

Standard Operating Procedure 4: Cross-Section Surveys

Version 1.0, June, 2018.

Change History

Original Version #	Date of Revision	Revised By	Changes	Justification	New Version #

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Overview

This Standard Operating Procedure (SOP) outlines the steps and location descriptions necessary to conduct cross-section surveys at continuous water quality monitoring sites that are maintained by the Eastern Rivers and Mountains Network (ERMN). These steps were adapted from U.S. Geological Survey techniques (USGS; Wagner et al., 2006; Wilde, 2008) and must be followed closely for trends in river water quality to be documented accurately.

As described by Wagner et al. (2006), data from cross-section surveys can be used to correct single-point measurements in poorly mixed streams to better represent the cross-section average. Cross-section corrections may not be needed by choosing a monitoring site with well-mixed flow; nonetheless, cross-section surveys must be conducted to verify that river water is thoroughly mixed and that cross-section corrections are not required.

A sufficient number of cross-section surveys at each monitoring site, conducted during different flow conditions are required to determine if discharge or seasonal changes significantly affect mixing in the cross section, and in turn, affect results from ERMN river water quality monitoring sites. A minimum of two cross-section surveys per year is required at each monitoring site to verify or revise results from previous surveys. Temporal changes in cross-section variability at some sites may require more frequent surveys. Documentation of vertical mixing is required at least once per year at a minimum of two depths for all cross sections.

The most efficient means of obtaining cross-section surveys is with a calibrated multiparameter water quality monitor (hereafter, monitor) that can measure the same parameters that are measured at monitoring sites. The process for conducting Equal-width Increment (EWI) cross-section surveys provided below was adapted from Wilde (2008). All data associated with this process are recorded on data sheets developed by USGS (see SOP 5, Data Management).

Cross-section Survey Locations

In addition to conducting cross-section surveys directly adjacent to monitoring sites, the ERMN conducts cross-section surveys upstream, and downstream of each monitoring site when possible to determine the longitudinal extent to which river water quality monitoring data are applicable (Table 1; Figures 1- 4). The upstream and downstream cross-sections are 1.0 km from continuous monitoring sites unless islands, rapids, or unsafe conditions are present. In those situations, cross-sections are sited at ideal locations ≤ 2.0 km from each monitoring site.

Table 1. Cross-section survey locations at Eastern Rivers and Mountains Network continuous water quality monitoring sites. Latitude and longitude coordinates are provided for left edge of water (facing in flow direction). New River coordinates are in zone 17S and Delaware River coordinates are in zone 18T.

River	Park	Site	Survey Location	Distance (km)	Easting	Northing
Delaware	Upper Delaware SRR	Lordville, NY	Upstream	1.0	483189.95	4635241.18
			Monitor	--	482287.23	4635080.93
			Downstream	1.0	481795.45	4634300.95
Delaware	Delaware Water Gap NRA	near Montague, NJ	Upstream	1.0	517296.50	4573922.52
			Monitor	--	517164.93	4573042.00
			Downstream	1.0	516356.79	4572466.08
Delaware	Delaware Water Gap NRA	Delaware Water Gap, PA	Upstream	1.3	494019.80	4540682.50
			Monitor	--	492830.01	4540285.71
			Downstream	2.0	491192.00	4539257.00
New	New River Gorge NR	Thurmond, WV	Upstream	1.0	493977.77	4199964.84
			Monitor	--	493322.98	4200688.64
			Downstream	1.0	492589.00	4201416.00

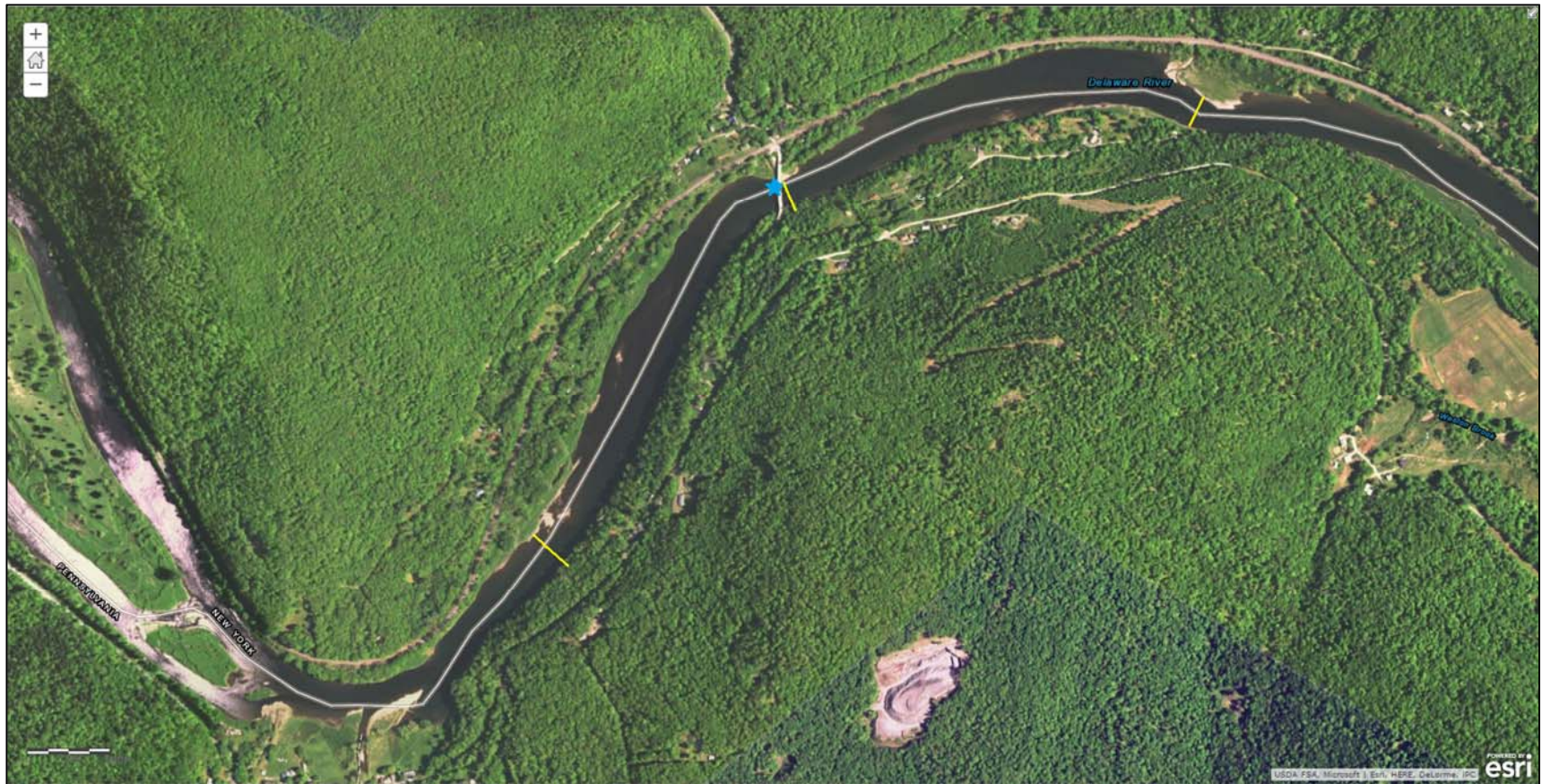


Figure 1. Approximate cross-section survey locations (yellow lines) relative to the Eastern Rivers and Mountains Network continuous water quality monitoring site (blue star) on the Delaware River at Lordville, NY.

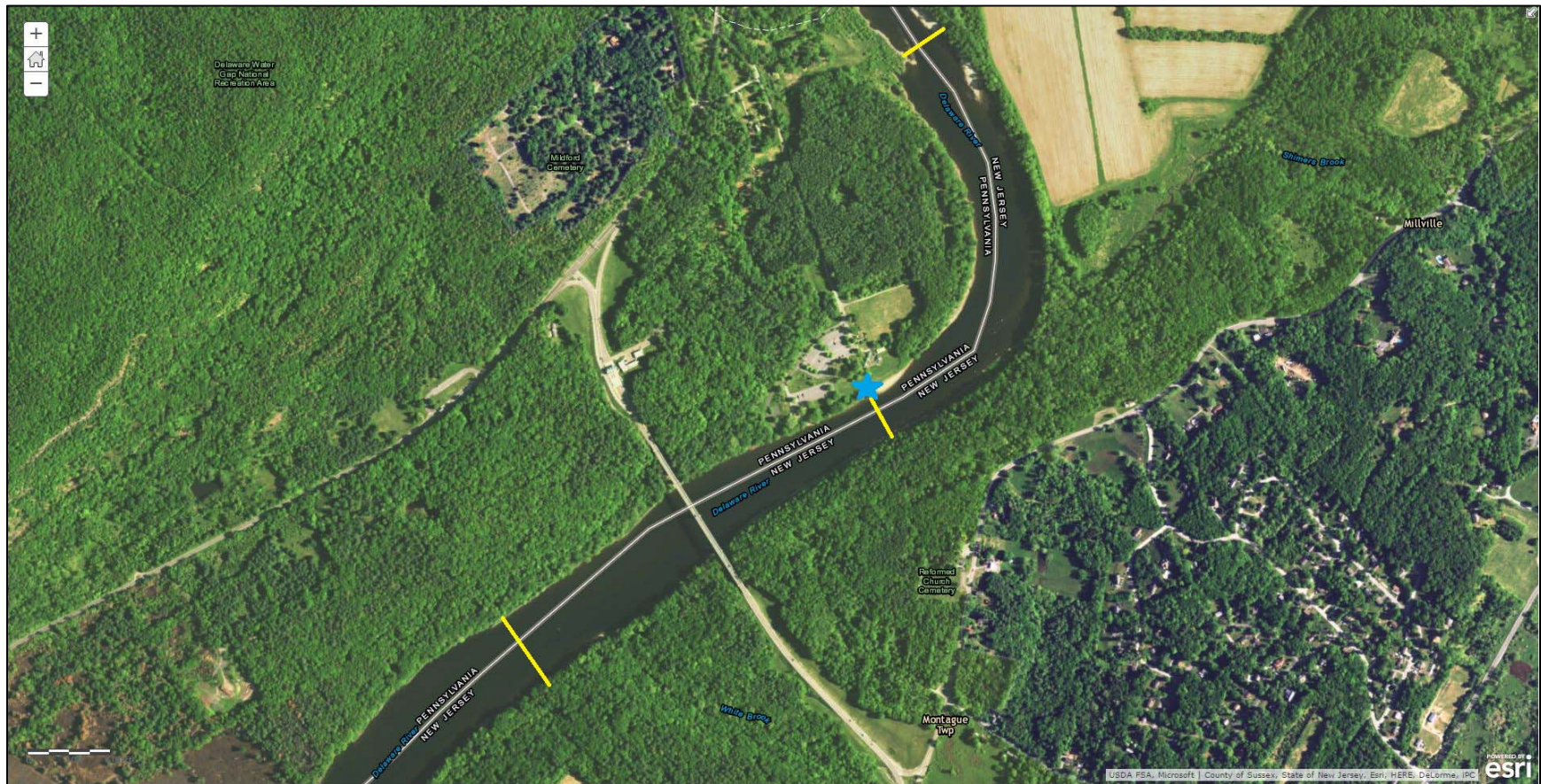


Figure 2 Approximate cross-section survey locations (yellow lines) relative to the Eastern Rivers and Mountains Network continuous water quality monitoring site (blue star) on the Delaware River near Montague, NJ.



Figure 3. Approximate cross-section survey locations (yellow lines) relative to the Eastern Rivers and Mountains Network continuous water quality monitoring site (blue star) on the Delaware River near Delaware Water Gap, PA.



Figure 4. Approximate cross-section survey locations (yellow lines) relative to the Eastern Rivers and Mountains Network continuous water quality monitoring site (blue star) on the New River near Thurmond, WV.

Procedure for Conducting Equal-Width Increment Cross-section Surveys

The EWI method (Wilde, 2008) is used at cross-sections that are relatively uniform in terms of depth and velocity; therefore, the ERMN conducts field-measurement discharge profiles of stream variability (Wilde, 2008) at least once every two years to demonstrate that the EWI approach is appropriate for conducting cross-section surveys at ERMN river water quality monitoring sites.

The overall goal of the cross-section survey is to compare water quality of a point measurement (i.e., the monitor or pump intake location) to transect measurement(s); therefore, timing of measurements is an important consideration because each cross-section survey can take up to an hour. Water quality conditions change throughout the day regardless of the time; therefore, it is best to have two measurements from the monitoring site (i.e., data collection platform, DCP) that bracket the timing of cross-section measurements. Be sure to use the MS Excel “toolkit” (Figure 5; modified from USGS) which is macro-enabled to automatically calculate and plot pertinent statistics (Figure 6).

To conduct a EWI cross-section survey:

1. Conduct calibration checks and calibrate (if necessary) a monitor that is equipped to measure core parameters.
2. Ensure that the continuous water quality monitoring system at the site is functioning properly and that the DCP program is running (SOP 2). A minimum of two measurements from the monitoring system, which are recorded near the top of the hour (e.g., 12:04) at most sites (Lordville, NY = 15 min interval), will be compared to the cross-section survey that is conducted between those points in time. Ideally, the monitoring site system (e.g., pumps and DCP) should be manually operated by a technician during the cross-section survey to take measurements for comparison.
3. Divide the river cross-section into increments of equal width:
 - a. Visually inspect the river from bank to bank, observing velocity, width, depth distribution, and the apparent distribution of sediment and aquatic biota in the cross section. Note the location of stagnant water, eddies, backwater, areas of faster than normal flow, and piers or other obstructions.
 - b. Determine river wetted width by using a rangefinder.
 - c. Divide the cross-section into 10 increments of equal width based on flow and stream-channel characteristics in addition to observed field-measurement variability during the cross-section discharge profile (this could be from previous profiles). This interval width will govern the number of vertical measurements used.

- d. Locate the midpoint of the first vertical at a distance of one-half of the selected increment width from the edge (e.g., in a 100 m-wide river that has been divided into 10 increments of 10 m each, the first vertical measurement would be 5 m from the water's edge, and subsequent midpoint vertical measurements would be at 15, 25, 35 m, and so forth, from the starting point at water's edge; Figure 5).
4. Measure core parameters at the midpoint of each equal-width increment¹.
 - a. Determine and record river depth using boat depth finder.
 - b. Lower monitor to half the river depth and record core parameter values within 60 seconds after the sensors have equilibrated with the river water.
5. Use the "toolkit" (Figure 5) to calculate the: 1) mean of midpoint measurements and 2) area-weighted median measurements for core parameters.
 - a. To calculate an area-weighted median, multiply the area of each increment by its corresponding field measurement, sum the products of all the increments, and divide by total cross-section area.
 - b. In the example (Figures 5 and 6), the area-weighted median conductivity equals 99.7 $\mu\text{S}/\text{cm}$. If the specific conductance (SC) reported were selected at mid-depth near the vertical of centroid of flow (section 5), it would have been reported as 98.9 $\mu\text{S}/\text{cm}$; if the conductivity reported were near the left edge of the water (section 1), it would have been reported as 104.7 $\mu\text{S}/\text{cm}$.
6. Compare mean and area-weighted median cross-section values to measurements recorded concurrently at monitoring sites (i.e., automated measurements recorded by the DCP) to determine/verify representativeness of continuous monitoring data collected at monitoring site (Figure 6).
7. When appropriate, perform cross-section correction(s) based on cross-section data at monitoring site using procedure in SOP 5 only if: a) the variability in the cross section exceeds data-correction criteria (see SOP 5) and b) sufficient cross-section surveys have been made to accurately define the variability of the physical property (Wagner et al., 2006).
8. Determine longitudinal extent to which monitoring data are representative on cross-sections conducted upstream and downstream of monitoring sites.

¹ Although it is not typical at ERMN monitoring sites, multiple vertical measurements may be required depending on the degree of vertical mixing. If physical or chemical vertical stratification is observed (i.e., beyond data-correction criteria), the number of vertical measurements may need to be increased from mid-depth to two measurements (0.2 and 0.8 of the depth) or more.

ERMN River Water Quality Monitoring Protocol and Quality Assurance Plan

Instructions:																																																																																																																																																																																																																																																																																																																																																																																								
Populate with site info:				Do not change time formatting. Obtain comparison readings @ site monitor @ start and end of cross section. Obtain any 15-min site monitor punches during cross-section. Service site monitor prior to cross-section. Obtain cross-sectional measurements 2x/yr and vertical profiles at each station 1x/yr at a minimum of 2 depths.																																																																																																																																																																																																																																																																																																																																																																																				
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At Site (After)				1300		16.62		16.64		101.1		101.6		2.6		2.4		9.96		9.86		100.2		100.6		7.52		7.50																																																																																																																																																																																																																																																																																																																																																												

Figure 5. Example of a completed Equal-Width Interval cross-section survey spreadsheet that was developed by USGS and modified by the Eastern Rivers and Mountains Network (ERMN). Parameters that ERMN does not monitor were retained in the file but are not currently used.

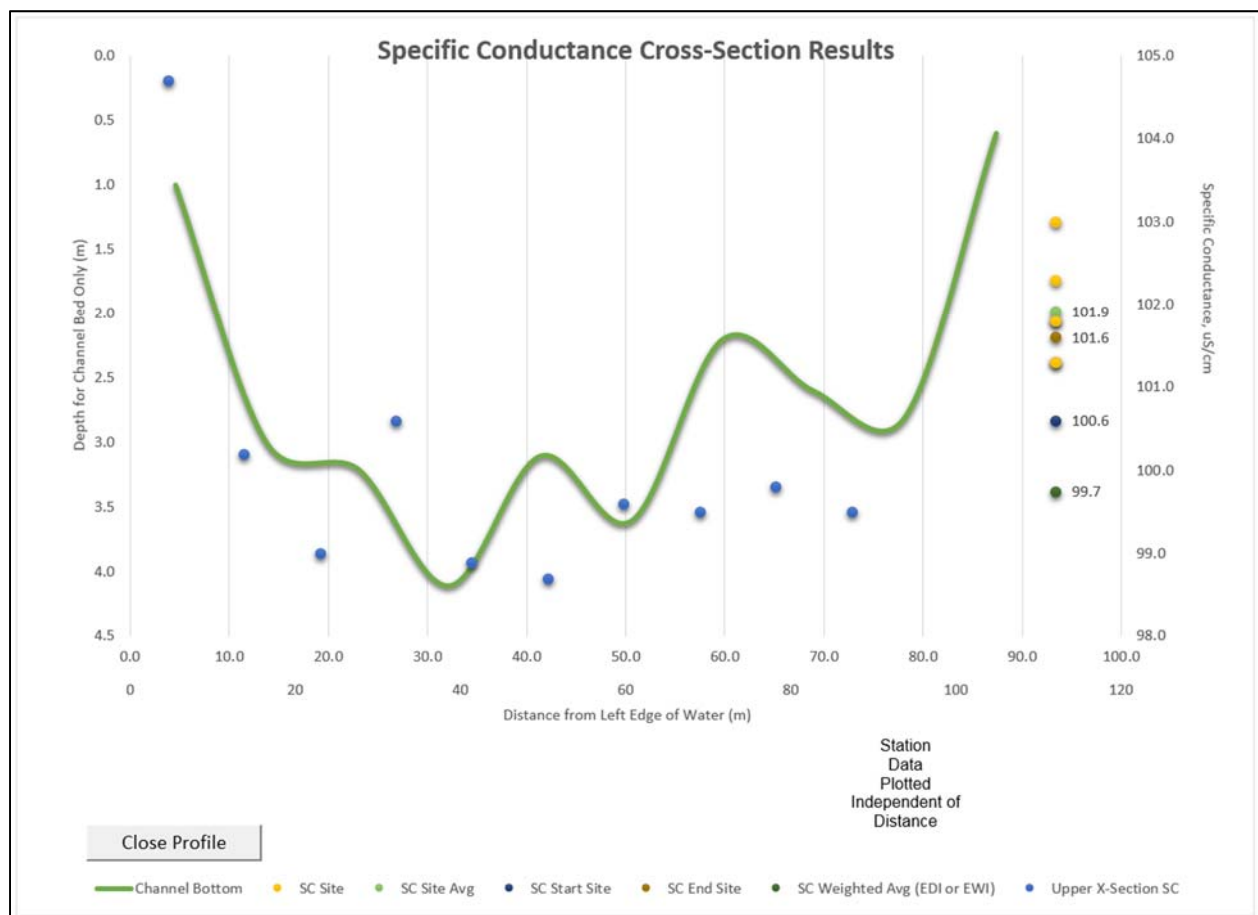


Figure 6. Example of an Equal-Width Interval cross-section survey plot that was automatically generated by the cross-section “toolkit” developed by USGS and modified by the Eastern Rivers and Mountains Network (ERMN).

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