Earth's Filter

Become an Environmental Engineer and solve a water-contamination problem

*Adapted version of the "Groundwater Detectives" teachengineering.com activity

Objectives:

At the end of this activity, youth should be able to:

- Understand how environmental engineers collect and analyze field data to identify polluted water and determine direction of contaminant flow
- Analyze how contaminants can be adsorb in sediment
- Apply various methods environmental engineers use to clean contaminated water

Time to complete activity: 45 minutes

Skill level: Intermediate to Advanced (middle through high school)

Background/Setting the Stage:

Students will complete a two-part activity to explore the work that environmental engineers do. First, they will analyze the pH of ten groundwater samples collected around a chemical spill in order to determine the extent and direction of contamination. Second, they will design a filtration treatment system to remove the sediment particles from the water, which the water-soluble chemical has become bound to. By measuring the turbidity, conductivity, and pH of the sample before and after treatment, students will determine the effectiveness of the filtration system.

Materials:

List of materials for class to use:

1. 7 small cups for "groundwater samples"
2. Low pH solution (vinegar or lemon juice)
3. Coffee filters (2/group)
4. Bag of cotton balls
5. Plastic spoons
6. Straws
7. Sand and/or gravel
8. Wire mesh
9. Rubber bands
10. Cheesecloth
11. Masking tape
12. Scissors
13. "Dirty" water
14. Turbidity meter or conductivity meter
15. Graduated cylinder

List of materials that each group (~4 people) should have:

1. Two pH strips
2. 1 short/wide 9 oz clear plastic cup with holes in the bottom to contain the filtering materials (Or plastic

bottle with bottom cut off and cap removed)

3. 1 tall 12-16 oz clear plastic cup that will hold filtering materials cup (or bottle) and collect filtered water

4. Cost handout (see below)

Methods

Part I: Identify location and direction of groundwater contaminant

Before: teacher should make the pH of samples 2, 3, and 5 approximately 5. All others should be a close to neutral pH.

1. On a slide, show the location of the spill (barrel) and describe the parts of the surrounding community using Figure 1.
2. Explain that the students are all environmental engineers hired by the City of Pawnee, Indiana. The City of Pawnee is very concerned because Eagleton Factory spilled the chemical, igedomium, this weekend. The City of Pawnee wants your firm to first identify what areas have already been contaminated and which direction the chemical is moving.
3. Compared to local groundwater, igedomium, has a low pH (5). You can use this property to identify the extent of the contamination.
4. Give each group 1-2 "samples" to test the pH using pH strips.
5. Have each group record their sample's pH on the slide so everyone can see the results.

Discuss as a group which way the contaminant is moving, and what some consequences of future movement may be. [Should be moving southeast and could possibly impact farm/school; warning should be giving to houses and they should not be allowed to consume any well water]

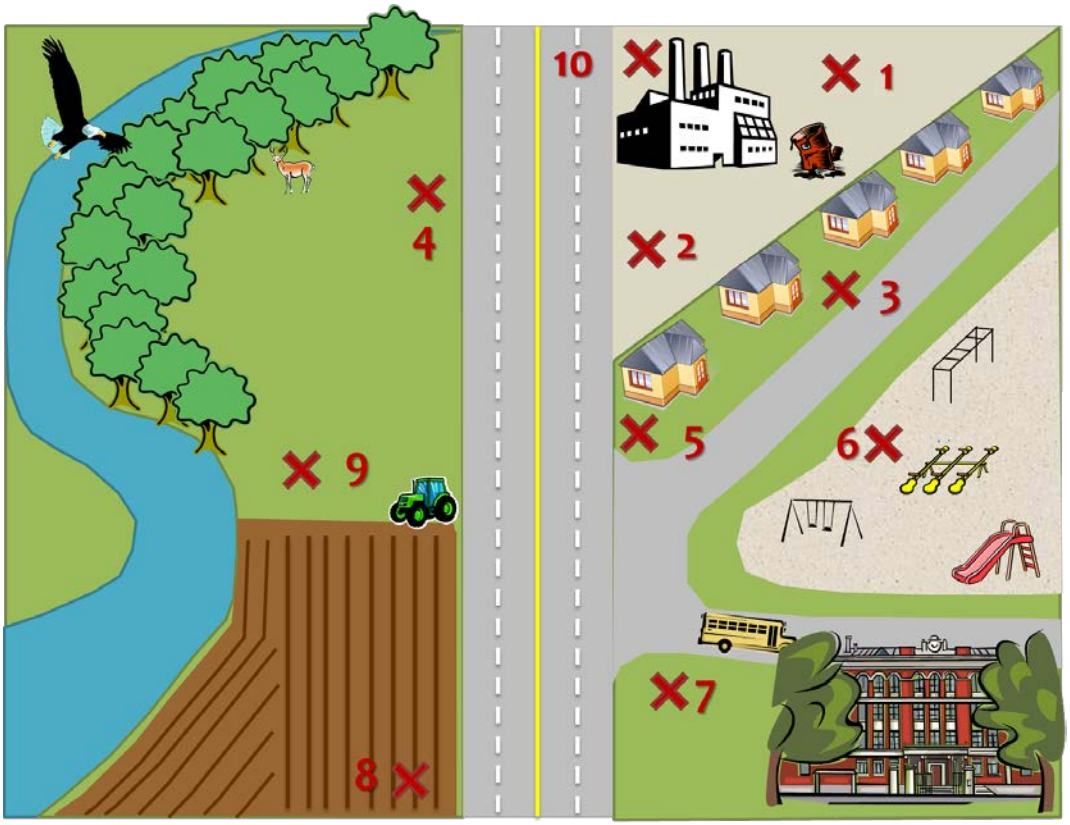

Figure 1. Site layout and location of samples.

Part II: Contamination remediation

1. The City of Pawnee is operating on a small budget. They need you to clean the contaminated water using a pump and treat method. You already have a usable pump, and City Councilwoman Leslie Knope finds $100 in the budget for the rest of your expenses.
2. The igedomium chemical has a very high affinity for sediment. This means that the chemical prefers to stay adsorbed to the soil/particles that are in the water. Therefore, you will want to design a method for treating the contaminated water, which can remove the most sediment.
3. We will determine the effectiveness of your treatment by measuring the turbidity before and after treatment.
4. The group that has the highest percentage removal will win a lifetime contract with City of Pawnee to work on environmental concerns.
5. Use your $100 with your group to design a treatment system to remove the igedomium-covered soil particles.

Material (Qty)	Cost ($)
coffee filters (1)	$25
cotton balls (4)	$10
plastic spoon (1)	$10
straws (4)	$25
sand and/or gravel (1 table spoon)	$10
wire mesh (1 square)	$20
cheesecloth (1 square)	$25
rubber bands (1)	$10

Reflection Questions (Journal or Discussion)

- What methods/systems worked the best for removing sediment? What didn't work?
- Do spills happen in the real world?
- When contaminants move in groundwater, what are some things that might cause them to move in one direction versus another?
- What is your filtering system actually modeling that occurs in the real worlds?

Supplemental Information:

Indiana 4-H Soil and Water Science manuals: https://www.edustore.purdue.edu/item.asp?Item_Number=4-H-1027-W

Vocabulary:

Affinity- attraction of one substance to another

Conductivity (total dissolved solids) - The measure of dissolved charged particles, which affects the ability of water to conduct electricity. In parts per million (PPM) 0-50 is ideal drinking water, 50-200 is moderate, 200-400 is hard water, 500+ is US EPA maximum contamination level for usable water.

Containment- The presence of a substance that has potentially harmful effects

Groundwater- Water held underground in pores of soil and crevices in rocks

pH- The measure of how acidic of basic a solution is. The lower the pH the stronger the acid (1-6), a pH of 7 is neutral, the high the pH the stronger the base (8-14).

Turbidity- is the measure of the relative clarity of water. Unit of measure is NTU's, <10 clear water, 50-100 is moderate clarity, 150-200 is low clarity, >200 no clarity.

Cost Sheet

Material (Qty)	Cost ($)	Qty Requested	Qty Requested x Price
Coffee filters (1)	$35		
Cotton balls (4)	$10		
Plastic spoon (1)	$10		
Straws (4)	$25		
Sand (1 table spoon)	$10		
Gravel (1 table spoon)	$10		
Rubber bands (1)	$10		

Total Cost: $_____._____

Data Table

Tests	Before	After	Drinking water Standards
pH			6.5-8.5
Total Dissolved Solids (TDS) ppm			0-50 ppm

Reflection Questions:

1. How well did your filtering system work in removing the contaminant?

   _____

   _____

2. With the design of your filter, what worked the best? What would you do to improve this?

   _____

   _____

3. What natural process did this activity simulate?

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