on the overhead transparency, outline these counties: Edwards, Real, Bandera, Kerr, Kendall, Blanco, Gillespie. Inform students that although the aquifer itself is not located in these counties, these counties play an important role in the aquifer system. Invite students to speculate as to how these other seven counties are involved with the aquifer.





Exploration - Distribute student activity *Diagram 2*. Instruct students to color the northernmost area (drainage area) red, the area in the middle (recharge zone) green, and the southernmost area (artesian area) blue. Have the students make a key at the bottom of the page, and label the counties.

Next, with the help or their textbook, an atlas, or the classroom poster, have the students draw in and label these rivers: Nueces, Frio, Medina, Guadalupe, and Blanco.

Last, have the students indicate the location of these cities with a dot in the proper location, and label: Brackettville, Uvalde, Hondo, San Antonio, New Braunfels, San Marcos.

Explanation - Pass out *Reading 3: The Three Zones of the Edwards Aquifer*. Read orally, taking time to discuss and explain, one by one, the three zones the students have colored in on their map.

Elaboration - (NOTE: have all materials needed for this activity set up at tables ahead of time.)

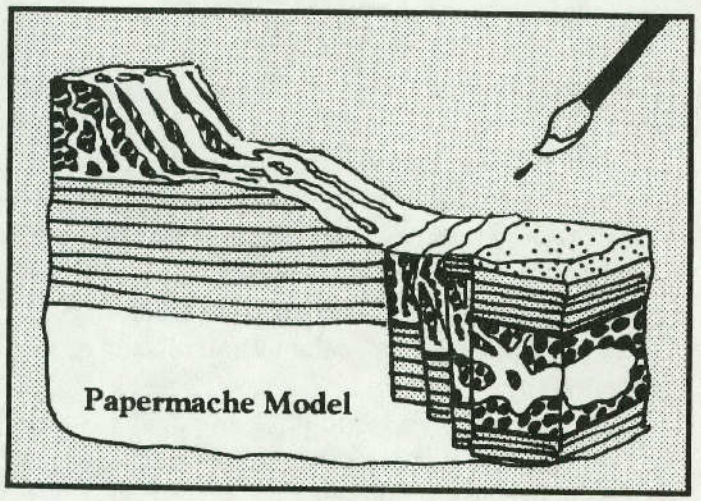
Divide students into groups. Instruct the students to try to envision what the aquifer regions look like through a cross-view of the region. Have them draw their interpretation of this.

Distribute one copy of *Diagram 3* (a cross-section drawing of the Edwards Aquifer region) to each group. Review the three zones learned in the previous lesson. Tie in the water cycle by studying the movement of the water.

Instruct students to create a three-dimensional map of the Edwards Aquifer region, using paper mache. They can use their copies of *Diagram 2 and Diagram 3* for reference. Tell them to make sure the upper half is much higher in elevation, and then gradually declines to a lower elevation.

After it is dry, instruct students to carefully draw in the boundaries between the three zones, and then paint it, using the three colors they used on their individual maps.

Challenge students to draw in the county boundary lines!!



Evaluation - Students should complete *Crossword Puzzle: The Edwards Aquifer*, using vocabulary terms and concepts previously learned in Lessons I, II,and III.

ACTIVITY 2: HOW DOES IT WORK? DYNAMICS OF A CONFINED ARTESIAN AQUIFER - AN EDWARDS MODEL

Goals: To reinforce the dynamics of the Edwards Aquifer system and highlight the possibility of contamination through the recharge zone.

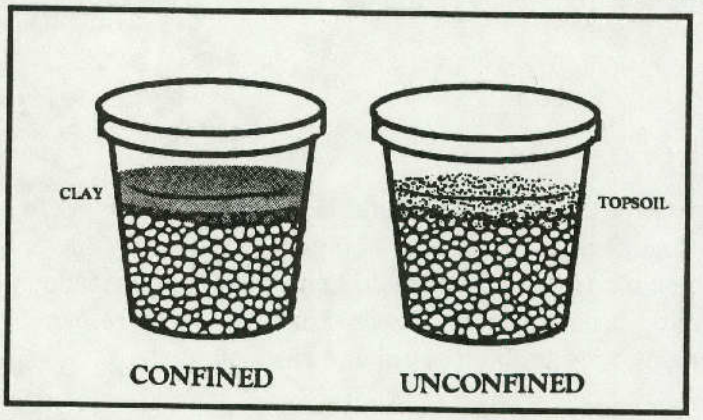
Curricula areas: Science, Social Studies

Materials: Student copies of *Investigation 6: An Edwards Aquifer Model*; plastic cups, glossy newspaper flyers or pages from magazines, spray bottle, water, eye dropper, an unsliced loaf of bread with a ridge down the center, food coloring, plastic boxes or old aquariums, sand, gravel, clay, top soil, clear straws, green felt or astroturf, model houses and buildings.

Procedures :

Engagement - Group activity (see below)

NOTE: Prior to beginning this activity, you may want to write the following terms on the board: permeable, impermeable, confined, unconfined, porous, non-porous. Instruct students to listen for the terms, and be prepared to attempt to define them. You should also have clear plastic cups on the tables for students to use for retrieving water throughout this activity.



Break students into groups. Challenge them with this question: *What is the difference between a confined aquifer and an unconfined aquifer?* Give each group two cups you have prepared ahead of time. One cup will be labeled "unconfined" and layered with these materials , in this order, from the bottom up: gravel, sand, and a thin layer of topsoil. The second cup will be labeled "confined" and layered with the following materials, in this order, from the bottom up: gravel, sand, clay (make sure it is flush with the sides of the cup), and a thin layer of topsoil.

Instruct students to slowly pour water simultaneously into the two cups. Ask the students why the water flowed through one of the cups, but is still standing on top of the material in the other cup.

Discussion:

* What kinds of material can water easily flow or find its way through?
  (These are permeable materials.)
* What types of material are almost impossible for water to make its way through?
  (These are impermeable materials.)
* What types of material have the ability to hold water?
  (These are porous materials)

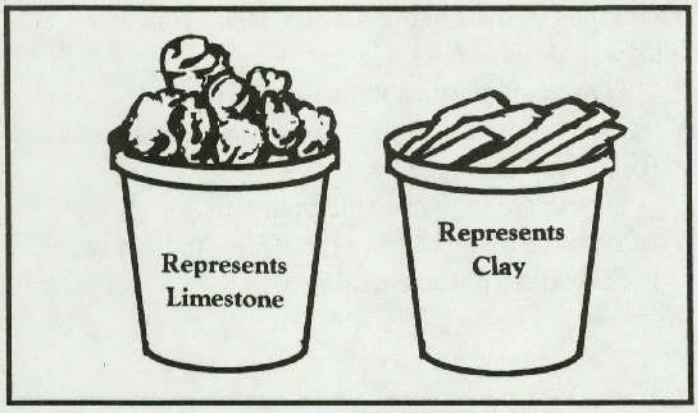
Exploration - To assist in understanding the concept of permeability, write the following list of materials on the board or on an overhead transparency. Instruct the students to circle the materials they think are impermeable.

Household items:	Natural items:	
styrofoam	soils	clay
cardboard		sand
paper	rocks	gravel
steel		limestone
aluminum		quartz
plastic		chalk
glass		diamonds
kitchen sponge	wood	
cloth (fabrics)	plants	
	petroleum	

Students may find the natural items a bit challenging to categorize. For critical thinking, have them try to determine if any of the household items are products made from the natural items listed. (For example, styrofoams and plastics are both petroleum based products.)

To further assist students in understanding permeability, have students complete the following activity:
Instruct students to take half of the glossy paper on their table and crumple it up into large balls and then put the balls into one of the flower pots. These balls of paper will represent large gravel or limestone particles. Next, they should take the remaining paper and tear it into strips that are approximately one inch wide. They should carefully lay the strips down in the remaining flower pot, one on top of the other. These strips will represent clay particles, which pack tightly together.

Students should again fill the two plastic cups with water and pour equal amounts of water into the two pots. Record the amount of time that it takes for the water to begin to drip out of the holes at the bottom of each flower pot.



Discussion:

a) Which pot did the water move through more quickly? Why?

(The pot with crumpled newspaper. Because the wads of newspaper are rather large, and because they do not stack very tightly, there are large air spaces between the "particles." The water flows through these air spaces.)

b) Which pot did the water move through less quickly? Why?

(The pot with layered strips of paper. This is because the paper strips are thin, and therefore stack very tightly. There is very little room for the water to move between the strips. The water must zigzag through very narrow spaces.)

c) Which pot is most like a container full of sand or gravel? Why?

(The one with wadded-up paper. Sand and gravel particles are rather large, irregular in shape, and do not stack very tightly.)

d) Which pot is most like a container with clay? Why?

(The one with layered strips of paper. Clay particles are very thin, like the strips of paper, and stack together very tightly.)

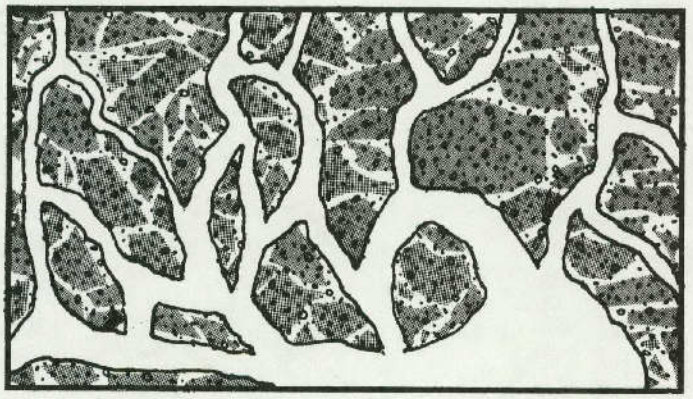
Go back to the chart and discuss which materials would be porous or not.

Explanation - Define and discuss the vocabulary listed on the board:

* Permeable -material that allows liquid (water) to flow through it
* Impermeable - material that does not permit liquid (water) to flow through it
* Porous - the ability of a material to hold and yield water or other liquids from spaces between particles
* Unconfined aquifer - an aquifer that does not have an upper layer of impermeable material
* Confined aquifer - an aquifer that is trapped between layers of impermeable material

NOTE: It would be of great benefit to you and your students if you were to obtain a large piece of the Edwards limestone to use while discussing porosity and permeability.

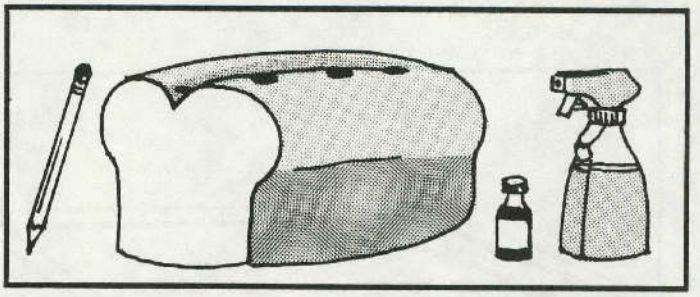
Using the map-poster *"Water Resources of the Edwards Aquifer Region"*, discuss in detail that the Edwards is a confined aquifer. Explain how the water reaches the aquifer only through the recharge zone. Emphasize that rain has to fall north or west of San Antonio in order for the water to reach the aquifer. Once it reaches the confined artesian (reservoir) area, water will remain there, relatively untouched, until discharged through wells or springs. Emphasize that the Edwards Aquifer is not an underground lake, but that most of the water is stored in the void spaces (holes, cracks, fissures and caves) of the Edwards limestone.



The city of San Antonio and other cities in the region are all located on the land surface above the artesian area. Because of the quality of water entering the recharge zone and the natural filtration of the Edwards limestone, the Edwards Aquifer produces some of the purest water in the entire nation. There is, however, the potential for contamination through the recharge zone, or through abandoned wells in the artesian area. Any solid, liquid, or gaseous substance that is present on the recharge zone or in the drainage area has the potential to reach the waters of the Edwards Aquifer.

Elaboration - The purpose of this activity is to visually demonstrate how water infiltration can carry pollutants underground; that not all pollutants are filtered out; and that human activities can affect groundwater. The loaf will represent limestone leading to the artesian area, and the ridge across the center of the bread will represent a creek and other features in the recharge zone.

Students should be divided into groups of three. Each student will have an assignment in this activity. The exercise requires each group to be provided with:
1) food coloring
2) one loaf of bread, unsliced, with a ridge in the center
3) a sprayer to produce rainwater

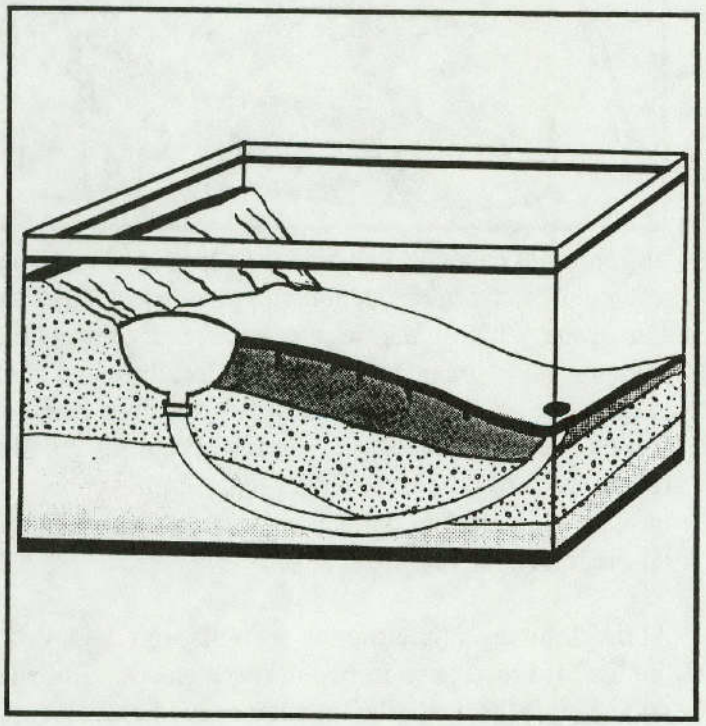


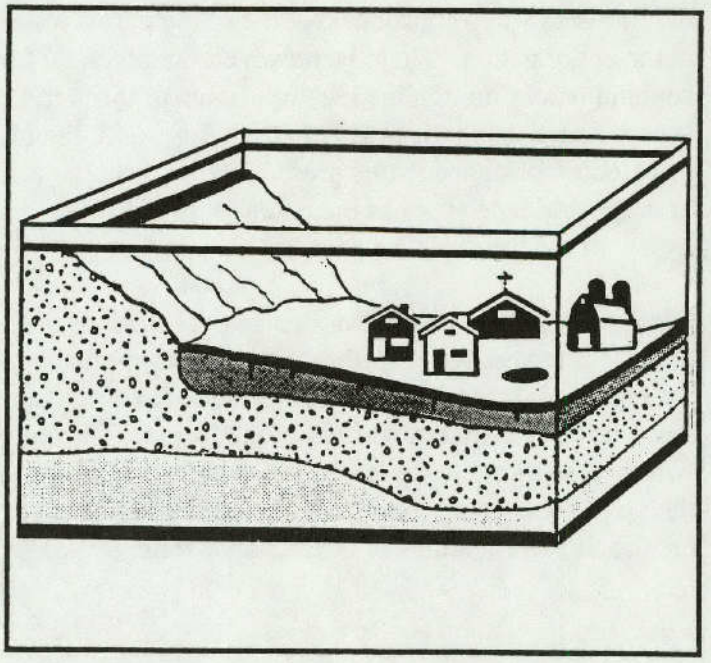
To represent caves and sinkholes in the recharge zone, a student should take a pencil and poke a few holes the size of the pencil in the ridge of the bread. Second, the student should create a few small holes, lines and cracks in the ridge of the loaf to represent a recharge creek. Another student should take the food coloring and place a few drops throughout the ridge, representing contamination. The last student will spray water, representing rain, on the food coloring.

Allow drainage ample time to seep through the bread. Cut the loaf of bread open in two or three places. Students will see that as the polluted water seeped down, it spread out, making it difficult to locate where the pollution originated (non-point source pollutant). The water and food coloring will remain together as the water moves.

Discussion:
1) Did the pollutant (food coloring) continue through the bread or was it filtered out, leaving only clean water to progress downward?
2) Did the water spread out or go straight down?
3) Do human activities on the surface have any effect upon groundwater quality?
4) What kind of pollutants might come from common household products?
5) What kinds of pollutants might come from septic tank fields?
6) What kinds of pollutants could come from landfill seepage?
7) What kinds of pollutants could come from an agricultural area?
8) How can groundwater contamination be prevented?

Evaluation - Complete *Investigation 6: A Working Model of the Edwards Aquifer*. Preferably, this should be done in groups of 4-5, but if materials and/or space are limited, it could be a class project. The building of this model and subsequent discussion will pull together all of the concepts introduced in Lessons I, II, and III.





Lesson IV: Water Usage and Conservation

Background Information:

Water is essential to life. People use water on a daily basis and for various functions. As a liquid, water serves as a beverage and assists in multiple daily cleansing chores including showers, washing dishes and washing clothes. When in its solid state of ice, water serves to keep things cool or frozen. People also use water to keep house plants and gardens alive, and to keep their lawns green.

Each day every person uses an average of 80 - 90 gallons of water at home (daily per capita usage is approximately 150 gallons). A plentiful supply of inexpensive, high quality water is something many Texans take for granted. Little attention is given to how much water an individual uses or how much water the average family uses on a daily, weekly, or monthly basis.

Household members can significantly reduce their daily consumption of water by keeping their faucets in good condition, storing a supply of cold water for drinking in the refrigerator, installing water-saving toilets, taking shorter showers, and avoiding letting the water run while brushing teeth, washing hands, or doing dishes by hand.

High quality, plentiful water is a valuable resource that must be used with care and consideration. Conservation efforts should become a way of life for inhabitants of the Edwards Aquifer region.

LESSON PLAN

This lesson includes activities focusing on water usage with an exploration of the students' and their families' usage. Additional activities and investigations promote an awareness and the implementation of conservation.

Concepts:

1.Water is necessary for us to sustain our lifestyles in the comfort to which we are accustomed.
2. Many people misuse the valuable resource and take it for granted.

Objectives:

To focus students' attention on how much water they use and ways they can conserve water.

Knowledge - Students will be able to describe
* how much water they, as individuals, and their families use
* why we do not have water to waste
* why water conservation is essential to meeting our future needs for a reliable supply of drinking water

Skill - Students will increasingly
* think of ways to conserve water
* change their daily habits so that conservation becomes a way of life

Attitude - Students will become more
* willing to do their part to save the Edwards Aquifer
* helpful to family members so they too can learn to save water

TEACHING TIPS

Preparation:

1. Collect and assemble all worksheets and materials before beginning activities.
2. Reserve the film *Water Follies* by calling the EUWD at 222-2204 (1-800-292-1047), or by requesting it through your Region Service Center.
3. Activity 1 will require a homework assignment to be completed prior to *Explanation* step.
4. Student copies of : *Investigation 7: Home Water Use Survey,* and *Water Conservation Checklist for Your Family.*
5. Group copies needed of *Drought Days Dilemmas* cards.
6. Transparency needed: *Water Follies, Math Jollies.*
7. Materials needed: 80 one gallon jugs or paper cut-outs of gallon jugs.

Procedures:

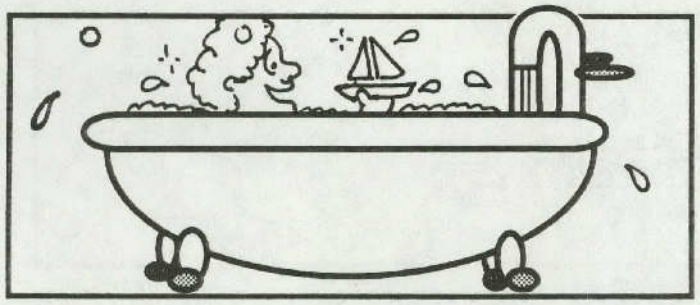
1. Use Activity 1 to investigate the amount of water students and their families use in everyday activities.
2. Use Activity 2 to discover how minor changes in everyday activities can result in huge water savings.

Major Ideas:

* Each person uses an average of 80 gallons of water per day in their home, and and average of 150 gallons per capita daily.
* If we develop better habits, we can make water conservation a way of life instead of having to make a conscious effort.
* Water-saving devices can also save hundreds of gallons a week.

Vocabulary:

conservation
water-saving fixtures



ACTIVITY 1: WOW! DO WE REALLY USE THAT MUCH?

Goal: To identify activities using water at home, and the amount of water each person uses for each activity.

Curricula areas: Math, Science, Social Studies, Art

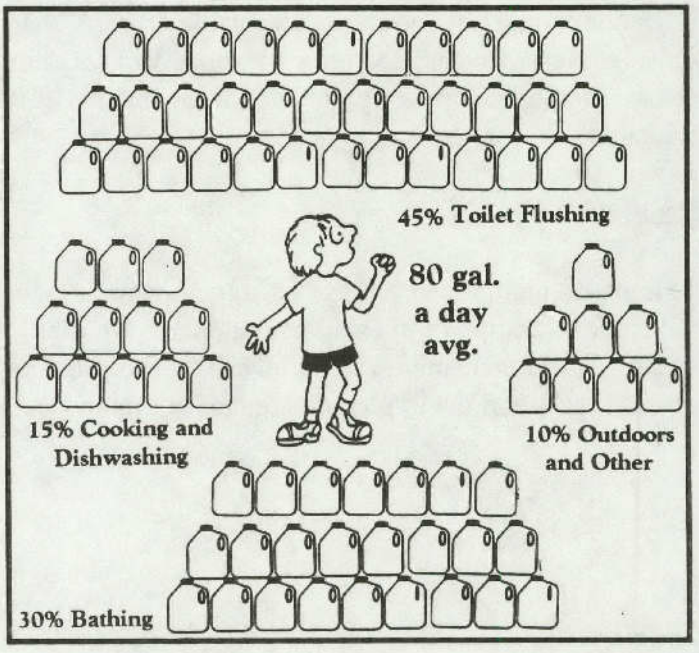
Materials: 80 one gallon milk jugs or group sets of 80 small cut-out gallon jugs;
Student copies of: *Investigation 7 - Home Water Use Survey*, and *Daily Family Water Use* graph.

Procedures:

Engagement - Have students recall ways they used water during the last 24 hours, and list the activities on the board.

Are there any activities not on the list?
(Toilet flushing, cooking, dish washing, fish tank, lawn watering, etc.)

Exploration - Take the 80 one-gallon containers to an outside area. Have four stations ready (titles on posters): Toilet flushing, Cooking and Dish washing, Outdoors and Others, Bathing. Students should distribute gallon containers to each area according to the amount they think they use daily for each of the categories.



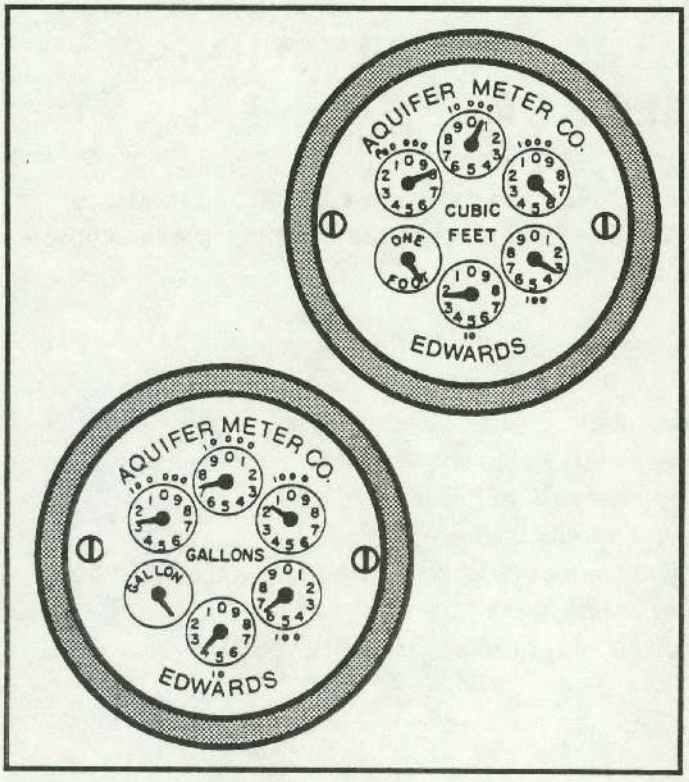
If you do not have access to or the physical room to work with 80 one-gallon jugs, break students into groups of 4 - 5, and give each group an envelope containing 80 small cut out jugs and title cards to work with. Students can work together to determine quantities used for each category. Tell them to write down how many they included in each area.

After students have worked out their estimates, give them the real figures (shown in diagram) - and redistribute gallons to the true numbers and percentages.

Compare and discuss students' guesses with actual figures.

(Adapted with permission from *Water Wizards*, Massachusetts Water Resources Authority.)

Explanation - Draw a chart on the board or on the overhead projector for students to copy and fill in as you deliver the information.
(Leave room on the right-hand side of chart for an addition during Activity 2 - Conservation.)
Have students project the amount of water that is typically used for each activity, then give them the actual amount to put on their chart.



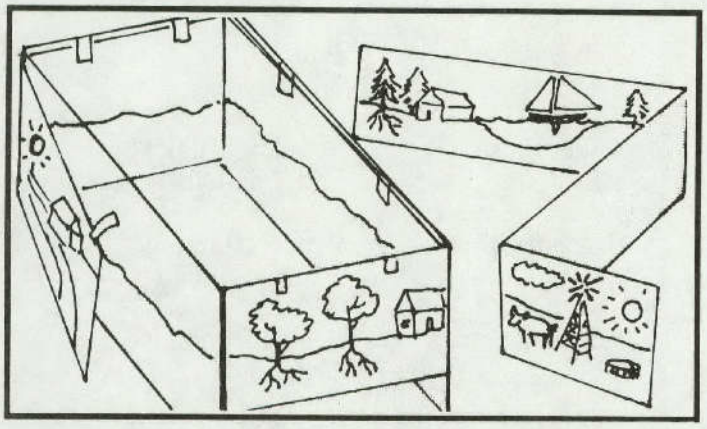
Activity	Normal Use
Shower	Water Running 5 min = 25 gallons
Tub Bath	Full 36 gallons
Toilet Flush	Standard Tank 5 to 7 gallons
Brushing Teeth	Faucet Running 2 to 5 gallons
Washing Hands	Faucet Running 2 gallons
Washing Dishes by Hand	Tap Running 30 gallons
Automatic Dishwasher	Full cycle 25 gallons
Washing Machine	Full Cycle 50 gallons
Outdoor Watering	Average hose 10 gallons per minute
Car Washing	Hose running 30 min. = 300 gallons

Elaboration - Students should take home *Investigation 7: Home Water Use Survey*, and complete Part 1 and the first part of Part 2 for homework. If they have access to their water bill, they should bring it in for discussion while finishing Part 2 the next day.

Work through Part 2 - *Water Use Comparison* in class. Discuss figures with students - how do they, as individuals, and their families compare?

Evaluation - Using information from *Investigation 7 - Home Water Use Survey*, students should estimate and graph how much water their family uses daily. Use *Daily Family Water Use* graph.

Extension - This activity will help demonstrate the effects of development on the water supply and how our need for water has increased over the years.



1. Have students draw a mural of the Earth's surface (see drawing). Tape the mural to the top half of the sides of a clear plastic box and fill the lower half with water. Mark the level of the water. Cover the top of the box with aluminum foil.

2. Set the scene at the year 1800. Four settlers live in a small valley in Texas. A new farming family of eight arrives with 4 horses and 3 cows.

Why do they need water?

(cooking, watering animals, washing)

The farmers have dug wells. There has been a great deal of rain and the wells are full of clean water.

Add 1 cup of water to the box.

3. Have students "drill" wells with straws through the foil into the box. Have them take sips of water to represent water use. Mark the water level.

Discuss a typical day in the life of this community.... farm wife does the washing, boys do the chores, farmer digs a well, etc.

4. Fifty years later, 1850. Ten more families move to the valley and bring many herds of cattle.

Drill 20 more wells, sip some water and mark the new water level.

5. Fifty years later, 1900. Fifteen families have moved in. A small hotel and two schools are built. For five years there has been less rain than usual.

What has happened to the level of water in the wells? The water table?

Some farm houses now have a hand pump at the kitchen sink. It lifts water from the well in a single pipe. Wastewater drains outdoors onto the ground into a ditch. One farmer bought a washing machine with a big paddle to push by hand. The privy has been built in the shed by the barn. Some wells have gone dry and new ones dug at a distance.

Drill 15 more holes, take sips of water and mark the water level again.

6. Fifty years later, 1950. Most homes now have a bathroom with a tub and a flush toilet, and an electric washing machine. There is a car wash in town. A new industrial plant is built and sends waste into a small stream. Only 2 old wells are still in use: others are polluted. The town has built a water system that connects every house by pipes with the local reservoir. Now every person uses at least 60 gallons of water per day.

Drill more (larger) wells, take more sips of water.

7. *Discussion*: Why didn't people in 1800 use as much water as those in 1950? How did some communities solve the problem of having enough water?

(Adapted with permission from *Water Wizards*, Massachusetts Water Resources Authority.)

ACTIVITY 2: WATER CONSERVATION - EVERY DROP COUNTS!

Goals: To learn to recognize good and bad water use habits, and to include students' families in water conservation efforts.

Curricula areas: Social Studies, Science, Math

Materials:

Water Follies video and accompanying math questions on transparency (*Water Follies, Math Jollies*),
Water Tripping Cards,
Student copies of: *Water Conservation Checklist for Your Family,*
Group copies of cards: *Drought Days Dilemmas.*

Procedures:

Engagement - Watch *Water Follies*. Discuss bad water use habits depicted in the movie. Discuss good water habits.

Using overhead projector, give students *Water Follies-Math Jollies* questions, one at a time. Have students work computations and discuss answers.

Exploration -

NOTE: This activity is designed to challenge students to think seriously about water use and conservation. This works best with self contained classes, but if your classes are departmentalized, simply let all of the teachers on your team know about the activity.

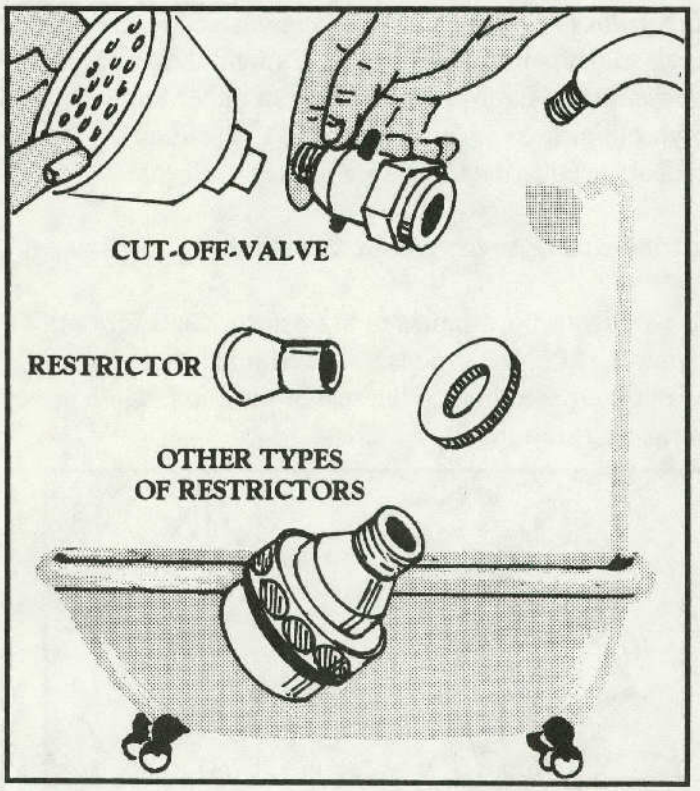
1. Tell students the class will engage in a 1-2 day game that demonstrates water use and reasons for conserving water.
2. List on the board reasons students use water during the school day. Explain that one ticket will be charged for each trip. (For example, restroom trips, trips to water fountain, lunch, recess, science labs, etc.)
3. Give each student 8-10 tickets and an envelope to keep them in. Have students put their names on the tickets.
4. Use a box near the door in the classroom for students to deposit tickets. Encourage them to be honest....the purpose of this game is not to see who has the largest or the smallest amount of tickets left at the end of the game!
5. Students should keep a record of their water use.
6. Discussion questions after the end of 1 1/2-2 days:
   a) What things did you spend your water tickets on? On some activities more than others?
   b) What if there were no water tickets for the rest of the week?
   c) What could you do to save water?
   d) What can you do to get more water?
   e) If one person has water tickets left over, and another does not, is it fair to trade? Purchase?
   f) If you are out of tickets now, do you wish you had saved some more for later?
   g) If you played this game again, would you do anything differently?

List things students can do to make the water they have (at home and at school) go further. List should include: turning off water while washing hands or brushing teeth, taking short showers instead of a bath, shutting off dripping faucets, only getting water in restaurants if you intend to drink it, etc.

(Adapted from: *A Sense of Water*, Southern Arizona Water Resources Association., 48 N. Tucson Blvd., Tucson, AZ, 85716)

Explanation - Pass out worksheet - *Water Conservation Checklist for Your Family*. Read through it orally and discuss, checking for understanding. Encourage students to take home the checklist and discuss the suggestions with their family members. You may want to print this on a colorful paper and suggest the students clip the paper into sections. They can then tape up the different categories in different areas of the house for family members to view as a reminder.

Go back to the chart: *Home Water Use* from Activity 1. Add and fill in a third column - Conservation Use. Emphasize the savings of water, and reinforce this by telling students that not only do these ideas help their families save water, but they also save money.



Activity	Conservation Use
Shower	Wet down, soap, rinse 4 gallons
Tub Bath	Minimal water level 7 to 9 gallons
Toilet Flush	Efficient toilet 1.6 gallons
Brushing Teeth	Wet brush, rinse briefly 1 cup
Washing Hands	Fill basin 1/2 gallon
Washing Dishes by Hand	Rinse in sink 5 gallons
Automatic Dishwasher	Short cycle 12 gallons
Washing Machine	Short cycle, minimal level 27 gallons

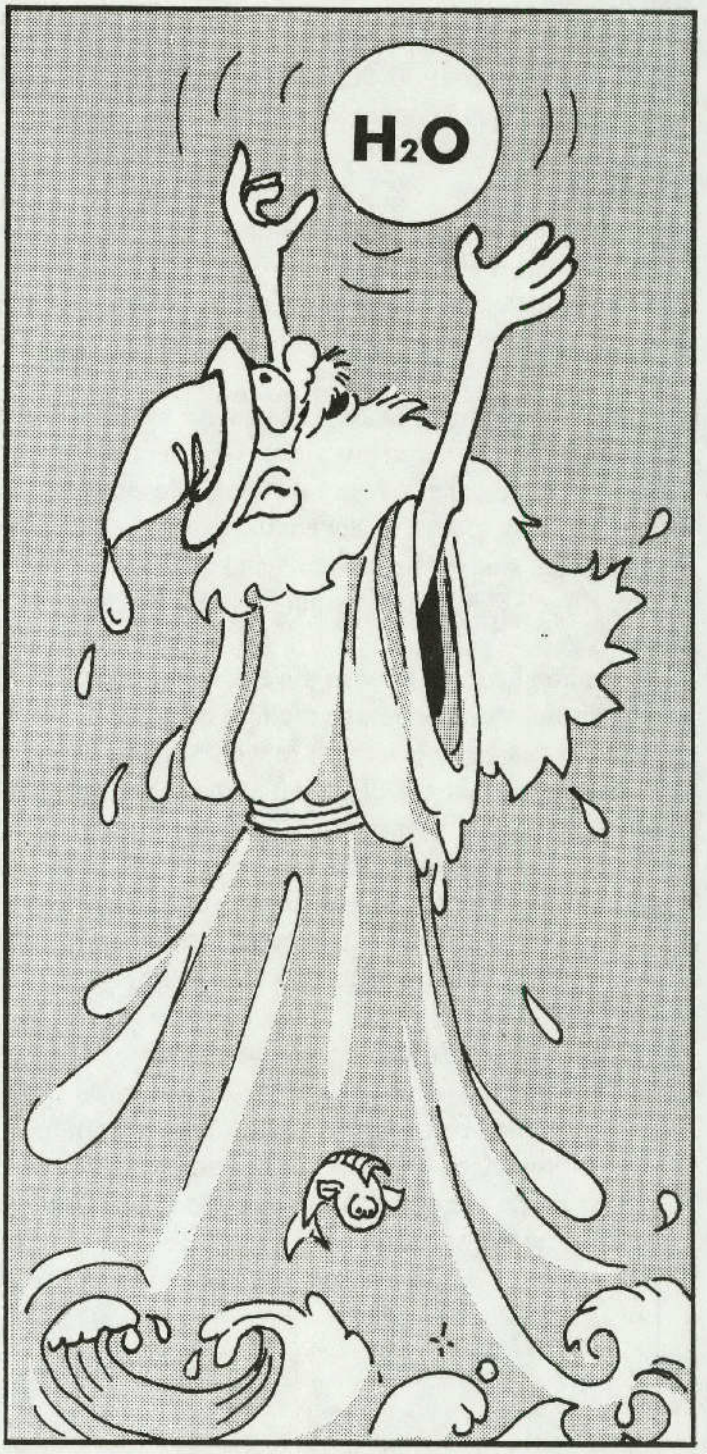
Elaboration - *Drought Days Dilemmas*
Break students into groups of 5. Explain that each group represents one family, consisting of a father, mother, 15 yr. old girl, 13 yr. old boy, and 11 yr. old girl. Students need to decide who will play each role.

Distribute cards to the groups, one dilemma at a time.

Give students 5-7 minutes to brainstorm ideas for each dilemma. After the time is up, have students orally present their solutions to the rest of the class. Give prizes for the best solutions!

Evaluation - Have students write an essay outlining ways they and their families can conserve water. Questions to focus on:

1) How does my family's water use compare to other families?
2) What are some ways I can save water?
3) What are some ways my family can conserve water?
4) Why is it important that we save water?



EDWARDS UNDERGROUND WATER DISTRICT GLOSSARY

ACEQUIAS - Water ditches of early San Antonio. Acequias were built to divert river water for cooking, drinking, and irrigation.

ACRE FOOT - The volume (as of irrigation water) that would cover one acre to a depth of one foot - 325,851 gallons.

AQUIFER - Any zone below the surface of the earth which stores, transmits, and yields water in sufficient quantities for human use.

ARTESIAN AQUIFER - One type of aquifer in which two impermeable layers surround one permeable water-bearing layer. The water is confined and stored under pressure and will rise above the top of the aquifer when penetrated by a well.

SALINE (BAD) WATER LINE - Characterized by having more than 1000 mg/l of dissolved solids. It may be low in dissolved oxygen, high in sulfates, and have a higher temperature. The BAD WATER LINE is the southern boundary of good water in the Edwards Aquifer.

BALCONES ESCARPMENT - A steep series of hills formed by faulting and erosion which divide the higher plateau from lower coastal prairie. Escarpments can be formed by erosion, or as with the Balcones, by faulting and erosion.

BALCONES FAULT ZONE - The area bounding the Edwards Plateau having extensive cracks and faults caused by the force of crustal movement.

BASE FLOW - A theoretical minimum flow of water down rivers, contributed from springs and other groundwater discharges.

CONDENSATION - The transformation of the gaseous water vapor into liquid water.

CONTAMINATE - To make unfit for use by the introduction of undesirable substances.

DISCHARGE - Water which leaves the aquifer by way of springs, flowing artesian wells, or pumping.

DISSOLUTION - The process of dissolving.

DROUGHT - A long period of time without sufficient rainfall.

ECOSYSTEM - The natural unit that includes a community of organisms and all of the environmental factors affecting the community.

EDWARDS AQUIFER - Water-bearing zone comprised of Edwards and associated limestones.

EDWARDS AND ASSOCIATED LIMESTONES - (Edwards Formation) - Layers of sediment, deposited during the Cretaceous period, which later became limestone rock.

EDWARDS PLATEAU - That area west and northwest of the Balcones Fault Zone, where the Edwards Formation is essentially flat-lying and is the principal aquifer of the region.

ESTUARY - An area where fresh water from rivers mixes with saltwater from the sea, and is characterized by reduced salinity. Estuaries are important nurseries for many marine species.

EVAPORATION - The process by which liquid water is transformed into gaseous water vapor due to the heat of the sun.

FAULT -Fracture of the earth's crust accompanied by movement.

FRACTURE - Breaks in rocks due to intense folding and faulting; a simple break in which no movement is involved.

GROUNDWATER- Water that is stored under the earth's surface.

HYDROLOGY - A science dealing with the properties, distribution, and circulation of water on the surface of the land, in the solid and underlying rocks, and in the atmosphere.

IMPERMEABLE - Material (such as dense rock) that will not permit liquid or water to flow through it.

INDEX WELL- A primary observation well used to report water levels on a continuous basis, generally reflecting water level conditions area wide. (Example: Bexar County index well, J-17.)

INFILTRATION - The process of water entering the ground through cracks, soil, or porous rock.

IRRIGATION - To supply water by artificial means to crops.

LEACHING - Process of dissolving, washing, or draining earth materials by percolation of groundwater or other liquids.

OUTCROP - A naturally occurring or man-caused exposure of rock at the surface of the earth.

POLLUTANT - A substance which restricts or eliminates the use of a natural resource.

POROSITY - Any property of geologic formations which has the ability to hold and yield water due to the spaces between particles.

POTABLE WATER - Water that may be drunk safely.

PRECIPITATION - Discharge of water from the air in the form of rain, ice or snow.

RECHARGE - Process by which water is added to an aquifer.

RECHARGE ZONE - The area on the earth's surface where water may enter into a groundwater aquifer. The Edwards Aquifer lies in a dipping position in the earth's subsurface, and the Edwards Recharge Zone is the area where the Edwards and Associated Limestone intersect the earth's surface.

RESERVOIR - A man-made body of water contained behind a dam.

SEDIMENT - Solid material (mineral and organic) which has been transported from its site of origin by air, water, or ice, and has been deposited either on the land's surface or on the sea floor.

SALINE - Salty; characterized by a high salinity.

SEPTIC TANK- A tank that receives and temporarily holds solid and liquid waste. Anaerobic bacterial activity breaks down the waste. The solid wastes are separated out, and liquid waste from the tank overflows into a drainage system.

SINKHOLE - A surface depression formed by the solution of limestone or the collapse over a subterranean void such as a cave.

SPRING - A place where water flows from rock or soil upon the land or into a body of surface water.

SUBTERRANEAN - Being or lying under the surface of the earth.

SURFACE WATER - Water on the land's surface including lakes, streams, rivers, and glaciers.

TRANSPIRATION - Loss of water vapor to the air from plants.

WATER CONSERVATION - Any beneficial reduction in water use or water loss.

WATER TABLE - The part of the aquifer nearest the surface or the upper surface of the zone of saturation.

WELL LEVEL - The surface of water as measured through a drilled hole (well) into a water bearing formation. This measurement can be expressed in elevation (feet) above Mean Sea Level (MSL) or feet below Land Surface Datum (LSD).

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Evaluation Form

Your assistance in evaluating this curriculum supplement would be very helpful in assessing its value. If you have used any activities in your classroom by May 1993, please fill out this evaluation form and mail it to the EUWD. All comments and suggestions will be greatly appreciated. Thank you.

NAME _____ SUBJECT OR GRADE _____

SCHOOL _____ DISTRICT _____

Questions 1 to 5 relate to the curriculum supplement and water education efforts in general. Circle your answer to each question.

1. The teacher has been provided enough background to successfully use this guide. yes no undecided

2. The focus of these lessons is appropriate for the grade levels indicated. yes no undecided

3. The activities provided ample opportunity for integrating water concepts into the designated related subject areas. yes no undecided

4. The guide encouraged the teacher to teach more about water and the Edwards Aquifer yes no undecided

5. The activities in the guide motivated and challenged the students to learn more about their water source. yes no undecided

Questions 6 - 10 relate to ***Water Wizards*** and other resources.

6. Which aspects of the guide were particularly helpful in the teaching of water issues?

_____

_____

7. Do you utilize any community resources such as a speaker or another publication? If so, please list.

_____

_____

8. How could this guide be improved? _____

_____

_____

9. What additional supplements or teaching aids would you find useful in teaching about water and the Edwards Aquifer? _____

_____

_____

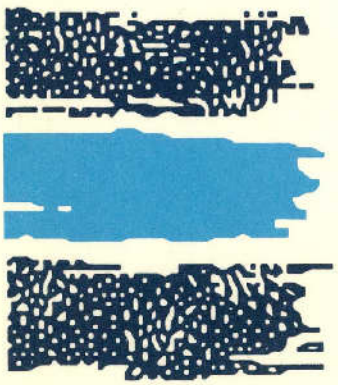
10. Please include any additional comments or suggestions. _____

_____

_____

_____

Edwards Underground Water District
Division of Information and Education
P.O. Box 15830
San Antonio, TX 78212-9030



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