STANDARD OPERATING PROCEDURE
FOR
STREAMFLOW MEASUREMENT

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Introduction

For sites where a flow measurement is necessary, always measure flow, read the USGS flow gage, or obtain a flow value at a later date from the USGS. Measure and record flow after recording visual observations. Do not collect water samples in the area disturbed during a flow measurement. At sites with a USGS flow gage, observe and record the gage height to the nearest hundredth of a foot in the field logbook. Contact the office responsible for the gage and obtain the flow (in cubic feet per second) that corresponds to the gage height. If there is any doubt about the accuracy of the gage-height reading, sampling personnel should measure the flow if possible. USGS gage heights can be measured by one of the three methods: staff gage, wire weight, or bubble gage. Staff gages are black and white steel plates with the appearance of large measuring tapes bolted to a stable structure. Gradations in feet, tenths of a foot, and two-tenths of a foot should be recorded (where the water level hits the gage) to the nearest hundredth of a foot. Wire-weight gages house a weight attached by wire cable to a graduated reel (gradations are tenths and hundredths of a foot) with a counter at one end. The weight should be lowered to touch the surface of the water (causing a slight ripple). At that position, the counter value should be recorded to the nearest whole number and the point indicated by the stylus on the graduated reel to the nearest hundredth of a foot. The wire-weight gage could be a movable type to accommodate braided streams. If the gage needs to be moved, use the correction value on the bridge near the repositioned gage location.

Bubble gages are installed in USGS gage houses, which are locked with a USGS key. The bubble gage uses a data logger attached to a pressure transducer system to indicate gage height in feet. Gage houses can also contain stilling wells with staff gages on the inside wall of the well. If no nearby USGS flow gages can be accessed to determine streamflow, personnel should measure flow. A summary description of the conventional current-meter flow-measurement procedure is included here for general guidance (mid-section method to determine discharge). A current-meter measurement is the summation of the products of individual subsection areas of the stream cross section and their respective average velocities. In the mid-section method of computing a flow measurement, it is assumed that the velocity sample at each vertical represents the mean velocity in the individual subsection areas.

Streamflow Measurement

Flow-measurement equipment required includes: (1) current meter or flowmeter, (2) top-setting wading rod (marked in tenths of a foot), and (3) tape measure or tagline (marked in tenths of a foot). The current meter or flowmeter brands or equivalent can be: Marsh-McBirney electronic, Montedoro-Whitney electronic, Price pygmy (with timer and beeper), Price meter, Type AA (with Columbus weight) or YSI FlowTracker Handheld ADV.

Determining the Number of Flow Cross Sections

The first step in streamflow measurement is selecting a cross section across the total width of the stream. Select a straight reach where the streambed is uniform and relatively free of boulders and aquatic growth. The flow should be uniform and free of eddies, dead water near banks, and excessive turbulence. Determine the width of the stream by stringing a measuring tape from bank to bank at right angles to the direction of flow. Next, determine the spacing or width of the verticals. ***Space the verticals so that no subsection has more than 10 percent of the total discharge***. If the stream width is less than 5 ft, use vertical spacing widths of 0.5 ft. If the stream width is greater than 5 ft, the minimum number of verticals is 10 to 25. The preferred number of verticals is 20 to 30.

Determining the Mid-Point of the Cross Section

To determine the mid-point of a cross section, for example, divide the cross section width in half, if the total stream width is 26 feet with 20 cross sections and each cross section width is equal to 1.3 feet. Divide 1.3 feet in half and the mid-point of the first section is 0.65 feet. In this example, the tape at waters edge is set at zero feet. By adding 0.65 to zero, the mid-point of the first section is 0.65 feet. Each subsequent mid-point is found by adding the section with (1.3 feet) to the previous mid-point. For example, the first mid-point = 0.65+0.0 = 0.65 feet; the second mid-point = 0.65+1.3 = 1.95 feet; the last midpoint = 24.05+1.3 = 25.35 feet.

Adjusting the Sensor Depth at a cross Section

Adjust the position of the sensor to the correct depth at each mid-point. The purpose of the top setting wading rod is to allow the user to easily set the sensor at 20%, 60% and 80% of the total depth. The total depth can be measured with the depth gauge rod (see Figure 2). Each single mark represents 0.10 foot, each double mark represents 0.5 foot, and each triple mark represents 1.00 foot.

Depths $\leq$ 2.5 Feet: If the depth is less than 2.5 feet, only one measurement id required at each measurement section. To set the sensor at 60% of the depth, line up the foot scale on the sliding rod with the tenth scale on the top of the depth gauge rod. For example, if the total depth is 2.0 feet, then line up the 2 on the foot scale with the 0 on the tenth scale.

Depths >2.5 Feet: If the depth is greater than 2.5 feet, two measurements should be taken at 20% and 80% of the total depth. To set the sensor at 20% of the depth, multiply the total depth by two. For example, the total depth is 2.7 feet the rod would be set at 5.4 feet. Line up the 5 on the foot scale and the 4 on the tenth scale.

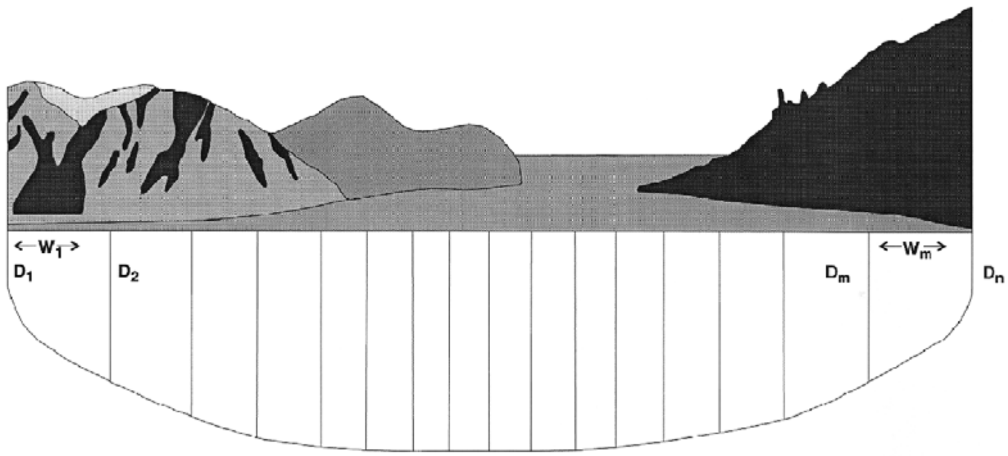
To set the sensor at 80% of the depth, divide the total depth by two. For example, the total depth is 2.7 feet the rod would be set at 1.35 feet. Line up the 1 on the foot scale with the 0.35 on the tenth scale. The average of the two velocity measurements is used in the flow calculation.

Measuring Velocity

The wading rod should be kept vertical and the flow sensor kept perpendicular to the tape rather than perpendicular to the flow while measuring velocity with an electronic flowmeter. When using a pygmy meter, the instrument should be perpendicular to the flow. Move to the next vertical and repeat the procedure until you reach the opposite bank.

Calculating Flow

Once the velocity, depth, and distance of the cross section have been determined, the mid-section method can be used for determining the discharge (formula in fig. 1). Compute the discharge in each increment by multiplying the averaged velocity or single velocity in streams less than 2.5 ft deep in each increment by the increment width and averaged depth (or single depth in streams less than 2.5 ft deep). (Note that the first and last increments are located at the edge of the stream and have a depth and velocity of zero.) Add the discharges for each increment to compute total stream discharge. Record the flow in liters (or cubic feet or cubic meters) per second in your field book.



$$Q = \left(\frac{D_1 + D_2}{2}\right)\left(\frac{V_1 + V_2}{2}\right)W_1 + \ldots + \left(\frac{D_m + D_n}{2}\right)\left(\frac{V_m + V_n}{2}\right)W_m$$

Q = discharge, D = depth, V = velocity, W = width (Rantz and others, 1982)

Figure 1. Stream cross section illustrating mid-section method to determine discharge.

STREAM FLOW (DISCHARGE) MEASUREMENT FORM

Stream Date

Station Description

Time Begin Time Ended Meter Type

Observers Stream Width[1] Section Width

Observations

Section Midpoint (ft)(m)	Section Depth (ft)(m)(cm)	Observational Depth[2] ft-m-cm	Velocity		Area W x D (ft^2) (m^2)	Flow (Q) V x A (m^3/s) (ft^3)
			At Point (ft/s) (m/s)	Average (ft/s) (m/s)		
①						
②						
③						
④						
⑤						
⑥						
⑦						
⑧						
⑨						
⑩						
					Total Discharge (ΣQ)(ft^3/s)	

[1]Make a minimum of 10 measurements when the total width is > 5.0 ft., 20 measurements preferred.

[2]Measure at 60% of depth from surface where < 2.5 ft. deep. Measure at 20% and 80% of depth in waters > 2.5 ft. deep.