This curriculum guide will lead you through the *Rain to Drain - Slow the Flow* 4-H experiment and additional activities.

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The activities in the *Rain to Drain—Slow the Flow* curriculum were written to emphasize the use of inquiry and the experiential learning model. The experiential learning model emphasizes the importance of youth being involved in each of the five stages of the model throughout their learning experiences. Youth *experience* the learning activity, *share* their experiences with others, *process* what was important about the experience, *generalize* how their experience relates to everyday experiences, and then *apply* the skills they gained to other parts of their lives. “Do, Reflect, and Apply” are ways to connect life skill development to any subject matter learning experiences.

Water is an incredibly important natural resource. We can’t live without it. We not only need water for our own daily uses, like drinking and washing, we also need water for agriculture, manufacturing, and energy production—and lots of it. Water is found in many places and in many forms on Earth. As a liquid, we can find it in lakes, rivers, and underground aquifers. As a gas, it is drifting through our atmosphere. As a solid, it is frozen in glaciers and on snow-covered mountains.

Not Enough Water

In some parts of the United States water is abundant. It many places, however, water is becoming scarce. Perhaps you have experienced a time when you have had to use less water than normal because your community was experiencing a drought. There are a number of different causes that are contributing to the decrease of water supplies in those communities. No matter what the cause, the result is that water supplies are not able to replenish themselves through rain and snow as fast as people need to use them.

Water found beneath the Earth’s surface, known as groundwater, has been decreasing rapidly in large parts of the United States in recent years. Nearly half of the US population gets its drinking water from groundwater supplies, including almost the entire rural population. Over 50 billion gallons of water used each day for agriculture also comes from groundwater. If groundwater supplies continue to get smaller, the impacts could affect many people.
This is a map of your community model in its natural state. No homes or businesses have been built here yet, and the five parcels of land are in the most natural condition they can be, which is represented by the sponges.

What was the natural environment like in the community where you live before people moved in and altered it? Was it forests, prairies, grasslands, something else? (You could discuss this question with someone who might know the answer.)
Make it Rain in Your Natural Community

1. Measure 8 oz of water in your measuring cup. We will use 8 oz of water every time we make it rain in our community, so this will be a **controlled variable** in our experiment. Controlled variables stay the same throughout an experiment.

2. Hold your rain maker bottle over your community model (8 - 10 inches above) and pour in the water from your measuring cup. *(You can move your rain maker over the model if you want, but the idea is for the rain to fall on your entire community model, but not outside the borders.)*

3. Observe where the rain water ended up after the storm in your community by looking in the cups under the model.

Measuring the Results

1. Carefully slide the blue cup out from under the muffin pan and use the measuring cup to measure how many ounces of water were captured there.

   This represents the amount of the stormwater that rained directly in the body of water (lake, river, etc.) and also the stormwater that drained from your community into that body of water. When stormwater moves across the land and directly into a nearby body of water, we refer to it as **runoff**.

   Record this runoff volume in the table.

2. The water in the other five cups, along with the water soaked up by the sponges, represents stormwater that **infiltrated** into the soil to become groundwater.

   To measure the groundwater, first squeeze each sponge into the empty measuring cup. Now lift the muffin pan off of the other five cups, and empty each of the five cups into the measuring cup as well.

   Record the infiltration volume in the table.
Using the table, calculate what percentage of the stormwater became runoff, the percentage that infiltrated, and the percentage of stormwater we lost during our experiment.

<table>
<thead>
<tr>
<th>Community—Natural</th>
<th>Total Volume Collected (ounces)</th>
<th>Total Volume of the Storm (ounces)</th>
<th>Percentage of Stormwater Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runoff into the local body of water (blue cup)</td>
<td></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Infiltration into groundwater (all other cups and sponges)</td>
<td></td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

What percentage of stormwater did you lose during your experiment? __________%  

(Lost stormwater should be 25% or less of the total stormwater; if it’s greater than that, you may want to repeat this part of the experiment while being more careful to direct your rain onto the community model. Small amounts of lost water could represent water that evaporated or that was used by plants and animals in the community.)
Glossary

- **Controlled variable**: in an experiment, something that is constant and unchanged
- **Evapotranspiration**: the process by which water is transferred from the land into the atmosphere by evaporation from the soil and other surfaces and by transpiration from plants
- **Force**: something that causes a change in the motion of an object
- **Friction**: the force exerted by a surface as an object moves across it or makes an effort to move across it
- **GIS technology**: A geographic information system, or GIS, is a computerized data management system used to capture, store, manage, retrieve, analyze, and display spatial information. Data captured and used in a GIS commonly are represented as maps.
- **Gravity**: the force with which the Earth, moon, or other massively large object attracts another object toward itself. All objects on Earth experience a force of gravity that is directed "downward" toward the center of the Earth.
- **Gray infrastructure**: refers to traditional practices for stormwater management and wastewater treatment, such as pipes and sewers
- **Green infrastructure**: an approach to water management in developed areas that protects, restores, or mimics the natural water cycle (see a list of examples on the next page)
- **Groundwater**: the water found underground in the cracks and spaces in soil, sand, and rock; the source of drinking water for many communities
- **Groundwater recharge**: the inflow of water to the groundwater system from the surface
- **Impervious surface**: constructed surfaces such as buildings, roads, parking lots, brick, asphalt, concrete, and human-made compacted soil that do not allow water to be absorbed
- **Infiltrate**: when a liquid permeates something by filtration
- **Net force**: the overall force acting on an object, or the sum of all forces acting on the object
- **Non-point source pollution**: pollution from dispersed sources like agricultural activities, urban runoff, and atmospheric deposition
- **Normal force**: the support force exerted upon an object that is in contact with another stable object; for example, if a book is resting upon a surface, then the surface is exerting an upward force upon the book in order to support the weight of the book
- **Outfall**: the discharge point of a waste stream, like a drain or sewer, into a body of water like a river, stream, or lake
- **Pervious**: a substance allowing water to pass through; permeable
- **Runoff**: the draining away of water, and the substances carried in it, from the surface of an area of land, a building, or structure, etc.
- **Soil compaction**: when soil has been compressed by foot traffic or by vehicles or equipment driven over it, decreasing the pore spaces and reducing the perviousness of the soil
- **Stormwater**: water that originates during precipitation events and snow/ice melt
- **Stream base flow**: the sustained flow (amount of water) in a stream that comes from groundwater discharge or seepage
- **Watershed**: an area of land that all drains to the same body of water
Science Standards

The following is a list of Middle School Level performance expectations from the Next Generation Science Standards (NGSS)*, which are addressed by Rain to Drain – Slow the Flow. For other grade levels, you can explore the NGSS Disciplinary Core Ideas to find appropriate performance expectations. The Cross-Cutting Concepts and Science & Engineering Practices addressed in this curriculum are also listed.

These lists are not meant to be all-inclusive, but rather a guide to incorporating Rain to Drain – Slow the Flow into a course framework.

PHYSICAL SCIENCE

**MS.FORCES AND INTERACTIONS**

**MS-PS2-2.** Plan an investigation to provide evidence that the change in an object’s motion depends on the sum of the forces on the object and the mass of the object.

*PS2.A: Forces and Motion*

LIFE SCIENCE

**MS.INTERDEPENDENT RELATIONSHIPS IN ECOSYSTEMS**

**MS-LS2-5.** Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

*LS2.C: Ecosystem Dynamics, Functioning, and Resilience*

*LS4.D: Biodiversity and Humans*

*ETS1.B: Developing Possible Solutions*

EARTH AND SPACE SCIENCE

**MS.EARTH’S SYSTEMS**

**MS-ESS2-4.** Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

*ESS2.C: The Roles of Water in Earth's Surface Processes*

*ESS3.A: Natural Resources*

**MS.HUMAN IMPACTS**

**MS-ESS3-2.** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

**MS-ESS3-4.** Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

*ESS3.C: Human Impacts on Earth Systems*

*Disciplinary Core Ideas listed in blue*
Crosscutting Concepts

Cause and Effect
- Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-4)

Stability and Change
- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)
- Small changes in one part of a system might cause large changes in another part. (MS-LS2-5)

Patterns
- Graphs, charts, and images can be used to identify patterns in data. (MS-ESS3-2)

Influence of Science, Engineering, and Technology on Society and the Natural World
- The use of technologies and any limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions. Thus technology use varies from region to region and over time. (MS-LS2-5), (MS-ESS3-2)
- All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. (MS-ESS3-4)

Science Addresses Questions About the Natural and Material World
- Scientific knowledge can describe the consequences of actions but does not necessarily prescribe the decisions that society takes. (MS-LS2-5), (MS-ESS3-4)

Science and Engineering Practices

Planning and Carrying Out Investigations
- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS2-2)

Engaging in Argument from Evidence
- Evaluate competing design solutions based on jointly developed and agreed-upon design criteria. (MS-LS2-5)
- Construct an oral and written argument supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon or a solution to a problem. (MS-ESS3-4)

Developing and Using Models
- Develop a model to describe unobservable mechanisms. (MS-ESS3-4)

Analyzing and Interpreting Data
- Analyze and interpret data to determine similarities and differences in findings. (MS-ESS3-2)

Scientific Knowledge is Based on Empirical Evidence
- Science knowledge is based upon logical and conceptual connections between evidence and explanations. (MS-PS2-2)
