the CEED

THE CENTER FOR ENERGY EFFICIENT DESIGN

Permeability

Grade Level	9-12	**Subject**	Earth Science

Objective(s): Compare the permeability of various natural and man-made substances.
To determine the best way to mitigate water run-off due to human construction around homes and other buildings.
Compare various materials used when landscaping in rural and urban areas.

Mitigate: To make less severe; compensate for the damage caused by an event or reduce the consequences.

SOL Addressed:

ES.8: The student will investigate and understand how freshwater resources are influenced by geologic processes and the activities of humans. Key concepts include

c. relationships between groundwater zones, including saturated and unsaturated zones, and the water table;

d. identification of sources of fresh water including rivers, springs, and aquifers, with reference to the hydrologic cycle;

Next Generation Science Standards:

HS-LS2-7: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-ESS2-2: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

HS-ESS3-3: Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

Materials Needed Per Class of 30 **and** **Prior Knowledge**	Anticipatory: 5 minutes Introduction: 5-10 minutes Guided practice and Independent practice: 30-60 minutes (8) 400 mL beakers,* filter paper (coffee filters), water supply, samples of sod, soil, sand, clay, gravel, porous concrete, and any other materials for testing. *You can create your own apparatus with plastic bottles by cutting them in half and punching holes in the caps. The top is a funnel and the bottom the beaker. Students should be familiar with porosity and permeability, aquifer, recharge zone, infiltration, and erosion.

<table>
<tr><td>Ways to differentiate this lesson plan</td><td colspan="2">EXTENSION: Change the slope of the surface that water flows over to see if there is any change in the amount of water that is absorbed.
MODIFICATIONS : Assign the materials tested at first, then allow students to extend their testing to approved materials.</td></tr>
<tr><td>Introduction/ Anticipatory Set</td><td>Anticipatory Set: Why do some areas flood more often than others?

Questions to ask students:
What happens to rainwater when it hits the ground?
Why might a well go dry?
How do aquifers recharge?</td><td>Introduction:
Because groundwater is an important reservoir for future water, it needs to be recharged on a regular basis. Certain man-made surfaces are impermeable to water, and other natural surfaces have been disturbed by human activities. All of these affect the amount of water that seeps back into the ground.</td></tr>
<tr><td>Guided Practice</td><td colspan="2">The teacher should model the activity by measuring water in a graduated cylinder and pouring into a funnel of gravel or soil. Observations such as how slowly or quickly water passes through, the amount of water that comes through into the beaker, noting dryness of substances beforehand all should be noted. Describe the observations/differences. What factors affect those differences? (porosity, material size, packing, shape of particles)

What natural and man-made substances are found in rural areas versus urban? Which materials allow groundwater recharging? What can be done in urban areas to decrease flooding and increase infiltration of water?
Students will design their own experiment to test the permeability of various surfaces. Explain where each surface might be useful.</td></tr>
<tr><td>Independent Practice</td><td colspan="2">In this activity, you will ask students to determine the best material to use around homes or urban areas (you can determine the site you prefer) that will allow groundwater to be recharged. The control can be asphalt, if urban, or garden/pasture soil if rural. The idea is to compare human activities with natural systems. Students will set up an experiment that can compare either how quickly water flows through a material, or the amount of water that flows through in a given amount of time. Have supplies available, but let them set up their own experiment.</td></tr>
<tr><td>Closure (Summary of Lesson)</td><td colspan="2">Students should share their results (on an ActivBoard) with the other groups, explaining how they ran the experiment and what conclusions were drawn. After all groups have shared, discuss common themes or results. How could this information be useful? It is hopeful that students would discuss the porous concrete as a viable solution in urban areas.</td></tr>
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CEED Building Application/ Sensor Data	Porous concrete is used around the CEED Building. Talk about the advantages to having this instead of standard sidewalks or even gravel. http://dashboard.intellergy.us/ceed/index.php
Assessment	Students should write a lab report from this experiment and their conclusion should explain the data and show an understanding of their results and how can be applied to current situations of building and landscaping.

Vocabulary

Aquifer: an underground reservoir of water; groundwater

Erosion: movement of sediment and rock from one place to another.

Infiltration: downward movement of water through the open spaces in soil and rock until it reaches the aquifer.

Permeability: How easily water flows through a material; factors that affect permeability are porosity, shape and size of particles, packing of particles, how connected the pore spaces are. Impermeable substances do not allow water through.

Porosity: the amount of open spaces in a material

Recharge zone: the area above an aquifer through which water infiltrates to refill groundwater. The zone needs to be permeable.