Schoolyard Infiltration

Instructional Goal

At the end of this lesson, SWKABAT:

- Define porosity and permeability
- Explain what happens to water after it infiltrates the ground
- Use an infiltrometer to measure rate of infiltration at various locations in the schoolyard

Next Generation Science Standards Addressed

Science & Engineering Practices:

Asking Questions
Planning & Carrying Out Investigations
Analyzing & Interpreting Data
Using Mathematics & Computational Thinking
Constructing Explanations
Obtaining, Evaluating, & Communicating Information

Disciplinary Core Ideas:

HSLS2: Ecosystems: Interactions, Energy, and Dynamics

Cross-Cutting Concepts:

Scale, Proportion, and Quantity
Systems and System Models
Energy & Matter

Common Core Standards Addressed

Mathematics:

Quantities- Reason quantitatively and use units to solve problems
Mathematical Practices- Reason abstractly and quantitatively
Model with mathematics

Maryland Environmental Literacy Standards Addressed

Standard 3: Flow of Matter & Energy Topic C: Interaction of Physical Systems & the Biosphere

Materials

- Infiltration Instruction and Data Sheet (each student)
- Infiltrometer and Stopwatch
- Container of water (~1 gallon)
- Ball of modeling clay in a baggie (~2" in diameter)
- Block of wood and rubber mallet
- Optional: Asphalt roof shingle

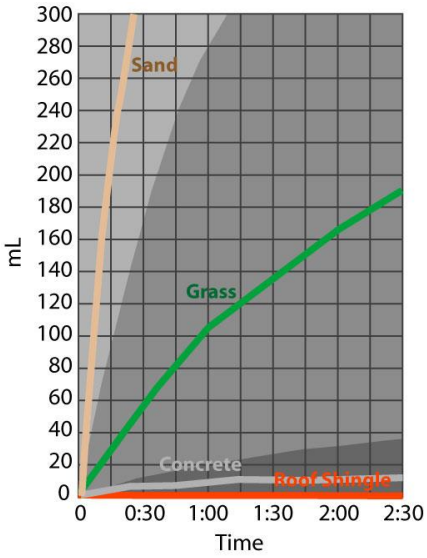
Lesson Procedure

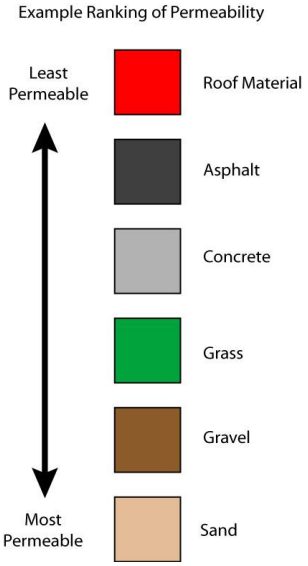
Different surfaces have different porosity and permeability. Porosity is a way to describe how much pore space is in the substance. Permeability is a measure of how well the pores are connected to allow water to flow through the substance. For this activity we will use the terms **permeability** and **infiltration**. Other similar words are absorb and percolate.

Note: This activity will not work if the ground is frozen

1 Administer Infiltration Formative Assessment.
2. Have students work in groups to complete *drivers and constraints tool*, discuss.
3. Have your students make a prediction by ranking the permeabilities of surfaces identified in Lesson 1. (Highest permeability allows the most water to flow through it. Lowest permeability allows the least water to flow through it.)
4. Use the infiltrometers to measure the rate of infiltration of each different surface.
5. Graph the results using the graph provided.
6. Have students compare their Rankings of Permeabiities, then combine student data from the infiltrometers onto an overhead transparency and discuss.

Examples of student work





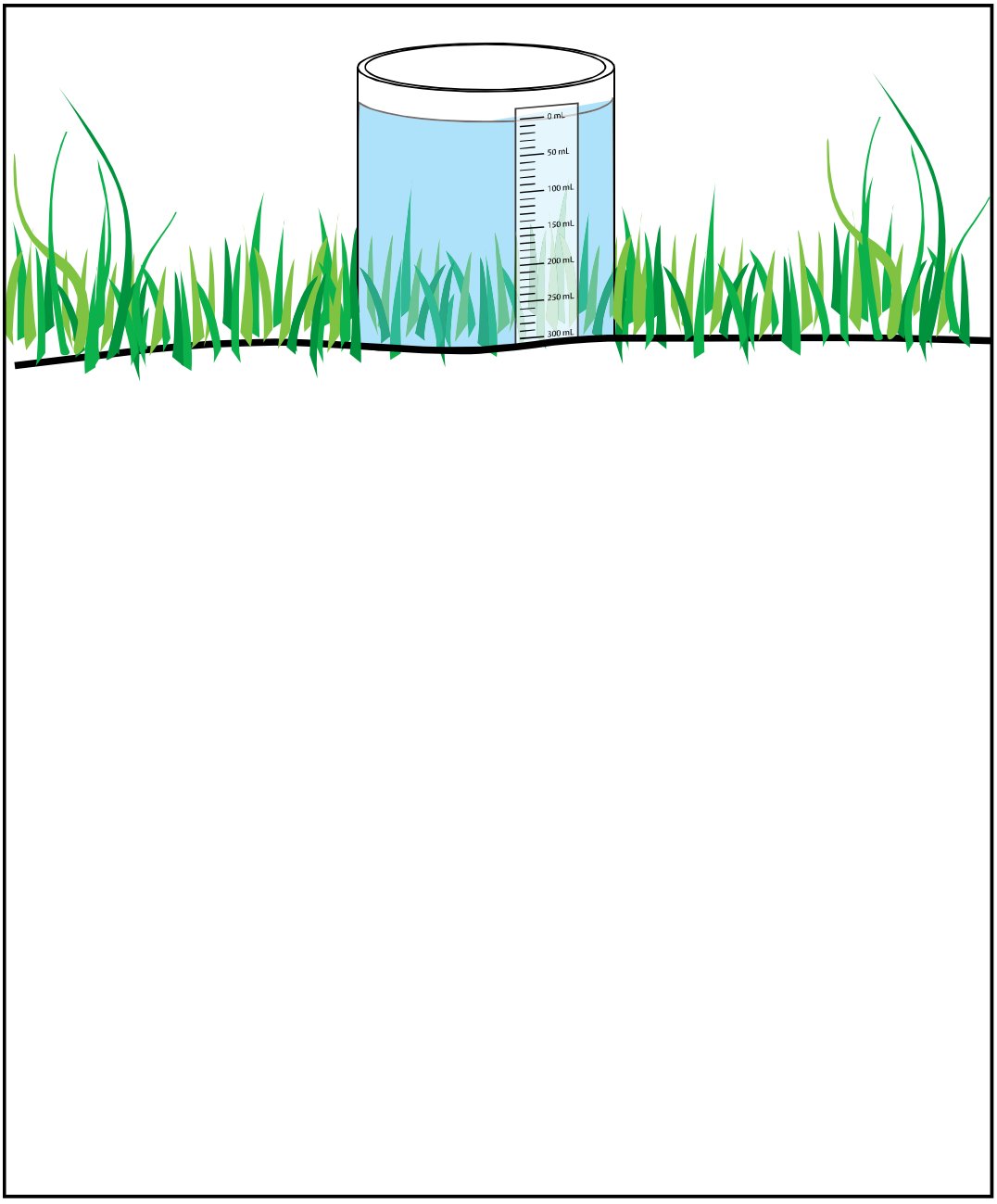
Discussion Prompts

- Where does water that infiltrates go?
- Why does sand drain faster than soil?
- What are some ways that might allow water to return to the surface?

Infiltration Formative Assessment

1. Start by drawing and labeling what you think it looks like underground.

2. A plastic tube is pressed into the ground and water is poured in. Next, use a combination of arrows and labels to show where water goes if it were allowed to drain out the bottom of the tube.



Purpose

This formative assessment probes students' ideas about where the water goes after it has infiltrated into the ground. Students' ideas about what it looks like underground and where the water moves underground are important for understanding students' thinking about the pathways that water takes through the school yard. How much water infiltrates into the ground is impacted by where the water goes once it infiltrates into the ground.

Soil water and groundwater is located within the small pores and cracks between soil and sediment particles. Water displaces the air that was filling these spaces and adheres to the soil and rock particles that make up the ground. When all of the pore spaces are filled with water, the ground is saturated. The top of this saturated zone is the water table. Above the saturated zone, both water and air fill the pore spaces. Within the unsaturated zone, capillary forces can cause the water to move upwards a small amount. However, overall, the force of gravity is stronger than the capillary forces and pulls water downwards.

How much water infiltrates into the ground depends on the porosity and permeability of the soil/sediment. Porosity is a measure of the volume of pore spaces and permeability is a measure of the connectedness of the pore spaces. In general, larger grain sizes have greater permeability. Small grain size materials can have high porosity because although the pore sizes are small, there are more pore spaces than between larger grain sizes. In general, more water can infiltrate into larger sized materials than into smaller sized materials.

Once in the ground, water can follow multiple pathways. Through capillary action, some water near the surface may evaporate into the atmosphere. Some water may be absorbed by plant roots and transpired back into the atmosphere. Most water will flow downwards into the soil towards the groundwater table.

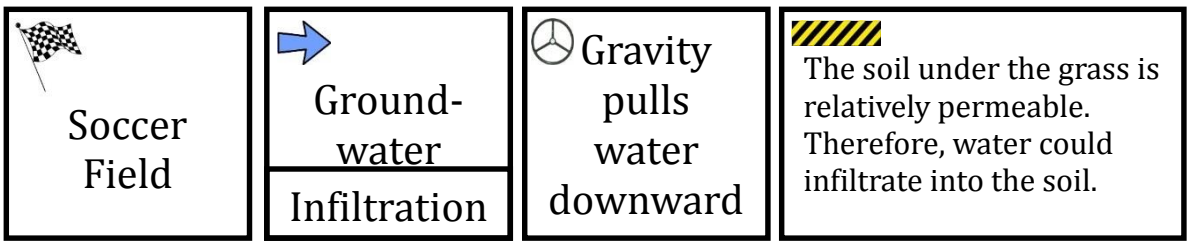
Suggestions for Administration

Give this prompt to students the day before you begin the infiltrometer activities in the School Water Pathways. Students may not know what an infiltrometer is, so you may have to explain that the tube of the infiltrometer is open at the bottom. If you have an infiltrometer available, show students what one looks like. Explain that water is poured in the top and they are supposed to draw and explain what where the water goes. You can provide a copy of the prompt for each student to write on and turn in to you at the end of the class period, or you can project the prompt and have students write their answers in their science notebooks.

Using Drivers and Constraints Tool

Use the Drivers and Constraints Tool to consider possible infiltration pathways. After students have measured infiltration rates for various surfaces, have students choose or assign students to consider various starting points on campus for infiltration pathways.

Where does the water **start**?	Where can the water **go**? What is the **process**?	What **drives or moves** the water? How?	What are the **constraining factors**, and how do they work?



Examples of Drivers and Constraints Tool for considering infiltration pathways.

Supporting student reasoning:

Use a *drivers and constraints tool* to support students in making the connection among sediment grain size, pore size, and permeability.

Infiltrometer Instructions and Data Sheet

1. Place the infiltrometer on the surface you want to test and make a good seal. In sand or loose soil, simply push the tube into the ground. In hard packed soil or gravel, you may need to twist, push harder, use a block of wood and rubber mallet, or wet the soil a tiny bit. On concrete, asphalt, or roofing shingles you will need to create the seal with a 25 cm long ‘snake’ made out of the modeling clay. The snake should be about 1 cm in diameter.

2. Find a spot on the ground that is smooth and free of plants. Have someone in your group get ready to write down the numbers you read off once the experiment begins.

3. Use the bucket of water to fill the infiltrometer up to the 0mL mark then quickly start the stopwatch. Every 15 seconds, read and record the water level.

4. Plot your results on the graph.

5. Repeat test three times on each surface and average your results. Conduct test on three different surfaces total.

6. Rank your three surfaces by permeability and be prepared to share with the class.

Surface #1		Surface #2		Surface #3	
Description		Description		Description	
Time	mL	Time	mL	Time	mL
0:00	0	0:00	0	0:00	0
0:15		0:15		0:15	
0:30		0:30		0:30	
0:45		0:45		0:45	
1:00		1:00		1:00	
1:15		1:15		1:15	
1:30		1:30		1:30	
1:45		1:45		1:45	
2:00		2:00		2:00	
2:15		2:15		2:15	
2:30		2:30		2:30	

Ranking of Permeability