Attachment B-3

Change in Deposition and Bed Scour Between the 2008 and 2011 Conowingo Reservoir Bathymetry Surveys

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Background

This document describes the change in bed elevation that occurred between the 2008 and 2011 bathymetry surveys of Conowingo Reservoir. To support this calculation, a high resolution mesh of Conowingo Reservoir was constructed using the SMS modeling graphical user interface. This mesh contained 25,000 nodes and 48,000 elements. Each of the surveys was interpolated to this mesh, with the 2008 interpolated bed elevation subtracted from the 2011 interpolated bed elevation. The result was the difference in bed elevation, with sediment deposition indicated by positive change in elevation and bed scour indicated by negative change in bed elevation. Figure 1 describes how the survey transect data were interpolated to the mesh, with Figure 2 showing the resolution of the mesh in the lower reservoir.

Results

The bed elevation change is depicted in Figure 3. The total deposition was 8.8 million tons assuming a bed bulk density of 1600 kg/$m^{3.}$ The total bed scour was 5.6 million tons also assuming a bed bulk density of 1600 kg/m^3. The reservoir was net depositional 3.2 million tons. Figures 4 and 5 show deposition and bed scour respectively, with the color contour representing the variable in question, with the other variable not contoured (white areas). Figure 4 indicates that deposition increases with distance from the upper reservoir, with 69 percent of the deposition occurring in the lower half of the reservoir. A relatively large amount of deposition (26 percent of the total deposition) is located in a relatively small area from the dam to a point about 2 miles upstream on the eastern side of the reservoir (see notation on Figure 4).

Figure 5 shows the bed scour depth, as well as spatial variation of scour. The bed scour trend is opposite of the deposition trend. The most bed scour is found in the top one-third of the reservoir, with a decreasing trend downstream. Approximately 73 percent of the total bed scour occurs in the top half of the reservoir. In the lower reservoir, approximately 120,000 tons scours from just upstream of the dam (see notation on Figure 5).

Discussion

The bed elevation change calculations for the 2008 and 2011 survey comparison show distinct trends in deposition and erosion. The 2011 survey was taken just after the Tropical Storm Lee event, which had a peak instantaneous discharge of 700,000 cfs, which is 75 percent greater than the scour threshold discharge of 400,000 cfs. Significant changes occurred in reservoir morphology due to this storm. Fifty percent of the scour occurred in the top one third of the reservoir which contained up to 50 percent sand. Suspended sediment samples taken below the dam indicate that 10 percent or less sand transported through the dam during Tropical Storm Lee, thus the remaining sand scoured from the upper reservoir is likely re-depositing in the lower reservoir reaches.

The lower half of the reservoir is net depositional, with a relatively large quantity of sediment deposited just upstream of the dam along the eastern shore of the reservoir. This deposit depicted on Figure 4 contains 26 percent of the total deposition over just 3 percent of the reservoir area. This area is on the opposite side of the reservoir from the power plant intake. The excessive accumulation of sediment in this area is likely due to reservoir operations during the flood. As the gates open to release floodwaters, sediment laden flows re-align to the middle of the channel, with the area along the eastern shore experiencing lower velocities and secondary circulation. Thus this area is subjected to constant sedimentation when the gates are releasing flood flows. Sediment scoured from upstream may enter this sedimentation zone and re-deposit.

Conclusions

Analysis of sedimentation and bed scour that occurred in Conowingo Reservoir between 2008 and 2011 indicates potential re-deposition of bed scour material in the lower reaches of the reservoir. Sand sized sediments scoured from the upper reservoir do not exit the reservoir in their entirety, and a depositional zone along the eastern shore of the reservoir just upstream of the dam contains a significant quantity of sediment given the area it occupies in the reservoir.

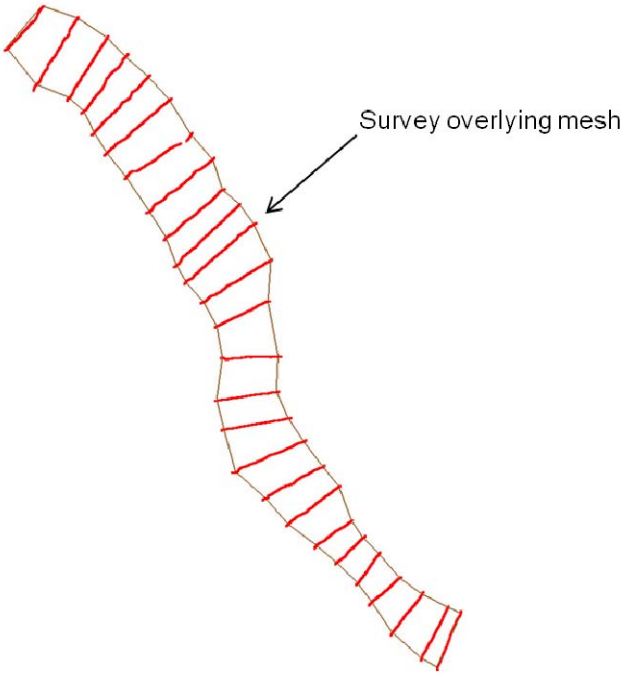

Figure 1. Bathymetric survey overlying the reservoir mesh

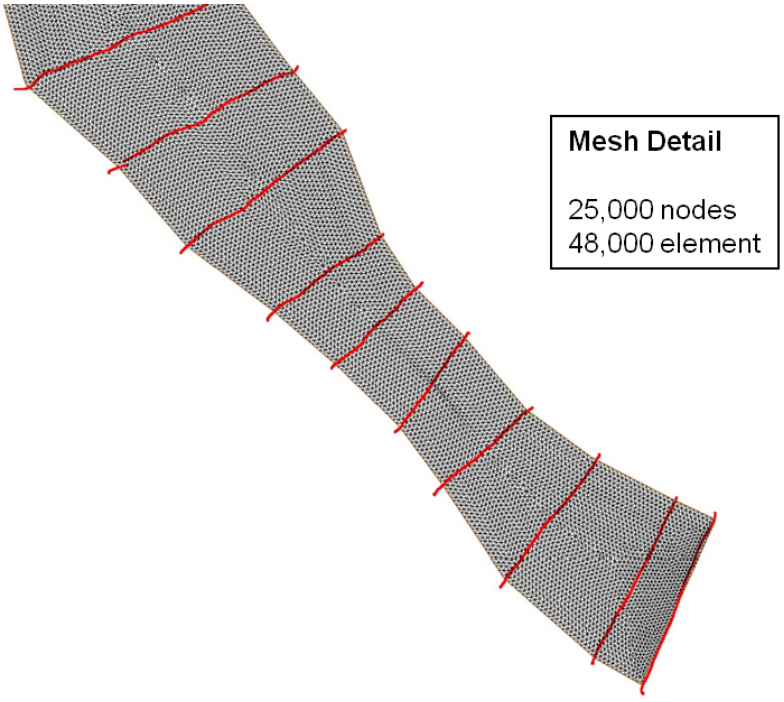

Figure 2. Bathymetric survey overlying reservoir mesh with details

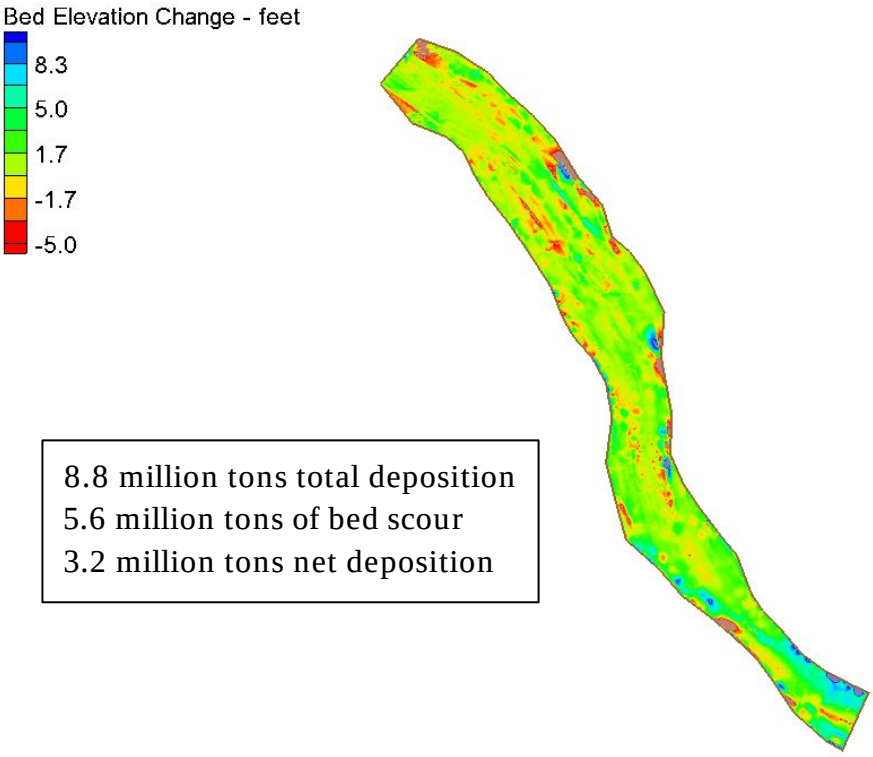

Figure 3. Bed elevation change between the 2011 and 2008 surveys

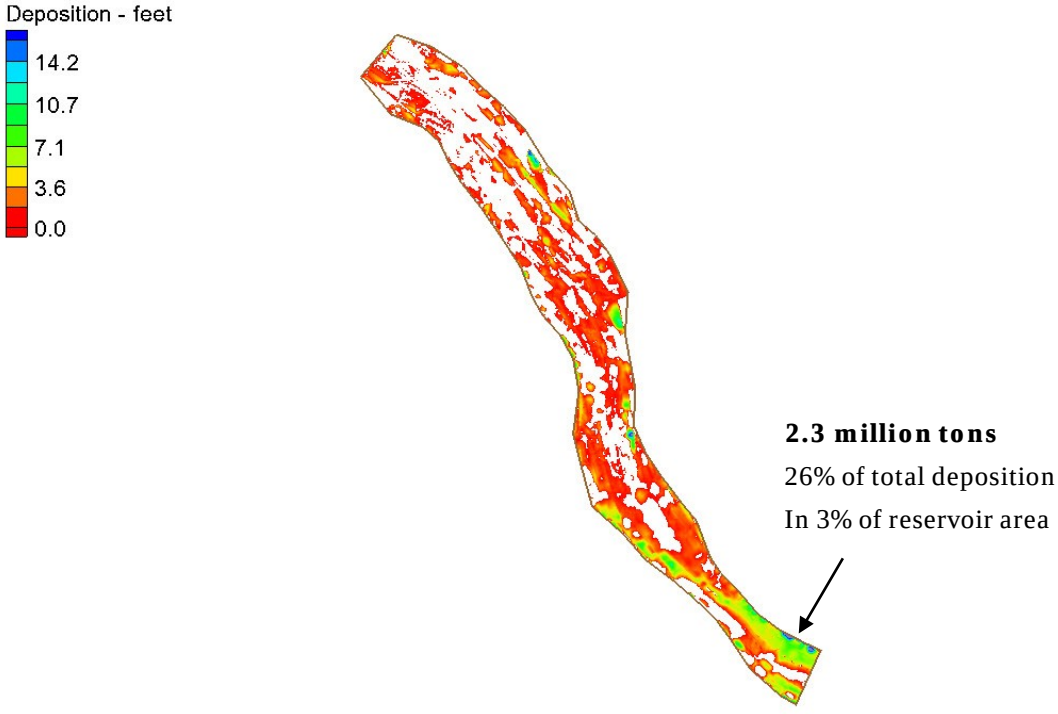

Figure 4. Change in deposition depth between the 2011 and 2008 surveys

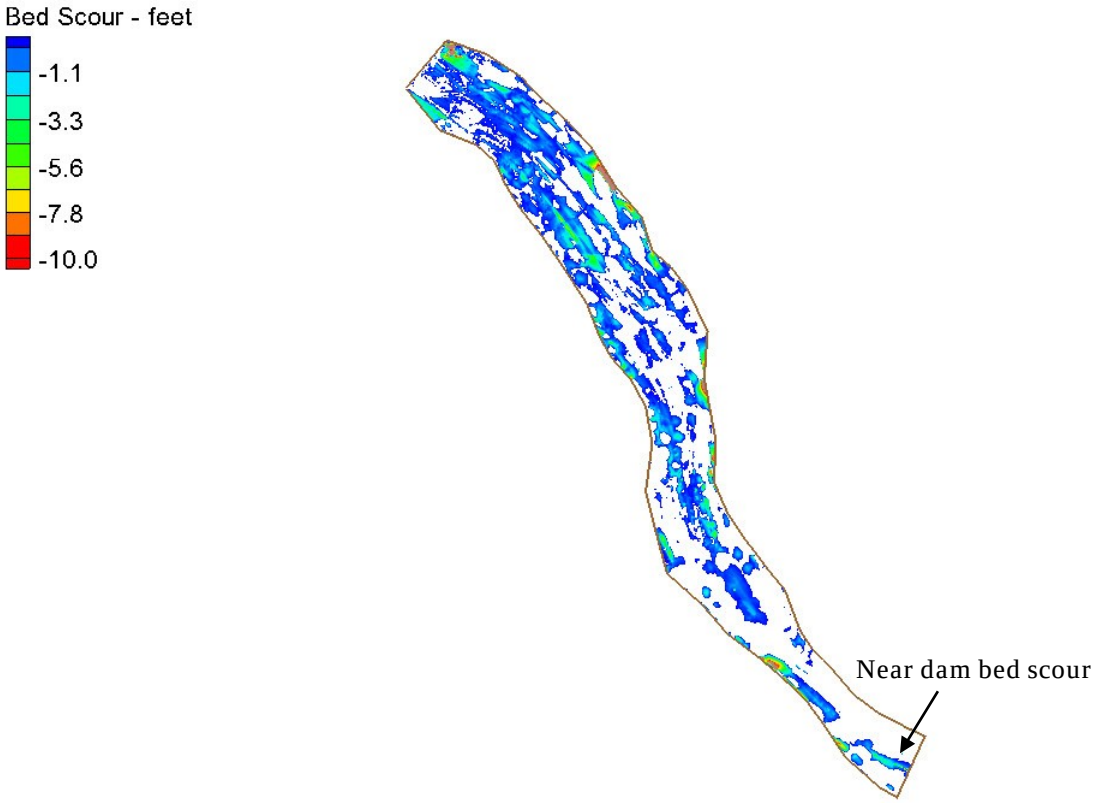

Figure 5. Change in bed scour depth between the 2011 and 2008 surveys