

Northern Great Plains Network

National Park Service



Using a Total Station to Conduct a Stream Survey

Stream Channel Monitoring

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Summary

This standard operating procedure (SOP) discusses how to use a total station to conduct a stream survey for NGPN Stream Channel Monitoring (Thornbrugh et al. 2019). The procedures are adapted from the Southeast Coast Network SOP 1.2.18 Using a Total Station to Conduct a Stream Survey—Version 1.0 (McDonald et al. 2018).

Revision Log

Previous Version	Revision Date	Author	Changes Made	Reason for Change	New Version
1.0	3/11/24	A.Rosse	Provide details related to operation of Trimble SX 10/12	Details previously missing	1.1
			List codes, point names, and diagnostic points used during survey	Details previously missing	1.1
			Added steps to get data off data collector and ready for TBC	Details previously missing	1.1

NGPN will implement the peer-reviewed and approved protocols and methods in SECN's SOP 1.2.18 Using a Total Station to Conduct a Stream Survey—Version 1.0 (McDonald et al. 2018). Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2254016>

Differences in methods

- NGPN uses rented, not owned SX 10/12 and a rented data collector, typically TSC 5 or higher.
- NGPN will use the same survey codes as SECN.
- NGPN will conduct the survey in the State Plane System, not in UTM's.
- NGPN numbers points differently, incorporating the transect name, t1-1, t1-2 instead of 1001, 1002.

Equipment/Materials List

- Trimble SX10/12 Total Station
 - Batteries
 - Battery charger
- Tripod for total station
- Trimble TSC5/7 data collector*
 - fully charged
 - antenna
 - data-logger rod-mounting cradle
- Prism and rod (with level)
- Bi-pod for prism rod
- Tape measure
- Compass
- Survey wire and chaining pins (6)
- Measuring tape
- Clipboard
- Forms 3 (three copies) and 3a (Appendix A)

- Pencil

Total Station Setup and Configuration

Refer to *SCM SOP Setting Up and Configuring a Total Station 1.1 (2024)* for instructions on how to setup and configure a Trimble SX 10/12 robotic total station using a TSC5/7 handheld data collector.

Procedures

The goal of the detailed transect surveys is to collect data to characterize the cross-sectional morphology of the detailed transects, by collecting distance and elevation data to allow for the identification and quantification of erosion and fluvial development, and provide an understanding of the out-of-channel features or habitats that characterize or influence the reach. The primary benchmark is the benchmark on which the total station is set up. The secondary benchmark is the mark on the opposite bank. The primary benchmark is ideally on the left bank but that can be switched depending on access. It is not advisable to carry the SX 12 or total station through more than a little water.

When beginning the detailed transect survey, the surveyor should first secure the measuring tape on the off-channel side of the primary benchmark, run it so it passes directly over the benchmark, over and past the secondary benchmark on the other bank. Secure the tape with chaining pins. If the terrain and water surface does not allow a measuring tape, a mason line can be used instead. The resulting lines will assist the surveyor in keeping a straight course along each transect during the survey. Ideally, the first total setup is on the benchmark that has a line-of-sight to two other benchmarks (this other benchmark will serve as the backsight). However, most NGPN parks have too much terrain and vegetation to have line of sight to the other benchmarks. In that case another known position must be marked, the backsight.

Locations of benchmarks and backsights should be recorded using high-accuracy GNSS methods (Ntrip, Opus, RTX satellite) which will be referenced in another SOP. Locations of the benchmarks and backsights should be stored N:\Monitoring\Stream_Channel\PARK\GIS and also in each year's data folder.

Prior to setting up the total station over each benchmark, walk the transect and fill out Form 3 (Appendix A). The purpose of Form 3 is to provide a context for the points that will be surveyed along each transect. Be sure to note the presence or absence of diagnostic geomorphic surfaces (e.g., floodplain or terrace) and provide a short description of the riparian habitat on each side of the stream (i.e., ground cover and presence/absence of woody plants)

Finish this initial reconnaissance by drawing a quick sketch of the cross-section with annotations that will help interpret the data by identifying the top of the bank (bankfull and/or channel full), bottom of bank, presence of emergent mid-channel bars, and any other noteworthy features. Once

Form 3 has been filled out, set up the total station, name the project according to the PARK, reach number, and date of survey, and then begin surveying (see *SCM SOP Setting Up and Configuring a Total Station 1.1 (2024)* for more details).

The following procedure is an idealized survey and modifications may need to be made depending on the characteristics of each reach:

Start on the side of the river where the benchmark is located (usually river left). Collect the first point far enough and high enough away from the stream to characterize the out-of-channel area beyond the benchmark. If possible, survey a point that is at a height that is twice the bankfull depth above the channel bed. Refer to any previous surveys to determine appropriate extent. Mark the starting location (river left or river right) on Form 3.

Select 'Measure Topo' from the 'Measure' menu (Figure 1). On the 'Measure Topo' screen, first define the point name. The point name will be a number that corresponds to the transect and point number recorded. For example, the first detailed transect's (BM 1's) first point will be t1-1, the second detailed transect's (BM 6's) first point will be t6-1, and the third detailed transect's (BM 11's) first point will be t11-1. After recording each point, the last digit will automatically change to the next in the series (e.g., BM 6's points will be t6-1, t6-2, t6-3).

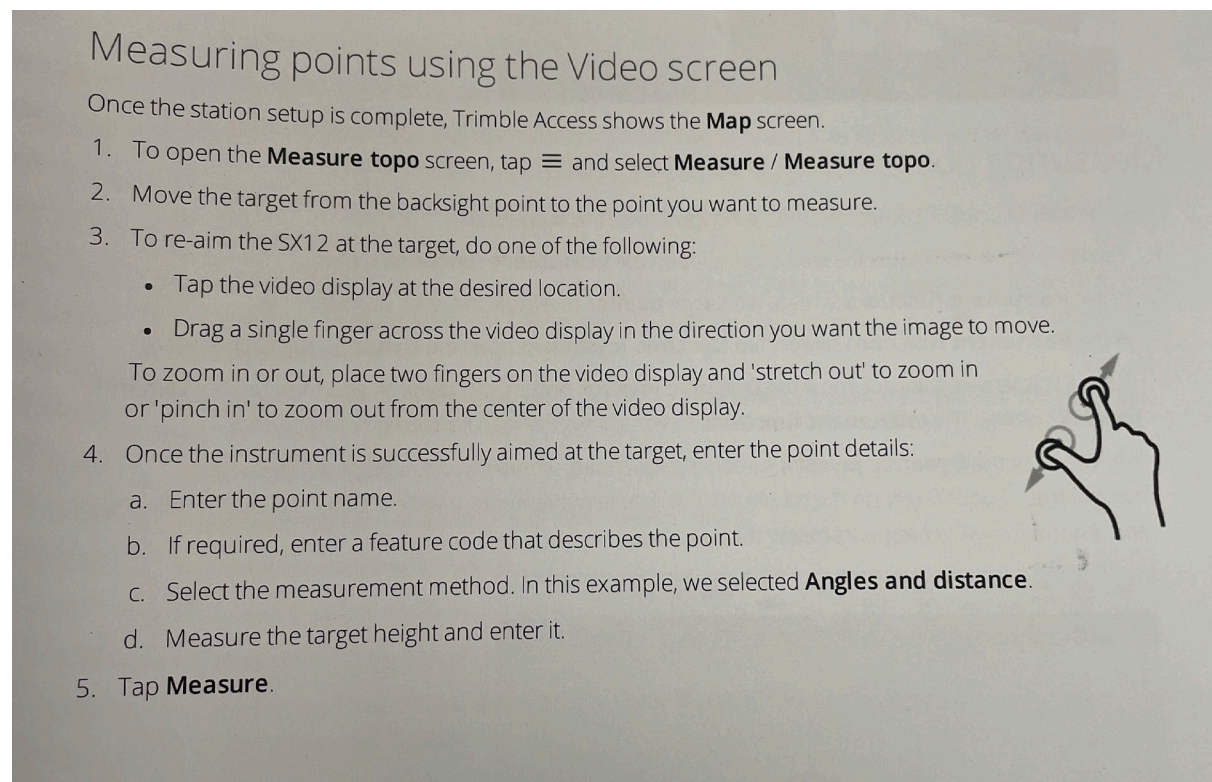


Figure 1. Measuring topo on a TSC5. (DP 2022)

IMPORTANT: The target icon should be set up correctly and should be visible in the top screen of the Trimble Access map on the data collector when taking topo points. Target height is measured from the ground to the center of the prism when on the pole. A generic 2 m range pole with a prism on top is not a 2 m target. NGPN owns one prism pole specifically to use with the prism, the notches on that do correspond to target height when the prism and extension is on top. MEASURE the pole with prism on top before beginning surveying and be consistent. Be sure the prism is screwed all the way down and is secure. Prism poles have different height notches, if height is changed to avoid a high bank or vegetation, be sure the target height is recorded correctly. The SX 10/12 has the ability to use a laser target. However in vegetation, this has been found to be extremely unreliable. Use a prism pole where possible.

The code will also be recorded when taking the topo points. Table 1 lists the diagnostic codes and their position on the landscape while Table 2 lists the code prefixes and suffixes used to create those codes.

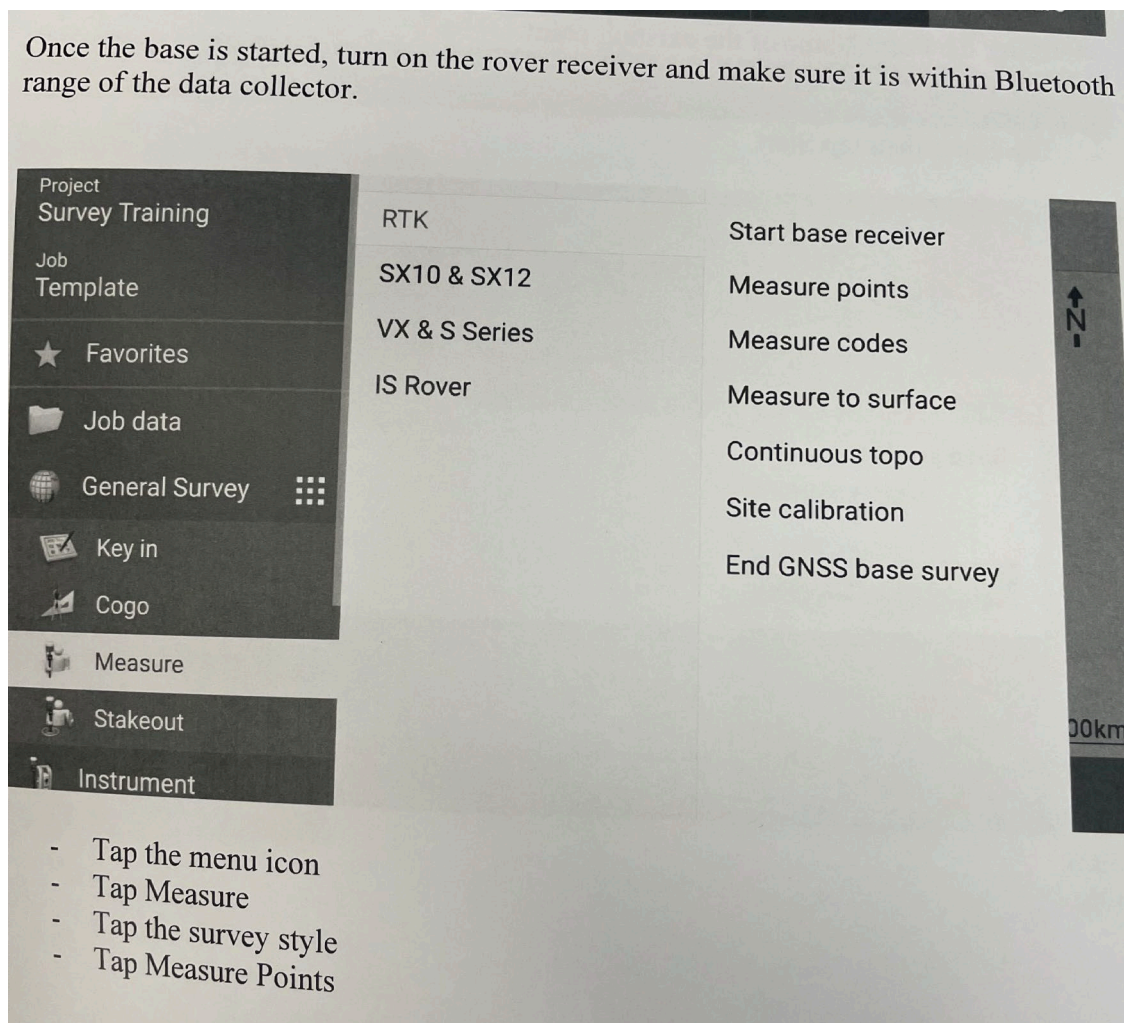


Figure 2. Measuring topo/points on a TSC5. Note this particular option does not show the SX 10/12, which would be the one we should use (DP 2022).

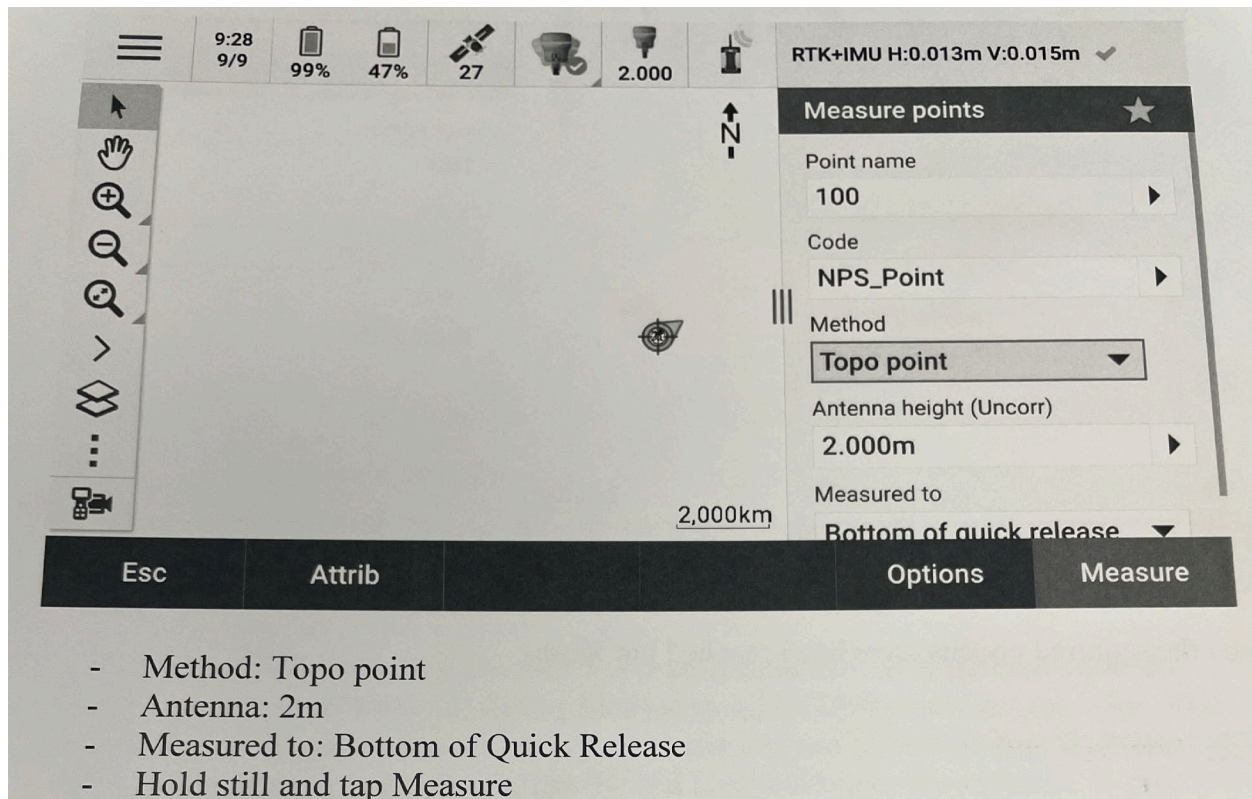


Figure 3. Measuring topo/points on a TSC5. Note this particular option shows measuring points using the R12i instead of the SX 10/12 and prism pole as target. (DP 2022).

After point name is filled in, enter the appropriate diagnostic code in the 'code' field, then stand still and hit measure, then store.

Table 1. Position and Code. Codes in bold are the special diagnostic points while the remaining codes are the default and are the same as the position. Figure 4 is a diagram showing the relation position of the points with the codes also included.

Position	Code	Location
LBMOC	LBMOC	
LOC	LBM	left benchmark
LOC	LOC	
LOC	LCF	left channel full
LOC	LOC	
LOC	LFPM	left floodplain margin
LOC	LOC	
LOC	LOC	
LOC	LBF	left bank full
CH	CH	
CH	LBB	left base of bank
CH	CH	
CH	LWE	left edge of water
CH	CH	
CH	TH	thalweg
CH	CH	
CH	CH	
CH	RWE	right edge of water
CH	CH	
CH	CH	
CH	RBB	right base of bank
ROC	RBF	right bank full
ROC	ROC	
ROC	ROC	
ROC	ROC	
ROC	RFPM	right plain margin
ROC	ROC	
ROC	ROC	
ROC	RCF	right channel full
ROC	ROC	
ROC	ROC	
ROC	ROC	
ROC	RBM	right bench mark
RBMOC	RBMOC	

Table 2. Prefixes and suffixes used to create point codes. (SECN 2022).

Point Code Name	Abbreviation
Left	L-
Right	R-
Benchmark	-BM
Backsight Point	BS
Out of channel	-OC
Channel full	-CF-
Floodplain Margin	-FPM
Bank full	-BF-
Bottom of Bank	-BB
Water's edge	-WE
Channel	CH
Longitudinal Profile	LONG
Water Surface	WS-

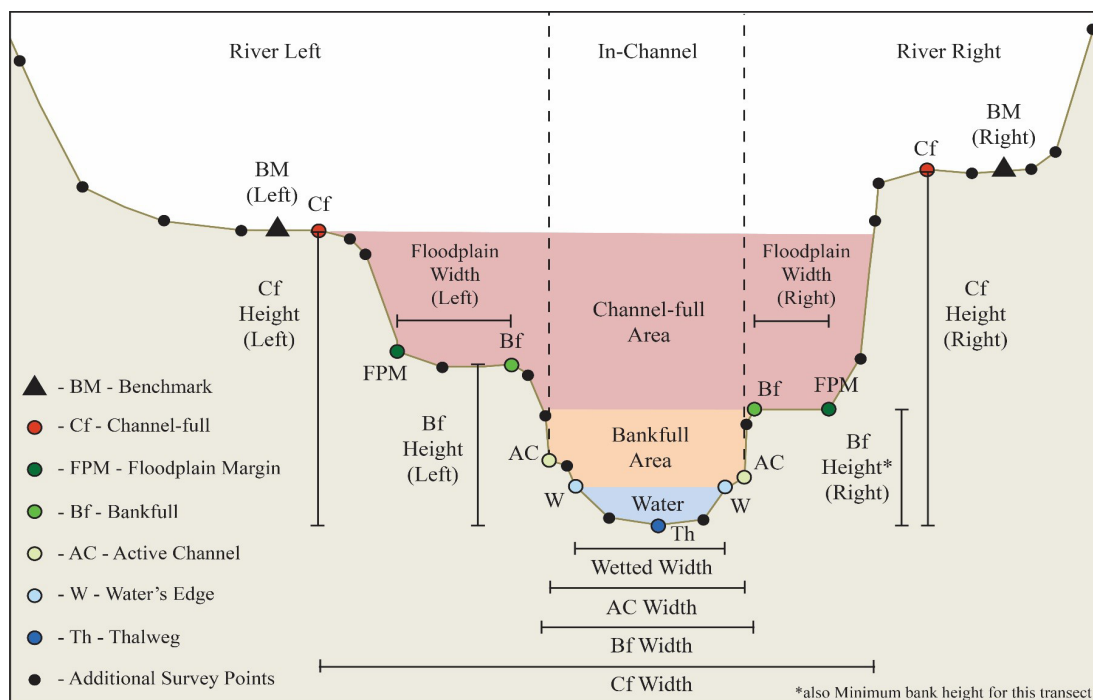


Figure 4. Stream cross-section with location of survey points. Triangles indicate benchmarks and colored points indicate the various potential diagnostic points with abbreviations and description. Black points represent unnamed survey point locations needed to accurately represent cross section. The blue water surface point needs be surveyed on all 11 transects. NOTE: Be sure to survey the left benchmarks ((SECN 2022).

Once the first point is surveyed, collect points along the installed survey line that runs between the left and right benchmarks, plus some points beyond the benchmark. Point spacing should be slope-dependent and should be close enough to accurately represent local slope (i.e., greater slope = more points). Every half meter could be measured on flat ground, while important areas of slope change like banks could be more like every 5-10 centimeters depending on the slope, just so good coverage of the slope is made.

While conducting the survey, be sure to collect all of the diagnostic points from Table 1 that are present (e.g., channel-full (bank-top), bankfull (bank-top), and edge of water) as well as additional points between each diagnostic point to accurately capture topographic variability (Figure 4).

Finish the detailed transect by surveying a point far enough and high enough away from the stream to characterize the out-of-channel area beyond the secondary benchmark. If possible, survey a point at least two times higher than bankfull depth on the side opposite the total station.

Once the detailed transect has been surveyed, record all longitudinal profile points visible from this setup. The longitudinal profile points should be taken on the water surface in the middle of channel at each standard transect (1–11). So that an accurate representation of the energy grade line within the reach can be created, water surface points also should be collected on riffle- and step-tops. Record which longitudinal profile points were surveyed from each benchmark on Form 3. Water surface points should be named WS## (e.g., water surface on transect 1 labelled as WS01) and use the code 'LONG' for these points.

Note: When processing the data, the benchmark on river left (regardless if left or right) will be used to compare all subsequent surveys. Be ABSOLUTELY SURE the river left benchmark is surveyed if the total station is not set up on it. The right benchmark should be surveyed as well.

Once all of the points are recorded (see **Note** above) be sure to select 'End Conventional Survey' in the 'Measure' menu (Figure 1) to save the points.

Upon completing the transect survey and before moving on the next transect, take a hydration break (5 minutes minimum).

Repeat these steps until all three of the detailed transects have been surveyed and all longitudinal profile points (transect water surfaces and riffle- and step-tops) have been recorded.

Points should be reviewed under 'review job' option to ensure nothing was missed before leaving the site. Scans can be taken of the site as the scanner has that capability, but scanning is not currently part of the protocol. See reference material on N:\Monitoring\Stream_Channel\Miscellaneous\SX-10 info for additional help.

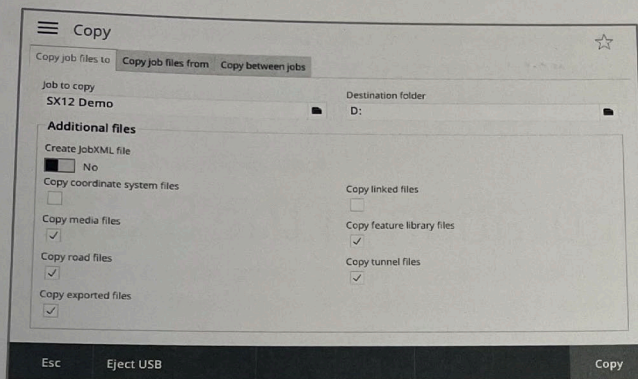
Once back at the office, the data should be taken off of the data collector and saved from import into Trimble Business Center. Follow the instructions in Figure 5 below.

Copying the job

Use the **Copy job files to** function to copy the job to a different location. This could be a removable external drive such as a USB drive or, if the controller is connected to your office network, it could be a folder that you have access to on the network.

1. Tap  and select **Job**, and then tap **Copy**
2. In the **Copy** screen, select **Copy job files to**.

2 Working with the SX12



TSC 5
- connect w/ lightning
- copy job files to
- job to copy
destination folder
(on data controller)
should be able to
copy from file
explorer.

3. Browse to and select the **Job to copy**.
4. Tap  to select the **Destination folder** for the copied job.
You can select a folder on any available drive, such as a network drive or a USB drive.
5. Select the folder for the copied job from the **Select folder** screen. Tap **Accept**.
5. To copy project files associated with the job, select the appropriate check boxes.
7. Tap **Accept**.

Figure 5. Export Procedures from TSC5/7 Trimble Access to laptop (DP 2022).

Literature Cited

Duncan Parnell. 2022. NPS Geodetic Survey Training 2022/2023.

McDonald, J. M., M. B. Gregory, J. Riley, and E. N. Starkey. 2022. Setting up and configuring a total station—Version 1.1. Southeast Coast Network Standard Operating Procedure NPS/SECN/SOP—1.2.17. National Park Service, Athens, Georgia. Available at: <https://irma.nps.gov/DataStore/Reference/Profile/2293669> (last accessed June 2022).

Thornbrugh, D. J., I. W. Ashton, A. R. Jarding, J. S. Mills, and K. Paintner-Green. 2019. Protocol implementation plan for stream channel monitoring in the Northern Great Plains Network: narrative version 1.0. Natural Resource Report NPS/NGPN/NRR—2019/1918. National Park Service, Fort Collins, Colorado.

Trimble Access 2023. Version 23.10.

Trimble Business Center 2023. Version 5.70.