El Paso Water Education Series

How A Well Works - Lesson Plan

Grade 4

Subject
Earth and Space

Duration
20-30 minutes

Skills
Gathering information (observing), Analyzing information, Interpreting

Vocabulary
aquifer, groundwater, infiltration, precipitation, recharge, saturated zone, unsaturated zone, well

Science TEKS
Grade 4: 4.1(A-B), 4.2(A-F), 4.3 (A-B), 4.4, 4.8(B)

For more lessons, activities, and to schedule a visit to EPWater's TecH_2O Water Resources Learning Center visit:

tech2o.org

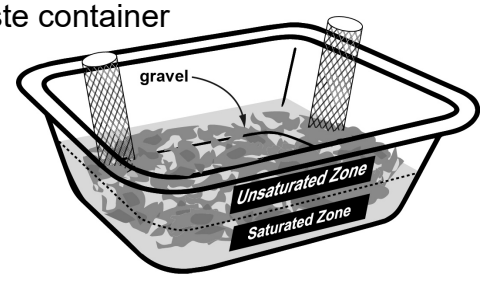
Lesson Overview: The Water Cycle describes the continuous movement of water on our planet, but several of these steps are hard for students to visualize. This lesson offers students the opportunity to model the movement of groundwater and consider how humans influence aquifers.

Objectives:
1. Review steps of the water cycle related to groundwater.
2. Use a model to visualize the movement of groundwater.

Engagement Questions:
1. Where does water go when it soaks into soil?
2. Is water under the ground stuck underground forever?

Making Connections: The citizens of El Paso rely on the Rio Grande river and two groundwater sources to satisfy their drinking water needs. During times when the Rio Grande is dry, two large aquifers supply all of El Paso's water. Though the city is situated in the Chihuahuan desert, these aquifers allow the city to flourish even during times of drought. These aquifers are large, but they are not infinite. Caring for the environment and conserving El Paso's water resources is a shared responsibility of all citizens.

Materials: *(per group of 3-4 students)*
(1) 4 cups rectangular food storage container
(4) cups of pea-sized gravel (similar in size to aquarium gravel)
(2) 2 inch lengths of braided cable sleeve
(2) disposable pipettes
(1) tube food coloring gel or quick dissolving dye tablets
(1) ruler
(1) foam cup
(1) 1000 mL beaker or measuring cup full of water
(1) 1000 mL beaker or similar sized waste container
(8) white or clear 3 oz bathroom cups
(1) permanent marker
(1) stopwatch/timer
(2) 150 mL syringes *(optional)*



Procedure:
Pre-Activity Preparation (by an adult)
1. Place the lengths of braided cable sleeve standing at either end of the food storage container and fill with pea-sized gravel.
2. Use a permanent marker to draw a line on the food storage container about half the height of the gravel. *This will serve as the initial "fill to" line for students to charge their aquifer model with water.*
3. Use a pen or pencil to poke 5-6 holes in the bottom of the foam cup. *This cup will be used to simulate a raincloud and rain. Students will use it to deliver water to the aquifer model.*

Activity

1. Define aquifer: water stored underground in permeable rock and between sediments.
   A. *Remind students that aquifers are not underground caves full of water. Instead, water fills the spaces in between rocks, gravel, and sand.*
   B. *El Paso relies on two aquifers: the Mesilla Bolson Aquifer west of the Franklin Mountains and the larger Hueco Bolson Aquifer east of the Franklin Mountains. Learn more about our aquifers at epwater.org .*
2. Fill aquifer model about halfway (to the line drawn in permanent marker) with water using the punctured foam cup to simulate rain.
   This is a good opportunity to review the process of infiltration.
3. Define recharge: refilling an aquifer through infiltration.
4. Define saturated zone: underground zone that contains water
   Use the model to point out the zone below the black line previously drawn.
5. Define unsaturated zone: underground zone near an aquifer that does NOT contain water
   Use the model to point out the zone above the black line.
6. Discuss the relevance of saturated vs unsaturated zones as it relates to extracting water from a well. *To extract water, one must reach into the saturated zone.*
7. Use a pipette to extract water once from each well and deliver to a bathroom cup. Do this separately for each of the two wells.
   Deliver only enough water to cover the bottom of the bathroom cup.
   It is helpful to assign a student to each well. The third student will be responsible for simulating rain to recharge the aquifer, managing the stopwatch, and labeling samples.
8. Use a marker to label each bathroom cup to describe the source and the sample number.
   Example: "WELL 1 SAMPLE 1" "WELL 2 SAMPLE 1"
9. Place a drop of food coloring or dye tablet anywhere on the surface of the rocks.
   Describe this as pollution that was dumped on the surface.
10. Use the ruler to measure the distance between the pollutant and each well. Record each measurement. *Students who have overfilled their aquifer may struggle with this step as the food coloring or dye tablet may begin to dissolve and spread immediately.*
11. Hypothesize what will happen to each well as a result of pollution, rain, infiltration, and water extraction. Record the group's hypothesis.
    Example: "Water extracted from WELL 1 will become contaminated faster than WELL 2 when rain dissolves the pollution and it infiltrates into the aquifer because WELL 1 is located closer to the pollution."
12. Start stopwatch.
13. Use the foam cup to simulate rain on the aquifer, dissolving the pollutant.
    Advise students to be mindful when simulating rain to avoid delivering too much water to their aquifer model and causing a flood.
14. Immediately begin extracting water from both wells using pipettes. Deliver the water into the waste container. Extraction will continue constantly and will not stop for 5 minutes.

Activity

15. Collect samples from each well and deliver them to a bathroom cup at the following time intervals: 1 minute, 3 minutes, and 5 minutes. Label each sample accordingly.

Example;	*"WELL 1 SAMPLE 2 1 MIN"*	*"WELL 2 SAMPLE 2 1 MIN"*	*"WELL 1 SAMPLE 3 3 MIN"*	*"WELL 2 SAMPLE 3 3 MIN"*	*"WELL 1 SAMPLE 4 5 MIN"*	*"WELL 2 SAMPLE 4 5 MIN"*

    A. *Between taking samples, while extraction is ongoing, list examples of water use. Example: "We are extracting water to use for a 5-minute shower. We are using water to irrigate grass at the park. Water is being used to cook dinner. We are extracting water to wash clothes and dishes. Etc."*

16. Examine each well sample and record observations. *Do they align with the group's hypothesis?*
17. Discuss the movement of water underground. Water in an aquifer is not stuck in place; it moves. Movement of groundwater can be difficult to predict, which is why observations may not exactly match a group's initial hypothesis. Water extraction from wells can cause water to move. When water is removed from underground, this creates an empty space in the aquifer. Water surrounding the empty space will flow in to fill the gap. Water extraction can make it even more difficult to predict how groundwater will move.
18. Describe how groundwater pollution is easier to prevent than to clean up.

Optional Activity Extension *(Can be done as a class-wide race between groups)*

19. Upgrade pipette to large syringe pumps.
20. Consider the final samples taken from each well at 5-minutes to hypothesize how much time will be needed to clear the groundwater pollution at each well. Record the group's hypothesis.
    A. *Example 1: "WELL 1 will be cleared of pollution in 3 minutes. WELL 2 will be cleared of pollution in 4 minutes because it is more polluted."*
    B. *Example 2: "Both WELL 1 and WELL 2 will be cleared of pollution in 3 minutes 30 seconds because they are equally polluted."*
19. Start stopwatch.
20. Repeat steps 12-13 using the large syringes instead of pipettes.
    A. *Students may need more water to clear the model of pollution.*
    B. *They may also need to empty their waste container.*
    C. *Remind students to be mindful when simulating rain to avoid delivering so much water that their model floods or overflows.*
    D. *It can be easy to pull a syringe plunger too quickly and separate it from the housing; this usually makes a popping sound. If this happens, the student has "popped a pump," and the pump is now "down for maintenance." The popped syringe pump is replaced with a pipette.*

Check for Understanding:
Did students meet the lesson objectives? Can they answer the engagement questions? Below are some key takeaways and questions that students should be able to answer following the lesson.

Key Takeaways:
- Aquifers are not underground caverns of water. The water is stored in spaces between rocks and sediment.
- Water stored underground moves.
- People extract water from aquifers using wells, and we use the water in many different ways.
- Extracting groundwater can cause water to move in unpredictable ways.
- If not managed properly, pollutants on the surface can make their way into aquifers.

Questions:
1. What steps in the water cycle might cause the amount of water stored in an aquifer to INCREASE?
2. When might the amount of water stored in an aquifer DECREASE?
3. When the Rio Grande river is dry, El Paso only has access to groundwater. What are three ways you can save water during the dry season or year-round?
4. What are some ways that you can protect El Paso's groundwater?

How A Well Works-Worksheet

Name: _____ Date: _____

Instructions: Use this worksheet to answer the following questions and record your observations.

Before you begin, you should know:

1. The _____ cycle describes how water moves on planet Earth. [*Fill in the blank.*]
2. Water stored in an aquifer is located (on the surface / underground). [*Circle the correct answer.*]
3. Describe the process of water infiltration. _____

_____

_____

Follow your teacher's instructions to set up an aquifer and well model.

Draw Your Observations

Draw your model setup below.

1) Assign each well a number or letter, and label the wells on your drawing.
2) Label the saturated zone of the aquifer model.
3) Label the unsaturated zone of the aquifer model.
4) Draw an **X** to represent where the pollution was placed on the surface of your model.

Describe Your Observations

Describe your aquifer model setup.
Include the terms saturated zone and unsaturated zone in your description.

Measurements

1) WELL _____ is _____cm from the pollution.

2) WELL _____ is _____cm from the pollution.

Prediction/Hypothesis:

Predict what will happen to each well now that pollution has been introduced. Write your hypothesis below.
Your hypothesis should answer the following questions:

1) Which well do you expect will become polluted first? (Consider your measurements.)
2) Which well do you expect will become more polluted over time?

_____

_____

_____

How A Well Works-Worksheet

Name: _____ Date: _____

Instructions: Use your recorded observations and online research to answer the following questions.

Cultural Application:

The people of El Paso rely on water from the Rio Grande river and groundwater to supply their needs.

Online Research:

What year was the first area water works created in El Paso?

How many wells supplied the city of El Paso in 1910?

What company operates over 150 wells and supplies safe drinking water to nearly all El Pasoans?

Conservation Application:

Circle only the action(s) that **protect** El Paso's aquifers from the list below.

1. Illegally dumping trash in canals.
2. Saving water every day at home and school .
3. Disposing of industrial pollution properly.
4. Storing extra river water underground to use in the future.
5. Pumping groundwater to refill the Rio Grande river when it is dry.

Analyze Your Observations

1. Did either well become more polluted than the other?

2. Describe how much pollution you observed in each well sample in the table below.

WELL ____	TIME	WELL ____
	Before Pollution	
	1 minute	
	3 minutes	
	5 minutes	

3. Did the groundwater in your aquifer model move? _____

4. Explain your answer to question number 3. Include observations you made during the experiment in your explanation.

5. Describe two ways human activity can affect an aquifer.

Cómo Funciona Un Pozo-Hoja de Trabajo

Nombre: _____ Fecha: _____

Instrucciones: Utiliza ésta hoja de Trabajo para responder las siguientes preguntas y registrar tus observaciones.

Antes de comenzar, debes saber:

1. El ciclo del _____ describe como se mueve el agua en el planeta Tierra. [*Completa el espacio en blanco.*]
2. El agua almacenada en un acuífero se ubica (en la superficie / subterráneo). [*Encierra en un círculo la palabra correcta.*]
3. Describe el proceso de infiltración del agua._____

_____

Sigue las Instrucciones de tu maestro para configurar un acuífero y un modelo de pozo.

Dibuja tus Observaciones

Dibuja la configuración de tu modelo a continuación.

1) Asigna a cada pozo un número o letra, y etiquétalos en tu dibujo.
2) Etiqueta la zona saturada del modelo de acuífero.
3) Etiqueta la zona no saturada del modelo de acuífero.
4) Dibuja una X para representar dónde se colocó la contaminación en la superficie de tu modelo.

Describe tus Observaciones

Describe tu modelo de acuífero.
Incluye los términos zona saturada y zona no saturada en tu descripción.

Medidas

1) POZO _____ está a _____cm de la contaminación.

2) POZO _____ está a _____cm de la contaminación.

Predicción/Hipótesis:

Predice qué pasará con cada pozo ahora que se ha introducido la contaminación. Escribe tu hipótesis a continuación.

Tu hipótesis debe responder a las siguientes preguntas:

1) Qué pozo esperas que se contamine primero? (considera las medidas)
2) Qué pozo esperas que se contamine más con el paso del tiempo?

_____

_____

_____

Cómo Funciona Un Pozo-Hoja de Trabajo

Nombre: _____ Fecha: _____

Instrucciones: Utiliza tus observaciones registradas y tu busqueda en linea para responder las siguientes preguntas.

Aplicación Cultural:

La gente de El Paso depende del agua del Río Grande y de las aguas subterráneas para satisfacer sus necesidades.

Investigación en Linea:

En qué año se creó la primera obra hidráulica en El Paso?

Cuántos pozos abastecían a la ciudad de El Paso en 1910?

Qué compañía opera más de 150 pozos y abastece agua potable a casi todos los residents de El Paso?

Aplicación de Conservación:

Encierra en un círculo sólo la accion(es) que protégé(n) los acuíferos de El Paso de la siguiente lista:

1. Tirar basura ilegalmente en los canales.
2. Ahorrar agua todos los días en la casa y escuela.
3. Eliminación adecuada de la contaminación industrial.
4. Almacenar agua extra de río en el subsuelo para un uso futuro.
5. Bombeo de agua subterránea para rellenar el Río Grande cuando está seco.

Analiza tus Observaciones

1. Alguno de los pozos se contaminó más que otro?

2. Describe cuanta contaminación observaste en cada pozo en la siguiente tabla.

POZO____	TIEMPO	POZO ____
	Antes de Contami-nación	
	1 minuto	
	3 minutos	
	5 minutos	

3. Se movió el agua subterránea del modelo? _____

4. Explica tu respuesta a la pregunta número 3. Incluye las observaciones que hiciste durante el experimento en la explicación.

5. Describe dos formas en que las actividades humanas afectan un acuífero.