Lesson Title: Where Does the Rain Go? (Soil Percolation)

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Grade Level: 5th

Type of Lesson: STEM

BVSD Essential Understandings:

Science Standard 1: Students apply the processes of scientific investigation and design, safely conduct, communicate about and evaluate such investigations.

- ✓ Measures, organizes, and records data accurately using metric units, tables, charts, graphs, and appropriate technology.

Enduring Understanding: Scientific inquiry involves asking scientifically-oriented questions, collecting evidence, forming explanations, connecting explanations to scientific knowledge and theory, and communicating and justifying explanations.

Essential Learning: 5S1

- b Controls variables in an investigation
- c Formulates a testable question related to a scientific investigation
- e Relates observations and data to a testable question
- g Identifies variables in an investigation
- h Makes predictions based on evidence

Essential Learning: 5S2

- b Gathers data in an organized fashion using appropriate tools and methods

Essential Learning: 5S3

- a Follows directions from the teacher regarding lab and safety procedures
- b Demonstrates proper care for equipment and facilities

Essential Learning: 5S4

- c Reflects on own work as a scientist

Science Standard 2: Students know and understand common properties, forms and changes in matter and energy.

- ✓ Explains that objects have physical properties that can change and that can be observed or measured before and after a change has occurred.
  --Specifically, this lab supports the teaching of the water cycle.

Enduring Understanding: Matter has physical properties that allow people to identify, describe, and classify it. When a new material is made by combining two or more materials, it has properties that are different from the original materials.

Essential Learning: 5S5

b Uses measurements to make qualitative and quantitative comparisons between physical properties of objects.

Science Standard 3: Students know and understand the characteristics and structure of living things, the processes of life, and how living things interact with each other and their environment.

✓ Explains the interaction and interdependence between and among nonliving and living components of ecosystems.

--Specifically, this lab teaches that changes in the properties of non-living soil can affect the amount of water that is then accessible by living things, such as plants.

Enduring Understanding: Ecosystems are composed of both living and non-living things, which interact with and depend on one another. Changing one part of an ecosystem usually affects many other things within the ecosystem. Energy flows through ecosystems, and this flow can be represented by food chains or webs.

Essential Learning: 5S7

a Identifies and describes the influence of nonliving components on living components of an ecosystem

Science Standard 5: Students understand that the nature of science involves a particular way of building knowledge and making meaning of the natural world.

✓ Explains why it is important to repeat scientific investigations
--Each student group represents a replicate; this is a repeated experiment

✓ Explains how models are used to represent events and objects
--This experiment models the process of infiltration and percolation

Enduring Understanding: Because we expect science investigations that are done the same way to produce the same results, when they do not, it is important to try to figure out why. Sometimes similar investigations give different results because of differences in the things being investigated, the methods used, or the circumstances in which the investigation is carried out, and sometimes just because of undertainties in observations. It is not always easy to tell which.

Essential Learning: 5S10

b Recognizes that the results of an experiment should be verified through repetition

d Distinguishes actual observations from opinion and speculation

Enduing Understanding: A model of something is similar to, but not exactly like, the thing being modeled. Some models are physically similar to what they are representing, but others are not.

Essential Learning: 5S11

b Create simple models to represent events and/or objects

Essential Questions Addressed:

- How do people use the process of science to investigate questions about the natural world?
- How do people describe changes in matter?
- How do living and non-living things interact within an ecosystem?
- What causes changes in the Earth's surface?
- Why do people repeat scientific investigations?
- How do people use models in science?

Objectives: Students will

1. review the water cycle;
2. understand what infiltration and percolation mean to the water cycle;
3. experiment with and witness how differences in soil quality affect infiltration and percolation;
4. connect the idea that soil quality (non-living) affects the amount of water available to plants (living);
5. collect and record data and analyze their data in relationship to that of the other members of the class;
6. understand the idea and importance of replication in an experiment;
7. generate ideas as to how one could increase or decrease infiltration/percolation in any given soil type.

Background Information: This lesson provides an opportunity for students to conduct an experiment that reinforces the water cycle. It can also be used as review or a segue to a unit on landforms in that any water that does not infiltrate can then act as an erosive force on the landscape.

Information for the teacher:

- Infiltration and percolation is generally a function of the size of the particles that make up the soil. Soil particle sizes can be thought of as on a continuum between clay (the smallest particles) and sand (the largest).
- Small particles pack more closely together, and therefore the space between particles is smaller. This slows down the rate at which water can infiltrate and percolate. Sand, with its larger size, has more space between particles and the water will move more quickly through it.
- Play sand, which can be used in this lab, actually contains a high proportion of smaller particles that would not be considered "sand" by an ecologist. Water, therefore, is slower to move through the play sand than it would through sand out in a natural setting.

- Potting soil, which can be used as a third medium through which the water percolates, contains high amounts of large organic matter bits. Because of this, water moves through it quickly.
- Compaction is the process by which soil is packed down. This happens when people walk repeated on an unpaved path (note that puddles form here more readily than on untrodden patches). Cows also do this in areas where they graze. Compaction will happen regardless of the size of the soil particles (clay or sand or anywhere in between).
- The amount of water that infiltrates and percolates has a direct impact on:
  1) the amount of erosion in an area (lower infiltration means more water moving over the surface, which can then erode landscapes), and
  2) the amount of water available to plants. Plants, of course, take up the water they need through their roots. If water does not infiltrate or percolate down to where the plants' roots are, the plant cannot get to that water or use it.

Lesson Vocabulary: infiltration, percolation, biotic (living), abiotic (non-living).

Materials Required:
- ✓ plastic cups with holes poked into the bottom (3 cups per group of ~4 students)
- ✓ plastic cups intact (i.e., no holes in bottom; 1 cup per group of ~4 students)
- ✓ potting soil (enough for at least 1 cup per group of ~4 students)
- ✓ clay (bone meal but any finely textured material will do; enough for at least 1 cup per group of ~4 students)
- ✓ sand (play sand will do; enough for at least 1 cup per group of ~4 students)
- ✓ measuring cups (1/8 C and 1 C)
- ✓ tub of water
- ✓ paper towel
- ✓ clock with second hand or stop watches
- ✓ paper and writing utensils for recording data

Preparation: Poke holes in the bottom of the plastic cups in advance. An awl on a pocket knife is ideal, but any sharp object with a relatively fine point will work.

Test what amount of water to use for your experiment. The exact amount will depend upon what you use for your clay/potting soil/sand. The amount of water should percolate all the way down to the paper towel under the cups with soil in them without profusely spilling out of the bottom (roughly an 1/8 cup of water).

Safety Information: The clay material is very fine and could be an irritant if inhaled. The instructor should fill the cups with clay for the students.

Engagement: Review the water cycle, including the concept of matter state change. Circle the infiltration/percolation segment of the water cycle.

Present the definitions for infiltration and percolation. An example of a set of functional definitions is:

infiltration: when water goes from being on top of the ground (soil) to getting into the ground (soil).

percolation: when water moves deeper into the soil

Tell the students that they are going to conduct an experiment today to see if the kind of soil affects how water can infiltrate and then percolate. They will test three (3) types of soil:

(i) potting soil
(ii) clay
(iii) sand

Show the students the three soil types. Ask them to formulate hypotheses ("which one will the water move the fastest/slowest through?").

Have them construct a data table that looks like this:

	Clay	Potting Soil	Sand
Time			

Do not identify the units for time as this is a teaching opportunity later in the lesson.

Provide the class with the following clear instructions before allowing for exploration.

1) Decide upon an amount of each soil type to be added to cups with holes in the bottom. This can be 1 cup as measured or up to a marking on the cups, provided all cups are the same. Identify (or have them identify) that we are controlling a variable (amount of soil) by doing this.
2) Tell the students they are to fill cups with holes in the bottom with the agreed upon amount with sand; repeat this for potting soil. Cups with clay should be provided by the instructor.
3) Place soil cups on top of paper towel to absorb the water once it has percolated all the way through.
4) They should then fill 1 plastic cup without holes in the bottom with 1/8 C of water (or the amount of water you determined from your preparation).
5) They will then pour the water over one of the soil cups, carefully recording how long it takes the water to get from initial contact with the soil to the bottom of the cup and to the paper towel.
6) Record their data in their data table.

Note: the clay can take a long time and may never reach the bottom. If a group starts with the clay, allow them to start on another soil type after they've waited on the clay for a while.

Exploration: Let the students conduct the experiment. After they have collected their data, have them post their data on a master data table that you have created in the **front of** the classroom that looks like:

Time for Percolation

	Sand	Potting Soil	Clay
Test 1			
Test 2			
Test 3			
Etc.			

where each student group is a test.

Explanation: Once all have conducted the experiment and recorded their data on the master data table, analyze the data together. If there are outliers (individual data points that do not jibe with the rest of the data), talk to the groups responsible for the outlier. Try to figure out what happened. Highlight the need for replication to account for just such scenarios.

Looking at the data, in which soil type was percolation the fastest? Why do they think? In which was it the slowest? Again, why? What could they do to speed up or slow down percolation in a given soil type? If time permits, allow the students to experiment with variations (mix soil types, poke holes in the clay [aeration], compact the potting soil, etc.).