Aquifer Model Activity

Summary: Students will create their own aquifer model

Background Knowledge: Aquifers are underground sources of water that can be measured and accessed through wells. To measure a well, a geohydrologist applies a layer of chalk to part of a long metallic ruler. They then attach a weight to the ruler's end and unwind it into the well. Once they go far enough, they wind the ruler back up and note the water line based on where the chalk is wet.

The primary aquifer in western Kansas is the Ogallala aquifer. Over thousands of years of slowly collecting water from rain and rivers, the Ogallala became a bountiful source of water. However, over the last few decades, water levels in the aquifer have dropped drastically as people pump water from it for irrigation. In some cases, more than a foot of water is pumped out for every inch going back in from rainfall. At the current pumping rate, many areas of the aquifer will become unusable within a century. Additionally, pumping wells may become useless if water levels drop too low, which means farmers will have to spend additional money to dig deeper wells.

This activity will introduce the aquifer model to students. Its primary goals are to show how sand and dirt can store water, how we can pump it out, and how geohydrologists measure the water level. After completing the main activity, students may participate in a bonus activity that encourages them to think about how to extract the purest water from their aquifer. Perhaps they can use different materials, such as cloth vs. nylon, introduce charcoal before or after the water goes through the pump, or even use different pumps. Additionally, if you have the material, students can determine water storage capacity of different soils, such as sand vs. dirt vs. pebbles and so forth.

Goals:

- Students will understand how sand and dirt can store water underground.
- Students will model how geohydrologists measure water levels below ground.
- Students will demonstrate the effects of well pumping on aquifer levels.

Related Activities

Two other experiments may be performed to extend student's working knowledge of an aquifer

Contamination in the aquifer

The first experiment simulates the movement of contamination through an aquifer. Add red dye droplets to some water, mix it up, and pour it into the model (make sure the model already has water in it to begin with). Have the students measure the amount of time it takes for the red water to come out of the pump. Red water represents contamination, which in the real world comes in the form of chemicals, such as spilled oil.

Different soil types

The second experiment demonstrates the speed at which water moves through the ground, depending on soil quality. It requires multiple types of soils: sand, dirt, clay, pebbles, and so forth. Using a clear plastic container, have the students layer in the different soils like a cake. Then pour water into the container and document how fast or slow the water moves through each layer.

Aquifer Model Activity

Summary: In this activity, you will create your own model using the materials listed below to learn how geohydrologists measure water levels in aquifers.

Materials

- Sand/dirt/pebbles
- Gallon-size or larger plastic container
- Toilet paper roll
- Water
- Soap Pump
- Nylon/cloth
- Rubber band
- Wooden Ruler
- Chalk

Setup

1. Measure out an amount of water that is far smaller than the container.
    a. Write the amount of water here for future use: _____
2. Pour that water into the container.
3. Rub chalk on the first few inches of the ruler and dip it into the container until it reaches the bottom.
4. Pull out the ruler and observe the water line as seen in fig. 1.
    a. Record the measurement from the ruler here: _____
5. Insert the soap pump into the water and the water amount you will pump out in milliliters
    a. Write the milliliters amount here: _____
6. Counting the number of times you pump until you match the number recorded in Step 5a, pump water into a separate container.
7. Apply a new layer of chalk to the ruler and repeat your water depth measurement.
    a. Record the new measurement here: _____
8. How many inches/centimeters did the water level go down?
    a. Subtract the measurement recorded in Step 7a from the measurement recorded in Step 4a and write the answer here: _____
9. Dump the water out of the container.
10. Using a pen, carefully puncture a few holes in the toilet paper roll.
11. Place the toilet paper roll, upright, into the middle of the container (fig. 2).
12. Carefully pour sand around the roll. Be sure little to no sand pours into the roll.
13. Fill the sand up to the top of the container or toilet paper roll, whichever comes first (fig. 3).
14. Wrap a small amount of cloth or nylon around the bottom of the soap pump. Use a rubber band to secure it in place (fig. 4). This is to ensure no sand enters the pump.
15. Gently insert the soap pump into the sand (fig. 5).
16. Measure out the same amount of water as in Step 1a and slowly pour it into the container. Be sure to pour onto the sand and not into the roll. At this point, your model should look similar to the one in fig. 6.
17. After you pour the water, record your observations:
    a. _____

    _____

    _____

18. Wipe the ruler and reapply the chalk. Insert the ruler through the toilet paper roll until it reaches the bottom.
    a. Record your water depth measurement: _____
19. Compare your answers in Step 18a and Step 4a. How are they different? Why?
    a. _____

    _____
20. Carefully pump water out of the model using the same amount of water as in Step 5a. If you have difficulty getting water through the pump, try removing it and inserting it into the toilet paper roll instead of the sand.
    a. How clean or dirty is the pumped water?_____
21. After you pump the water, dry the ruler, chalk it up, and remeasure the water level in the aquifer model as you've done before.
    a. Record your new water depth measurement:_____
22. Subtract the water depth measurement (subtract 21a from 18a)
    a. Record the difference here:_____
23. Compare your answers from Step 8a and Step 22a. How different are they? What is your inference behind this phenomenon?
    a. _____

    _____

    _____
24. BONUS ROUND 1. Your mission? Design a new pump and use whatever materials you have on hand to create a more efficient pumping mechanism, one with cleaner water than before!
    a. Carefully remove the pump from your aquifer model.
    b. Photograph or set aside the pumped water sample from 20a. You will compare this water sample to the final result in this bonus round.
    c. With your group, brainstorm how to design a new pump. Write down your idea here:_____

    _____
    d. Assemble the pump and gently reinsert it back into the model. Pump water out using the same number of pumps as before. Compare your new water sample with the old one. Is it cleaner than before? Why or why not?

    _____

    _____
25. BONUS ROUND 2. Your mission? Determine how different types of soils affect water levels in an aquifer.
    a. Remove the old soil from the container and replace it with a different kind of soil. If your original model used sand, for example, try large pebbles or clay.

b. Add the same amount of water as in Step 1a. Measure the water level and compare it to the water level from Step 18a.
c. What is the new water level?_____
d. Why do you think the water level is different? _____

e. Is the pumped water cleaner or dirtier than the original water? Why?_____

f. Given your observations in this activity, how do you think the type of soil might affect irrigation?_____

_____

Figure 1 : Ruler with chalk on it showing the water line

Figure 2: Empty bucket with toilet roll

Figure 3 : Bucket now filled with sand surrounding roll

Figure 4 : Soap pump with cloth rubber banded on the end of it

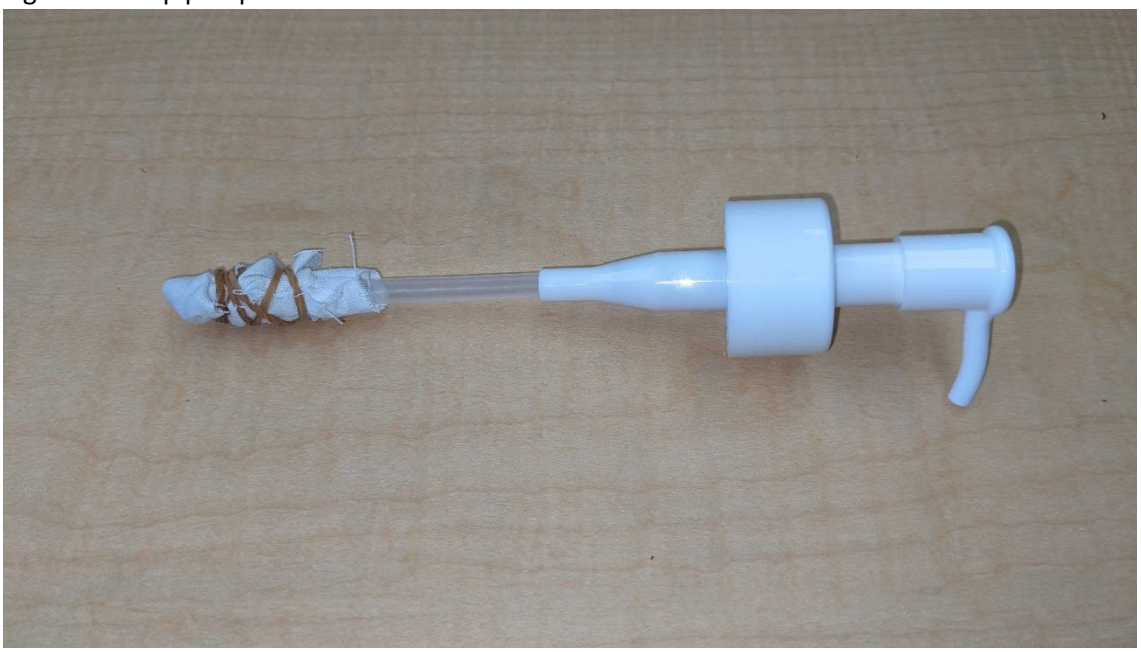

Figure 5 : Soap pump inserted to bucket

Figure 6 : Bucket wtih water poured in it