

## HEC-RAS Model Results Description - WEST Consultants, Inc.

### Brief Description of Modeled HEC-RAS Results

The particle gradation loading curves provided by WEST Consultants and Gomez and Sullivan (GSE) represent modeled mass outputs from an unsteady HEC-RAS model developed for the Lower Susquehanna River reach between the USGS stream gage at Marietta, PA and Holtwood Dam. In addition to the Susquehanna River, lateral water and sediment inflows include Chickies Creek (included in USGS gage records at Marietta), Conestoga River and Pequea Creek. The model was run using gaged and other inputs from 1Jan2008 to 15Oct2015, with a 10-min computation interval and daily output interval.

Among many other sediment output parameters, HEC-RAS calculates a time series of the mass transport of various sediment particle size classes at each cross-section-defined control volume. The results were aggregated into three broader size classes for HSPF—sands (included gravels), silts, and clays—and plotted versus discharge at the Marietta gage, Safe Harbor Dam, and Holtwood Dam. The degree of scatter increased in the downstream direction, and piecewise functions were fit to the points as necessary. Mass loading rates (in tons/d) were extracted for 29 discharges ranging from 5,000 to 1,000,000 cfs.

### Major Assumptions and Considerations

Several key assumptions should be understood before applying the modeled results; this is not an exhaustive list, and a more complete description will be included in a later report.

1. It is important to understand the limitations of the model itself. The HEC-RAS model developed for this project is one-dimensional, and while the newest version (5.0) offers many advantages over previous HEC models developed for the same reach, the model's performance is limited in its ability to capture the effects of some two-dimensional flow dynamics. Both reservoirs have islands and other areas with dynamic bathymetric features that are two-dimensional in nature. While the best available methods and data were used, it was neither reasonable nor possible to fully capture the effects of those features given the limitations of a one-dimensional model. The modeling effort's goal was to represent general trends rather than exact values.
2. The model's input geometry is a major source of uncertainty. The 2008 channel geometry is based on Langland and Koerke's HEC-RAS model, which drew from a number of sources with varying levels of detail and accuracy. The current model was calibrated using calculated volume change in each reservoir as a whole and in a number of sub-areas from 2008-2013 and 2013-2015; those calculated volume changes are themselves subject to uncertainties based on the methods used and the quality of the bathymetric data. Volume changes calculated by the model were found to be within the acceptable error ranges of the bathymetry datasets for each reservoir and time period, and the model results generally agree with hypothesized behavior (net deposition at lower flows, net scour at very high flows).
3. Four production runs were executed to simulate the 1993, 1996, 2004, and 2006 high flow events in order to provide more data points at the upper end of the rating curves. Even with these

enhancements, sediment outputs should still be considered less reliable at very high discharges, given the relatively small number of data points. The largest modeled output discharge was approximately 660,000 cfs, so the sediment output values for discharges greater than 600,000 cfs are based on projected curves fit to data at lower discharges.