"Rainfall to Tap"

Lesson #1 - The Groundwater Model

Introduction:
Using a hands-on visual aid, students are guided through the process of building an interactive groundwater model. We will learn where our drinking water comes from, where it is stored, how we are able to use it, and ways we can protect it to ensure safe and adequate drinking water for years to come!

Concept:
Groundwater is stored in between the spaces of the rocks, gravel and sand that Glaciers deposited.
Action:
Explain glaciers and share samples of materials from typical aquifers.

Concepts:
Rocks have different porosity and permeability.
Actions:

A. Illustrate porosity by pouring water into gravel and sucking it out with a syringe and measure. Do the same with sand and clay. Which holds the most water?
B. Illustrate permeability by filling a funnel with gravel, pour water through and time. Do the same with sand and clay. Which restricts water the least? Usually porosity correlates with permeability, except with clay.

Concept:
Materials were deposited in irregular layers as Glaciers receded.
Actions:

A. Divide students into groups of 3.
B. Take apart the containers and lay contents aside.
C. Place container #1 in the center of the tray.
D. After making note of the marked area on the bottom of container #1, layer the container with 3 **full** cups of different sizes and colors of materials, creating the confined aquifer.
E. Add 1 cup of water from the cloud container and observe that water is stored in the spaces between the materials.
F. Carefully move gravel out of the marked area.

Concept:
Subsequent glacial events formed confining layers over the lower aquifers, and last glacial event was 10,000 years ago.

Actions:
Attach container #2 on top of container #1, placing the bottom of the well casings in the open area and snap the two containers together. (Point out the well screen) The bottom of this container represents the confining layer.

A. This layer was deposited as the Glacier advanced, and it is referred to as glacial till and can sometimes be visible at the surface.
B. Lift up the aquifer containers and gently shake back and forth to distribute gravel evenly.
C. The confined aquifer is under pressure, and wells relieve that trapped pressure. Students illustrate this by pressing on the confining layer (Bottom of container #2) while watching the water level come up in the well casing. (Artesian)

Concept:
The unconfined aquifer or water table aquifer is in direct hydraulic continuity with the surface.

Action:
Layer container #2 with 6 cups of mixed gravel to form the water table/unconfined aquifer.
(Be careful to not drop gravel down the well casings.)

a. What happened to the water level in the confined aquifer?

Concept:
We live on top of our drinking water.

Actions:

A. Place container #3 on top of container #2, sliding the well casings through the holes in container #2. Container #3 represents the surface.
B. Install the well caps.
C. Build a slope down to the stream and lake using 2 cups of mixed gravel. (Topsoil)
(Be careful to not drop gravel down the well casings.)
D. Cover everything with felt, (Root Zone) and tuck the felt into the stream and lake.
E. Place an impermeable surface as well as trees and vegetation to form a neighborhood and recharge area.

Concept:
Wells are drilled through the unsaturated zone and the water table, into saturated zones called aquifers to get potable water to the surface.

Actions:

A. Place pump #1 into the left well casing. (Confined Aquifer)
B. Place pump #2 into the right well casing. (Unconfined Aquifer)
C. Pump the confined aquifer (Pump #1) into the cloud container.
    a. What happens to the confined aquifer?

Concepts:

1. Aquifers in Kitsap County only recharge when it rains.
    i. Some water runs off and gathers into lakes and streams and some water infiltrates into the aquifer.
    ii. Vegetated areas are the best recharge areas.
2. Groundwater moves and can be connected to surface water.
    i. Talk about how water uses surface tension and capillary action to move toward streams and lakes.

ii. Water can also move from streams and lakes into the groundwater.

Actions:
Make it rain in the recharge area and see how groundwater and surface water interact.

A. **Slowly** pour 3 cups of water from the cloud container on the recharge area and observe the unconfined aquifer becoming saturated, and the direction the groundwater is traveling as it discharges to the lake and stream.
B. Does water go through the impermeable surfaces?
C. Observe surface tension and capillary action as water moves?
    a. Which way did the water move?
D. Observe that water does not infiltrate easily into the confined aquifer.
    a. Did any water get into the lowest container? It can take 100's to 1000's of years to recharge a confined aquifer!
E. Observe the level of the water table.
F. Pump all of the water from the unconfined aquifer (well #2) into the cloud container.
    a. What happens if you pump to fast? (Drawdown and Cone of Depression)
    b. What effect did the pumping have on the stream and lake?
G. Explain that pumping the confined aquifer (Pump #1) would not have this same effect due to the confining layer.

Concept:
Anything that we put on the ground has the potential to end up in our drinking water.
Actions:

A. Some groups add 1 drop of red food coloring to the surface to represent oils and pesticides, while other groups inject 1 drop of red food coloring into the water table to represent a failing septic tank, leaking landfill or ruptured underground storage tank.
    a. What types of pollution can you imagine in your neighborhood?
B. Make it rain **slowly** by adding the rest of the cloud container onto the surface and observe the runoff and infiltration of pollution.
C. Pump the unconfined aquifer (Pump #2) observing pollution in the stream and lake.
    a. What are some ways to prevent this pollution from happening in your neighborhood?

Concept:
The Earth is a natural filter.
Actions:

A. Students finish pumping out the polluted water, while explaining that with more rain and continued pumping, the water would become cleaner over time.
B. Explain that plants, soil, sand and gravel helps to clean water naturally and that the confined aquifer is additionally protected from surface contaminants due to the confining layer.

Clean up:

1. Remove and set aside the forest, driveway, house, car, felt, pumps and well caps.
2. Put the lid on container #3, unlatch container #2, and drain the remaining water into a sink by carefully cracking one side of the lid while holding the containers upside down.
3. Remove the lid from container #3 and pour the gravel into the aquifer materials bucket.
4. Put the lid on container #1, drain the remaining water in the same way and pour the gravel into the aquifer materials bucket.
5. Place containers #2 & #3 on top of container #1, place all materials inside container #3 and put on lid on.
6. Empty cloud container and wipe off tray.