

Water Runoff and the Environment



This guided activity explores the process of erosion and pollution caused by water runoff, using 3D Molecular Design's Water Kit® and paper clips. It also demonstrates how protective covers such as perennial grasses and buffers can intercept rainfall, providing a barrier to water runoff. You may choose to conduct this activity as a demonstration for your class, or have your students work through each exercise in small groups.

Vocabulary

Pollution is any contamination of air, water or land that affects the balance of the environment.

Nonpoint Source (NPS) Pollution is believed to be the leading cause of water quality problems today and comes from many diffuse sources (spread over a large area). NPS pollution is caused by rainfall or snowmelt moving over and through the ground. As the runoff moves, it picks up and carries away natural and human-made pollutants, finally depositing them into lakes, rivers, wetlands, coastal waters and groundwater. (***Point Source Pollution** is pollution from industrial facilities and wastewater treatment plants discharged directly into bodies of water.*)

Runoff is the portion of precipitation on land that ultimately reaches waterways, often with dissolved or suspended material.

Erosion is the process by which sand, silt, rocks and sediment are moved from one place to another. Water is the most powerful agent of erosion.

Vegetative Environmental Buffers are trees, shrubs and grass planted around fields that can help prevent nutrient pollution by absorbing or filtering out nutrients before they reach a body of water.

List of Resources

www.epa.gov/polluted-runoff-nonpoint-source-pollution

www.epa.gov/polluted-runoff-nonpoint-source-pollution/nonpoint-source-kids

www.epa.gov/nutrientpollution/sources-and-solutions-agriculture

water.usgs.gov/edu/watercycleinfiltration.html

In the News

Have students read **The Water Crisis in Flint, Michigan** found at www.dogonews.com/2016/1/20/the-water-crisis-in-flint-michigan/page/4. This article discusses the lead-contaminated water problems in Flint, Michigan. The Flint River has a high concentration of chloride ions attributed to runoff from large amounts of salt used to de-ice roads in the winter. The negatively-charged chloride ions cause the water to be more corrosive than water from the Great Lakes, thus causing the lead from old pipes to leach into the water flowing through.

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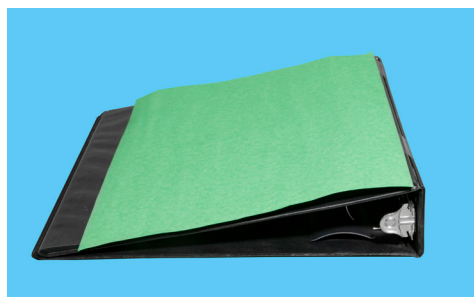
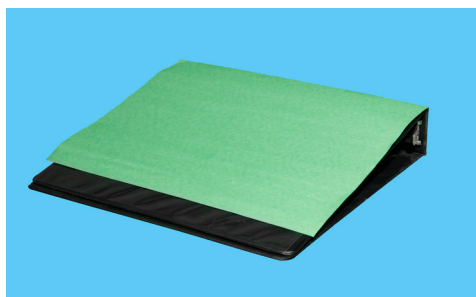
Activity

Materials:

- 3D Molecular Designs' Water Kit®
- 2" 3 ring binder
- Tape
- Green construction paper
- 40 colored paper clips (20 each of two different colors)
- Tissue box, dry erase board eraser or block

Set Up:

Tape a piece of green construction paper to the binder along the back binding at the top of the slope. Tape the construction paper so that you can flip it off and back onto the slope to cover the binder. Gather the rest of the materials for the activity.



NOTE: Water that does not run off **infiltrates** the soil. The water either remains in the shallow soil layer or runs deeper, recharging groundwater aquifers. During these activities, you can point out water infiltration when the water molecules remain on the slanted surface without rolling down to various waterways. Additionally, if you position your slanted surface near the edge of a table, the molecules that drop off the table represent water infiltrating deeper into groundwater aquifers.

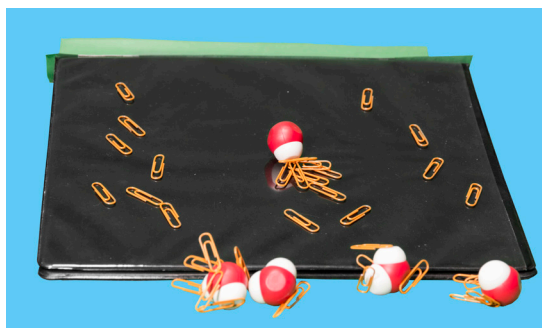
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Erosion via Water Runoff

Choose and spread out 20 *same-colored* paper clips directly on the sloped surface. The paper clips represent soil. Drop five magnetic water molecules one at a time from four inches above the top of the incline onto the binder.



set-up



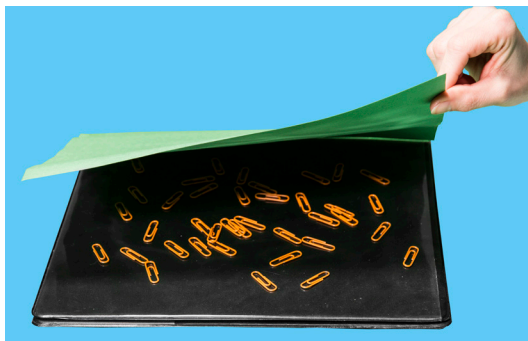
result

As the molecules roll down the slanted surface they will collect the paper clips, representing soil erosion caused by water runoff. At the bottom of the slant you can explain how water then collects in waterways with the soil and other materials suspended or dissolved in the water.

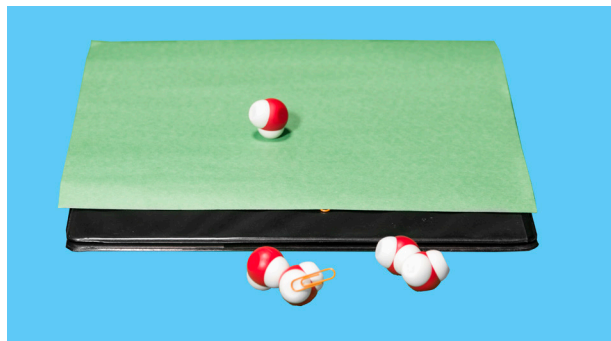
Erosion Prevention – Ground Cover

To demonstrate how ground cover helps reduce erosion caused by water runoff, repeat the previous lesson; however, this time flip the construction paper on top of the paper clips to represent ground cover. Then, drop the water molecules down the slant.

Fewer or no paper clips will be collected this time. This demonstrates how to prevent or slow soil erosion over time by planting protective ground covers.



set-up



result

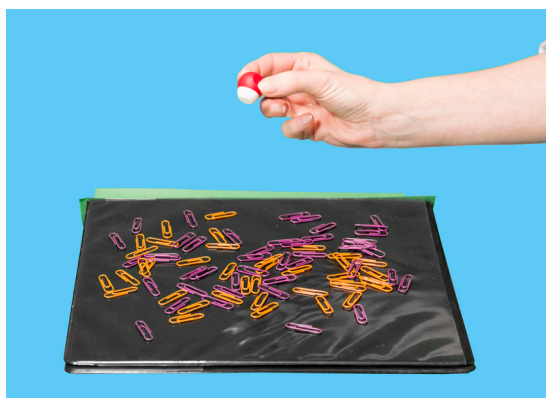
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Math

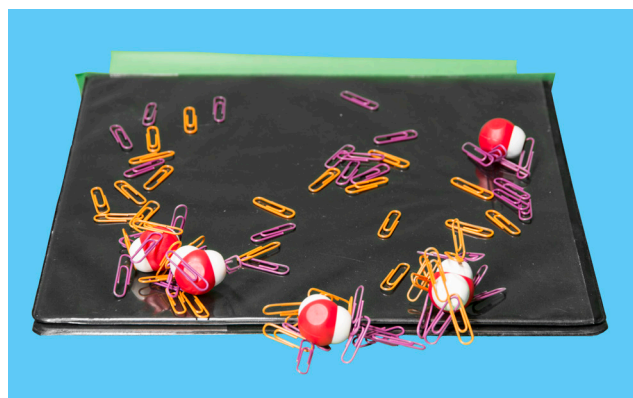
Count the number of paper clips collected in the first trial (without ground cover) and compare that to the number of paper clips collected in the second trial (with ground cover). Calculate averages based on how many paper clips per water molecule are collected. Measure the angle of the incline and have students experiment with different inclines and compare results.

Nonpoint Source Pollution via Water Runoff

To use this lesson to teach about nonpoint source (NPS) pollution, select 20 paper clips of a *different color* and add them to the “soil” paper clips placed directly on the slanted surface of the binder. The new paper clips represent contaminants found in soil such as salt spread on streets and sidewalks in urban areas to manage ice in the winter, or fertilizers spread on fields to manage crops in rural areas. Do not cover the “soil” and “pollutants” with the construction paper ground covering. As you drop water molecules and they roll down the slanted surface, they will collect the soil and other contaminants and transport them to waterways.



set-up



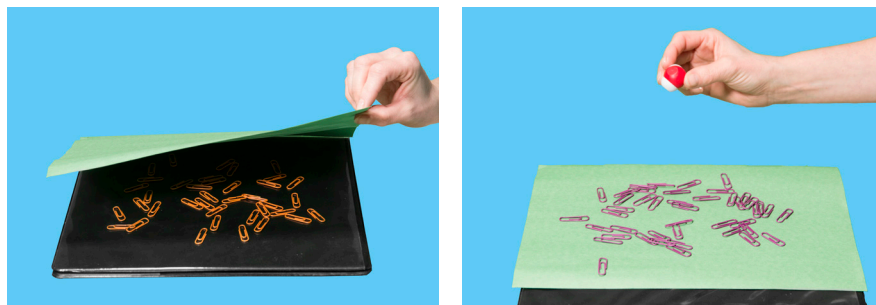
result

This would be a good opportunity to teach or review **solubility** using the Water Kit®. See pages 20-21 of the Basic Water Lesson found here: www.3dmoleculardesigns.com/3DMD-Files/Water-Kit/PDFs/BasicLessonPlan.pdf.

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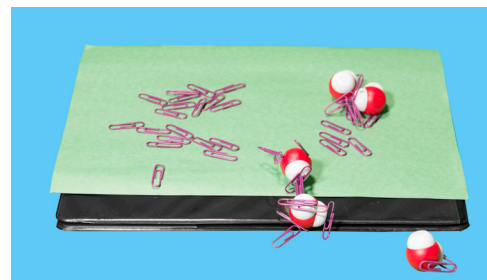
Nonpoint Source Pollution – Applied to Ground Covers

Spread the 20 paper clips that represent “soil” onto the slanted surface of the binder and cover them with the green construction paper “ground cover.” Spread 20 paper clips of a different color on top of the paper to represent salt accumulation or pesticides that are applied to or found on ground cover.



set-up

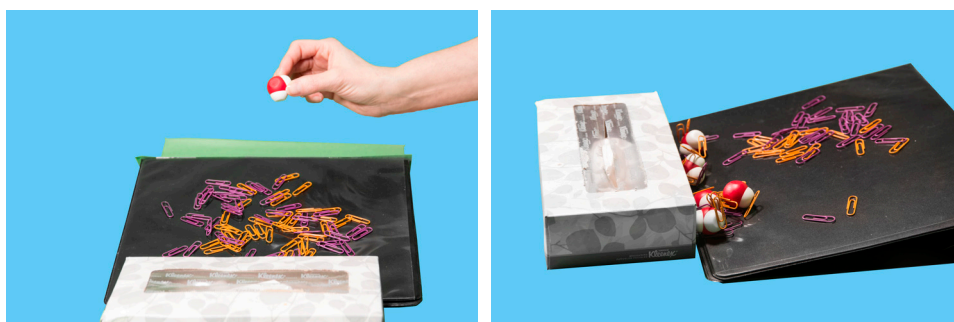
As you drop the water molecules down the hill and the paper clips move along with them, this demonstrates how nonpoint source pollution applied to ground covers moves into waterways. Note: It is common for none of the “soil” paper clips beneath the construction paper to stick to the water molecules.



result

Erosion and Pollution Prevention – Buffers

To demonstrate how environmental buffers can help prevent erosion and pollution, repeat the *Erosion via Water Runoff* or *Nonpoint Source Pollution via Water Runoff* scenarios. This time place a barrier item such as a tissue box, dry erase board eraser or block at the bottom of the slope. The barrier item represents buffers that can be planted around fields bordering bodies of water. The buffer will stop or slow the water molecules before they reach the water source. Buffers also help filter out excess nutrients before they enter the waterways.



set-up

result

Water Runoff and the Environment

Water Kit® Connections to: A Framework for K-12 Science Education Practices, Crosscutting Concepts, and Core Ideas*

Dimension 1: Scientific and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking

Dimension 3: Disciplinary Core Ideas

Physical Sciences

PS1: Matter and Its Interactions

PS1.A: Structure and Properties of Matter

PS2: Motion and Stability: Forces and Interactions

PS2.A: Forces and Motion

PS2.B: Types of Interactions

PS2.C: Stability and Instability in Physical Systems

Life Sciences

LS4.D: Biodiversity and Humans

3-LS4-4: Populations live in a variety of habitats, and change in those habitats affect the organisms living there.

Earth and Space Sciences

ESS2.A: Earth Materials and Systems

2-ESS2-2: Wind and water can change the shape of the land.

4-ESS2-1: Rainfall helps to shape the lands and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around.

Dimension 2: Cross Cutting Concepts

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

Earth and Space Sciences Cont.

ESS2.E: Biogeology

4-ESS2-1: Living things affect the physical characteristics of their regions.

ESS3.C: Human Impacts on Earth Systems

K-ESS3-3: Things that people do to live comfortably can affect the world around them. But they can make choices that reduce their impact on the land, water, air, and other living things.

5-ESS3-1: Human activities in agriculture, industry, and everyday life have had major effects on land, vegetation, streams, oceans, air, even outer space. But individuals and communities are doing things to help protect Earth's resources and environments.

*The NSTA Reader's Guide to A Framework for K-12 Science Education, National Research Council (NRC), 2011. A Framework for K-12 Science Education; Practices, Crosscutting Concepts, and Core Ideas. Washington, D.C.: National Academies Press.