Water Introduction

Water is essential for all life and a very precious natural resource. Over 70% of the Earth's surface is covered by water, but only .32% of that is readily available for human use. Most of the water on the Earth is salt water which is found in the oceans and seas. Just over two percent of the water on the Earth is fresh water frozen in glaciers and the polar ice caps. Of the fresh water found in lakes, rivers, streams and groundwater, most is not easily obtained.

The water that we use today has been around since the Earth was formed. The water is constantly recycled through a process called the water or hydrologic cycle. Water evaporates into the atmosphere, leaving minerals behind and moves through the atmosphere as water vapor. Water vapor condenses and falls to earth as rain, snow, sleet, or hail, depending on the air temperature.

When precipitation hits the ground, it can either stay on the surface and form **surface water** or it can soak into the ground. The water that soaks into the soil sustains plant and animal life in the soil. Some seeps into underground aquifers. An **aquifer** is any geologic formation that holds and transmits large quantitites of groundwater. The water table is the boundary between where the ground is saturated with water and where the ground is filled with water and air. **Groundwater** is any water at or below the water table. Most groundwater is held in spaces within sand and gravel deposits. Groundwater is the largest single supply of freshwater available for use. About half of the water used in New Mexico comes from groundwater.

Human beings require less than 2 L of water per day to survive, but in the United States, the average person uses 340 L each day at home. Water conservation is essential because the primary sources of water available to humans will not increase. People need to return water to streams, lakes, and oceans as clean as possible and reduce the use of slowly replenished groundwater.

According to the National Science Education Standards(1996), students in grades K-4 should develop an understanding that:

- Some resources are basic materials, such as air, water and soil.
- The supply of many resources is limited. If used, resources can be extended through recycling and decreased use.
- Changes in environments can be natural or influenced by humans. Some changes are good, some are bad and some are neither good nor bad. Pollution is a change in the environment that can influence the health, survival or activities of organisms, including humans.

Applicable standards for grades 5-8 state that students should develop an understanding that:

- Water, which covers the majority of the Earth's surface, circulates through the crust, oceans, and atmosphere in what is known as the **water cycle**. Water evaporates from the Earth's surface, rises and cools as it moves to higher elevations, condenses as rain or snow, and falls to the surface where it collects in lakes, oceans, soil and in rocks underground.

- Water is a solvent. As it passes through the water cycle, it dissolves minerals and gases and carries them to the oceans.

- Causes of environmental degradation and resource depletion vary from region to region and from country to country.

- Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.

- Human activities also can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal. Such activities can accelerate many natural changes.

- El abastecimiento de muchos de los recursos es limitado. Si se usan, los recursos se pueden extender a través del reciclo y del decrecimiento en su uso.

- Los cambios en el ambiente pueden ser naturales o inducidos por los humanos. Algunos cambios son buenos, algunos otros son malos, y otros no son ni buenos ni malos. La contaminación es un cambio en el ambiente que puede influir en la salud, la supervivencia o las actividades de los organismos, incluyendo los humanos.

Las normas aplicables para los grados 5-8 estatuyen que los estudiantes deberían desarrollar el entendimiento de que:

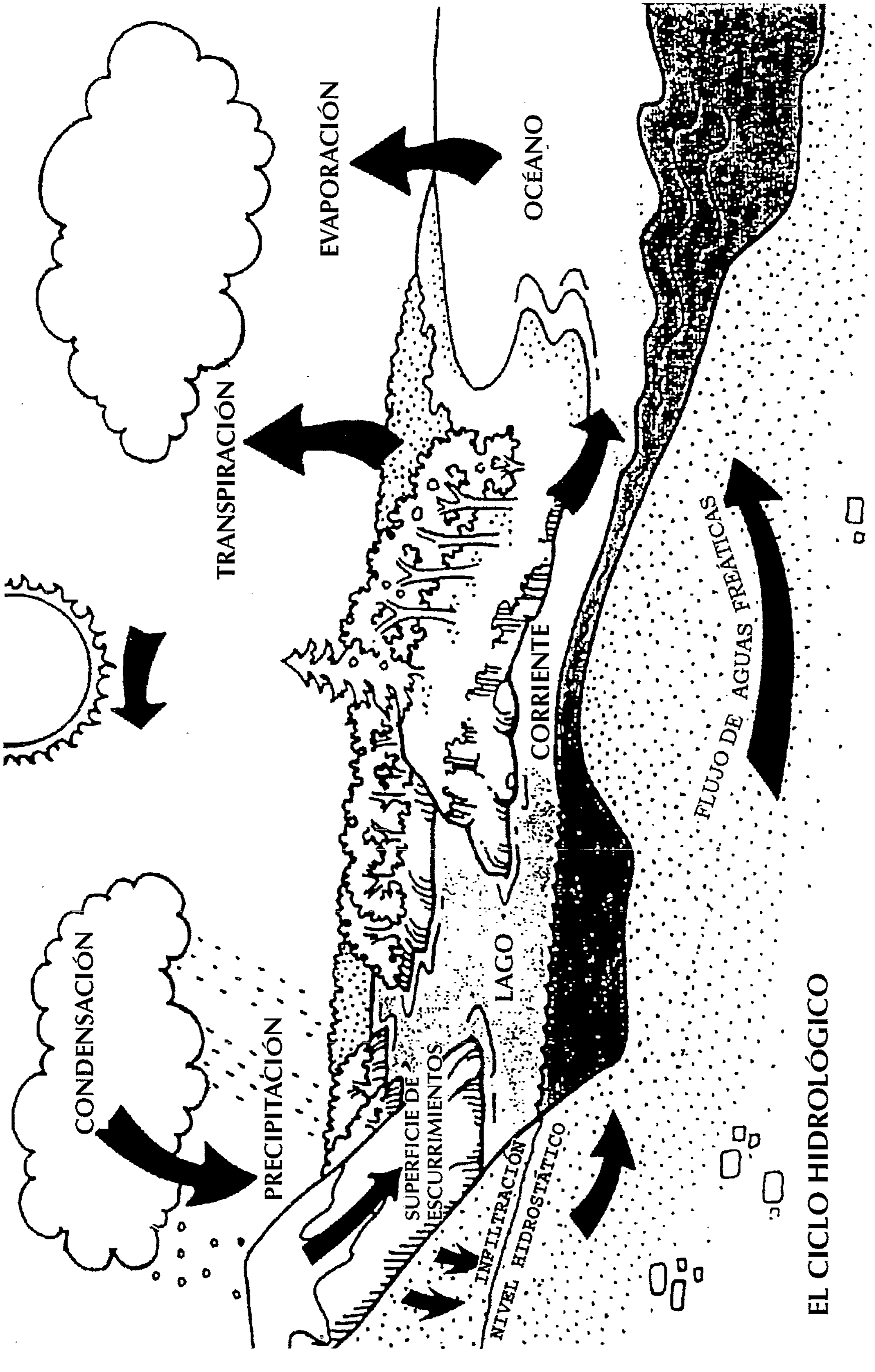
- El agua, que cubre la mayor parte de la superficie terrestre, circula por la capa terráquea, océanos y atmósfera, en lo que se conoce como **ciclo acuático**. El agua se evapora de la superficie terrestre, se alza y se enfría; mientras sube a altas elevaciones, se condensa como lluvia o nieve, y cáe a la superficie en donde se concentra en lagos, océanos, suelo y en rocas subterráneas.

- El agua es un solvente. A medida que pasa por el ciclo de agua, disuelve los minerales y gases y los transporta a los océanos.

- Las causas del deterioro ambiental y la reducción de los recursos varía de región a región y de país a país.

- Mantener un ambiente saludable implica establecer y observar normas de calidad relacionadas con el uso de la tierra, del agua y del aire.

- Las actividades humanas también pueden causar peligro por la adquisición de recursos, crecimiento urbano, decisiones en el uso de la tierra y eliminación de deshechos. Tales actividades pueden acelerar muchos cambios naturales.



EL CICLO HIDROLÓGICO

HOW MUCH WATER IS THERE?

Grades		
4-8	4	60-80 min

Description: Using 10 liters of water to represent all the water on the Earth, students will predict, calculate and measure how much water would represent all the categories of water.

Materials:

For class demonstration:
- 5 or 10 gallon aquarium or other clear container
- 1 liter container
- a variety of containers, measuring cups, buckets
- food coloring (optional)
- paper towels, sponges
- marker

For each group:
- container with 264 ml of water
- 25 ml graduated cylinder
- 10 ml graduated cylinder (marked to .1 ml)
- medicine dropper
- paper towels
- calculator

Safety: Wipe spills quickly and do not drink any of the water.

Procedure:

1. In front of students, fill the aquarium with 10 liters of water. Tell them that this represents all the water on the earth in any form. Mark the water level on the outside of the tank.

2. Have students work in groups to discuss and record their guesses for how much water in the tank represents all the water in the oceans. Each group can give its guess and reasons for it. As a class, decide on how much water represents the oceans. Once the group decides, use subtraction to determine how much water remains. For example, if they guess 8 liters make up the oceans, then 2 liters remain (10 - 8=2). Remove the "not ocean" water from the 10 liters and put it in a container labeled "Not Oceans." You may want to use food coloring to make this water easier to see. Label the water remaining in the aquarium "Oceans."

3. Student groups then discuss and record how much water they believe makes up the other categories of water as listed on the Student Activity Sheet. Have them use milliliters—review 1L = 1000 ml as needed.

4. As a class, discuss the guesses for each category of water and try to reach an overall consensus. Using student assistants and appropriately labeled containers, measure out the amount of water that the class assigned to each of the categories from the "not ocean" water previously removed from the 10 liters.

5. Refill the tank to 10 liters and relabel the tank "All Water."

6. Using the following chart, either have students calculate the correct amount for ocean water or do it for students (approximately 9720 ml). Remove the correct "not ocean" water (264 ml) and put it in a labeled container. Compare this amount to the amount the class had guessed.

7. Give each group of students 264 ml of water. Using the chart, students are to measure out the correct amount for each category of water. Again, depending on the level of the students, you can either calculate the amounts based on the percentages or allow the students to do the calculations themselves. Given the limitations of the measuring equipment, it is very likely students will not be able to measure accurately the amount of water in all of the categories, as the amounts become very small.

8. Have students calculate the amount and combine the appropriate containers of water potentially available for human use: groundwater, freshwater lakes, and rivers (about 62.9 ml). Add in the icecaps/glaciers (about 200 ml).

9. Discuss with students their findings. Mention that in practical terms, the amount of accessible fresh water is smaller than calculated here due to pollution and because it is not possible to extract more than a small fraction of the water in an aquifer.

Questions to Ask During the Activity:

1. Why is water important? [see unit Introduction]

2. Of the water categories listed, which could provide water for humans to use? [Groundwater which is near enough the surface, freshwater lakes and rivers. Ice caps and glaciers could potentially be used, but are difficult to manage currently.]

3. Where do we (in Albuquerque) get our water? [Currently, we use groundwater.]

Why It Happens: Many people do not realize how little of the Earth's water is even potentially available to humans and other species.

Category	**Percent**	**Amount** (out of 10L or 10,00ml)
Oceans	97.2%	9,720 ml
All icecaps/glaciers	2.0%	200 ml
Groundwater	.62%	62 ml
Freshwater lakes	.009%	.9 ml
Inland seas/salt lakes	.008%	.8 ml
Atmosphere	.001%	.1 ml
All rivers	.0001%	0.01 ml
Unaccounted for	.1619%	16.19 ml

Extensions: About half of the water used in New Mexico comes from groundwater.

Have students research the amount of water Americans use daily and/or annually. Resources such as the World Almanac for Kids can be used for this information. Have students estimate how much water their families use in a week.

Have students contact the city water office to find out how much water is consumed by residential use and commercial use in Albuquerque as well as ways water is being conserved in Albuquerque.

Water Conservation Hotline:	768-3655
Water Resources Info Line:	768-3619
Water Waste Hotline:	768-3640

References:

Aquatic Project Wild. Western Regional Environmental Education Council, Inc., 1992.

The Cousteau Almanac. New York, NY: Doubleday/Dolphin, 1981.

Gartrell, Jack E., Jane Crowder, and Jeffrey C. Callister. Earth: The Water Planet. Arlington, VA: National Science Teachers Association, 1992.

How Much Water Is There?
Student Activity Sheet

Below are listed seven categories of water found on the earth. With your partners, predict and record what percentage of the earth's water is found in each category.

Category	Predicted %	Actual %
Oceans		
Icecaps/glaciers		
Groundwater		
Freshwater lakes		
Inland seas/salt lakes		
Atmosphere		
All rivers		

Use the information provided by your teacher to complete the Actual Percent column on the above chart.

Questions

1. Overall, were your predictions close to the actual?

2. Which of the above categories of water do humans use?

3. What is the total percent of water available to humans?

¿Cuánta Agua Hay?
Hoja de Actividades para el Estudiante

Enseguida se listan siete categorías de agua encontrada en la tierra. Predecir y registrar con sus compañeros qué porcentaje del agua de la tierra se encuentra en cada categoría.

Categoría	% Predicho	% Actual
Océanos		
Capas de Hielo/Glaciares		
Agua Subterránea		
Agua Dulce		
Mares Interiores/ Lagunas Saladas		
Atmósfera		
Todos los Ríos		

Usar la información proveída por el maestro para completar la columna de Porcentaje Actual en la gráfica que antecede.

Preguntas

1. En balance, ¿Estuvieron sus predicciones aproximadas a las actuales?

2. ¿Cual de las categorías de agua arriba mencionadas sirve para consumo humano?

3. ¿Cual es el porcentaje total de agua disponible para la humanidad?

PROYECTO
FUTURO

GROUNDWATER: Teacher Demonstration

Grades		
2-8	whole class	30 min.

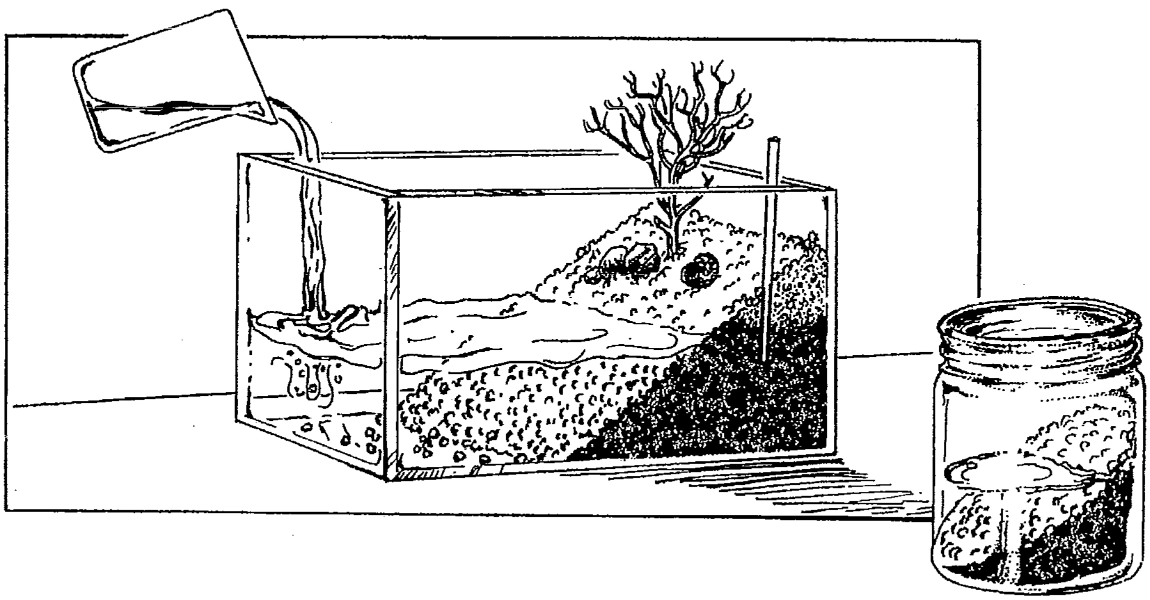
Description: Build and use a model to demonstrate the relationship between surface and ground water.

Materials: aquarium or other large, clear container
gravel
clear straw
long, thin bulb syringe
water
artificial plants (optional)

Safety: Use care in putting gravel into a glass container to avoid cracking the container.

Procedure:

1. Place gravel in the container so that it slopes up one side. Carefully add water until the water level covers about half of the slope. You can place artificial plants on the slope. See figure below.



2. Have students describe the relationship between the ground and surface water.

3. Push the straw into the dry side of the gravel to a depth below the water level, to model a well. Trim the straw so that it extends about 1 inch above the dry gravel.

4. Have students describe what they observe as you:
   - add water to the pool of water;
   - pour water onto the dry slope;
   - try to remove water by using the bulb syringe to draw water up through the straw.

5. Discuss with students the relationship between surface and groundwater as an introduction to the activity on soil porosity and permeability.

Questions to Ask During the Activity:

1. Once water is removed, how can it be replaced? [Groundwater is slowly replaced naturally by precipitation. Man-made techniques have been used with limited success.]

2. What would happen if pollutants such as oil were dumped on the ground? [Pollutants can slowly seep into the groundwater. Once there, they are extremely difficult to clean up.]

Why it Happens: In this demonstration, students should be able to observe a small pool of water, an area of water-soaked sand (groundwater), and an area of relatively dry sand on top. Groundwater and surface water are often connected and one replenishes the other. When water is added to the pool, the water in the pool should rise and the groundwater should respond by increasing (the change may be small). When water is poured on the slope, it will run down the dry side, picking up particles of gravel and carrying them to the pool of water. The pool's water level will rise and the groundwater level may also rise. Some of the water may seep into the soil and eventually reach the water table. If water is removed through the straw, both the ground and surface water levels will decrease.

For more information on groundwater in general, see the Introduction to this unit.

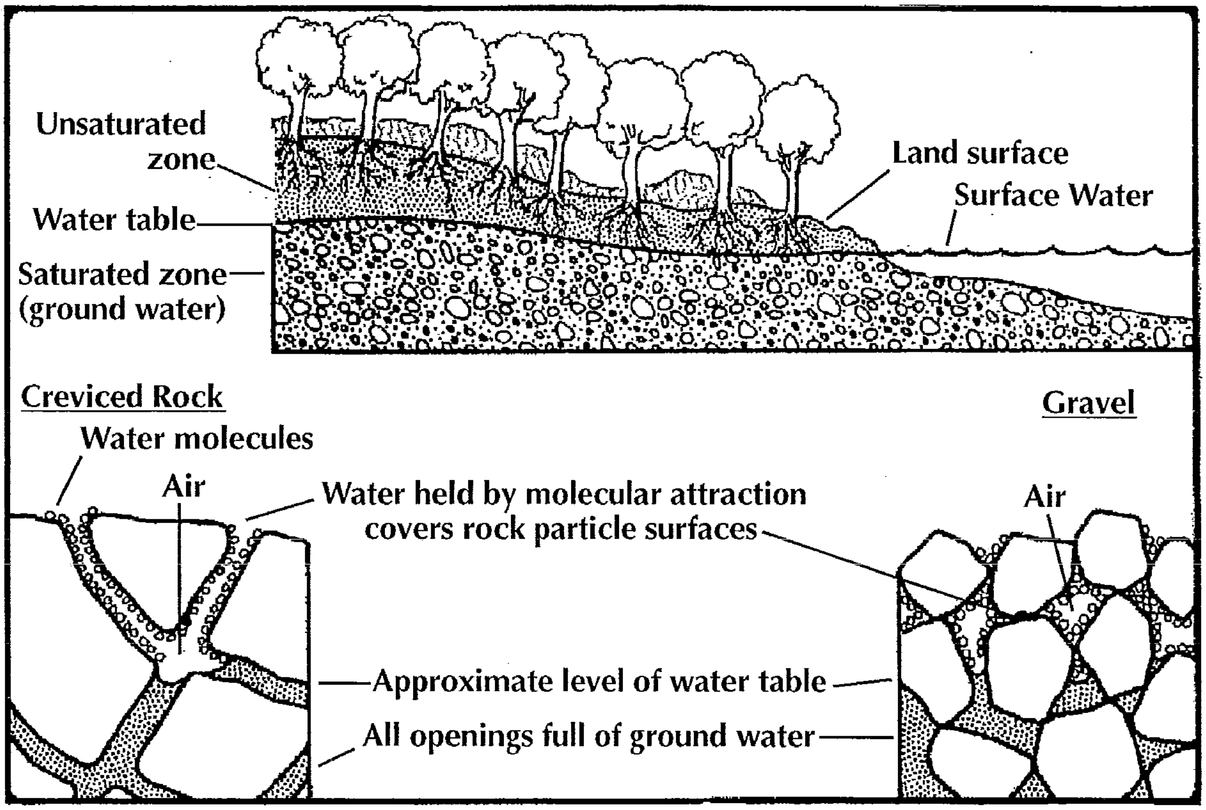
Extensions: Pour cooking oil on the dirt as a contaminant and observe over several days. Then have students try different strategies to clean it up.

Contact the City of Albuquerque Water Department for information about Albuquerque's water supply and the rate of depletion of the aquifer.

References: Potter, Marne and Caitlyn Howell, eds. Arid Lands, Sacred Waters. New Mexico Museum of Natural History, U.S. Geological Survey, and U.S.D.A. Forest Service, 1992.

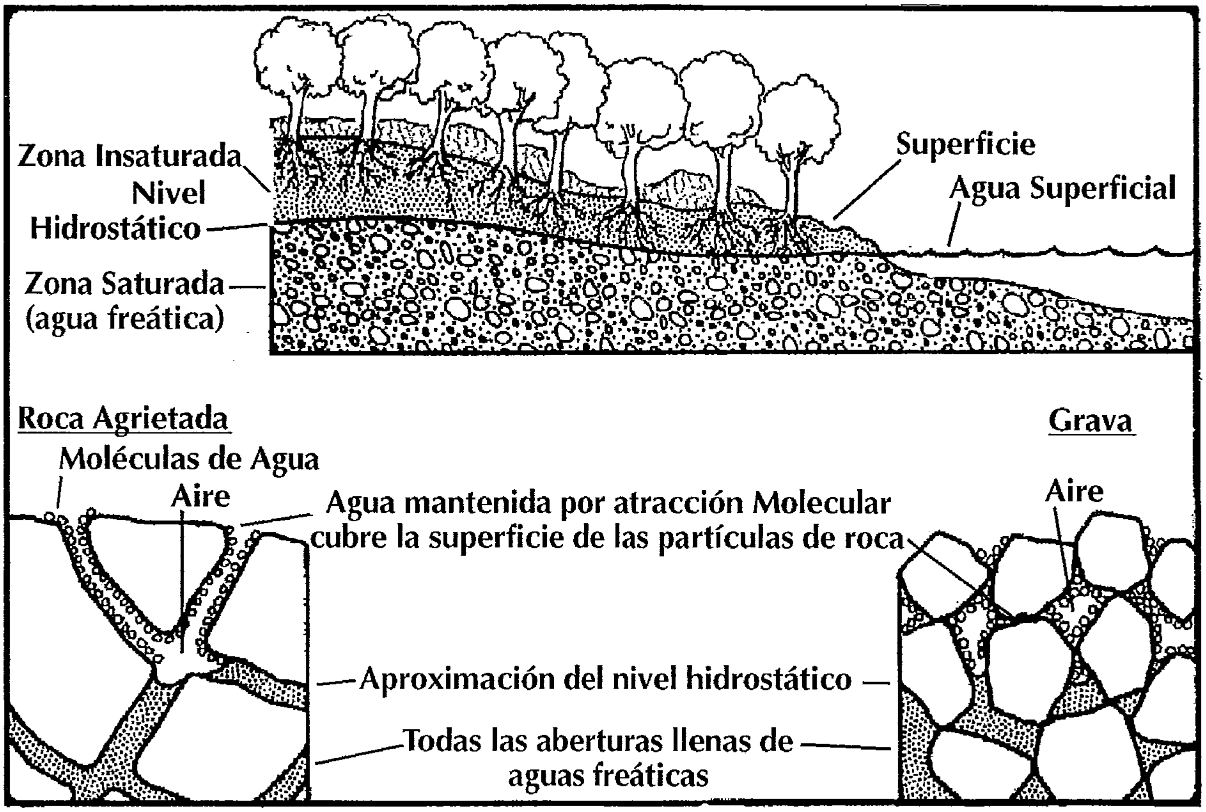
Gartrell, Jack E., Jane Crowder, and Jeffrey C. Callister. Earth: The Water Planet. Arlington, VA.: National Science Teachers Association, 1992.

How Groundwater Occurs in Rocks



Origin: USGS, *Groundwater*, 1981.

CÓMO SE FORMAN LAS AGUAS FREÁTICAS O SUBTERRÁNEAS



Origin: USGS, *Groundwater,* 1981.

POROSITY and PERMEABILITY

Grades		
4-8	2-3	40-60 min.

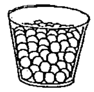
Description: Students investigate the porosity and permeability of three different soil types.

Part 1: Porosity

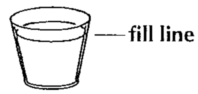
Materials for Each Group:

1 graduated cylinder or metric measuring cup
1 medicine dropper
water
3 clear cups filled to the same level:

- one with pebbles (marble-sized)



- one with fine sand which has been dried



- one with a mixture of pebbles and sand

Note: Any clean sand, such as sold for sandboxes, will be adequate. Dry the sand by spreading it on a baking sheet and heating it for 15-30 minutes in a 350º oven.

Safety: Use rigid plastic cups. If glass cups are used, be careful when putting gravel into the cup to avoid cracking the glass.

Procedure:

1. Show samples of the three materials: pebbles, sand, and the mixture of pebbles and sand. Have students predict which container will be able to hold the most water.

2. Have students follow the instructions on the Student Activity Sheet.

Questions to Ask During the Activity:

1. What is in the space between particles; it is really empty? [air fills the spaces]

2. Is there a relationship between particle size and how much water the soil can hold? [Large particles leave larger openings or pores between them for the water to fill, but the same volume of a soil with small particles has more numerous pores. In this activity, the pebbles and sand may hold about the same amount of water.]

3. Which of these materials do you think would dry out fastest?

Why It Happens: **Porosity** is a measure of how much open space, or pores, a material has for water to move through. Porosity is one of the factors that determines how much water a soil can hold and how fast water can move through the soil.

The sizes of the particles in soil determine the size and number of pores in soil. The pebbles and sand demonstrate that the pore space is larger in coarse soils. In actual soils, the large pores may be partially filled with smaller particles. When small particles fill the large pore spaces, there is less "empty space" remaining for water to fill, thereby reducing the soil's porosity.

Soil containing a mixture of large and small particles will retain its water more efficiently than coarse soils, because the small particles provide more surface to which the water can adhere. Coarse soils dry out faster than do fine soils.

Adaptations for Participants with Disabilities:

- Students with hearing impairments will have no trouble performing this activity with appropriate modifications in communicating the instructions.
- Students with visual impairments can handle the materials before adding water to get a sense of particle size.

Extensions: Repeat the activity using actual soil samples from around the community.

Allow materials to dry to determine which one dries quickest.

Part 2: Permeability

Materials for Each Group:

2/3 cup of fine, dry sand
2/3 cup of pebbles
water
1 graduated cylinder
3 paper cups
1 extra cup to catch water
small wad of cotton
1 stop watch

Note: Any clean sand, such as sold for sandboxes, will be adequate. Dry the sand by spreading it on a baking sheet and heating it for 15-30 minutes in a 350º oven.

Procedure:

1. Have students predict which of the materials will allow the water to move through it most quickly.

2. Students follow the instructions on the Student Activity Sheet.

3. Demonstrate for students how to calculate the flow rate for each "soil" by dividing the amount of water which was collected by the time (30 seconds) it was collected.

Questions to Ask During the Activity:

1. What factors affect how easily water flows through the ground? [Pore size, how well the pores are connected]

Why It Happens: **Permeability** is the measure of how fast and easily water flows through materials such as soil or rocks. As water is pumped out of an aquifer, more water will flow in to take its place. This process of recharging the aquifer is generally quite slow and depends partly on how easily water can flow through the rock and soil. Particle shape, how tightly the particles are packed, and how many different sizes of particles there are affect the permeability of a soil.

Adaptations for Participants with Disabilities:

- Students with hearing impairments will have no trouble performing this activity with appropriate modifications in communicating the instructions.
- Students with visual impairments can handle the materials before adding water to get a sense of particle size.

Extensions: Have students repeat the activity with soil samples from different locations in the community.

References:

Gartrell, Jack E., Jane Crowder, and Jeffrey C. Callister. Earth: The Water Planet. Arlington, VA.: National Science Teachers Association, 1992.

Lind, Karen K., ed. Water, Stones, & Fossil Bones. Arlington, VA.: National Science Teachers Association, 1991.

Soda Bottle Hydrology. Prepared by HAZWRAP under contract to the U.S. Department of Energy (DOE/EM-0215).

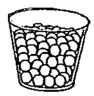
Porosity and Permeability
Student Activity Sheet

Description: You will compare the porosity and the permeability of three different soil types.

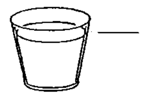
Part 1: Porosity

Materials for Your Group:
1 graduated cylinder or metric measuring cup
1 medicine dropper water
3 cups filled to the same level:

- one with pebbles (marble-sized)



- one with fine sand which has been dried



- one with a mixture of pebbles and sand

Safety: If glass cups are used, be careful when putting gravel into the cup to avoid cracking the glass.

Procedure:
1. Observe the three cups. Which cup seems to have the most empty space between its particles?

2. Fill the graduated cylinder with water. Slowly pour the water into the cup of sand until the sand is completely wet and the water is level with the top of the sand. Allow time for the water to soak all the way through the sand. Use the medicine dropper to remove any excess water on top of the sand. Record how much water you used; this is a measure of the volume of space between the particles.

3. Repeat step 2 for the cup of pebbles and the cup of sand and pebbles.

Data

Material	Pore Volume
Sand	ml
Pebbles	ml
Sand & Pebbles	ml

Questions to Ask During the Activity:

1. Which material held the most water?

2. Which material had the largest particle size?

3. Does there appear to be a relationship between particle size and porosity?

Part 2: Permeability

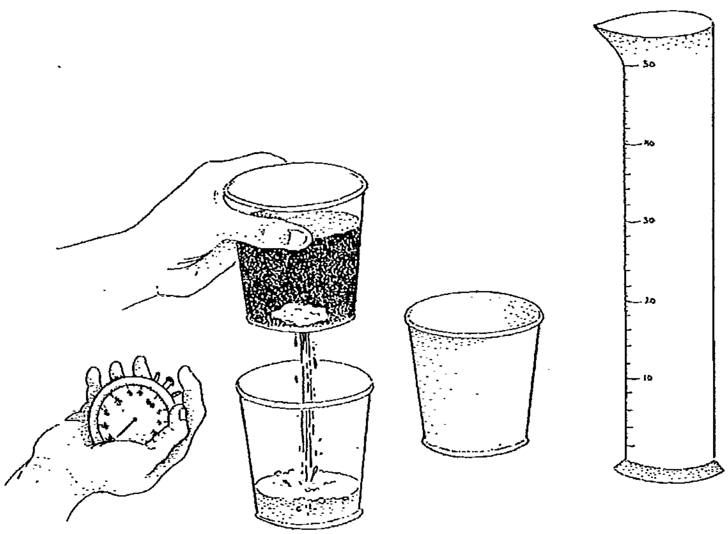
Materials for Your Group:

2/3 cup of fine, dry sand
2/3 cup of pebbles
water
1 graduated cylinder
3 paper cups
1 extra cup to catch water
small wad of cotton
1 stop watch

Procedure:

1. Poke a hole in the bottom of a cup. Cover the hole with a wad of cotton, but don't pack it tightly.

2. Fill the cup 2/3 full with the fine, dry sand. Hold the cup over another cup or container. Pour 50 ml of water into the cup and begin timing when water begins to emerge from the bottom of the cup. Let the water flow for 30 seconds. Use a graduated cylinder to measure how much water is in the collecting container.



3. Repeat step 2 for the pebbles and the sand and pebbles mixture.

Data

Cup	Amount of Water
Sand	ml
Pebbles	ml
Sand & Pebbles	ml

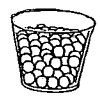
Questions: 1. Which material was the most permeable?

Porosidad y Permeabilidad
Hoja de Actividades para el Estudiante

Descripción: Se comparará la porosidad y permibilidad de tres diferentes tipos de tierra.

Parte 1: Porosidad

Materiales: un cilindro graduado o taza con medidas métricas
agua
tres vasos deshechables, llenos
al mismo nivel de:



* uno con piedrecillas (tamaño canica)

* uno con arena fina, previamente seca

* uno con una mezcla de piedrecillas y arena

Notas: Cualquier arena limpia es adecuada, tal como la que se vende para cajas de arena. Secar la arena extendiéndola sobre una charola para hornear y calentarla en el horno de 15 - 30 minutos a 350.

Medidas de Seguridad: Si se utilizan vasos de vidrio, tener cuidado al poner la grava en ellos para evitar que se rompan.

Procedimiento:

1. Observar los tres vasos, ¿Cual de ellos parece tener más espacios vacíos entre sus partículas?

2. Llenar el cilindro graduado con agua. Lentamente vaciar el agua en el vaso con arena hasta que la arena esté completamente mojada y el agua esté al nivel de la arena. Esperar a que el agua, en su curso, remoje toda la arena. Usar el gotero para quitar todo exceso de agua que haya sobre la arena. Registrar la cantidad de agua que fué usada; esto es una medida del volúmen de espacios entre las partículas.

3. Repetir el paso 2 para el vaso con piedrecillas y para el vaso con la mezcla de piedrecillas y arena.

Datos 1

Material	Volúmen Poroso
Arena	ml
Piedrecillas	ml
Arena y Piedrecillas	ml

Preguntas: 1. ¿Cuál material retuvo mas agua?

2. ¿Cuál material tenía el tamaño de partícula mas grande?

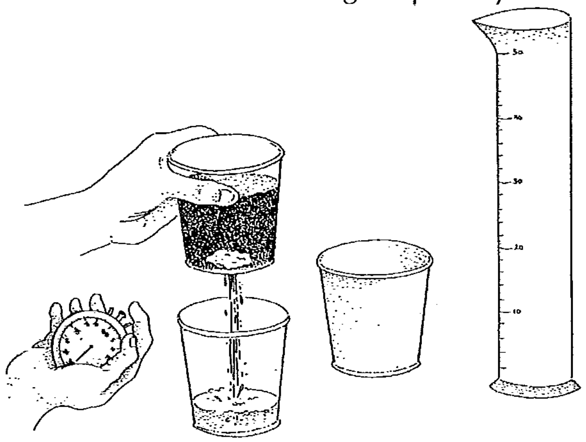
3. ¿Parece haber una relación entre el tamaño de partícula y la porosidad?

Parte 2: Permeabilidad

Materiales: 2/3 de taza de arena fina y seca
2/3 de taza de piedrecillas
agua
1 cilindro graduado
3 vasos de cartón
1 vaso extra para recoger agua
trozo chico de algodón
1 reloj marcador

Procedimiento: 1. Hacer un agujero en el fondo de un vaso. Cubrir el agujero con el algodón, pero sin que quede muy apretado.

2. Llenar 2/3 partes del vaso con arena fina y seca. Sostener el vaso sobre otro vaso o recipiente. Vaciar en el vaso 50 ml. de agua y empezar a marcar el tiempo cuando el agua empiece a salir del fondo de la taza. Dejar fluir el agua por 30 segundos. Utilizar el cilindro graduado para medir la cantidad de agua que hay en el recipiente receptor.



3. Repetir el paso 2 para el vaso con piedrecillas y para el vaso con la mezcla de piedrecillas y arena.

Datos 2

Vaso	Cantidad de Agua
Arena	ml
Piedrecillas	ml
Arena y Piedrecillas	ml

Preguntas: 1. ¿Cuál material fué el más permeable?

CLEANING UP THE WATER

Grades		
3-8	2-3	2-3 class periods (80-120 min)

Description: Students will construct a model filtration device and use it to filter a water sample.

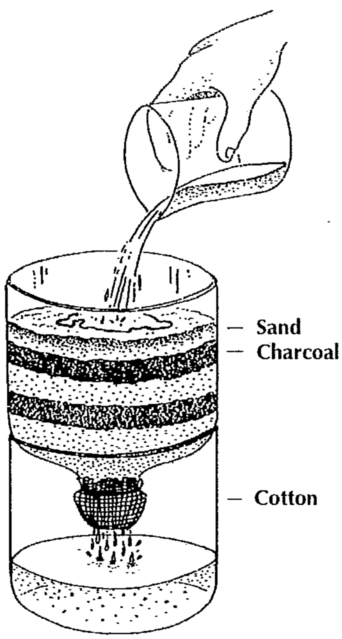
Materials for Each Group:

- 1 2-liter plastic bottle cut in half
- 1 rubber band
- 8-cm square of mesh or nylon netting
- 500 ml of sand
- 100 ml of soil
- 1 crushed charcoal briquette
- 2 cotton balls
- 250 ml of water
- 3 500-ml graduated beakers
- 50-100 ml white vinegar
- pH test paper with color chart
- food coloring
- 9 small containers (i.e., baby food jars or film canisters)

Safety: ***DO NOT drink the water at any time, even after it has been filtered.*** The water may contain bacteria or other harmful microbes.

Procedure:

1. For younger students, you might want to prepare the bottle and filtering layers ahead of time.



2. If you think it is at all possible that students will drink the water either before or after filtering, it would be best to first bake the sand in a 450º oven for one hour to kill any pathogenic organisms present before adding it to the water.

3. Have students follow the steps on the Student Activity Sheet.

Questions to Ask During the Activity:

1. After each pass through the filter, what changes in the water can you observe?

2. Is it possible this filter would miss some kinds of contaminants?

Why It Happens: Water goes through several steps to make it suitable for human consumption. Filtering is one of the steps by which particles can be removed from the water.

pH is a measure of the acidity or alkalinity of a substance. pH is measured on a scale of 1 to 14. Uncontaminated water has a pH of 7, which indicates it is neutral, neither an acid nor a base. A pH below 7 indicates an acid; above 7 indicates a base. If the pH of water is changed, it will affect the types of plants and animals that can survive in the water.

Adaptations for Participants with Disabilities:

- Students with hearing impairments will have no trouble performing this activity with appropriate modifications in communicating the instructions.

Extensions: Try:

- changing the order of filtering materials;
- using different combinations of sand, pebbles, crushed limestone, or soils;
- omitting one of the materials to find out if all are necessary.

Find out about visiting the area's water treatment facility.

Find out about home water filters: what do they do and how effective are they?

References:

Lind, Karen, ed. Water, Stones, & Fossil Bones. Washington, D.C.: National Science Teachers Association, 1991.

Gartrell, Jack E., Jane Crowder, and Jeffrey C. Callister. Earth: The Water Planet. Arlington, VA: National Science Teachers Association, 1992.

Cleaning Up the Water

Student Activity Sheet

Description: You will construct a model filtration device and use it to filter a water sample.

Materials for Your Group:

- 1 2-liter plastic bottle cut in half
- 1 rubber band
- 8-cm square of mesh or nylon netting
- 500 ml of sand
- 100 ml of soil
- 1 crushed charcoal briquette
- 2 cotton balls
- 250 ml of water
- 3 500-ml graduated beakers
- 50-100 ml white vinegar
- pH test paper with color chart
- food coloring
- 9 small containers (i.e. baby food jars or film canisters)

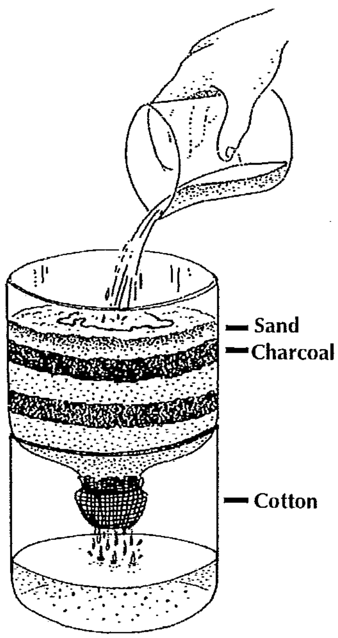
Safety: ***DO NOT DRINK the water at any time, even after it has been filtered.*** The water may contain bacteria or other harmful microbes. Use care when cutting the bottle in half.

Procedure:

1. Cut the plastic bottle in half. Place the mesh over the bottle's mouth and secure it in place with the rubber band.

2. Place cotton balls in the neck of the bottle. Alternate layers of sand and charcoal in the top of the plastic bottle as illustrated.

3. Place the top half of the bottle into the lower half with the mouth of the bottle inside the lower half of the bottle.



4. Place 100 ml of soil into a beaker. Add water to the 500 ml mark and stir. This is the water you will filter. Describe the dirty water's appearance and smell. ***DO NOT TASTE THE DIRTY WATER!!***

5. Pour the dirty water through the filter. Measure the amount of water that filters through; save and label a small sample for reference. Repeat this step with the same water two more times, saving small samples each time. Compare the samples: what has happened to the water? Is the water drinkable yet? ***DO NOT TASTE THE WATER!!***

6. Add 50 to 100 ml of vinegar to the filtered water (not the samples). Use pH paper to test the pH level of the vinegar and water mixture.

   pH is __________ Is the liquid an acid or base? ____________

7. Pour the vinegar-water mix through the filter. Test and record the pH of the filtered water.

   pH is _________ Is the liquid an acid or base? _____________

8. Repeat the filtering with the same liquid and test the pH level again. What effect did the filter have on the pH level of the water?

9. Add several drops of food coloring to the filtered water. Pour the water through the filter and observe the filtered water carefully. Save a small sample of this water. Repeat the filtering two more times, saving a sample each time. What happens to the color of the filtered water?

10. Compare all the samples of filtered water. What does this filter effectively remove from water?

Limpiando el Agua
Hoja de Actividades para Estudiantes

Descripción: Se construirá un aparato modelo de filtración y se usará para filtrar una muestra de agua.

1 botella de plástico de 2 litros cortada a la mitad
1 liga
1 cuadrado de 8 cm de malla o red de nailon
500 ml de arena
100 ml de tierra
1 carbón quebrado
2 bolas de algodón
250 ml de agua
3 probetas graduadas de 500 ml
50-100 ml de vinagre blanco
papel de ensayo de pH con gráfica de color
colorante vegetal
9 recipientes chicos (vgr. frascos de comida para bebé o recipientes para rollo de película)

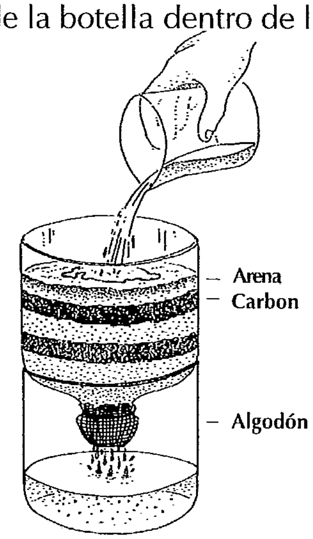
Medidas de Seguridad: **NO TOMAR EL AGUA A NINGUNA HORA, NI AUN DESPUES DE QUE HAYA SIDO FILTRADA.** El agua puede contener bacteria u otros microbios dañinos. Tener precaución al cortar la botella por la mitad.

Procedimiento:

1. Cortar la botella de plástico por la mitad. Colocar la malla sobre la boca de la botella y asegurarla con la liga.

2. Colocar las bolas de algodón en el cuello de la botella. Alternar capas de arena y de carbón en la parte superior de la botella de plástico como se ve en la ilustración.

3. Colocar la mitad de la parte superior de la botella en la parte inferior de la misma con la boca de la botella dentro de la parte inferior.



4. Poner 100 ml de tierra en la probeta. Agregar agua hasta la marca de 500 ml y agitarse. Esta es el agua que se filtrará. Describir la apariencia y olor del agua sucia. **NO PROBAR EL AGUA SUCIA!!**

5. Vaciar el agua sucia a través del filtro. Medir la cantidad de agua que se filtra; guardar y rotular una muestra pequeña para referencia. Repetir este paso con la misma agua dos o más veces reservando pequeñas muestras cada vez. Comparar las muestras: ¿Qué le ha pasado al agua? ¿Ya es agua potable? **NO PROBAR EL AGUA!!**

6. Agregar de 50 a 100 ml de vinagre al agua filtrada (no a las muestras). Usar el papel de ensayos pH para probar el nivel de pH de la mezcla del agua y vinagre.

pH es ________ ¿El líquido es un ácido o una base? _________

7. Vaciar la mezcla vinagre-agua a través del filtro. Examinar y registrar el pH del agua filtrada.

pH es ________ ¿El líquido es un ácido o una base? _________

8. Repetir la filtración con el mismo líquido y examinar nuevamente el nivel del pH. ¿Qué efecto tuvo el filtro sobre el nivel de pH del agua?

9. Agregar algunas gotas de colorante vegetal al agua filtrada. Vaciar el agua por el filtro y observar el agua filtrada cuidadosamente. Reservar una pequeña muestra cada vez. ¿Qué le pasó al color del agua?

10. Comparar las muestras de agua filtrada. ¿Qué fué lo que el filtro efectivamente removió o quitó del agua?

WATER CYCLE in a BAG

Grades		
K-4	2-3	20 min. set up 10 min. for observation 4 days

Description: Use a plastic bag to create a miniature water cycle which demonstrates the processes of evaporation and condensation.

Materials for Each Group:
1 quart size zipper style baggie
1 small, clear plastic Solo cup (3.5 oz)
masking tape

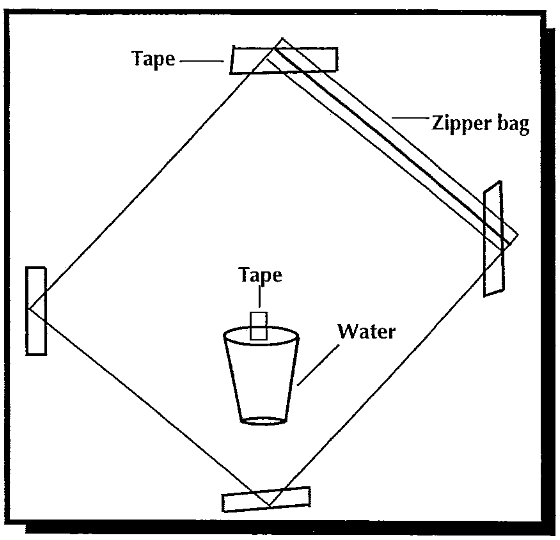
Note: For very young students prepare the baggie as a whole class and let individual students record observations of the same bag.

Procedure:

1. Place about 2 ounces (35 ml) of water into the cup and mark the water line. Tape the cup to the inside of the baggie to prevent spilling.

2. Close the bag tightly. Tape the bag to a window or other sunny, warm spot, tilted so one corner of the top edge is at the top.

3. Have students use pictures and words to describe what they see every day for four days.



Questions to Ask During the Activity:

1. Ask students to predict what they think will happen to the water in the cup.

2. Why is the baggie placed in a warm sunny spot? What would happen if it were placed somewhere else? [Heat from the sun speeds evaporation.]

3. What would happen if the baggie were left in place for a month?

Why It Happens: Water evaporates from the cup, condenses on the sides of the baggie and accumulates in the bottom of the baggie. This models the natural water cycle in which water evaporates from the earth's surface (oceans, lakes, etc.), condenses to form clouds, and precipitates back to the earth as rain, snow, or hail.

Adaptations for Participants with Disabilities: Students with hearing impairments will have no trouble performing this activity with appropriate modifications in communicating the instructions.

Extensions: Try the same experiment with salt water to show how the salt is left behind in the cup.

Add food coloring to the water and observe whether it evaporates with the water.

References:

Water Precious Water. AIMS Education Foundation, 1988.

DISAPPEARING PUDDLES

Grades		
K-4	4-5	60 min.

Description: Students will observe that the water in a puddle evaporates.

Materials for Each Group:
1 piece of chalk
1 ball of string
scissors
water

Safety: The area used for puddle observation needs to be safe from traffic and other disturbances.

Procedure:

1. Make or find natural puddles on concrete or asphalt—someplace where the water will not soak into the ground. For young students, stick to small puddles. The closer to round the puddles are, the easier it will be for students to make observations.

2. Give each group a piece of chalk and let them select a puddle. Students use their chalk to draw around the outside of the puddle and mark the time of day next to the puddle.

3. Return indoors. Be sure the puddle area is secured so that the puddles will not be disturbed. Ask students to predict what will happen to their puddles after 15 minutes (or any other time period which seems appropriate for the day's weather).

4. After 15 minutes (or the chosen time period), go back outside and have students observe their puddles. Students can draw a new chalk ring around the puddle and mark the time. Repeat this several times.

5. When all the observations have been made, give students one piece of string for each chalk circle they drew. They cut the string to the length of each circle. The strings can then be measured and their lengths recorded on the Student Data Sheet.

Questions to Ask During the Activity:

1. What happens to the size of the puddle? [It gets smaller.]

2. Did everyone's puddle get smaller? Did anyone's disappear completely? What could account for differences in how much smaller the puddles got? [depth of puddle, amount of shade over puddle]

3. Where do you think the water from the puddle went? [It evaporates into the air.]

Why It Happens: Energy from the sun causes the water molecules to become water vapor—the water evaporates. The rate at which the water evaporates will depend on air temperature, wind, and amount of sunlight.

Adaptations for Participants with Disabilities: Students with physical disabilities may need assistance in drawing the puddle rings on the pavement.

Extensions: Older students could try to measure the changing surface area of the puddle.

References: AIMS Newsletter, vol. IX, No. 6, AIMS Education Foundation, 1995.

Disappearing Puddles
Student Data Sheet

Use the following chart to record your puddle data.

Time	String Length	Change in String Length	Notes

Desaparición de los Charcos
Hoja de Información para el Estudiante

Hora	Longitud del Hilo	Cambio en la Longitud del Hilo	Notas

RIO GRANDE WATER CYCLE

Grades		
3-6	whole class	30 min.

Description: Students role-play water molecules going though a water cycle to understand the processes in the water cycle as well as issues of water management and conservation.

Materials for Whole Class:

- 2 large buckets labeled **Ocean** and **Aquifer**--mark fill line about 1" below the top of the aquifer
- 6 bowls with different labels: **Stream**, **Plants & Animals**, **Reservoir**, **Agriculture**, **Industry**, **Residents**
- 7 paper coffee cups (need to be bigger than Dixie cup) to take ground water from aquifer for agriculture, industry, & residents
- 18 plastic spoons, or small cups with a 1-spoon equivalent marked on the side. Condiment containers would work well.
- 4 Dixie cups labeled **Clouds**--mark fill line at 2/3 of the cup capacity
- water
- cards copied and laminated (if possible), from following pages

Safety: Monitor for spills in which someone could slip.

Procedure: **Preparation**

1. Label all containers.

2. Copy and cut out game cards.

3. Fill **Ocean, Aquifer, Plants and Animals, River** and **Reservoir** containers with water. Spread the containers around the room.

4. Place the **Clouds** (empty) together in another spot in the room. Clouds should be as far as possible from the **Ocean** container because water moving from the ocean to New Mexico to form clouds must travel a long distance.

5. For Round 2, fill **Agriculture**, **Industry** and **Residents** bowls. During Round 2, these containers will also be placed around the room.

Doing the Activity - Round I (Rio Grande Viejo)

1. Pass out index cards and appropriate equipment (spoon, cup). Have each student stand at the first station marked on the card. For example, the student with the "Cloud to River" card stands at the cloud station.

2. Explain the basic procedure. Students will move the water in the containers according to the directions on their card. For example, "River to Reservoir" moves one spoon of water from the **River** to the **Reservoir**, and returns to the **River** to take another spoon of water to the **Reservoir**.

3. Announce the following special considerations.
   * Clouds cannot dump their water until their cups have been filled to the fill line.

   * Players taking water from the **Aquifer** and moving to **Plants and Animals** may not take water if the water in the **Aquifer** falls below the marked line.

   * If a container is empty, players must wait for water to be added by the appropriate process before they may take water from the container.

4. Allow five minutes for students to do their assigned task. Switch cards and repeat the process for five more minutes so students may participate in another part of the cycle.

Round 2 (Rio Grande Nuevo)

5. Add **Agriculture, Industry**, and **Residents** containers to the set-up. Pass out cards and equipment for Round 2.

6. Repeat the exercise as in steps 3 & 4.

For Round 1 (Rio Grande Viejo):

1. Why do the clouds wait so long to dump their water? [Air in New Mexico is very dry. Clouds must gather a lot of moisture before they are able to rain.]

2. Why are the cloud stations so far from the ocean station? [New Mexico is a long way from the nearest ocean. Moisture must travel a long distance before it can rain on New Mexico.]

3. Is there enough water available for the plants and animals? Is there enough water available for the river? [In an undisturbed system, the plants and animals have adaptations for survival with the water available.]

4. Where is there the most water available for use? [Aquifer (ocean is saline and too far away from New Mexico for use)]

5. Where is there the least water available for use? [Clouds]

For Round 2 (Rio Grande Nuevo)

6. How was this water cycle round different from Round 1?

7. Was there enough water available for plants and animals? Why?

8. Was there water in the river? Why?

9. How would you make changes to insure everyone, including **residents**, **agriculture**, **industry**, **plants**, and **animals** have enough water?

10. Where would pollutants enter this system and where would they go? What would be affected by pollutants?

Why It Happens: The water cycle is a process by which water on the surface of the earth evaporates, condenses to form clouds, and then precipitates. Conditions in New Mexico affect the rate at which water evaporates, condenses and precipitates.

This is not a black-and-white, easy-to-answer issue. There are many pieces to the problem and very good reasons for what each party wants to do with water. We encourage a discussion about the need for agriculture, industry, and communities to use water. Who is allowed to use how much water has been an issue since the first people arrived in this area, with many fights between differing parties. We want students to be able to make responsible decisions about water in the Southwest.

Adaptations for Participants with Disabilities:

- Students with hearing impairments will have no trouble performing this activity with appropriate modifications in communicating the instructions.
- Students with visual impairments may need access to a list of the different cards (in a format legible to the student).

Extensions: Have students determine their daily water use and suggest what impacts they have on the New Mexico water cycle/water budget.

Take an imaginary "field trip" through the water cycle.

References:

The Bosque Education Guide. Middle Rio Grande Initiative, Albuquerque, New Mexico, 1995.

Water Cycle Cards

Rio Grande Viejo (old river)

1.
Cloud to River
small drink or "Dixie" cup

rio viejo 1

2.
Cloud to Plants & Animals
small drink or "Dixie" cup

rio viejo 1

3.
Cloud to Aquifer
small drink or "Dixie" cup

rio viejo 1

4.
Cloud to Reservoir
small drink or "Dixie" cup

rio viejo 1

Water Cycle Cards

Rio Grande Viejo (old river)

5.
River evaporates to
Cloud
plastic spoon

rio
viejo
1

6.
Plants & Animals
transpire and respire to
Cloud
plastic spoon

rio
viejo
1

7.
Reservoir evaporates to
Cloud
plastic spoon

rio
viejo
1

8.
Reservoir evaporates to
Cloud
plastic spoon

rio
viejo
1

Water Cycle Cards
Rio Grande Viejo (old river)

9.
Ocean evaporates to Cloud
plastic spoon

rio viejo 1

10.
Ocean evaporates to Cloud
plastic spoon

rio viejo 1

11.
Aquifer to Plants & Animals
plastic spoon

rio viejo 1

12.
River to Aquifer
plastic spoon

rio viejo 1

Water Cycle Cards

Rio Grande Viejo (old river)

13.
Aquifer to River
plastic spoon

rio
viejo
1

14.
River to Plants & Animals
plastic spoon

rio
viejo
1

15.
River to Reservoir
plastic spoon

rio
viejo
1

16.
River to Ocean
plastic spoon

rio
viejo
1

17.
Aquifer to Agriculture
coffee cup

rio
nuevo
2

18.
Aquifer to Agriculture
coffee cup

rio
nuevo
2

19.
Aquifer to Industry
coffee cup

rio
nuevo
2

20.
Aquifer to Industry
coffee cup

rio
nuevo
2

Water Cycle Cards

Rio Grande Nuevo (new river)

21.
Aquifer to Residents
coffee cup

rio
nuevo
2

22.
Aquifer to Residents
coffee cup

rio
nuevo
2

23.
Aquifer to Residents
coffee cup

rio
nuevo
2

24.
Evaporation from Agriculture
plastic spoon

rio
nuevo
2

Water Cycle Cards

Rio Grande Nuevo (new river)

25.
Evaporation from Industry
plastic spoon

rio
nuevo
2

26.
Evaporation from Residents
plastic spoon

rio
nuevo
2

27.
Agriculture runoff to River
plastic spoon

rio
nuevo
2

28.
Industry runoff to River
plastic spoon

rio
nuevo
2

Water Cycle Cards

Rio Grande Nuevo (new river)

29.

Residents return to River

plastic spoon

rio
nuevo
2

Tarjetas del Ciclo del Agua

Río Grande Viejo

1.
De la Nube al Río
recipiente pequeño o vaso deshechable

rio viejo 1

2.
De la Nube a Plantas y Animales
recipiente pequeño o vaso deshechable

rio viejo 1

3.
De la Nube al Aquífero
recipiente pequeño o vaso deshechable

rio viejo 1

4.
De la Nube a las Represas
recipiente pequeño o vaso deshechable

rio viejo 1

Tarjetas del Ciclo del Agua

Río Grande Viejo

5.
Evaporación del Agua del Río a las Nubes
cuchara de plástico

rio viejo 1

6.
Respiración y Transpiración de Plantas y Animales a las Nubes
cuchara de plástico

rio viejo 1

7.
Evaporación del Agua de Represas a las Nubes
cuchara de plástico

rio viejo 1

8.
Evaporación del Agua de Represas a las Nubes
cuchara de plástico

rio viejo 1

Tarjetas del Ciclo del Agua
Río Grande Viejo

9.
Evaporación del Agua del Océano a las Nubes
cuchara de plástico

rio viejo 1

10.
Evaporación del Agua del Océano a las Nubes
cuchara de Plástico

rio viejo 1

11.
Del Acuífero a Plantas y Animales
cuchara de plástico

rio viejo 1

12.
Del Río al Acuífero
cuchara de plástico

rio viejo 1

Tarjetas del Ciclo del Agua
Río Grande Viejo

13.
Del Acuífero al Río
cuchara de plástico

rio
viejo
1

14.
Del Río a Plantas y Animales
cuchara de plástico

rio
viejo
1

15.
Del Río a la Represa
cuchara de plástico

rio
viejo
1

16.
Del Río al Océano
cuchara de plástico

rio
viejo
1

Tarjetas del Ciclo del Agua
Río Grande Nuevo

17.
Del Acuífero a los Campos Agrícolas
taza de café

rio nuevo 2

18.
Del Acuífero a los Campos Agrícolas
taza de café

rio nuevo 2

19.
Del Acuífero a las Zonas Industriales
taza de café

rio nuevo 2

20.
Del Acuífero a las Zonas Industriales
taza de café

rio nuevo 2

Tarjetas del Ciclo del Agua
Río Grande Nuevo

21.
Del Acuífero a las Zonas Residenciales
taza de café

rio
nuevo
2

22.
Del Acuífero a las Zonas Residenciales
taza de café

rio
nuevo
2

23.
Del Acuífero a las Zonas Residenciales
taza de café

rio
nuevo
2

24.
Evaporación del Agua de los Campos Agrícolas
cuchara de plástico

rio
nuevo
2

Tarjetas del Ciclo del Agua
Río Grande Nuevo

25.
Evaporación del Agua de las Zonas Industriales
cuchara de plástico

rio nuevo 2

26.
Evaporación del Agua de las Zonas Residenciales
cuchara de plástico

rio nuevo 2

27.
Deslizamiento de Aguas de los Campos Agrícolas al Río
cuchara de plástico

rio nuevo 2

28.
Deslizamiento de Aguas de las Zonas Insustriales al Río
cuchara de plástico

rio nuevo 2

Tarjetas del Ciclo del Agua

Río Grande Nuevo

29.
Aguas de las Zonas Residenciales Regresan al Río
cuchara de plástico

rio nuevo 2

PROYECTO
FUTURO