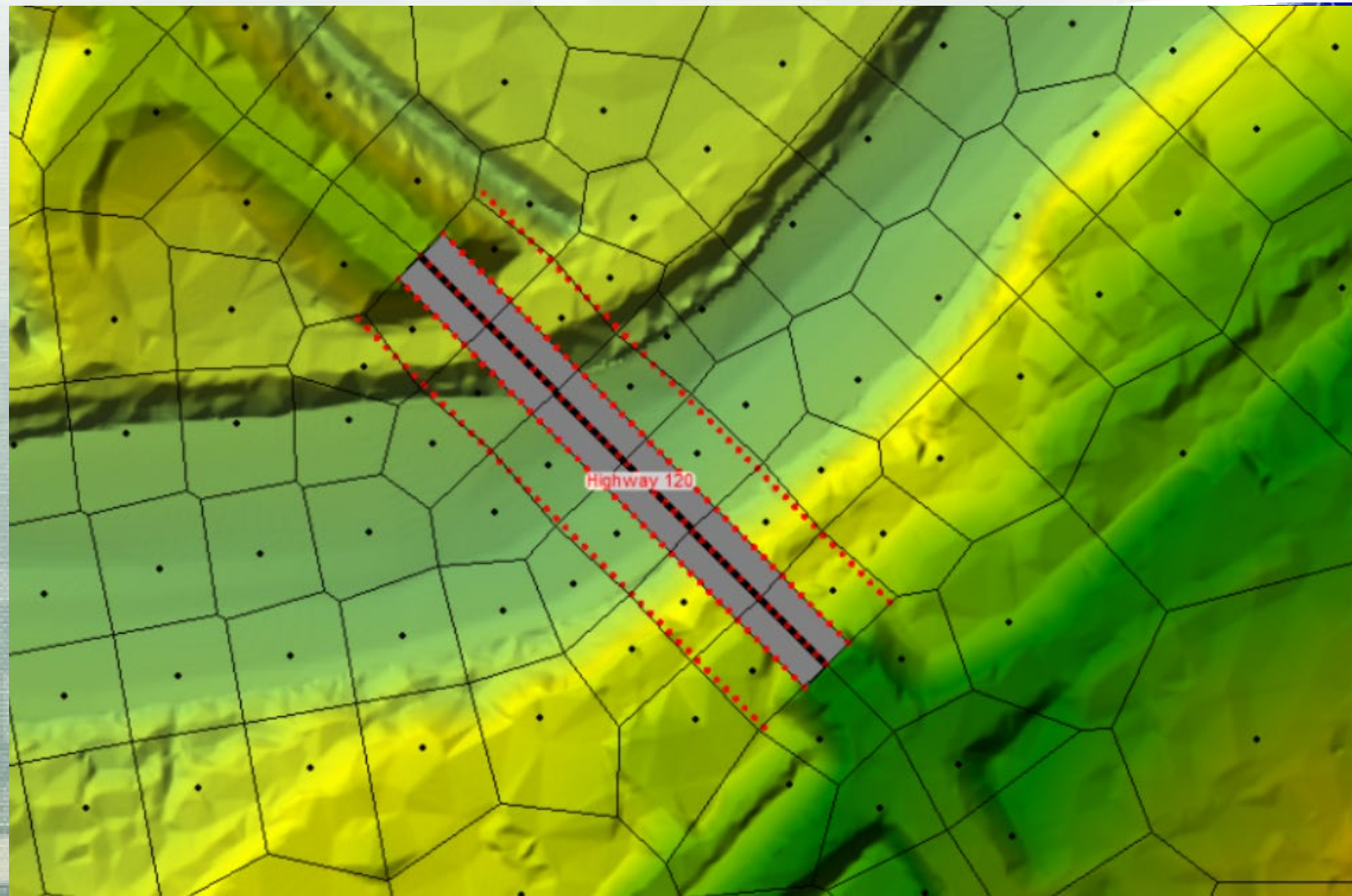
Simplified Bridge Modeling in 2D Flow Areas

Mark Jensen



US Army Corps of Engineers

Objective

- The purpose of this lecture is to describe how the 1D bridges can be used inside in 2d flow areas. The details of how the computations are performed in 6.0-6.1 and 6.2 will be explained. Some examples will demonstrate how to enter the required data. Assumptions and issues will also be discussed.

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Simple 1D Bridge inside 2D Flow Areas

- Bridges are a new option for SA-Connection structures that are completely inside 2D Flow Areas. New approach in 6.0 and new simplified solution approach for 6.2

- Structure centerline should be enforced as a breakline with appropriate cell spacing.

- Select Bridge Mode and enter general bridge like Deck, Piers, Abutments and Modeling Approach and some data specifically needed for bridges inside 2D flow areas.

- Loses will be computed during simulation from family of curves

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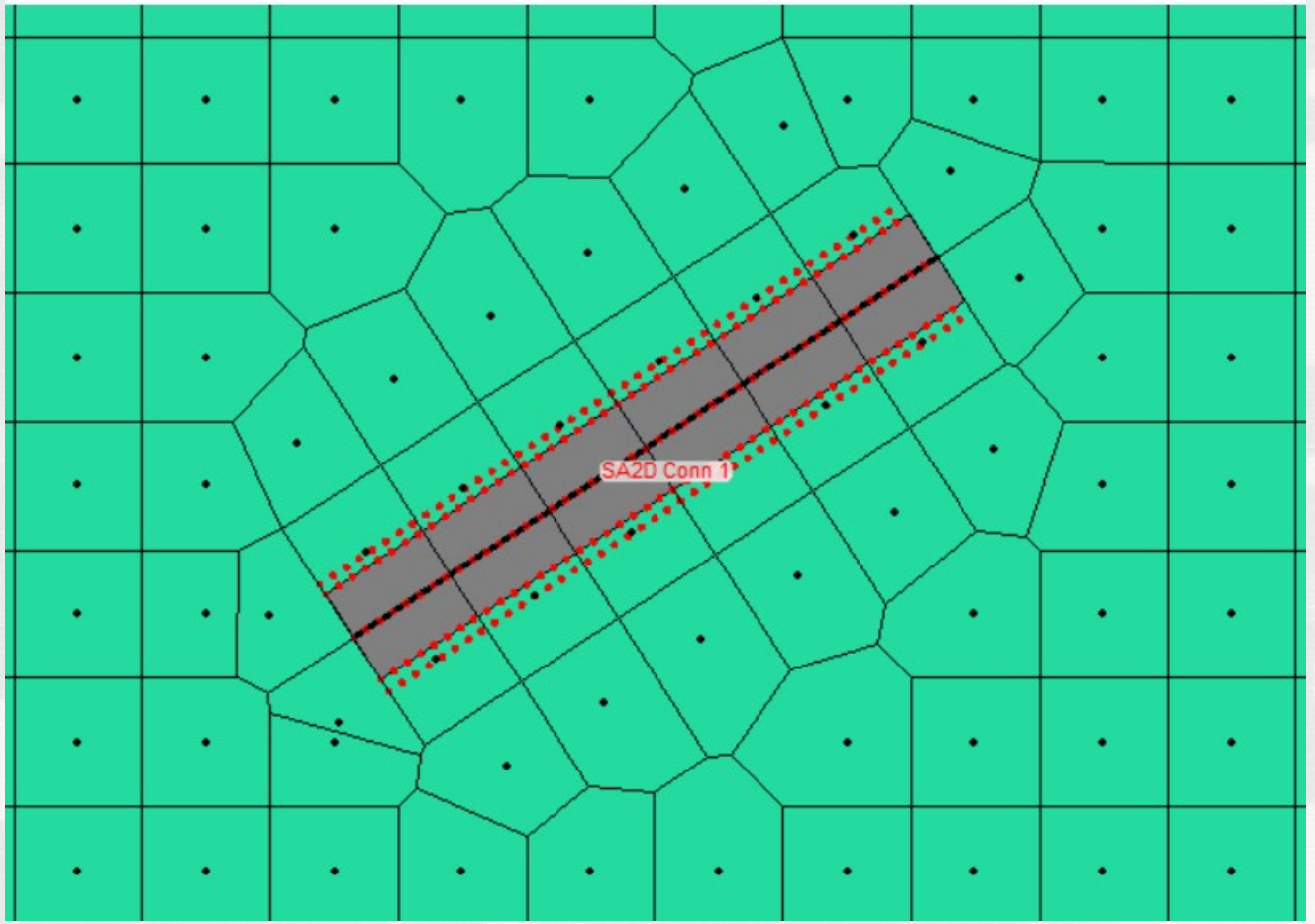
Structure Enforced as Breakline

- 1D Bridge loses computed between “XS” downstream of deck through the bridge to “XS” upstream of bridge deck.
- Cells sizes (or cell US-DS length) set so that the cell centers match the domain covered by 1D Bridge Loses



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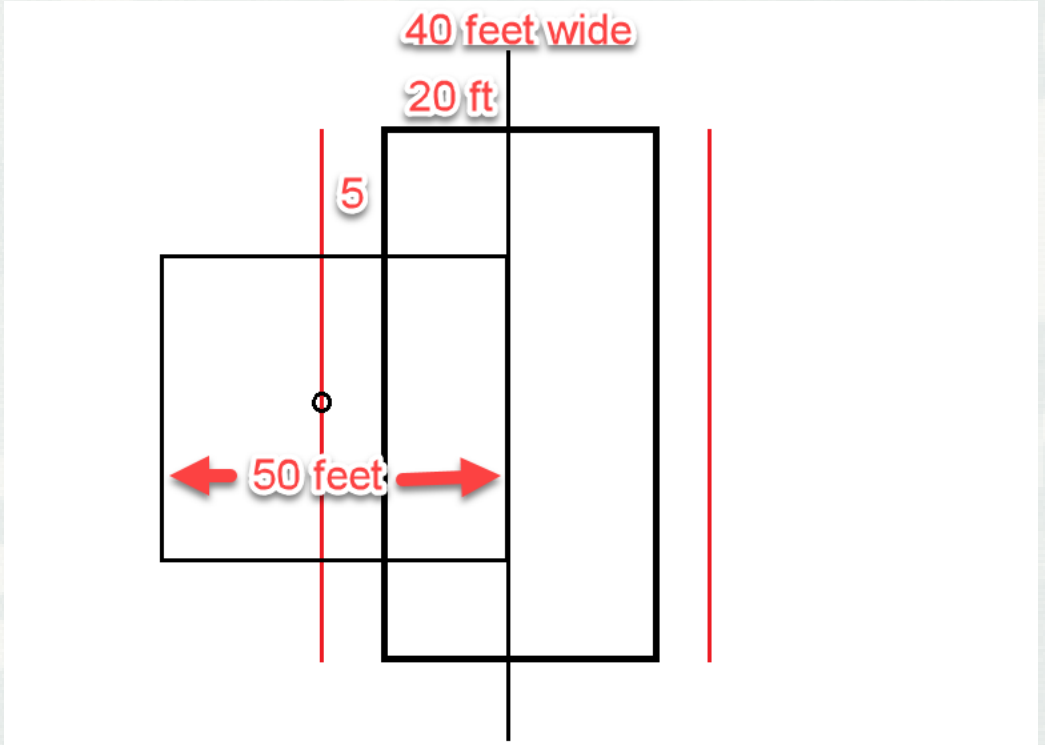
Structure Enforced as Breakline

- Cell Size Example
  - Bridge Deck width = 40 feet and US Distance = 5 feet
    - half deck width = 40/2 = 20 feet
    - distance from centerline to first cell center = 20+5
    - row of cells needs to be 50 feet



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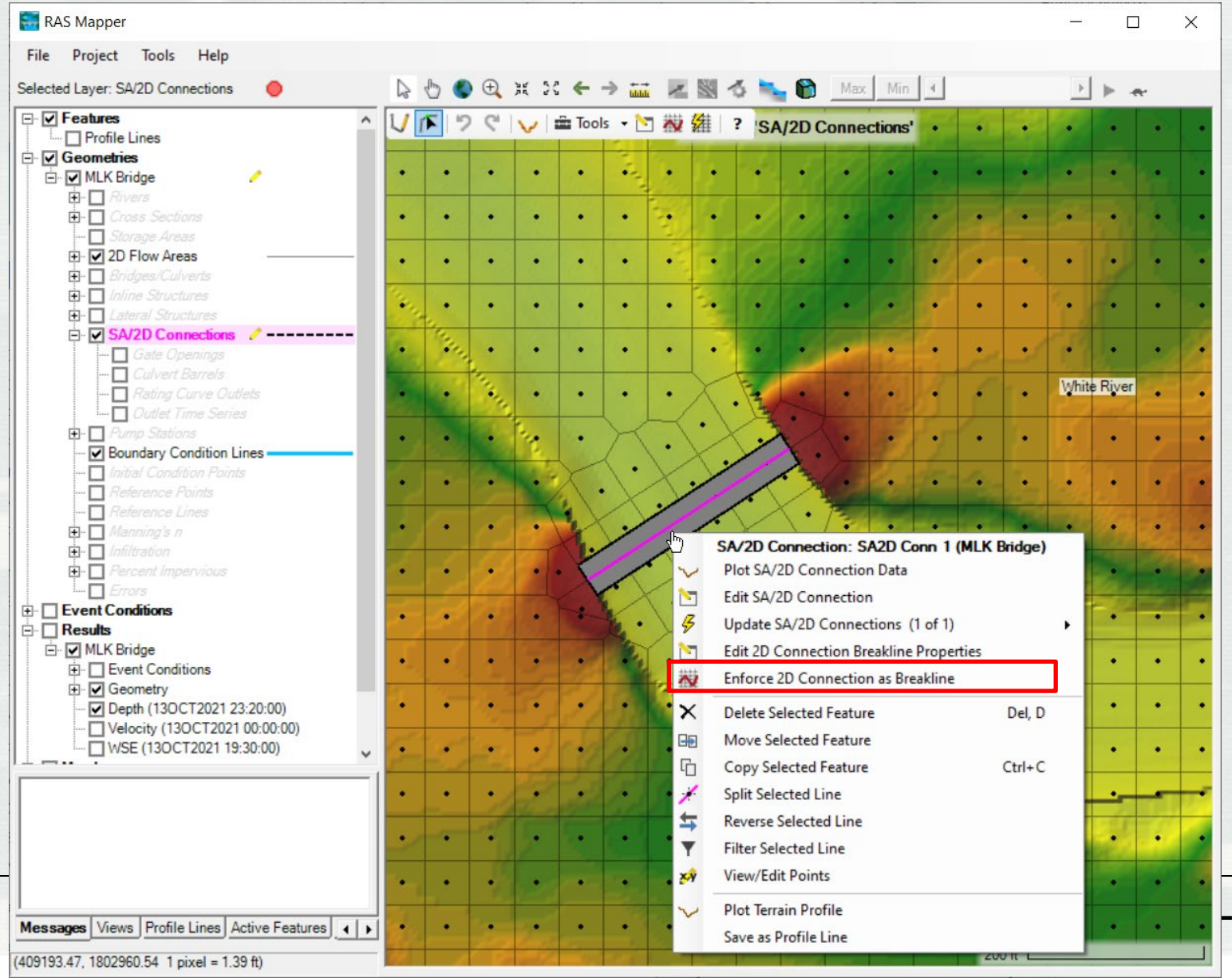
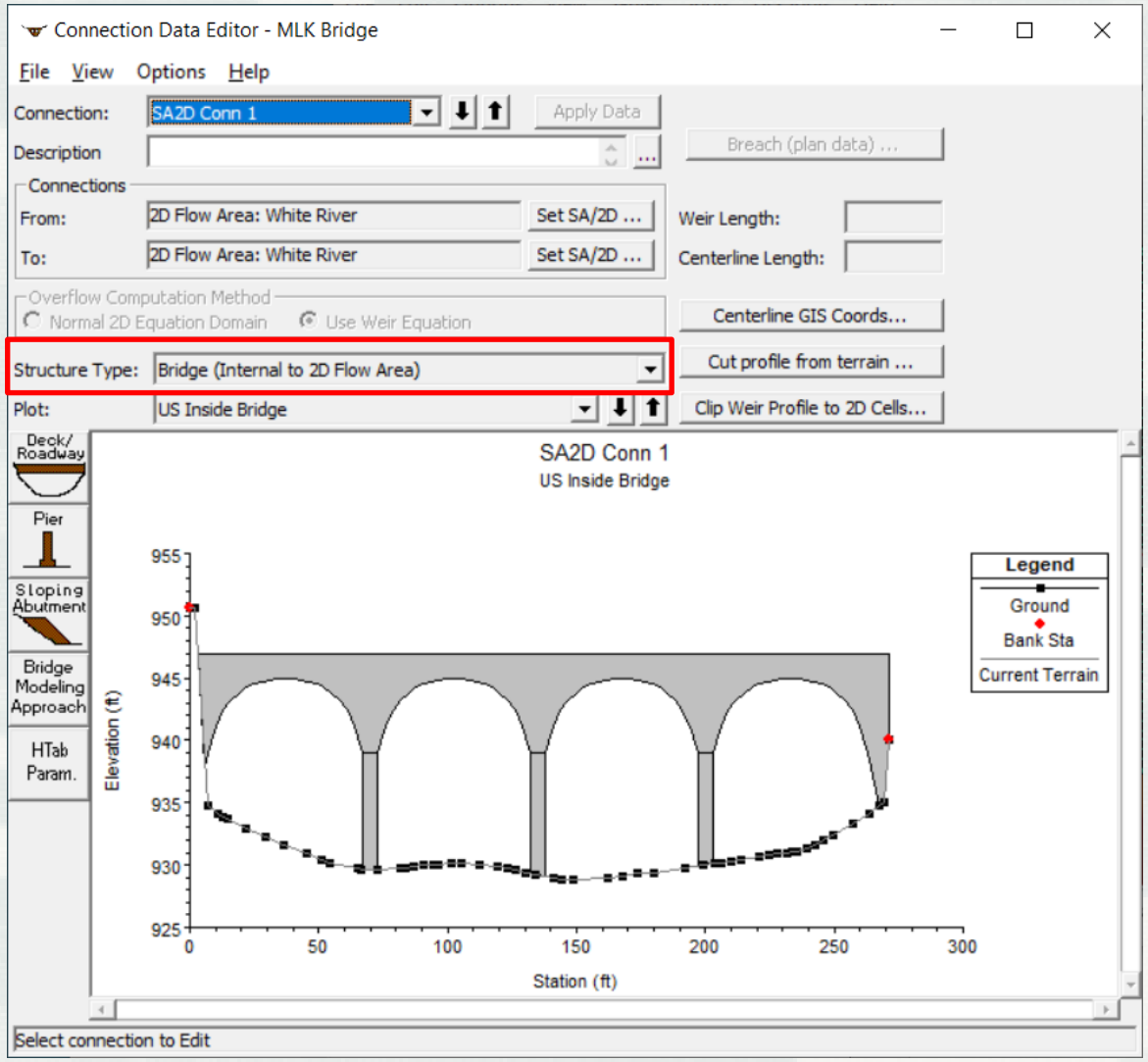
Structure Enforced as Breaklines



Connection in Bridge Mode

- SA Connection must be completely inside a 2D flow area (from and to are same)
- Set Structure Type



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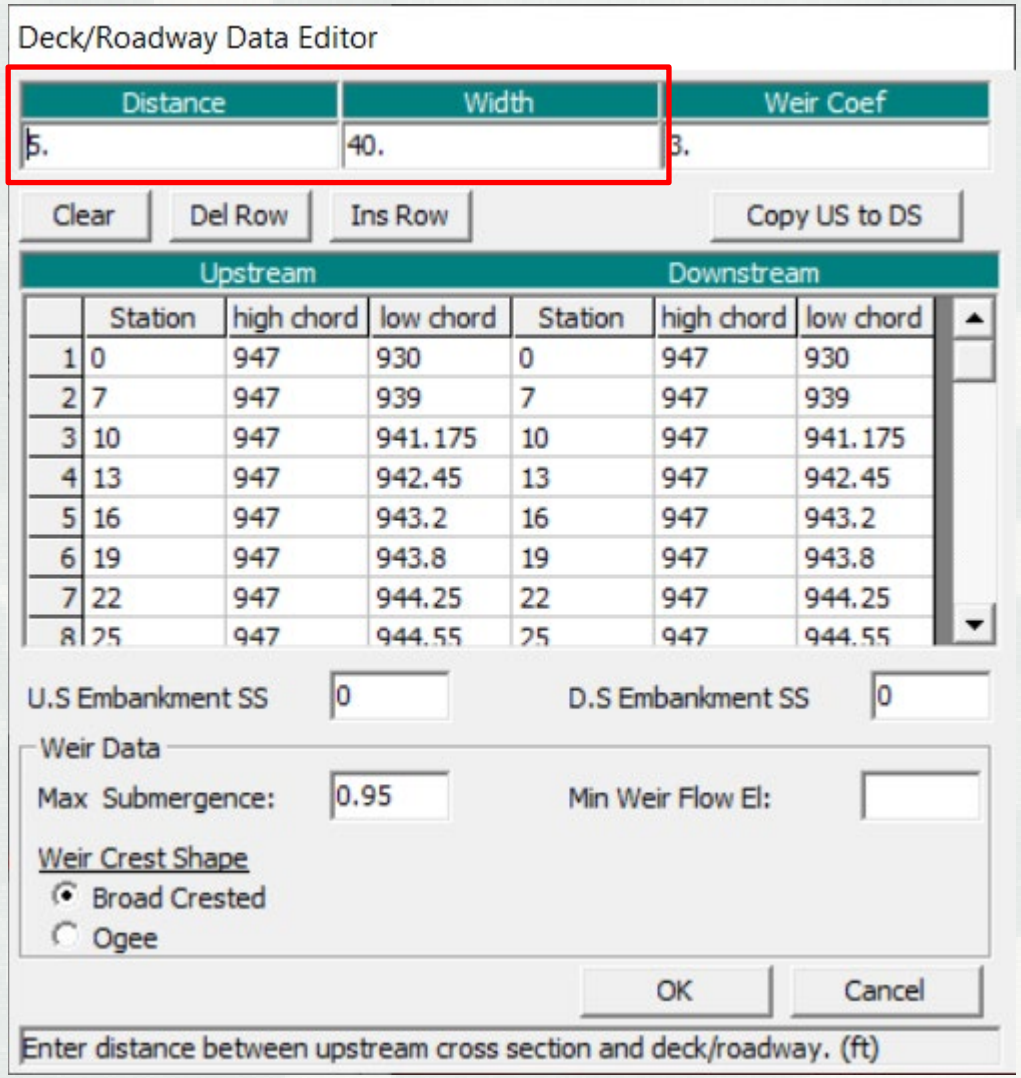
Bridge – Deck

- Set US Distance and Width
  - Will set the “XS” and range of bridge curves loses
- Enter rest of bridge data



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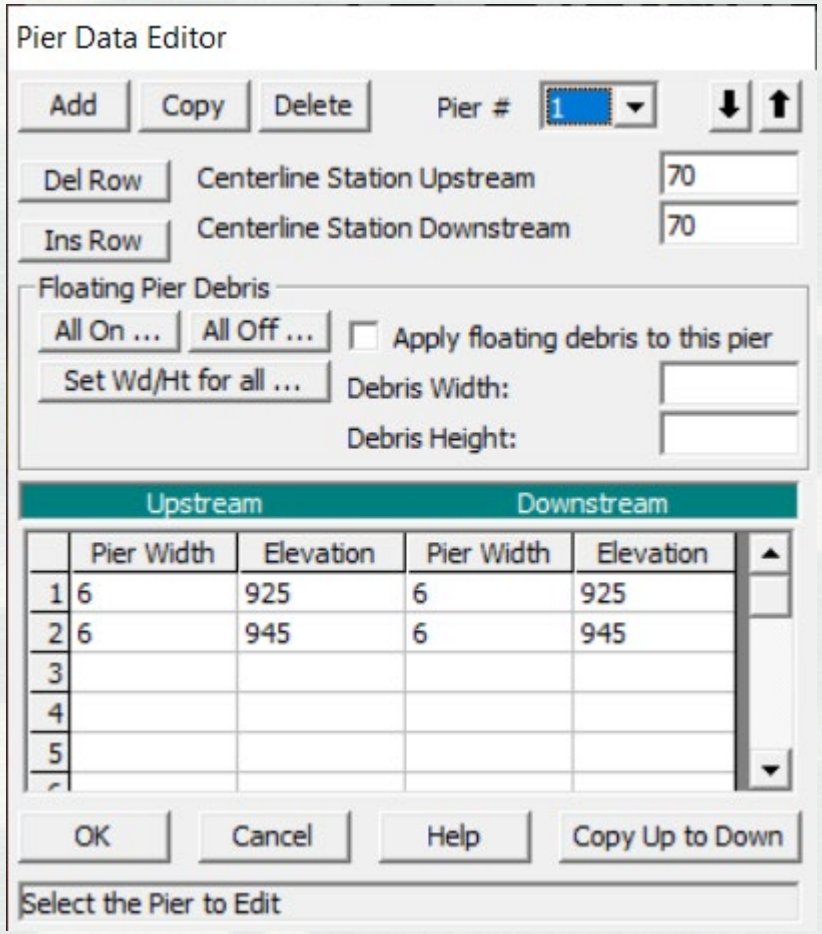
Bridged - Piers

- Enter Piers
  - Same as normal 1D Bridge



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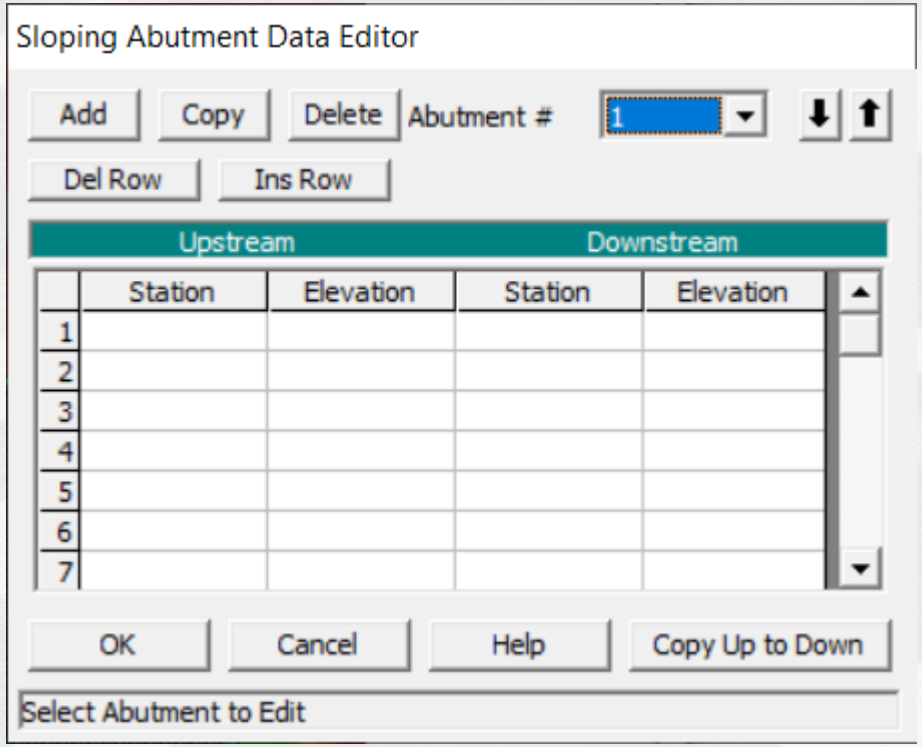
Bridge - Abutments

- Enter Abutments
  - Same as normal 1D Bridge



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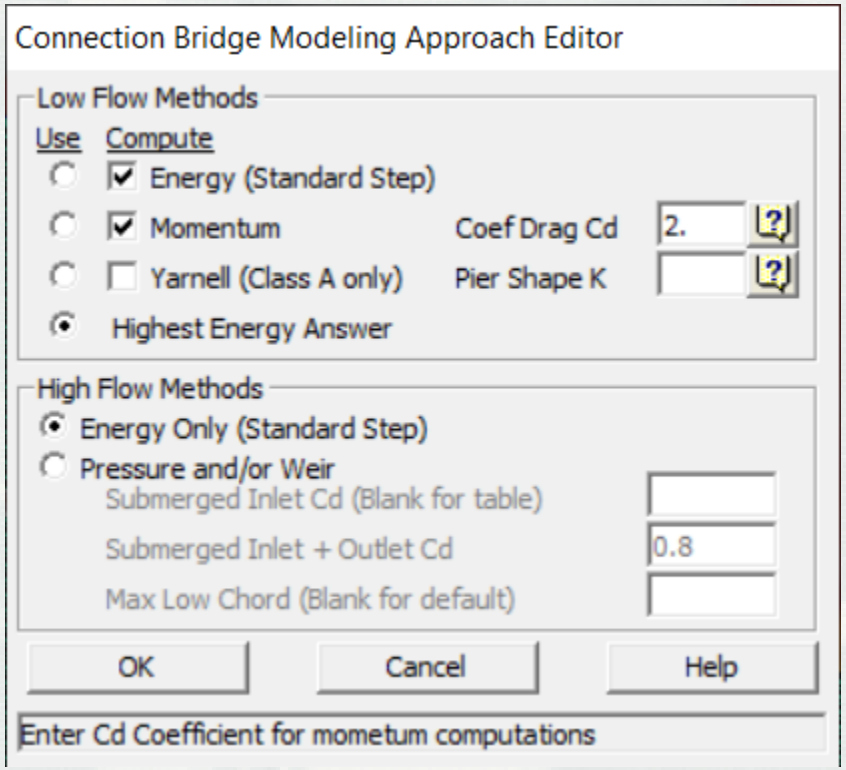
Bridge - Modeling Approach

- Enter Modeling Approach
  - Same as normal 1D Bridge



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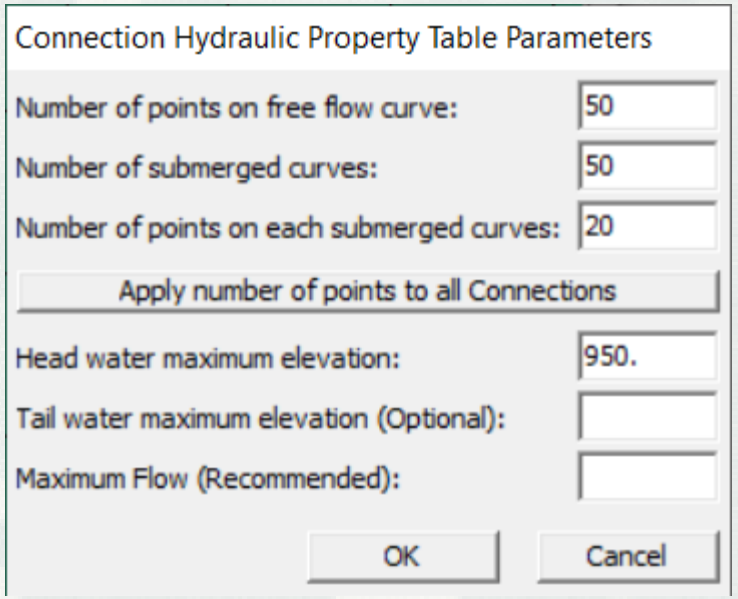
Bridge – HTab Param

- Enter Hydraulic Tables Parameters
  - Same as normal 1D Bridge



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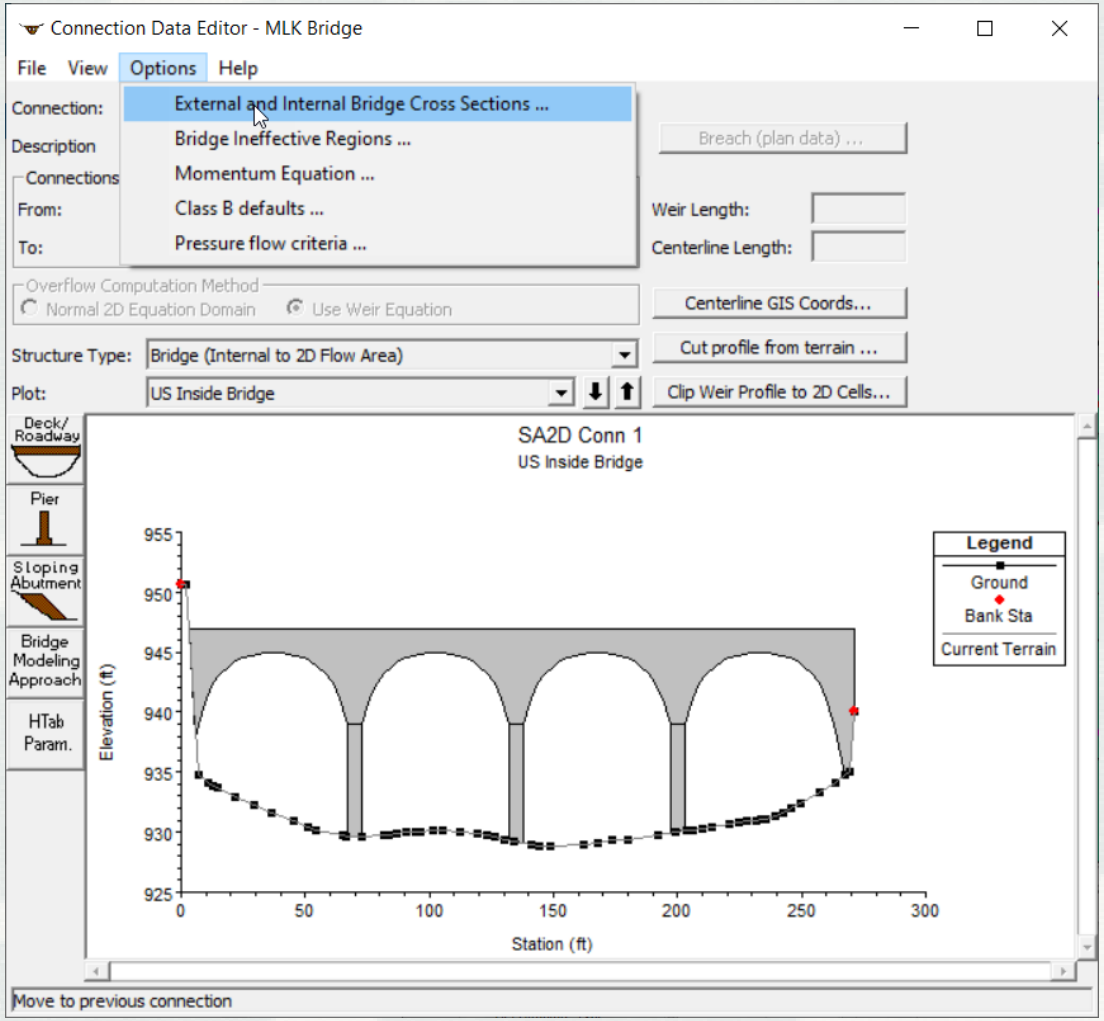
Bridge – Additional Parameters

- Additional Data – Options Menu



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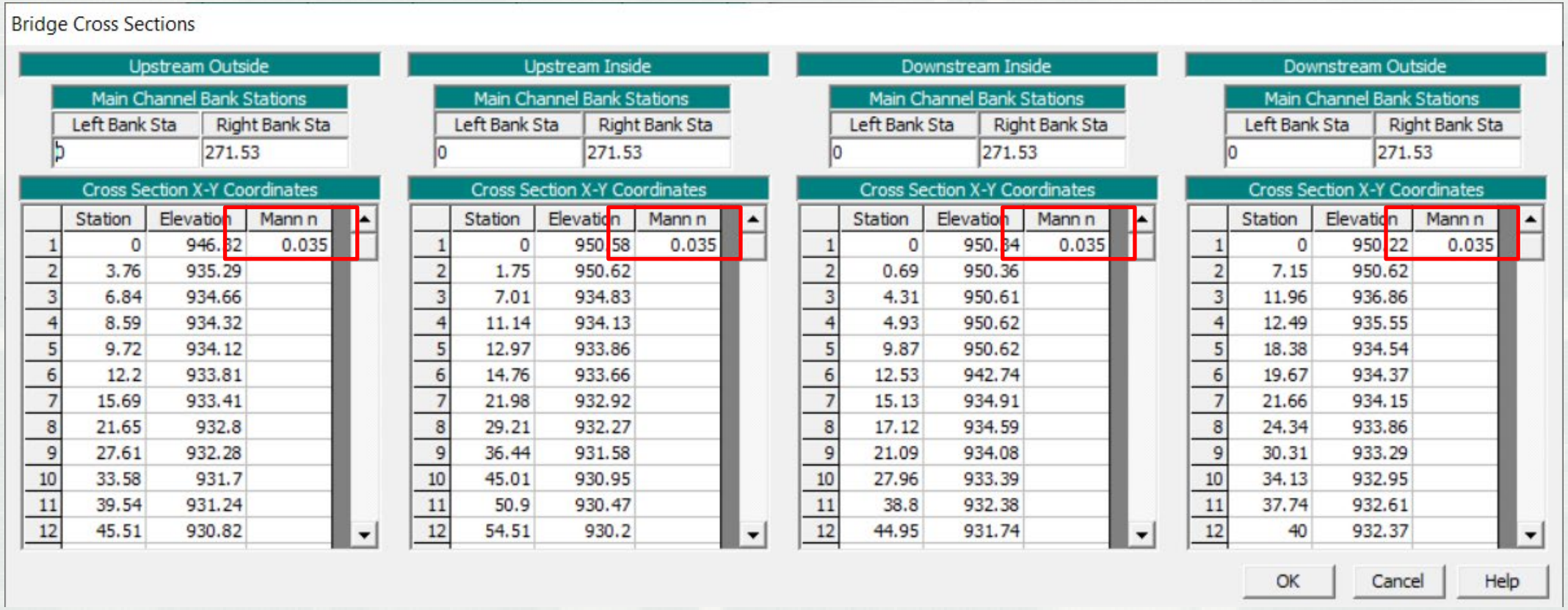
Additional Options – XS (and Manning's n)



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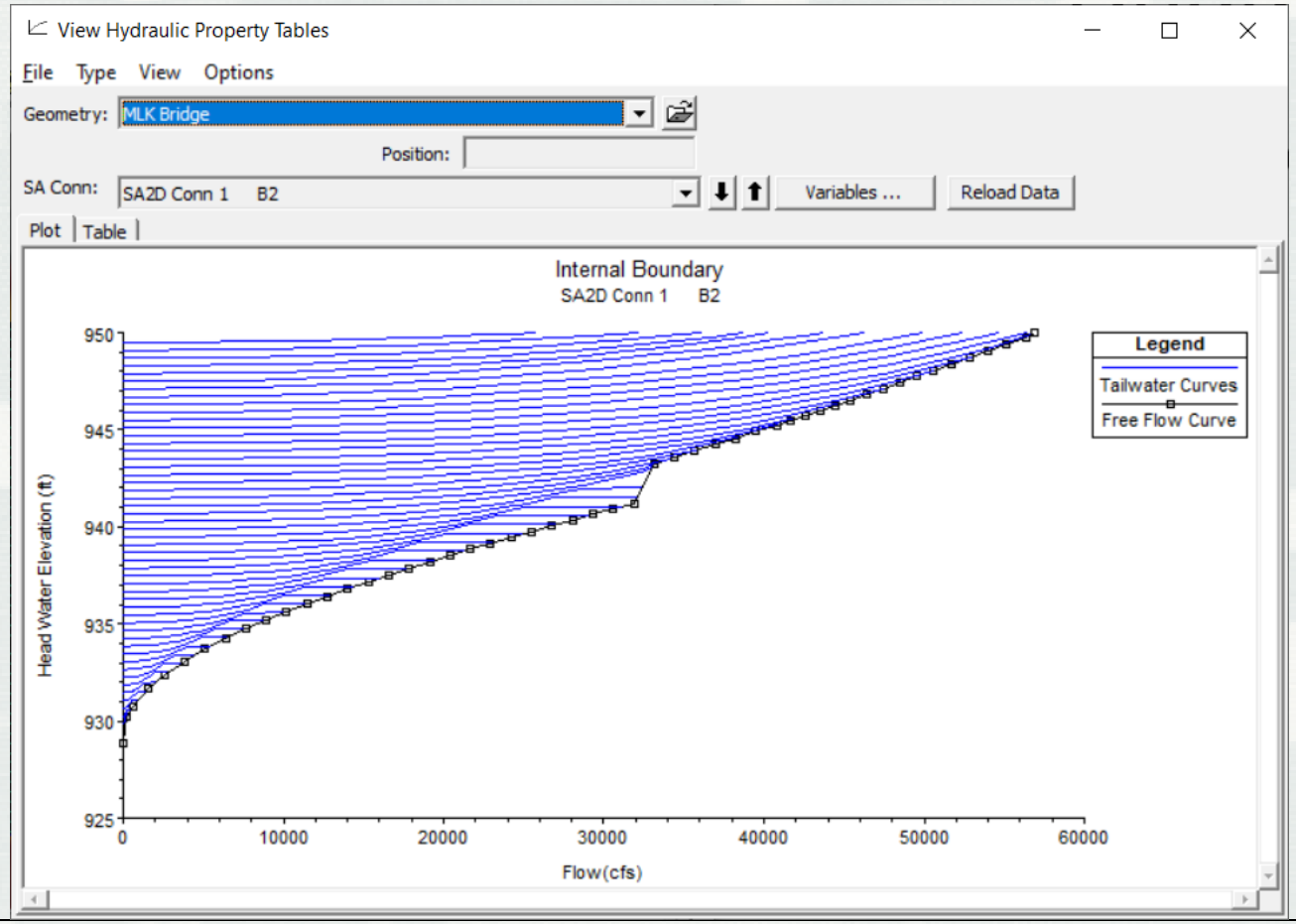
Family or Rating Curves

- Geometry Preprocessor computes family of rating curves



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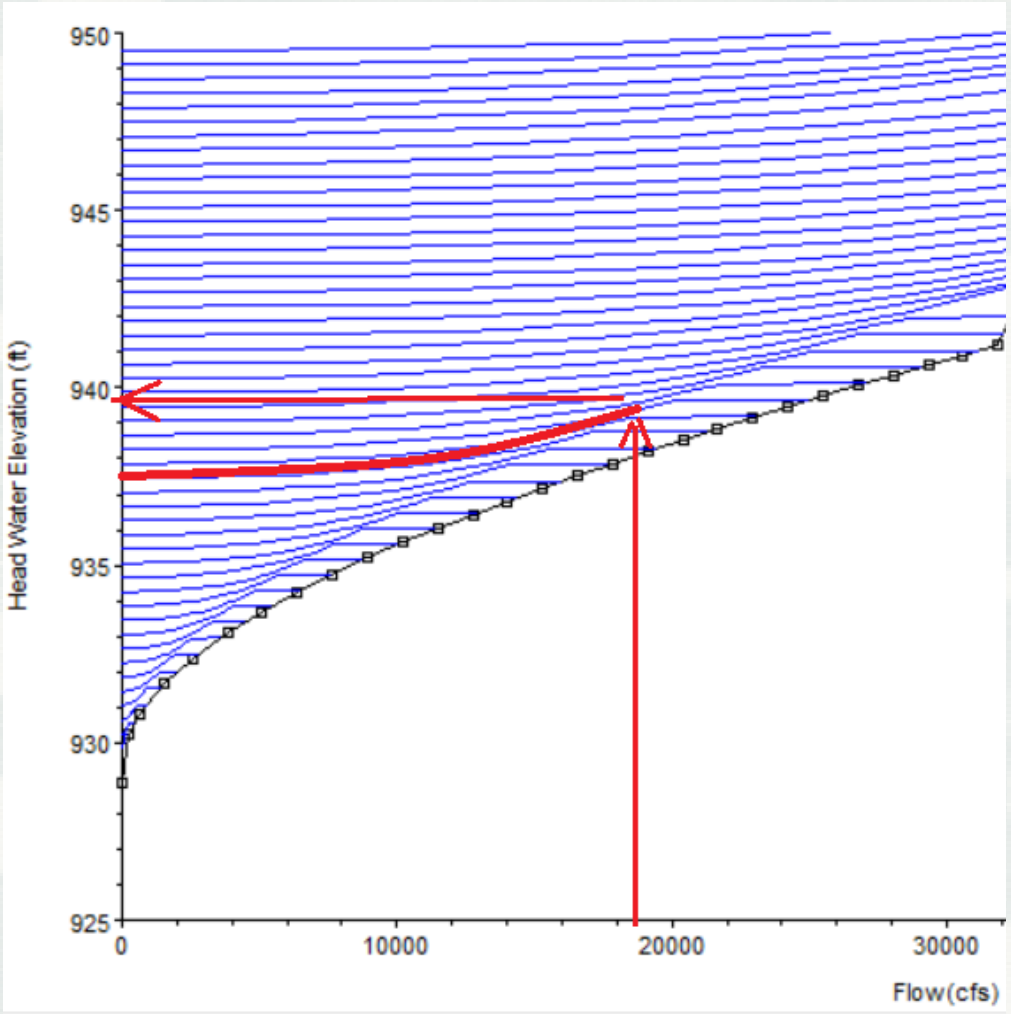
Family of Rating Curves - Riverine1D

- Current (last time step or last iteration) DS XS water surface and flow are used to compute the US XS water surface

- Matrix Coefficients for US XS row are changed to impose this computed US water surface



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Family of Rating Curves - 2D Flow Areas

- Curves are used differently
  - Compute US XS and DS XS are used to compute expected 1D Flow
  - Friction lose terms are adjusted so that compute 2D flows match expected 1D Flow

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Family of Rating Curves - 2D Flow Areas

- Version 6.0 (and 6.1)
  - Bridge Losses imposed using the family of rating curves and velocity distribution at each 2D face in bridge opening
  - Different adjustment factor for each face in bridge centerline
  - Can be instable when 2D face velocity distribution does not match 1D velocity distribution

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Family of Rating Curves - 2D Flow Areas

- Version 6.2
  - Computes total 2D flow of the all the bridge centerline faces
  - Computes average upstream WS and average DS water surface
    - At cells along bridge centerline faces
  - Family of curves compute the expected total 1D flow
  - Manning's n roughness adjusted for centerline faces so 2D flow solution matches 1D flow
  - One adjustment factor for all the bridge faces

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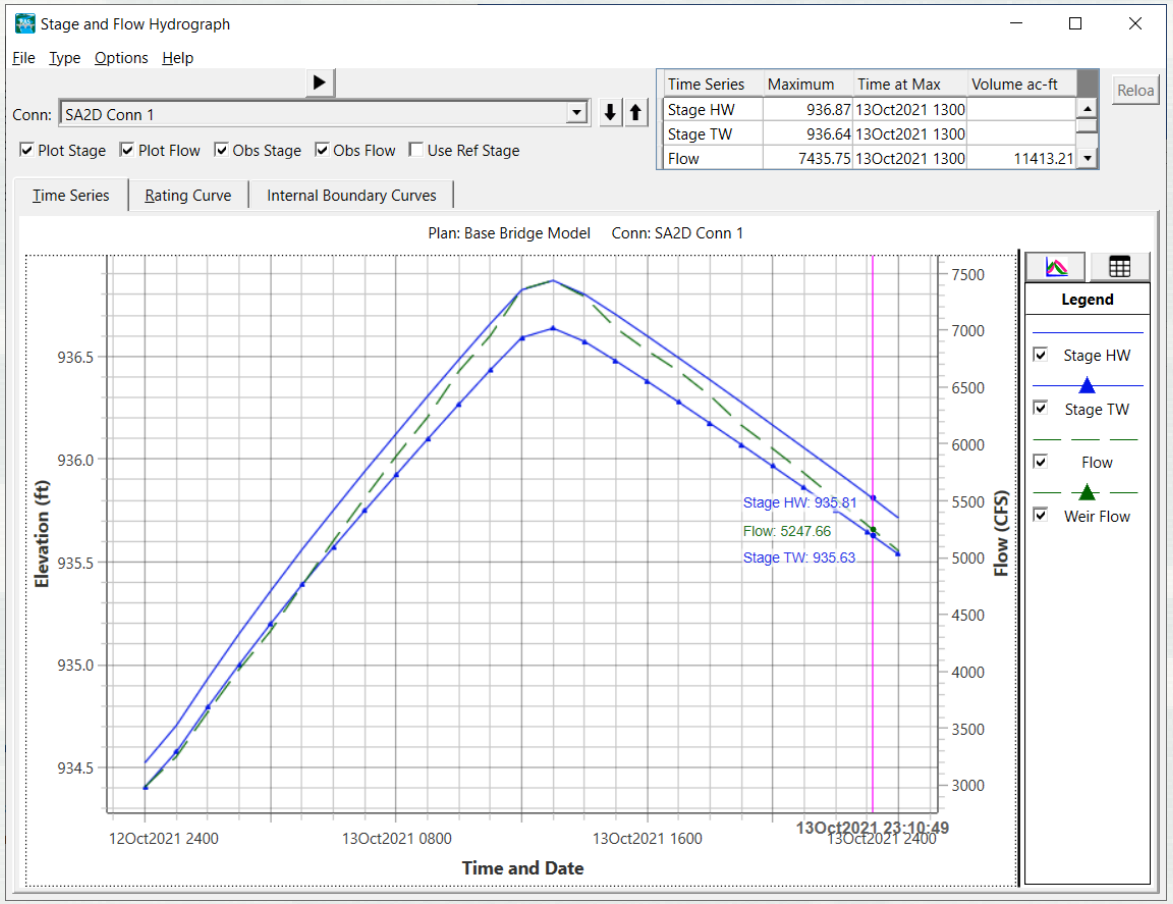
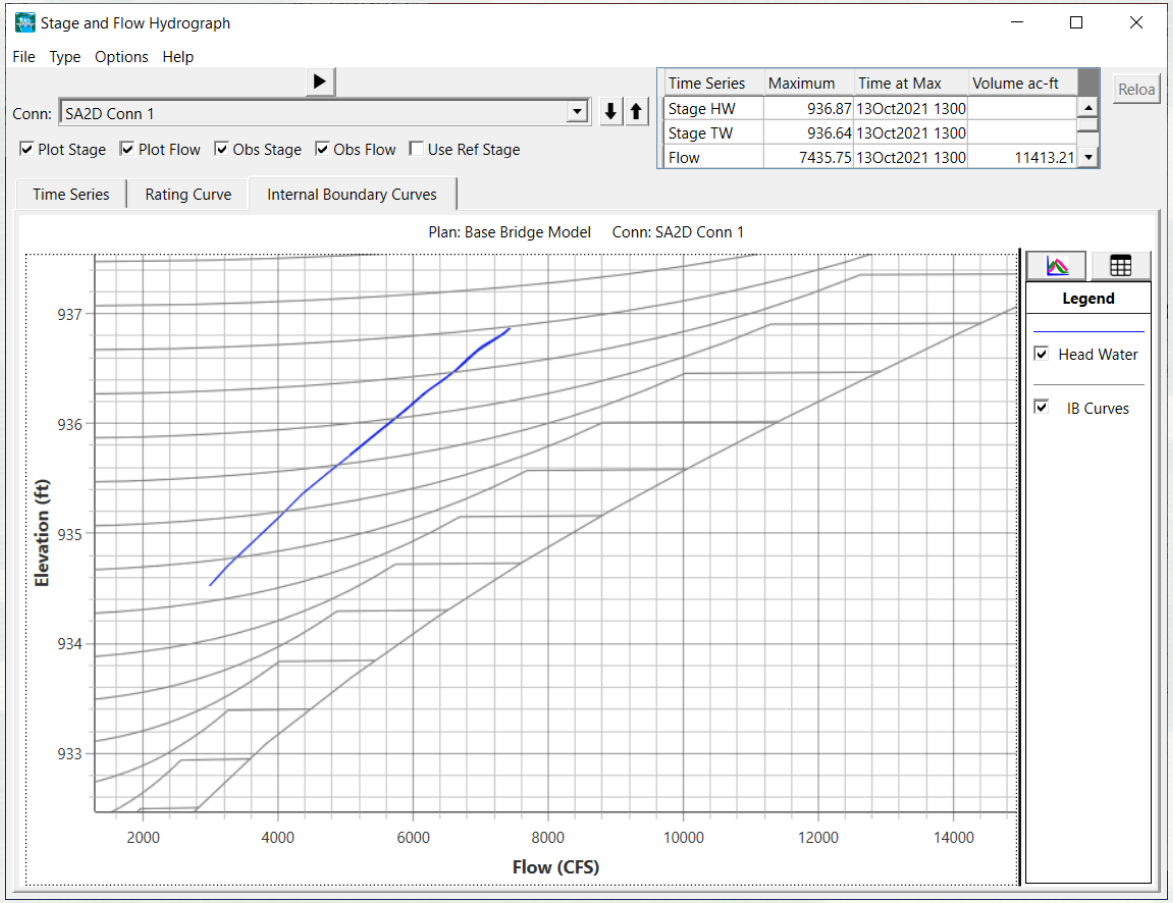
Bridge - Output

- Stage and Flow Plot





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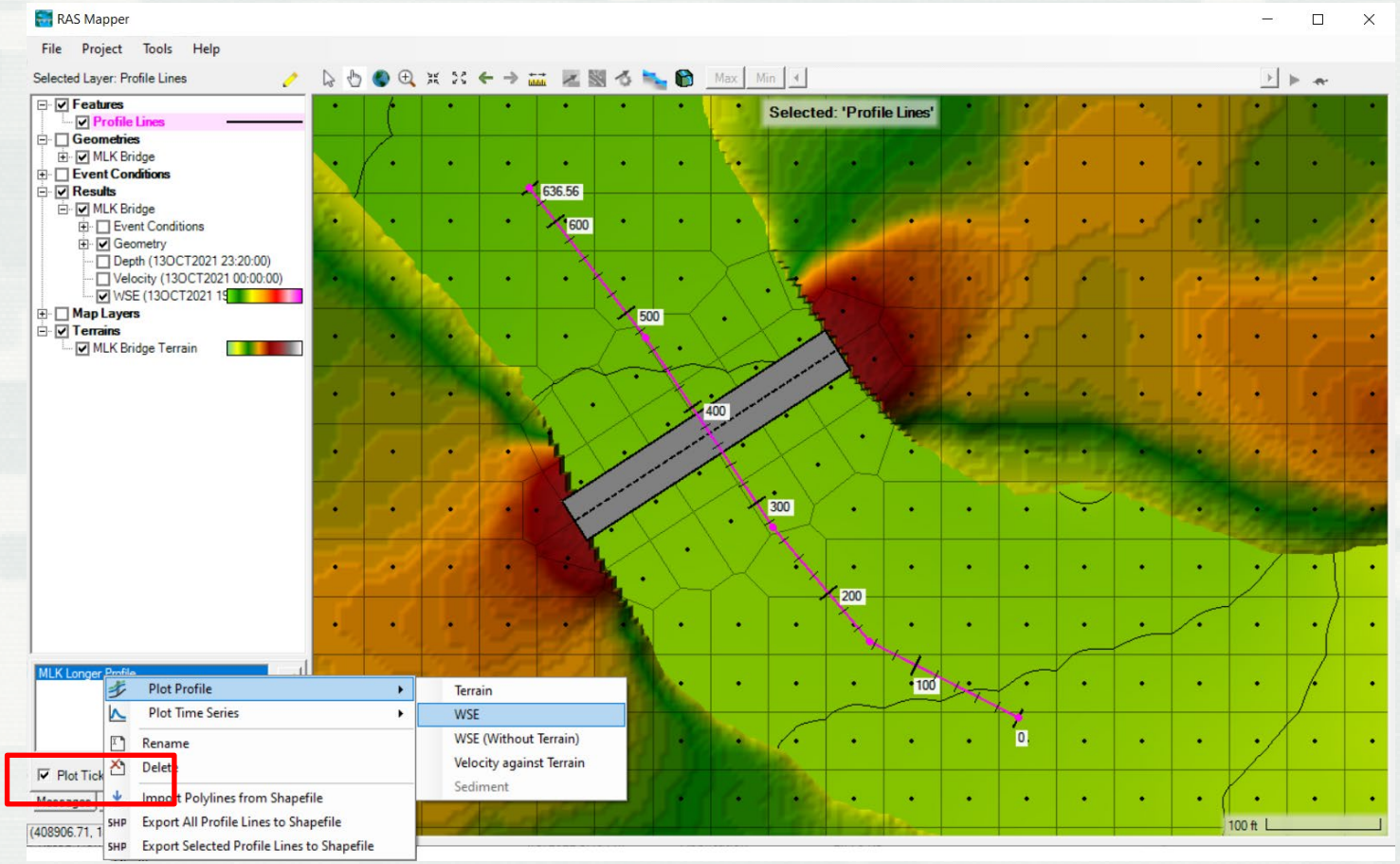
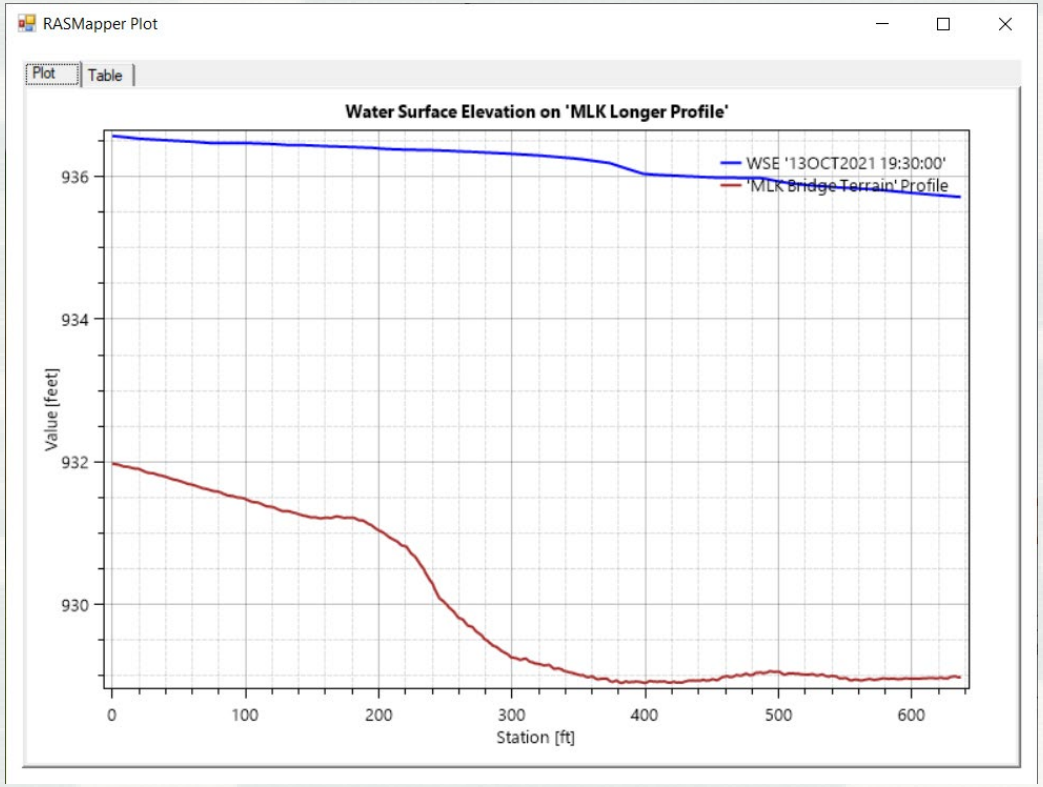
Bridge Output

- Profile Lines – Plot Tick Marks





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Issues in 6.2

- New approach in 6.2 sometimes has an error in the reported flow through the bridge in stage and flow plot
- Not a computation error, correct flow is transported through the bridge
- Can add a Reference line downstream or upstream of bridge to get the real flow through the bridge.

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Issues Overall

- Spacing/cell sizes through a bridge modeled as 1D are generally larger than users would like.
- Necessary to use these cell sizes so that we do not duplicate contraction and expansion loses in 2D domain and in 1D curves.

Questions?

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