**Sediment Transport**[[1]](#footnote-1)

In this exercise, we are going to estimate the flow necessary tomobilize the sediments in a streambed.

# Goals

* Practice field techniques for measuring stream discharge
* Learn basic field technique for sediment sampling
* Derive empirical coefficients from field data
* Use field data and theoretical and empirical relations to make predictions about bed mobility

# Data Collection

In small groups you will rotate through using field protocols to measure:

* Channel area
* Channel slope
* Average velocity
* Velocity profile
* Pebble counts

Different groups will measure channel geometry, velocity, and sediments at different locations and we will compile our data into a class dataset.

# Data Analysis

## Discharge:

1. Compute stream discharge using the velocity-area method.

## Sediment:

1. Calculate the median grain size from your pebble count data.
2. Enter field data into the provided spreadsheet which will generate two plots for you. The first is a cumulative frequency distribution (% finer) and the second is a simple histogram. We will use the % finer plot to estimate the median size of the bed sediment (D50). Look at your histogram – do you think that your sediment size distribution is well represented by the median value?

**TURN IN:**

Now that you have collected the field data, you need to organize, analyze, and present it. Make sure that you prepare clean, neat, and appropriately labeled and annotated figures, tables, and calculations. Show all of your work and make it *easy* for us to give you full credit.

1. Create a table (Table 1) which summarizes:
* Median **grain size (*D50*)** for each cross section.
* Mean max grain size (***Dmax*)** for each cross section.
* Mean **depth** (***d***) for each cross section.
* Mean **velocity** (***U***) for each cross section (this is the average of all your individual velocity measurements).
* **Water area** (***A***) for each cross section in square meters. Area can be estimated as the sum of all flow cells along a cross section.
* **Discharge** (***Q***), calculated using velocity-area method.
* Calculated slope(***S***) of the stream channel from longitudinal profile data. This can be done in Excel by plotting water depth data vs. distance. Use the "Add Trendline" option to create a linear regression line through the data points to determine the slope of the points. Remember to select “Display equation on chart” in the options window.
1. Submit the following figures:
	* Figure 1: A site sketch
	* Figure 2: A cross section of the river channel drawn to scale (vertical exaggeration is acceptable, but should be noted). Be sure to include the water surface elevation.
	* Figure 3: A separate cross section showing how you divided the flow area for discharge calculations. Show the velocity data points on this figure as well.
	* Figure 4: A plot of velocity distribution from the bed to the surface at the thalweg. Where is the velocity at a maximum? at a minimum?
	* Figure 5: A contour plot of the transverse (cross sectional) velocity distribution. Where is velocity fastest? Slowest? Why?
	* Figure 6: A plot of the sediment size distribution of the bed surface material showing how you determined D50.
2. Refer to the background reading and submit answers to the following questions. Answers should be given in complete sentences and include calculations:
	1. Based on the velocity, hydraulic radius and slope you surveyed, what is the roughness (*n*) of the channel according to the Manning equation? How does this value compare to the literature values presented in the background reading.
	2. Using the cross section and slope information you surveyed, and your estimate of roughness from question 1, calculate the bankfull discharge using the Manning equation.
	3. Calculate the shear stress (τ0) at the channel bed at bankfull discharge (Eq. 4 from the background reading).
	4. Use D50 determined by pebble count to calculate the critical shear stress required to mobilize the bed (Eq. 5 from background reading).
	5. Would the shear stress at bankfull flow be sufficient to initiate sediment transport? Make sure your answer quantifies bankfull discharge, shear stress at bankfull discharge, and the critical shear stress required to mobilize the bed.
	6. The **competence** of a stream is the maximum size of sediment that the stream can move. The critical velocity (Vc) required to initiate motion of these clasts is estimated to be:

$$V\_{c}=0.18D\_{max}^{0.487}$$

where Dmax is the b-axis diameter (measured in mm). and Vc is velocity in m/s.

What is the critical velocity required to move the largest clasts in the stream? Is this velocity reached at bankfull stage?

1. Exercise modified from SEIS Institute: What controls the shape of a river? https://d32ogoqmya1dw8.cloudfront.net/files/sp/process\_of\_science/courses/watersheds\_rivers\_field\_assign.pdf [↑](#footnote-ref-1)