Backyard STEM

Project Area:
Environmental Science

Skill Level: Intermediate—Advanced

Learner Outcomes:

⇒ Be able to describe the difference between a riffle and a pool in a creek..

⇒ Be able to measure stream channel dimensions.

⇒ Be able to calculate stream flow rate.

Tennessee Science Curriculum Standards:

Grade 7. Geometry

Bridge Math, Applications in Geometry

Success Indicator:

Students can explain the concept of flowrate in the units of volume per time.

Science Skills:
Calculate, observe

Life Skills: Observing, Reasoning

Tags: streams, water flow rate

Materials:

Creek Critters: Home in the River

Investigating Habitats in Streams

Vocabulary Word	**Definition**
Benthic Macroin-vertebrate	Organisms that do not have a backbone and are visible to the naked eye and live in the benthos environment; benthos is the bottom of a stream channel. [abbreviated BMI]
Riffle	Stream habitat with shallow, fast-moving water and large substrates.
Pool	Stream habitat with deep, slow-moving water and small substrates.
Substrate	Eroded soil that is a pollutant in large quantities.
Watershed	The land area that drains to a common point.

GO OUTSIDE!

Take the students on a schoolyard tour of a stream or river! Measure the dimensions and time a ping pong ball floating down the channel.

Ask your students:

⇒ Which has a higher flow rate, the Tennessee River or {insert local creek name]? How do you know? Talk about how as small creeks combine to make larger streams and rivers, the flows combine to make larger flow rates.

⇒ Use your hand and arm as an example. The fingers are small creeks (or tributaries) that flow into each other to make the river, or your arm. Two arms flow together to make a bigger body of water, or your torso.

Introduce Key Concepts:

Discuss the concept of a watershed: a river is formed by the combination of many small creeks that are fed from runoff and groundwater from the land area that drains to that point, or its *watershed*. A river's watershed gets larger as you move downstream, and in turn, a greater amount of water flows in the river. Use a shoebox to represent a channel and show how a stream has dimensions of width and depth, just like the shoebox. These stream dimensions affect how water flows and the type of habitat in the stream. Two types of habitats in rivers are *riffles* and *pools*. **Riffles** are relatively short and shallow with fast moving water (or high velocity) and larger substrates (like gravel, cobbles, and boulders). Insect larvae generally live in riffles in between rocks, along stream banks, and in natural debris like leaf packs and wood. **Pools** are relatively long and deep with slow moving water (or low velocity) and smaller substrates (like sand and muck). Pools provide fish and other larger aquatic organisms shelter.

Credits: Andrea Ludwig and Jennifer DeBruyn

The overarching goal of this activity is to show students that the stream is a complex mosaic of different habitats that are formed by varying substrates, channel dimensions, and water velocities. Here, the students will see that channel dimensions and water velocity will change in any given reach of a stream but flowrate—or the total amount of water moving through the reach—will stay the same.

Indoor option:

Materials:

Chairs (at least 4, or preferably more), Stop watch, Measuring tape (at least 25'), Ping pong ball

Procedure: If possible, split class into two groups and perform the activity with two simulated channels.

- Ask the students to arrange chairs (or two lines of chairs) to act as "creek banks" for the stream channel. Make the channel as long as possible in your space available (but not longer than the measuring tape).
- Ask the students to measure 2-3 places between the banks and calculate an average channel width.
- Measure the channel length in feet.
- Then ask for a volunteer to act as the "flow." Ask the students to imagine that the volunteer is the river flow and that the flow is as deep as the volunteer student is tall. Measure the student's height, and this becomes the river's average depth.
- Give the flow volunteer the ping pong ball and ask the student to run or walk down the channel to simulate flow "velocity." Have the other students use the stop watch to time the student (moving in feet/second). This will simulate flow in a riffle.
- Ask the students to fill in the cross-section on their worksheet and calculate river flow rate.
- Repeat this process with a different channel width, taller height of "flow" volunteer, and ask them to walk slower through the channel. This will simulate flow in a pool.

Riffle Cross-section: Shallow, fast-moving water.

Outdoor Option:

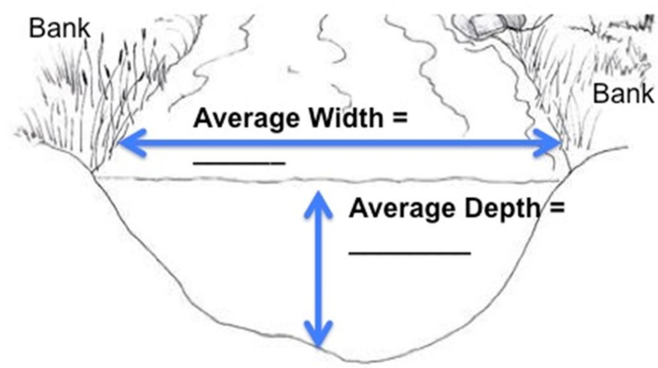
Materials:

Wading boots (optional, for all students), Stop watch, Measuring tape (at least 50'), Metal meter stick, Ping pong ball

Procedure: Class may work in small groups to measure different areas.

- Locate the nearest creek to your classroom.
- Identify a riffle and a pool, preferably wadeable.
- Ask the students to take at least three channel width measurements with the measuring tape and find the average width.
- Ask the students to take at least three water depth measurements with the metal scale and find the average width.
- Ask the students to measure out a segment along the bank, approximately 50' if possible.
- Have the students put a ping pong ball in the flow and time how long it takes to travel 50'. Ask them to calculate the flow velocity (ft/s)
- Ask the students to calculate the flow rate with the equation below.
- Repeat this process in both a riffle and pool. The calculated flows should be similar.

Pool Cross-section: Deep, slow-moving water.



Equation with units:

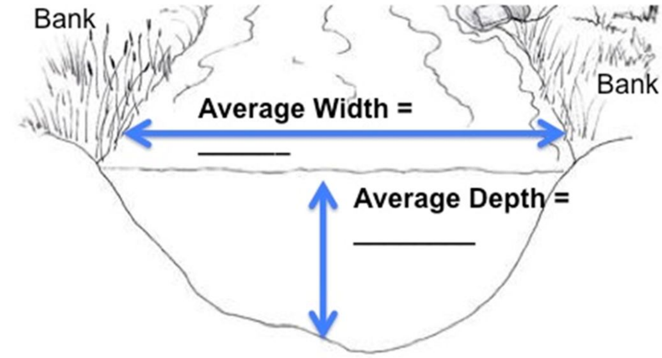
Flow Rate = Average Width x Average Depth x Velocity

Units: Flow Rate (cubic ft per second or ft^3/s) = Width (ft) x (Depth (ft) x Velocity (ft/s)

Creek Critters: Home in the River

Riffle Cross-section: Shallow, fast-moving water.

Pool Cross-section: Deep, slow-moving water.

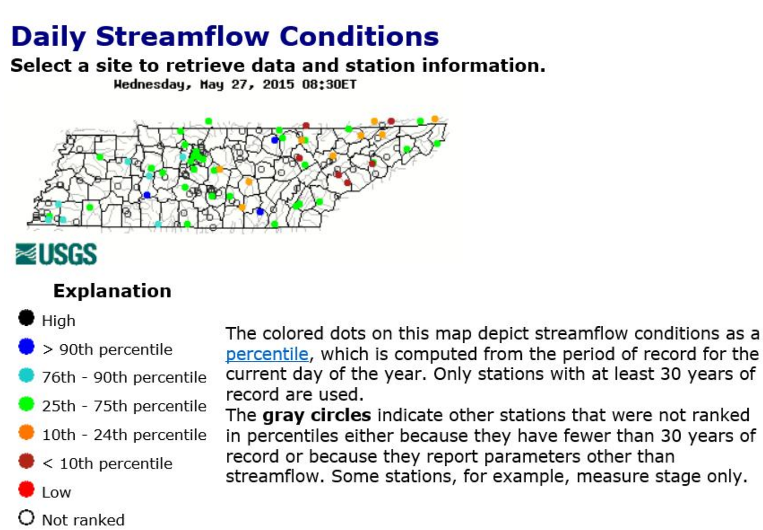


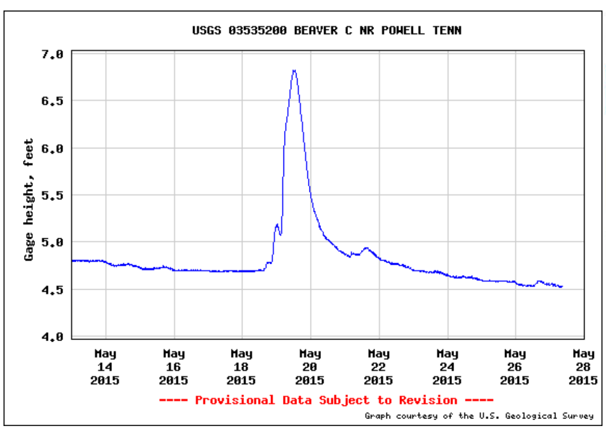
To find volume of water passing a point, multiply the flow rate (ft^3/s) by the time in question (e.g. one day, or 86,400 seconds. For example, a stream flowing at 0.5 ft^3/s will pass 43,200 ft^3 of water past a bridge in a single day.

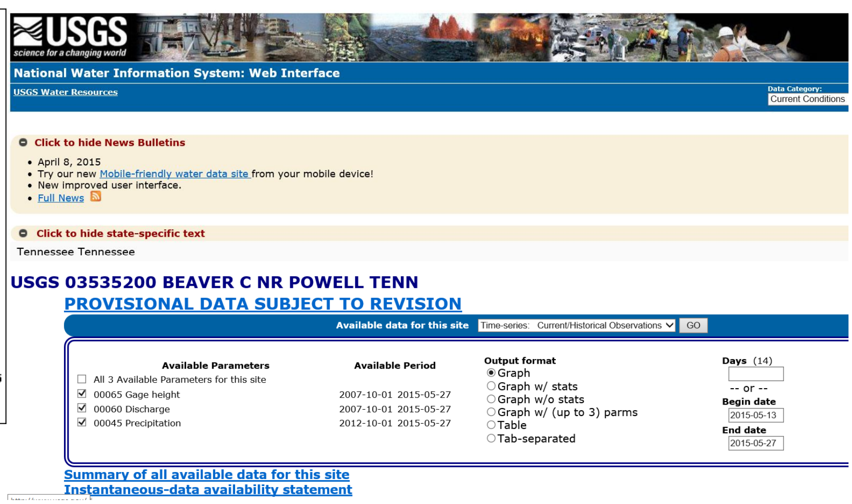
Technology Time!

Comparing and Summarizing Options:

Visit the US Geologic Survey (USGS) website and find real-time stream flow data for streams and rivers across Tennessee: http://waterdata.usgs.gov/tn/nwis/rt. Find a station close to your school, click on the station dot on the map, and show students the flow rate of the stream. Then use the graphing feature to show how the flow rate has changed over time (e.g. the past 14 days). The graph of flow rate over time is called a *hydrograph*. Use this information to ask your students questions that compare their stream flow rate data to that of the selected stream station. An example is below.







Ask your students to compare:

- How does the flow rate at the USGS station compare with the flow rate measured during the activity?
- Based on that comparison, which stream is bigger? Which stream has a larger watershed?
- How much water will pass under a bridge at the USGS station in one day? How does that volume compare to the water passing by the schoolyard stream?

References:

Adapted from http://www.rivanna-stormwater.org/aquatic.pdf