Ground Water Simulator
Set-up and Presentation Techniques
SWEET Workshop
2006

Simulator Set up:

Step 1: To avoid getting water everywhere, put the drain valve on the outside of the tank at the bottom and make sure it is closed (valve lever is perpendicular to the drain hole).

Step 2: Open the valve (valve lever is parallel to the drain hole) on the inside of the tank at the bottom by the stream, otherwise water will not circulate through the model.

Step 3: Initially open the valves coming from the stream and the lake to get water to flow through them.

You can play with these as you use the model to show gaining and losing streams and lakes. I have used it to show how contamination will pass by a lake that is contributing water to the aquifer (closed valve) and how the lake gets contaminated when its accepting water from the aquifer (open valve). Since gaining/losing conditions vary throughout the year in Ohio, either scenario is possible.

Step 4: Fill the water reservoir to just past the water-table line that is marked on the side of the simulator. After the reservoir fills the front of the simulator with water, the water in the reservoir will drop a little.

Step 5: Position the pump in the recharge area, and fill the pump reservoir completely with water before plugging it in. No water in the pump reservoir will burn up the pump.

You can vary the amount of water going into the recharge area by moving the pump side to side.

It will take close to 5 minutes for the pump to prime and begin pumping water from the reservoir to the simulator's recharge area.

Presentation Techniques:

Ground Water Flow Concepts:

1. Begin by explaining what the apparatus is and how it works.

Show the reservoir in the back and explain how a pump is used to pump water from the reservoir into the front of the simulator. Without this introduction, your audience may pay less attention to your presentation because they are sitting there wondering how the apparatus works.

2. Explain that the simulator shows an example of what the earth looks like underneath our feet. The simulator is a very realistic interpretation of Ohio's geology.

3. Begin by describing each of the sand and gravel aquifers (fine, medium, and large graveled).

It is easy to go from top to bottom when describing the three different sand and gravel aquifers.

Helping the audience to understand the concept of porosity is a key component to helping them understand the ability for different geologic materials to transmit ground water through the subsurface:

- **Fine grained sand:** Example is like the sand on a beach. Most likely, everyone has been to a beach and can relate to how tightly the sand packs under your feet while walking across the beach. Another example, beach sand is really good for making sand castles because the individual grains are small, uniform in size, and have the ability to pack tightly together.

- **Medium grained sand:** Example is like the gravel we would find on a driveway or on a playground. Unlike beach sand, driveway gravels are not uniform in size and shape. You can characterize driveway gravel as a mixture of irregular shaped objects that vary in size. You can see the pore space in between the individual gravels, unlike the beach sand. The size and shape of gravels prevent them from packing together as tightly as the sand on a beach. Could you imagine building a sand castle out of driveway gravel? No.

- **Large gravels:** This is the most under-scaled example in the simulator. These gravels are meant to represent cobbles that range in size similar to golf balls and lemons. Could you imagine a container filled with golf balls and lemons? You would definitely be able to see the pore spaces in between the golf balls and lemons, right?

4. Based on the description provided in #3, ask the audience which of the three aquifers will

transmit water at a faster rate. Accept there answers and ask them to explain why they think their answer is correct. Then do a race between the three sand and gravel aquifers. Start the race by putting dye in the fine grained aquifer, then in the medium grained aquifer, then lastly in the large grained aquifer.

The large gravel aquifer is able to transmit water at a faster rate because it has larger pore spaces which allows the water to both spread out and move easily with less obstruction. Review the dye's response to each of the three aquifers. Fine grained aquifer - the dye sits there because it has a low ability to transmit water, the Medium grained aquifer - transmits the water well but in a streamlined fashion (good pore spaces here but still not as good as the large gravel aquifer), the large gravel aquifer transports the dye faster and it allows the dye to spread out because of the large pore space in between the cobbles.

Ask the audience which of the aquifers that they would rather have their well located in. Either the medium or large gravel aquifer is a good answer.

5. **Bedrock Aquifer**, is good to save for last. Explain to the audience that water travels through fractures in the bedrock. Rock outcrops seen along the road can be used as a good example to explain how ground water travels through fractures in the bedrock. We've all seen icicles hanging from the road outcrops during the winter. During the winter, icicles form at road outcrops because ground water traveling through the bedrock fractures is forced to exit the ground at the outcrop and when introduced to the cold surface temperatures it freezes.

   Ask the audience if they think water will travel through the bedrock faster or slower than the sand and gravel aquifers. You get a rise out of the audience if you wait to give the answer. As you put the dye into the bedrock aquifer give the syringe a good pump and it will rush the dye through the bedrock fractures very quickly. Therefore, the answer is faster because the fractures are larger and less convoluted.

   I like to provide the example that water flow in a sand and gravel environment can be like driving on a side street with lots of stop signs, turns, and stop lights. Therefore, traveling on a side street can be fast but usually is somewhat slow. Traveling through a fractured bedrock aquifer is like traveling along the freeway. On a freeway there are no stop signs, turns, or stop lights.

Ground Water Protection:

1. The aquitard layer is a good lead into ground water protection. The aquitard, was placed into the subsurface by the glaciers that traveled through Ohio. The aquitard is a layer of clay that can range from 5ft, 50 feet, within a 100 feet thick. The clay layer was created as the glaciers churned up organic material (trees, grass, dirt, etc.) while traveling over the surface of the earth. Clay is the end result of churned up organic material. The clay has very fine pore spaces so it can store water but it lacks the ability to easily transmit water. Because clay has a low ability to transmit water it slows the down the migration of ground water and any contaminants that it may be carrying with it.

Dye flowing through the medium sized sand and gravel aquifer can be referred to when demonstrating water flowing along the top of the aquitard. The dye doesn't even try to push its way through the clay layer. Imagine taking a can of play-dough and squishing it flat, then placing a drop of water on top of the flattened play-dough. Would the water flow through the play-dough or would it sit on top? It would sit on top because the play-dough material, like clay, does not have the ability to transmit water.

The unconfined surface aquifer is more susceptible to contamination that occurs at the surface. Particularly the shallow wells.

2. You can then switch to pretending the dye is pollution by asking the audience how an aquifer can become polluted. As the audience provides suggestions, begin placing contamination into the simulator to demonstrate their pollution sources. If they are lacking ideas, fill in the sources for them by beginning to over fertilize the lawn, create a leaking UST, and allow the septic leach field to begin functioning as it should. The septic system leach field is a way in which humans pollute the environment by just existing - it has to happen but we can do it with as little impact as possible.

Septic and UST hints:
To get the UST and septic tank to put out contamination, back-off the water supply from the pump to get the water-table in the simulator to drop. This drop will allow the dye to flow out of the UST and septic tank. You may need to pump the UST and septic tank with the syringe to push the dye out.

You can show how you don't want to put a septic system upgradient of a drinking water well. Use the syringe to pull water out of the drinking water well that is down-gradient of the UST and septic tank. This will suck dye up into the drinking water well. This is a good time to refer to the Health Department needing to site a well and septic system on a new home site. It is an important step that should be taken seriously for this very reason.

Drinking Water Well Contamination: Demonstrate how a down gradient drinking water well can become contaminated by upgradient pollution sources. Stress that you can not always see, taste, or smell contamination and you may not know you are drinking

contaminated water. Therefore, it is important to have your drinking water well tested if you have your own well. Public water systems are required to sample their water and report these results to Ohio EPA.

Simulator Clean up:

Pump colored water out of the wells using the syringes. Flush the UST and septic tank, otherwise you will pull sand back into these areas and they will not work in the future.

Pour clean warm water over the top of the simulator to flush any residual dye out of the simulator.

When you get as much water as possible out of the simulator. Close the inside valve that connects the aquifers to the reservoir to prevent excess water from trickling into the reservoir.

Remove the outside valve.

Let the simulator air out before storing it back in the case for a long period of time.