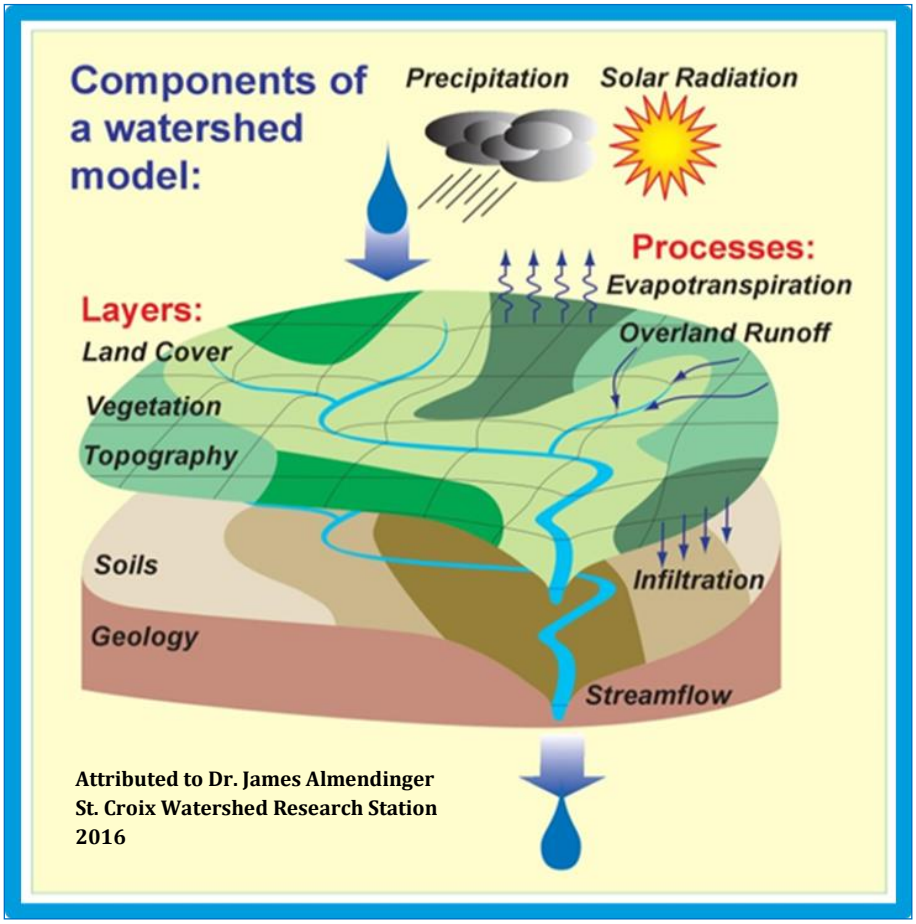
Effects of Land Cover & Soils in Watersheds

Introduction

Essential Question: What can you do to improve water quality in your watershed?

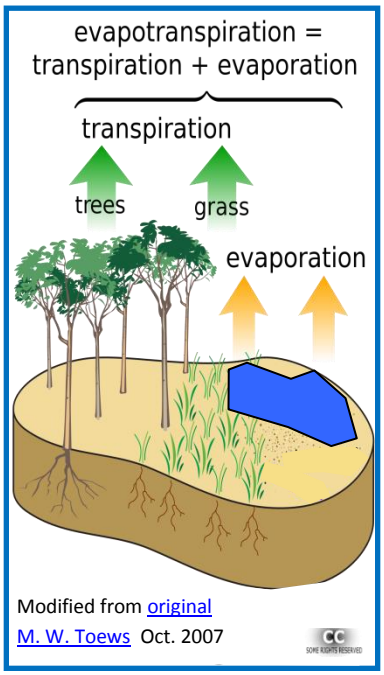
Do you know of water in your area where fishing or swimming is not allowed or where the water is not safe to drink? Water is a vital natural resource and protecting our water is a national priority. In 1972, the United States Congress passed the Clean Water Act to protect the nation's water. The goal of this important law is to make sure that our lakes, rivers, and streams are "fishable, swimmable, and drinkable." The United States Environmental Protection Agency or EPA is the federal agency responsible for enforcing this law.

However, many waterways in our country are still polluted. Almost fifty years after the Clean Water Act was passed, there are still many places that we cannot safely use for fishing, swimming, and drinking. But thanks to help from everyone, our water is improving due to improvements in land and water **conservation practices**. A **watershed** is a system defined by the area of land over which all water drains downhill through a series of streams and rivers to a common outlet (river, lake, bay or ocean). Take a moment to review the parts of a watershed in the diagram on the next page to begin this activity.



All conservation starts with the land. Gravity, topography, **soil type**, and **land cover** play important roles in **watersheds**. Gravity causes water to travel from the highest elevation to the lowest elevation in a land area. Topography refers to the elevation changes (slopes) and physical features (hills and valleys) of an area that affect the direction and speed of water flow. Soil type impacts **runoff** and **infiltration**. Different types of land cover in a watershed determines to what degree water infiltrates, accumulates (remains as puddles), or flows over the land (runoff).

- **Precipitation** (rain, sleet, snow or hail) that falls on land can either **evaporate** directly from the surface back into the air, soak into the ground (**infiltration**), or **runoff**.
- Water that infiltrates into soil with vegetation can be absorbed by the roots of plants and be released through leaves (called **transpiration**).
- **Evapotranspiration** is the term used to describe all of the water that returns to the atmosphere directly by evaporation, or by transpiration.
- Precipitation that does not return to the atmosphere via evapotranspiration may infiltrate downward through soil and rock layers as **groundwater**. Groundwater is used to supply water to many houses and cities, and it keeps streams and rivers flowing (called recharge) during long time periods without any precipitation (**droughts**).
- Precipitation that moves downhill over the surface is called **runoff**. Runoff can cause erosion when moving over land without significant vegetation and carry **sediment** and **pollution** into waterways.



Learning Objectives

- Students will identify how land cover, rainfall totals, and soil texture affect evapotranspiration, runoff, and infiltration using an interactive computational model.
- Students will interpret the impact of land cover and soil texture on the movement of water through a watershed system.

Introducing the Simulation Model

The **Model My Watershed®- Runoff Simulation** is an interactive model used to investigate how changing the type of **land cover**, amount of rainfall, and **soil type** (Hydrologic Soil Group) affects where water goes after it rains. On a computer, navigate to runoff.modelmywatershed.org (or click on the link below) to open the Runoff Simulation and discover some of the important features.

Click here to start the Runoff Simulation.

In the **Runoff Simulation**, the column in the middle has the labels ET (green in the bar graph), R (red in the bar graph), and I (yellow in the bar graph). What do these labels stand for?

R = _____ I = _____

ET = _____

Part I

Investigating Land Cover

The term "**land cover**" is used to explain what is happening on a particular piece of land. Land cover describes the physical features (types of vegetation, buildings, etc.) as well as how the land is being used (farming, residential, commercial, and undeveloped). Each land use type affects the movement of water in a **watershed** differently. In areas where there is a lot of pavement, for example, most rainwater runs off into storm drains that take the water directly to storm sewers and then to streams or rivers.

Land cover surfaces that prevent **infiltration** are called **impervious.** Land cover types that allow water to infiltrate into the ground are called **pervious**. If the land has lots of trees or unmown grass, the water can soak into the ground. Lawns are not good at soaking up water because the roots of grass are very dense and mowing makes the ground too hard to allow much water through. The same is true of row crop fields. Plowing the field into rows does the same thing that the mower does – making the soil hard.

Use the **Runoff Simulation** to investigate how each land cover type affects where water goes when it rains.

- Notice that the model displays three sections along the right-hand side, representing three different variables (**precipitation** at the top, **land cover** type in the middle, and **soil group** at the bottom). Set the "Precipitation for a 24-hour storm event" to **8.0 cm** of rain and set the "Hydrologic Soil Group" to **B-Moderate Infiltration** (silt loam or loam).
- Hover the cursor over each of the land cover choices to read the brief descriptions and answer the following questions.

1. Which land cover type has the most impervious surfaces? _____

2. Which land cover type has the most vegetation (and give the amount in %)?

_____ _____ %

3. Which **land cover** type has the least vegetation (and give the amount in %)?

_____ _____ %

- Click on the Developed – High Intensity icon as a land cover and see what happens to the amount of **evapotranspiration**, **runoff**, and **infiltration**. Record this data in the table below.
- Continue clicking on each of the other land cover types and watch how the type of land cover affects evapotranspiration, runoff, and infiltration.
- Select two other land cover types around your school and record the evapotranspiration, runoff, and infiltration results for each in the data table below **(8.0 cm of precipitation / Soil Group B)**.

Land Cover	Evapotranspiration (cm)	Runoff (cm)	Infiltration (cm)
Developed - High Intensity			

Which type(s) of land cover produces the most amount of runoff? Why?

_____

_____

_____

_____

_____

What type(s) of land cover would increase the amount of water infiltration from a storm event?

_____

_____

_____

_____

Part II

Investigating Hydrologic Soil Groups

The "dirt" in your yard is what scientists call soil. Soil is made up of broken down rocks, decomposed roots, leaves, and other organic material. Soil also contains water, air, and living things like bacteria, fungi, and protozoans. Soils have pores too, spaces between the pieces of rock and organic material that are filled with air, which allows water to soak in (**infiltrate)** and move downwards. When scientists and engineers look at different soils, they consider the size of the particles in the soil and its effect on pore size and their ability to allow water to infiltrate the soil. Smaller soil particles create smaller pores that make it harder for the water to pass through. The **Runoff Simulation** has four types of **hydrologic soils**: A-High Infiltration, B-Moderate Infiltration, C-Slow Infiltration, and D-Very Slow Infiltration.

- Set the Runoff Simulation to a **land cover** that best describes your schoolyard and record the land cover you selected at the top of the Data Table. Check to make sure the precipitation bar is set to a 24-hour storm event of 8 cm. of precipitation and the soil group is set to A-High Infiltration (sand). Record the amount of **evapotranspiration**, **runoff**, and **infiltration** that occurs.
- Select each of the other soil group types and record the evapotranspiration, runoff, and infiltration results for each in the data table below (**8.0 cm of precipitation**).

Land Cover at Your School:_____

Hydrologic Soil Group	Evapotranspiration (cm)	Runoff (cm)	Infiltration (cm)
A-High Infiltration			
B-Moderate Infiltration			
C-Slow Infiltration			
D-Very Slow Infiltration			

Progress Checkpoint: Compare the data in the table. Which **soil group** produces the least amount of **runoff**? Why do you think this happens?

_____

_____

_____

_____

_____

Analysis & Conclusion

Set the Runoff Simulation for the current conditions at your school by selecting the best match for Land Cover and Soil Group and record your choices at the top of the data table. Run the simulation with an 8.0 cm 24-hour storm event and record the results for **evapotranspiration**, **runoff**, and **infiltration.**

Land Cover:_____ **Soil Group:**_____

Evapotranspiration (cm)	Runoff (cm)	Infiltration (cm)

Given the current conditions of your school's land cover and soil type, how would you assess the impact from your school's property on the local watershed from runoff?

Which condition (land cover or soil group) would be easiest to change at your school to protect the local watershed, and why?

Application

Think about everything that you learned about **runoff**, **infiltration**, **evapotranspiration**, **land cover**, **soil type**, and **land use**. What could your school do to reduce its impact on the local **watershed**? Explain how and why your suggestions will work.

STEM Career Extension

What is a Fluvial Geomorphologist? Click on this **LINK** (or navigate to https://youtu.be/0teypmM5yeY) to watch a video about how STEM education and skills led into an exciting career at Stroud Water Research Center.

What parts of the **watershed** does a fluvial geomorphologist study? How does Dr. Daniel's research relate to the topic of **runoff** that you've been studying in this unit?