Let’s Talk Water – Making streamflow measurements

By Dr. Mike Strobel

You may have seen a scientist standing in a stream, holding a measuring rod and taking notes. Or you may have driven past a small gage house near a river or adjacent to a bridge. These are ways that scientists measure how much water is flowing in rivers.

It is important to understand streamflow for a number of reasons. As mentioned in previous articles, we use streamflow to help estimate recharge and discharge to the ground-water system. Changes in streamflow often are related to climatic variations, such as seasons and droughts. Streamflow can be used to estimate precipitation volumes in some basins. And streamflow measurements help agencies such as the National Weather Service understand climate patterns and assess the risk of floods. These are just some of the many reasons why measuring streamflow is important.

The purpose of making a streamflow measurement is to assess the discharge of a stream. The discharge is the amount (volume) of water moving past some point over a given period of time. We typically measure streamflow in cubic feet per second (cfs). For example, if a stream has a discharge measurement of 15 cfs, that means that 15 cubic feet (or about 112 gallons) of water is flowing past that section of the stream channel each second. That seems like a lot of water.

To measure streamflow, we need to measure the cross section of the stream channel and the velocity (speed) of the water flow. Let’s first talk about each of these separately and then discuss how they relate to each other.

The cross section of the stream channel is the width of the stream times the depth of the stream at a particular measuring location. Obviously, stream widths and depths vary greatly along any stream channel. This is why scientists try to measure streamflow at the same location each time. The stream channel is not a rectangle, and the bottom varies as one crosses a stream. Because of this, it is important to measure the depth of water at many points across a stream in order to get an accurate profile of the channel bottom.

The stream velocity is the measure of how fast the water is moving past a point. You can get an idea of how fast a stream is flowing by throwing a stick into the water and watching how quickly it is carried downstream. However, because the stream flows quickest at the middle of the stream on the stream surface, this simple method might be misleading. Friction along the base of the stream, where water is flowing past rocks and sediment, makes the water move slower in these areas. Therefore, to get an accurate picture of how fast the stream flows, you need to make many measurements both across the stream and with depth to get an average velocity for the stream.

The cross section and stream velocity are closely tied to one another. It makes sense that in most cases the same volume of water moving through a stream in one location is about the same volume of water moving through the same stream at a point 100 yards down stream. Yet, the water may be moving faster in one location than the other. Maybe one location even has rapids, where the water seems to be full of energy. This is a factor of the cross section. If the stream narrows through a canyon, then that same volume of water has to move much quicker to get through. Likewise, if the stream banks get wider, then the streamflow slows down accordingly. The velocity of the stream is controlled by the surrounding channel conditions.

Scientists calculate streamflow by making a number of measurements of depth and velocity across the stream. This is done using a flow meter, which consists of a rod that can measure water depth and an attached set of cups that spin in the water as the flow passes by. The spinning cups will click with each rotation, so that the scientist can count the number of clicks over a period of time (for example, one minute) and calculate the velocity of the stream at that depth and location along the cross section.

Because it is important to get a good profile of the stream due to the changes in the channel bottom and variations in velocity, scientists make a number of measurements along each cross section. Typically, the stream is divided into sections such that each section has no more than about 5 percent of the total stream flow. This means that the scientist needs to measure the depth and velocity at about 20 to 25 locations across the stream. Also, because the stream velocity changes with depth, measurements of velocity are made at depths of 60 percent (shallow streams) or 20 percent and 80 percent (deep streams) of the total depth for each section. Calculations have shown that averaging the velocities at these depths gives a good estimate of the average velocity for that particular section.

By calculating the average velocity and depth of water at each measuring point along a stream cross section, a discharge can be calculated for each section. Then, by adding all the discharges together, a total disharge for a stream at a location can be calculated. Scientists typically visit a stream about every six weeks to make these measurements.

Because streamflow can vary greatly in between visits to a site, we also collect information about stream stage (the height of the water in the stream). This is collected by measuring the level directly in the stream, or in many cases, through a stilling well. A stilling well is a large shaft that goes into the ground near a stream and has a pipe from the shaft that is open in the stream. Water levels in the stilling well are the same as the levels in the stream, so changes in stream stage can be measured in the stilling well. There often is a small gage house built over the stilling well. In the gage house are instruments to record the changes in the stage. Scientists either collect the recorded information when visiting the site each 6 weeks or it is transmitted via satellite to the science offices and presented right away on the internet.

If enough measurements of stream discharge and stream stage are made over time, a relationship between the two values can be determined. This is very useful because scientists can then use measurements of stream stage to estimate discharge. Therefore, the stream discharge in between the times a site is visited can be determined using the continuous stage measurements.

Obviously, there is much more to making and using streamflow measurements, but this gives a general overview of how and why the measurements are collected. Next time you see a small green house near a river or a scientist in an orange vest standing in a river with a metal rod, you will know what is going on.

If you have any questions about making stream measurements or any other water issue, please write to me in care of the Ely Times or via email at mstrobel@usgs.gov. Next week, we will begin discussing a topic of recent news stories: natural disasters. The topics of hurricanes and volcanoes, although not of close concern to eastern Nevada, have been making headlines lately and deserve some discussion. I will address some of the water issues related to these events.