

Unit	Hydrology
Lesson	2.2 Measuring stream discharge
Essential question	How can we quantify and interpret stream discharge?
Objective	Students will be able to collect, manipulate and interpret stream discharge data.
Key words	stream discharge, velocity, cross-sectional area, thalweg
Related Standards	
NGSS standard	HS-PS2-1
AP Env Sci topic	4.6
IB Biology topic	
IB ESS topic	4.1
Suggested sequence of learning activities	<p>Classroom-based lesson:</p> <ol style="list-style-type: none"> 1. Starter quiz/prior knowledge check 2. Direct instruction (if traditional) or classroom discussion (if flipped). Slides here. 3. Students work on stream discharge database activity (print out or give electronic access to student instructions here). 4. Individual exit ticket/comprehension check <p>Additional or alternative field-based lesson:</p> <ol style="list-style-type: none"> 1. Starter quiz/prior knowledge check 2. Direct instruction (if traditional) or classroom discussion (if flipped) 3. Students go to stream to measure stream velocity, build a stream profile and calculate stream discharge. Teacher instructions here. Student worksheet here. 4. Individual exit ticket/comprehension check
Assessment	Exit ticket/comprehension check
Possible modifications	<ul style="list-style-type: none"> ● Give a keyword list (with or without definitions already included) to students before or during class ● Be intentional about student groupings (can be individual or group task with heterogeneous skill levels) ● Reduce/increase the amount of data to gather and process ● Give data tables to students to fill in.

Resources required	<p>Classroom-based lesson: internet access/computer for each student; hard copies or electronic access to student worksheet</p> <p>Field-based lesson (for each group): hard copies of student sheet for each student, floating object, timer (could be personal phone), meter stick, waders/wading shoes for students entering water, personal flotation devices (if required by risk assessment) in addition to a hard</p>
Starter questions	<ol style="list-style-type: none"> 1. What are two factors that might affect the amount of water in a stream? 2. What is the formula for velocity? What is the formula for volume?
Concepts covered in lesson	<p>Stream discharge is a measure of the volume of water that is flowing in a stream or river at any given time. Stream discharge can be measured at any point along the stream by measuring width, depth and velocity of the water. Many factors affect stream discharge including the size of the watershed that is drained into the stream and the amount of precipitation that has fallen in the watershed. Stream discharge varies along the course of the stream because of factors such as the steepness of the stream, the amount of water that is lost to infiltration into the ground, the amount of water coming in via tributaries, the amount of evaporation and the type of material at the bottom of the stream, among other factors.</p> <p>Velocity is a measurement of the distance travelled over a certain amount of time. In the case of water velocity, it is how fast the water is moving down a section of stream. A stream will have different velocities in different sections depending on the depth, the type of material at the bottom and the straightness of the section.</p> <p>Cross-sectional area is the area of a cross-section of a stream perpendicular to the direction of flow. The thalweg is the deepest point of a cross-section of stream. This is the point where there will often be the fastest velocity and the greatest erosion.</p> <p>Stream discharge can be measured by multiplying the cross-sectional area with the velocity, resulting in the volume of water that is moving down a river in a given time.</p>
Slide presentation	Link here
Activities	In-class on-line activity gathering and graphing real-life stream flow data

	<p>here</p> <p>Field activity measuring stream velocity and calculating discharge teacher instructions here. Student worksheet here.</p>
Exit ticket questions	<ol style="list-style-type: none"> 1. If a stream has a cross-sectional area of 5 m² and a velocity of 3 m/sec, what is the stream discharge? 2. What are two ways that human activities might affect stream discharge? <p><u>Answers:</u></p> <ol style="list-style-type: none"> 1. 15 m³/sec 2. Building dams upstream, removing water for drinking water or irrigation, contributing to climate change
Extension questions/activities/resources	<p>Video on measuring stream discharge with more detail here.</p> <p>Short USGS video on stream gauges here.</p> <p>Have students research a flood event that they find interesting. Encourage them to find an example of a river flood rather than a coastal flood. Examples include: Johnston PA (1889), Mississippi River (1927), St. Francis dam failure in Los Angeles (1926).</p>