

# The Flow Below

## Activity Description

Through a groundwater model the students learn about the water table and an aquifer, and they can see how pollution by one person travels through the entire aquifer. They can also see the effects on ponds and rivers, and the speed that the contamination can travel.

## Take Home Message

An aquifer is the sand and gravel underground that is saturated with water. Everyone's actions affect the water in the aquifer.

## Massachusetts Frameworks

Earth Science

Earth Material #1 and #4

## Supplies List

- Groundwater Flow Model
- Fish Tank Pump
- Clear Plastic Gate
- Blue moveable plastic piece
- Valves
- Syringe
- Dye bottles
- 2 Buckets, one for clean water- one for wastewater
- Plastic tubing
- 

## Set-Up

Pull the groundwater model out of the traveling case and put it on the table. You will need to be near an electrical outlet. Next pull out the fish tank pump. Attach the pump with the small opening on the left and the large opening on the right. Then attach the siphon tube. See the picture below for help.



After you attach the pump, fill the pump reservoir completely and fill the tank reservoir with clean water to the fill line as indicated on the side of the tank (When filling the tank, make sure the drain valve is closed before you fill. See the pictures below for help). Plug in the pump and allow 1-2 minutes before the water starts to flow. You may add some water directly to the pump reservoir to help prime it. Once the water is flowing, you will want to install the plastic gate. Place the gate so as to prevent water from spilling out of the upper reservoir. Keep an eye on the clear plastic gate: it is small, clear and very easy to misplace. (see picture below).

Open



Closed



Once the tank is full, you should be able to see the water table. The lake should be a little more than half full and the spring should also have water in it. If these have not filled up, then you should check the valves behind the lake and spring to make sure they are in the right position. The external reservoir drain valve and aquifer compartment valves should be closed, the river/ocean valve should be open, and the lake can be open or closed. You should watch the video or the tutorial power point to help you set up the Flow Below the first few times. Refer to the direction manual in the box if needed. There is a lot going on with this model, but once you get the hang of it it's a great one to teach.

### Activity Procedure/Script

- 1 Begin by asking the students where we get our water here on Cape Cod.**
  - Students will say oceans, rivers and lakes
  - You are looking for them to say wells
  - Tell them that indeed they get water from wells that are pumped from the aquifer
- 2 Next ask them if they know what an aquifer is.**
  - The students may or may not have a vague idea about this depending upon their age and what activities they have been to so far in the festival.
  - You want them to know that an aquifer is the sand and gravel underground that is saturated with water.
    - You can also tell them that the aquifer provides their homes and towns with water for washing, cooking, showering, etc. You can tell them that on Cape Cod the aquifer is mostly made of sand.
    - Emphasize that **under Cape Cod there is only one aquifer**, and that this is called a sole-source aquifer.
- 3 Ask the students if they can see the water line that has formed in the model, through the wells, lake, and in the spring. See if any of them know what it is called.**
  - The line that is formed is the water table.
    - Have the students use the long blue piece of plastic to connect the top of the water table at several locations, and highlight how the water table isn't even and straight across. Be sure to point out how the water table follows the gradient of the land. As the land slopes, so does the water table. The water slopes from the high ground near the pump, down to the pond or sea.
- 4 Ask the students how they think groundwater flows, where they think it goes, and how fast they think it travels.**
  - You will get the famous answer of an underground river
  - You want to guide the students away from this thought, because although it is true in a few parts of the world, on Cape Cod groundwater travels through the sand and gravel aquifer at a very slow pace. You can talk about how slowly it travels and why it travels so slowly (no clear path, has to go around particles, pressure, etc.)
- 5 Ask the students if they know types of pollution that pollute the aquifer, then demonstrate pollution: how it flows and who it affects.**
  - In order to show this, have one student carefully inject dye into Well 2. The students can watch how the dye flows to see how the groundwater flows.

- The students will ask what the dye is. At first tell them that it is harmless food coloring. Once they begin to see how the flow is going, change your mind, and tell them suppose it was a harmful chemical that someone spilled into their well. Explain that this harmful chemical is forming what is called a plume and it is slowly traveling through the aquifer, headed right for their house above Well 5.
- 6 Ask the students what they think will happen when they take a drink out of their well.**  
*Previous members have said they used Well 3 instead of 5 because 5 took too long. Also the pump can be finicky, so if it's not working well you might want to pump yourself instead of having the students do it.*
- The students will note that the plume does move, but not extremely fast. You can explain that the water moves about 1-2 feet per day on average.
  - Have another student take the syringe and pump a "glass" of water out of Well 5 which is like a shallow private well.
  - As you pump the first few glasses, have the students look at both the water in the syringe as well as how the plume moves.
  - They should note that although the initial glasses are still clean, the plume moves faster when you pump water from the well.
- 7** When the water is no longer clear, **ask the students if they want to drink a glass of that water.**
- The students will not like what they are seeing. They wouldn't want to drink that water.
  - Even more important is for them to see that water moves, and when we pumped the well it moved right into our well.
  - Explain or remind them that even though the neighbor who poisoned his well could be miles away, water travels and carries with it everything we dump into it.
  - Remind them that the aquifer is for everyone's use!
- 8 Point out the deepest well which is like a public supply well and siphon off a glass of water.**
- Even when the rest of the model is fairly well polluted, this water should be clear (or much clearer). Explain that the deep well is much better protected from surface contamination. Explain that public supply wells are located in protected areas to prevent contamination, and that they are regularly tested as well.
  - You want the students to have the confidence that their public water supply is safe to drink. **\*This is a key point because you don't want to scare the students!\***

#### **MOST OF THE TIME THIS IS AS FAR AS YOU WILL GET**

- 9** *Depending on your time, (this activity takes a long time, but it is one of the most influential in showing students what is really going on underground), you can continue with the script and information or jump to the summing it up.*
- 10 Ask the students if they would like a big storage tank to be put outside their window- such as a gas or oil tank.**
- Like the rest of the world they will say no, and explain to them that for years we have been burying the large metal gas and oil storage tanks underground so people don't have to look at them.
  - Explain that we haven't been as careful as we should have been in the past years though.
- 11 Ask the students what they think happens when metal tanks sit in water from the aquifer.**
- Most of them will guess right on this one. The tanks have begun to rust and therefore they are leaking toxic chemicals into the ground. And we all know now that when something leaks into the ground, it gets into the groundwater and can be carried anywhere. Water is always on the move!
- 12 Ask the students how they would feel if they were living next to a 30 year old gas station.**
- Fill the UST with dye to form a plume
  - Have the students pump until contamination is evident in the drinking water.
  - Would they want to drink that water? Remind them that it doesn't matter how close or far away you live from the contamination point, water is always on the move and carries with it everything we put into it!

**13 To sum up the activity ask the students what an aquifer is, how does groundwater flow (fast or slow), are dumping chemicals underground a good or bad idea, and who does dumping those chemicals affect? Recapping is always a good idea to ensure the students learned something.**

- Get the students to remember that water travels and carries pollution with it. It doesn't matter how far away or long ago it was, it will eventually seep into your drinking water, lakes, ponds, and rivers.
- Because we were not careful years ago we have already polluted water in many places. It is important to realize that our aquifers are not a never-ending supply. We have to conserve our water as well as protect our water for future generations. This can start with you!

## **Clean-Up**

### *During the Festival*

- You will want to wash the plumes out of the model by flushing clean water through the wells. The water in the back will start to get dirty.
- Sometimes the pump misbehaves, make sure that you have done the following, 1) the water level is at the fill line in the tank, 2) the pump is level (use the black leveling device), 3) the pump is on high (adjust flow lever), and 4) you have the uptake tube inserted correctly. If it still doesn't work, it might be clogged (with hair and stuff), and if this is the case it can be taken apart and cleaned out. Also occasionally if it is left in the van overnight in very cold weather, it will need a while just to warm up.
- You will at least have to drain the back in the middle of the day if not before. To drain the back, attach the plastic tubing to the drain valve on the bottom of the tank. (Make sure to unplug the pump before removing the water, so the pump doesn't run dry). Dump the water into the bucket and then it can be put down the drain. The food coloring is not harmful to the environment.
- You will have to refill the tank with clean water.

### *After the Festival*

- You will again have to wash the plumes out by pouring some water onto the top of the model, and drain all the water from the tank.
- You will want to thoroughly dry all parts that you can, like the inside of the tank and the pump.
- After you transport the model back to storage, keep the lid open for a few days to ensure that it has thoroughly dried out.

**HINT: PUSH/PULL THE SYRINGE GENTLY! OTHERWISE THE ONE WAY CHECK VALVES GET BLOWN OUT AND THE SYRINGE BREAKS.**