Combined 1D River and 2D Floodplain/Levee Areas

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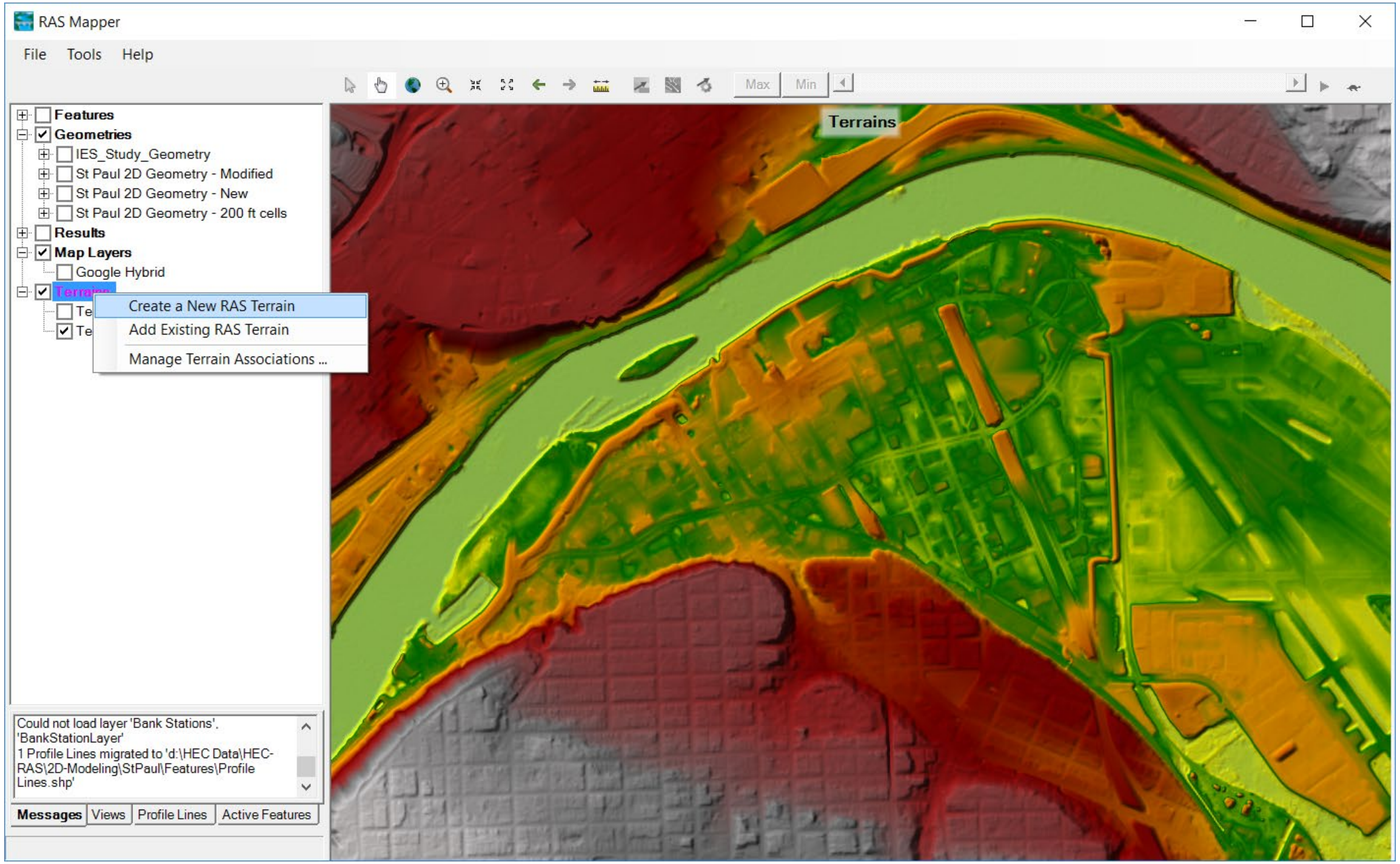
Overview

- Using a 2D Flow Area to model inside of Levees
  - Saint Paul Levee Breach Example
- Using 2D Flow Areas to model overbank areas (i.e. 1D Channels and 2D Floodplains)
  - Carson River Example

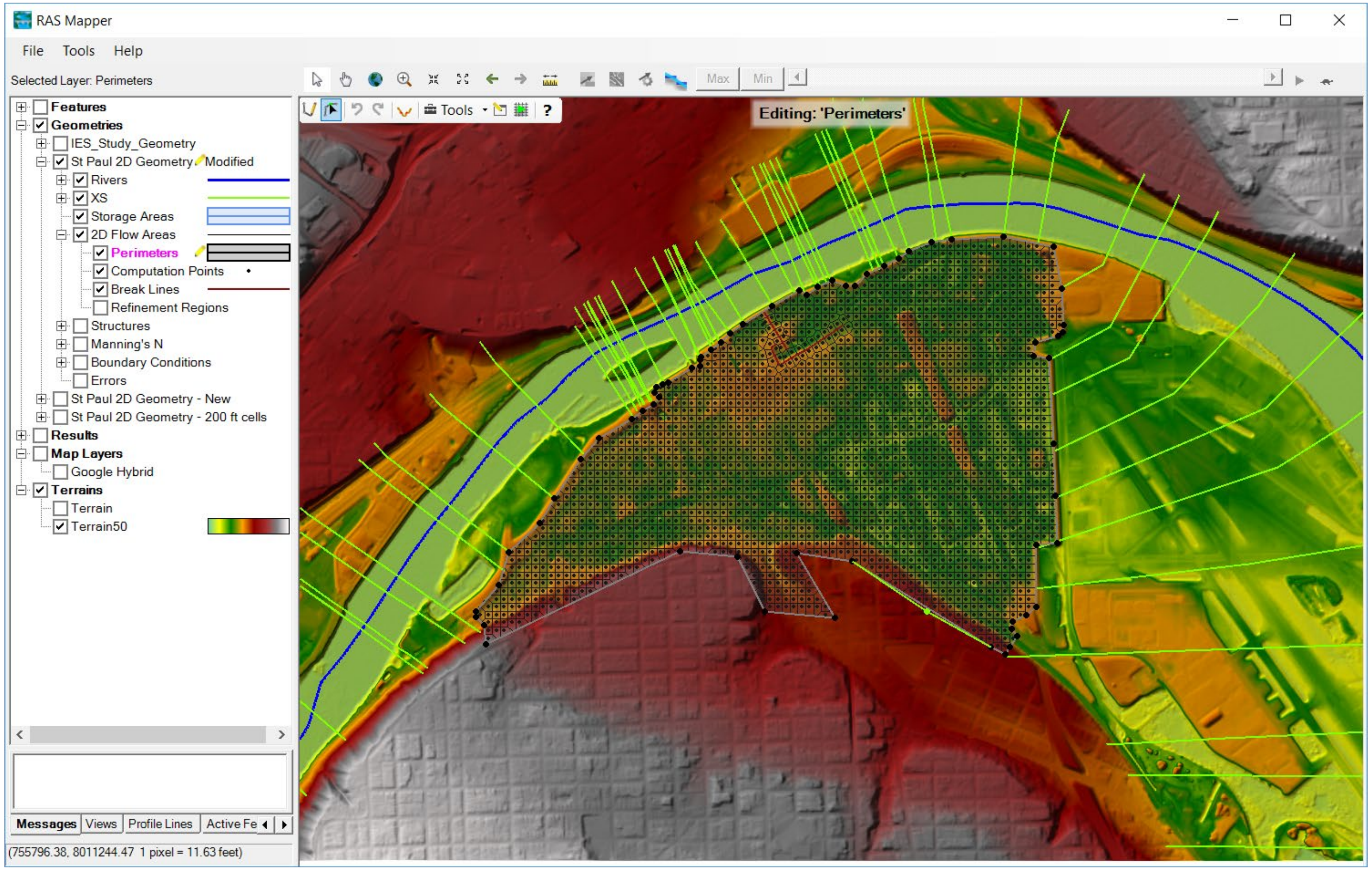
Using a 2D Flow Area to model inside of a Levee system

- Bring in terrain and background map layers into RAS Mapper
- Draw a Polygon for the 2D Flow Area Boundary Inside of the Levee
- Create the 2D Computational Mesh
- View the Mesh Boundary Cells to ensure there are no Mesh Problems
- Modify The Mesh if Needed (add break lines for roads, high ground, etc. Use mesh refinement regions to refine or coarsen areas of the mesh)
- Hook up the 2D Flow Area to a 1D River Reach with Lateral Structures
- Weir Coefficients for Lateral Structures
- Levee Breaching
- Weir and Levee Breach Submergence Issues

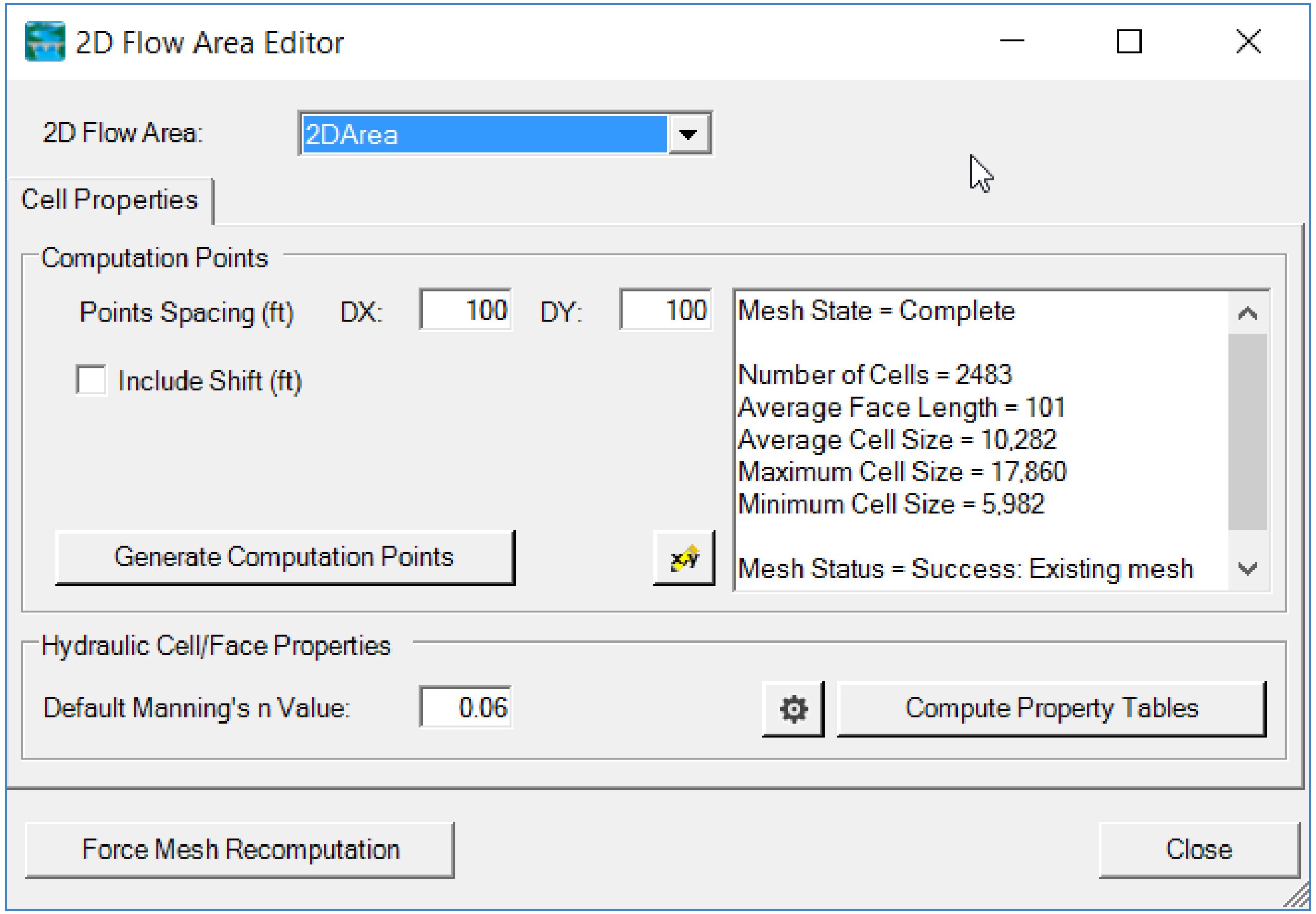
From HEC-RAS Mapper Create a Terrain Model and Map Layers



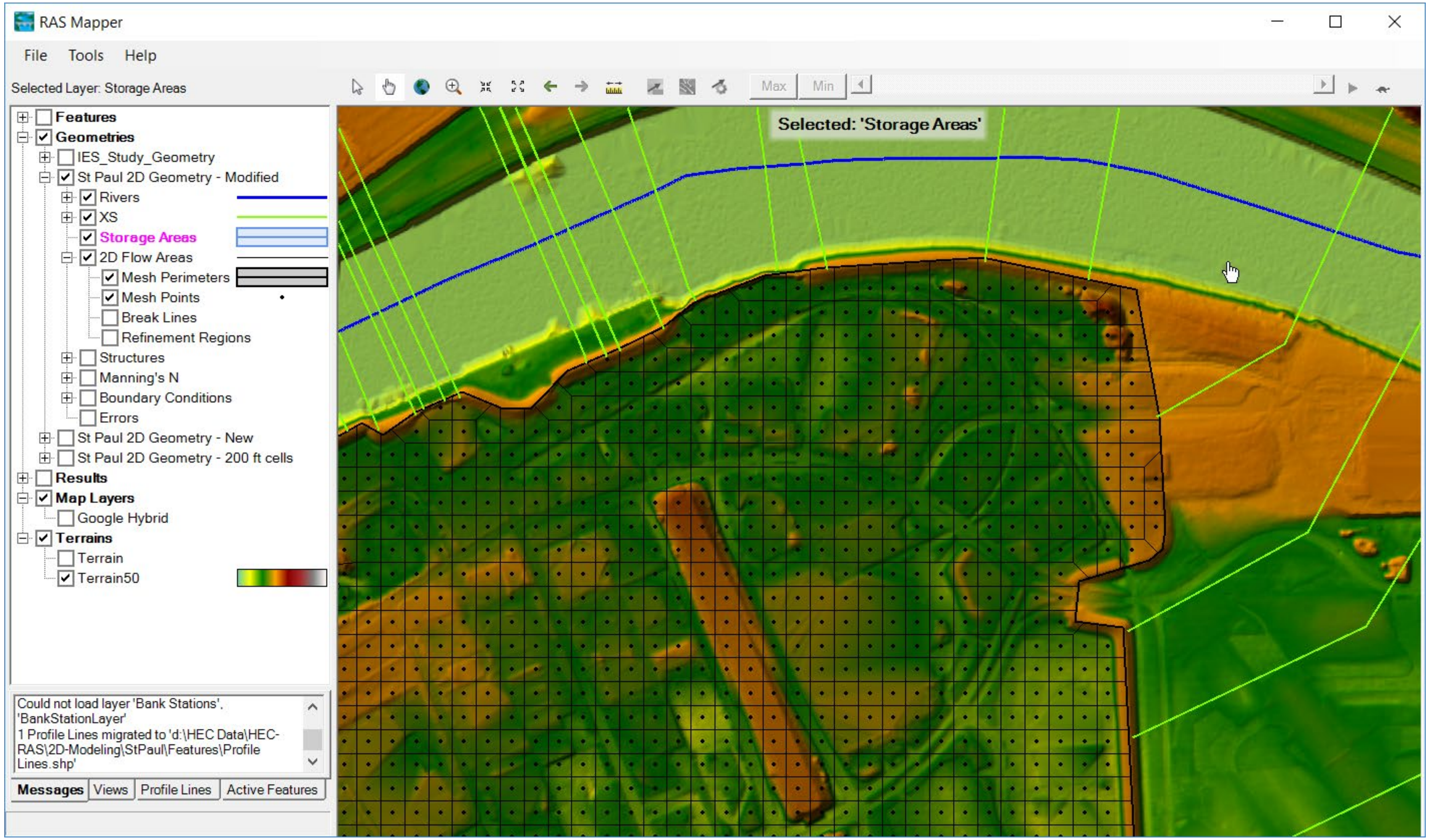
Draw a Polygon for the 2D Flow Area Boundary Inside of the Levee



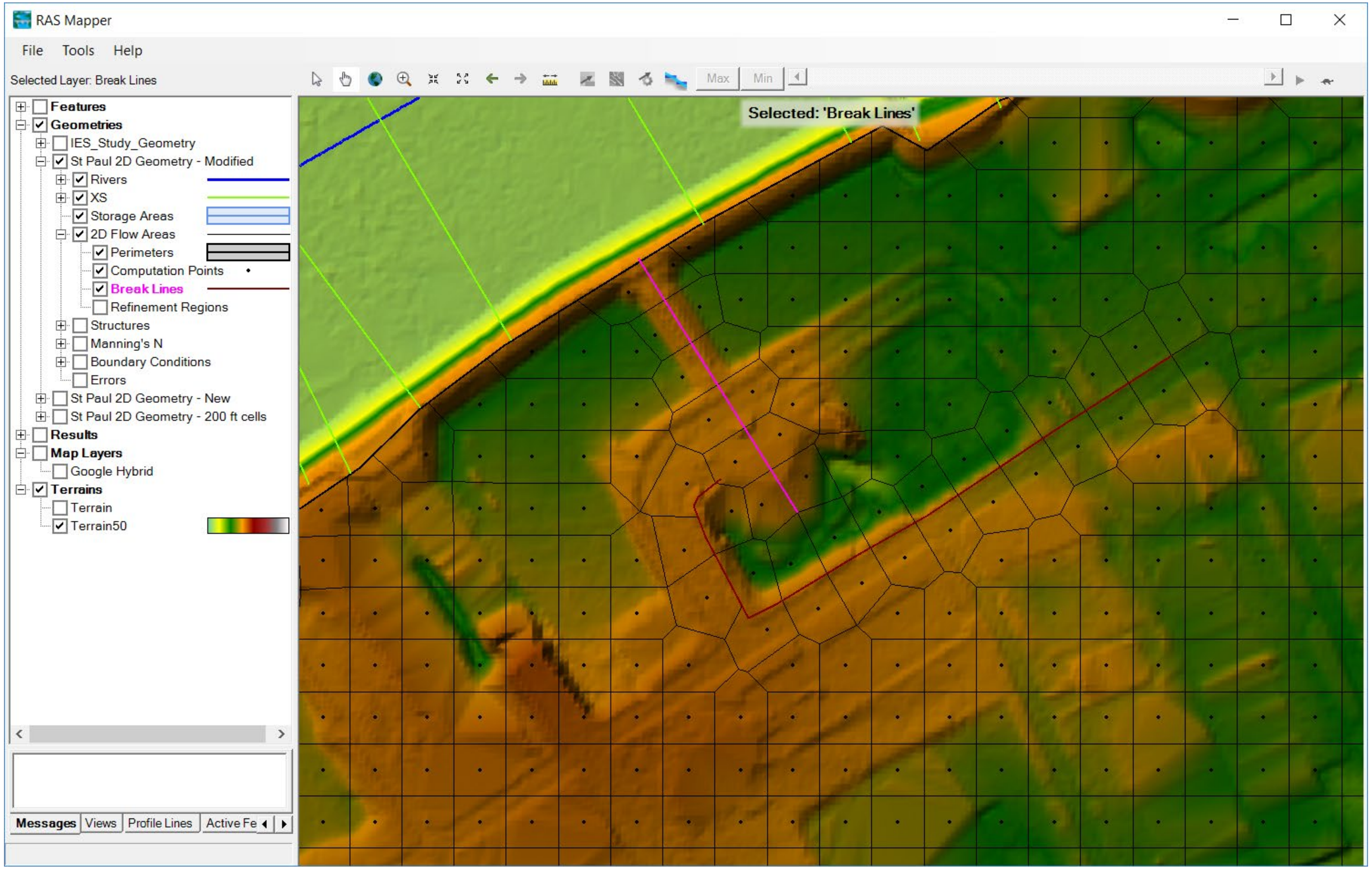
Create the 2D Computational Mesh using the 2D Flow Area Editor



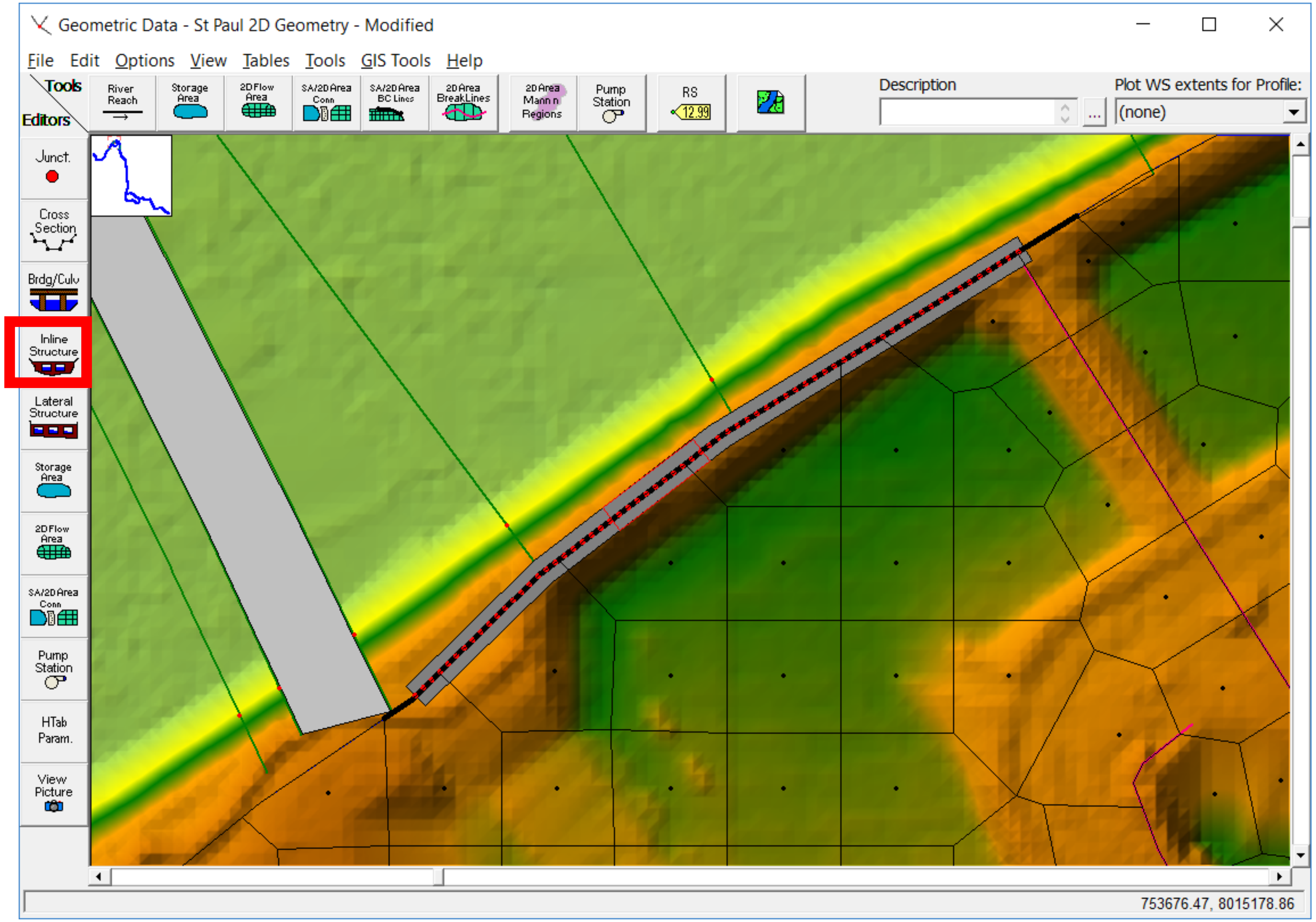
View the Mesh to ensure there are no Mesh Problems



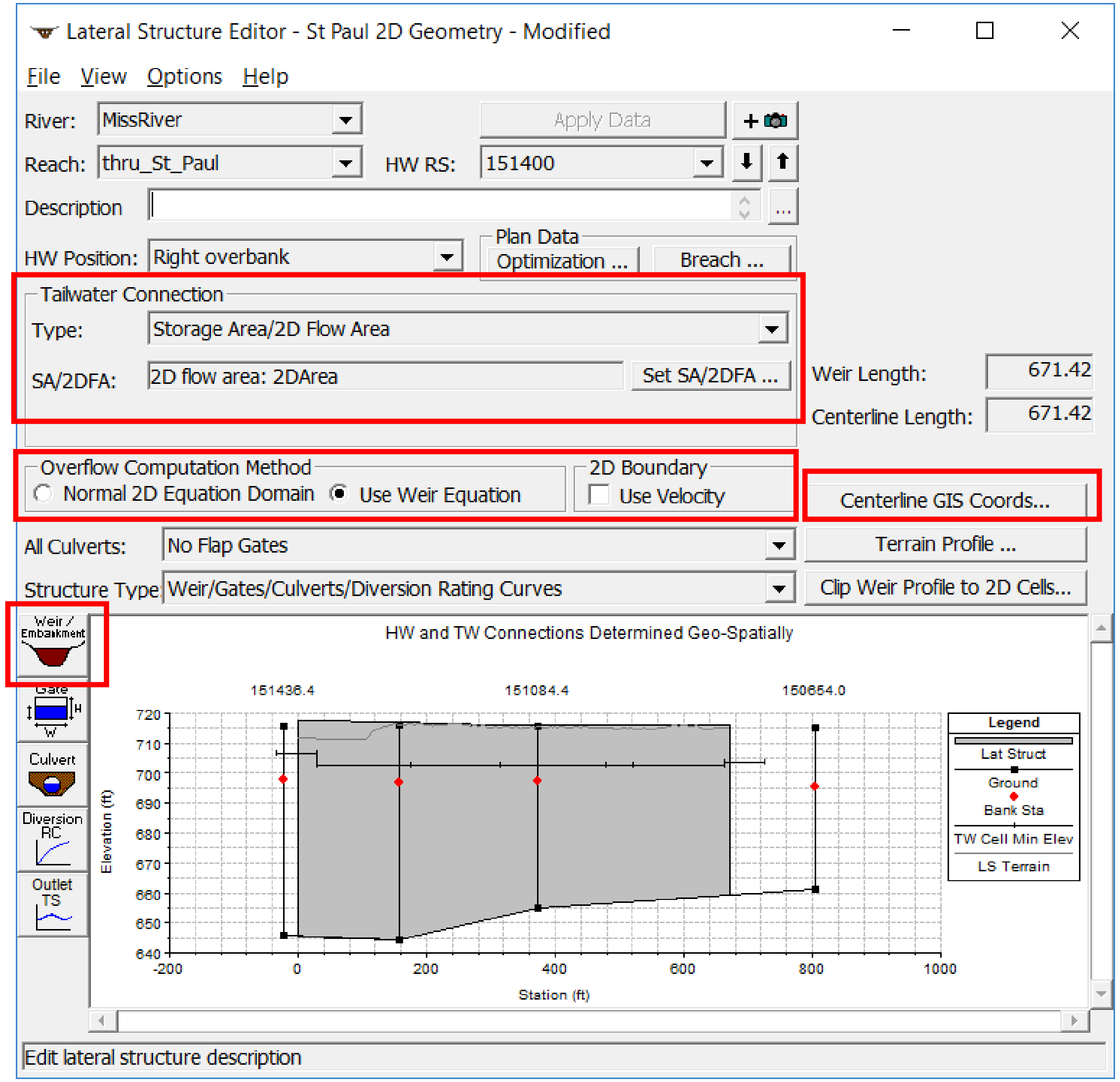
Modify The Mesh as Needed



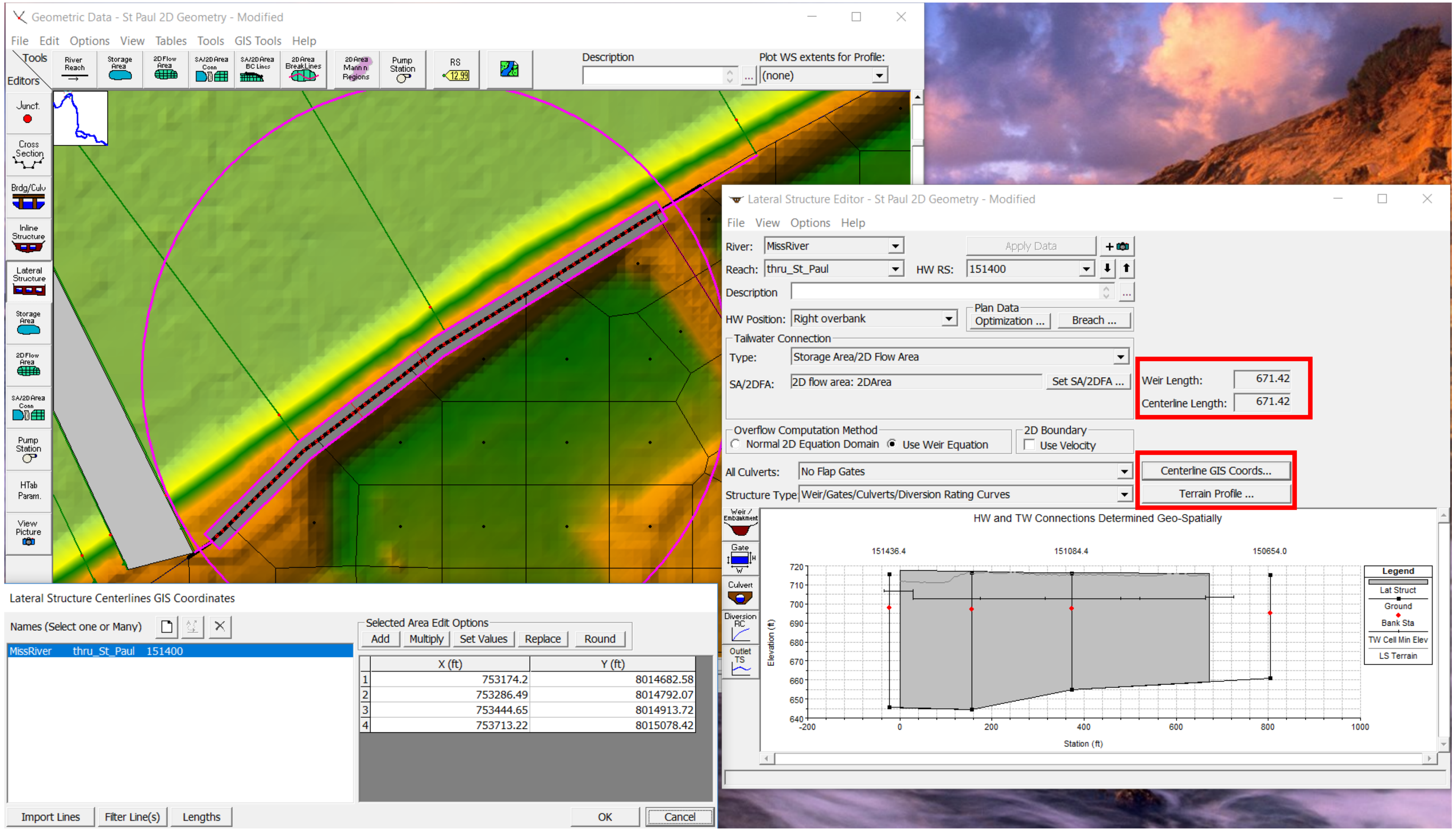
Hooking up a 2D Flow Area to a 1D River Reach with Lateral Structures



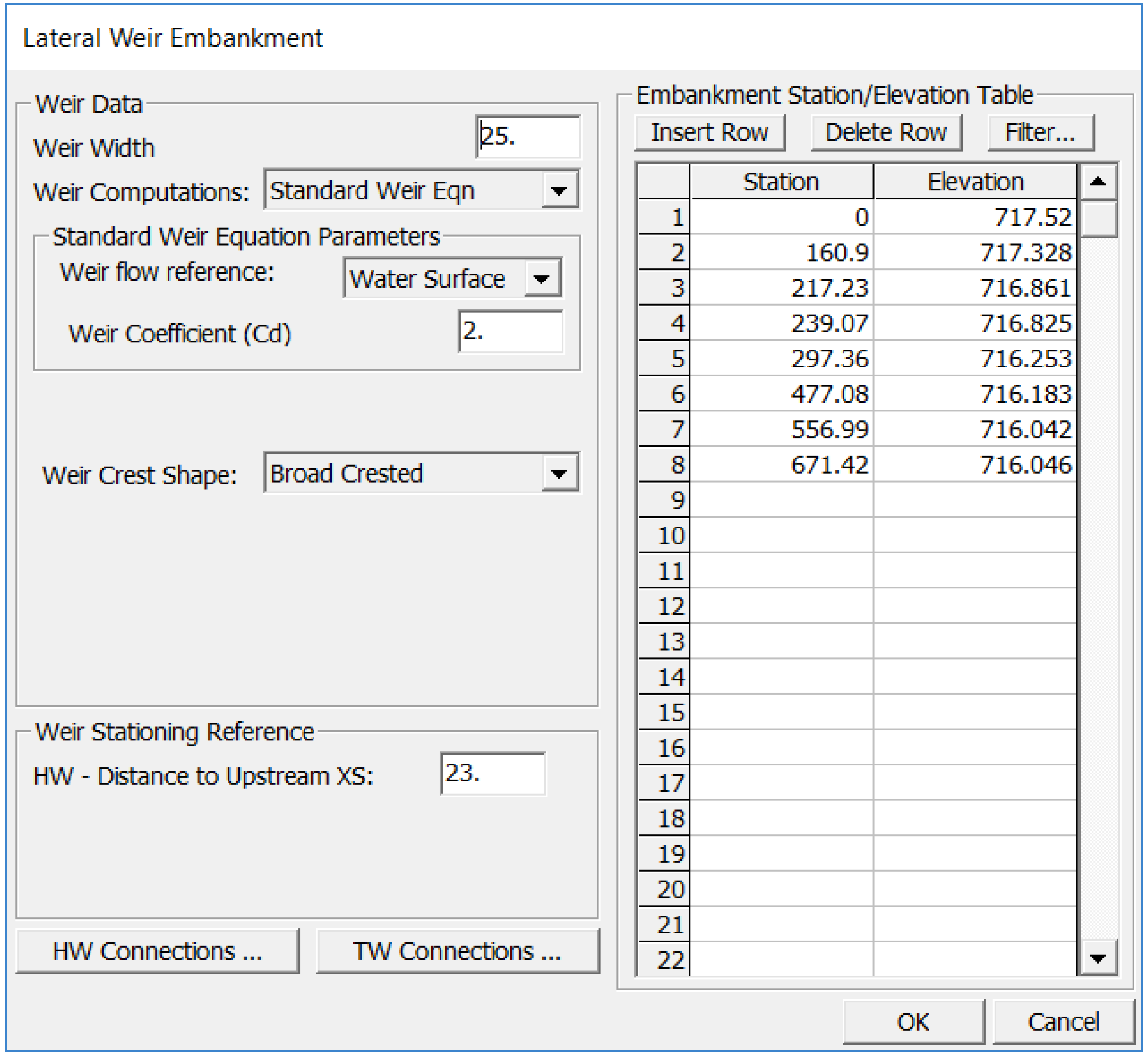
Lateral Structure editor



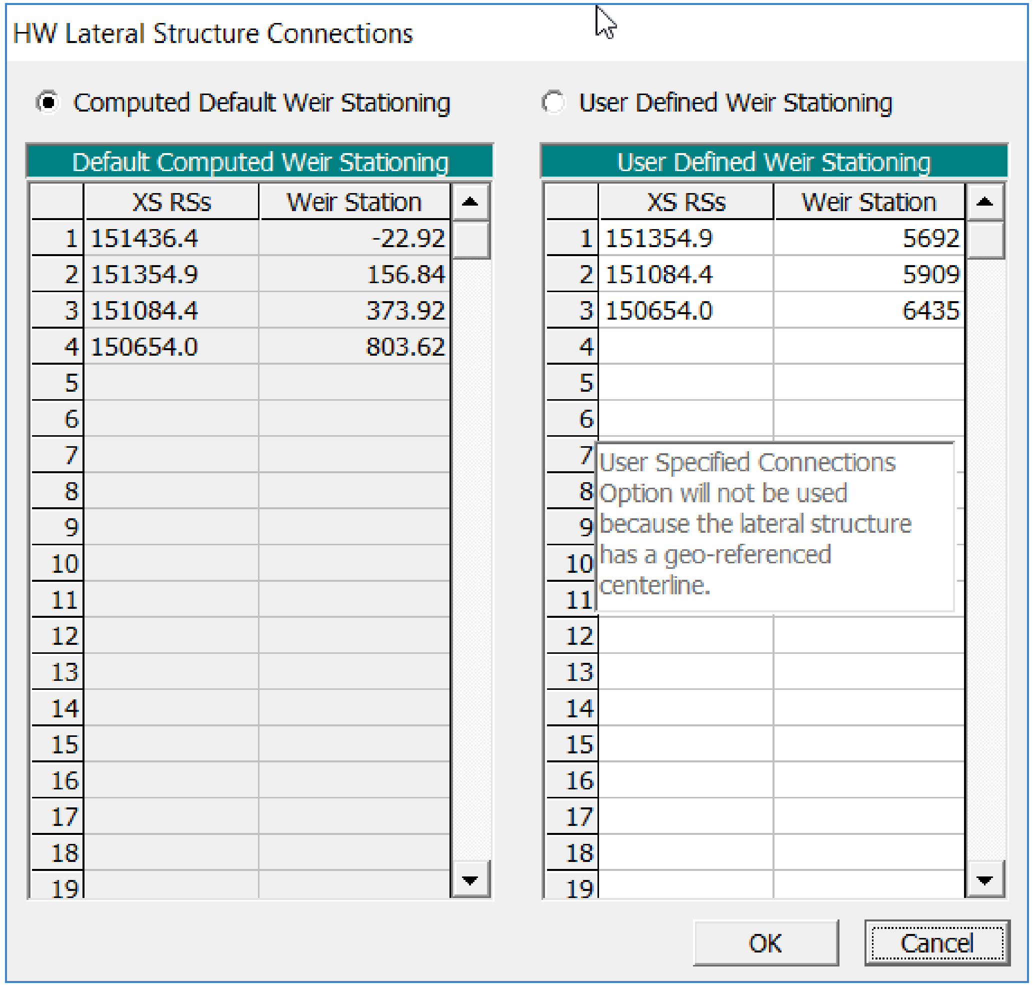
Using Geospatial Coordinates for Lateral Structures



Lateral Weir/Embankment Editor



Lateral Weir Headwater Connections (HW)



Lateral Weir Tailwater Connections (TW)

TW Lateral Structure Connections

(●) Computed Default Weir Stationing ( ) User Defined Weir Stationing

Default Computed Weir Stationing

	2D Face Points	Weir Station
1	456	-34.3083
2	412	28.59606
3	368	174.9681
4	319	314.8326
5	322	479.7218
6	325	521.3957
7	2408	663.5559
8	239	725.6677
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

User Defined Weir Stationing

	2D Face Points	Weir Station
1	454	5470.98
2	411	5537.3
3	368	5703.08
4	319	5861.57
5	322	6048.15
6	325	6095.38
7		
8		
9		
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12		
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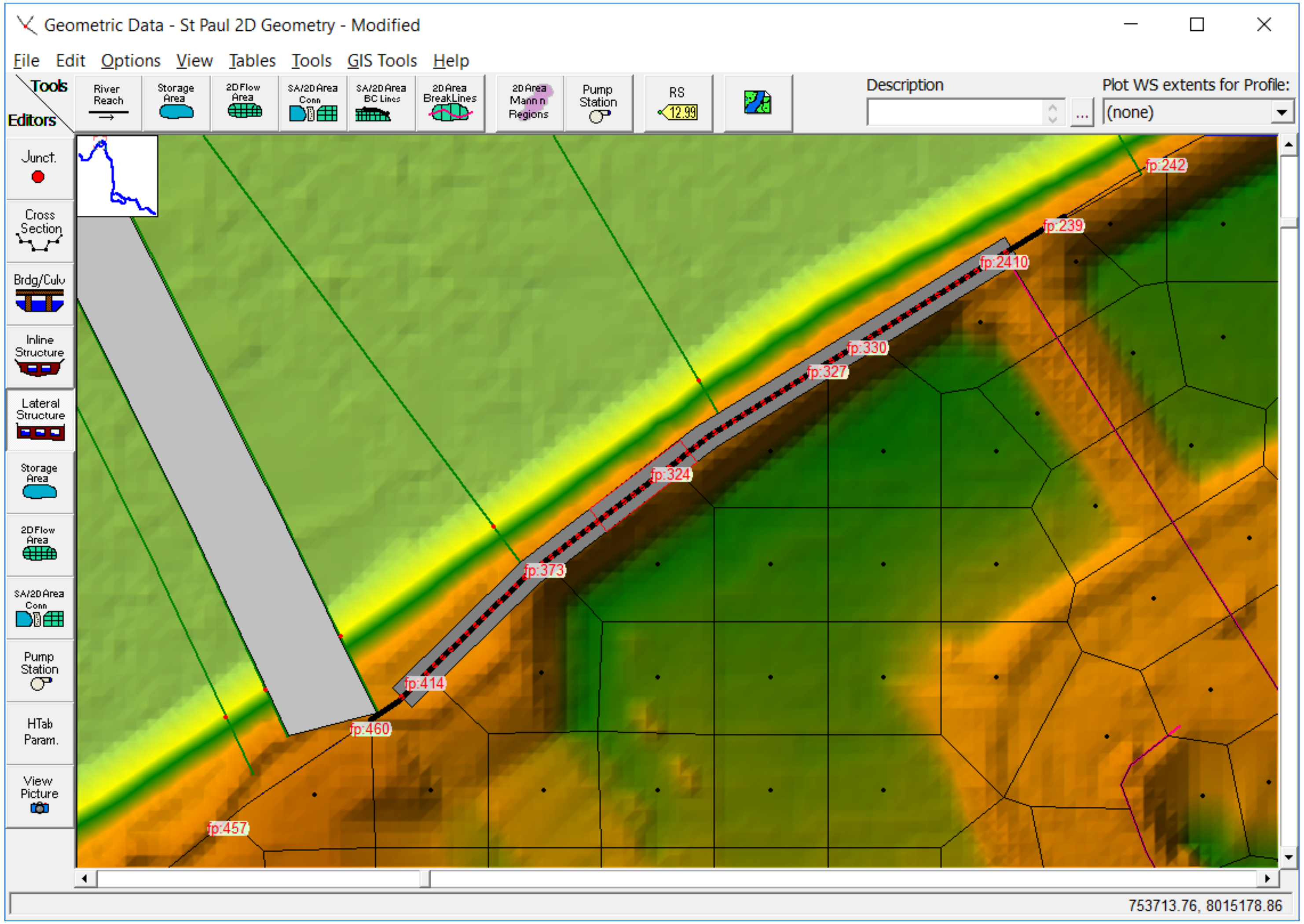
19		

User Specified Connections Option will not be used because the lateral structure has a geo-referenced centerline.

OK Cancel

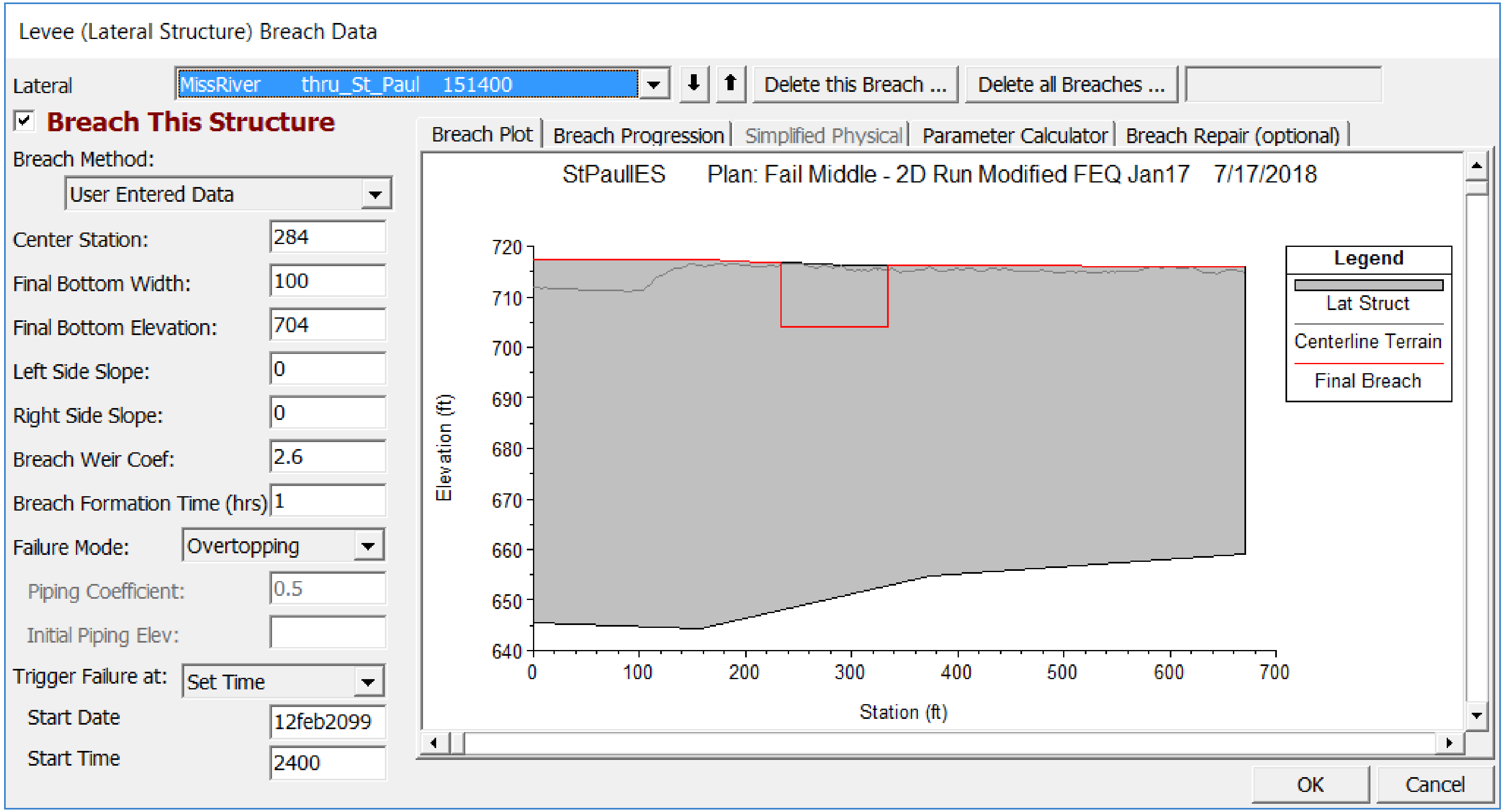
Connected 1D River to 2D Flow Area with Lateral Structure



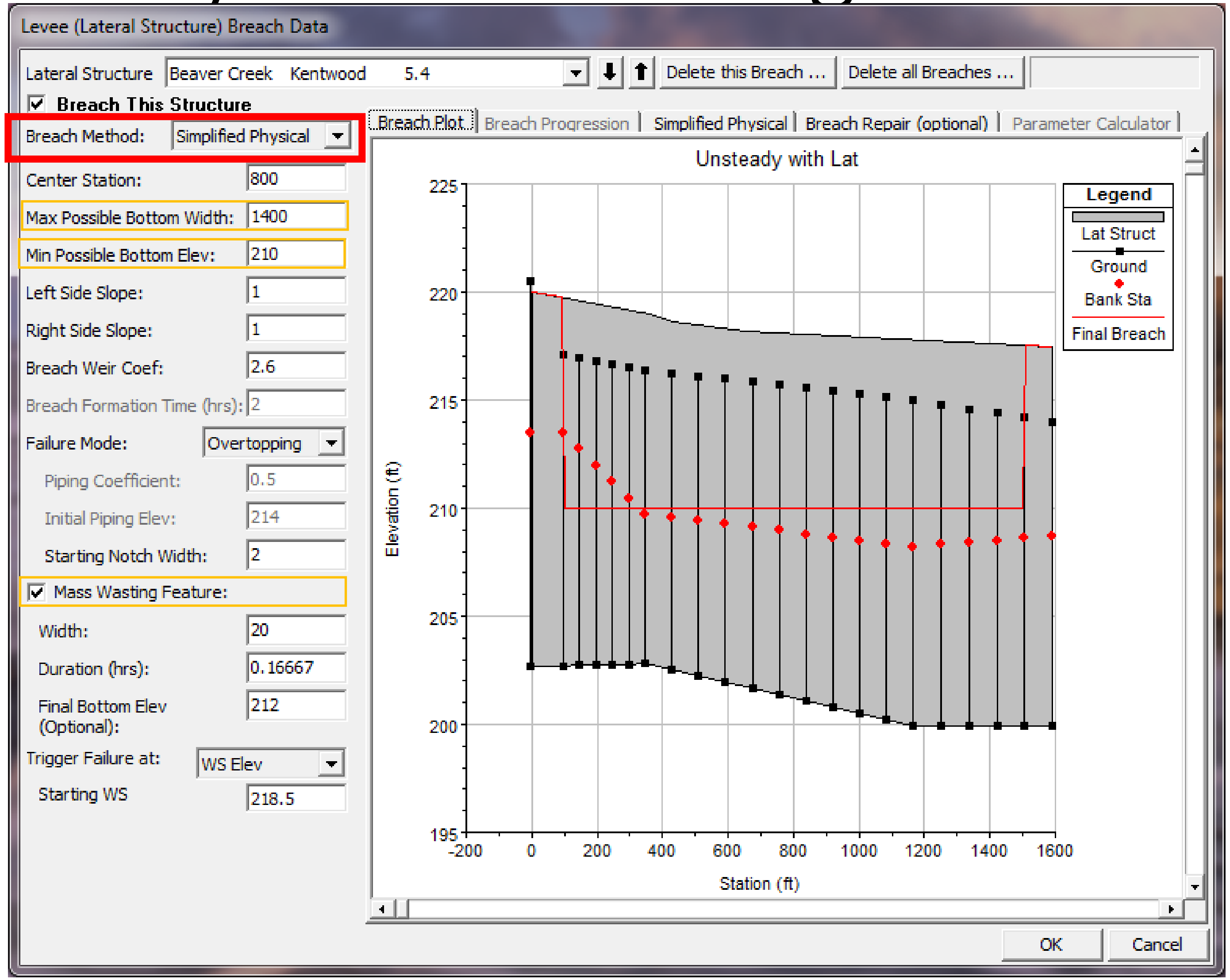
Weir Coefficients for Lateral Structures

What is being modeled with the Lateral Structure	Description	Range of Weir Coefficients
Levee/Roadway – 3ft or higher above natural ground	Broad crested weir shape, flow over Levee/road acts like weir flow	**1.5** to **2.6** (2.0 default) SI Units: 0.83 to 1.43
Levee/Roadway – 1 to 3 ft elevated above ground	Broad Crested weir shape, flow over levee/road acts like weir flow, but becomes submerged easily.	**1.0** to **2.0** SI Units: 0.55 to 1.1
Natural high ground barrier – 1 to 3 ft high	Does not really act like a weir, but water must flow over high ground to get into 2D area.	**0.5** to **1.0** SI Units: 0.28 to 0.55
Non elevated overbank terrain. Lat Structure not elevated above ground	Overland flow escaping the main river.	**0.2** to **0.5** SI Units: 0.11 to 0.28

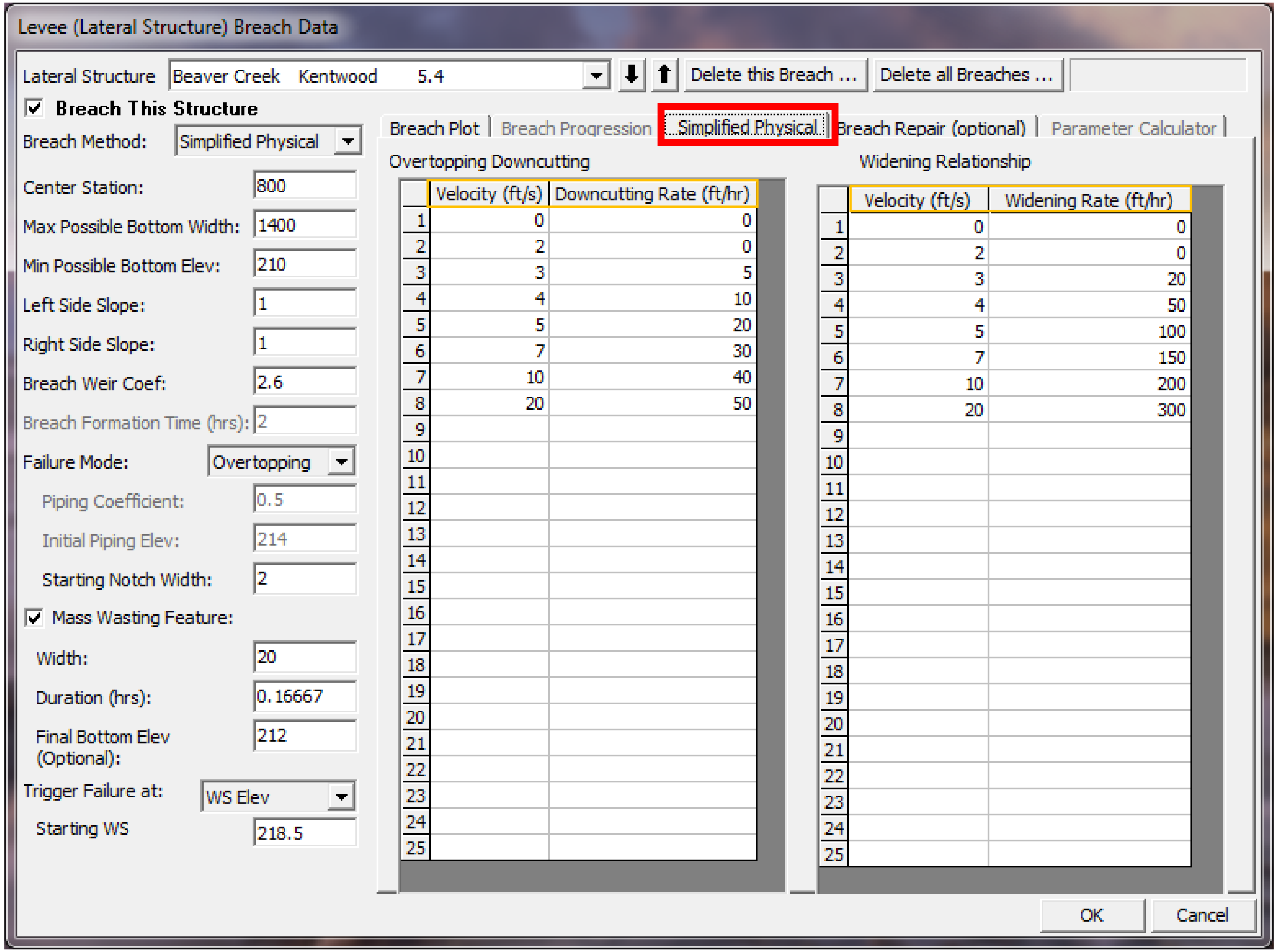
Levee Breaching



Simplified Physical Breaching



Velocity vs. Downcutting and Widening



Overtopping Downcutting

	Velocity (ft/s)	Downcutting Rate (ft/hr)
1	0	0
2	2	0
3	3	5
4	4	10
5	5	20
6	7	30
7	10	40
8	20	50

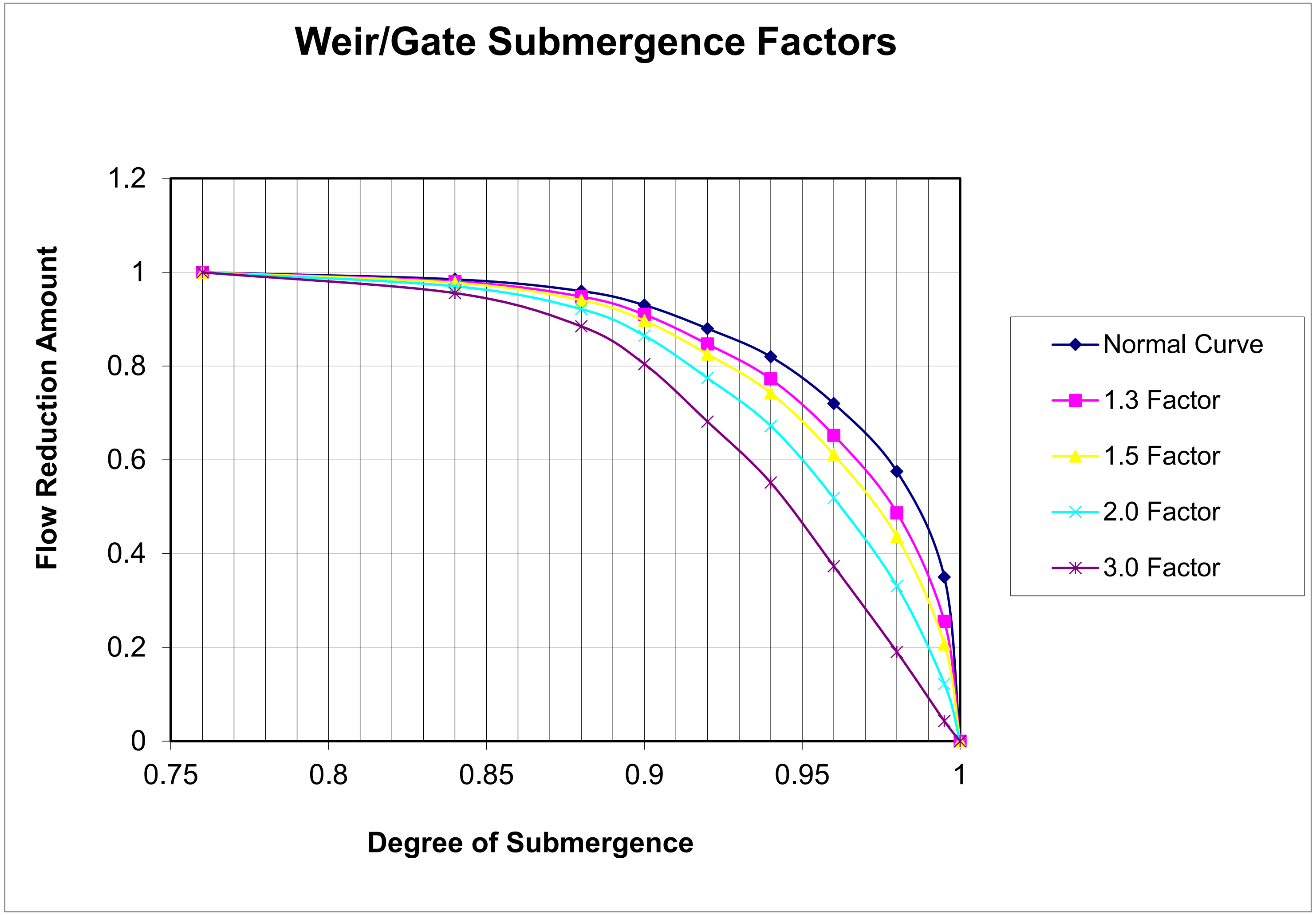
Widening Relationship

	Velocity (ft/s)	Widening Rate (ft/hr)
1	0	0
2	2	0
3	3	20
4	4	50
5	5	100
6	7	150
7	10	200
8	20	300

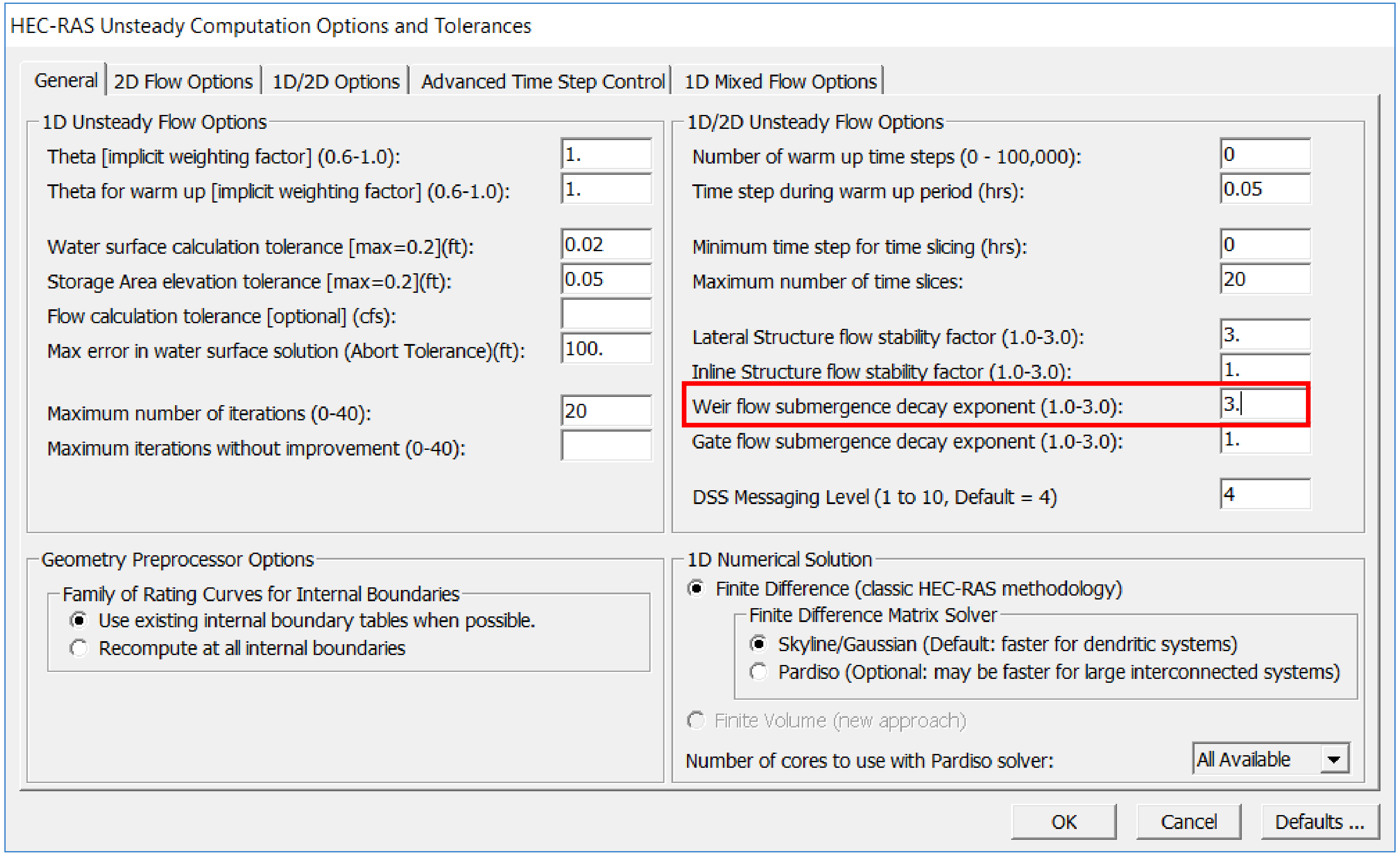
Weir and Levee Breach Submergence Issues

- When a lateral structure gets highly submerged, HEC-RAS uses a weir submergence curve to compute the flow reduction over the weir. The curve is very steep (i.e. the flow reduction changes dramatically) between 95% and 100% submergence. This can cause oscillations and possible model stability issues. To reduce these oscillations, user can have HEC-RAS use a milder sloping submergence curve by going to the 1D “Computational Options and Tolerances” and setting the field labeled “**Weir flow submergence decay exponent**” to 3.0.

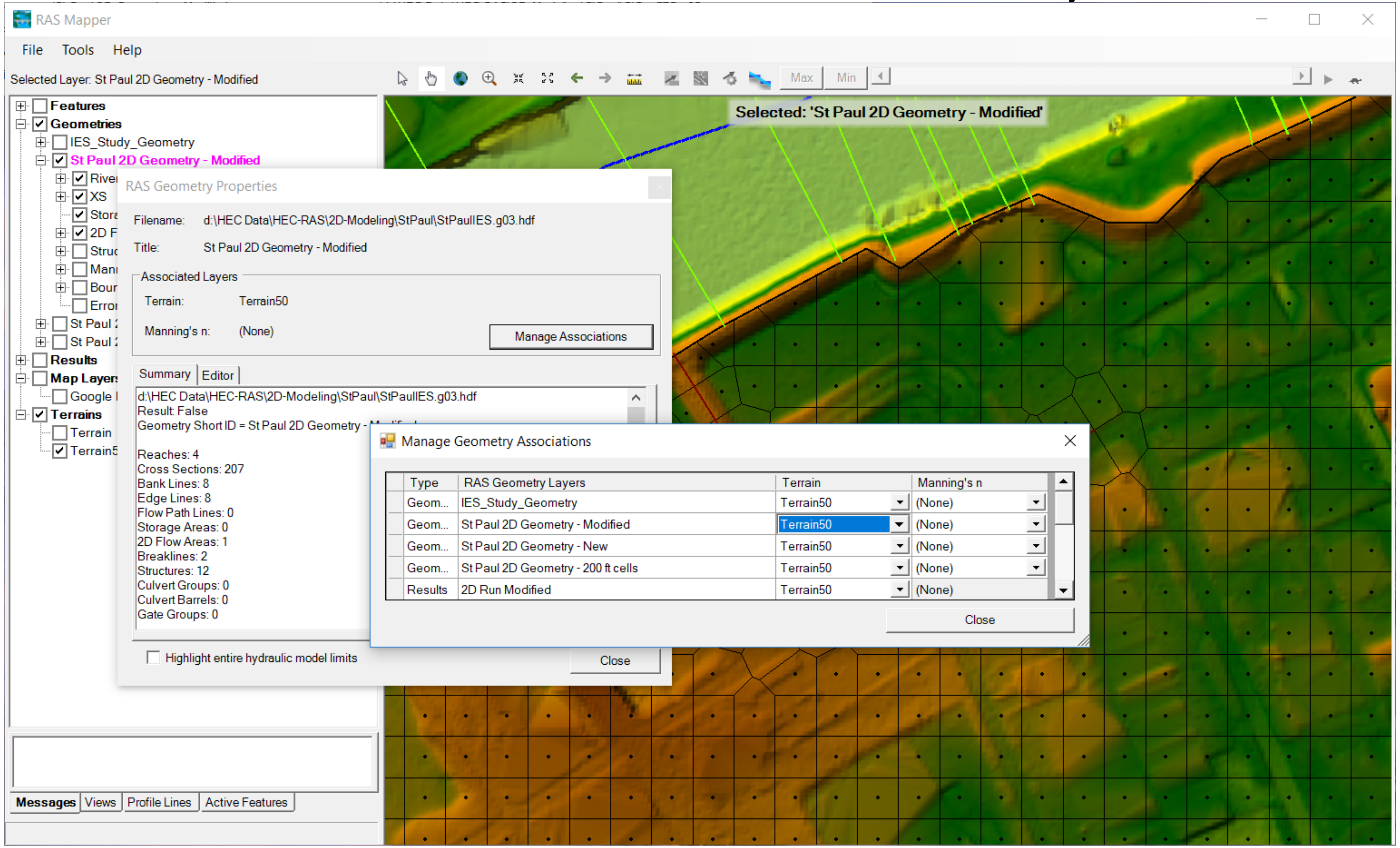
Weir Submergence Curves



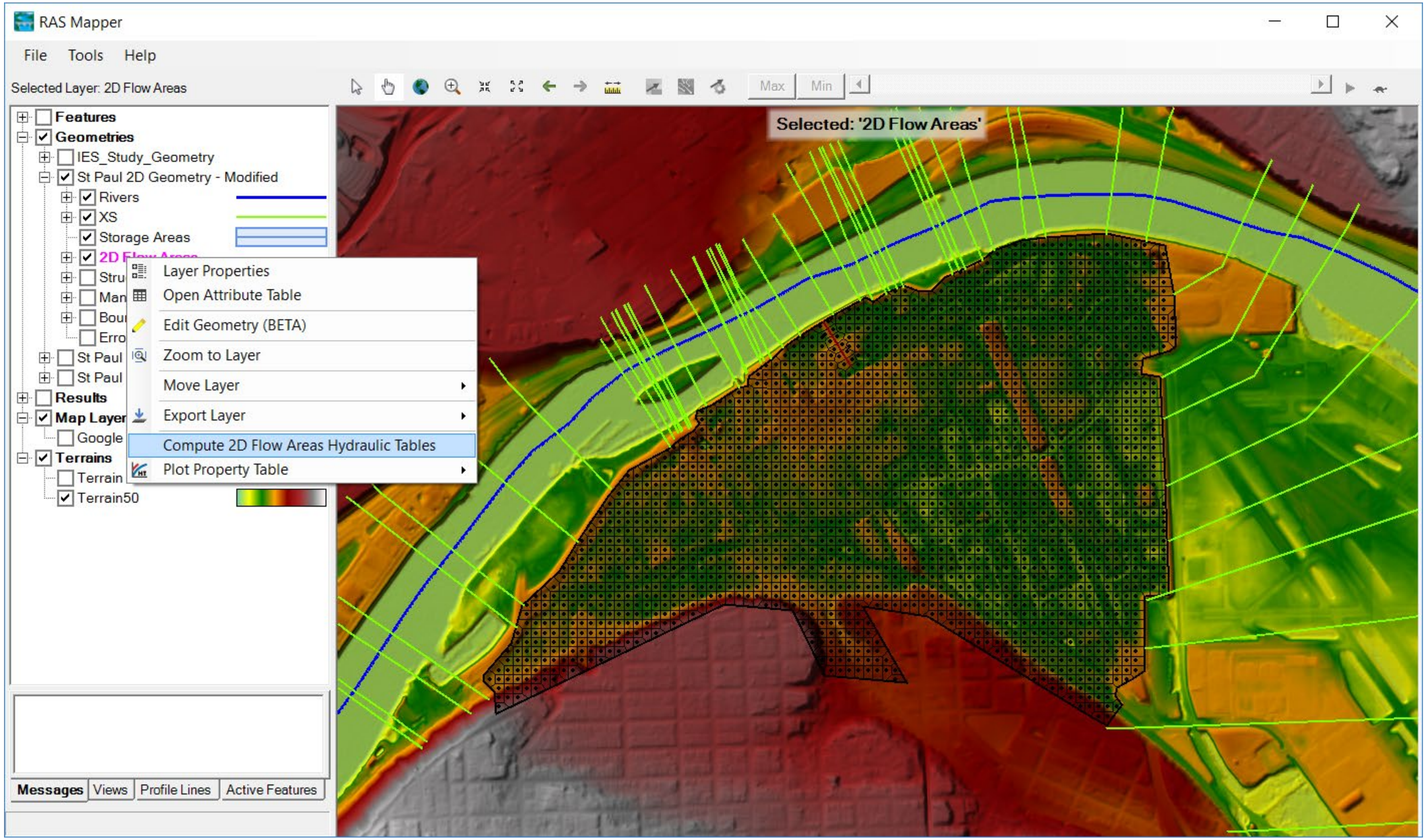
Unsteady Flow Computational Options and Tolerances



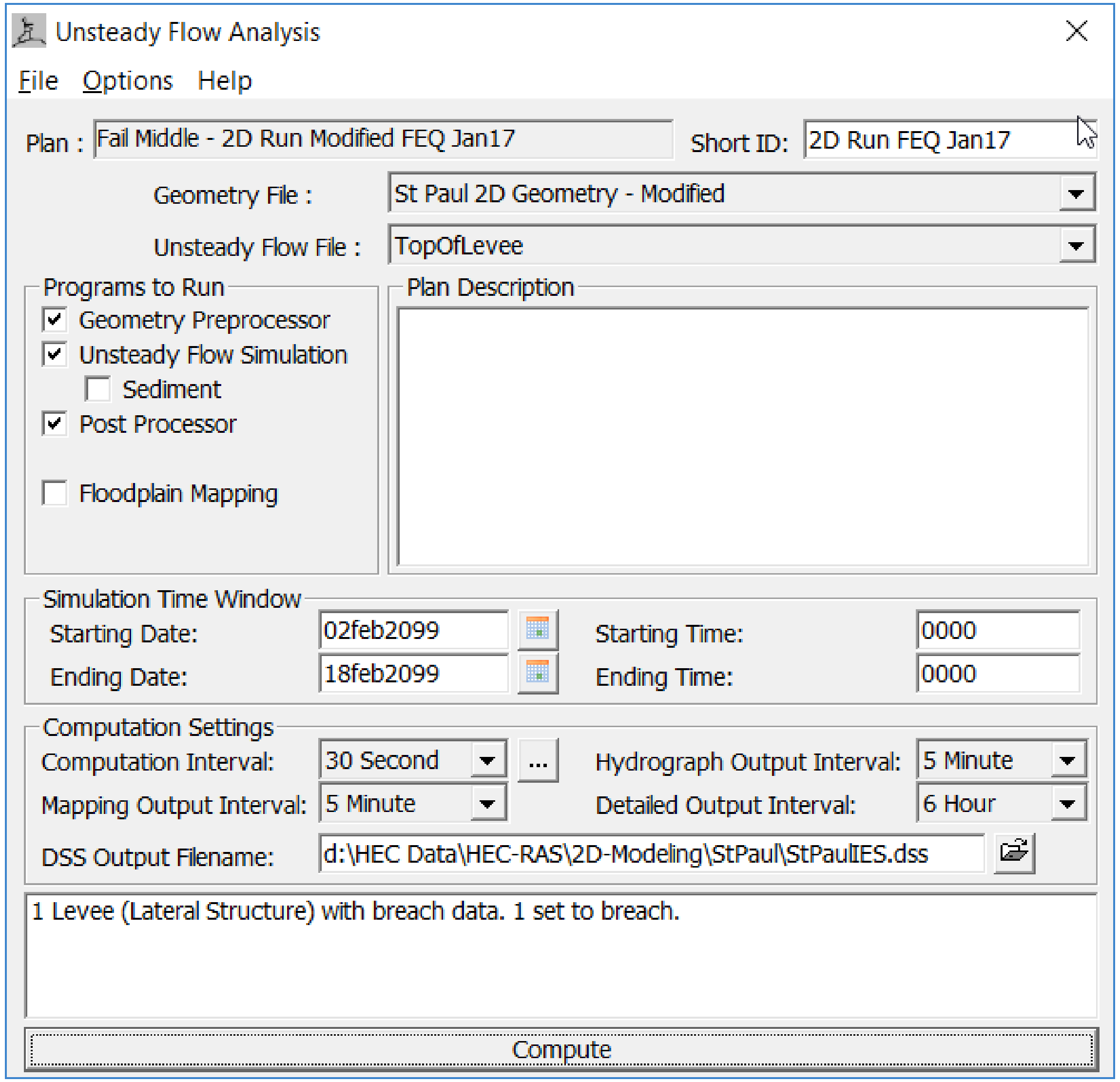
Using RAS Mapper
Associate the Terrain to the Geometry



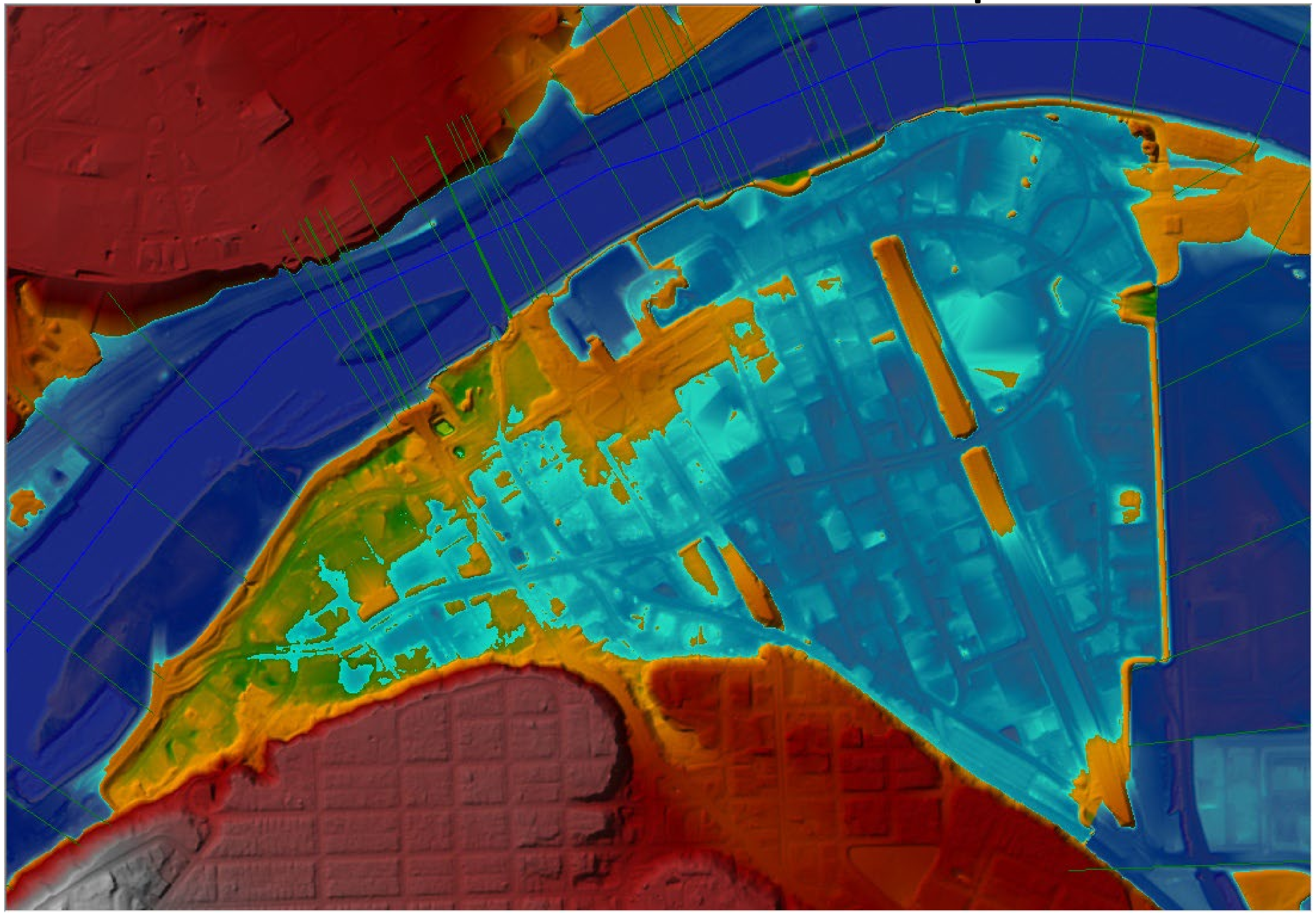
RAS-Mapper
Running the 2D Pre-Processor



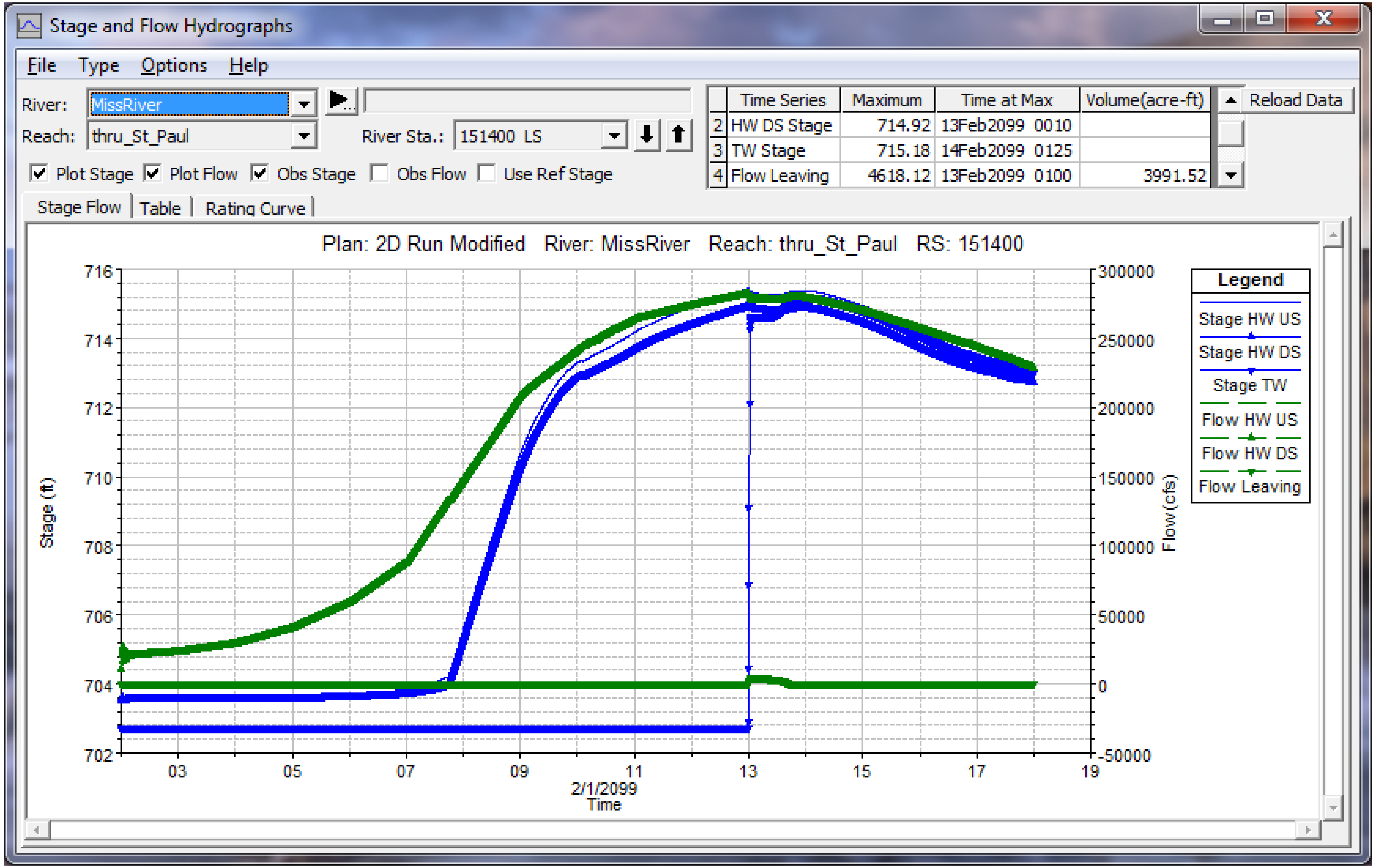
Run the Model and View the Results



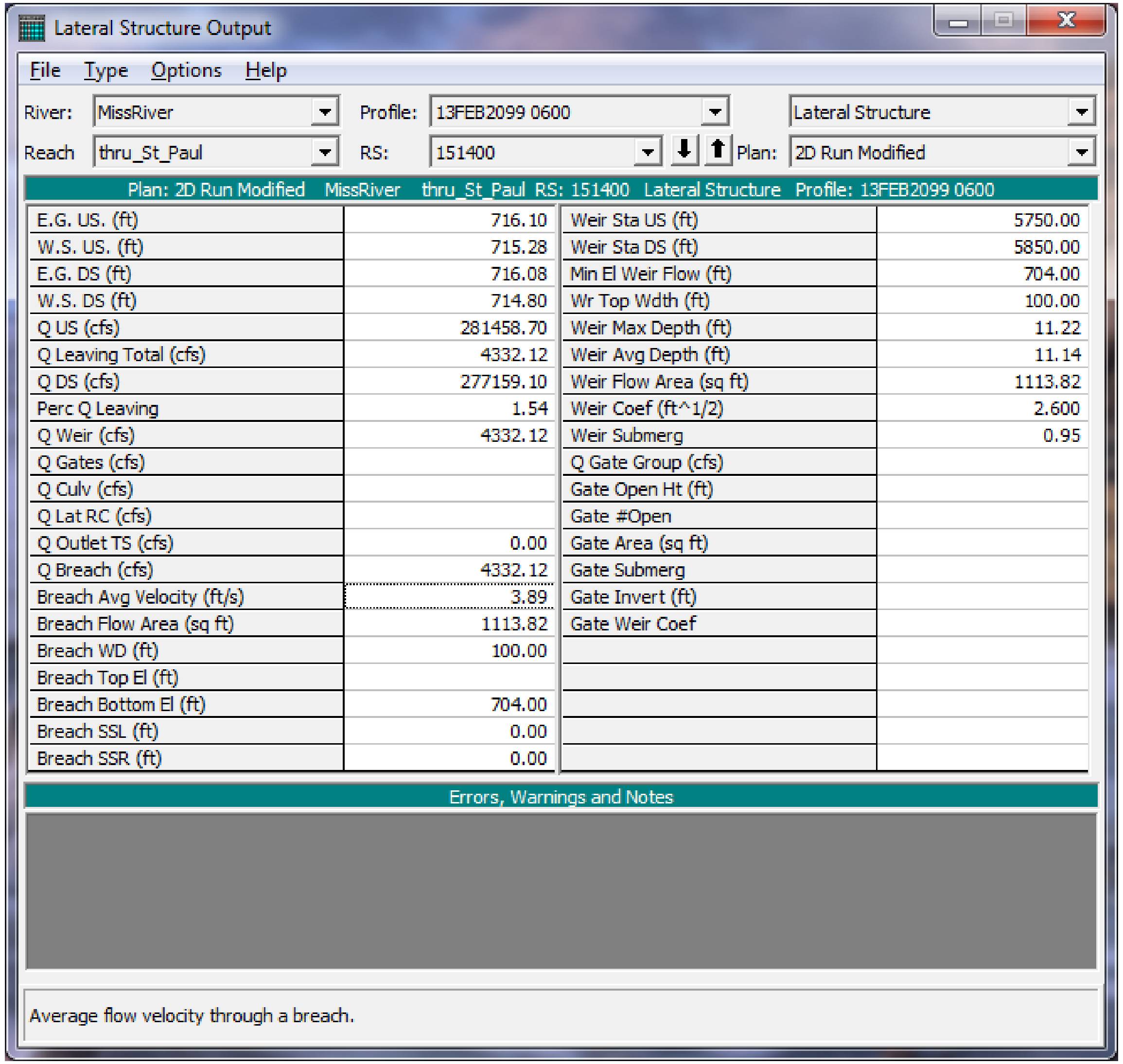
Saint Paul Levee Breach Example



Lateral Structure Time Series Output



Lateral Structure Detailed Output



Lateral Structure Output

File Type Options Help

River: MissRiver Profile: 13FEB2099 0600 Lateral Structure

Reach thru_St_Paul RS: 151400 Plan: 2D Run Modified

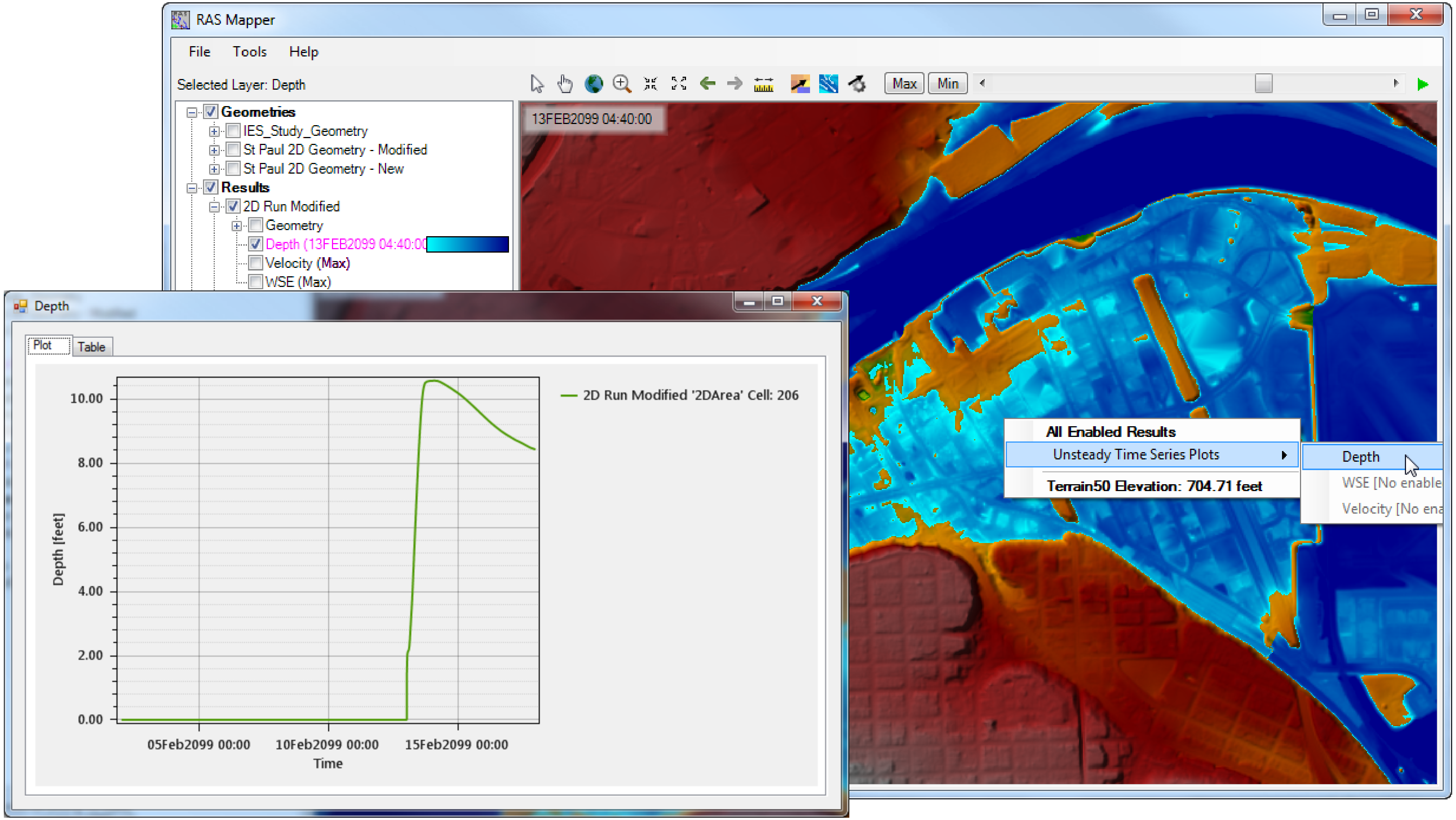
Plan: 2D Run Modified MissRiver thru_St_Paul RS: 151400 Lateral Structure Profile: 13FEB2099 0600

E.G. US. (ft)	716.10	Weir Sta US (ft)	5750.00
W.S. US. (ft)	715.28	Weir Sta DS (ft)	5850.00
E.G. DS (ft)	716.08	Min El Weir Flow (ft)	704.00
W.S. DS (ft)	714.80	Wr Top Wdth (ft)	100.00
Q US (cfs)	281458.70	Weir Max Depth (ft)	11.22
Q Leaving Total (cfs)	4332.12	Weir Avg Depth (ft)	11.14
Q DS (cfs)	277159.10	Weir Flow Area (sq ft)	1113.82
Perc Q Leaving	1.54	Weir Coef (ft^1/2)	2.600
Q Weir (cfs)	4332.12	Weir Submerg	0.95
Q Gates (cfs)		Q Gate Group (cfs)	
Q Culv (cfs)		Gate Open Ht (ft)	
Q Lat RC (cfs)		Gate #Open	
Q Outlet TS (cfs)	0.00	Gate Area (sq ft)	
Q Breach (cfs)	4332.12	Gate Submerg	
Breach Avg Velocity (ft/s)	3.89	Gate Invert (ft)	
Breach Flow Area (sq ft)	1113.82	Gate Weir Coef	
Breach WD (ft)	100.00		
Breach Top El (ft)			
Breach Bottom El (ft)	704.00		
Breach SSL (ft)	0.00		
Breach SSR (ft)	0.00		

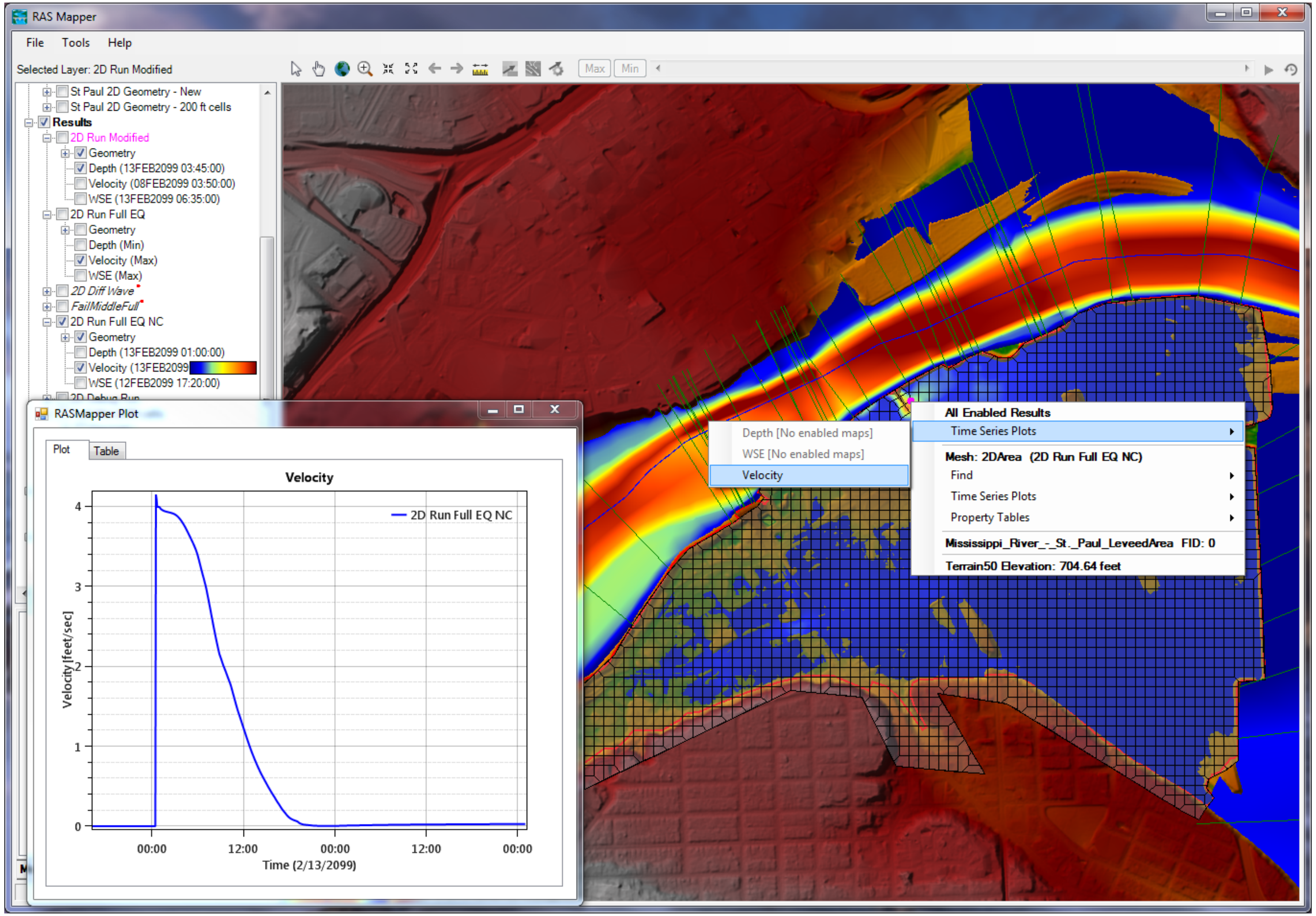
Errors, Warnings and Notes

Average flow velocity through a breach.

Stage Hydrograph Plots from RAS Mapper



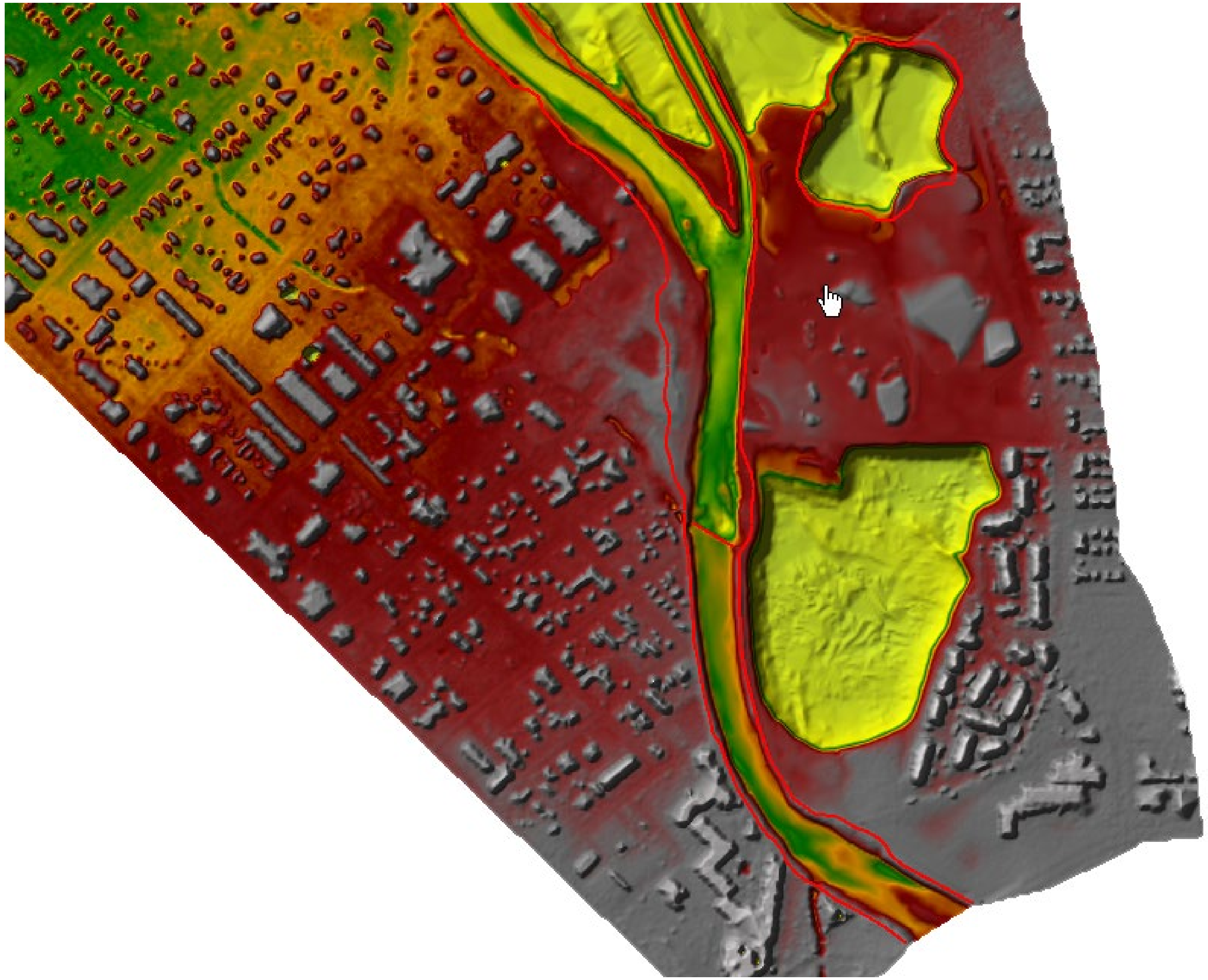
Velocity Hydrograph Plots from RAS-Mapper



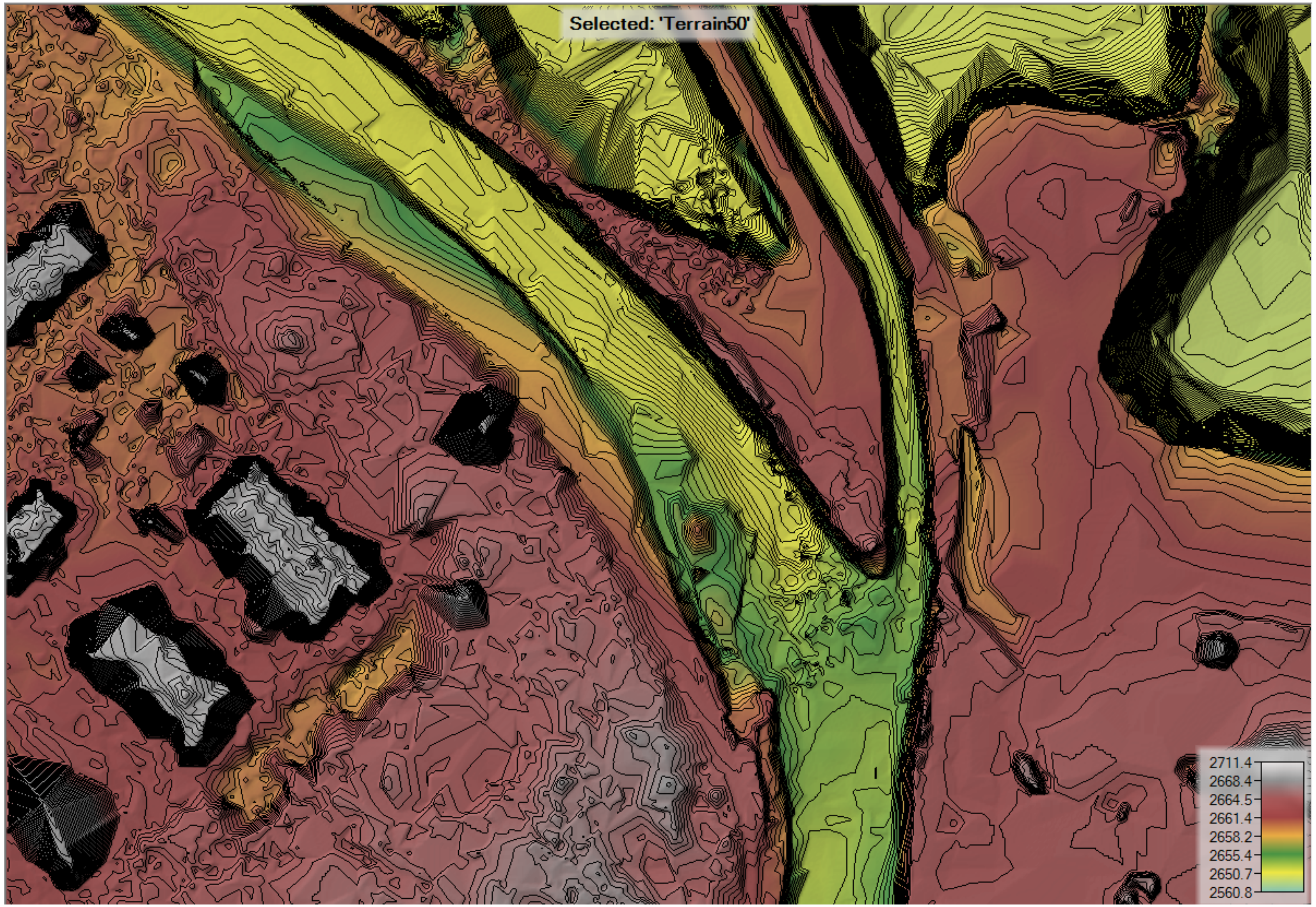
Using 2D Flow Areas to model Overbank Areas (floodplains)

- Draw a Polygon for the Overbank/Floodplain Area
  - The 2D Flow Area boundary should be drawn at a High Ground Separation between the 1D Main Channel and 2D Floodplain
- Create the 2D Computational Mesh
- View the Mesh to ensure there are no Mesh Problems
- Modify The Mesh if Needed (add break lines, points, etc…)
- Hooking up a 2D Flow Area to a 1D River Reach with Lateral Structures
- Overflow Computation Method
- Weir Coefficients for Lateral Structures
- Weir Submergence Issues

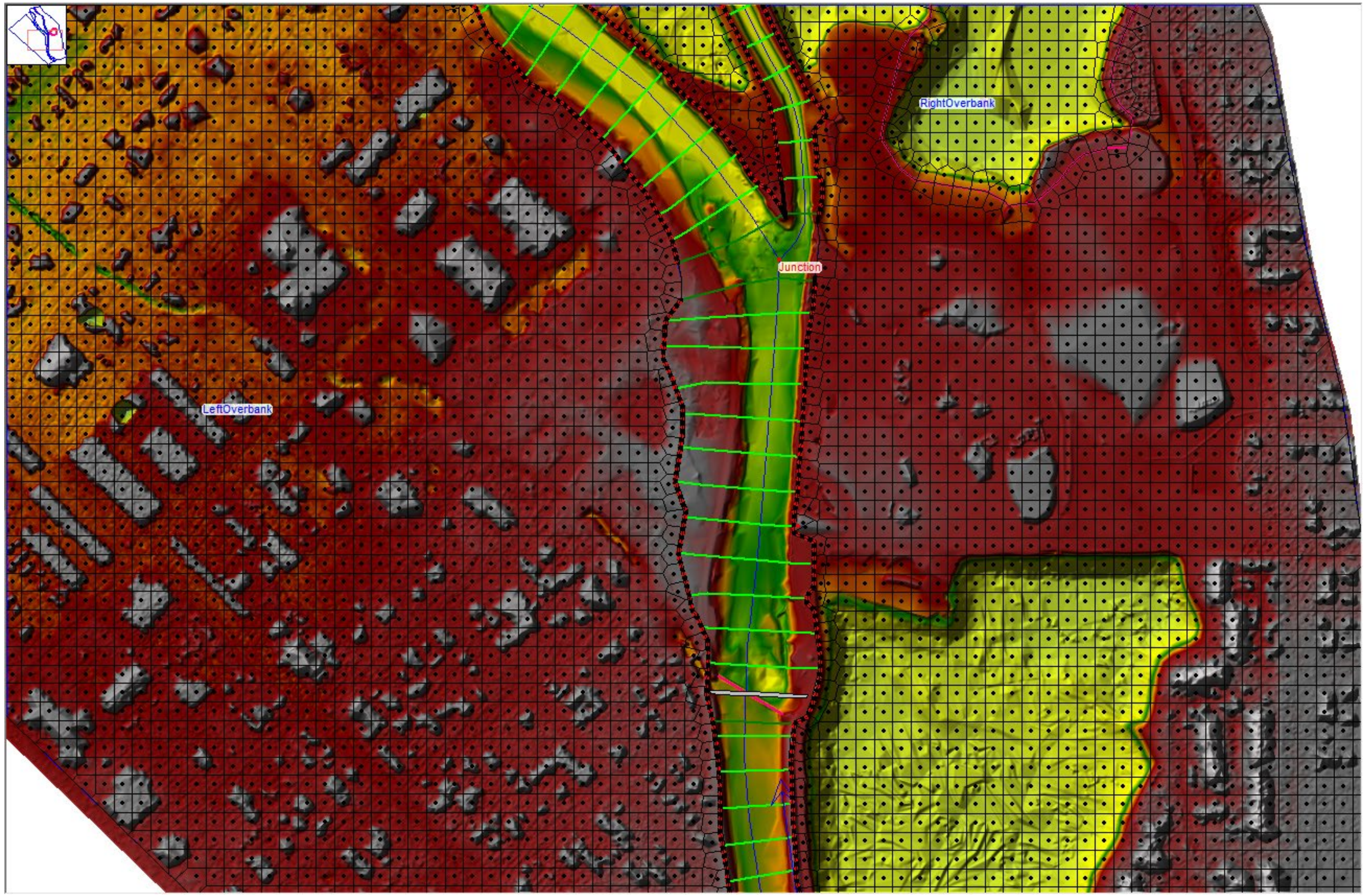
1D Channel to 2D Interface Should be at High Ground Separating the two

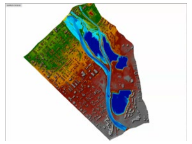


Terrain Contours

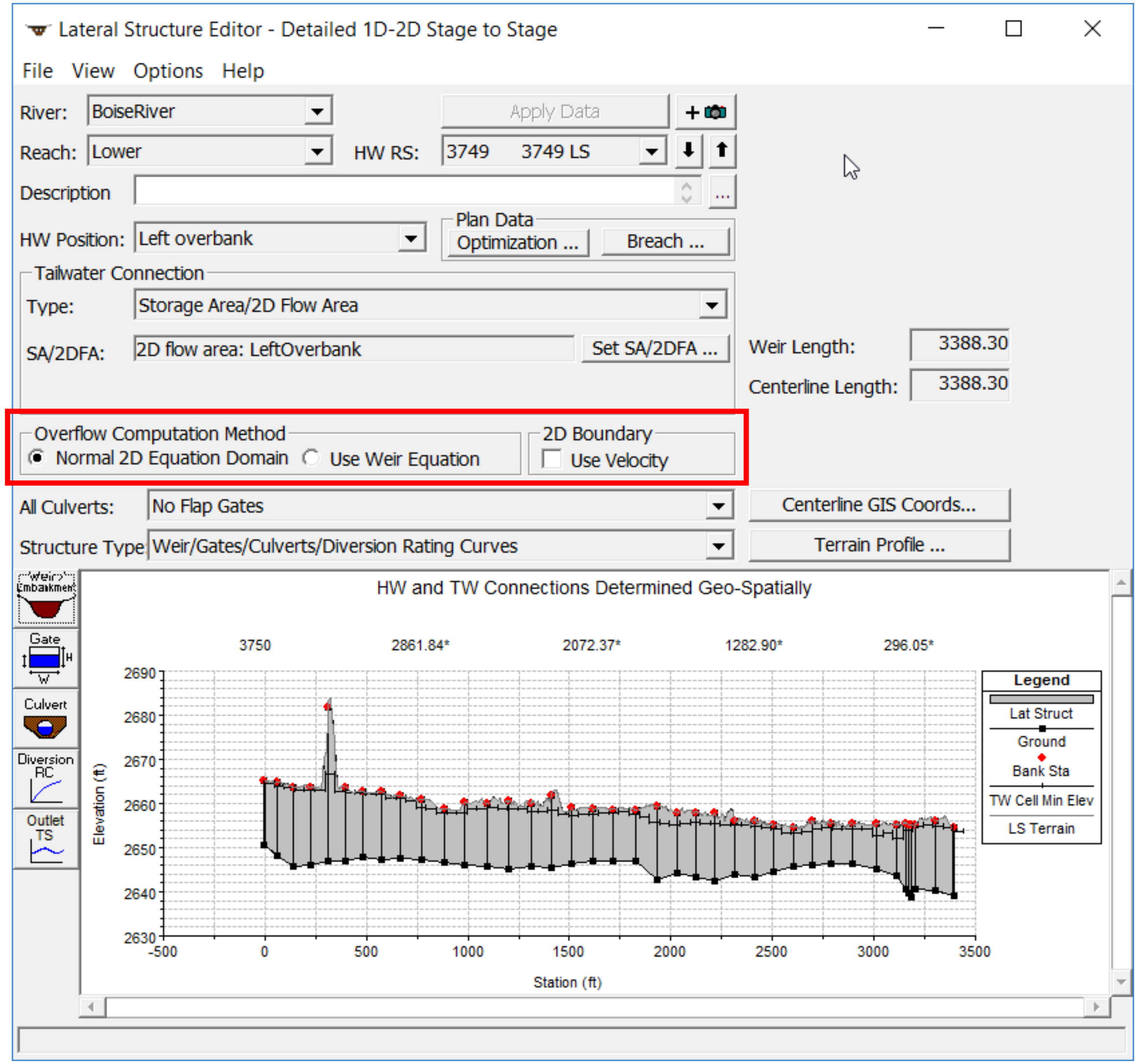


Lateral Structure to connect 1D river to 2D overbank areas





Overflow Computation Method



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Questions?

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