Aquifer water is vital to life in the San Antonio River Basin. An aquifer is an area that contains large amounts of groundwater. The water in these underground areas is more protected from evaporation than surface water, so they are an important source of water when precipitation has been scarce. But one of the main misconceptions about aquifers is that they are underground lakes. This is not the case. Even though aquifers contain large amounts of water, the water is held in pore spaces within solid material, such as sand, clay, gravel, sandstone, or limestone rock. The porosity of the material determines how much water the aquifer can hold.

Some aquifers can be replenished easily, while others cannot. The speed with which water is able to infiltrate and percolate through an aquifer is referred to as permeability. An aquifer can be porous without being permeable, and it can be permeable without being porous, but the two are often related.

There are three major aquifers located within the San Antonio River Basin: the Edwards Aquifer, the Carrizo-Wilcox Aquifer, and the Gulf Coast Aquifer. Of the three major aquifers located within the San Antonio River Basin, the Edwards Aquifer is both more porous and more permeable than either the Carrizo-Wilcox or the Gulf Coast aquifers. The Carrizo-Wilcox is more porous and permeable than the Gulf Coast Aquifer.
The Edwards Aquifer is a large limestone karst aquifer, about 240 miles long and ranging from 4 to 30 miles wide, depending on location. The Edwards Aquifer receives recharge water from rainfall that falls on the Edwards Plateau. Because the Edwards limestone that comprises the recharge area and the aquifer is very permeable, water can infiltrate rapidly into the aquifer and flow rapidly through it. The Carrizo-Wilcox aquifer is a sand and gravel aquifer, and the Gulf Coast Aquifer is a sand, silt and clay aquifer.

The Edwards, Carrizo-Wilcox and Gulf Coast aquifers all contain areas that are under artesian conditions. This is especially true for the Edwards. The geologic conditions necessary for artesian conditions are an inclined aquifer sandwiched between impervious rock layers located above and beneath the aquifer that trap water. If a well is drilled into the water-bearing layer, the pressure of water located at a higher elevation will cause the water level to rise in the well. If the pressure is great enough, water will flow out of the well pipe. Water does not have to flow completely out of the pipe for the well to artesian, but it does have to rise above the level of the water table.

**KEY TERMS**

**Aquifer** is an area where large amounts of water are stored underground in natural formations of sand, gravel or rock.

**Artesian spring** is a spring that flows because the groundwater is under pressure. The word artesian comes from the Artois region of France, where these types of springs are common.

**Karst** is a type of terrain usually composed of limestone rock on and below the surface that has been eroded and dissolved by water. Sinkholes and caverns are common and the subsurface drainage system is very porous. The name comes from the Karst region of Slovenia, where this type of landscape was first noticed.

**Permeability** is the characteristic of an aquifer that describes how easily water passes through.

**Porosity** is the characteristic of an aquifer that describes how much water can be held in air spaces between solid particles. It is expressed as the ratio of the volume of air spaces in a material to the total volume of the material.

**Spring** is a place where there is a natural flow of groundwater to the surface.
PROCEDURES

A. Start by introducing the students to the concepts of an aquifer, porosity, and permeability. For reference, have them look at Student Sheets 1-2.

B. Have the students fill each of the three cups to within one inch of the top of the cup with one of each type of material. You will end up with one cup of sand, one cup of gravel and one cup of pebbles. The cup with pebbles in it represents the Edwards Aquifer, the cup with gravel in it represents the Carrizo-Wilcox Aquifer, and the cup with sand in it represents the Gulf Coast Aquifer.

C. Instruct the students to determine the permeability of each material:
   1. Measure out 50 ml of water. If you do not have a graduated cylinder, you can measure out ¼ cup of water.
   2. Get your stopwatch ready! Pour the water into cup of sand, and time how long it takes for the water to stop flowing. This might be when it reaches the bottom of the cup. Record this value in the table for this activity.
   3. Measure the distance from the top of the cup to where the water stopped flowing. Record this value in your table.
   4. Calculate the permeability of the material by dividing the distance traveled by the time of travel, and record this value in your table.
   5. Repeat steps a through d for the cup of gravel and the cup of pebbles.

D. Instruct the students to determine the porosity of each material:
   1. Fill your graduated cylinder or your measuring cup with water until it reaches the last measurable line. You want to make sure that you know exactly how much water is held in your container.
   2. Record the initial amount of water in your graduated cylinder or measuring cup, and include the amount of water that you already poured into the cup in the permeability activity.
   3. Pour water into the sand cup until the water level just reaches the top of the sand.
   4. Record the amount of water remaining in your graduated cylinder or measuring cup.
   5. Subtract the amount of water remaining from the amount of water you initially had to determine how much water is stored in the cup with the sand. This number represents the porosity of the sand.
   6. Repeat steps a through e for the cup with gravel and the cup with the pebbles.

MATERIALS

- Three transparent plastic cups of the same size
- A graduated cylinder or a glass measuring cup that divides volume measured into small increments
- Sand (can be purchased at craft store)
- Gravel or small rocks (like those for an aquarium or in your backyard)
- Pebbles (larger stones from your back yard)
- A watch or stopwatch
- A ruler
- Student Sheet 3
GUIDING QUESTIONS

- Through which aquifer model did water move the fastest? What does this mean about the permeability of that aquifer?
- Through which aquifer model did water move the slowest? What does this mean about the permeability of that aquifer?
- Which of your aquifer models held the most water? What does this mean about the porosity of that aquifer?
- Which of your aquifer models held the least water? What does this mean about the porosity of that aquifer?
- What does the permeability of each of the aquifers tell you about how fast water can infiltrate into them?
- Based on your aquifer models, why is the recharge of the Carrizo-Wilcox and the Gulf Coast aquifers smaller than the Edwards Aquifer?
- Using your map, what aquifer or aquifers do you think supplies water to Bexar County? Wilson County? Karnes County? Goliad County?
- How was your model like what actually happens in nature?
- How was your model different from what actually happens in nature?

EVALUATION

Have the students write a short paper describing the three major aquifers in the San Antonio River Basin. They should explain what an aquifer is, identify the aquifer over which they live, and compare such things as location, composition, porosity, permeability, recharge and human impacts among the three aquifers.
Major Aquifers of Texas

Legend
- Cenozoic Pecos Alluvium
- Seymour
- Gulf Coast
- Carrizo - Wilcox (outcrop)
- Carrizo - Wilcox (downdip)
- Hueco - Mesilla Boslon
- Ogalala
- Edwards - Trinity Plateau (outcrop)
- Edwards - Trinity Plateau (downdip)
- Edwards BFZ (outcrop)
- Edwards BFZ (downdip)
- Trinity (outcrop)
- Trinity (downdip)

NOTE: Outcrop (that part of a water-bearing rock layer which appears at the land surface)
DownDip (that part of a water-bearing rock layer which dips below other rock layers)

Courtesy of the Texas Water Development Board
Model of Sand, Gravel and Limestone aquifers

Sand represents Gulf Coast Aquifer.
Gravel represents Carrizo-Wilcox Aquifer.
Limestone pebbles represents Edwards Aquifer.

Data Table 1. Composition, permeability and porosity of models of the Edwards Aquifer, Carrizo-Wilcox Aquifer and Gulf Coast Aquifer.

<table>
<thead>
<tr>
<th>Aquifer name</th>
<th>Composition of the aquifer model</th>
<th>Distance the water traveled (cm)</th>
<th>Time of travel (seconds)</th>
<th>Permeability of the material (cm/second)</th>
<th>Initial amount of water in the graduated container (mL)</th>
<th>Amount of water remaining in the graduated container (mL)</th>
<th>Porosity of the material (mL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edwards Aquifer</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Carrizo-Wilcox Aquifer</td>
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<tr>
<td>Gulf Coast Aquifer</td>
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<td></td>
</tr>
</tbody>
</table>

Data Table 2. Aquifers of the San Antonio River Basin.

<table>
<thead>
<tr>
<th>Aquifer Name</th>
<th>Location (county or counties) of the Aquifer within the San Antonio River Basin</th>
<th>Composition of the Aquifer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edwards Aquifer</td>
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</tr>
<tr>
<td>Carrizo-Wilcox Aquifer</td>
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<tr>
<td>Gulf Coast Aquifer</td>
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# REFERENCES


