Workshop
2D Bridge Hydraulics

Introduction

This workshop will help students learn how to use HEC-RAS to model bridges inside of 2D Flow Areas and review and understand pertinent 2D Bridge output.

NOTE: While this data is from an actual river system, the model and results of this workshop do not represent current or future conditions of the river. The United States Army Corps of Engineers has granted access to the information in this model for instructional purposes only. Do not copy, forward, or release the information without United States Army Corps of Engineers approval.

Background

Figure 1 shows the extent of an existing 2D Flow model. The Terrain data is from Bald Eagle Creek. For this workshop you will be modeling just a small portion of Bald Eagle creek, which contains one bridge crossing. You will be starting with an existing model of the area that does not contain the bridge. The goal of this workshop is to add the bridge data; run the model; review the output; and answer some questions about the model.

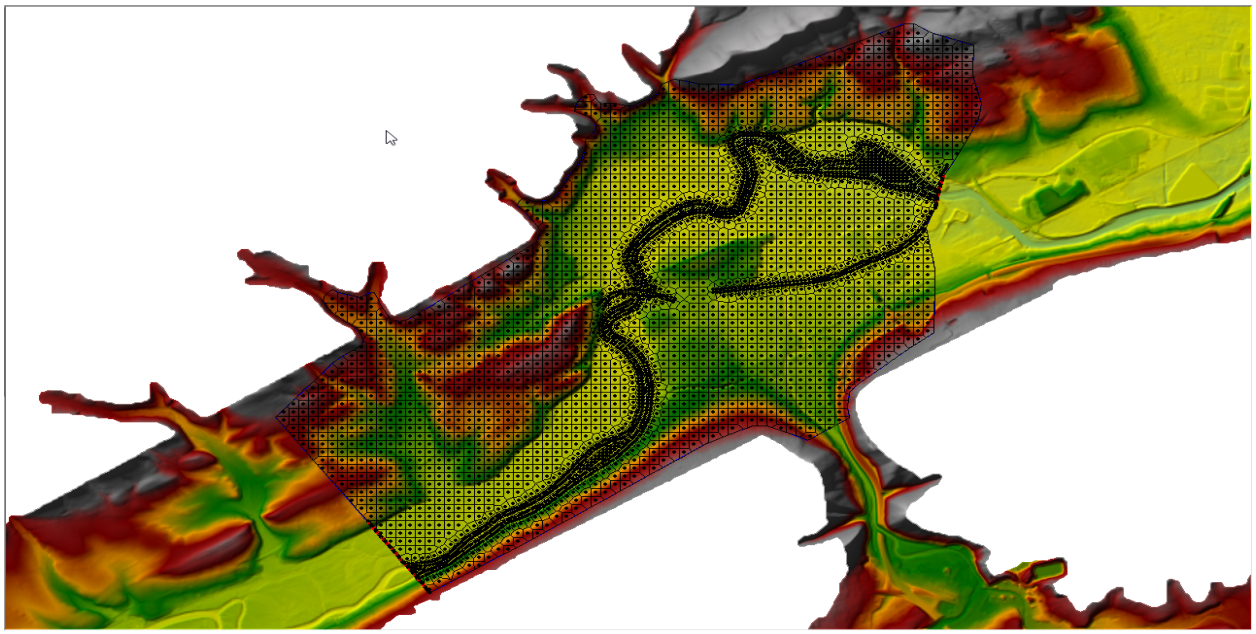
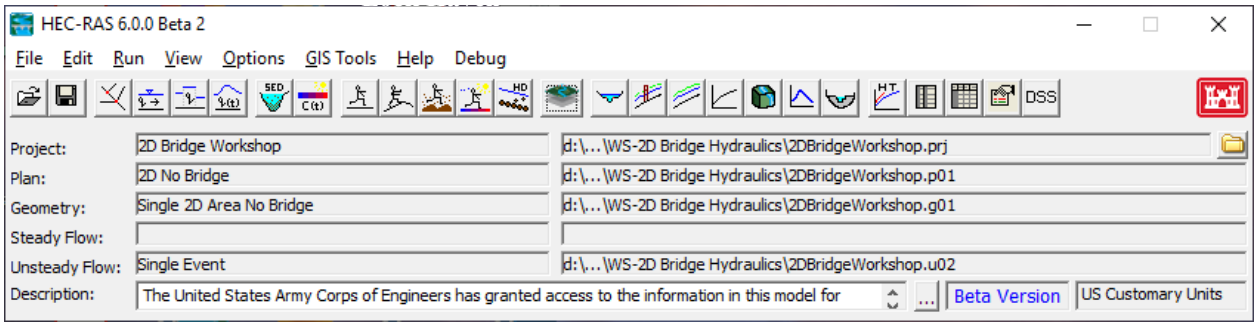


Figure 1. Terrain and existing 2D Model for Bald Eagle Creek Bridge workshop.

Tasks

1. Open the Project and Run the 2D No Bridge Plan

Open the Project and run the only plan, which is called "**2D No Bridge**".



2. Make a Copy of the Geometry File

Go to the Geometric Data editor and make a copy of the current Geometry data using the "**Save As**" option. Label the new geometry file something like: "**Single 2D Area with Bridge**".

3. Add the Bridge into the Geometry Data.

You can add a 2D Bridge with either RAS Mapper or the Geometry editor. However, RAS Mapper only allows you to lay out the geospatial centerline of the 2D Bridge, and to give it a name. All of the actual bridge data must be entered from the Geometry editor. So, for this workshop we will do the whole thing in the geometry editor. To add a bridge to the 2D Flow Area from the Geometry editor, perform the following steps:

a. Zoom into the bridge location (see below), then select the **SA/2D Area Conn** tool. Draw the bridge centerline from left to right, while looking downstream, as shown in Figure below:

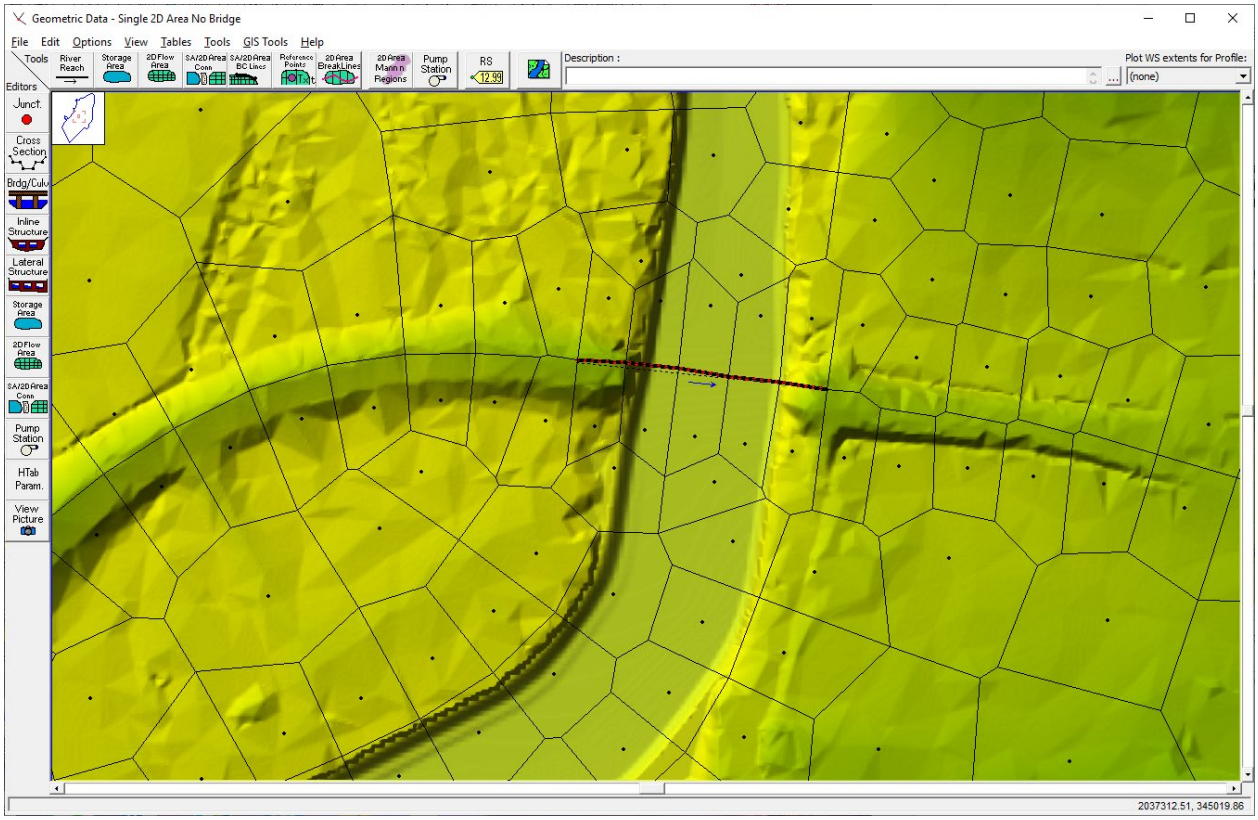


Figure 2. Using the SA/2D Area Conn to draw the bridge centerline.

b. Left click on the Bridge centerline and select "**Edit Internal Connection Cell Spacing**". This will bring up the editor shown below. Put in a minimum cell spacing = 30 ft, and a maximum cell spacing = 30 ft.

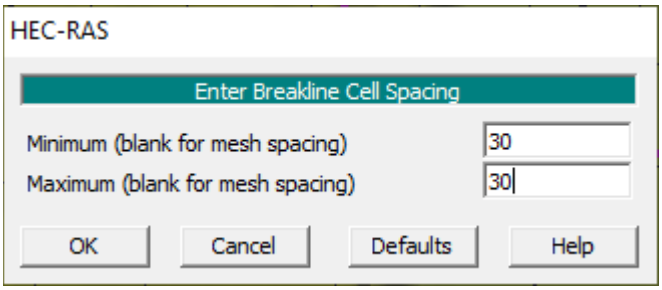


Figure 3. Internal Connection Cell Spacing editor.

b. Next, left click on the 2D Bridge centerline and select "**Enforce Internal Connection as Breakline in 2D Flow Area**". You mesh should look like this:

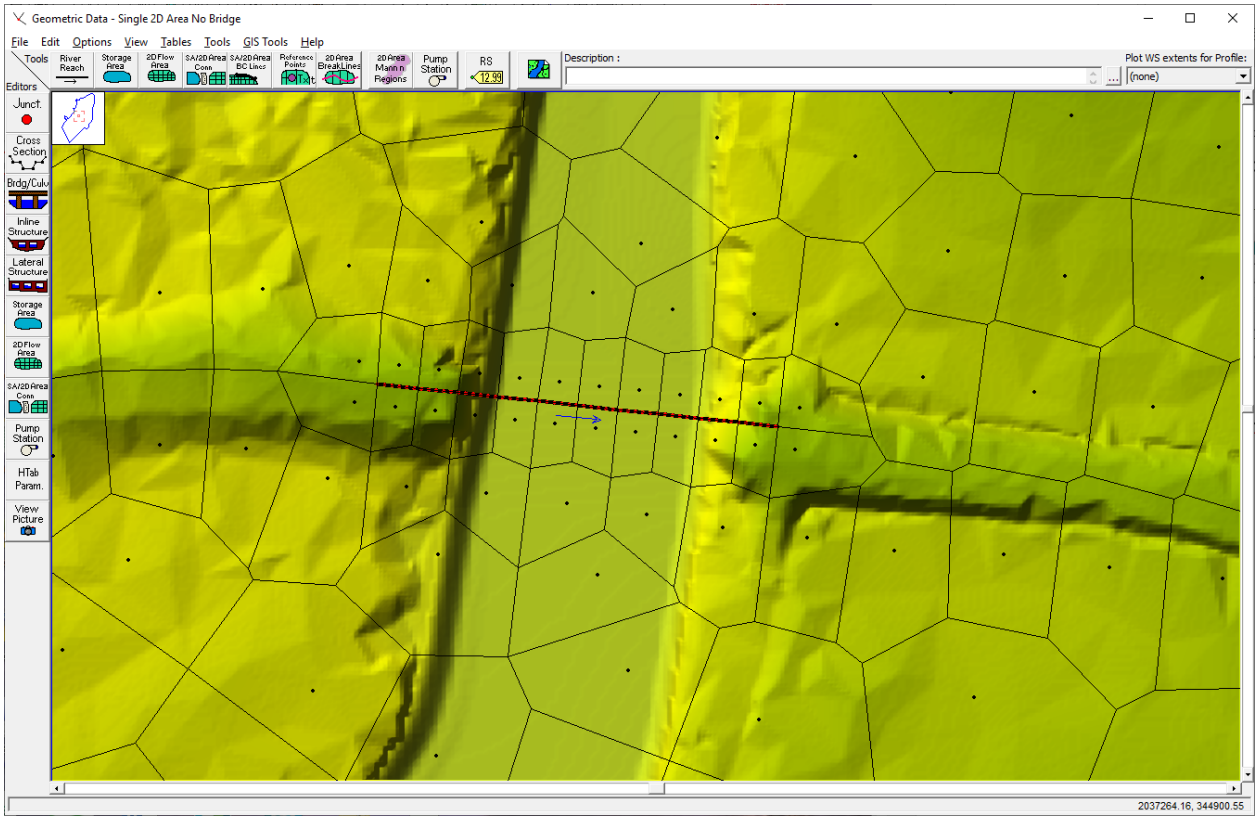


Figure 4. 2D Bridge Mesh after Breakline Enforcement.

d. Right click on the 2D Bridge centerline and select "**Edit** Connection. This will bring up the SA/2D Area Conn editor as shown below. Change the **Structure Type** to **Bridge (Internal to 2D Flow Area)**.

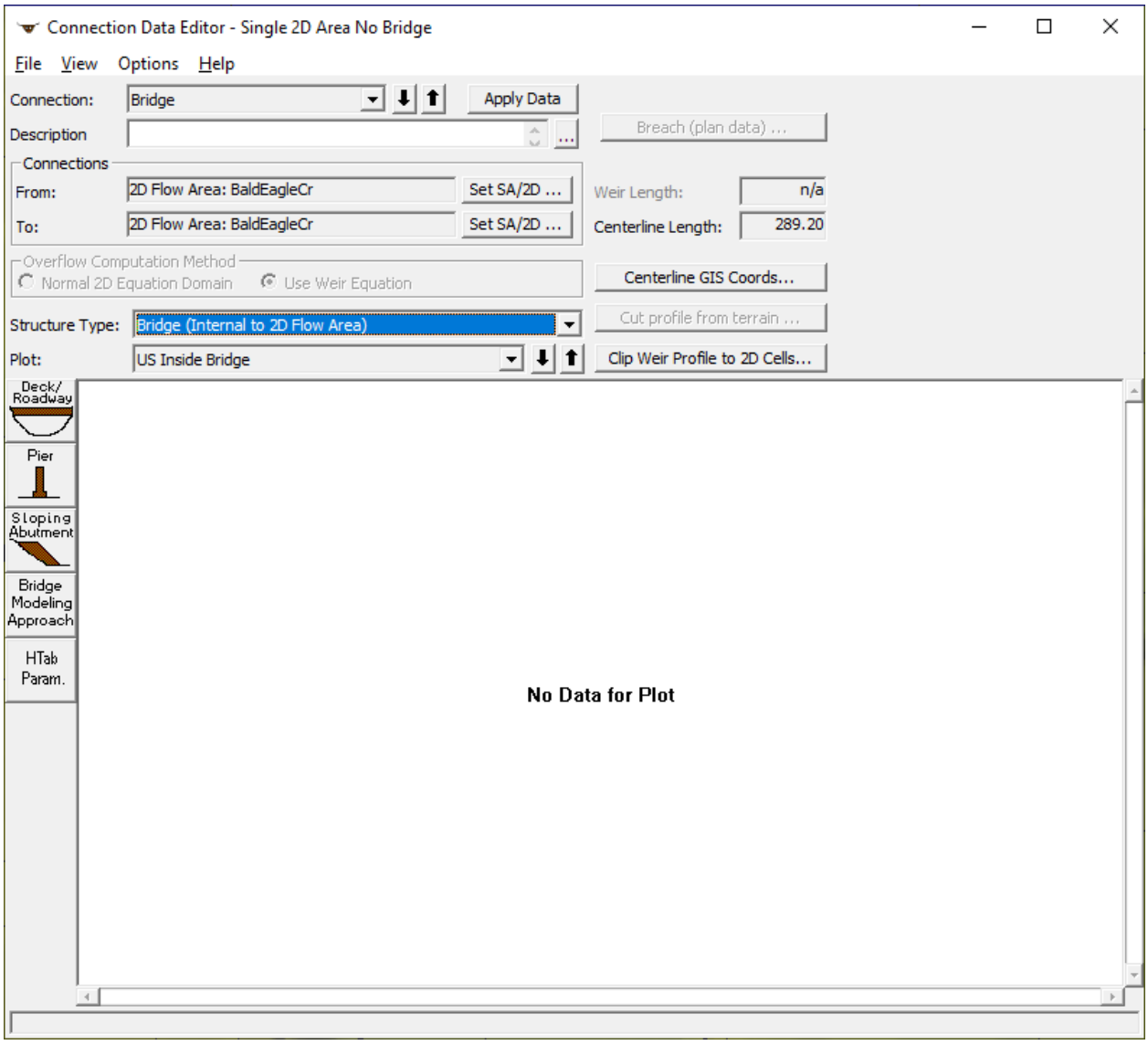


Figure 5. SA/2D Area Conn editor, with Bridge Structure Type selected.

e. Select the **Deck/Roadway** editor on the left and enter the data as shown in the Figure below:

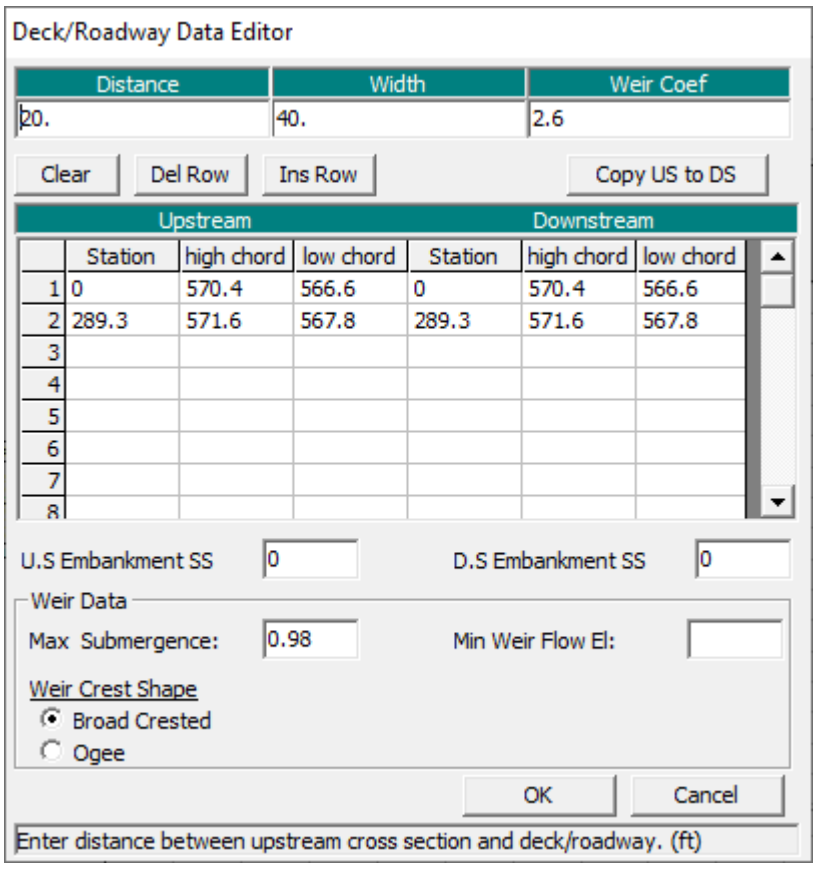


Figure 6. 2D Bridge Deck and Roadway data editor with data shown.

Once you have entered all the data, close the editor. In order to get the editor to update the drawing, click on the window or move the window. The editor should now look like this:

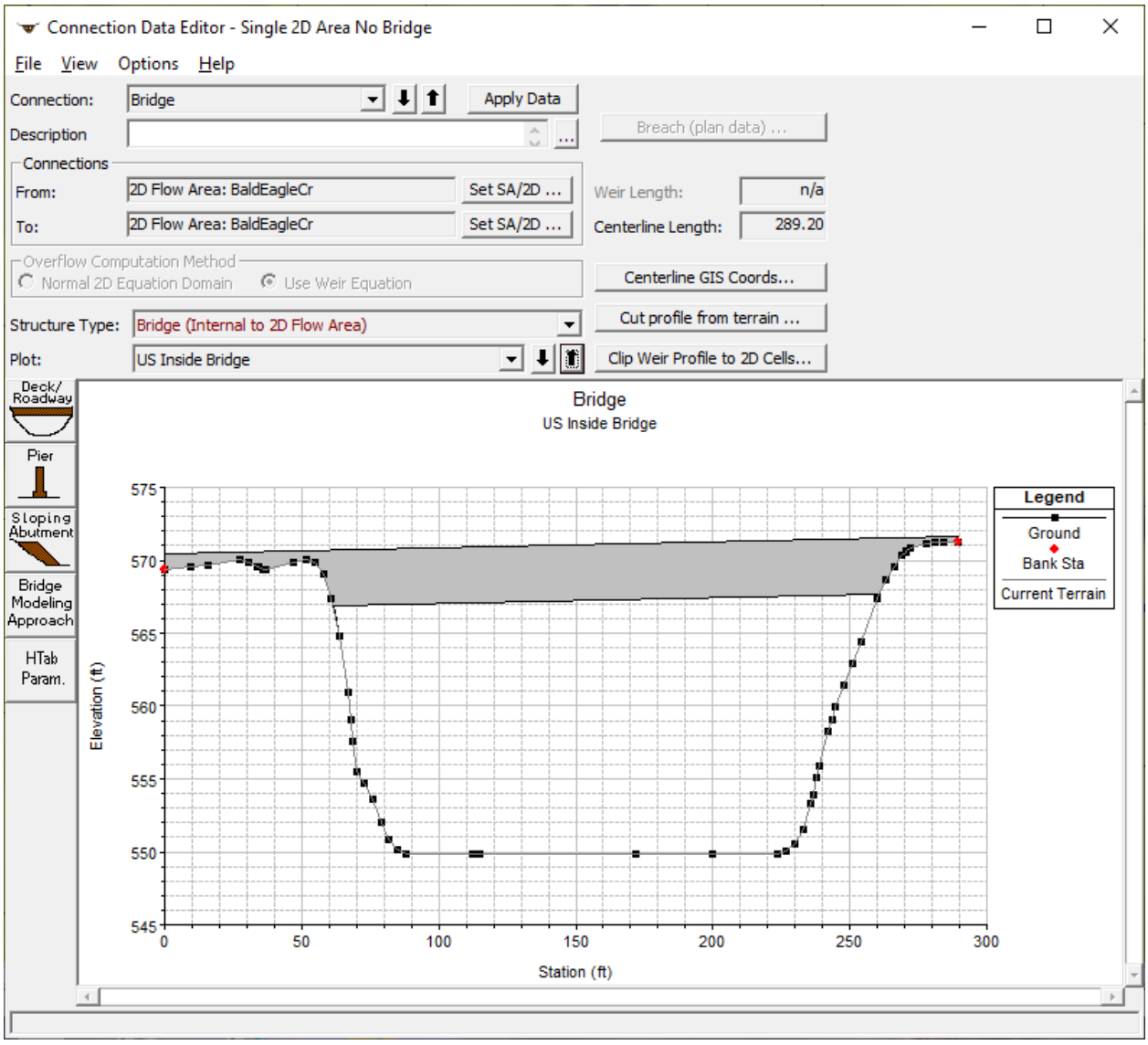


Figure 7. SA/2D Area Conn with 2D Bridge Deck/Roadway data added.

f. The next step is to add the bridge piers. Open the **Pier** editor on the left and enter the pier data. There are two piers, they are each 2 ft wide. One is a station 125, the other is at station 185. See the data in the Figure below:

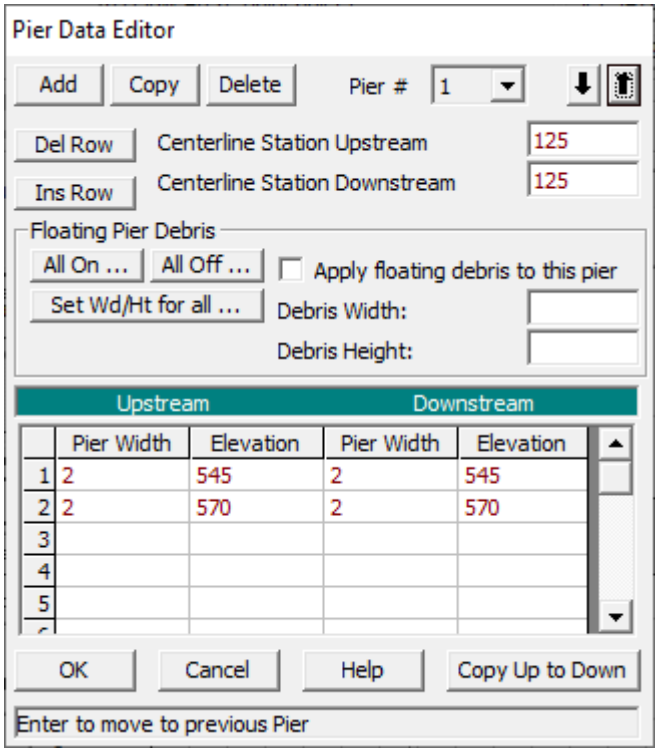


Figure 8. Pier Editor with the data for the first pier.

g. Next, add the **Bridge Modeling Approach** data as shown below:

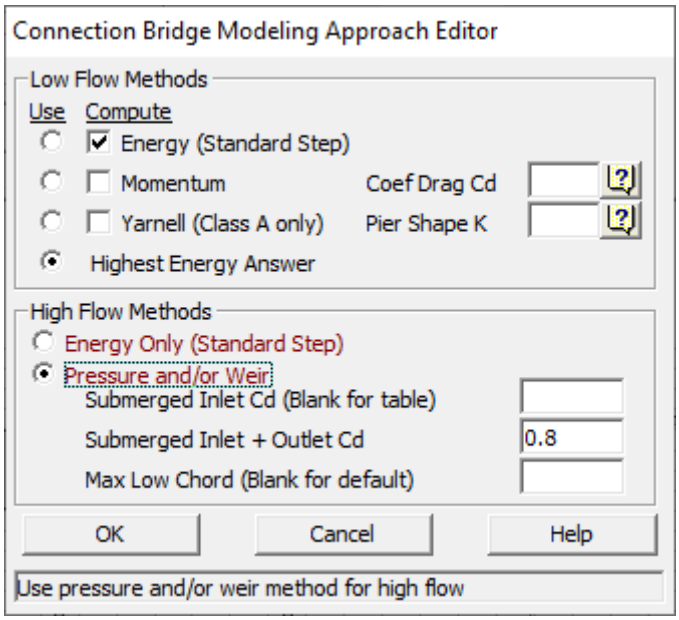


Figure 9. Bridge Modeling Approach Editor.

h. Next select the **HTab Param** button to enter the Hydraulic Tables parameters. See below:

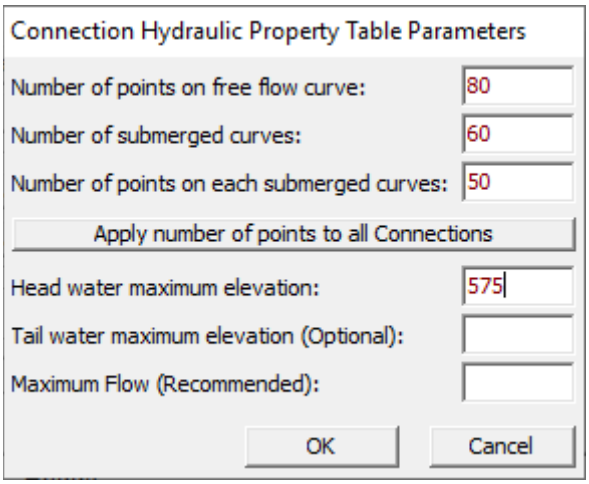


Figure 10. Htab Parameters to control how the Bridge Curves get built.

h. Next. Close the editor. This is required in order for the software to automatically locate the two cross sections outside of the bridge. The bridge and the 1D cross section locations should look like what is shown in the Figure below:

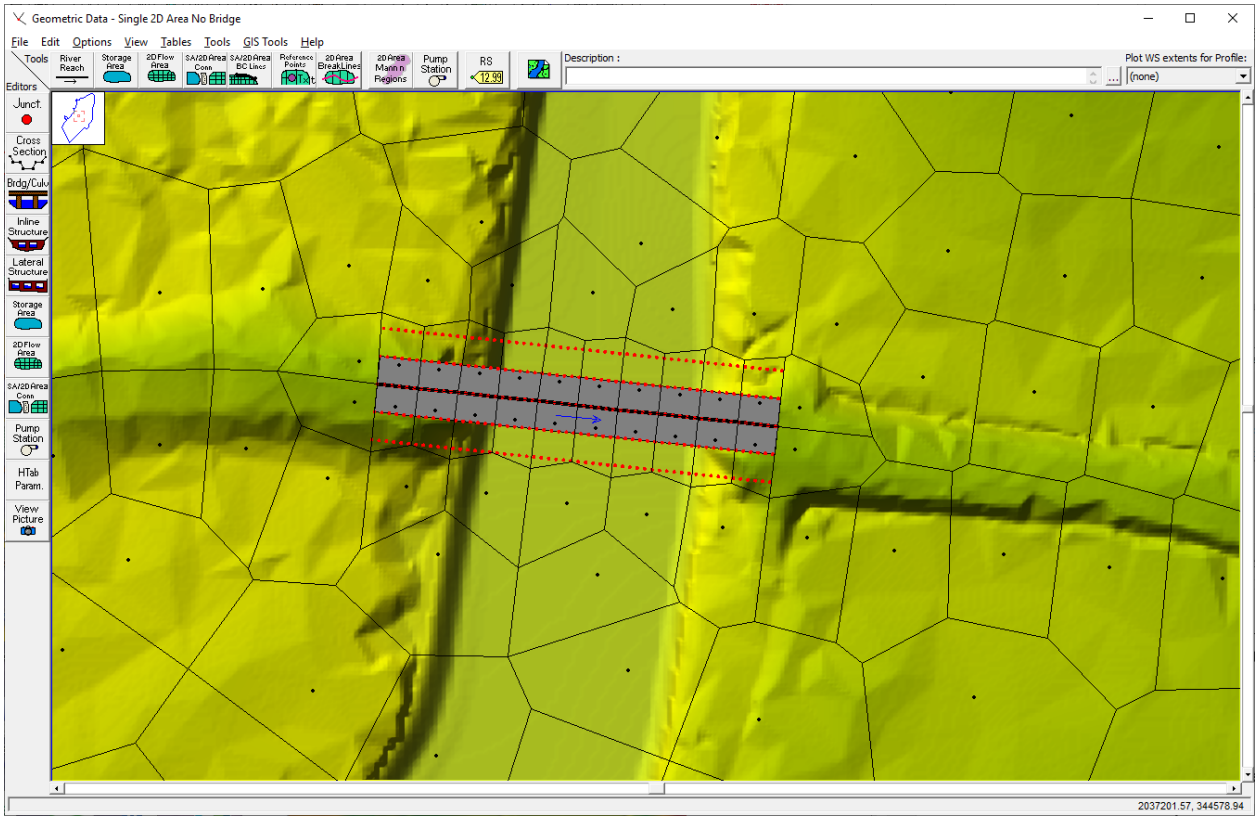


Figure 11. Final location of 1D Bridge Cross Sections after Bridge Data is entered.

I. Go back into the SA/2D Area Conn editor and inspect all of the 1D cross sections that will be used to create the Family of Bridge curves. Next go to the **Options** menu and select **External and Internal Bridge Cross Sections**. This will bring up the editor shown below. This editor allows you to change the cross section data (just in case the terrain data is not accurate); change the main channel bank station locations (the default is the ends of the cross sections); and to enter Manning's n data for the cross sections. Entering Manning's n data for the cross sections is required and must be done in this editor. You must enter a Manning's n value at Station zero. This Manning's n values will remain in affect until you change it at another station. At least one Manning's n value is required at the first station. For this workshop we will only enter a single Manning's n value of .04 at the first station (See figure below):

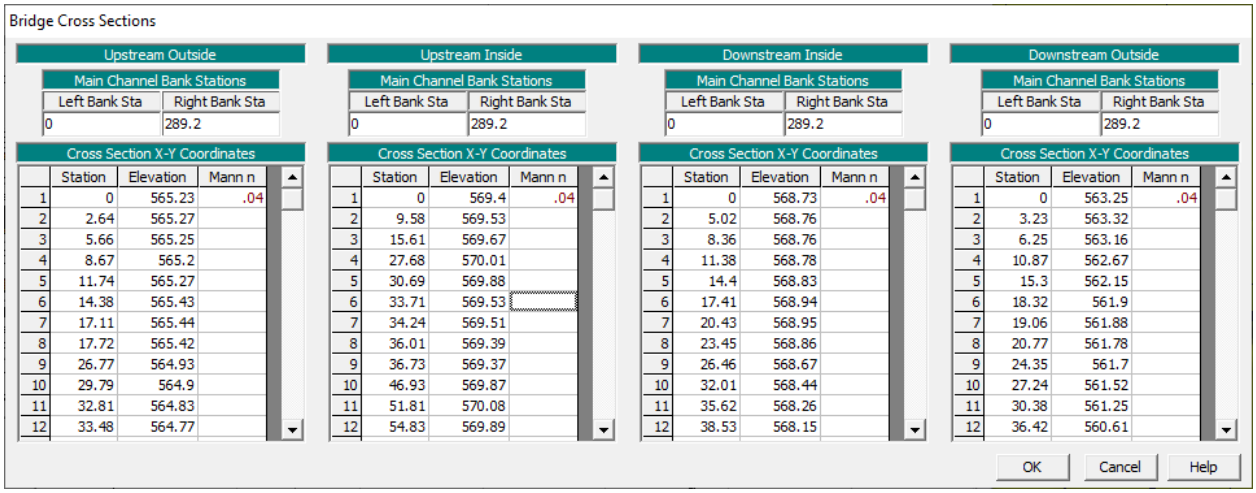


Figure 12. Internal and External cross sections editor with Manning's n values for all of the 1D cross sections.

After you have enter all of the bridge data and Manning's n values, close the editor and **SAVE THE GEOMETRY DATA**.

4. **Make a new Plan using the "Single 2D Area with Bridge" Geometry.**

Go to the **Unsteady Flow Analysis** window (**Run: Unsteady Flow Analysis**). Make a new Plan file using the **Save Plan As** option from the **File** menu under the **Unsteady Flow Analysis** editor. Label the Plan something like: "**2D Bridge Run"**. Give the Plan a relevant short ID, like "**2D Bridge**". No special computational options will be needed for this run, as we will use the same computational options and time step that were used for the No Bridge plan. See the Unsteady Flow Analysis window below:

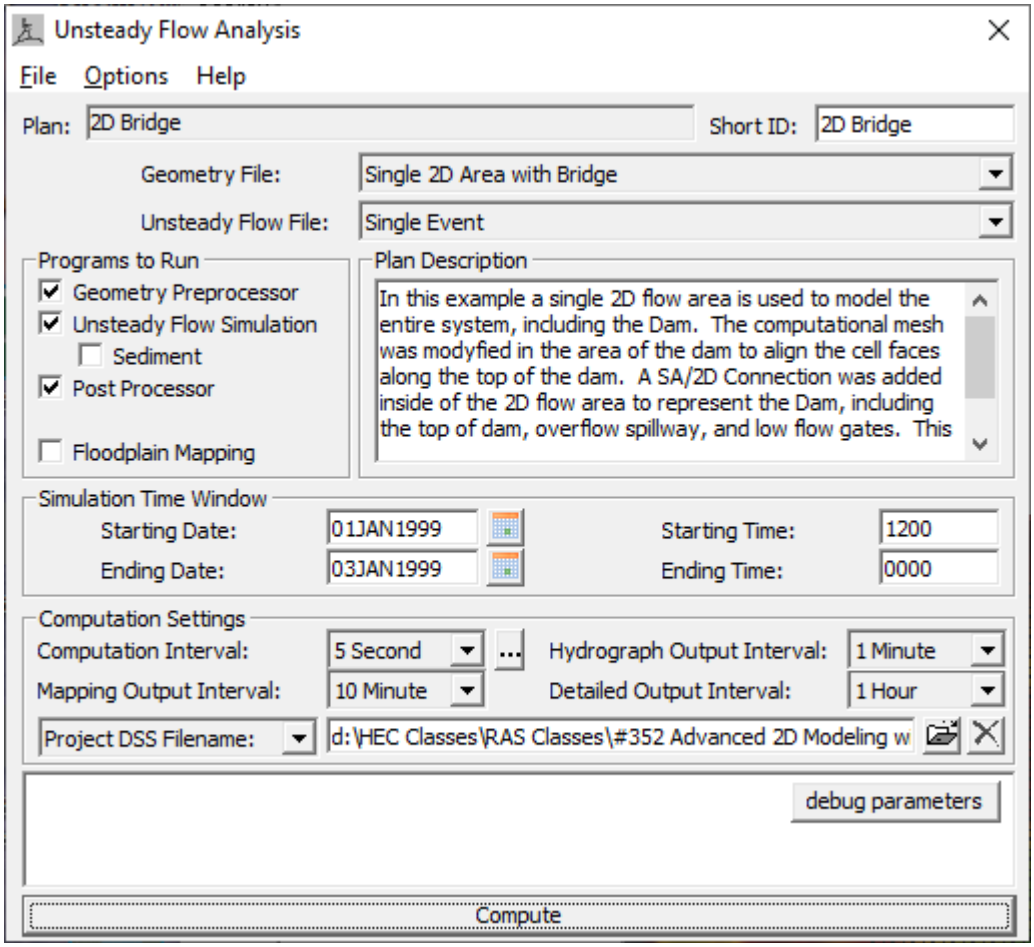


Figure 13. Unsteady Flow Analysis window for 2D Bridge run.

6. **Perform the Computations and Review the Model Output**.

Run the new 2D Bridge model Plan. When the model has finished running, review the output for the new run by looking at the results in RAS-Mapper. Compare the no bridge to the 2D with Bridge plan by plotting a profile plot of the water surface elevations for the user defined profile line called "**Channel Centerline**". Also inspect the map view and animate the water surface elevations, as wells as looking at the velocities.

7. **Answer the following Questions:**

   A. How do the results from the with and without Bridge Plans compare? What is the water surface difference between the two Plans upstream of the bridge?

   B. What is the maximum difference in Water Surface from the headwater side (Upstream of Bridge) to the Tailwater side (downstream of bridge) for the 2D Bridge Plan? How did you find this answer? (i.e. what plot did you use).

   C. Does the Bridge go into Pressure Flow?

   D. Is the left roadway approach, bridge deck, or right roadway approach overtopped? Do you think that it is correct, given the terrain data? How could you make the model more accurate with respect to this question?