Contaminating an Aquifer

Setting the Scene: Underground Water
Jacksonville's drinking water, like the water used in many other homes and communities around the world, comes from deep underground. Wells are drilled to layers of earth saturated with water, and pumps carry it to the surface. Hydrologists are scientists who study water in nature. (*Hydro* means water in Greek.) They study the aquifer to determine how much water it can provide. Water engineers design the pumps, pipes, and storage systems to deliver the water to customers. Our faucets flow with fresh, pure, safe water at the simple twist of a knob. We don't see all the science, planning, equipment, and maintenance required to get it there.

The Basic Science: Threatening the Purity of Underground Water
We're all told from our earliest years to wash our hands frequently. Dirt can make us sick. So how can water stored underground be clean enough to drink?

Two kinds of contamination can make water unhealthy to drink: biological material, such as bacteria or viruses, and chemicals, such as heavy metals or pesticides. Water on the earth's surface, as in rivers, lakes, or reservoirs, is almost certain to carry bacteria, mostly from animal waste. That bacteria must be removed or treated before the water is safe to drink. Water in an aquifer undergoes nature's own filtration process as it soaks through the ground. The fine particles of sand and soil strip away most of the bacteria, so aquifer water is generally free of biological contamination. That's why people living in the country, far from community water systems, can drill wells and drink the water with minimal or no treatment.

Groundwater, though, is vulnerable to some kinds of chemical contamination. People can spill chemicals or dump them illegally. Those chemicals can then dissolve in the water and flow into the aquifer. When they do, the chemicals are called "contaminants." Enough contaminants can make the water unsafe to drink. Sources of contamination can be single locations, such as a particular factory or waste disposal site, which are called "point" sources. They may also be many "non-point" sources, such as runoff from roads, farms, or lawns. That water can usually be treated to make it safe, just like surface water. However, the cleaner the water is at the source, the less expensive the treatment will be. Also, there is less chance for human error in the treatment process.

Aquifers In Your Community
The quality of water in Jacksonville's aquifer depends in part on how people have used the land near its wells. The best-protected aquifers have water that has soaked through soils uncontaminated by chemicals. They tend to be far from large population centers. Where are Jacksonville's aquifers? How well protected are they? You can find out by requesting JEA's annual water quality report checking out http://www.jea.com/about/ourwater/quality/index.asp.

Modeling and observing groundwater and contamination

You can make a model aquifer with a clear plastic container and some aquarium gravel, preferably white or light colored. To build the model, you will need:

Materials

- A clear or translucent plastic food container (such as one of the rectangular ones you can get at the grocery store that will hold a quart or two of water)
- A piece of clear vinyl tubing (from a hardware hobby store)
- Sand or light-colored aquarium gravel
- A clamp to pinch the end of the vinyl tubing (a paper clamp from an office store will work fine)
- Food coloring
- A drill or a sharp poker (for making a hole in the container for the tube
- Silicon sealant or hot glue for securing the seal around the tubing

Procedure

1. To build the model, drill or poke a hole in a side of the container near the bottom. (Make the hole as snug as possible.) Insert a section of vinyl tubing to serve as a drain, and seal the drain with silicone sealant or hot glue. (You may want to experiment with sealants to see what works best.) You can close the drain by pinching it with the paper clamp; just be sure it's heavy-duty enough to really close the tube.

2. Put a few inches of sand or gravel in the container and close the drain tube. Pour in a cup or two of water that you have tinted with a small amount of blue food coloring. The blue water represents "clean," uncontaminated water. Can you see the water in your aquifer? The "aquifer" is the region of sand or gravel that is saturated with water. The highest level of water in the aquifer is called the "water table." Why do you suppose it has that name?

3. Open the tube and drain the water into another clear container. Is it the same color as the water you started with? (If it isn't, you may want to rinse the dust and dirt off the sand or gravel.)

4. Now place a drop or two of red food coloring on the surface of your aquifer. The red represents a "contaminant" that will enter your aquifer. Clamp the tube and pour in more blue water. Does the water in your aquifer look different? Drain the water. Can you see the effect of your "contamination?" Add another cup of "clean" blue water, and capture it as it drains out. Can you still see the contamination? How many times must you rinse the aquifer before the effects of the contamination are gone?

5. Do the experiment using different amounts of red food coloring. Does adding twice as much "pollution" mean that you have to flush the aquifer twice as many times to clean it?

6. Graph that information and see if you can find a relationship between the amount of contamination in an aquifer and the amount of effort needed to clean it.

Suggested projects

1. Some kinds of chemicals, such as minerals, occur naturally in groundwater. Read the JEA's Water Quality Report (http://jea.com/about/ourwater/quality/index.asp) to learn about the minerals that occur naturally in your water. Are they present at levels close to the regulatory limits for drinking water? Does JEA treat the water to remove them? How do they treat the water?

2. Does your water ever have a funny smell? Learn about what might be causing that smell and what JEA is doing to remove it. Learn about whether or not it has any health effects, either positive or negative.

3. Instead of letting the water rinse through the aquifer, try clamping the drain tube between rinses, filling up the aquifer, and then draining it. Does cleaning the aquifer require the same number of rinses?

4. Your model is a very simple one. Try building an aquifer that more closely models Jacksonville's. Build a model or create a poster showing JEA's treatment and distribution system.

5. Write a public information message using what you learned that tells the people of Jacksonville about the important of protecting the watersheds and the aquifer.

Putting it Together

Prepare your aquifer to demonstrate how pollution on the surface can enter an aquifer and be hard to purify. Make displays of the data you collected about how many times it took to flush out the red contaminant with clean blue water. Make posters or other visuals that show how pollution traveled through your aquifer. Create a public service bulletin to raise people's awareness of the importance of preventing surface pollution in order to keep our aquifers pure.