



Environmental Analysis Program

Pomona College
Biogeochemistry Laboratory

SOP-F202

SonTek Acoustic Velocity Meters

Standard Operating Procedure

SOP Number	SOP-F202
Revision	0.2
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Date	2026-06-26
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1. Purpose

This SOP describes the operation, calibration verification, and maintenance of SonTek acoustic Doppler velocity meters used for point velocity and discharge measurements in wadeable streams. Acoustic Doppler instruments measure water velocity by transmitting ultrasonic pulses and detecting the frequency shift of sound reflected by suspended particles in the water column (Rehmel, 2007). Unlike mechanical current meters ([SOP-F201](#)), acoustic meters have no moving parts, respond faster to turbulent fluctuations, and can measure very low velocities.

2. Scope

- **Applies to:** SonTek FlowTracker2 and FlowTracker (original model) handheld acoustic Doppler velocimeters (ADV) used for wading discharge measurements in streams and channels
- **Does not apply to:** SonTek ADP/ADCP profiling instruments for non-wadeable rivers or boat-mounted surveys; mechanical current meters (see [SOP-F201](#)); fixed-installation acoustic flow meters in pipes or culverts
- **Location:** All EA Program wadeable stream sites

3. Responsibilities

Role	Responsibility
PI / Field Lead	Approve instrument deployment; ensure firmware is current
Trained Personnel	Operate instrument per this SOP; download and archive data
New Students	Complete training before independent use

4. Definitions

- **ADV (acoustic Doppler velocimeter):** An instrument that measures water velocity at a single point by transmitting ultrasonic pulses and measuring the Doppler frequency shift of sound scattered back from suspended particles in a small sampling volume located at a fixed distance from the transducer head (Rehmel, 2007).
- **Averaging time:** The duration over which velocity samples are collected and averaged at each measurement vertical; the FlowTracker default is 40 seconds; increase to 60 seconds in low-velocity or highly turbulent flows to improve measurement stability (SonTek/Xylem, 2019).
- **Beam check:** A pre-measurement quality check in which the FlowTracker2 tests all three acoustic beams and reports signal-to-noise ratio (SNR) for each; all beams must return SNR > 4 dB before a measurement can proceed (SonTek/Xylem, 2019).
- **Boundary flag:** An automated QC flag set by the FlowTracker when the probe is too close to the streambed or water surface for the sampling volume to be fully within the water column; corrected by adjusting the depth setting.

- **Doppler effect:** The change in frequency of a wave (sound or light) observed when the source or the reflector is in motion relative to the observer; the physical basis of acoustic Doppler velocity measurement – the frequency shift of reflected ultrasound is proportional to the component of particle velocity along the acoustic beam axis (Rehmel, 2007).
- **FlowTracker2:** The current production SonTek handheld ADV for wading discharge measurements; uses three acoustic beams and integrated pressure depth sensor; stores data internally and transfers via USB; includes automated QA/QC flagging (SonTek/Xylem, 2019).
- **Mid-section method:** The standard USGS discharge calculation method in which each vertical's discharge is the product of measured velocity, depth, and the horizontal width extending halfway to the adjacent verticals on each side; computed automatically by the FlowTracker (Turnipseed & Sauer, 2010).
- **MMT file:** The proprietary binary data file format produced by the SonTek FlowTracker; stores raw velocity data, QC flags, site information, and the computed discharge summary; must be archived before exporting to CSV.
- **Sampling volume:** The small water volume approximately 10 cm from the FlowTracker transducer head from which velocity data are collected; must be free of boundary interference (streambed, water surface, or large obstacles) for valid measurements (SonTek/Xylem, 2019).
- **SNR (signal-to-noise ratio):** The ratio of acoustic signal strength returned from suspended particles to background noise; expressed in dB; the FlowTracker requires $\text{SNR} > 4$ dB on all three beams for a valid measurement; low SNR typically indicates insufficient suspended particles in very clear water (SonTek/Xylem, 2019).
- **Spike flag:** An automated QC flag set by the FlowTracker when a single velocity sample deviates significantly from the running mean, indicating a transient disturbance (bubble, debris, wading disturbance); the affected sample is excluded from the average.

5. Safety and Hazards

Hazards

- **Physical:** Wading in flowing water carries drowning risk. Always work in pairs. Do not wade in flows deeper than waist height or where footing is unstable.
- **Electrical:** The FlowTracker uses internal rechargeable batteries. Do not open the sealed housing in the field.
- **Biological:** Waterborne pathogens; decontaminate equipment between sites per [SOP-F007](#).

5.1. Required PPE

- ☐ Chest or hip waders with felt or studded soles
- ☐ Closed-toed shoes or wading boots
- ☐ Sun protection (hat, sunscreen)

5.2. Emergency Procedures

A minimum of two people must be present for all in-stream work. Refer to [SOP-F001 Field Safety](#) for general emergency procedures.

6. Instrument Specifications

6.1. FlowTracker2

Parameter	Value
Measurement principle	Acoustic Doppler velocimetry (ADV)
Velocity range	0.001–4.0 m/s (0.003–13 ft/s)
Velocity accuracy	±1% of measured velocity
Velocity resolution	0.0001 m/s
Sampling volume	Located 10 cm from the transducer
Depth sensor	Integrated pressure sensor, 0–5 m range
Data storage	Internal memory; USB download
Battery	Rechargeable lithium-ion; ~12 hr continuous
QC diagnostics	Automated QA/QC (SNR, boundary, flow angle, spike detection)

(SonTek/Xylem, 2019)

6.2. FlowTracker (Original)

Parameter	Value
Measurement principle	Acoustic Doppler velocimetry (ADV)
Velocity range	0.001–4.5 m/s
Velocity accuracy	±1% of measured velocity
Sampling volume	Located 10 cm from the transducer
Data storage	Internal memory; RS-232 download
Battery	3 C-cell alkaline batteries

7. Equipment and Materials

Item	Notes
SonTek FlowTracker2 (or original)	Charged and firmware updated (SonTek/Xylem, 2019)
Top-setting wading rod	Standard USGS-type; FlowTracker mounts on the rod

Item	Notes
Mounting bracket and thumbscrew	Specific to SonTek; included with instrument
USB cable	For data download (FlowTracker2)
RS-232 cable and adapter (original model)	For data download
Measuring tape (50 m)	For establishing the tag line
Tape stakes (2)	For anchoring the tag line
Laptop or tablet with SonTek software	FlowTracker2 uses SonTek's desktop software
Field data sheet (backup)	Printed on waterproof paper
Spare batteries	C-cells for original model

8. Procedure

8.1. Pre-Field Setup

1. Charge the FlowTracker2 battery fully before each field day (SonTek/Xylem, 2019). For the original model, install fresh batteries.
2. Power on the instrument and verify that the firmware version is current. Update if prompted.
3. Set the site information: site name, station ID, date, and operator initials.
4. Select the measurement method:
 - **Mid-section** (default, consistent with USGS practice (Turnipseed & Sauer, 2010))
 - **Mean-section** (if required by the project)
5. Set the measurement parameters:
 - Averaging time: 40 seconds (default; increase to 60 seconds for low or turbulent flows) (SonTek/Xylem, 2019)
 - Number of measurements per vertical: 1 (six-tenths method) or 2 (two-point method at 0.2 and 0.8 depth) (Turnipseed & Sauer, 2010)

8.2. Beam Check

Perform a beam check before each measurement (SonTek/Xylem, 2019).

1. Submerge the probe head at least 15 cm below the water surface in a location with minimal turbulence.
2. On the FlowTracker2, select **QC > Beam Check** from the menu.
3. The instrument tests all three acoustic beams and reports SNR for each beam.
4. All beams must report SNR > 4 dB. If any beam fails, clean the transducer faces and retest. If the beam check still fails, do not proceed with the measurement.
5. Record the beam check result in the field notebook.

8.3. Site Selection and Tag Line

Follow the site selection and tag line procedures described in [SOP-F301 Stream Discharge Measurement](#), Sections 7.1–7.3 (Turnipseed & Sauer, 2010). The same cross-section criteria apply to acoustic and mechanical meters.

8.4. Making the Measurement

1. Mount the FlowTracker probe on the wading rod at the correct depth setting:
 - **Six-tenths method:** Set the probe at 0.6 of the total depth below the water surface (same as for mechanical meters)
 - **Two-point method:** Measure at 0.2 and 0.8 of the depth
2. At each vertical, the instrument automatically records velocity (V_x , V_y components) and runs QC checks (SNR, spike detection, boundary check, flow angle).
3. If a measurement is flagged, the instrument displays the reason. Common flags and responses:

Flag	Meaning	Response
Low SNR	Insufficient suspended particles	Increase averaging time; stir bed gently upstream
Boundary	Probe too close to bed or surface	Adjust depth setting
High flow angle	Flow not perpendicular to tag line	Reposition tag line or note angle
Spike	Velocity spike detected	Repeat measurement

(SonTek/Xylem, 2019)

4. After completing all verticals, the instrument computes total discharge automatically using the mid-section method (Turnipseed & Sauer, 2010).
5. Review the on-screen discharge summary before leaving the site.

8.5. Post-Measurement

1. Save the measurement file on the instrument.
2. Record a backup note in the field notebook: site, date, total discharge, number of verticals, and any flagged stations.
3. Rinse the probe with clean water. Do not use solvents or abrasives on the transducer faces.
4. Decontaminate per [SOP-F007](#) before moving to the next site.

8.6. Data Download

1. Connect the FlowTracker2 to a laptop via USB.
2. Open the SonTek desktop software and download all measurement files (SonTek/Xylem, 2019).
3. Export each measurement as a **.csv** and a **.dis** (discharge summary) file.
4. Save files using the naming convention: YYYY-MM-DD_SiteID_discharge_FT2.csv
5. Upload to the project GitHub repository under **data/discharge/** within 48 hours.
6. Archive the raw **.mmt** file to the lab shared drive.

9. Maintenance

9.1. After Each Field Day

1. Rinse the entire probe head and cable with clean fresh water.
2. Dry with a lint-free cloth.
3. Inspect the transducer faces for scratches, algae buildup, or debris. Clean gently with a soft brush if needed.
4. Charge the battery (FlowTracker2) or remove batteries (original model) if storing for more than one week.

9.2. Periodic Maintenance

- **Monthly (active use):** Inspect the wading rod mounting bracket for wear. Verify firmware version.
- **Annually:** Contact SonTek for factory calibration verification if the instrument is used for regulatory or compliance monitoring (Rehmel, 2007).

10. Quality Control

- Beam check before every measurement (§7.2) (SonTek/Xylem, 2019).
- If two measurements are made at the same cross-section, they should agree within 5%; if they differ by more than 5%, make a third measurement and use the mean of the two closest values (Turnipseed & Sauer, 2010).
- Compare FlowTracker results with mechanical meter results at least once per year; results should agree within 5–8% (Rehmel, 2007).
- Review all automated QC flags during data processing. Do not discard flagged data without documentation.

11. References

- SonTek/Xylem (2019)
- Turnipseed & Sauer (2010)
- Rehmel (2007)

Rehmel, M. S. (2007). *Application of acoustic Doppler velocimeters for streamflow measurements* (Scientific Investigations Report 2007-5091). U.S. Geological Survey. <https://doi.org/10.3133/sir20075091>

SonTek/Xylem. (2019). *FlowTracker2 handheld ADV technical manual*. <https://www.sontek.com/flowtracker2>

Turnipseed, D. P., & Sauer, V. B. (2010). *Discharge measurements at gaging stations* (Techniques and Methods 3-A8). U.S. Geological Survey. <https://doi.org/10.3133/tm3A8>

12. Related SOPs

SOP	Title	Relationship
F001	Field Safety	Required prerequisite
F007	Field Decontamination	Between-site cleaning
F201	Pygmy and Type AA Velocity Meters	Mechanical alternative
F301	Stream Discharge Measurement	Cross-section procedures

13. Training Record

Before using SonTek velocity meters independently, personnel must:

1. Read this SOP and [SOP-F301](#) in full
2. Complete [SOP-F001 Field Safety](#) training
3. Observe a trained operator perform a complete discharge measurement including beam check, measurement, and data download
4. Perform a supervised discharge measurement with results that agree within 5% of the trainer's independent measurement
5. Be signed off by the PI or field lead