Miscellaneous Measurements

Narrated by Heather Best

Discharge cannot always be measured using standard procedures.

Low flow in this stream is too slow and shallow to be accurately measured using a mechanical current meter.

Here is an example of a site where it would be useful for you to use one of the miscellaneous methods discussed in this section of the class to measure discharge. You can see that water is flowing out of a pipe into a shallow pool with low velocity. It would be difficult to obtain a good measurement using a current meter because the pool is shallow, water velocity is slow, and extreme angles of flow are apparent.

Floats can aid in measuring or estimating flow when:

1. No conventional or optical current meter is available.
2. A current meter is available but the measurement structure - bridge or cableway - has been destroyed, and equipment for measuring from a boat is unavailable.
3. A conventional current meter is available, but floating ice or drift make it impossible to use the meter.
4. It is unsafe to make a discharge measurement.

An example of float made especially for measuring surface velocity. Holder at top is designed to hold a light stick for night-time use.

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Floats or floating material are not used in routine data collection in the United States but they are useful in an emergency for measuring high discharges under the circumstances shown in this slide.

You don't need even need specialized equipment to estimate surface velocity.

Oranges make good floats because they are:

1. Readily available
2. Float low in water, thus better representing water velocity
3. Inexpensive
4. Highly visible

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Anything that is highly visible and floats can be used. For example, organic material like oranges have been used as floats in an emergency.

Floats are classified as surface floats or rod floats.

- Surface floats are by far the most common as they can be almost anything that floats. Examples would be wooden disks, partly filled plastic bottles, and oranges.
- Rod floats are usually wooden rods weighted at one end so they will float upright down the channel. Rod floats have an advantage of integrating the varying velocities in a vertical profile of the channel. However, they have the disadvantages of potentially touching the streambed and having variable and uncertain velocity coefficients, which are used to convert rod velocity to mean channel velocity. They are not used as often as surface floats.
- Because floats are difficult to recover from the stream, they should be considered disposable.

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There are two types of floats; surface floats and rod floats. Surface floats can be any highly visible object that floats on the water surface. Rod floats are usually wooden rods weighted at one end that will float upright in the water. Rod floats have an advantage of integrating the varying velocities in a vertical profile, but have the disadvantages of potentially touching the streambed and having uncertain velocity coefficients, which will be discussed in a later slide. Floats should be considered disposable because they are difficult to recover.

Water Supply Paper 2175 and TWRI Book 3, Chapter A8 provide detailed descriptions on how to use floats to make a discharge measurement.

-Find a length of stream that is straight and uniform.

-Select two cross sections to designate the start and end points of a reach for timing the floating object. The designated reach will be of sufficient length to accurately measure the time the float takes to travel from one cross section to the other. A traveltime of at least 20 seconds is recommended. However, if it is difficult to find a straight reach of sufficient length, a traveltime less than 20 seconds may be used.

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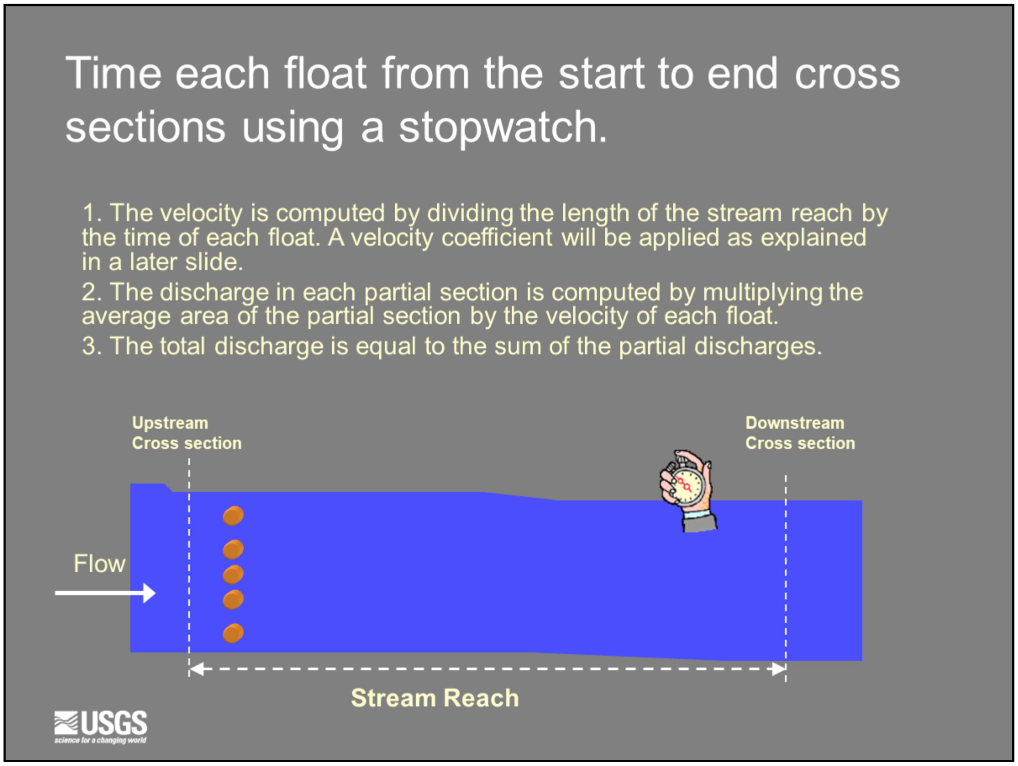
Two cross sections are selected along a reach of straight channel for a float measurement. The cross sections should be far enough apart so that the time the float takes to pass from one cross section to the other can be measured accurately. A traveltime of at least 20 seconds is recommended.

Measuring discharge using several floats in the designated stream reach is the most accurate method.

Distribute a number of floats over the width of the stream upstream from the starting cross section. Note the distance along the width for each float. The floats should achieve a constant velocity at the upstream cross section.

For best results multiple floats should be used. A number of floats are distributed over the width of the stream with distance along the width noted for each float.



Time the floats through the stream reach from the upstream to downstream cross sections. The velocity is computed by dividing the length of the stream reach by the time for each float and applying a coefficient (typically 0.85). The discharge in each partial section is computed by multiplying the average area of each partial cross section by the velocity of the float. The total discharge is the sum of the partial discharges. If a number of people are available, the floats can be dropped into the water at the same time. Usually, the floats are dropped into the water and timed separately, unlike this animation.

Discharge can also be estimated using one float.

If a number of floats can't be used, as a last resort, toss a single float into the main flow of the channel and measure the time it takes to travel through the designated stream reach. Several trials will add confidence to the estimated discharge. The discharge can only be considered an estimate because no information will be available with regard to the range of velocities across the channel.

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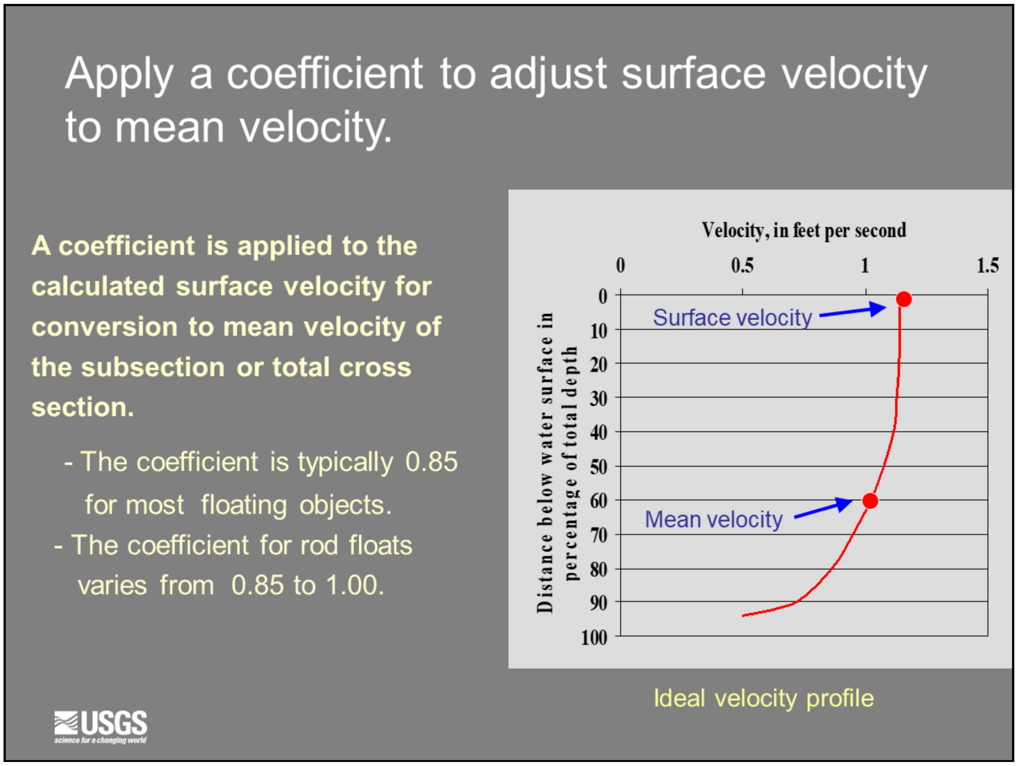
Discharge can also be estimated using a single float. Several trials will add confidence to the estimated discharge. Because no information will be available with regard to the range of velocities across the channel, the computed discharge can only be considered an estimate.



To convert the computed surface velocity to the mean velocity, each float must be multiplied by a velocity coefficient. The coefficient is typically 0.85 for most surface floats. For rod floats, the coefficient must be determined by calibration. It usually varies between 0.85 and 1.00.

As flows recede, survey cross sections to determine average cross-sectional area of the reach.

- For several floats distributed across the width of the reach, note the position of the floats for the survey. Subsection areas for each cross section can then be surveyed and computed for later computation of subsection discharges.
- For a single float tossed into the reach, survey each cross section to determine a representative cross section area for the stream reach.
- Another method to determine cross section area is to use cross sections of recent discharge measurements made in the stream reach. A last resort would be to estimate width and average depth to compute cross section area.

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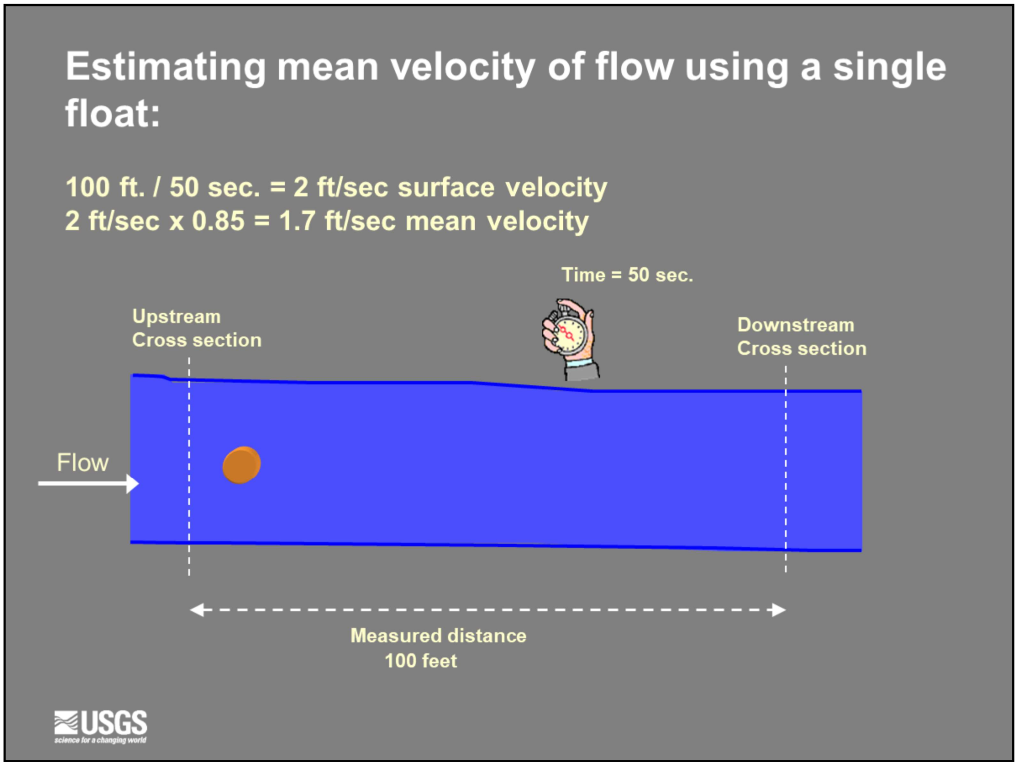
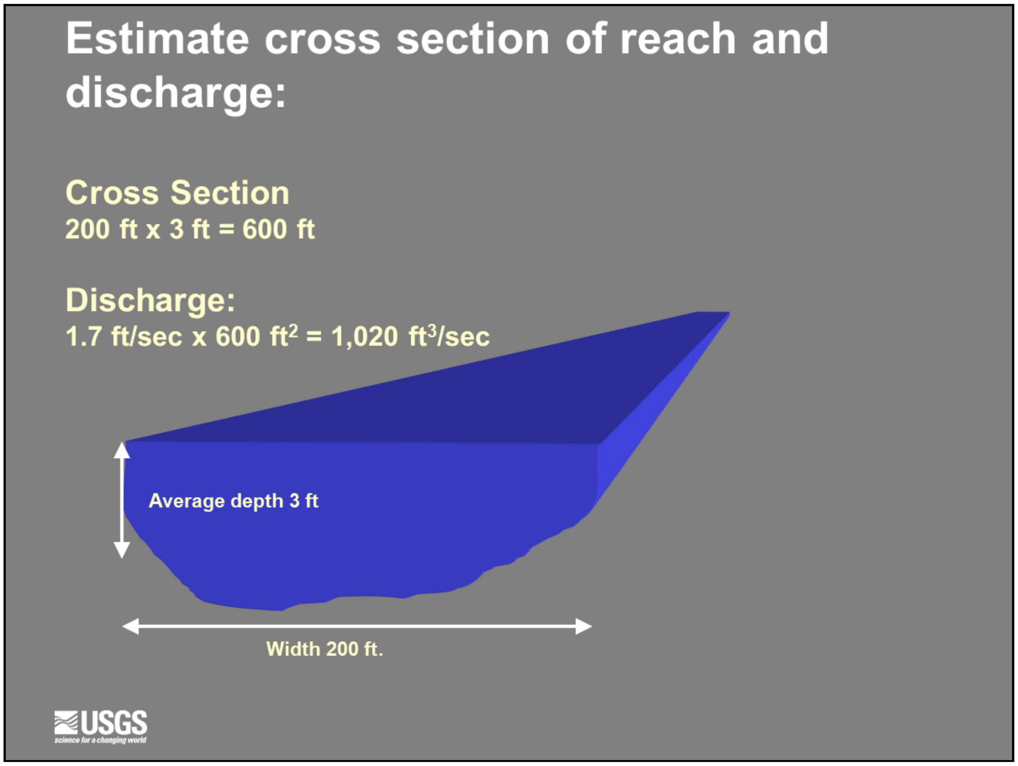
A representative cross-sectional area of the stream reach must be determined. Usually, surveys are run at the upstream and downstream cross sections. Alternative methods to determine representative cross sections include (1) using cross sections of recent discharge measurements made in the stream reach and as a last resort, (2) visually estimating width and average depth of a cross sections. Note that when several floats are used, the subsection areas for each float must be determined.



Here is an example of determining velocity in a stream reach using a single float. The stream reach is 100 feet and the time for the float from the upstream to downstream cross section is 50 seconds. The computed mean velocity is 1.7 feet per second.



Discharge for the previous example is determined by multiplying the mean velocity by the estimated cross-sectional area. The estimated discharge is 1,020 cubic feet per second.

The Hydrologic Instrumentation Facility is quality-assurance testing radar instruments as a method to measure surface-water velocity, which can in turn, be used to compute streamflow. Radars transmit a beam of microwave energy of which a portion is reflected back from the water surface to an antenna. The motion of the target, in this case surface-water velocity, shifts the frequency of the transmitted energy by an amount that is proportional to the velocity of the water. Just like the using floats, the surface water must be multiplied by the cross sectional area to compute streamflow.

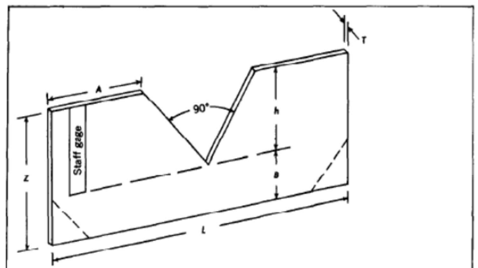
Radars can be mounted on many types of platforms in addition to portable radar guns. These photos show radar instruments mounted on a cableway, on a tripod, under a bridge, and on the bottom of a helicopter. Unlike the portable radar gun shown in the previous slide, radar transmitters and antennas are usually separate units.

Portable weir plates are another tool that can be used to make excellent low-flow measurements.

See WSP2175 for a detailed description on how to install and use weir plates

A portable weir plate is a useful device for determining discharge when depths are too shallow and velocities too low for a reliable current-meter measurement of discharge. A 90-degree V-notch weir is particularly suitable because of its sensitivity at low flows. Remember, such installations can also be used for volumetric measurements when flow is sufficiently low to be captured in some sort of container.

90º V-notch weirs are a commonly used weir due to their sensitivity at low flows.



Weir	Z	h	B	L	A	T	Weight (lb)
Large	1.75	1.00	0.75	4.0	1.0	16 ga.	24
Medium	1.25	.80	.45	3.0	.7	14 ga.	17
Small	.75	.47	.28	2.0	.53	10 ga.	8

All dimensions, other than T, are in feet

FIGURE 129.—Portable weir-plate sizes.

- A staff gage attached to the upstream side of the weir plate is used to read the head of the weir.
- Be careful to install the staff gage far enough from the V-notch so it will not be in the zone of drawdown of water flowing through the notch. Drawdown is usually negligible at a distance of greater than twice the head on the notch.
- To install the weir, it is pushed into the streambed with enough penetration to prevent leakage around the plate. The top of the weir plate must be horizontal.

Here is a plan drawing of a typical 90-degree V-notch weir. A staff gage is typically attached to the upstream side with a gage height of 0.00 ft. corresponding to the bottom of the V-notch. Be careful to install the staff gage fare enough from the V-notch so it will not be influenced by the drawdown zone. The weir is installed by pushing it into the streambed with enough penetration to prevent any leakage. Be careful to ensure that the top of the weir is horizontal.

For accurate flow measurements, make sure the weir is not submerged when reading the staff gage.

- A weir is considered submerged when the water surface downstream from the weir is higher than the elevation of the bottom of the weir notch.
- Although the weir pictured to the left is not a portable 90° V-notch weir, it illustrates submergence.

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For accurate flow measurements, the weir must not be submerged. A weir is considered submerged when the water surface downstream from the weir is higher than the elevation of the bottom of the weir notch.