Permeability of Soils

Time: One 2-hour lab period.
National Benchmarks: Benchmarks 5A: Diversity of Life; 5D Interdependence of Life; 5E: Flow of Matter and Energy; 9B:Symbolic Relationships; 9D:Uncertainty; 12B:Computation and Estimation; 12D:Communication Skills; 12E:Critical-Response Skills.
National Science Content Standards: *Science as Inquiry: A*; *Life Science: C*: Biological Evolution; The Interdependence of Organisms; Matter, Energy, and Organization in Living Systems; *Science and Technology: E:* Abilities of Technological Design; Understandings about Science and Technology; *Science in Personal and Social Perspectives: F:* Population Growth; Natural Resources: Environmental Quality; Natural and Human-induced Hazards; Science and Technology in Local, National, and Global Challenges
New York State Standards: 1, 2, 3, 4, 5, 6, 7

Objective: Students will know the connection between land use and water quality, and be able to use data from a classroom activity to explain this connection.

Lesson Outline:

1. Students will look at aerial photos of their schoolyard and/or community and discuss the different types of land use in the area.
2. Students will use a model to determine the difference in runoff vs. infiltration of different surfaces.
3. Students discuss the relationship between soils, land use, and water quality.

Materials:
For each group:

-plastic funnel
-water
-500 mL beaker
-graduated cylinder (250 mL)
-coffee filters (5 for each group)
-potting soil
-gravel
-sand
-clay
-plastic wrap
-collection tubs (beakers, jars, other containers)
-food coloring (optional)

Preparation: Depending on the amount of soils you have, you can use smaller or larger funnels. We recommend using a small, 16 oz plastic kitchen funnel into which a coffee filter can be placed. Students should use 100-200 mL of water. The soils should be dried ahead of time, and the results of the first trial should be discarded if you are running multiple trials. With multiple trials, the second trial will use wet soil, while the first will use dried, which will change the results but not the relationship between the substrates.

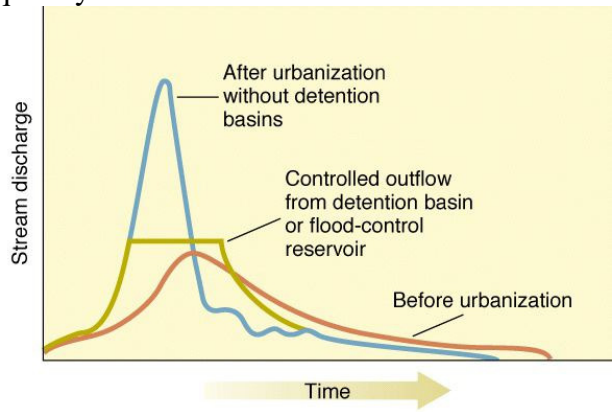
Engage: Show students photographs of different types of land cover, and ask what would happen if there was a large storm in the area. Which area would flood? Which types of soil would suffer from the most erosion?

Explore: Students will obtain the materials and run three trials, measuring how long it takes for the rainwater to enter the "groundwater". Each group will test four different substrates: clay, potting soil, sand, and pea gravel, one control (just the coffee filter), and one impermeable surface (the clay or soil covered with plastic wrap).

Students should fill the funnel with the same amount of substrate, and pour the same amount of water onto the substrate. Student should start timing as soon as the water touches the surface of the substrate, and stop timing when the water stops dripping through the funnel or after five minutes. When students have finished with the soil types, they should cover their last soil sample with plastic wrap, making sure not to pull it tight but laying it on top of the soil inside of the funnel. Then, they should add the water (it will not permeate through, but, the effect should help them understand permeability).

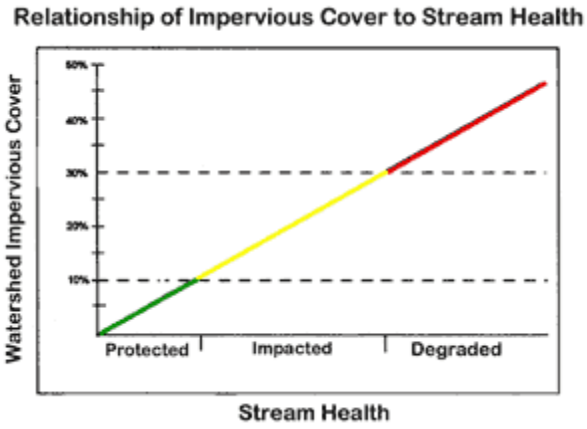
Students should record the volume of rainwater that enters the groundwater after each trial, since some of the soils will absorb more of the water than others. When all students have finished the experiment, compile the class data and create a graph in Excel.

Explain: Water quality is linked to permeability of soils in a number of ways. Since soil acts as a water filter, water that moves through permeable surfaces tends to become cleaner than water that runs over an impermeable surface. Runoff from impermeable surfaces also contributes to water pollution when the water moves pollutants such as oil, rubber from tires, antifreeze, etc into the waterways. In addition to water pollution, impermeable surfaces heighten the effect of storm runoff because water moves more quickly over these surfaces and causes flooding more quickly.



From: http://serc.carleton.edu

Finally, when a storm event does occur, the extra water that reaches the water treatment plant often overwhelms the facility, causing the plant to discharge both sewage and runoff into local waterways without being treated. Forested watersheds also tend to retain more nutrients, especially nitrogen, then suburban or urban watersheds. For more on nitrogen and watersheds, see lesson 6 "Land Use and Water Quality".



From: www.epa.gov

Extend: Students could design additional activities with their soil samples and investigate pollution movement through different substrates, or create mixtures of the substrates. Students could also build a stream model with a riparian zone and observe ways in which the riparian zone improves water quality and erosion.

Evaluate: Students will turn in their completed experiment worksheets.