Missouri Streams Fact Sheet

MONITORING STREAM FLOW

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Flow, or *stream discharge,* is the volume of water moving past a point in the stream. Flow affects everything from the concentration of various substances in the water to the distribution of habitat and organisms throughout the stream.

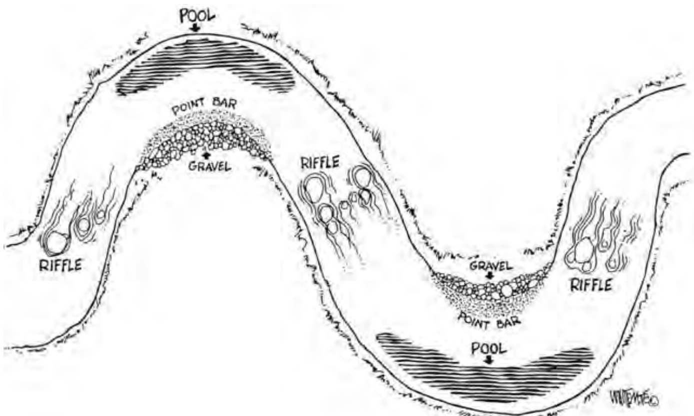

Figure 1 From Streamkeeper's Field Guide

The concentrations of pollutants and natural substances are influenced by stream flow. In larger volumes of faster moving water, a pollutant will be more diluted and flushed out more quickly than an equal amount of pollutant in a smaller volume of slower moving water. Flow also affects the amount of oxygen dissolved in the water, as well as the temperature of the water. Higher volumes of faster moving water help mix atmospheric oxygen into the water. Smaller volumes of slower-moving water can warm up more quickly in the heat of the summer. The amount and size of sediment and debris a stream can carry also depend on flow. A large volume of fast moving water carries more sediment and larger debris than a small volume of slow moving water. High volume, sediment-bearing flows have greater erosional energy, while smaller and slower flows allow sediment to be deposited. The alternating erosional and depositional activities of flowing water help to determine stream channel shape and sinuosity (Figure 1).

The volume of stream flow is determined by many factors. Precipitation is generally the key factor, as it usually provides the primary source of water. After a rainstorm, stream flow follows a predictable pattern in which it rises sharply in response to the storm and then falls, usually more gradually, following the storm. Vegetation also affects the volume of streamflow by absorbing water and releasing it to the atmosphere through *evapotranspiration*. Vegetation also increases the water storage capacity of soil, helping to conserve moisture in dry times (Figure 2).

Figure 2

Stream flow can be altered by human activities both in the surrounding watershed and directly in the stream. When naturally vegetated areas and wetlands are converted into bare soil and impervious surfaces, the volume of stream flow will increase during wet years. In addition, there will be more water entering the stream channel faster due to less infiltration and higher overland flows. Reduced infiltration will also result in decreased groundwater recharge and lower base flows. Channelizing a stream and removing woody debris and other large objects can increase the velocity of flow. In the past, it was a common practice to straighten and clean-up streams, in order to prevent flooding by facilitating the movement of water quickly downstream. More recently we have realized that these practices can create worse problems than they solve. Besides the serious consequences they have for aquatic and riparian life, these practices often cause erosion and flooding problems in downstream locations. A straight, clean stream channel has much less ability to dissipate and absorb the force of flood waters.

Dams or diversions change the flow of water in stream channels directly by slowing it, detaining it or re-routing it. Hydroelectric dams, like Bagnell Dam (Figure 3), can cause flow to fluctuate greatly at times when power is needed, dramatically altering the physical and chemical conditions of rivers. Some aquatic organisms that have timed their life cycles to natural flow regimes are able to adapt to the new situations, but many are seriously affected by the highly altered systems created by dams or diversions.

Figure 3

Measuring Stream Flow

To measure *flow*, select a stream section that is relatively straight, free of large objects such as logs or boulders, with a noticeable current and with a uniform depth. Two components make up flow: the cross-sectional areas of the stream (Figure 4) and the velocity, or speed, of the water moving past a given point. Stretch a tape measure across the stream. The end of the tape should be anchored at the wetted edge of the stream. The other end of the tape should be anchored at the opposite side of the stream perpendicular to the current and anchored so it is taut.

Figure 4

The first step in determining cross sectional area is to measure and calculate the average stream depth. Measure the depth at one foot intervals along the tape measure. The depth must be measured in tenths of a foot, not in inches. The average depth is calculated by dividing the sum of depth measurements by the number of measurements made (Figure 5). The final step in calculating the cross sectional area is to multiply the average depth, in feet, by the stream width, in feet, at the point where the tape measure was stretched across the stream.

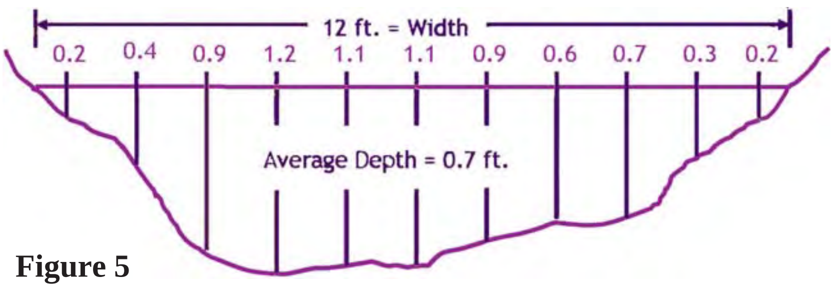

Figure 5

The next step is to determine the average velocity at this site. For a stream less than ten feet wide, select three points in the stream approximately equal distances apart for velocity measurements. For streams greater than ten feet wide, at least four velocity measurements should be taken at approximately equal distances across the stream. This method of measuring the stream velocity will insure that velocity measurements are recorded for the slow and fast portions of the stream.

Once you have determined the number of velocity float trials you need, measure the water's surface velocity in the following manner. Select two points located equal distances upstream and downstream from the tape measure stretched across the stream. Determine the distance between these two points and record this value, in feet. Count the number of seconds it takes a neutrally buoyant object, such as an orange, apple or wiffle golf ball, to float this distance. Record this time, in seconds, for each float trial you complete.

The next step in calculating the surface velocity is to determine the average float time. Average float time is equal to the sum of float times, in seconds, divided by the number of float trials. The final step is to divide the distance floated by the average float time to give you the average surface velocity in feet per second.

Water does not travel at the same speed in a stream. Water near the bottom travels slower than water at the surface because of friction or drag on the stream bottom. When calculating stream discharge, the water's velocity for the entire depth needs to be determined. Therefore, you must multiply the average surface velocity by a correction factor to make it represent the water velocity of the entire stream depth. If the stream bottom is rough with loose rocks or coarse gravel use a *correction factor* of 0.8. If the stream bottom is smooth, mud, sand or hard pan use a correction factor of 0.9.

To calculate the stream discharge, multiply the cross section area (in square feet) by the corrected average stream velocity (in feet per second) to get discharge in cubic feet per second (cfs). See the example data sheets on the next page.

Stream Discharge Worksheet

Stream Turkey Creek **County** Boone **Date** 4/18/08 **Time** 1018
Site # 1 **Description** 100 ft. upstream from Co. Rd K Bridge
Trained Data Submitter Sarah Wolken **Stream Team #** 3525
Trained Participants Kip Kendrick

Instructions for Calculation of Stream Discharge (Flow)

Select a section of stream that is relatively straight, free of large objects such as logs or large boulders, with a noticeable current, and with a depth as uniform as possible. Stretch the tape measure provided by the program across the stream. The "0" point should be anchored at the wetted edge of the stream. The end of the tape measure should be anchored at the opposite end so that it is taut and even with the other wetted edge.

Stream Width (Feet): 12

Step 1: Determine stream cross-sectional area. The first step in determining cross-sectional area is to measure and calculate the average stream depth. In the table below, record depth measurements at one-foot intervals along the tape measure you have stretched across the stream. The depth must be measured in **tenths of a foot** (e.g., 1.7 feet equals one foot and seven tenths). **DO NOT MEASURE DEPTH IN INCHES.**

Record Depth at 1-Foot Intervals

Interval Number	Depth in Feet	Interval Number	Depth in Feet	Interval Number	Depth in Feet
1	0.2	11	0.2	21	
2	0.4	12		22	
3	0.7	13		23	
4	0.9	14		24	
5	1.1	15		25	
6	1.2	16		26	
7	1.1	17		27	
8	0.9	18		28	
9	0.6	19		29	
10	0.3	20		30	
Sum	7.4	Sum	0.2	Sum	

The average depth is calculated by dividing the sum of depth measurements by the number of intervals at which measurements were taken.

7.6 (Sum of Depths (Feet)) ÷ 11 (Number of Intervals) = 0.7 (Average Depth (Feet))

The final step in calculating the cross-sectional area is to multiply the average depth (in feet) by the stream width (in feet) at the point where the tape measure is stretched across the stream.

0.7 (Average Depth (Feet)) × 12 (Stream Width (Feet)) = 8.4 (Cross Sectional Area (Feet)^2)

Step 2: Determine the average velocity for the stream. **For a stream less than ten feet in width,** select three points in the stream approximately equal distances apart for velocity measurements. **For streams greater than ten feet in width,** no fewer than four velocity measurements should be taken at approximately equal distances across the stream. For example, if the stream were eight feet wide, then velocity measurements would be taken at approximately two foot intervals across the stream in order to derive three measurements. If the stream were sixteen feet across, then velocity measurements would be taken at approximately three foot intervals across the stream in order to derive four measurements. This method of measuring the stream velocity will insure that velocity measurements are recorded for the slow and fast portions of the stream.

Once you have determined the number of velocity float trials you need to complete, measure the water's surface velocity in the following manner. Select two points located equal distance upstream and downstream from the tape measure you have stretched across the stream. Determine the distance between these two points and record this value (in feet) in the **Distance Box** on the back of this page. Count the number of seconds it takes a mutually buoyant object (such as a wiffle practice golf ball) to float this distance. Record this time (in seconds) in the table on the back of this page for each float trial you complete.

Water Quality Volunteer

Velocity Float Trials

Trial Number	Time (Seconds)
1	22
2	16
3	13
4	16
5	26
6	
7	
8	
9	
10	
Sum	93

Distance Box: 10 ft.
Distance Floated (in Feet)

The next step in calculating the surface velocity is to determine the average float time. Average float time is equal to the sum of float times (in seconds) divided by the number of float trials.

93 (Sum of Float Times (Seconds)) ÷ 5 (Number of Trials) = 18.6 (Average Float Time (Seconds))

The final step is to divide the distance floated (from the **Distance Box** at top) by the average float time.

10 (Distance Floated (Feet)) ÷ 18.6 (Average Float Time (Seconds)) = 0.5 (Average Surface Velocity (Feet per Second))

Water in a stream does not all travel at the same speed. Water near the bottom travels slower than water at the surface because of friction (or drag) on the stream bottom. When calculating stream discharge, the water's velocity for the entire depth (surface to bottom) needs to be determined. Therefore, you must multiply the average **surface** velocity (from above) by a correction factor to make it represent the water velocity of the **entire stream depth.**

Choose the correction factor that best describes the bottom of your stream and multiply it by the average surface velocity to calculate the corrected average stream velocity.

Stream Bottom Type: Rough, loose rocks or coarse gravel: **correction value = 0.8**
Smooth, mud, sand, or hard pan rock: **correction value = 0.9**

0.8 (Correction Value) × 0.5 (Average Surface Velocity (Feet per Second)) = 0.4 (Corrected Average Stream Velocity (Feet per Second))

Step 3: Calculate the stream discharge. Multiply the cross-sectional area (Feet)^2 from **Step 1** by the corrected average stream velocity (Feet/Second) from **Step 2.**

8.4 (Cross-Sectional Area (Feet)^2) × 0.4 (Corrected Average Stream Velocity (Feet per Second)) = 3.4 (Stream Discharge (Feet)^3 per Second or Cubic Feet per Second (CFS))

Fish Present (Please Mark) **Yes** ☐ or **No** ☐

PLEASE KEEP A COPY AND SEND ORIGINAL DATA TO: Priscilla Stotts/Water Protection Program
Department of Natural Resources
PO Box 176
Jefferson City, MO 65102-0176

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Water is a multi-use resource, being utilized for agricultural, domestic and industrial needs. These increased demands for water is having serious impacts on water quality throughout the United States. Stream flow affects everything, from the concentration of substances dissolved in the water, to the distribution of habitats and organisms throughout the stream!