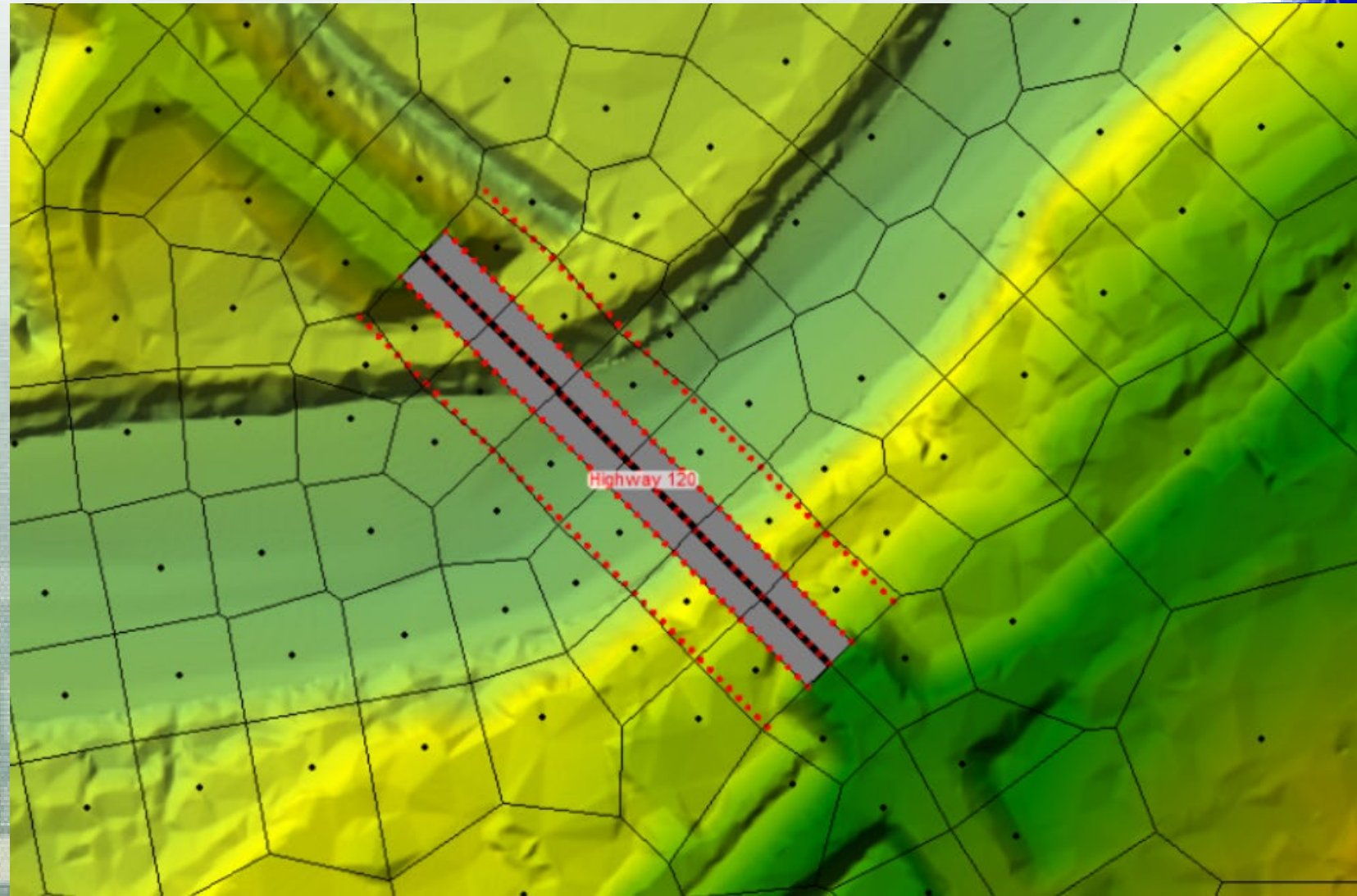


Simplified Bridge Modeling in 2D Flow Areas

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US Army Corps
of Engineers



Objective

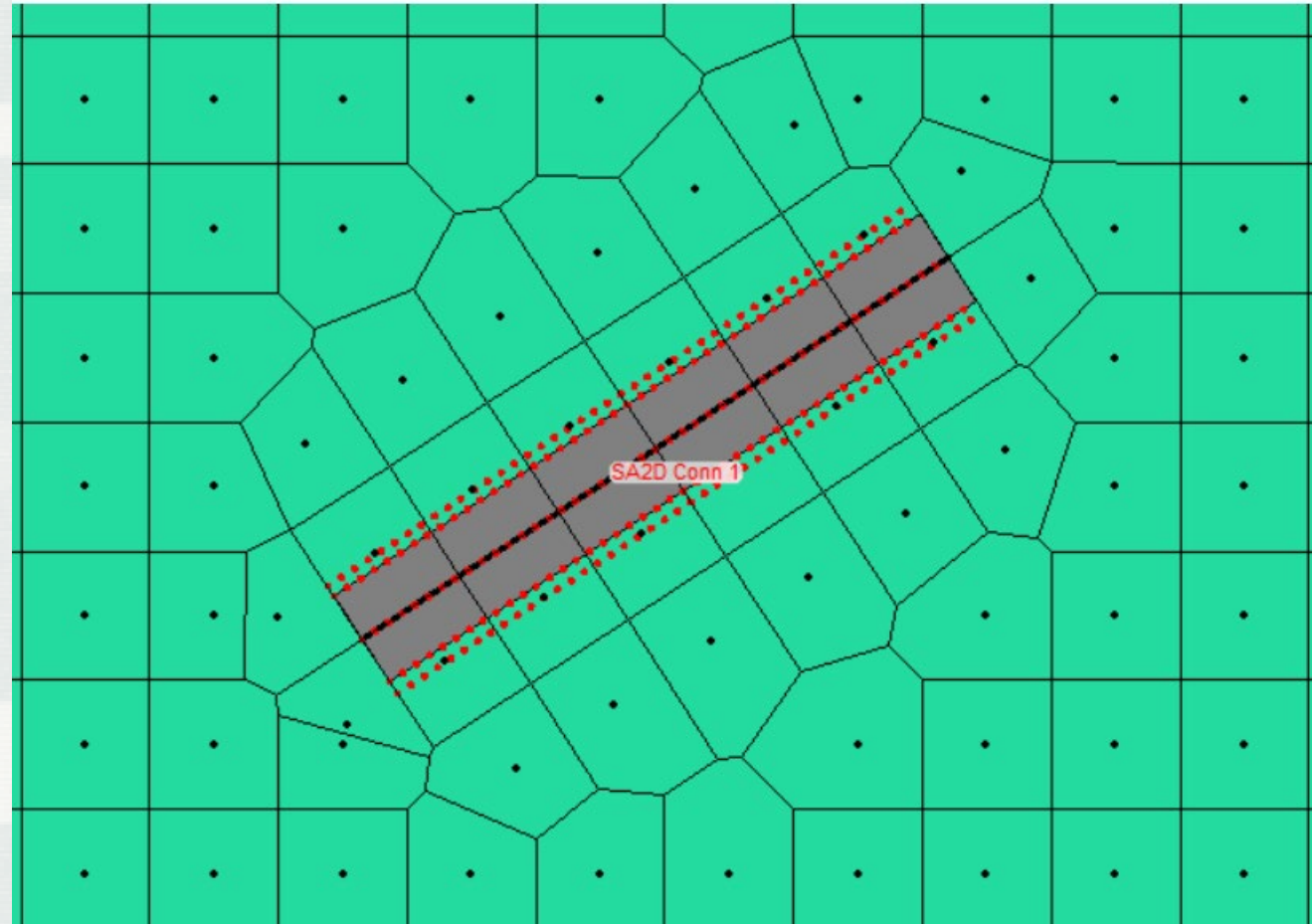
- The purpose of this lecture is to describe how the 1D bridges can be used inside in 2d flow areas. The details of how the computations are performed in 6.0-6.1 and 6.2 will be explained. Some examples will demonstrate how to enter the required data. Assumptions and issues will also be discussed.

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.
- Losses will be computed during simulation from family of curves

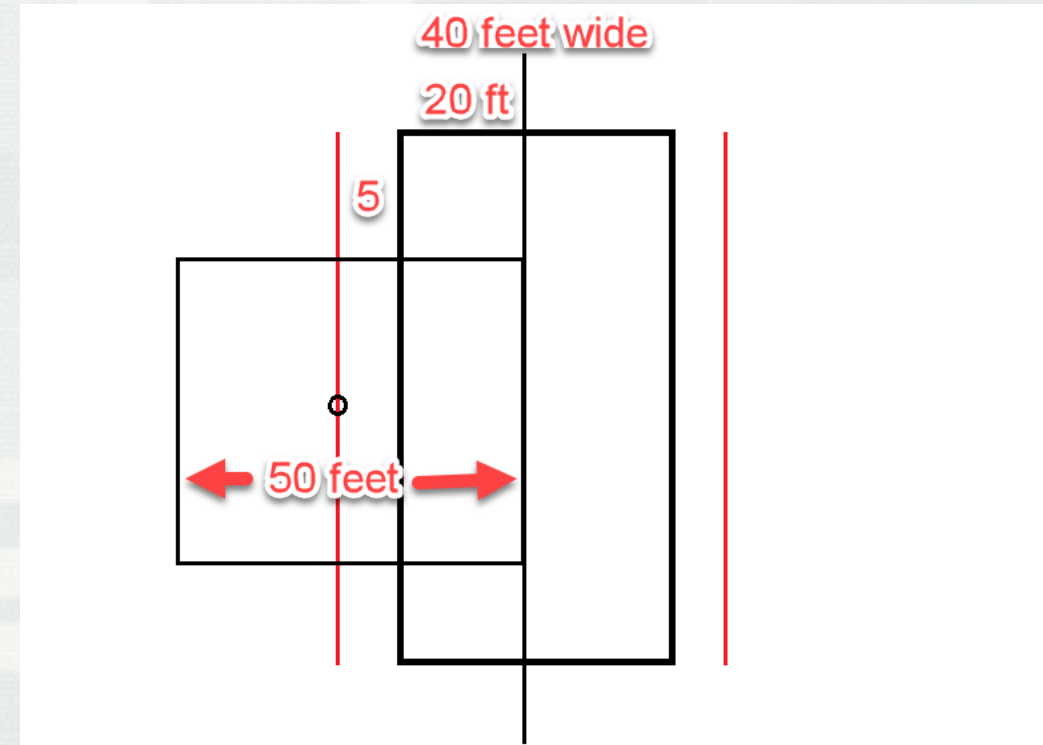
Structure Enforced as Breakline

- 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



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



Structure Enforced as Breaklines

The screenshot displays the RAS Mapper interface. The main window shows a topographic map with a grid overlay and a bridge structure labeled 'MLK Bridge'. A context menu is open over the bridge, listing various actions. The option 'Enforce 2D Connection as Breakline' is highlighted with a red rectangle. The left sidebar shows a tree view of features, with 'SA/2D Connections' selected. The bottom status bar indicates the current coordinates and pixel size: (409193.47, 1802960.54 1 pixel = 1.39 ft).

Selected Layer: SA/2D Connections

SA/2D Connections'

SA/2D Connection: SA2D Conn 1 (MLK Bridge)

- Plot SA/2D Connection Data
- Edit SA/2D Connection
- Update SA/2D Connections (1 of 1)
- Edit 2D Connection Breakline Properties
- Enforce 2D Connection as Breakline**
- Delete Selected Feature Del, D
- Move Selected Feature
- Copy Selected Feature Ctrl+ C
- Split Selected Line
- Reverse Selected Line
- Filter Selected Line
- View/Edit Points
- Plot Terrain Profile
- Save as Profile Line

White River

HEC
HEC

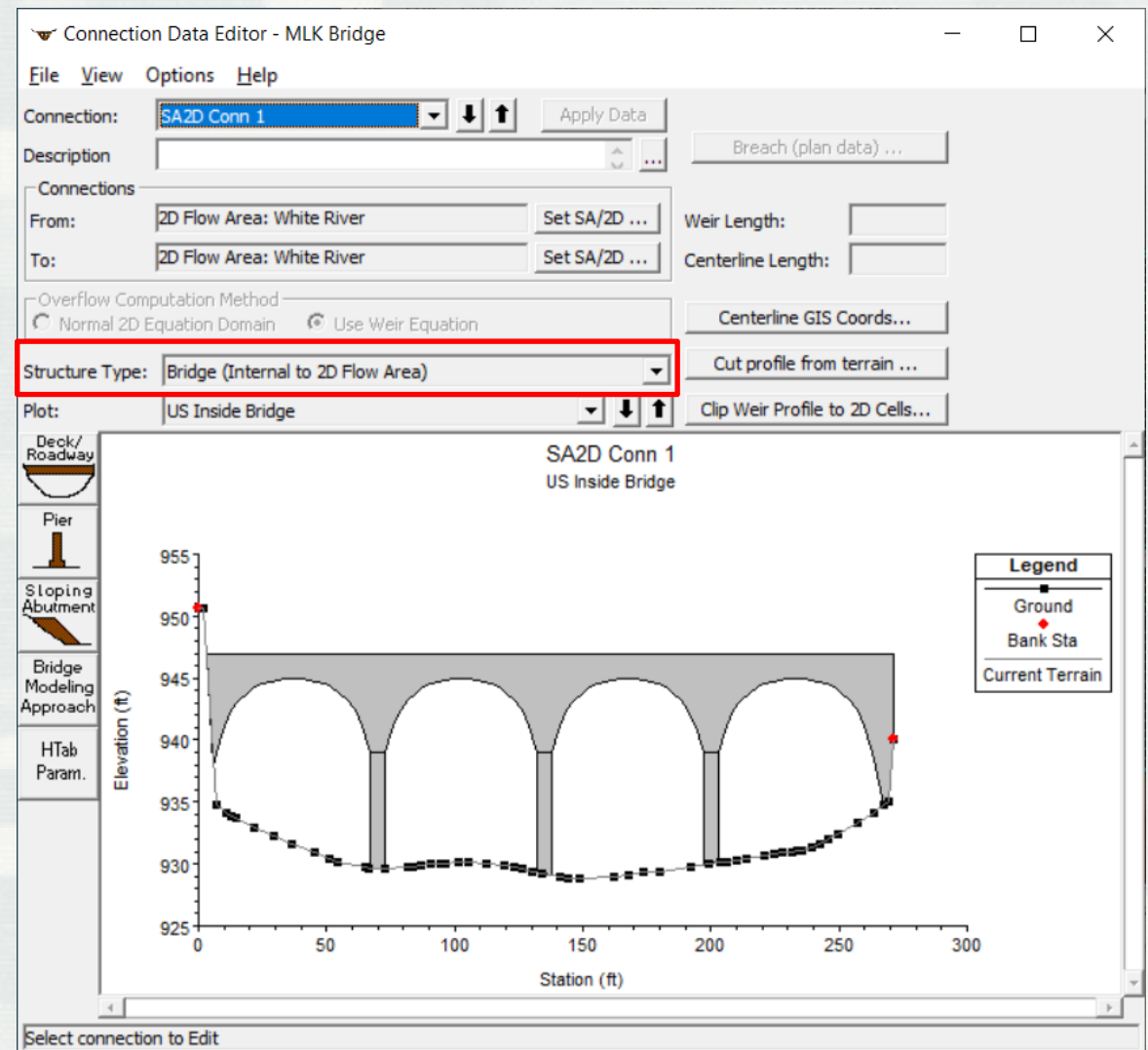
Messages Views Profile Lines Active Features

(409193.47, 1802960.54 1 pixel = 1.39 ft)

ENDING STRONG®

Connection in Bridge Mode

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



Bridge – Deck

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

Deck/Roadway Data Editor

Distance	Width	Weir Coef
5.	40.	3.

Clear Del Row Ins Row Copy US to DS

Upstream				Downstream		
	Station	high chord	low chord	Station	high chord	low chord
1	0	947	930	0	947	930
2	7	947	939	7	947	939
3	10	947	941.175	10	947	941.175
4	13	947	942.45	13	947	942.45
5	16	947	943.2	16	947	943.2
6	19	947	943.8	19	947	943.8
7	22	947	944.25	22	947	944.25
8	25	947	944.55	25	947	944.55

U.S Embankment SS D.S Embankment SS

Weir Data

Max Submergence: Min Weir Flow El:

Weir Crest Shape

Broad Crested
 Ogee

OK Cancel

Enter distance between upstream cross section and deck/roadway. (ft)

Bridged - Piers

- Enter Piers
 - Same as normal 1D Bridge

Pier Data Editor

Add Copy Delete Pier # 1 ↓ ↑

Del Row Centerline Station Upstream 70

Ins Row Centerline Station Downstream 70

Floating Pier Debris

All On ... All Off ... Apply floating debris to this pier

Set Wd/Ht for all ... Debris Width:

Debris Height:

	Upstream		Downstream		
	Pier Width	Elevation	Pier Width	Elevation	
1	6	925	6	925	▲
2	6	945	6	945	
3					
4					
5					
6					▼

OK Cancel Help Copy Up to Down

Select the Pier to Edit

Bridge - Abutments

- Enter Abutments
 - Same as normal 1D Bridge

Sloping Abutment Data Editor

Add Copy Delete Abutment # ↓ ↑

Del Row Ins Row

	Upstream		Downstream		
	Station	Elevation	Station	Elevation	
1					
2					
3					
4					
5					
6					
7					

OK Cancel Help Copy Up to Down

Select Abutment to Edit

Bridge - Modeling Approach

- Enter Modeling Approach
 - Same as normal 1D Bridge

Connection Bridge Modeling Approach Editor

Low Flow Methods

Use	Compute		
<input type="radio"/>	<input checked="" type="checkbox"/>	Energy (Standard Step)	
<input type="radio"/>	<input checked="" type="checkbox"/>	Momentum	Coef Drag Cd <input type="text" value="2.0"/>
<input type="radio"/>	<input type="checkbox"/>	Yarnell (Class A only)	Pier Shape K <input type="text"/>
<input checked="" type="radio"/>		Highest Energy Answer	

High Flow Methods

<input checked="" type="radio"/>	Energy Only (Standard Step)	
<input type="radio"/>	Pressure and/or Weir	
	Submerged Inlet Cd (Blank for table)	<input type="text"/>
	Submerged Inlet + Outlet Cd	<input type="text" value="0.8"/>
	Max Low Chord (Blank for default)	<input type="text"/>

OK Cancel Help

Enter Cd Coefficient for momentum computations

Bridge – HTab Param

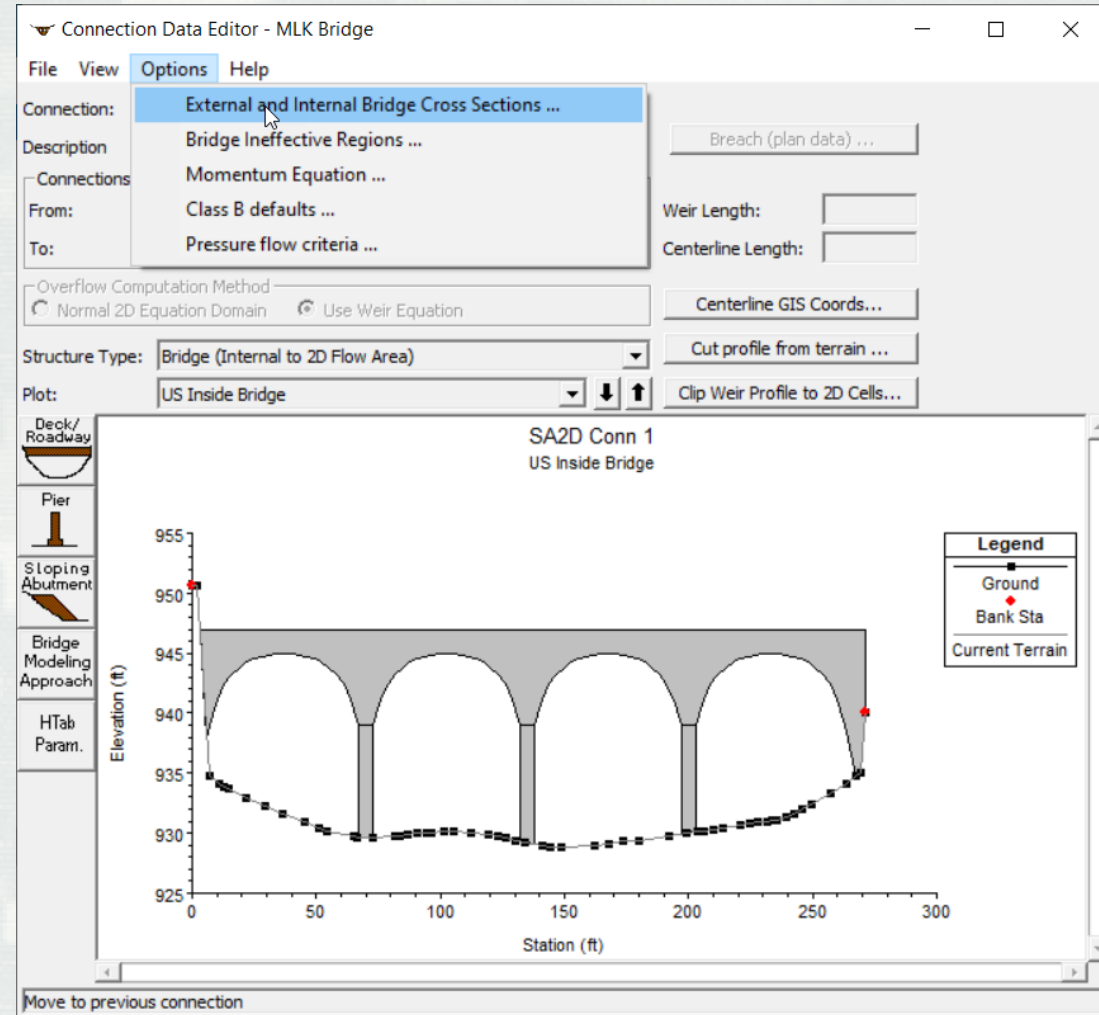
- Enter Hydraulic Tables Parameters
 - Same as normal 1D Bridge

Connection Hydraulic Property Table Parameters

Number of points on free flow curve:	<input type="text" value="50"/>
Number of submerged curves:	<input type="text" value="50"/>
Number of points on each submerged curves:	<input type="text" value="20"/>
<input type="button" value="Apply number of points to all Connections"/>	
Head water maximum elevation:	<input type="text" value="950."/>
Tail water maximum elevation (Optional):	<input type="text"/>
Maximum Flow (Recommended):	<input type="text"/>

Bridge – Additional Parameters

- Additional Data – Options Menu



Additional Options – XS (and Manning's n)

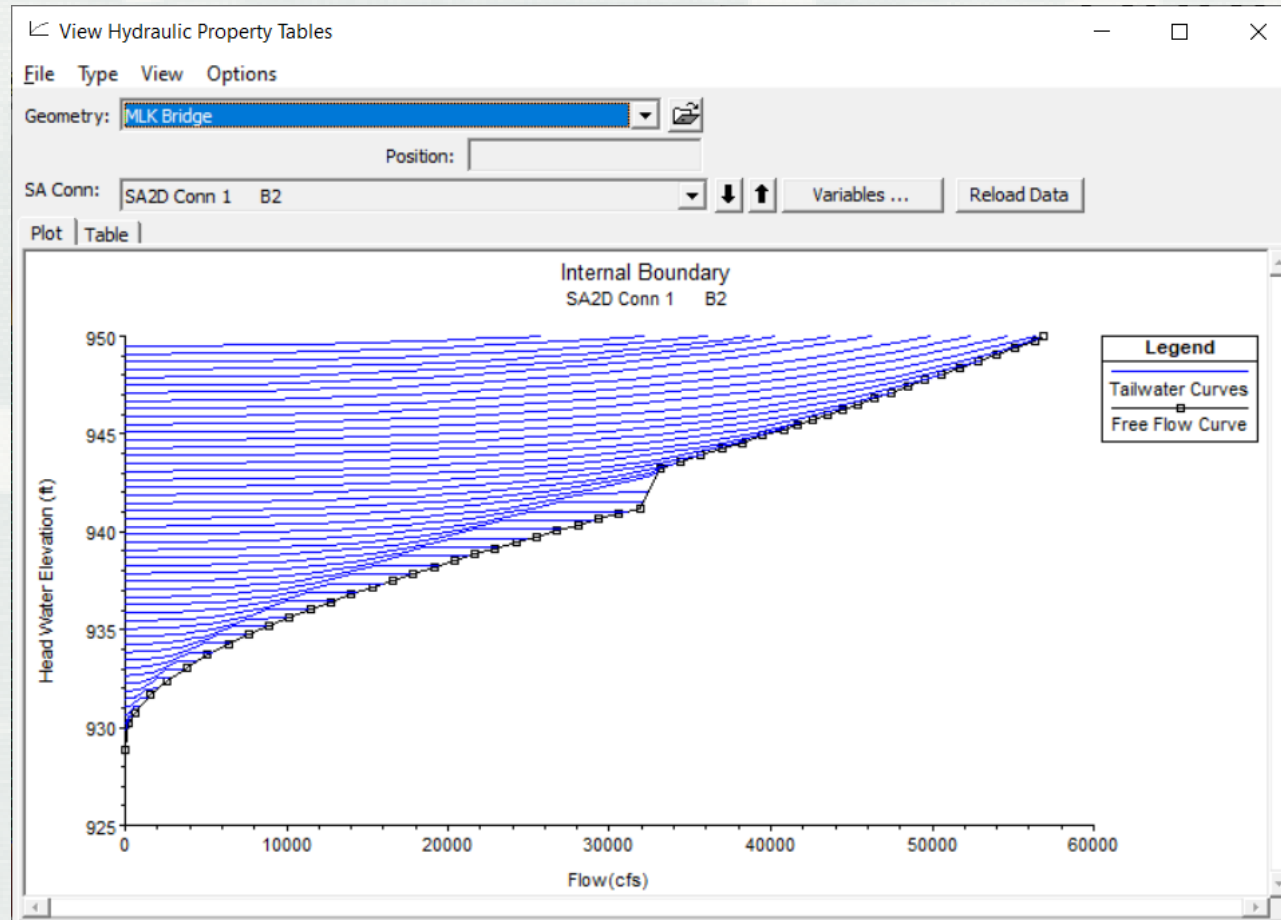
Bridge Cross Sections

Upstream Outside				Upstream Inside				Downstream Inside				Downstream Outside			
Main Channel Bank Stations				Main Channel Bank Stations				Main Channel Bank Stations				Main Channel Bank Stations			
Left Bank Sta		Right Bank Sta		Left Bank Sta		Right Bank Sta		Left Bank Sta		Right Bank Sta		Left Bank Sta		Right Bank Sta	
0		271.53		0		271.53		0		271.53		0		271.53	
Cross Section X-Y Coordinates				Cross Section X-Y Coordinates				Cross Section X-Y Coordinates				Cross Section X-Y Coordinates			
Station	Elevation	Mann n		Station	Elevation	Mann n		Station	Elevation	Mann n		Station	Elevation	Mann n	
1	0	946.82	0.035	1	0	950.58	0.035	1	0	950.34	0.035	1	0	950.22	0.035
2	3.76	935.29		2	1.75	950.62		2	0.69	950.36		2	7.15	950.62	
3	6.84	934.66		3	7.01	934.83		3	4.31	950.61		3	11.96	936.86	
4	8.59	934.32		4	11.14	934.13		4	4.93	950.62		4	12.49	935.55	
5	9.72	934.12		5	12.97	933.86		5	9.87	950.62		5	18.38	934.54	
6	12.2	933.81		6	14.76	933.66		6	12.53	942.74		6	19.67	934.37	
7	15.69	933.41		7	21.98	932.92		7	15.13	934.91		7	21.66	934.15	
8	21.65	932.8		8	29.21	932.27		8	17.12	934.59		8	24.34	933.86	
9	27.61	932.28		9	36.44	931.58		9	21.09	934.08		9	30.31	933.29	
10	33.58	931.7		10	45.01	930.95		10	27.96	933.39		10	34.13	932.95	
11	39.54	931.24		11	50.9	930.47		11	38.8	932.38		11	37.74	932.61	
12	45.51	930.82		12	54.51	930.2		12	44.95	931.74		12	40	932.37	

OK Cancel Help

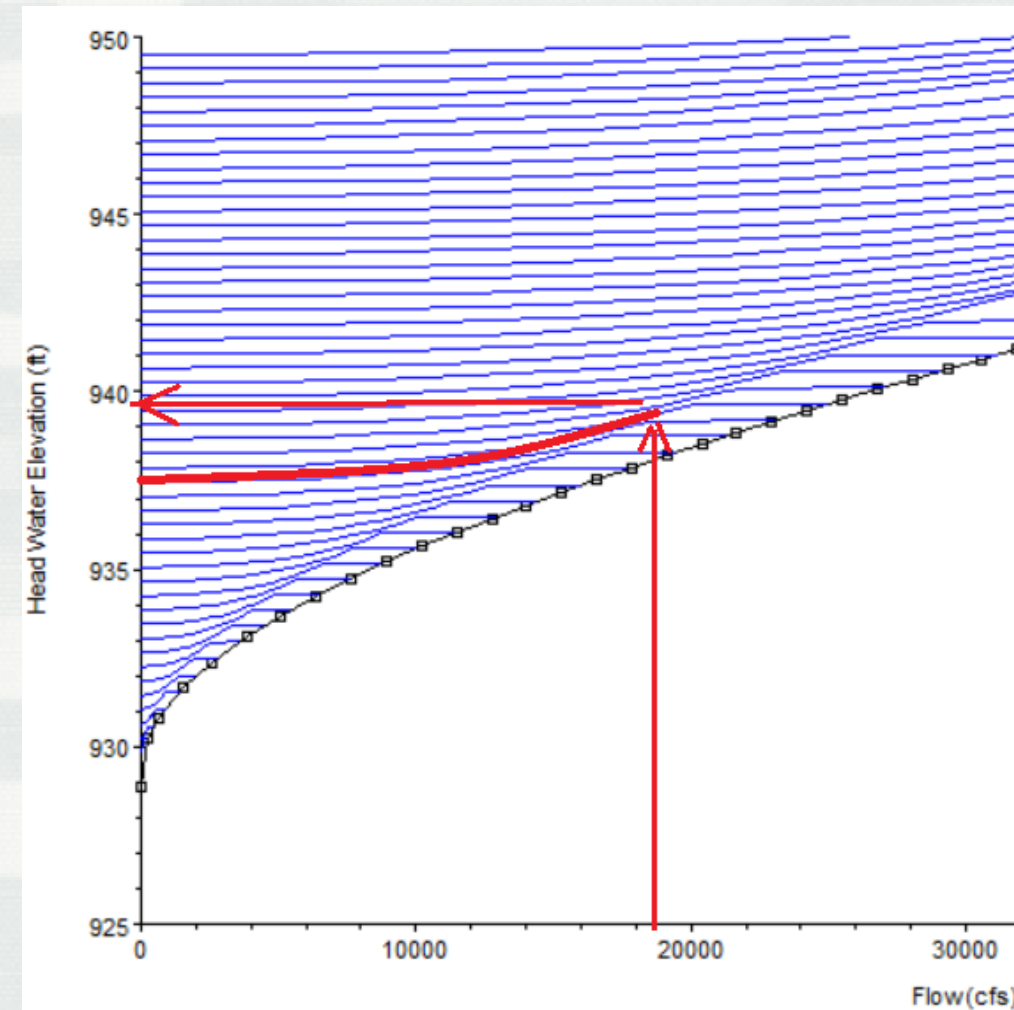
Family or Rating Curves

- Geometry Preprocessor computes family of rating curves



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



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 loss terms are adjusted so that compute 2D flows match expected 1D Flow

Family of Rating Curves - 2D Flow Areas

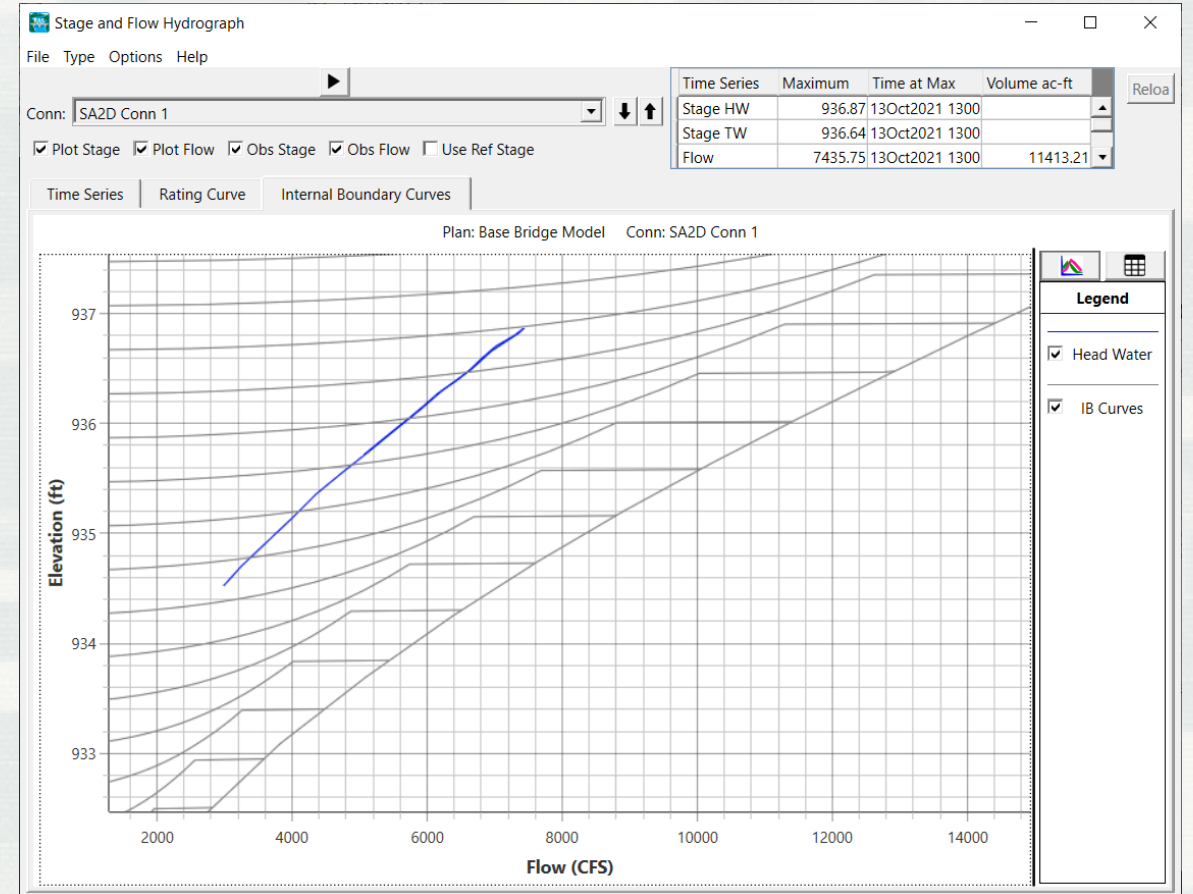
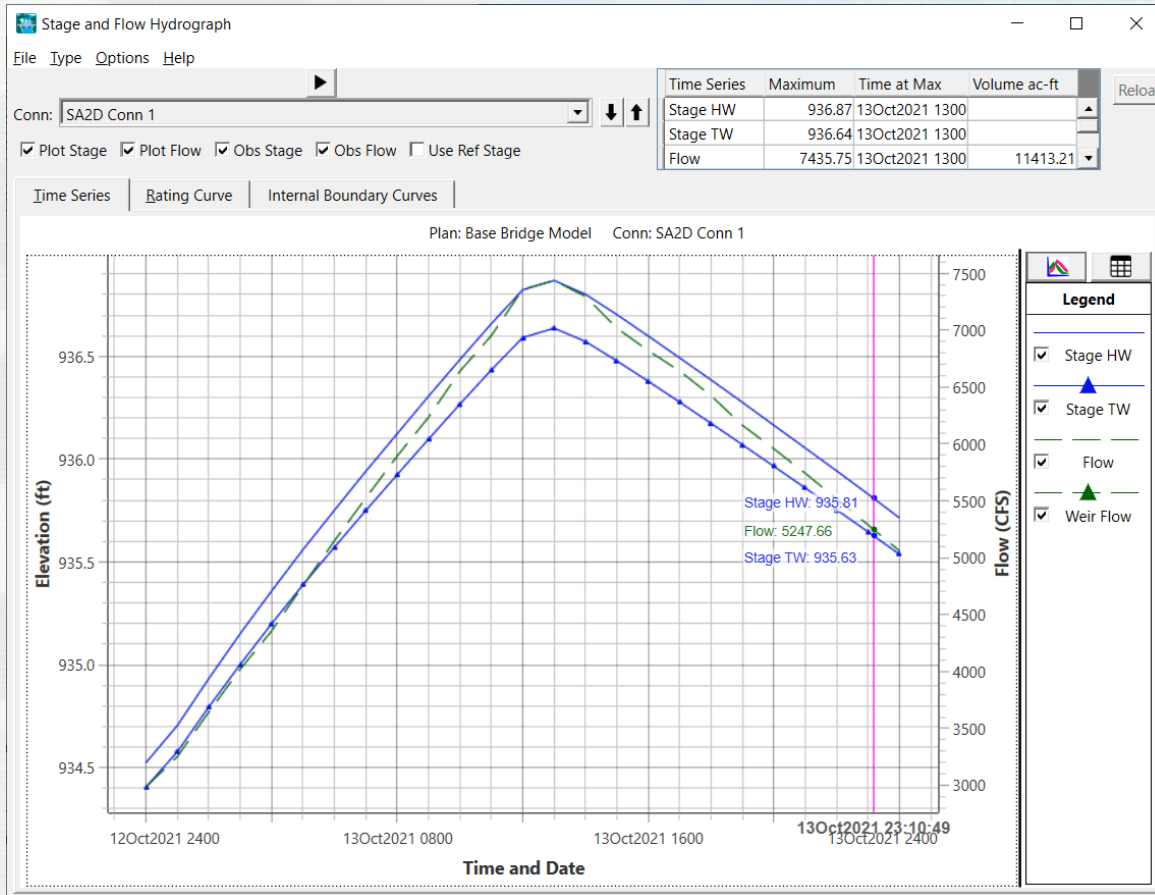
- Version 6.0 (and 6.1)
 - Bridge Losses imposed using the family of rating curves and velocity distribution at each 2D face in bridge opening
 - Different adjustment factor for each face in bridge centerline
 - Can be unstable when 2D face velocity distribution does not match 1D velocity distribution

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

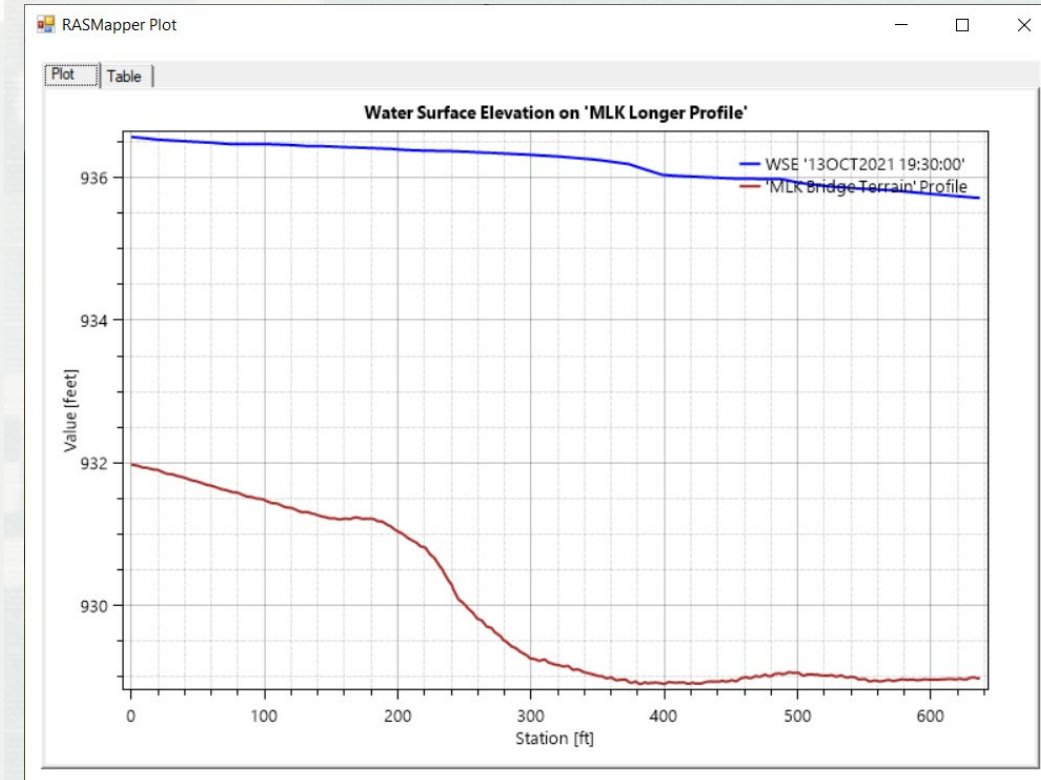
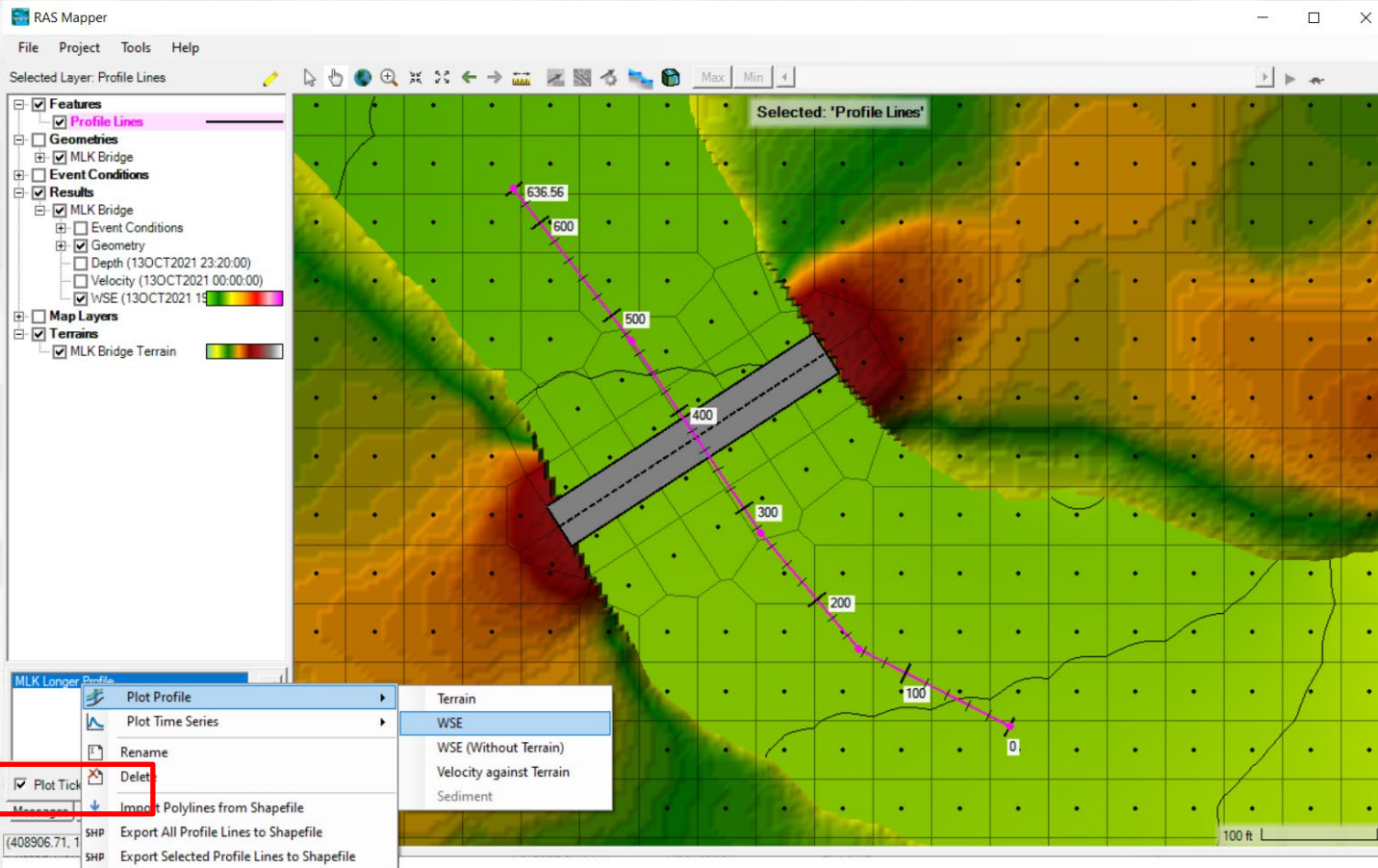
Bridge - Output

■ Stage and Flow Plot



Bridge Output

Profile Lines – Plot Tick Marks



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.

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 losses in 2D domain and in 1D curves.

Questions?