Chapter 10. How Water Behaves in the Ground

Lesson 2. Although aquifers are protected from contamination by the layer of soil that lies on the earth's surface, once aquifers become contaminated, they are difficult to cleanse.

Overview: Although we each use between 120 and 200 gallons of water each day, we seldom have a full understanding of where our water comes from, how it is stored and delivered to us, or what can happen when it is not respected. In the United States, most water used for domestic purposes comes from surface systems (lakes, rivers, streams, reservoirs) or groundwater (wells or springs). Desalinization of ocean water (a surface water system) produces fresh water in only a few coastal areas. Most of us are aware that our actions on land have an impact on surface systems. We can read almost daily about pollution of our major rivers, lakes and oceans. We do not, however, often hear about groundwater systems; yet, in the United States, nearly 50 percent of the people rely on groundwater as their primary source of water. A recent study of well water (not only in Montana but throughout the United States) showed that nearly 50 percent of the well water samples tested were contaminated with bacteria.

With these facts in mind, we must understand groundwater systems how and why groundwater systems exist, how they are affected by land surface activities, and how we can effectively use them.

Materials Needed:

- Pumping wells constructed in Part 1 of this lesson
- Water supply
- Food coloring
- Plastic cups, glasses or jars, or 8-12oz. plastic tumblers
- Graduated cylinders
- Veterinary syringes or atomizer pumps as groundwater wells

Procedure: The procedure for this activity is to contaminate the groundwater in the well; show how easy it is to contaminate water and have it show up in a water sample; and show how difficult it is to clean up groundwater once it is contaminated.

Divide the class into teams of two or three students. Have each group construct a model groundwater well (i.e., a pop bottle/tumbler/jar with an atomizer pump in the center, extending to the surface; a layer of coarse gravel in the bottom, sand/soil extending to within an inch of the soil surface). If you do not have atomizer pumps, use some stiff tubing for your well casing, and do the

pumping with a veterinary syringe when the time comes. Have students wet the model's soils and add water until they can easily pump water from groundwater. Have them pump out as much of the water as they can (i.e., have them repeatedly pump the well until no more water can be pumped out).

Each team adds two to three drops of food coloring to the groundwater well model. After about a minute, have them add 200 ml of water to the surface of the groundwater well model. Then have them pump and save the water, which can then get out of the well. Be sure they measure the amount of water that they can pump out, to compare to the amount they added. They might want to prepare a tally sheet to record the amount of water removed following each addition of water. Ask them if they could detect any of the food coloring "contaminant" in the pumped water. If not, have them add another 200 m1 of water, then catch, observe and measure the pumped water. Point out to the students how quickly the contaminant reaches the well when the soil is wet and the contaminant is wetted up. Also, they can pump out almost as much water as they add at the surface. Tell or show that when the soil is dry, it takes longer to get the response, and it is not the same in intensity. When the soil is dry, it takes much more water to get the contaminant to the bottom of the soil. The intensity (concentration), however, is much greater.

Now, have them add 200 m1 of additional water and observe the color. This suggests the degree of contamination of the pumped water. Have students keep track of (1) amount of water added, (2) amount of water pumped from well, and (3) intensity of color or degree of contamination on the tally sheet. Have students continue adding water in 200 ml increments and pumping the well until they can no longer detect any contaminant in the pumped water. They will need to keep each pumped amount separately in a clear tumbler until there are no remaining contaminants. Have them compare the amount of water to contaminate with the amount remove evidence of contamination.

After the activity, discuss the ease with which the contaminant made it to the bottom of the model and appeared in the well water. Also, after a time, the amount of pumped water is quite similar to the amount added. In natural systems, the amount entering groundwater is less than that falling as rainfall, but the idea is similar. That is, there is a balance between the amount of water falling on the land and the amount reaching groundwater, and the travel time is short. Discuss the difference between the amounts of water required to contaminate the groundwater system and to decontaminate it. It should become evident to the students that contamination is a complicated process, and recovery or clean-up requires much more effort and water than may be available.

Lessons Learned: Although aquifers are protected from contamination by the layer of soil that lies on the earth's surface, once aquifers become contaminated, it takes quite a bit of effort to cleanse.

The lesson above was adapted from "What is Water Quality? A Resource Guide for 4-H Leaders and Teachers," 80 pages of activities and experiments related to water quality. ($5.00) Order from the Montana 4-H Program at Montana State University-Bozeman. Phone 406-994-3501.