

Surveyed Cross-Sections

Overview: Surveyed cross-sections can be used to delineate channel form, for measuring current velocity, and calculating discharge. These measurements are the basis for developing at-a-station hydraulic geometry and for long term records of stream flow. The surveyed cross-section transect is established across the stream (perpendicular to the direction of stream flow) located in a representative riffle, or specific habitat unit of interest. Endpoints of the cross-sections are established and then starting at left bank, distance and height measurements are taken along the transect line to characterize the shape and feature along the stream's profile. One or more surveyed cross-sections may be measured.

Methods:

1. Identify the cross-section transect to be surveyed.
 - a. For reaches that have previously established a cross-section benchmark (a benchmark is essentially a monument feature for surveyed cross-sections with an assumed), use the previous crew's comments and photos to relocate the benchmark and cross-section endpoints. If you are unable to locate the benchmark, move to step 2. If you are unable to locate the benchmark feature, record that this is a newly established location and move to step 1b to establish a suitable new location for the cross-section.
 - b. For reaches that have never had cross-sections collected, walk your entire reach and identify a representative riffle, or other specific habitat unit of interest. Which habitat units to survey should be driven by monitoring questions and established prior to sampling. When choosing a location to place your cross-section transect ensure that the transect is safely wadeable, has clear indicators of bankfull with one or more benches, has both ends of the cross-section that are well above the banks or at the edge of the inactive bench, has a reasonably clear view of geomorphic features and the channel section and form is typical of the reach being sampled.
 - i. In most cases transects should be placed in a representative riffle. Ensure the riffle meets the below criteria:
 1. A straight reach between two meander bends
 2. Clear indicators bankfull discharge
 3. Presence of one or more benches or terraces
 4. Channel section and form typical of the stream
 5. A reasonably clear view of geomorphic features
 6. Avoid features such as large boulders, bars, big deadfalls, etc., that have altered the extent and form of the channel.
 - ii. In some cases a specific habitat unit of interest (e.g., a pool) will be surveyed to address monitoring objectives and additional directions to select a specific applicable cross-section location will be outlined outside this protocol.
2. Stretch the measuring tape across the chosen transect and stake the tape down at the cross-section endpoints with the zero end of the tape on the left bank endpoint. The measuring tape should be level, and the end points should be placed well outside of the stream channel. If

permanent endpoint markers are being placed, use rebar with plastic caps (or other specified markers) as the endpoints. If the stream is so wide that the tape sags excessively, use a tag line that can be stretched straight. If rebar endpoints are established, stake the tape adjacent to the rebar to minimize strain on the rebar which could cause shifting over time.

3. Choose a benchmark feature, or use a relocated benchmark feature to ensure the transect location can be re-established in future visits and to establish the relative elevation of the endpoints. A benchmark is essentially a monument feature for surveyed cross-sections with an assumed elevation. A good benchmark should be located close to the cross-section and be immobile (e.g., an embedded boulder, healthy long-lived tree away from the water's edge, tree spikes, or rebar and caps). The elevation of this feature is generally assumed to be 100 m for calculation purposes unless a USGS monument is present (this is rare).
4. Record the benchmark coordinates and the Profile Station (i.e., the closest main or intermediate transect).
5. Measure and record the distance and orientation from the benchmark feature to the left bank endpoint as a descriptive comment.
6. Record a description of your benchmark feature and describe its location in relation to the left bank endpoint. Always relate your benchmark feature to your left bank endpoint for consistency.
7. Take several photos of the benchmark feature and cross-section. At a minimum, a photograph should be taken that shows your benchmark feature and left bank starting point for future crews to reference when re-establishing your cross-section. Take a close-up photo of your benchmark, with a stadia rod placed at your benchmark for repeatability. Also ensure that a photograph is taken looking downstream at your cross-section location with the tape strung across the channel. Try to capture as much of the valley bottom in this photograph as possible. Ideally stadia rods or annotations are used to identify both left and right bank endpoints. Finally take a photograph looking across the channel from the left endpoint to the right endpoint and ensure that both locations are contained in the photo.
8. Set up the autolevel and tripod in a location with a clear line of sight to both your endpoints.
9. Record your backsight measurement by placing the stadia rod on the benchmark feature and using the autolevel to read the height measurement. The backsight reading standardizes the horizontal line projected by the instrument.
10. Move the stadia rod to the left bank endpoint and begin taking measurements of height and distance for all significant features or changes in slope that occur across the channel. Each time the stadia rod is placed on a feature a distance, height, and geomorphic feature should be recorded. Continue to move the stadia rod across the channel to the right endpoint stake while the tripod remains stationary. Comments can be made about each location to give context to the data and the cross-section profile. Figure 1 and Table 1 provide an example of the collected data.
 - a. All heights are recorded in centimeters using the autolevel and stadia rod, starting on left bank at the 0 mark on the tape.
 - b. Distances are the measurements in meters to the nearest hundredth along the stretched tape in each location where the stadia rod is placed for a height reading.

- c. The stadia rod should be placed along the tape at each significant feature or change in slope. Set the rod on slope breaks (such as the edge of the low terrace), on indicators of active floodplain boundaries or bankfull discharge, and on other features of interest. For features with a large horizontal range such benches, be sure to measure both the front and back of the feature. Data collection points should be more concentrated from bankfull through the active channel to adequately capture data points for some of the most useful calculations.
 - d. Always measure the height of the water surface at the wetted edge. If an undercut bank occurs, use the aerial view of the wetted edge, do not try to measure under the bank. Comments should be made for undercut presence. A vertical bank may also have a measurement with the stadia rod placed on the streambed at the same tape distance location.
 - e. Once in the channel, place the stadia rod on the streambed and record heights at a regular interval (0.25m-0.5m intervals are commonly used) with additional measurements to capture features such as breaks in slope. Avoid the tops of isolated boulders and logs.
 - f. Geomorphic feature categories include:
 - i. Inactive Bench
 - ii. Active Bench
 - iii. Bankfull Indicator
 - iv. Left Bank/Right Bank
 - v. Wetted Edge
 - vi. Streambed
 - vii. Thalweg
 - viii. No Feature- used for breaks in slope between features, where possible a feature should be selected
11. Record a final backsight in the form to complete the cross-section. The final backsight must be with +/- 1% of your initial backsight, if it is not within 1% remeasure the entire surveyed cross-section.

Citation:

Harrelson, Cheryl C; Rawlins, C. L.; Potyondy, John P. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

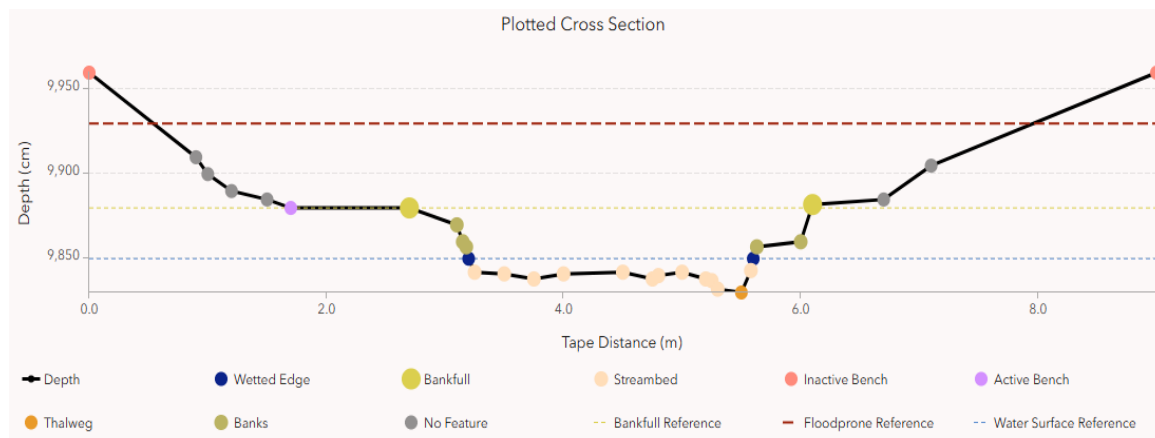


Figure 1. Graphical representation of a surveyed cross-section.

Table 1. Data values for a surveyed cross-section including the measurement number, tape distance, height, calculated elevation based on the assumed benchmark elevation, and the geomorphic feature

Measurement number	Tape distance (m)	Height (cm)	Elevation (cm)	Geomorphic Feature
Benchmark	NA	10	10,010	Benchmark
1	0.00	50	9,960	Inactive Bench
2	0.90	100	9,910	No Feature
3	1.00	110	9,900	No Feature
4	1.20	120	9,890	No Feature
5	1.50	125	9,885	No Feature
6	1.70	130	9,880	Active Bench
7	2.70	130	9,880	Left Bankfull
8	3.10	140	9,870	Left Bank
9	3.15	150	9,860	Left Bank
10	3.18	153	9,857	Left Bank
11	3.20	160	9,850	Wetted Edge
12	3.25	168	9,842	Stream Bed
13	3.50	169	9,841	Stream Bed
14	3.75	172	9,838	Stream Bed
15	4.00	169	9,841	Stream Bed
16	4.50	168	9,842	Stream Bed
17	4.75	172	9,838	Stream Bed
18	4.80	170	9,840	Stream Bed
19	5.00	168	9,842	Stream Bed
20	5.20	172	9,838	Stream Bed
21	5.25	173	9,837	Stream Bed
22	5.30	178	9,832	Stream Bed
23	5.50	180	9,830	Thalweg
24	5.58	167	9,843	Stream Bed
25	5.60	160	9,850	Wetted Edge
26	5.63	153	9,857	Right Bank
27	6.00	150	9,860	Right Bank
28	6.10	128	9,882	Right Bankfull
29	6.70	125	9,885	No Feature
30	7.10	105	9,905	No Feature
31	9.00	50	9,960	Inactive Bench