

Rating Extensions for Water Resources Streamgages

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UDFCD operates a network of real-time flood monitoring streamgages for early flood detection and warning. Other agencies including the Colorado Division of Water Resources (DWR) and the United States Geological Survey (USGS) also collect data from Front Range streams, which is used primarily for water resources management. Whether they are operated for flood detection or water availability use, gages located in natural streams typically measure the water depth or stage, and report their respective gage height readings. Stream stage can be continuously monitored economically and accurately, but knowing flow rates associated with the stage data is also critically important. The corresponding discharge data is analyzed to characterize streamflow and estimate impacts.

The software that receives and stores stage data from remote streamgages uses a stage/discharge rating to assign a discharge for each stage measurement in the record. There are some challenges inherent in developing reliable stage/discharge ratings for gages in natural stream channels. The relationship between stage and discharge is unique for each gage site and can change over time, either gradually through incremental aggradation or degradation, or suddenly in response to a flood or other event that impacts the channel's hydraulic characteristics.

Water resources agencies like DWR and USGS are tasked with providing very accurate estimates of discharge, especially during low flow periods. They are continually

challenged by the gradual geometric changes that occur naturally in stream channels. Streamgage flow ratings are typically developed empirically from an on-going program of relatively frequent direct flow measurements. To compensate for changing channel capacities, ratings are frequently "shifted" and occasionally revised to match field measurements, which involve surveying the stream cross-sectional area, measuring the flow velocity and calculating the discharge. Discharge monitoring is not continuous, like stage monitoring, but it is relatively frequent, with each gage site visited multiple times a year to provide a comparison between the rated discharge and the flow rate measured in the field. Discharge measurements are made during summer low flows and during spring runoff, and if possible, during flood events. It is important to understand, however, that stage/discharge ratings for many DWR and USGS gages extend only as far as the highest discharge measured in the field. During a flood, gages with ratings that fall "short" of the peak do not provide any useful high flow information even though they continue to report accurate stage values.

Saint Vrain Creek was one of many Front Range streams that experienced very large flows during the September 2013 floods. The DWR streamgage at Lyons (SVCLYOCO) provides an example of when a water resources gage with a "short" rating fails to deliver critical flow data. Figure 1 below shows that SVCLYOCO appears to have done an excellent job of reporting stages (plotted in blue) until it was destroyed by the

Figure 1. Stage and discharge measured at SVCLYOCO (St. Vrain Creek @ Lyons), September 11-12, 2013

