SOP-F-103

Flow Measurements and Estimates

Revision 7

Field Operations Supervisor	Date 19/7/18
TIAER Project Quality Assurance Officer	Date 19 July 2018

Texas Institute for Applied Environmental Research

Effective Date: 19 July 2018

1. **Applicability**

   This procedure applies to stream flow measurements taken at all sampling sites under study by the Texas Institute for Applied Environmental Research (TIAER), Tarleton State University, Stephenville, Texas.

2. **Purpose**

   The purpose of this procedure is to establish guidelines for the uniform collection of streamflow data using the Sontek FlowTracker Velocimeter. RDI ADCP, Price AA and Pygmy current meters, and float tests.

3. **Equipment**

   3.1. USGS wading rod – a device used with Price and Pygmy current meters and FlowTracker to measure shallow streams in tenths of a foot. Its handle is marked at 0.1 foot depth settings to position the flowmeter at the proper depth for measurements.
   3.2. Sontek Flowtracker handheld ADV unit – an acoustic Doppler Velocimeter that attaches to a rod to measure depth and velocity while wading across a water body
   3.3. Teledyne RD Instrument ADCP (Doppler boat) – a battery-operated acoustic Doppler current profiler unit on a floating platform that measures depth and velocity across a stream transect and calculates discharge.
   3.4. Tag line - a chord or wire marked in specific length increments, e.g. feet or tenths of feet, for use in cross section delineation.
   3.5. Stopwatch or other device that displays time in seconds.

4. **Equipment Calibration & Maintenance** – all maintenance and calibrations are performed according to manufacturer's specifications and operator's manuals.

5. **Procedure**

   5.1. **Determine method of flow measurement to use.**
      5.1.1. For streams that can be waded, use the SonTek FlowTracker.
      5.1.2. For unwadeable streams that have a bridge, use the ADCP Doppler boat.
      5.1.3. For unwadeable streams without a bridge, perform a float test.
      5.1.4. Some projects allow the use of USGS gauge data, if available.
   5.2. **Flow measurement increments.**
      5.2.1. Flow measurements are to be taken in increments not exceeding 10% of the total stream width across the entire cross section, starting as close to the water's edge as is possible. A minimum of 10 measurements must be collected. The ideal measurement is one in which no increment contains more that 10% of the total discharge; consequently it is best to take at least 20 measurements. Equal section widths are not recommended unless the

discharge is evenly spread across the entire stream width. Measurements made in parts of the stream with higher velocity should generally be closer together than those in parts of the stream with lower velocity.

5.2.2. Use a tag line to determine distances across the stream cross section. Select a site in the stream that is wadeable and is of approximate average width for the area. Stretch a tag line across the stream cross section in a manner perpendicular to the stream flow direction. Secure the tagline to available trees or other stationary object, as needed. The tag line is used for all types of velocity-measuring equipment and procedures, except the Doppler boat.

5.3. **Procedure for FlowTracker Handheld ADV unit with USGS Wading Rod**

5.3.1. Turn on the FlowTracker handheld and press the Enter key.

5.3.2. Press 3: Start Data Run.

5.3.3. Press 1 and input the appropriate site name. If the site file already exists, you will also need to input an extension name.

5.3.4. Press 9 to accept the name.

5.3.5. Press the set location key and input the edge of the water tagline reading.

5.3.6. Press the set depth key and input a depth of 0.

5.3.7. Press the next station key and walk to the first in-stream section, which should be approximately one-twentieth of the total stream width from the edge, adjusted for any noticeable changes in stream velocity.

5.3.8. Place the wading rod on the stream bottom and measure the total stream depth using the staff gage on the rod. (Total stream depth is used to determine location of velocity measurement(s) at each increment.)

5.3.9. Use the depth chart in the operator's manual to determine where to place the FlowTracker probe.

5.3.10. Input the appropriate location tagline reading into the FlowTracker probe and press Enter. Input the depth measured with the wading rod and press enter. Press the measure key, wait 20 or 40 seconds, and press enter. Press 1 to accept the reading.

5.3.11. Repeat step 5.3.10 until you get to the opposite edge of the stream. When the opposite edge is reached, press the end section key.

5.3.12. Input the appropriate location. Input the depth as zero.

5.3.13. Press the Calculate Discharge key to calculate the flow. Document the calculated flow reading on the appropriate field data sheet before putting up the instrument.

5.3.14. Press the 9 key to exit. All entered data values are saved electronically on the FlowTracker.

5.3.15. Turn the FlowTracker handheld unit off and place it back in the carrying case.

5.4. Doppler Boat Procedure

5.4.1. The Doppler boat is used to determine flow when the stream is not wadeable.

5.4.2. Instructions are included in Attachment 8.2, Instructions for Use of the Doppler Boat

5.5. Float Method Procedure

5.5.1. When stream levels are too high or too swift to safely wade with the Global Water flow probe and no bridges are available to operate the weighted current meter or Doppler boat, flow measurements can be obtained using the float method.

5.5.2. First, measure the distance to a visible location downstream from the starting place and mark it so it can be easily seen from the starting place.

5.5.3. Obtain a small object that will float and place it in the water. A leaf or small toy can serve as the floating object. Other objects of choice are floating debris, horse apples, oranges or even cactus.

5.5.4. Drop the object into the stream at the starting place at the same time the stopwatch is started. Time the object over the known distance and calculate the velocity. Several float tests should be done at different locations along the width of the stream.

5.5.5. Document all measurements on the appropriate field data sheet.

6.0 Quality Control & Safety Aspects

6.1 All aspects of this procedure shall conform to the criteria established in SOP-S-102 "Field Safety".

6.2 No unauthorized repair or maintenance shall be performed on any instrument. Permission of the Field Operations Supervisor shall be obtained prior to performing any equipment maintenance.

7.0 References

7.1 Linsey, R.K. 1982. *Hydrology for Engineers.* McGraw-Hill Book Company, New York.

7.2 U.S. Geological Survey, 1969. *Discharge Measurements at Gaging Stations, Book 3 Chapter A8,* United States Government printing office, Washington.

7.3 Instruction Manual, FlowTracker Handheld ADV, 2001

7.4 StreamPro Documentation CD, RD Instruments, 2004

8.0 Attachments

8.1 Instructions for Use of the Doppler Boat

Attachment 8.1: INSTRUCTIONS FOR USE OF THE RDI DOPPLER BOAT

BOAT Place transducer so 1 and 3 are forward
White button is power, orange light comes on when powered

PDA Turn on PDA, tap iPAQ Wireless icon (bottom right corner of PDA); then tap middle Blue Tooth icon. Select "OK" button at top right.
Press Start, select StreamPro, then StreamPro again (blue light on boat turns on)
Select Configuration File\ Load Factory Default. Select Units and change to English.
Select Test\ Instrument\ Start Pinging

BOAT Walk across bridge, dragging the boat across stream from edge to edge. Observe depth readings on PDA to determine the deepest portion.

PDA Select Instrument \ Stop Pinging
Set Max depth to about half a foot more than the maximum observed depth. To change depth, select Setup \ Configuration File \ Change Settings.
Select (drag over) value; use keyboard icon in bottom right to make changes. Select Accept.
Select Configuration File \ Save As\ SD card
Select Directory of the waterbody/project
Name file (naming convention is yymmdd_5 digit site ID). Select "OK".
Select Data Collection; tap Transect Start
Input distance from location of boat to water's edge. Select "OK" and allow instrument to collect edge data and program the boat. Wait for message "Proceed across stream."

COLLECT MEASUREMENTS:

- Walk across bridge, dragging boat to collect one set of measurements.
- At the far side, select "Transect Stop". Estimate how close to the water's edge the boat gets. Input that value for the other side. Or allow instrument to collect edge data and program the boat. Wait for message "Proceed across stream."
- Boat will automatically calculate discharge for the transect.
- Walk back across bridge, collecting the next set of measurements and discharge calculation.
- Collect at least 4 sets of measurements. Calculate what 5% of the average would be. If the range of discharge measurements exceeds 5%, take additional measurements.
- Select History to display all measurements. The average of the measurements will be shown.
- Review discharge calculations on PDA. Uncheck those not within 5% of the average. If there are fewer than four measurements within 5% of the average, take additional measurements until you obtain 4 within 5%. If, after 8 tries, there are not 4 measurements within 5% of the average, note it on the field data sheet with any pertinent comments about conditions at the site.

EXIT File\Exit StreamPro
Turn off blue tooth, PDA, and boat.