Excerpts from the Active Watershed Education Curriculum (AWESome!) developed by the RI Southern Conservation District and updated by Denise Poyer, Program Director, Wood-Pawcatuck Watershed Association

ACTIVITY IV: **TESTING OUT AN AQUIFER**

OBJECTIVE: Students will learn how an aquifer and well functions, and how the hydrology of surface and groundwater resources are connected.

METHOD: Students are able to experiment with a three-dimensional model of an aquifer and well.

MATERIALS: two vertical flow columns*, one of sand and gravel, one of just large gravel (or materials to build your own – see instructions); materials for model aquifer*: aquarium, ¼-½" pebbles, 3" diameter x 8-12" long PVC plastic tube, window screening, strong rubber band or duct tape, turkey baster, watering can, green food coloring

BACKGROUND INFORMATION:

1. See #3-6 on groundwater, aquifers, and wells, in Activity III: "Where Does our Water Come From?"

2. Since an aquifer is the beds of sand, gravel, or rock that store and move groundwater, it is the <u>saturated</u> portion of the Earth's crust. Saturated means that the pore spaces between the sand grains are filled with water. Thus an aquifer lies in the portion of the soil called the <u>zone of saturation</u>. The <u>zone of aeration</u> is the soil zone in which pore spaces are not completely filled with water – instead some air exists in these pore spaces. Plant roots live in this zone because they need aeration as well as moisture. The <u>water table</u> divides the zone of saturation and the zone of aeration.

3. When a well is drilled into a water table aquifer, a pump is used to draw the water out of it. When it rains, the aquifer recharges as water infiltrates into the ground. If too much water is pumped out of the aquifer too quickly for the rain to replenish the water table level will go down, and thus the level of water in the well will also go down (these levels are the same in a water table aquifer). If there is any body of surface water associated with the aquifer, its water level will also decline with excessive pumping.

4. Pollutants can travel through an aquifer. Some pollutants may "stick" to the soil or sand particles, while others which can dissolve in water will travel with the groundwater. Thus if a pollutant enters an aquifer, it may turn up in a well as the water in the aquifer is pumped into the well.

5. Water usually flows more quickly through well-sorted, coarser grained materials, because the pore spaces are larger and form more direct routes for flow. Thus well-sorted gravel would make a better aquifer than an unsorted mixture of gravel and sand because it would supply more water per time unit.

PROCEDURE:

1. Show students the two vertical columns of sand and sand & gravel. Have them pour an equal amount of water into the top of each, starting at the same time, and record the time it takes for water to travel through. Ask them to try to explain the results. Which column would make a better aquifer? Why?

2. Explain the terms “zone of saturation” and “zone of aeration” by drawing the following diagram on the board. The concept of aeration versus saturation may be simulated by a damp versus soaked kitchen sponge. The saturated sponge will accept no more water, and any air has been replaced by water. Point out the importance of the pore spaces between particles of soil, sand, or gravel.

3. **Building the model aquifer** (see diagram below): Using the rubber band or duct tape, attach window screening to one end of the clear PVC tube. This is your “well”. After placing the well in one corner, fill the aquarium (around the well, not inside it) with pebbles.

4. Have students pour water tinted with green food dye onto the aquifer with a watering can to simulate rain. (Colored water allows you to more clearly see the water table level). With erasable markers have other students draw lines on all sides of the aquarium where they see the top of the water. This is the water table. Why does the level of water in the well match the water table?

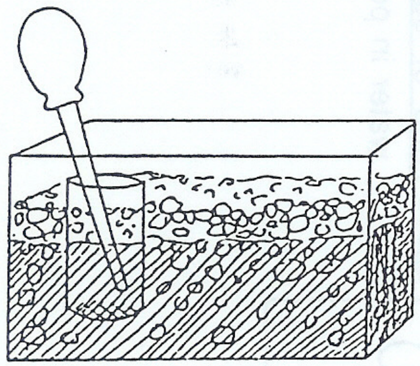
5. Ask students if the water table ever moves? If so, what makes it go up (precipitation, floods)? What makes it go down (droughts, pumping wells)?

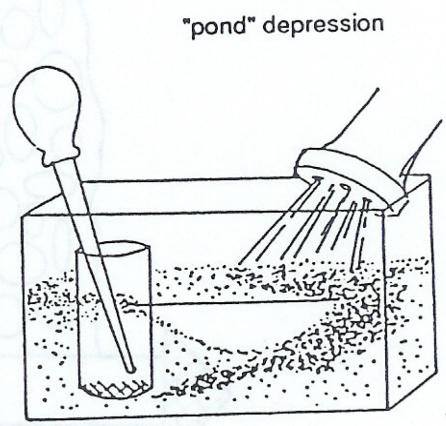
6. Let students take turns using the turkey baster “pump” to remove water from the well. What happens to the water table? Using a different colored erasable marker, have students draw a line where they see the new water table. See if students can match a rainfall rate to a pumping rate to keep the water table constant.

7. Ask students if they have ever seen the water table? Create a “pond” depression in the zone of aeration. Add more water to fill up the pond. Have students draw a new line to show how the level of the water in the pond is even with the level of water in the ground. What happens when water is pumped out of the well? How are the surface and groundwater related?

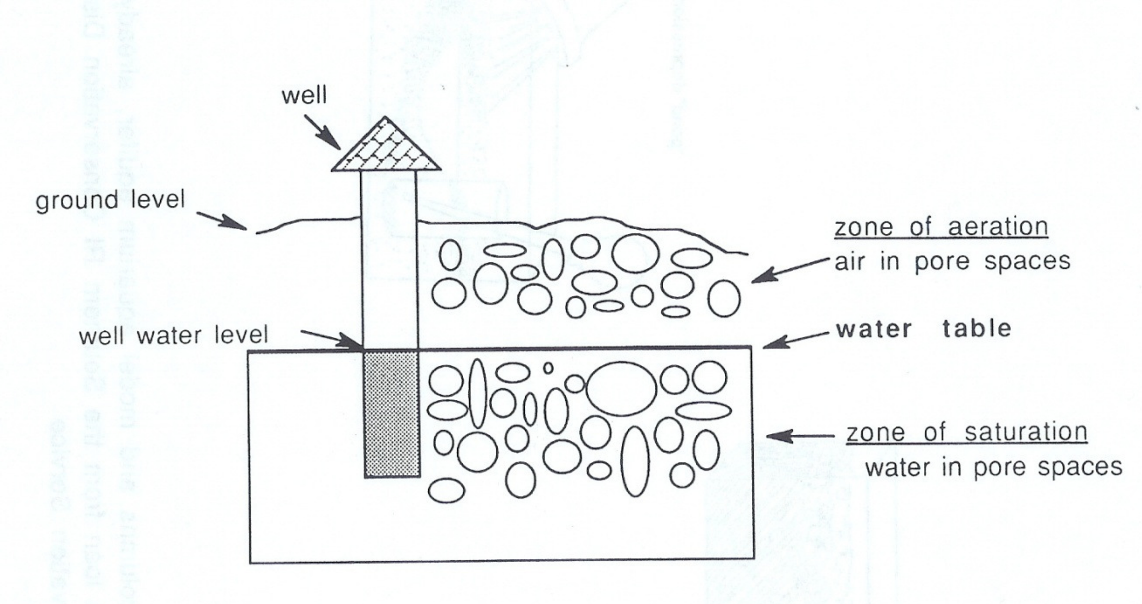
8. Discuss how this model aquifer differs from a real aquifer. Most aquifers consist of a mixture of sand, gravel, and rock or variously sized particles. The flow would be much slower than in this aquifer of equally large sized gravel pieces. Recall the difference in

flow rate between the vertical column with the sand and gravel mixed versus the column with just the gravel.





* Groundwater models are available for purchase from Envision Environmental Education (www.gwmodel.com), but may be available on loan from your local state environmental agency, cooperative extension service or conservation district. It is worthwhile to check around. They are quite expensive to purchase ($500 - $1,000).



Instructions to build a vertical column aquifer model

(Two options are provided. The first uses very sturdy material that will last for many years and gives good results. The alternate option is much less expensive and laborious, but results may vary.)

TYPE 1. PVC Pipe
Materials:

- clear PVC pipe 1.5 – 3 feet long, 1.5 – 3 inches diameter
- end cap with the same diameter as PVC pipe (does not need to be clear)
- PVC pipe cleaner and glue
- ¼ to 3/8 inch male threaded to hose insert
- Teflon tape
- 2 feet of clear polyvinyl tubing; inside dimension to fit insert tightly
- clamp to restrict the flow through tubing
- glass wool (used for aquarium filters)
- approximately 2-3 cups of gravel (use large-grained aquarium gravel)
- more gravel, a mixture of sand and gravel, or other medium to be tested (enough to fill the vertical column)
- jar to catch outflow water
- a drill bit slightly smaller than the insert
- stand to hold filter assembly (optional)

Assembling the Apparatus:

1. Cut pipe to desired length with a hack saw. Clean pipe end and inside of end cap with PVC cleaner. Let dry. Put PVC glue on the end of the pipe and the inside of the cap. Push pieces together and hold for 30 seconds.

2. Drill hole approximately one inch above the top of the end cap. The drill bit hole must be one size smaller than the insert diameter. Use a tap to thread the opening of the PVC pipe.

3. Put Teflon tape on the insert and screw it into the PVC pipe.

4. Push polyvinyl tubing into the insert. The clamp should be placed on the opposite side of the tubing.

5. Put gravel into the pipe above the opening of the insert and approximately one inch of glass wool.

6. Add medium to be tested. Best if use large-grained gravel in one, and a mixture of large-grained gravel and sand in another, for comparison. Silt can be used, but will tale many hours to drain.

TYPE 2. Soda Bottles

Materials:

- 2 clear plastic liter size soda bottles (best if they are clear throughout the whole bottle)
- pieces of nylon hose
- elastics

Procedure:

1. Cut the bottom third out of soda bottle.

2. Cover the neck of the soda bottle with a piece of nylon and secure with elastics.

3. Invert the top of the bottle into the bottom, so that the neck is facing down into the bottom. If cut correctly, this should be a secure fit with the bottle able to standing stable.

4. Add medium to be tested.