DEEP SUBJECTS—WELLS AND GROUND WATER

Grades
3 - 6

➤ OBJECTIVES

- Demonstrate knowledge about what ground water is in terms of how it exists in the ground.
- Explain how ground water moves through the soil and how it interacts with surface water.
- Demonstrate knowledge about how ground water is extracted for use as drinking water.

➤ ESTIMATED TIME

- Part A - 20 minutes
- Part B - 20 minutes
- Part C - 45 minutes
- Part D - 25 minutes
- Part E - 20 minutes
- Part F - 25 minutes
- Part G - 20 minutes

BACKGROUND INFORMATION

Water that falls to the earth in the form of rain, snow, sleet, or hail continues its journey in one of three ways: It might land on a waterbody and, essentially, go with the flow; it might run off the land into a nearby waterbody or storm drain; or it might seep into the ground. Water that seeps into the ground moves in a downward direction because of gravity, passing through the *pore* spaces between the soil particles, until it reaches a soil depth where the pore spaces are already filled, or saturated, with water.

When water enters the *saturated zone*, it becomes part of the *ground water*. The top of this saturated zone is called the *water table*. The water table may be very close to the ground surface, which is often the case when it is adjacent to a waterbody, or it may be as much as 200 to 600-feet deep, which is the case in many areas of the Southwest United States. A water-bearing soil or rock formation that is capable of yielding enough water for human use is called an *aquifer*. In bedrock aquifers, water can move through cracks, or fractures. Some types of bedrock—like sandstone—can absorb water like a sponge; other types of bedrock—like granite—do not.

How quickly water passes through, or *infiltrates*, the soil is a function of the size and shape of the soil particles, the amount of pore space between the particles, and whether or not the pore spaces interconnect. For example, soils that consist primarily of larger sand and gravel particles tend to have larger, interconnected pore spaces that allow water to flow easily and relatively quickly. In contrast, some soils, such as silts and clays, have poorly connected pore spaces, a soil structure which tends to slow down infiltration.

➤ MATERIALS

- ❑ Flip chart or black board
- ❑ Markers
- ❑ Clear plastic cups
- ❑ Pea-sized un-colored aquarium gravel (available from pet supply stores)
- ❑ Sand
- ❑ Water bottle spray nozzles (available from a hardware store)
- ❑ Pieces of nylon stockings or tights
- ❑ Cake pan(s) (glass is preferable) or a clear, plastic salad tray
- ❑ Water
- ❑ Food coloring (at least one teaspoon per gallon)
- ❑ Unsweetened red Kool-Aid
- ❑ "Rain cups" - paper cups with holes punched in the bottom
- ❑ Water Maze handout

DEEP SUBJECTS—WELLS AND GROUND WATER

NOTES

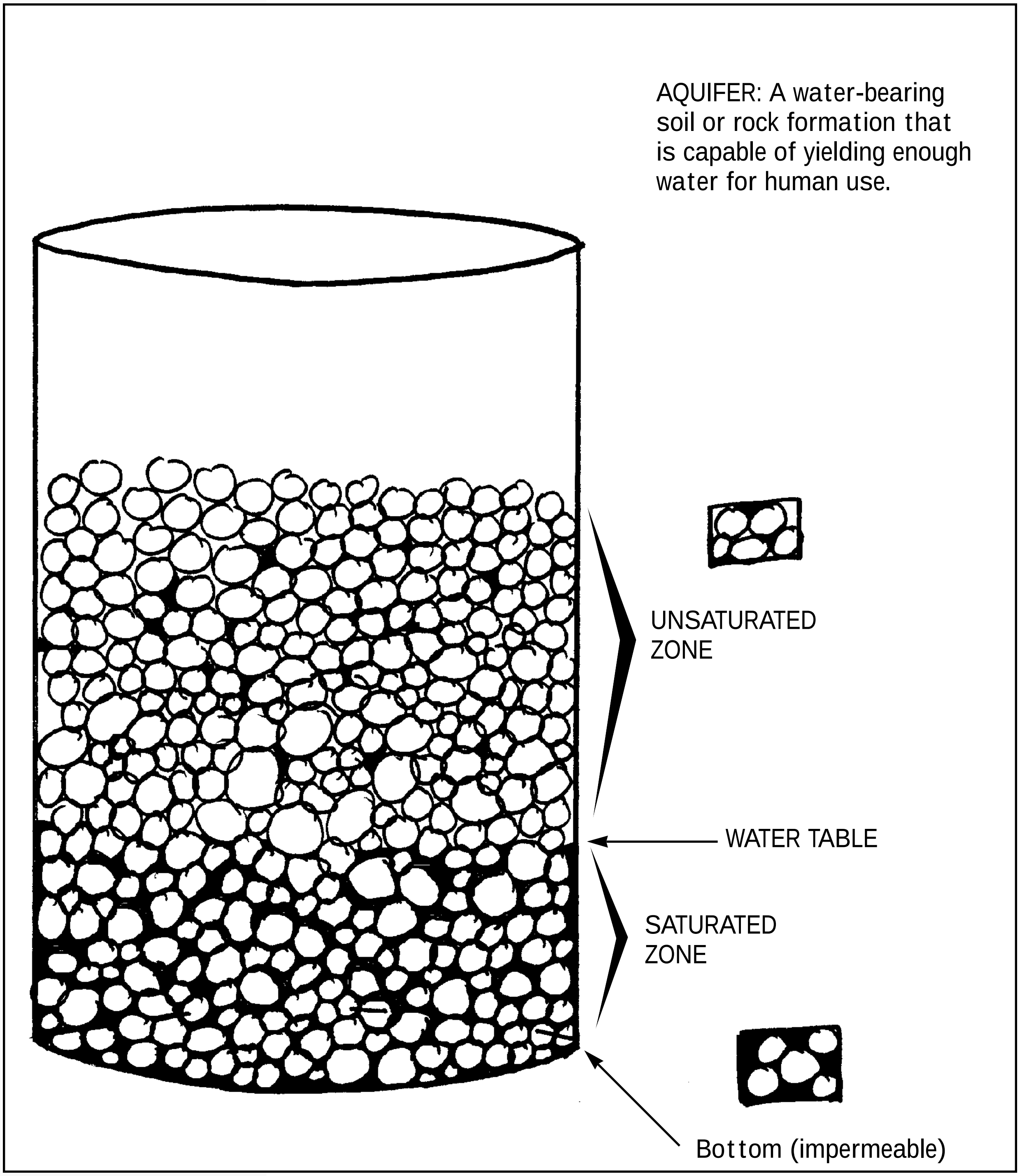
When infiltrating water reaches the water table, it begins to move along with the ground water flow, which tends to follow a down-hill, or down slope, direction. Compared with water in rivers and streams, ground water moves very, very slowly, from as little as a fraction of a foot per day in clay to as much as 3-4 feet per day in sand and gravel.

In time, ground water "resurfaces"—perhaps when it intersects with a nearby waterbody, such as a stream, river, lake, pond, or ocean; or perhaps when it emerges from a hillside as a spring or as water seeping out of a cutaway roadside rock formation. Ground water is very much a part of nature's water cycle.Another way ground water resurfaces is when it is withdrawn from the ground by way of a well. Wells are drilled and installed to capture ground water and pump it to the surface. In New England, the average depth to ground water ranges between 8-20 feet.

When pollutants leak, spill, or are carelessly discarded into and onto the ground, they, like water, move slowly or quickly through the soil, depending on the soil, the nature of the pollutant, and the amount of extra help it gets from incoming precipitation. If there is a water supply well near a source of contamination, that well runs the risk of becoming contaminated by polluted ground water. If there is a nearby river or stream, that waterbody may also become polluted by the ground water. Because it is located deep in the ground, ground water pollution is generally difficult and expensive to clean up. In some cases, people have had to find alternative sources of water because their own wells were contaminated.

GROUND WATER DIAGRAM

GROUND WATER TERMS



NOTES

TEACHING STRATEGY

NOTE: These exercises may be completed over several class periods.

Part A - Brainstorming About Ground Water

1. Have a discussion with the class about ground water so that you can get some idea of what, if any, preconceptions exist. (Many adults still think ground water exists as an underground lake or river.) Ask students to describe what they think ground water is, where it is, and how it got there. List the answers on the board or a flip chart.
2. Ask for a volunteer(s) to come to the board and draw a X-section of what he/she thinks the ground water environment might look like. Allow the students to contribute to the drawing by making suggestions or even volunteering to draw their own versions. Keep the drawings on hand so you can refer back to them when you have completed the demonstrations.

Part B -The Water Cycle Connection

1. Take your students outside onto the school grounds. Ask them to think about the last time it rained. Where did the water go when it fell on pavement? On roofs? On soil?
2. Take a cup of water, and ask a student to pretend it is rain. Have the student pour the water on unpaved ground. What happens to the water? *First, it makes a puddle. Then, it soaks into the ground.*
3. Discuss what might be happening to that water once it disappears into the soil.

Part C - Demonstrating Ground water

You may want to do this exercise as a class or as small groups.

1. Ask the students to think of the cup and sand and gravel models that they are about to make as part of a ground water system. Explain that the bottom of the cup is similar to bedrock or clay that is found beneath the earth's soil layers. Because we can't see ground water, we make models to demonstrate how it looks.

NOTES

2. Fill one clear cup(s) 3/4 full with gravel and the other(s) with sand. Ask the class to describe the spaces (pores) between the gravel and between the sand. *The gravel has bigger spaces.*

3. Pour water slowly into each of the cups until it reaches the top of the gravel or sand (not the top of the cup). Where is the water? *It has filled in the pore spaces.*

4. Explain that when we refer to ground water, we are talking about that part of the soil where all the pore spaces are filled, or saturated, with water.

5. Explain that when it rains, some of the rain (or other precipitation) flows into the soil. It moves through the spaces or pores between the particles. As water flows through the soil, it eventually reaches an impermeable layer of rock or clay and begins to fill the pore spaces of the soil.

6. Have students complete the water maze activity. This activity illustrates how water must find its way through available openings and paths in the soil structure.

7. To demonstrate where ground water (the saturated zone) begins, fill another cup(s) to nearly the top with gravel. At the edge of the cup, gently pour in the water (dyed with food coloring) until the cup is half filled with water. (If you pour the water too fast, you may have to let it "settle" for a few minutes). Tell students that the *water table* is the place where the soil becomes saturated and the drier sand or gravel ends. Water found below the water table is called *ground wate*r. For older students, you may want to mention that the area above the water line is called the *unsaturated zone*; the area that has every space filled with water is called the *saturated zone*.(See "Ground Water Terms" diagram on page C4 with this activity.)

Part D - Well Demonstration

1. Explain to students that many people use ground water as a source of drinking water or as a source of water for crops/plants.

2. Explain that wells are used to pump water out of the ground. This demonstration shows how wells pump out ground water.

NOTES

3. Cover the bottom of the tube of a spray nozzle with a piece of nylon stocking. Secure the stocking with a rubber band.
4. Put the spray nozzle into an empty cup. Fill the cup 3/4 full with gravel. Pour water into the cup until it reaches the top of the gravel (not the top of the cup). The sprayer is used to simulate pumping water through a well.
5. Pump water through the spray nozzle into another cup or into the sink.

Follow-up Questions

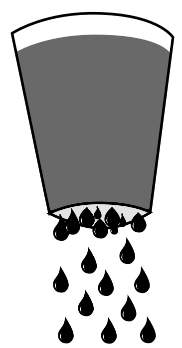
1. Why did we use the stocking at the base of the spray nozzle? *To keep sand and gravel from being pumped into the tube. Real wells have screens too.*
2. How are most real wells powered? *By an electric pump.*

Part E - The Ground Water/Surface Water Connection

1. Put a layer of un-colored aquarium gravel in a clear cake pan or clear plastic salad bowl (about 3” deep). Dig a hole (depression) in the gravel, so that when water is added students can see the water table (the thoroughly wet gravel, or saturated zone, versus the area that is dry or just damp) as well as the relationship between ground water and surface water.
2. Add light blue food coloring to a pitcher of water. Gently pour the water into the pan at one edge until it saturates about 1 1/2” of the gravel throughout the pan. What happens? *Water will seep into the hole.*
3. Explain that in many parts of the country, when people dig a big hole in the ground it slowly fills up with water and becomes a man-made pond or lake. From where does the water come? *Ground water flows into the hole.*
4. Explain to students that lakes and ponds receive their water from many sources—direct rainfall and melted snow, runoff of water during storms, and ground water. Just as ground water fills a man-made lake or pond, it also moves and discharges into naturally occurring waterbodies. For grades 4-6, hand out the ground water diagram in this activity (see page C3) to show how the water table intersects with lakes and streams.

NOTES

RAINCUPS



Part F - Polluting Ground Water

1. Using the ground water/pond set up from Part E, take the spray nozzle and withdraw water from the ground. (Do this in a corner away from the pond.) What happens to the water level in the pond as you withdraw more and more water? *The water level in the pond goes down.*

2. Replenish the ground water level, then place 1 tablespoon of the red Kool-Aid in one location on the ground surface, away from the pond. Make it rain by adding water using "rain cups." What happens to the pond? *Eventually, the contamination make its way into the pond.* This exercise demonstrates how ground water quality can impact surface water quality.

3. Using your spray nozzle to simulate a well, withdraw water from the ground. What happens? *As you continue to withdraw water, the contamination eventually moves into the well.* Look underneath the clear pan to see how it spreads.

Part G - Wrap-up Discussion

1. Have students review the earlier ground water brainstorming discussion to see how their answers might have changed as a result of what they now know about ground water. What have they learned?

2. How might they modify their earlier ground water X-section diagram?

Alternate Strategy

Make parts E-F more interesting and fun by having the students create whole, landscaped settings in larger see-through containers. Settings can include houses, roadways, ponds or rivers, bridges, etc. Using a spray nozzle, install a well near the home or business.

Adapted from: SEE-North. *Ground water Education in Michigan's Schools.* Petoskey, MI: Science and Environmental Education - North, 1991.

Adapted from *Watershed to Bay: A Raindrop Journey*, U. Mass. Cooperative Extension System. This curriculum was printed with funds from the U. Mass Extension Program, the U.S. Dept. of Agriculture, and the Massachusetts Bays Program.

Using a pencil, follow the paths that rain water might take as it travels down into the ground between the soil particles to the water table (the shaded area at the bottom).