Basic Unsteady Flow Modeling
Workshop

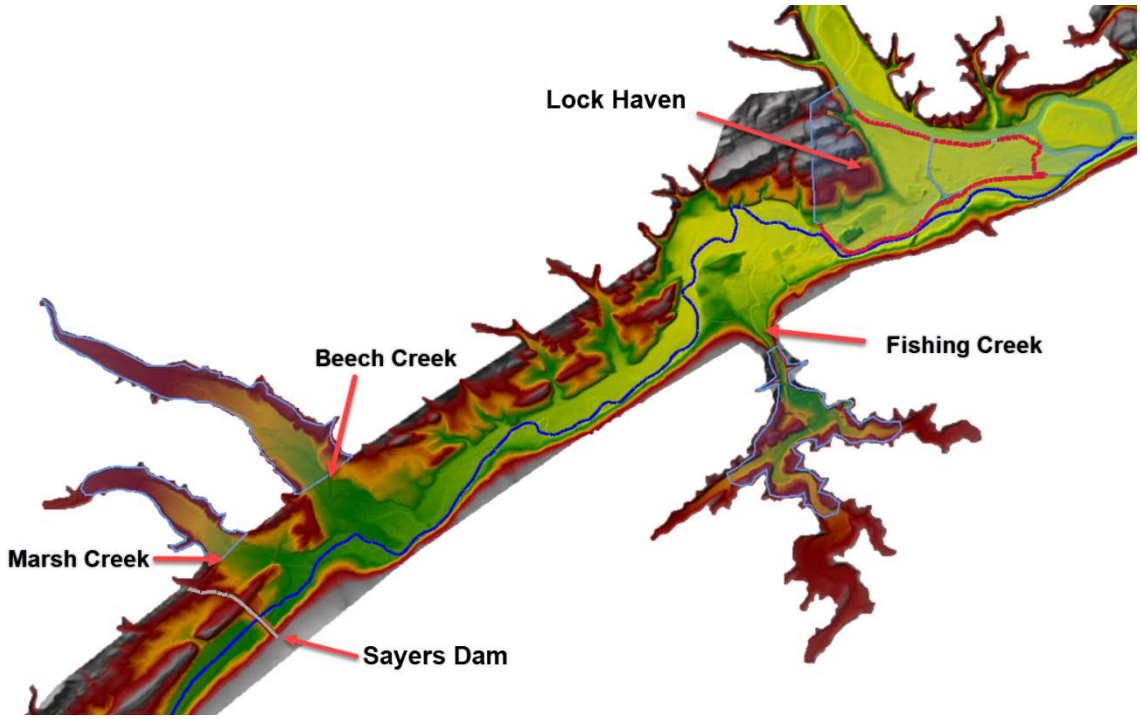
1 Objective

In this workshop, you will exercise your knowledge on the basics on unsteady flow modeling to setup and compute a simulation for Bald Eagle Creek.

- Creating an Unsteady Flow file and adding boundary conditions
- Linking boundary conditions to DSS data
- Setting initial conditions
- Performing a sensitivity analysis on boundary conditions
- Revieing results using various methods

2 Background

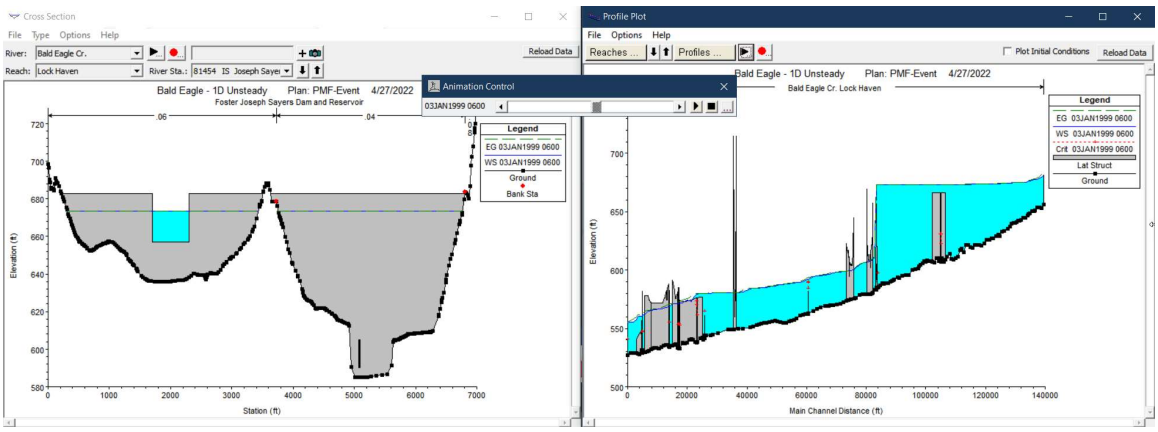
You worked with a dataset for Sayers Dam on Bald Eagle Creek in central Pennsylvania. Sayers Dam is approximately 15 miles upstream of the town of Lock Haven, which is protected by a levee system (see the figure below).



3 Setup Unsteady Flow Boundary Conditions

Question: Which profile (date and time) had the highest water surface elevation at the dam. What was the water surface elevation?

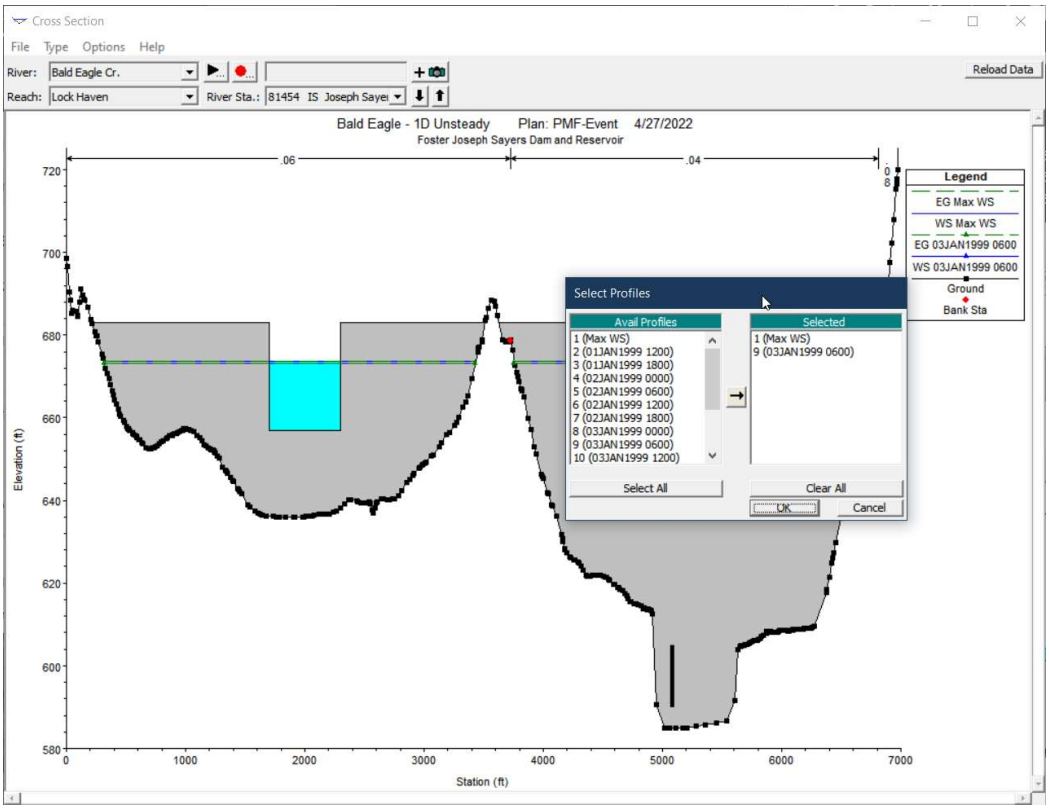
*The **03Jan1999 0600** profile contained the highest water surface elevation at the dam. The water surface elevation was **673.27 ft**.*



Question: What is the water surface elevation at the dam for the "Max WS" profile? Why is this different than the answer above?

*The Max WS profile shows a water surface elevation of **673.68 ft**.*

*Plotting both the Max WS profile and the **03 Jan1999 0600** profile simultaneously in the Cross Section Plot, was an easy way to see the difference between the two.*



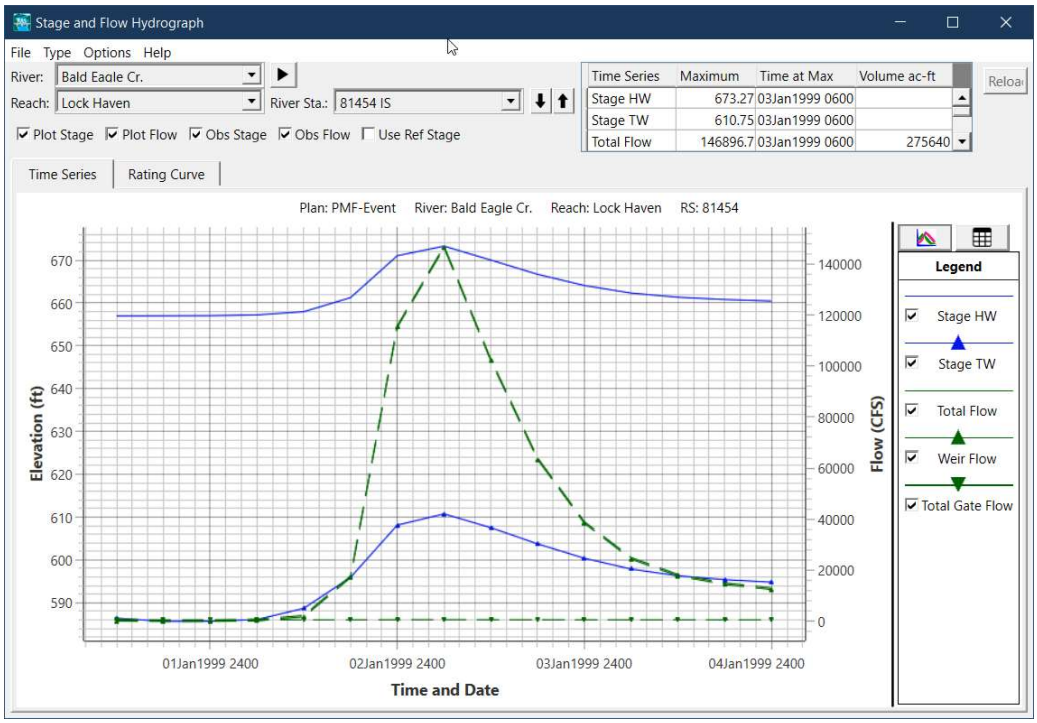
*The Max WS profile had a water surface elevation at the dam of **673.68 ft**, less than a **0.5-ft** difference from the **03 Jan1999 0600** profile. Since the difference is not large the actual peak water surface elevation must have been close to our output interval, but this is not the case downstream.*

*The reasoning for the difference is that **Detailed Output Interval** which controls the frequency of the output in these plots was significantly more coarse than the computation interval, so we are only seeing the results every 6 hours. The Max WS profile which is generated by default shows the maximum at all locations in a single profile, regardless of output interval selected.*

Question: What is the maximum water surface elevation and maximum total flow for the dam? Comment on the shape of the hydrographs.

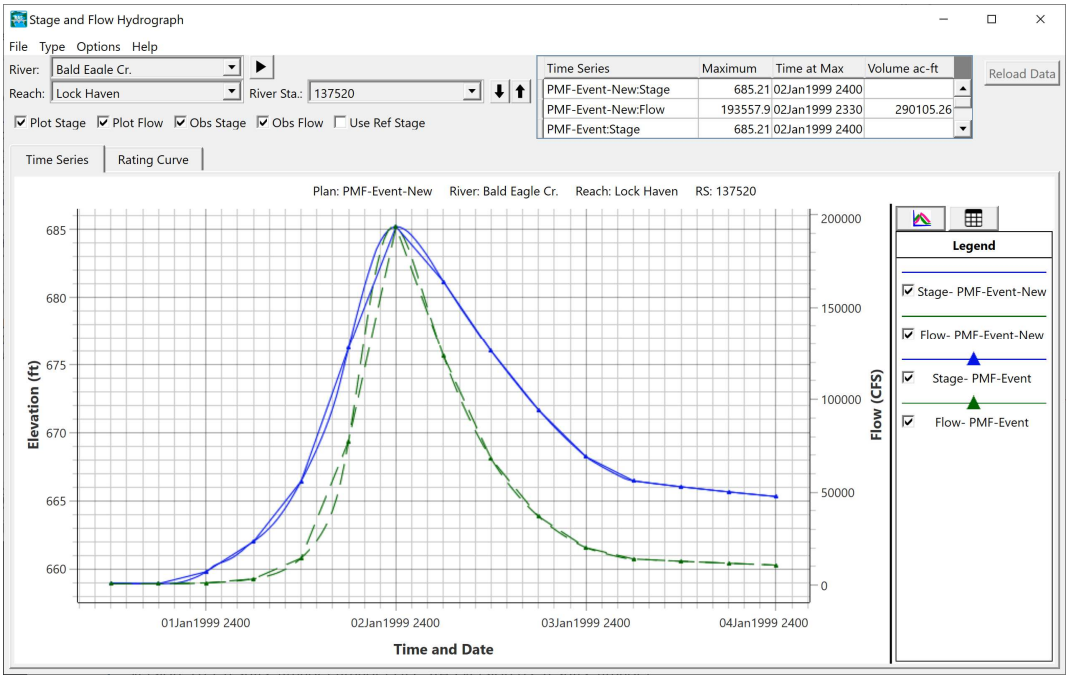
*The maximum water surface elevation is **673.27 ft** and the total flow is **146,896 cfs**. Since the Hydrograph Output Interval is the same as Detailed Output Interval, the results in the Cross Section Plot and the Profile plot are the same.*

The shape of the hydrographs is blocky and unnatural. The flow hydrograph in particular is triangular in shape. This is because the output points are only every 6 hours and straight lines are drawn in between them.



Question: Now that we've decreased the output interval, how do the stage and flow hydrographs compare to the previous run?

*The flow hydrographs look much more realistic in shape for the 30-minute plot. Additionally, the peak water surface elevation is now **673.68 ft** which was identical to the value in the Max WS profile. The peak flow is **152,901 cfs**; approximately **6,000 cfs** different than in the peak in the 6-hour plot. That means we have set the output interval fine enough to catch the peak stage (and likely flows) at this location.*



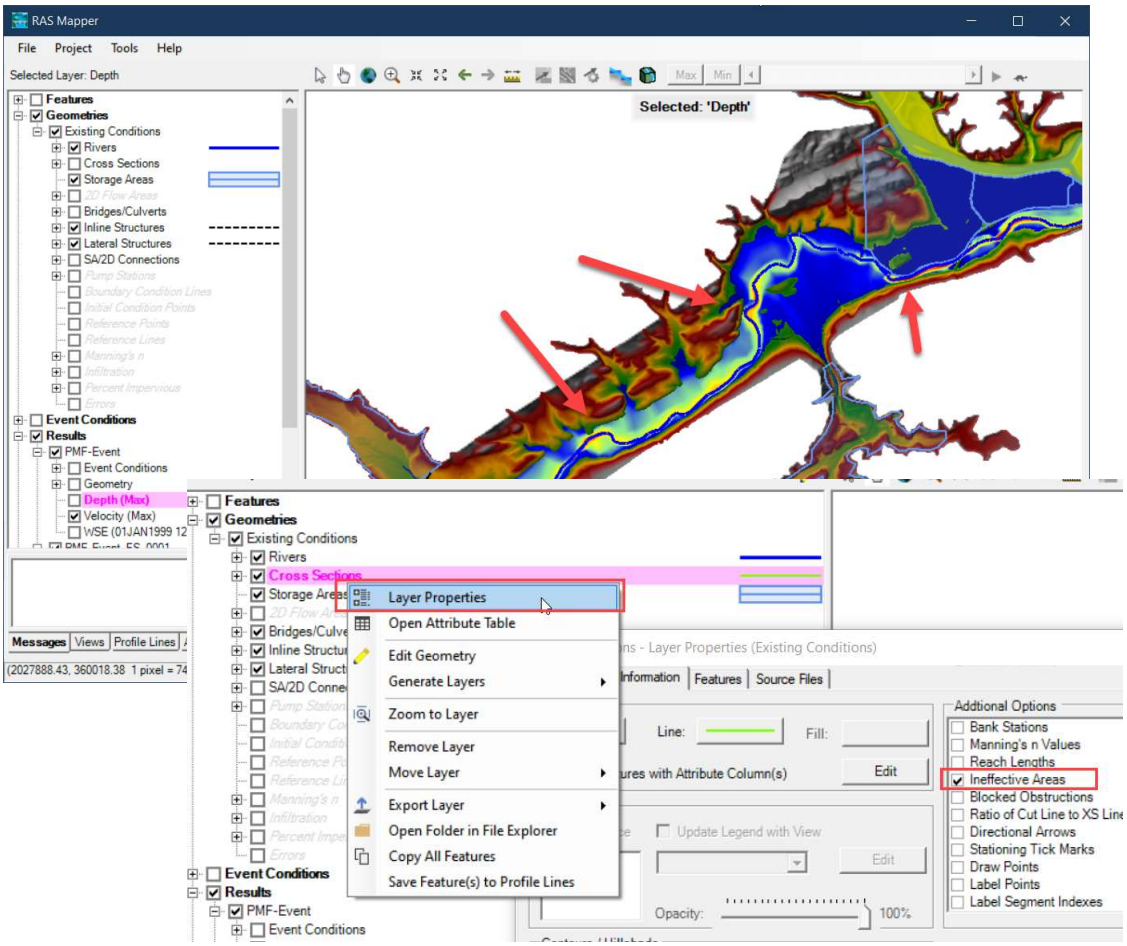
Question: Similarly, how does Profile Plot compare to the previous run?

Since we also decrease the Detailed Output Interval, the Profile plot more clearly shows the flood wave moving through the system. With this finer resolution of output we can get a better idea of the timing in the system and better answers for questions like 'when did the levees first overtop'

4 Revieing Result in RAS Mapper

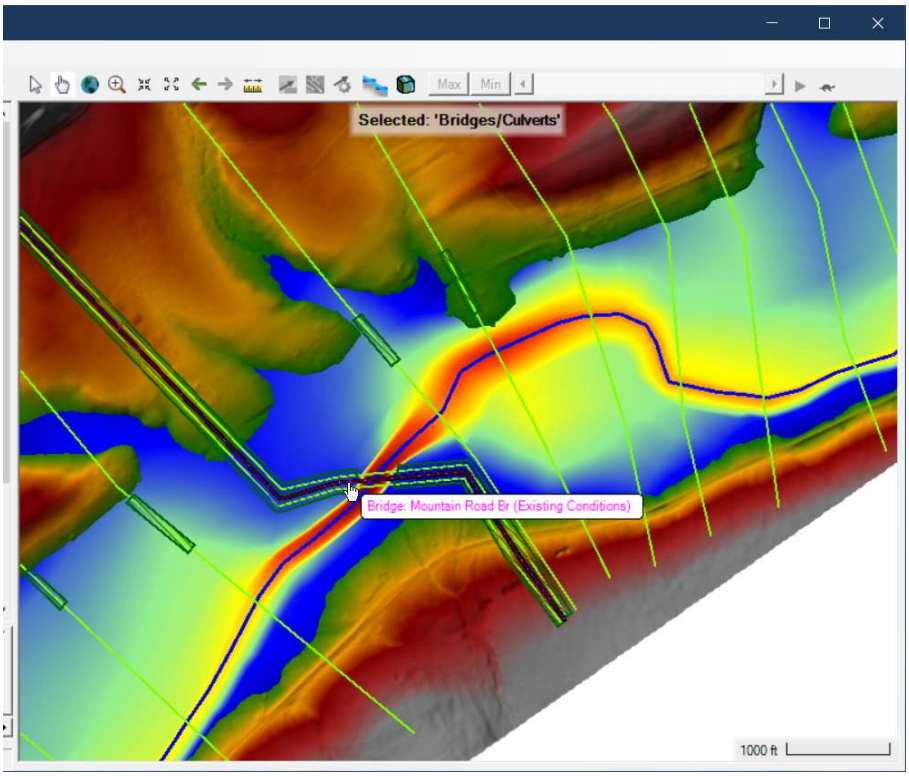
Question: Locate 3 areas where velocities are the highest. What are the velocities in these areas? What do you think is causing the high velocities?

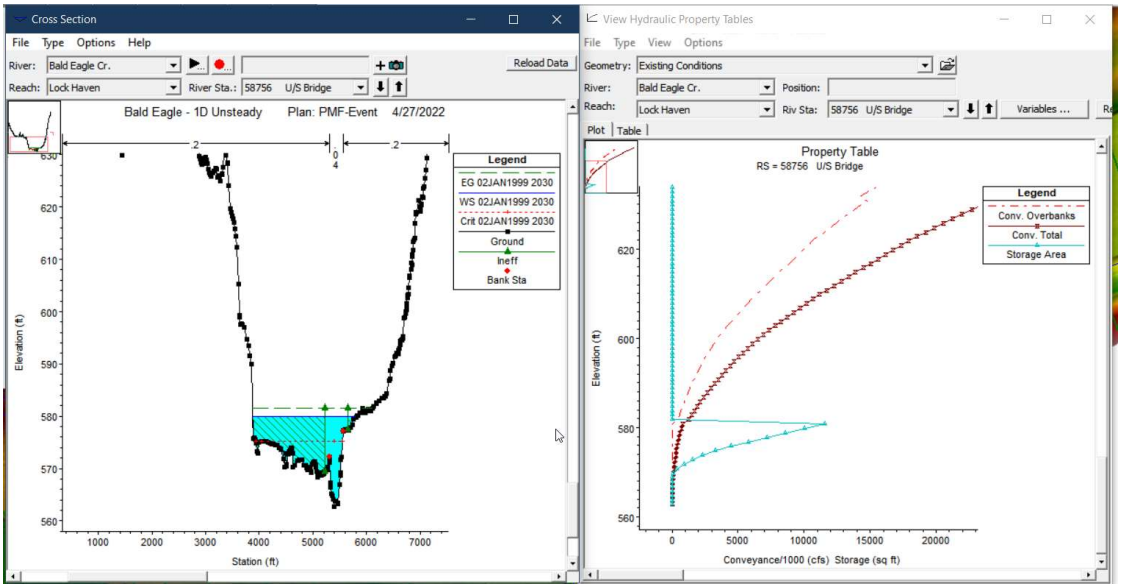
*In RAS Mapper, turning on the Max Velocity layer and navigating the model, there are five locations where velocities exceed **10 ft/s** and three locations where velocities exceed **15 ft/s**.*



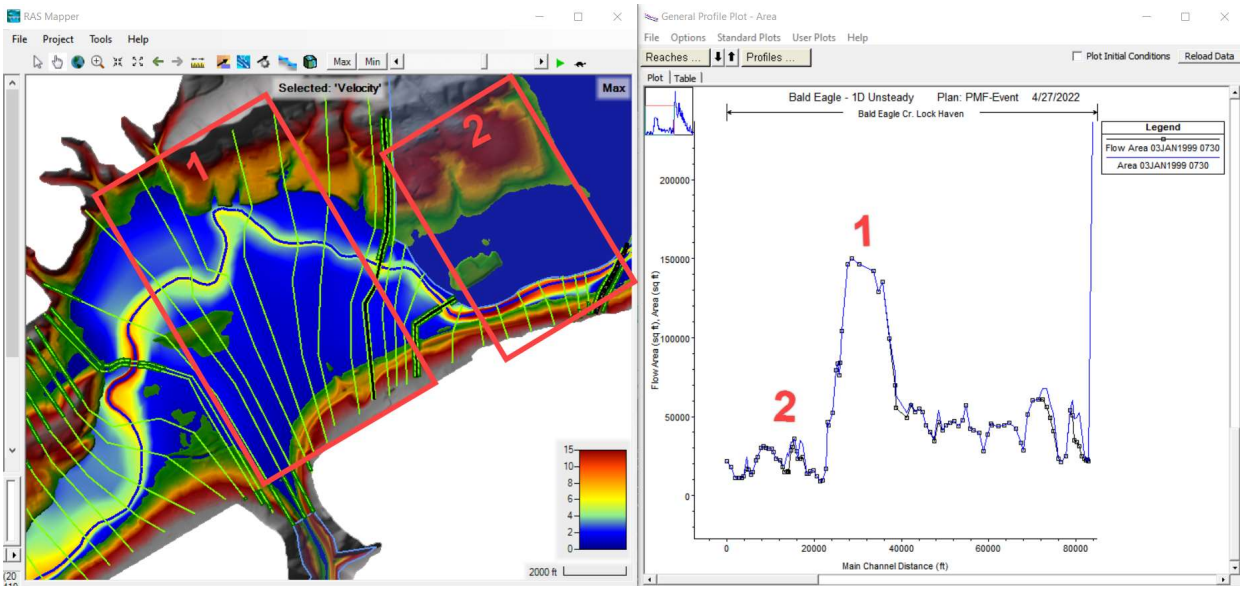
*Turning on all the geometry layers helps us better investigate what is causing the high velocities in these areas. Also, turning on the **Ineffective Flow** areas in the cross-section layer properties helps show where in the geometry we have reduced conveyance and constricted flow.*

Mountain Road Bridge at River Station 58673 shows high velocities where the road embankment causes much of the overbanks to be ineffective. This is confirmed in the hydraulic property tables showing no conveyance in the overbanks until the road embankment is exceeded.





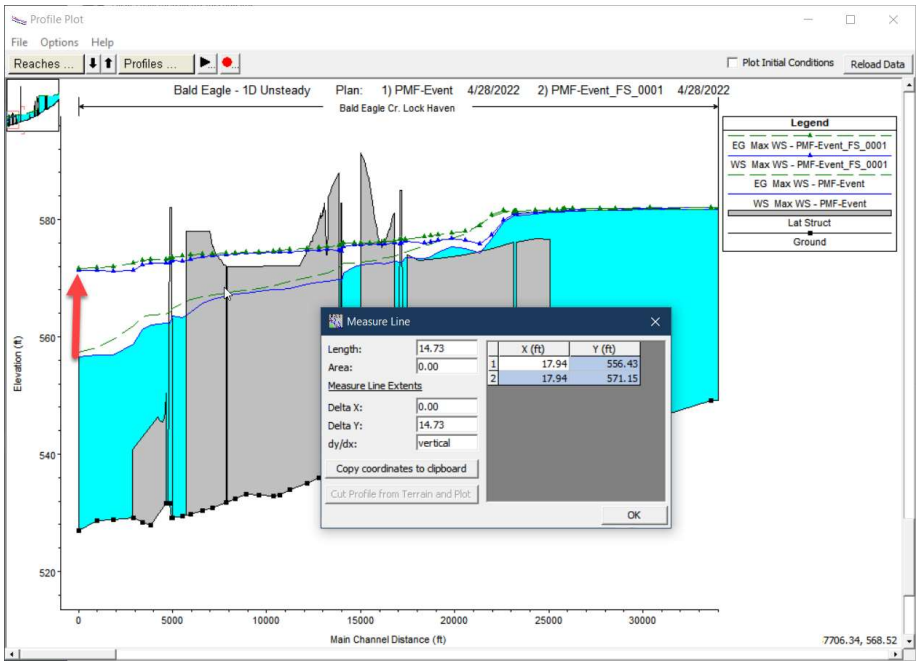
Another high velocity location is at the upstream end of the Town of Lock Haven. The high velocities in this location are probably driven by the dramatic decrease in flow area where the floodplain widens then decrease dramatically when it is squeezed by the levees. Plotting Flow Area in the General Profile confirms that the flow area is decreasing dramatically at Lock Haven.



5 Downstream Boundary Sensitivity

Question: What is the largest difference in maximum water surface elevations between the two plans? Where does this occur?

Decreasing the friction slope for the downstream boundary condition dramatically changed the results at the downstream end of the model and had smaller impacts many miles upstream. The largest difference in the maximum water surface profile was approximately ***14.5 ft****! and not surprisingly, occurred at the last cross section in the reach.*



Question: Do you think this is a good location for a downstream boundary condition? Why or why not?

Lock Haven is the most urbanized and populated area in the model, so it is certainly an area of interest in our domain. That said, having the downstream boundary condition be so close to this area of interest is probably not advisable, especially now that we have seen how big of an impact the boundary condition has. Secondly, the boundary condition occurs at a confluence and a substantial widening of the floodplain. This makes for more uncertainty in selecting an appropriate boundary condition.

Performing a sensitivity analysis against the location of the downstream boundary condition would be helpful for this dataset.