WATER QUALITY

Watersheds and soil profiles

Focus question	What soils are most vulnerable to erosion?
Learning target	Students develop an understanding of what soil types/profiles are most susceptible to erosion.
Vocabulary	Runoff, erosion, groundwater

MS-ESS Earth and Human Activity

Performance expectation MS-ESS3-3	**Classroom connection:** This lesson helps students understand the properties of water and its effects on soil, particularly erosion.

Science and engineering practices

Constructing Explanations and Designing Solutions	**Classroom connection:** Students will apply scientific principles to determine the effect of soil type on water movement rates then build a watershed model to test various solutions to slow runoff and erosion.

Disciplinary core ideas

ESS3.C: Human Impacts on Earth Systems	**Classroom connection:** Students investigate the physical properties of water as they investigate the ability of water to transport materials. (Typically as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise.)

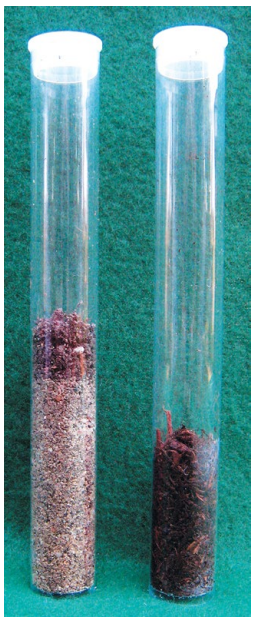
Cross-cutting concepts

Cause and Effect	**Classroom connection:** Students will investigate the effect of moving water across various earth materials.
Influence of Science, Engineering, and Technology on Society and the Natural World	**Classroom connection:** Students will determine the most vulnerable soil profile types then determine what practices might help to hold soils in place.

These activities focus on **constructing explanations and designing solutions** while students perform an investigation of soil types to determine the effects of water on soil. The effect of water acting on the earth's surface results in runoff and erosion of soil particles that may carry additional materials into water sources. The sediments and whatever is attached to them may have multiple impacts on surface water, both on biotic and abiotic factors.

Background

Water flow is governed by gravity, not directionality, therefore all water runs downhill. **Runoff** commonly refers to the drainage of water from a land surface, be that a yard, a parking lot, roads, a farm field, feedlot, or other surface. When water runs off of a land surface, many materials may be picked up and moved with the water. This action is called erosion. Erosion might be due to water, or wind or glaciers. Water erosion can be of many types depending on the quantity of water running off and the elevation.



The water cycle incorporates surface water, groundwater, and water in the atmosphere. Surface water is what we see in lakes, rivers, streams, and the ocean. **Groundwater** is stored in aquifers that provide underground water for drinking and it may feed surface water sources. Precipitation recharges aquifers. The hydrologic cycle is constantly recycling water through the processes of precipitation, evaporation, and condensation. *Time frame: 30 minutes.*

Materials

- Slide deck "Understanding watersheds"
- Student lesson pages
- Profile tubes and lids (2–5 per group)
- Samples of sand, silt, clay, and pea gravel

Prior knowledge

Students should have some basic background and knowledge about:

- How soils are formed (physical and chemical weathering, soil profiles, parent materials, etc.)
- The general types of sediment that make up soils (sand, silt, clay)
- The difference between runoff and groundwater and aspects of the hydrologic cycle
- The types of erosion and how they may impact water systems (surface vs. groundwater)
- See `qld.gov.au/environment/land/management/soil/erosion/types` for information related to types of water erosion.

Teacher preparation

1. Review the Driving Question Board to help students address questions they would like to investigate.
2. Depending on the questions different groups decide to pursue, the following activities can be used to increase their knowledge and understanding of watersheds.
3. Review **Understanding watersheds** deck, if needed.
4. Certain soils are better in helping to prevent erosion and excess runoff during certain weather conditions. Students will learn how water moves through various soil types, providing them with the understanding as to what soils run the highest risk of extensive runoff. The profile tubes and lids, as well as the sand, silt, clay, and pea gravel, can be purchased from Lab Aids or Ward's Science.
5. As an extension to this activity, students may investigate what practices help to hold soil in place to prevent erosion. There are many sites they could visit to determine the best techniques, develop a rubric for judging, (i.e. cost, ease of construction, effectiveness, etc) to test in the following investigation.

Student handout

Reflection

1. Farmers use equipment to travel across their fields while planting, spraying for weeds or pests and harvesting. What effects might the continued movement of equipment over the soil surface have on percolation rates?

Possible answer: Soil will become compacted as equipment moves over it. The effect of the compaction will decrease the amount of water percolation through the soil surface. Although the amount of erosion may decrease intially, the amount of runoff will increase dramatically leading to the potential for additional erosion over time.

2. How does percolation rate connect to runoff and erosion?

Possible answer: A fast percolation rate through a soil profile can help to reduce runoff from a field. If the water enters the ground, it may recharge an aquifer and to become part of growndwater. A slower percolation rate may increase the amount of water that runs off a field, especially during a hard rain storm.

Rubric for self-assessment

Skill	Yes	No	Unsure
I was able to plan and conduct an investigation that resulted in data that served as reliable measurement.			
I considered limitations and refined the design to address those limitations.			

Differentiation

Other ways to connect with students with various needs:

- **Local Community:** Students may investigate local aquatic ecosystems to predict the health of the system and observe possible causes for that quality assessment.
- **Students with special needs (language/reading/auditory/visual):** Students may investigate real aquatic ecosystems. Teachers can also create copies of the phenomena slides to pass out to the students so that they can write on the slides as they identify the potential harm and possible remediation to that harm on that slide.
- **Extra support:** Volunteer Stream Monitoring, A Methods Manual: `epa.gov/sites/production/files/2015-06/documents/stream.pdf`. Nebraska Department of Environmental Quality, Stream Monitoring: `deq.ne.gov/NDEQProg.nsf/OnWeb/SBMP`
- **Extensions:** Students can observe real-time data in Nebraska through USGS: `nrtwq.usgs.gov/ne/`. Students can help to solve real water problems within their community. Take part in organizations such as Give Water a Hand: `erc.cals.wisc.edu/gwah/`.

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Planning and conducting investigations	Planned and conducted an investigation which produced data that did not serve as reliable measurement.	Planned and conducted an investigation which produced data that served as reliable measurement.	Planned and conducted an investigation which produced data that served as reliable measurement, considered limitations, and refined the design.

Rubric for self-assessment

Skill	Yes	No	Unsure
I was able to plan and conduct an investigation that resulted in data that served as reliable measurement.			
I considered limitations and refined the design to address those limitations.			