01A140 – Nooksack River above the Middle Fork
Technical Notes: 2009 Water Year
Chuck Springer

The telemetered stream gaging station on the Nooksack River above the Middle Fork Nooksack River operated throughout water year 2009 without interruption. During the water year, seven discharge measurements were made and 15 discrete manual stage readings were taken at this station.

Rating Curve

This station began water year 2009 on Rating Table 1. Table 1 covers a range of discharge from 350 cubic feet per second (cfs) to 17,800 cfs. Three of the 16 discharge measurements used to develop this rating were taken during water year 2009. The measured flows for this rating, ranging from 693 to 6,370 cfs, cover only 33% of the rating curve. Flows exceeded the measured range of flows 31% of the time while Table 1 was in effect during October 2008. Thirty percent of flows were lower than the lowest measured flow, and 1% exceeded the highest measured flow. The rating curve was interpolated between discharge measurements and extrapolated to half the lowest measured flow using Johnson's method to temporarily straighten the rating curve using a log offset (e=4.2) calculated from the stage-discharge relationship. The potential error for flows derived from this rating curve is ±17%.

A large storm event in October 2008 caused substantial channel scour, shifting back to the stage-discharge relationship reflected by Rating Table 3. Table 3 covers a range of discharge from 186 to 17,800 cfs. Two of the 15 discharge measurements used to develop this rating were taken during water year 2009. The measured flows for this rating, ranging from 373 to 6,370 cfs, cover only 34% of the rating curve; however, flows only exceeded the highest measured flows 1% of the time while Table 3 was in effect during water year 2009. The rating curve was interpolated between discharge measurements and extrapolated to half the lowest measured flow using Johnson's method to temporarily straighten the rating curve using a log offset (e=2.1) calculated from the stage-discharge relationship. The potential error for flows derived from this rating curve is ±17%.

Another large storm event in January 2009 caused the channel to fill, shifting the stage-discharge relationship back to that reflected by Rating Table 1, which is discussed above. Flows exceeded the highest measured flows only 1% of the time while Table 1 was in effect between January and June 2009.

During spring snowmelt in 2009, the channel filled substantially, but gradually, from April to July, shifting to the stage-discharge relationship reflected by Rating Table 2. Table 2 covers a range of discharge from 250 to 17,800 cfs. One of the 14 discharge measurements used to develop this rating was taken during water year 2009. The measured flows for this rating, ranging from 505 to 6,370 cfs, cover only 33% of the rating curve; however, the measured range of flows was not exceeded while Table 2 was in effect during water year 2009. The rating curve was interpolated between discharge measurements using Johnson's

method to temporarily straighten the rating curve using a log offset (e=-16.1) calculated from the stage-discharge relationship. The potential error for flows derived from this rating curve is ±16%.

Flows greater than 6,370 cfs were modeled for all rating curves using a slope-conveyance model developed for this site. The initial model closely approximated measured flows. Extrapolative results were scaled using linear regression, which increased the modeled flows by an average of 6%. These scaled results approximated measured flows to within 8% on average, indicating a good fit of the flow model.

Stage Record

The station logged continuously throughout water year 2009 without interruption. The wire weight gage at this site is generally readable to within 0.05 ft during low-flow conditions, and the readability deteriorates as much as ±0.10 ft during high-flows. Conditions surrounding the terminal end of the bubbler orifice are similar to those around the wire weight gage. The stage height readings typically differed from manual wire weight gage readings by highly variable amounts, as much as 0.32 ft. Time-weighted corrective adjustments were made to the continuous stage record whenever the wire weight gage readings and datalogger readings differed. All adjustments are documented in the Hydstra Data Workbench. Where adjustments resulted in a 20% or greater change in discharge for any given day, the data for that day were qualified as estimates. For water year 2009, seven days were qualified as estimates.

Turbulent conditions surrounding the terminal end of the bubbler orifice, particularly at high flows, resulted in a great deal of noise in the continuous stage data at times. This noise gives the appearance of highly variable flows at this site, when in fact the variability is due to turbulence. The entire data set for water year 2009 was "smoothed" using a 5-point moving mean to eliminate the effects of the turbulence and reduce the appearance of highly variable flow.

Quality control measures were taken to identify potentially erroneous wire weight gage observations. A linear regression of wire weight observations versus tape down observations had an r2 of 0.954, with a standard deviation of 0.18 ft. The high standard deviation is indicative of the inherent difficulty in reading both the wire weight gage and tape down at this site. The regression identified three outliers, two of which were tape down readings that were incorrectly entered in the database. The third outlier could not be reconciled; however, the wire weight gage reading was consistent with surrounding readings, both in terms of stage height and in the magnitude of logger drift. It was thus presumed that the tape down reading was erroneous, and it was qualified as an "unreliable estimate" in the Hydstra database.

The calculated potential error of the continuous stage data for this station is ±9%.

Future Efforts

This station primarily oscillates between three primary stage-discharge relationships, and does so rather frequently. Continued frequent discharge measurements will be vital to ensuring an accurate discharge record.