Let's Talk Water – Surface Water and Hydrographs

By Dr. Mike Strobel

Surface water refers to any water overlying land surface. This can include oceans, rivers, streams, creeks, lakes, ponds, wetlands, and puddles. This even includes sheet flow and runoff associated with heavy rainstorms. Springs are another example of surface water, but the topic of springs will be the focus of a future article because springs are locations of ground-water discharge to the surface and can be complex.

Many people view surface water as a resource separate from ground water, but except for some situations where this is true, typically there is a connection between surface water and ground water and they really are part of the same system. Generally, many surface-water bodies are expressions of where the water table intersects the land surface, such as in many of the lakes and streams that occur in the valleys in eastern Nevada. Often, increases and decreases in stage (elevation of water levels) in lakes and streams relates closely to similar changes in the water table. Thus, a lowering of the water table can result in a decline in lake and stream stage, and in some cases, the drying up of these features.

So, how do surface-water bodies form? A simple approach would be to look at the process of Horton overland flow. This describes a three-stage process where rainfall first infiltrates the land surface. As soils become saturated, the water begins to puddle in depressions. This is followed by puddles becoming filled and overflowing into surface flow. This surface flow will run downhill due to gravity and usually through low areas, such as valleys and channels. The term used for the surface flow of precipitation or snowmelt is called runoff.

As previously mentioned, some of the water on the surface as rainfall or snowmelt infiltrates into the ground and becomes either soil moisture, held in the pore spaces above the water table, or reaches the water table an becomes ground water. If the water table intersects the land surface along a valley or channel, then the ground water can contribute to the streamflow. This contribution of ground water is called baseflow. Baseflow is what keeps streams flowing during periods in-between storm events. So, some of the precipitation contributes directly to streams and lakes as runoff and some of the precipitation flows along a different path and contributes to these surface-water features after traveling through the subsurface (baseflow).

Streamflow and lake levels can be expressed graphically using hydrographs. A hydrograph is a plot of water verses time. For example, a hydrograph can show changes in streamflow verses time (figure 1). Similarly, hydrographs can be use to show lake levels verses time and ground-water levels verses time. Hydrologists use hydrographs to help understand how lakes, streams, and ground water change with various impacts, such as storm events and droughts. In the hydrograph below, the amount of water from runoff (directly from precipitation and snowmelt) and the amount of water from ground-water discharge to the stream are shown.

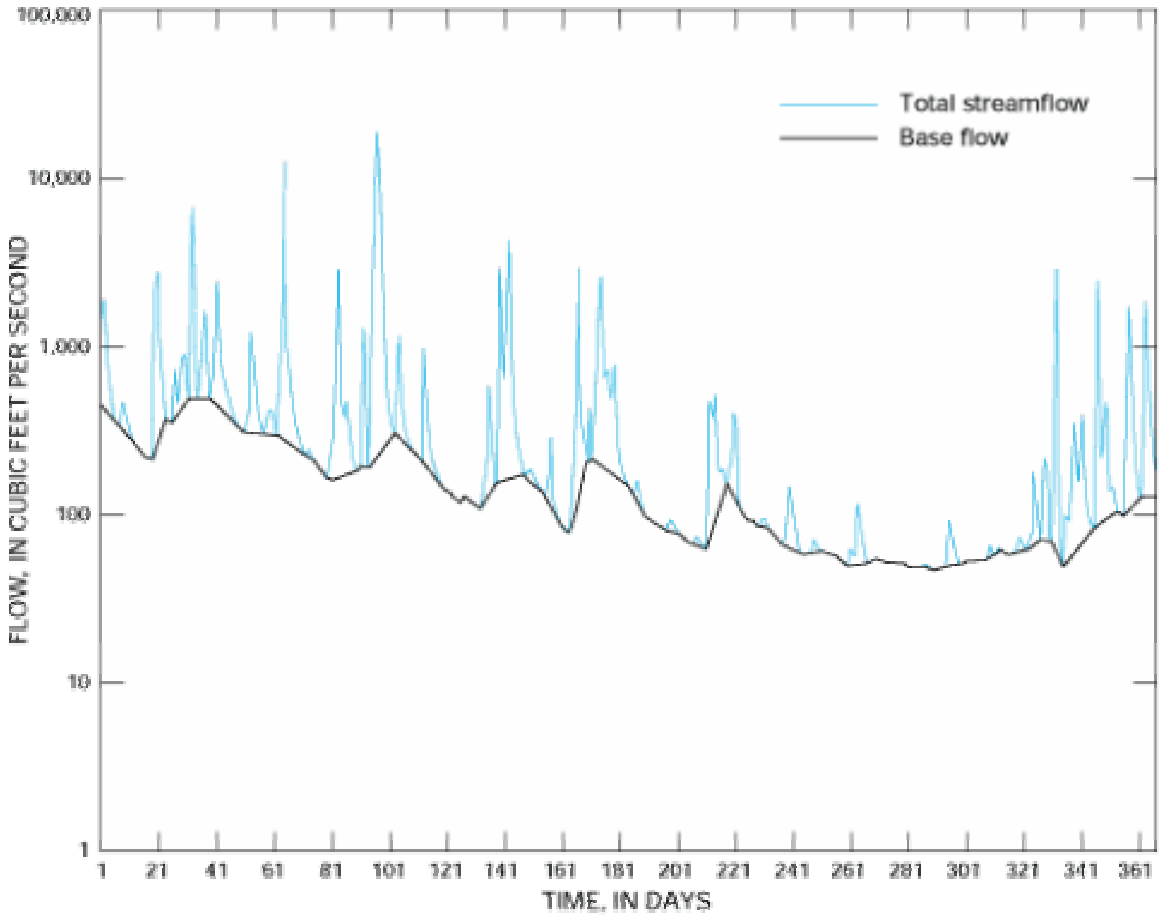

Figure 1. Streamflow hydrograph showing estimated baseflow (from Winter and others, Ground water and surface water, a single resource: USGS Circular 1139)

Hydrographs also are useful for seeing how local conditions, such as geology, slopes, vegetation cover, and other factors, affect streamflow following rain and snowmelt events. Here are two examples. In the first example (figure 2), the peaks in the hydrograph are wide, which indicates that a lot of the water from precipitation and snowmelt goes into the ground and gets released to the stream over time.

Figure 2. Streamflow hydrograph for Sturgeon River, MI (from Winter and others, Ground water and surface water, a single resource: USGS Circular 1139)

The second example (figure 3) is from an area that has very low-permeability, so the water from rainfall and snowmelt gets into the stream quickly (doesn't infiltrate into the ground) and produces narrow peaks in the hydrograph. This is because the land surface is frozen (this is North Dakota) during parts of the year and also because the geology at the surface is mostly clay, which doesn't allow water to infiltrate readily.

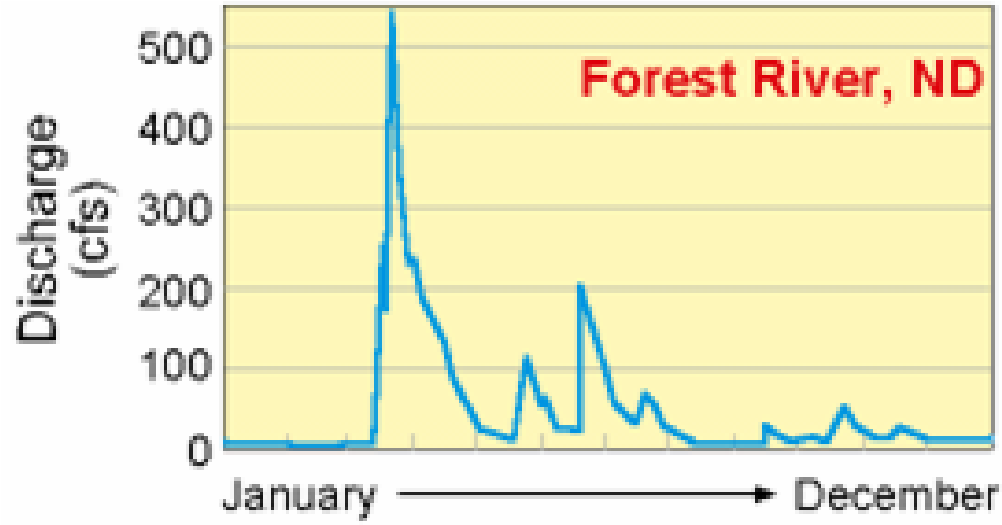

Figure 2. Streamflow hydrograph for Forest River, ND (from Winter and others, Ground water and surface water, a single resource: USGS Circular 1139)

The annual snowmelt event is very apparent in this hydrograph.

There are many other factors that affect the shape of hydrographs, and hydrologists use hydrographs as a tool to better understand how water moves in particular locations.

Next week, we will discuss springs. If you have specific questions concerning water, please email me at mstrobel@usgs.gov and I will try to provide answers.