A Plume of Contamination

Learning Objectives: Students will: (1) determine the extent of contamination by taking samples and testing them for pH, (2) interpret data to draw a plume of contamination, (3) evaluate whether more information is needed and (4) make conclusions about the movement of contaminants in groundwater.

Subjects: Science, Health Education and Environmental Education

WMASs: SC: A.8.6, C.8.6, H.8.3

HE: A.8.2, C.8.3

EE: A.8.4, C.8.2

Grades: 6–9

Materials:

- A Plume of Contamination activity sheet
- clear plastic containers—one for demonstration and one for each group of 3–4 students
- sand
- powdered grape drink mix (do not add water)
- powdered lemonade mix (do not add water)
- for each group of 3–4 students
  - watering cans or spray bottles
  - plastic straw, cut in half
  - pH paper
  - tape
  - plastic container lids or pencil erasers for props

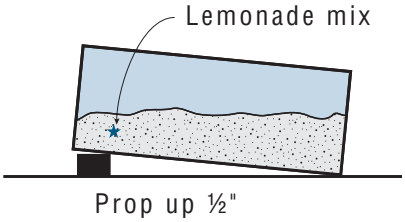
Background: Contaminants on the surface of the ground can move slowly through soils and reach groundwater. Contaminants spread outward from the point of origin, forming a plume which "points" to the source of contamination. A small amount of some contaminants can ruin a large quantity of groundwater.

Some chemical contaminants are easily detected by changes in color, odor, or taste of groundwater. However, most contaminants are "invisible" and require chemical testing for detection. Testing of many wells in an area may be required to determine the source of contamination.

Procedure:

A) Preparation.

1. Before class, fill one clear plastic container for each group of 3–4 students with 1 inch of sand. Wet the sand with water and smooth off the surface. Station containers around classroom.



2. Prop up one end of each container about ½ inch.

3. Make a small depression in the sand and add ½ teaspoon of dry lemonade mix at the elevated end. Cover the lemonade with sand. Vary the location of the lemonade contaminant in each container and keep a record of the contaminant location. After the demonstration, students will use pH paper to find the source of contamination.

B) Demonstration.

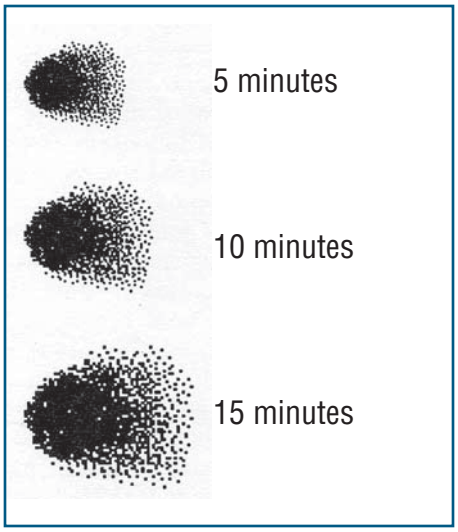
1. Prepare a plastic container as above, but don't add lemonade.

2. Make a small depression on the elevated side of the container. Place about ¼ teaspoon of powdered grape drink mix in the depression. This represents a chemical contaminant.

3. "Rain" water on the contaminant, using the spray bottle or watering can. The "rain" should be light so the food coloring is diluted and seeps into the sand rather than running off the surface. If sand erodes badly, try again, using lighter "rain" or spread a layer of pea gravel on top to hold the sand in place.

4. Every 2–3 minutes check the bottom of the container for evidence of color. After about five minutes, a plume of color should begin to appear. Draw the shape of this plume, to scale, on the chalkboard.

5. Check the size and shape of the plume after ½ hour and draw the new plume, to scale, on the chalkboard. Discuss the results. The plume should be broad and fanlike, pointing to the source of contamination. Notice that the red and blue dye components of the grape drink mix separate. Why do you think this happens?



C) Investigation.

1. Tell students they will now have to use a chemical test to find the source of an invisible contaminant. Point out the containers in which you've placed the lemonade mix. Explain that a lemonade "contaminant" has been put in a different location in each container and they will be using pH paper to find the plume of contamination. Lemonade is acidic and will lower the pH of water it encounters. It may be helpful to review the meaning of pH and the use of pH paper. Remind students that as acidity increases, pH decreases.

2. Work in small groups at the lemonade contaminant stations.

3. Lay a 6-inch strip of pH paper on a dry desk or counter. You may need to secure the paper to the desk or counter by placing a piece of tape at each end. Put a small drop of water on one end of the pH paper, note the

color and record the pH of the water on your activity sheet.

4. With a watering can, "rain" lightly on the upper end of each container so there's no runoff. Keep watering lightly for about 5 minutes. Wait 15 to 20 minutes.

5. Using a piece of plastic straw, remove a plug of sand (and water) from one of the locations indicated on the activity sheet diagram. Drop the wet sand on the pH paper. Note the color of the pH paper and determine the pH of the sample. If the sample is more acidic (has a lower pH) than tap water, place a "+" on that location on your activity sheet. If the acidity is the same or lower (pH same or higher), place a "–" at that location on your activity sheet. Rinse the straw.

6. Take a total of 12 "test well" samples from the locations shown on the diagram, rinsing the straw after each sample. Determine the pH of each sample and record a "+" or "–" on your activity sheet at each location.

7. Complete the activity sheet and discuss your results.

- ❖ What makes a contaminant move from where it is buried?
- ❖ What is a "plume of contamination?"
- ❖ What are some real contaminants that could be seen, smelled or tasted if they got into groundwater?
- ❖ What are some real contaminants that could not be seen if they got into groundwater?
- ❖ In the real world, what factors underground might influence the movement of contaminants?

Going beyond:

1. Research and report on the types and effects of groundwater contamination from various sources in your area (e.g. private homes, schools, farms, landfills, gasoline stations, mine sites, septic tanks, industries, businesses, salt stockpiles, etc.) See if your water utility has conducted an inventory of potential contaminant sources around its' wells. Check out the *Wisconsin Groundwater Directory* included with the Groundwater Study Guide packet for databases containing information on potential contaminant sources.

2. Research and report on the effects contaminated groundwater may have on human health. Have a physician or public health official visit and discuss the topic.

3. Investigate bottled drinking water. Where does it come from? How much does it cost? What does the company do to ensure that it is safe for human consumption? What regulations govern the quality of bottled water?

Adapted from: *Groundwater Quality Protection in Oakland County: A Sourcebook for Teachers,* 1984, The East Michigan Environmental Action Council, 21220 West 14 Mile Road, Birmingham, MI 48010.