

HEC-RAS Subgrid Bathymetry

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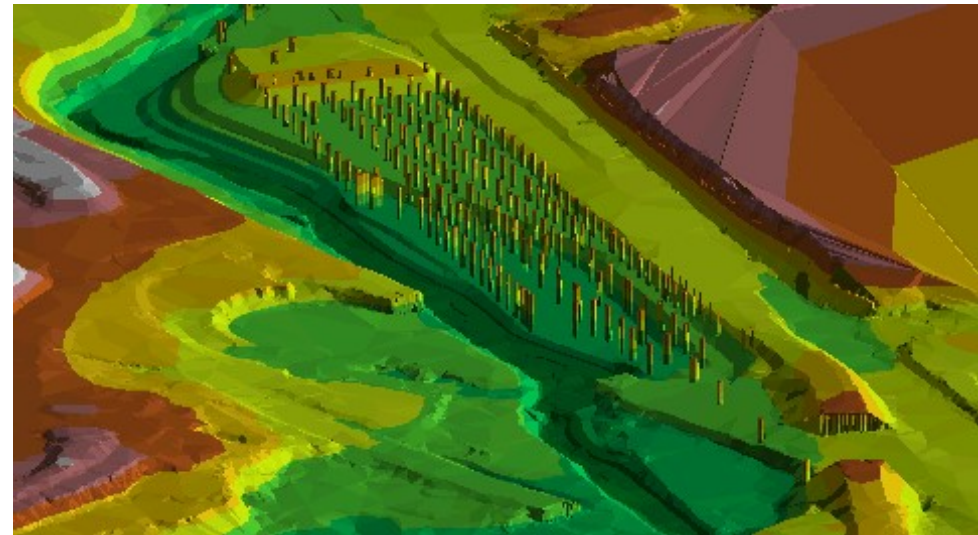
USACE, Institute for Water Resources, Hydrologic Engineering Center






Objective

- Understand the Subgrid Technology in HEC-RAS.
- Problem
 - Water levels usually vary much more smoothly than the terrain
 - Unfeasible to resolve every detail of the terrain with the computational mesh
- Approach
 - Utilize a grid resolution sufficient to resolve the hydraulics
 - Capture the details of the subgrid terrain through hydraulic properties tables



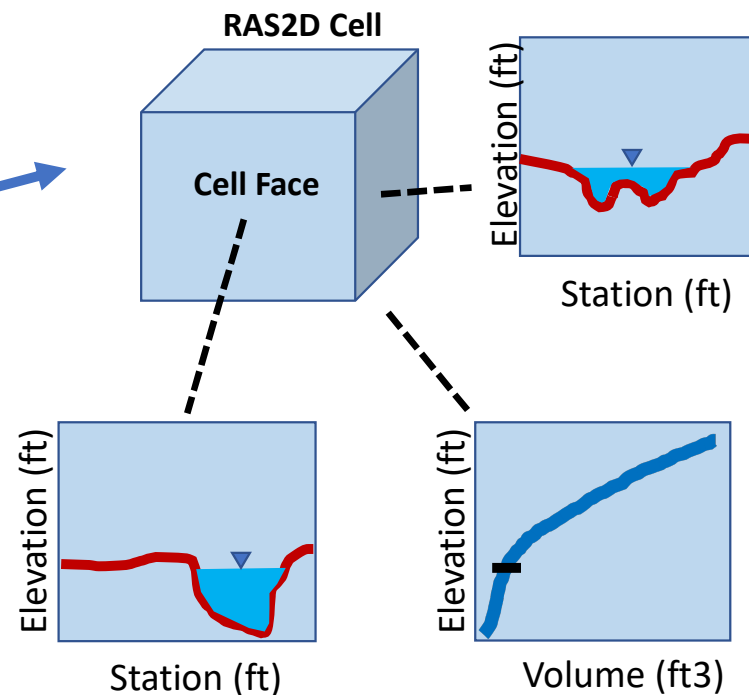
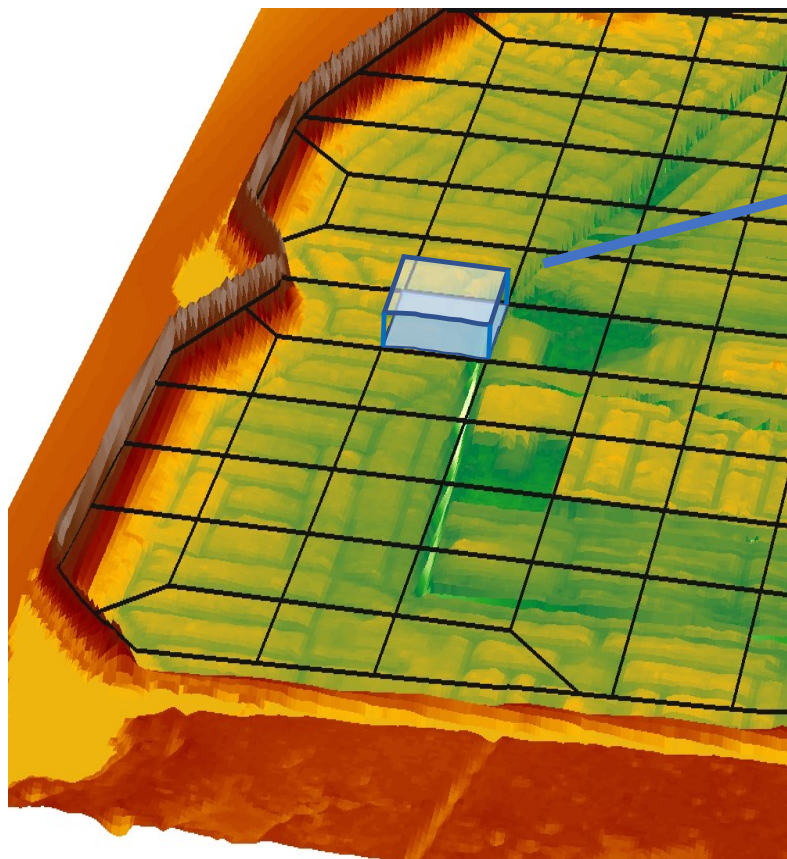
A red square icon containing a white silhouette of a castle with three towers.

2D Modeling Subgrid Technology

- Detailed elevation-volume relationship for each 2D Cell.
- Hydraulic properties for each Cell Face (pre-computed).
- Cells can be partially wet.
- Allows for larger computational cells, without losing details of the underlying terrain.
- Larger cells = less computations = faster run times!
- HEC-RAS produces more detailed results for a given cell size than models using a single elevation for each cell and face.



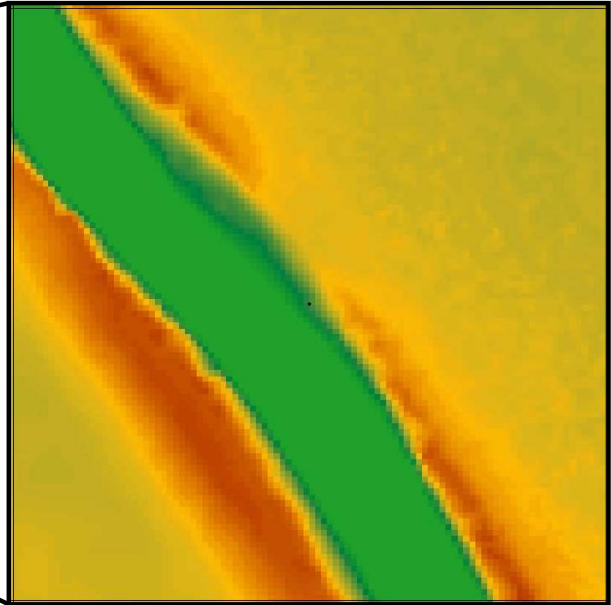
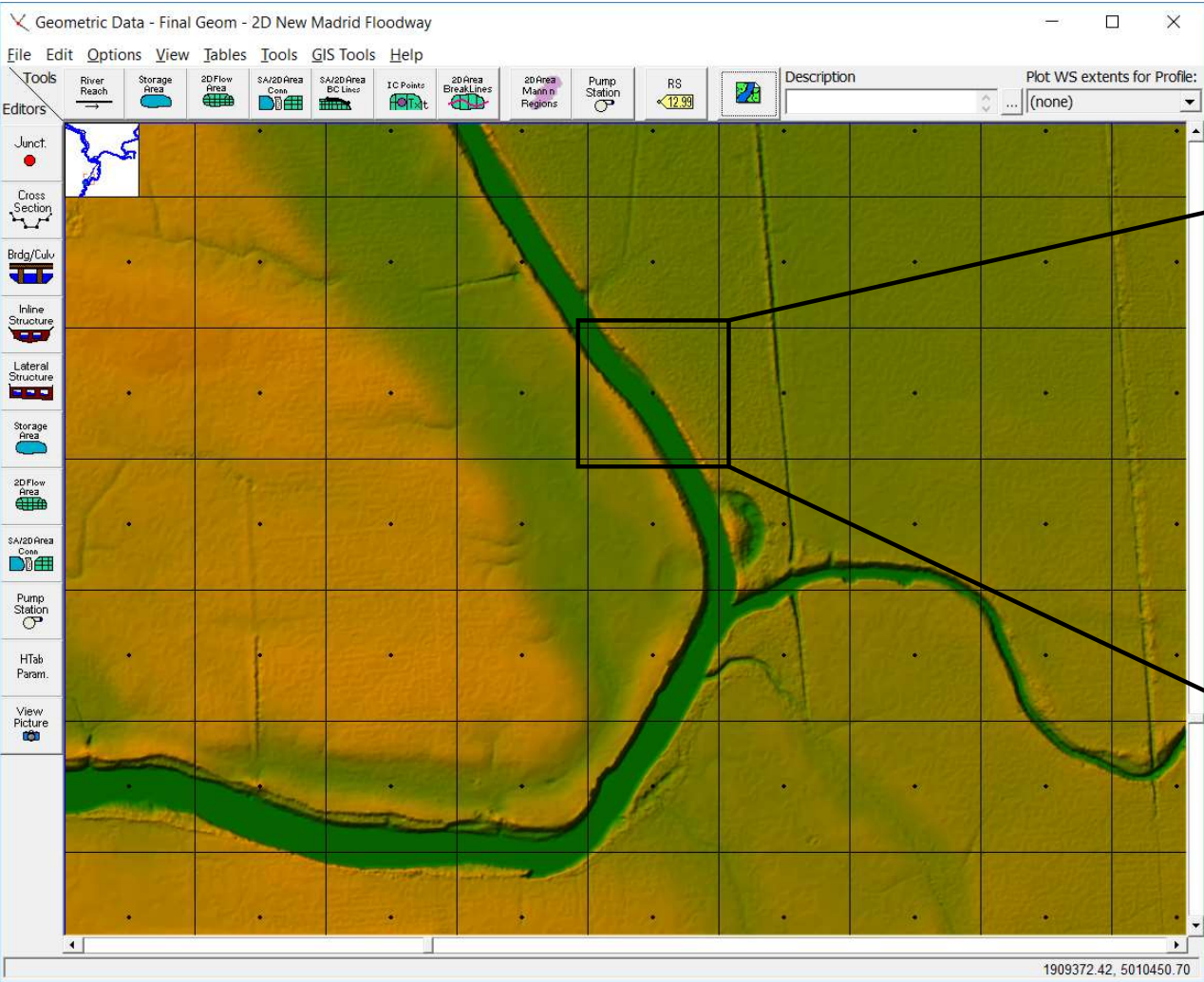
2D Computational Mesh Subgrid Terrain



Each cell face profile and stage-volume curve is based on **hundreds to thousands topo-bathymetric data-points**, depending of resolution of underlying terrain raster. Cell approach very efficiently discretizes space including complex terrain & surface roughness.

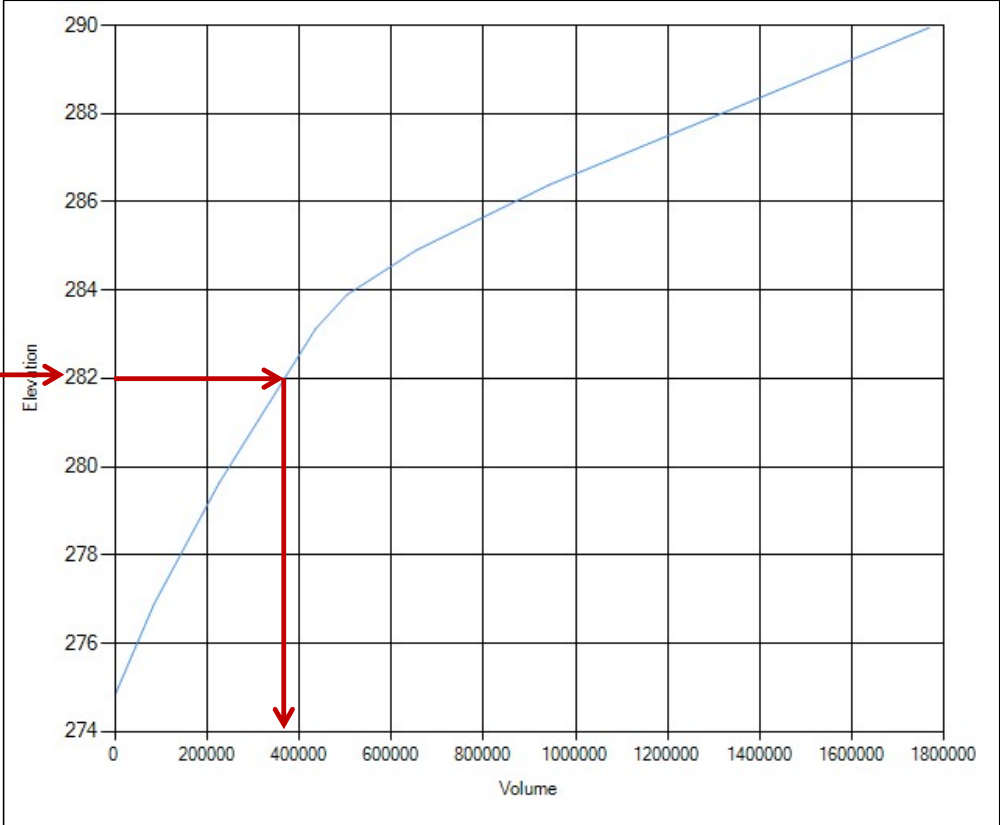
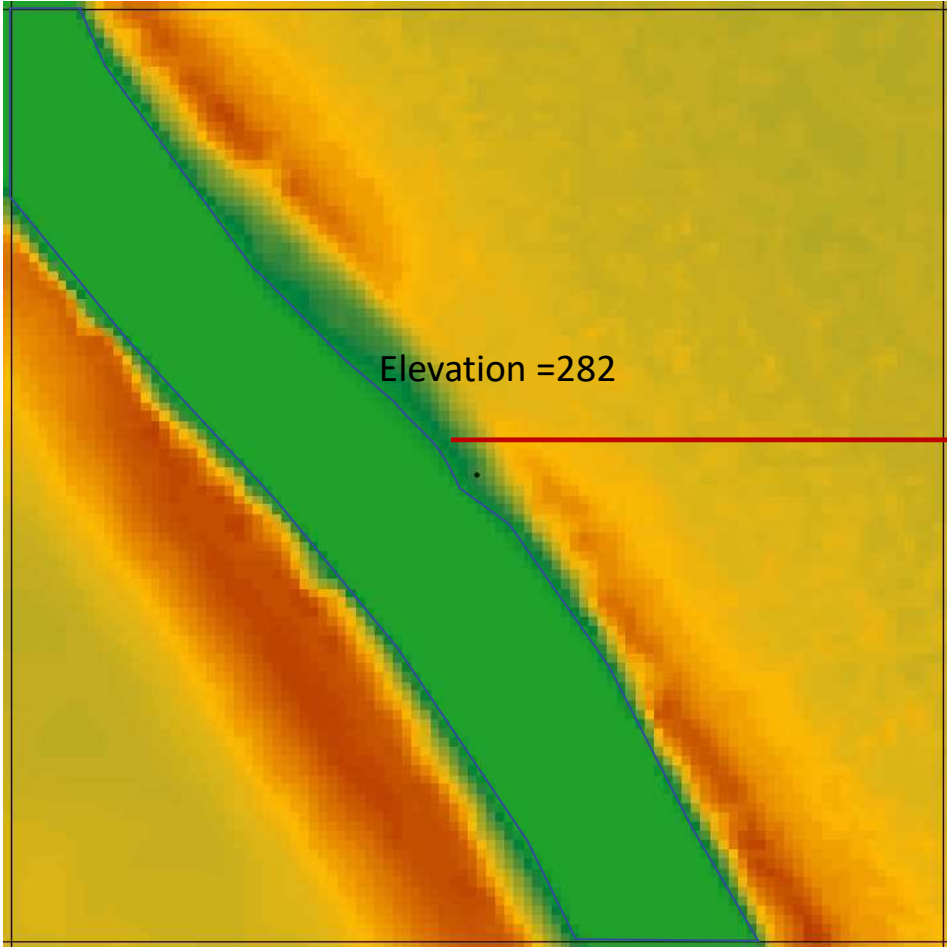


Computational Mesh Sub-grid Terrain



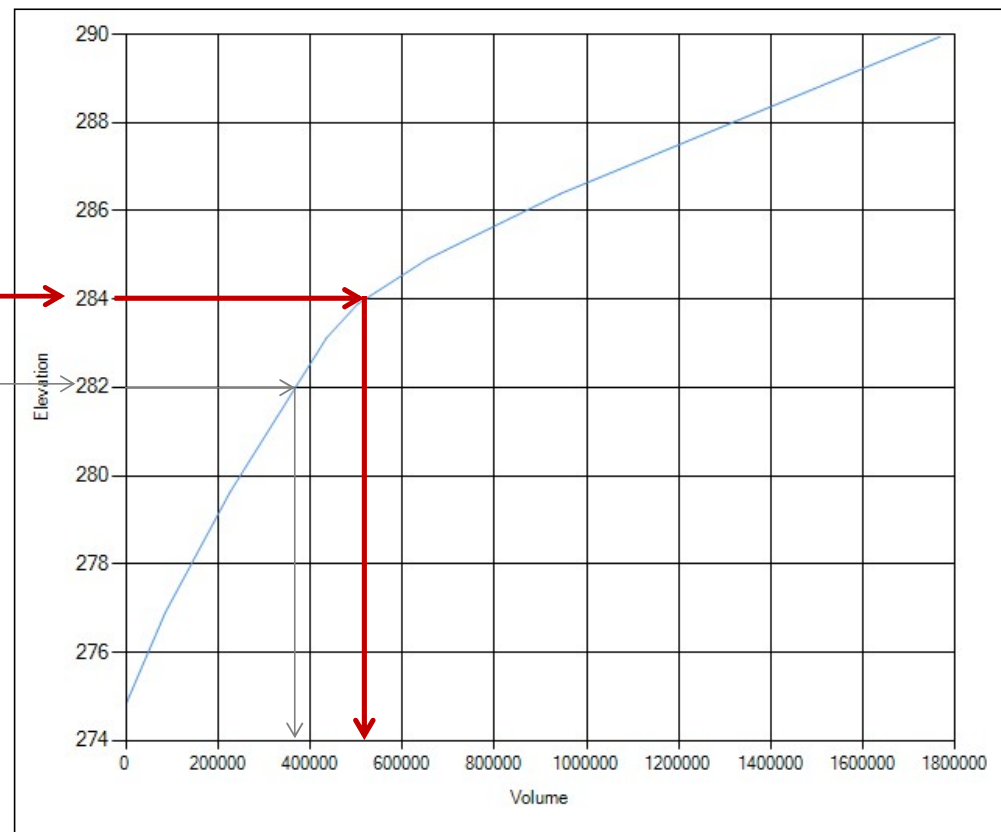
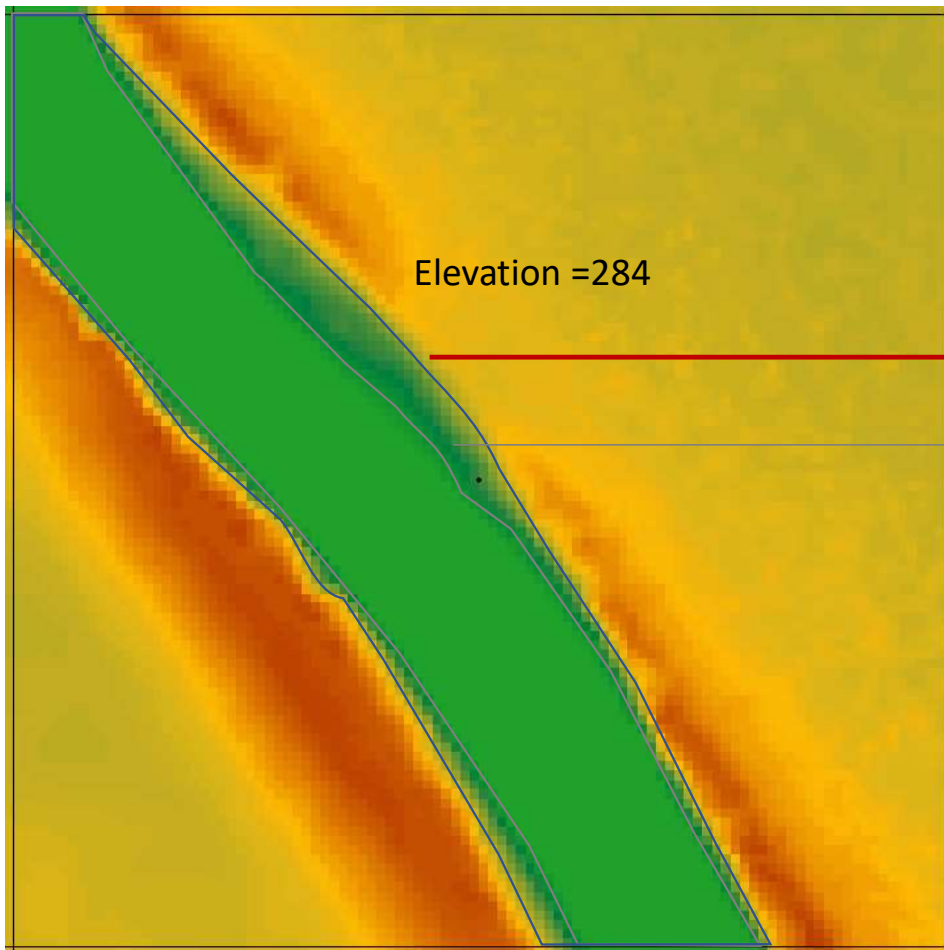


Computational Cells - Elevation vs. Volume





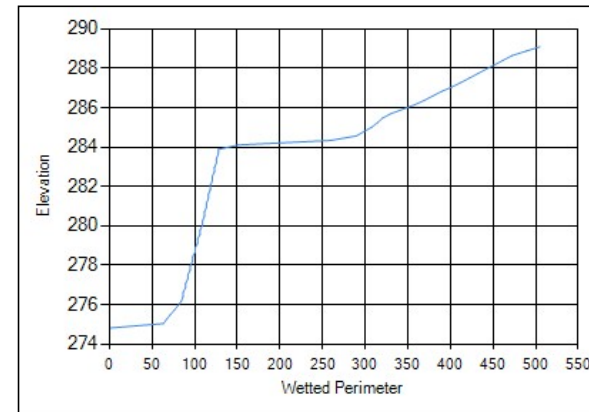
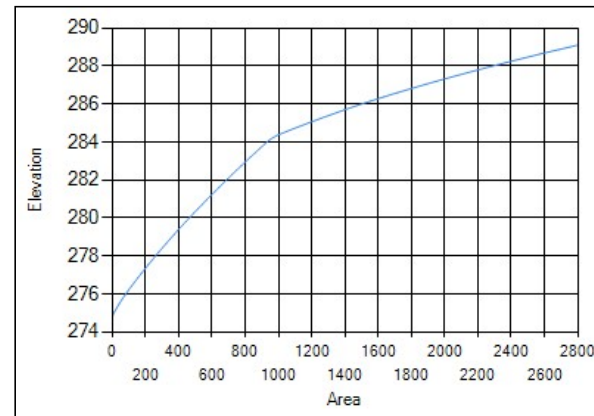
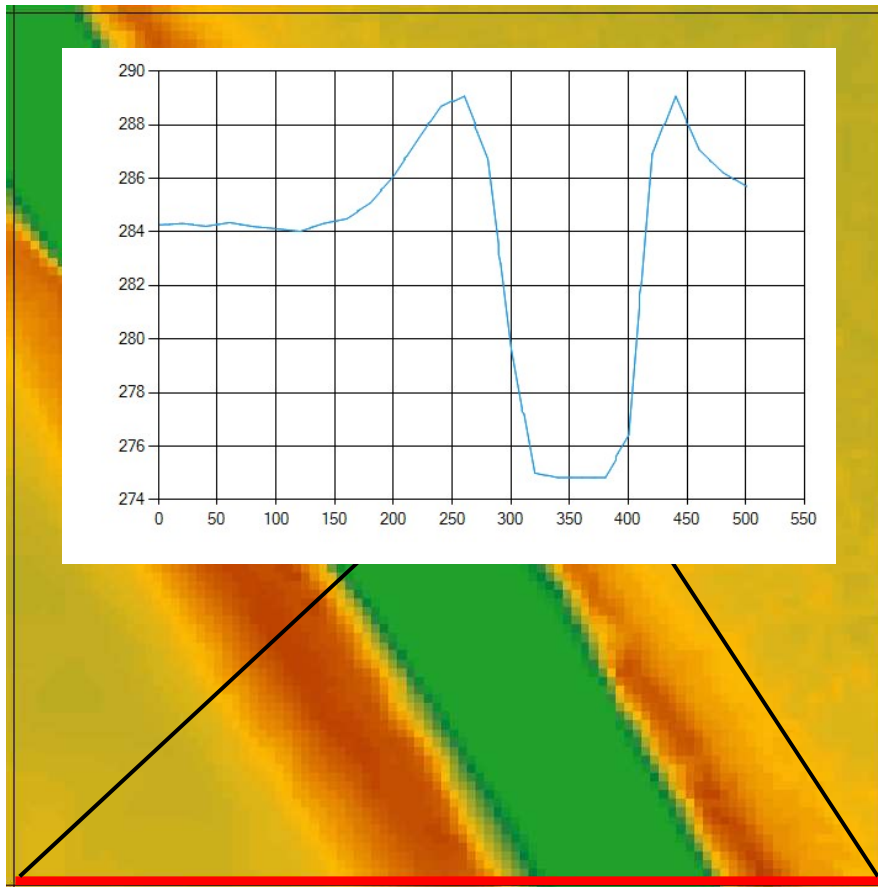
Computational Cells - Elevation vs. Volume



Subgrid = Higher fidelity cell volume tracking ⁷

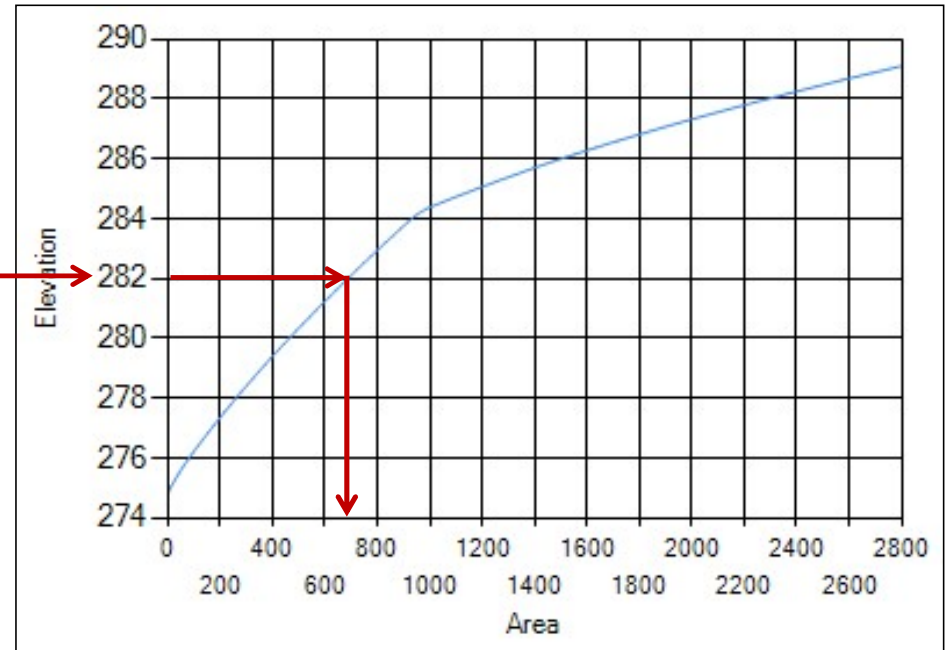
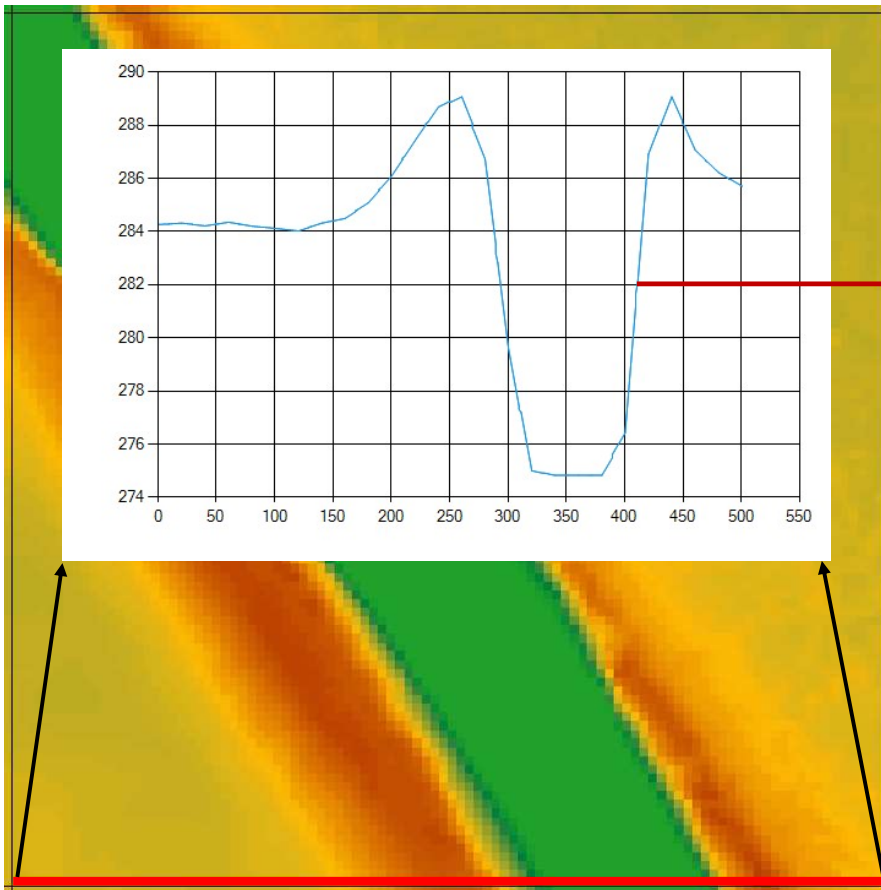


Computational Faces - Elevation vs. Area, Wetted Perimeter, and n





Computational Faces - Elevation vs. Area



Subgrid = Controls flow into and out of cell



Benefits of using the detailed sub-terrain



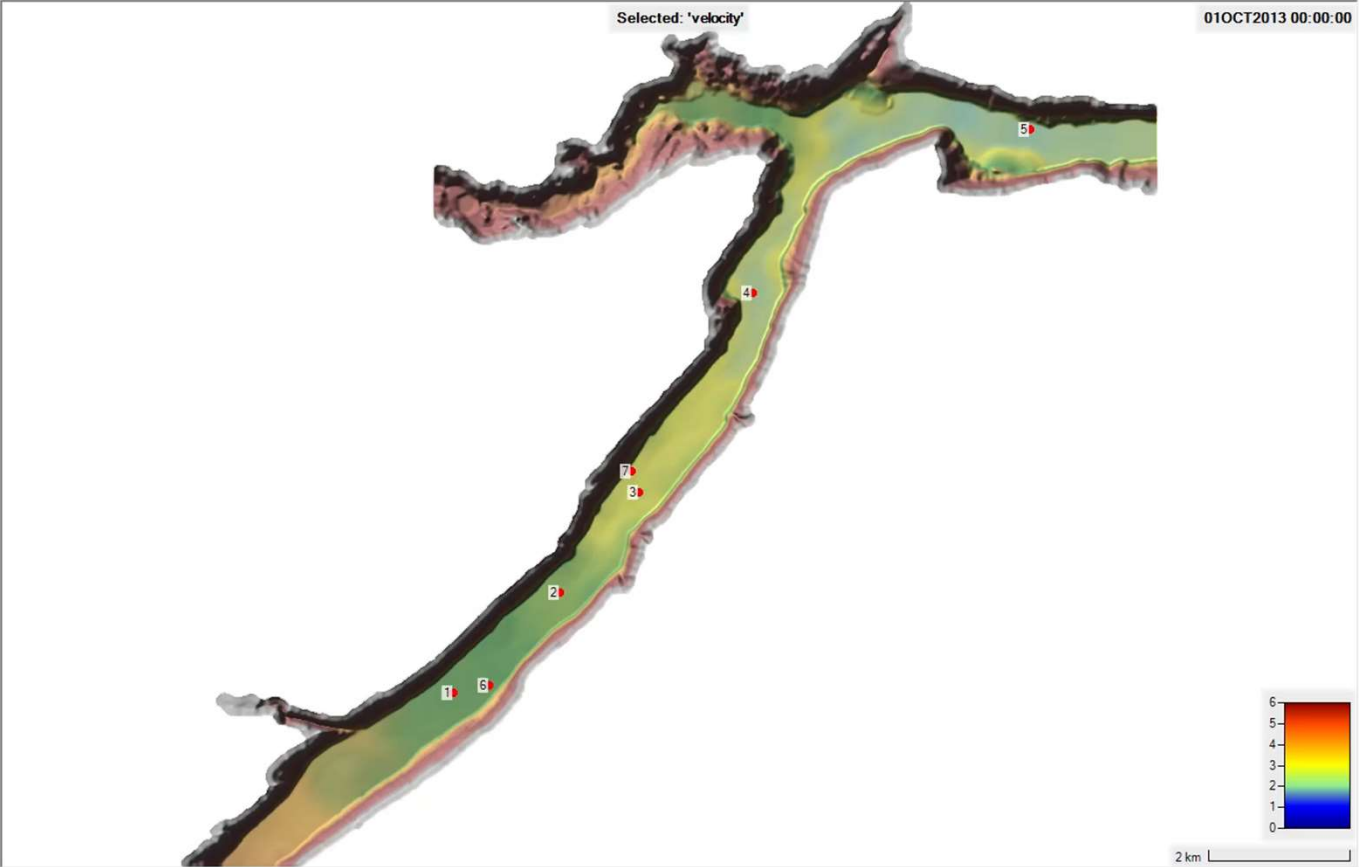
Example Application – EU Test 5

- Extremely Rapidly rising hydrograph of a dry bed. From 0.0 to 3000 cms in 5 minutes.
- Compare results at multiple locations for three grid resolutions (25, 50, and 100m)
- Compare Computational times



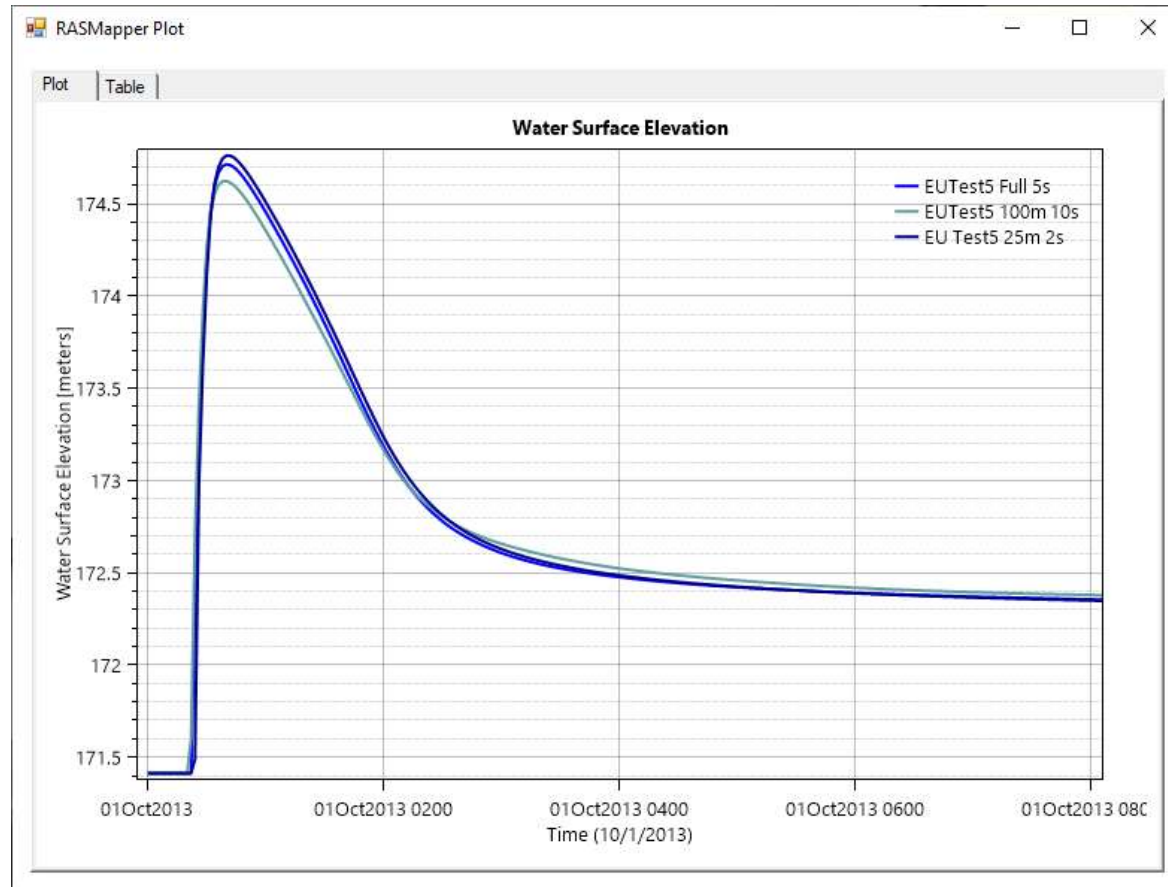


EU Test 5 – Animation



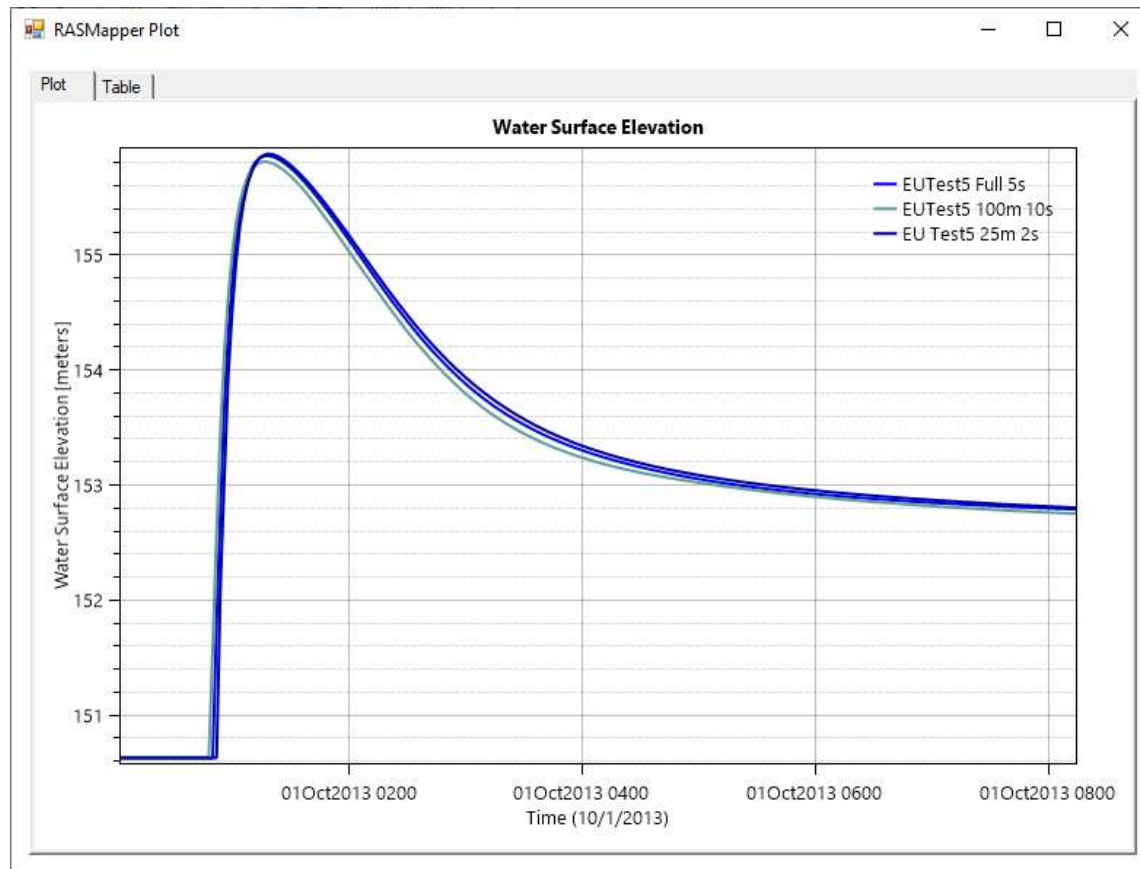


EU Test 5 – Location 1



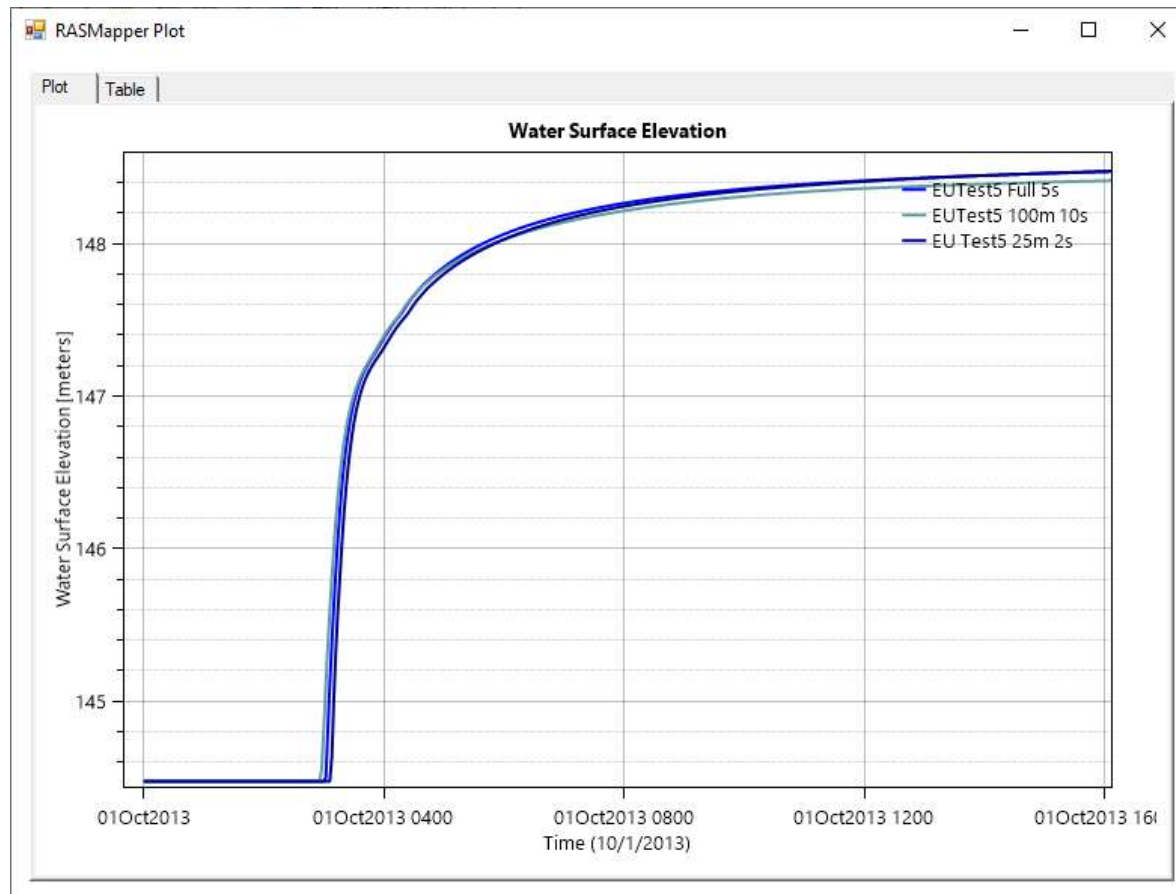


EU Test 5 – Location 3





EU Test 5 – Location 5



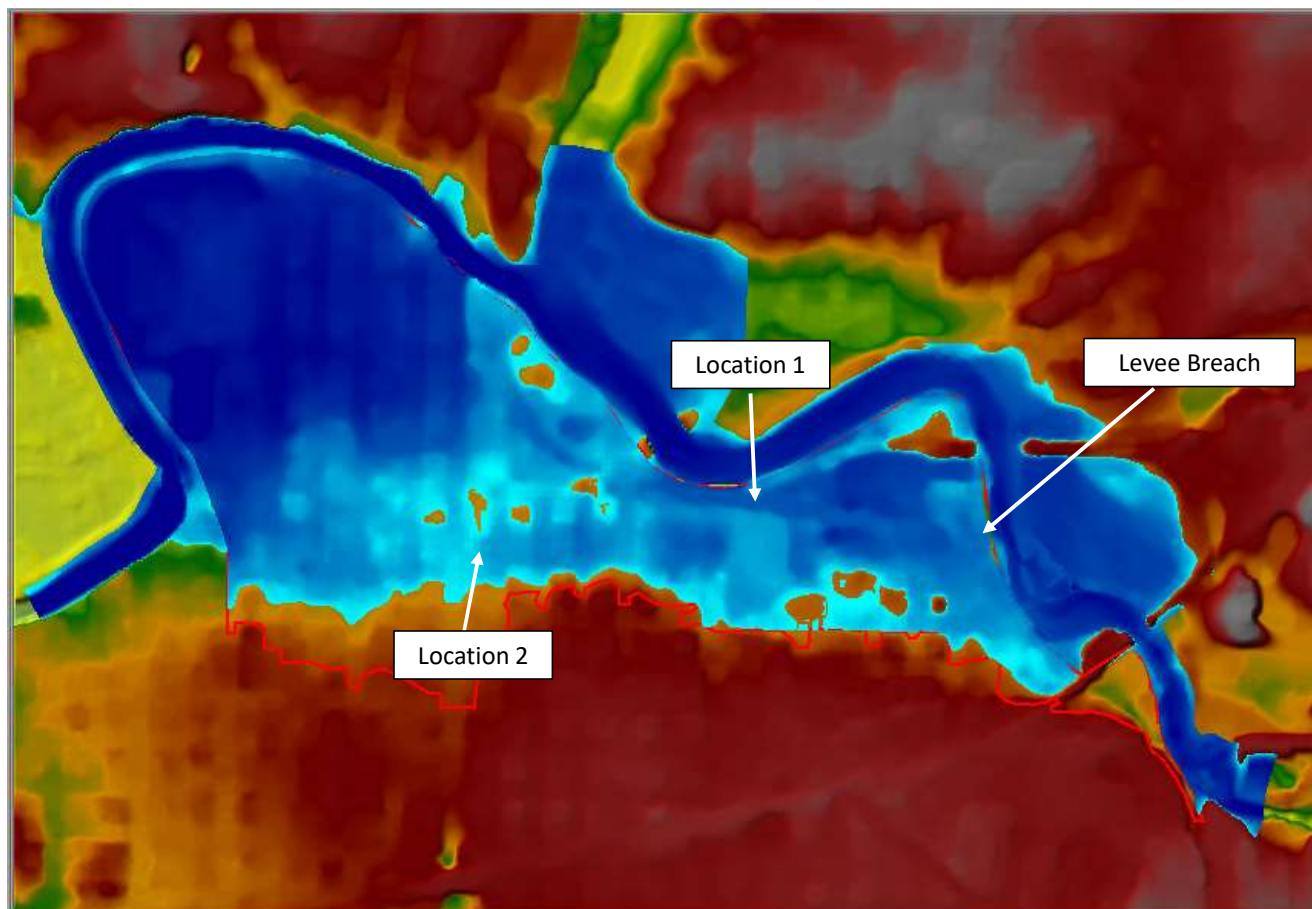
EU Test 5 – Computational Time



Test No	Grid Size	No. Cells	Time Step	RAS Full Saint Venant
1	25m	30340	2 sec	7 min 34s
2	50m	7460	5 sec	1 min 38s
3	100m	1809	10 sec	13s



Grid Resolution Evaluation

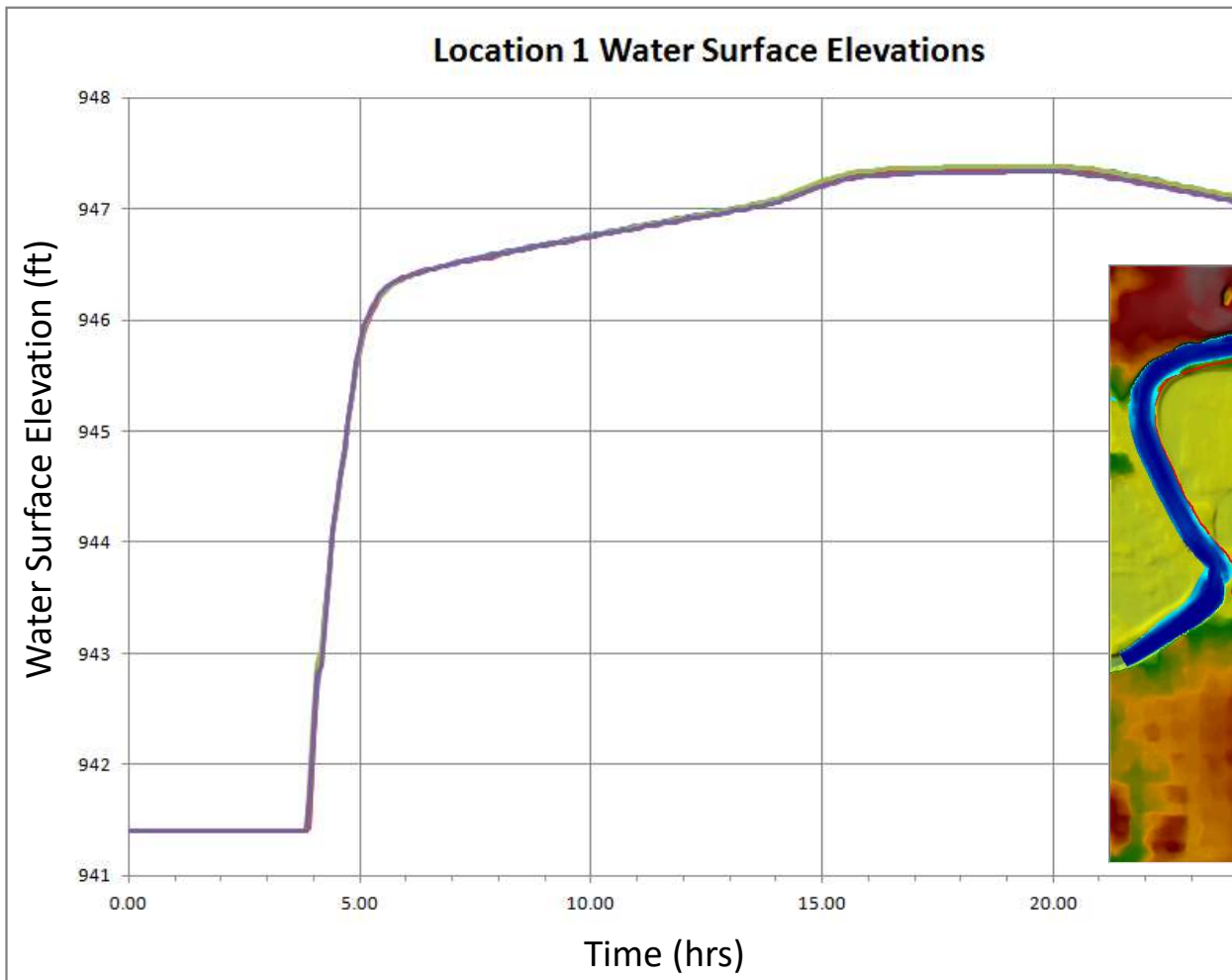


Modeled With Four
Grid Resolutions:

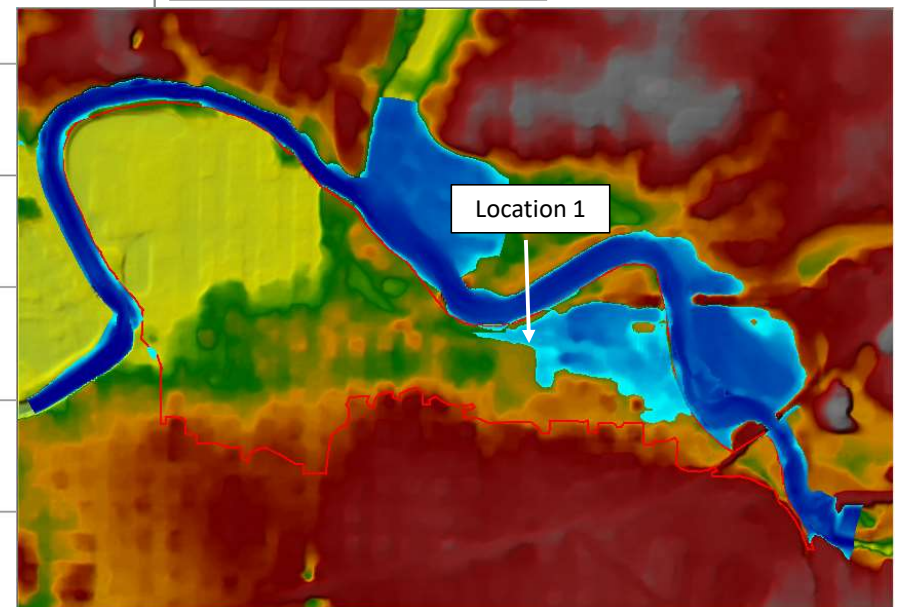
- 25 ft (7.6m)
- 50 ft (15.2 m)
- 100 ft (30.5 m)
- 200 ft (61.0 m)



Grid Resolution Sensitivity

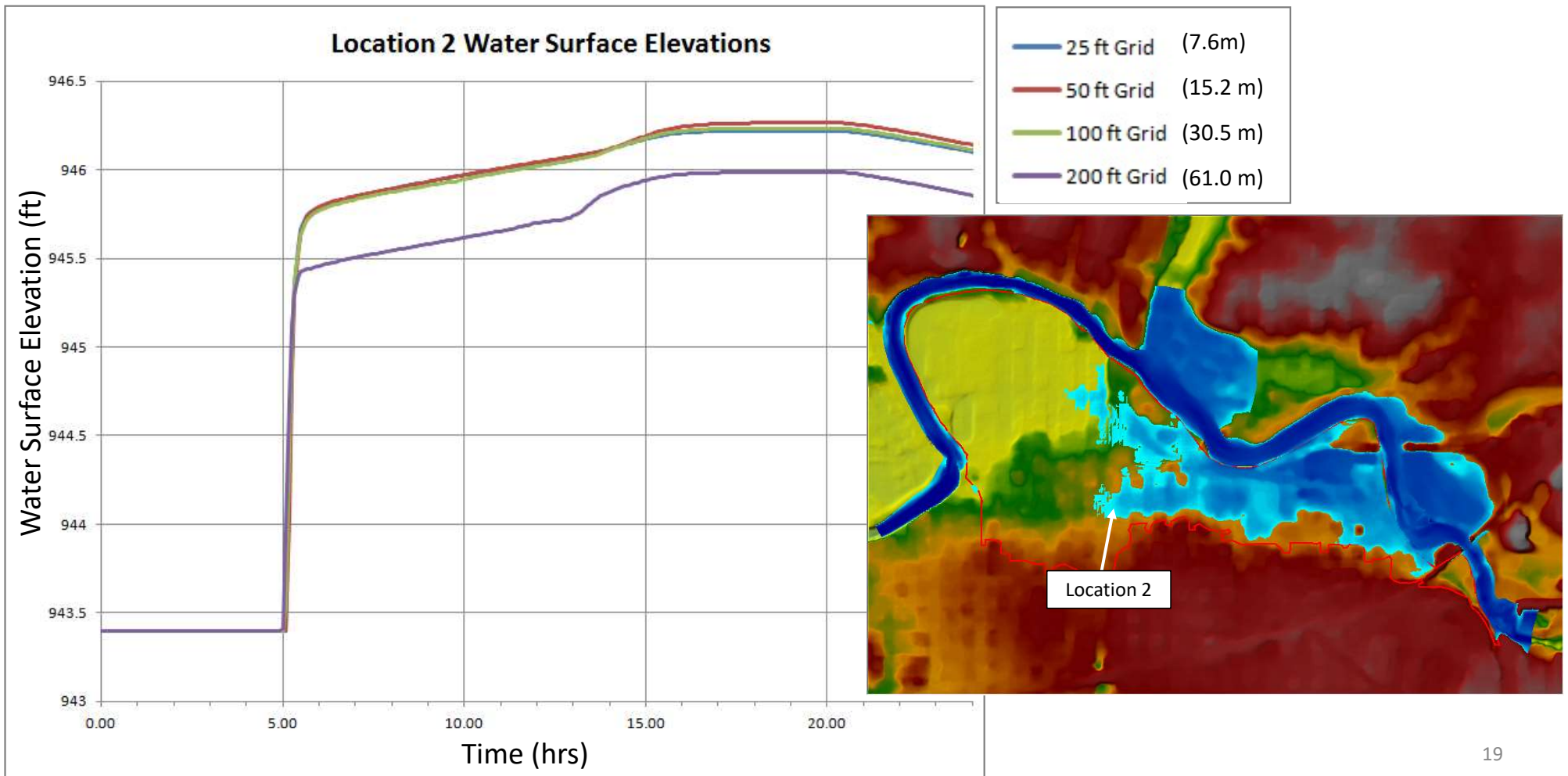


- 25 ft Grid (7.6m)
- 50 ft Grid (15.2 m)
- 100 ft Grid (30.5 m)
- 200 ft Grid (61.0 m)



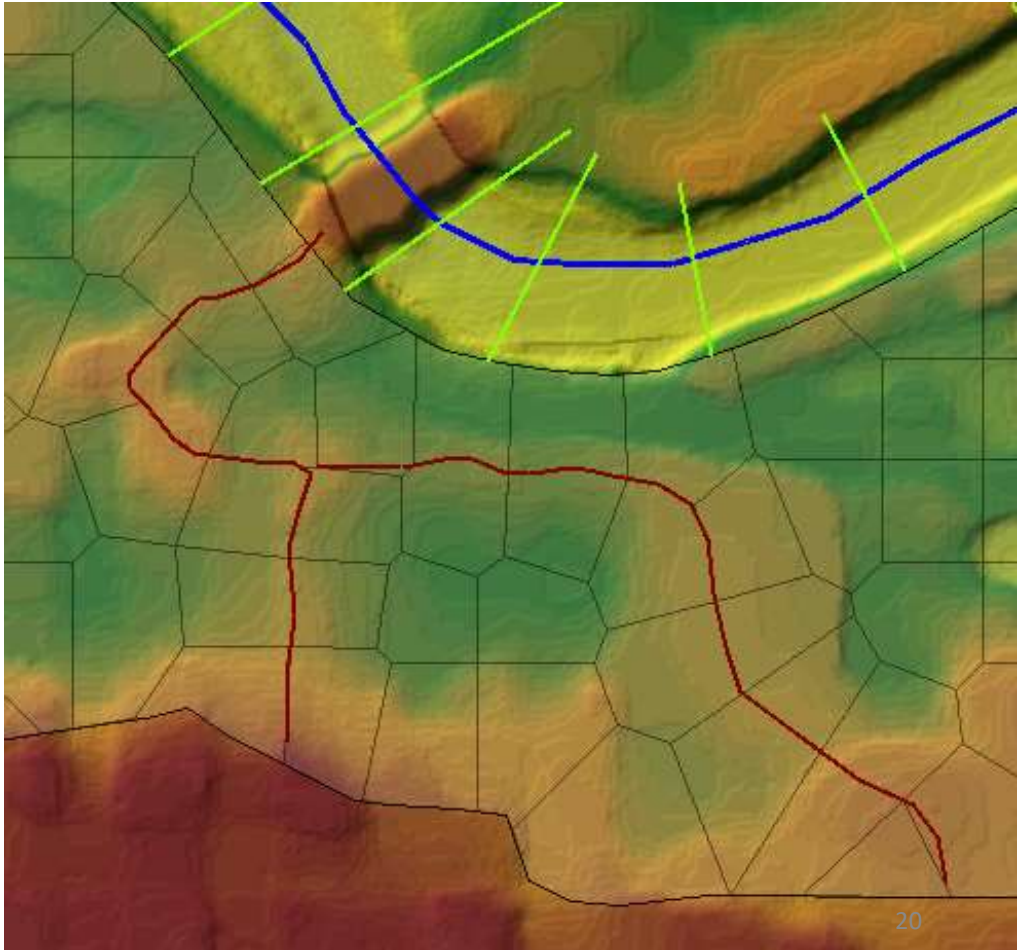
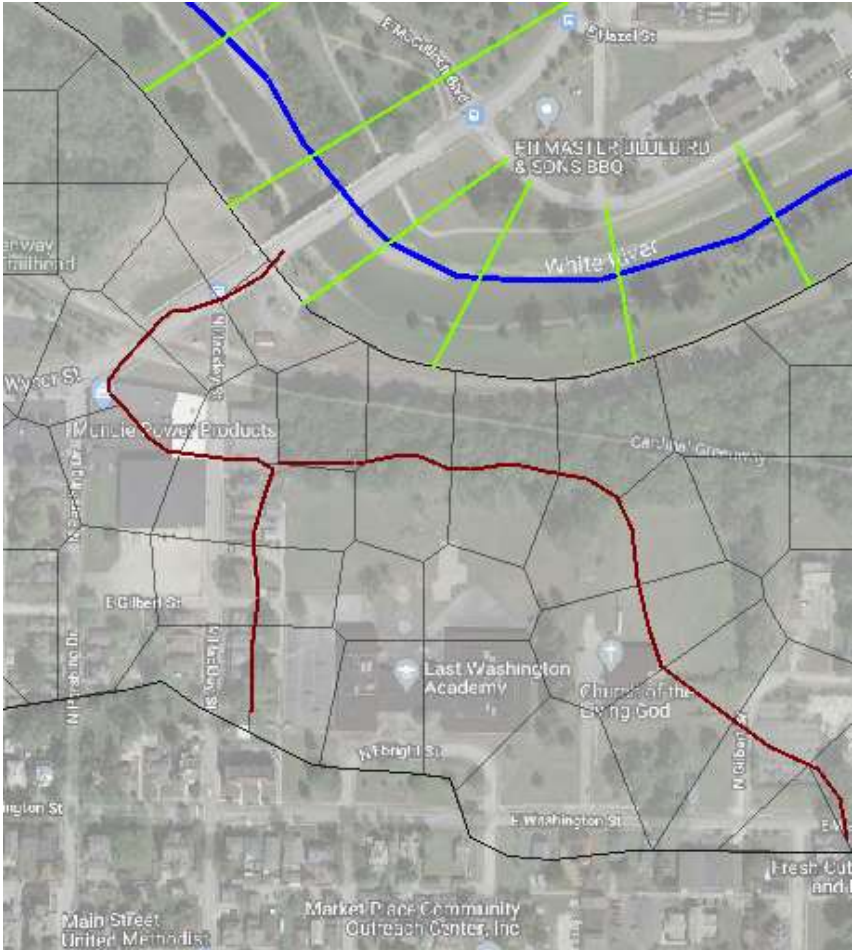


Grid Resolution Sensitivity



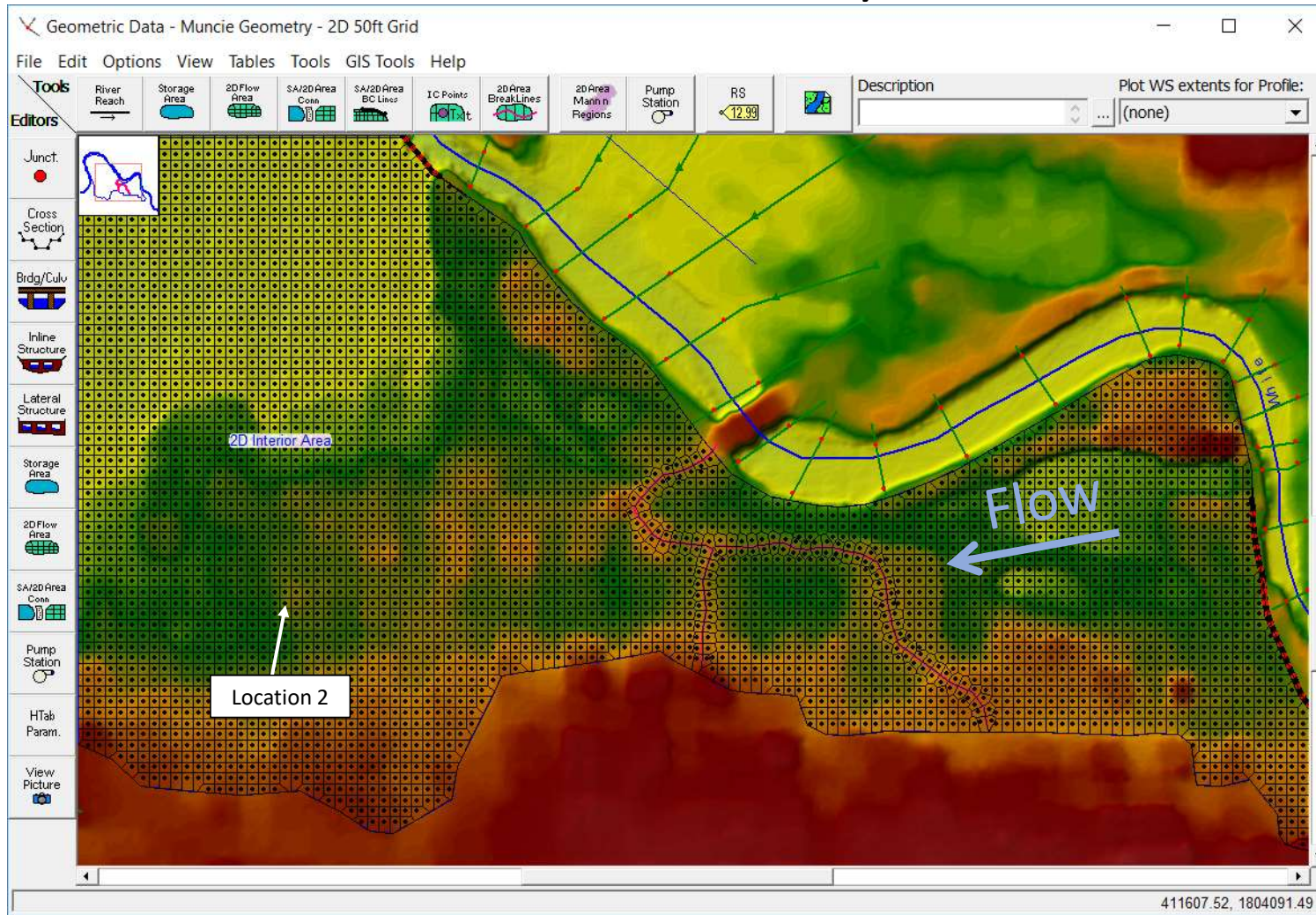


Breaklines - Define Hydraulic Control



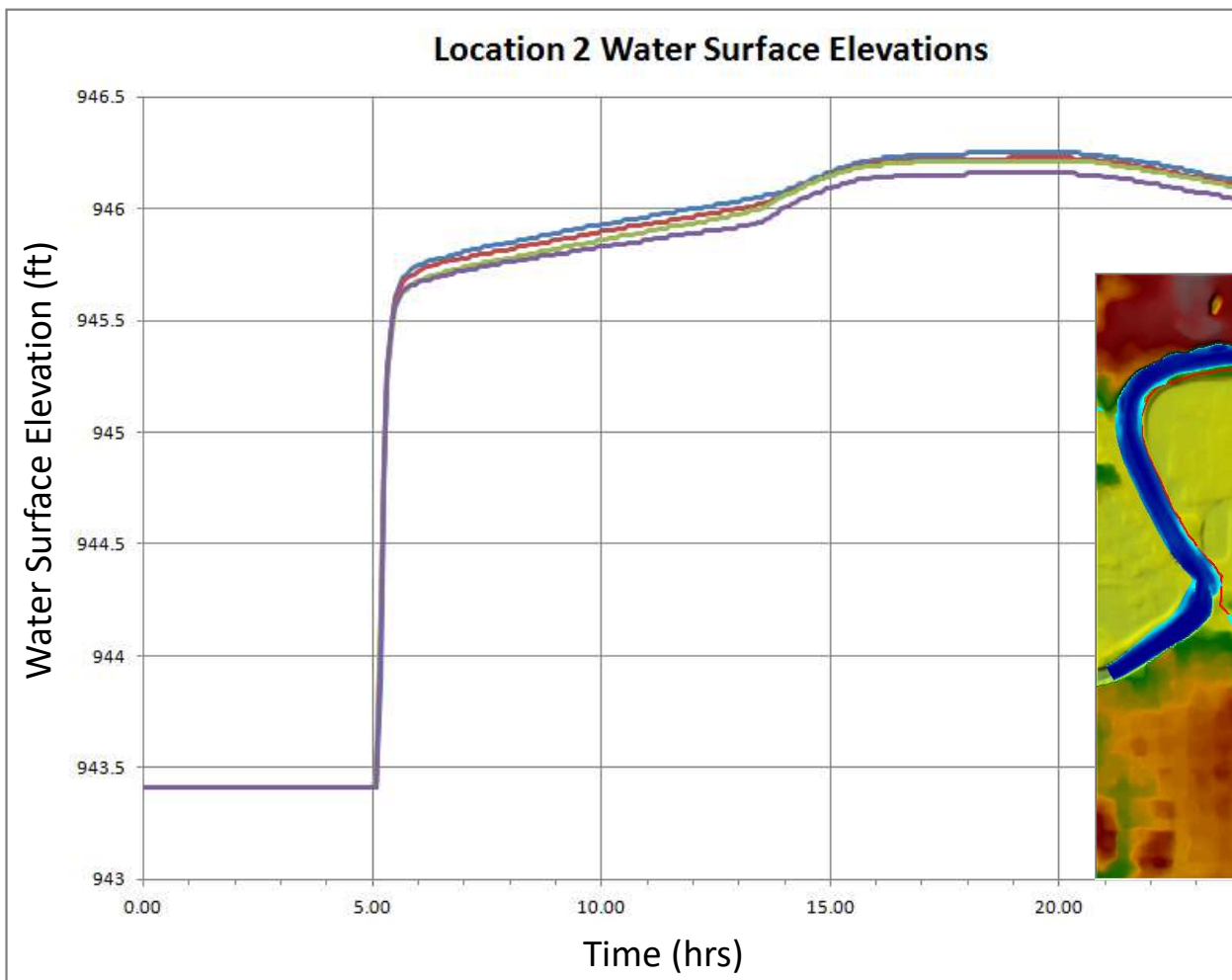


Add Breaklines to Control Hydraulics

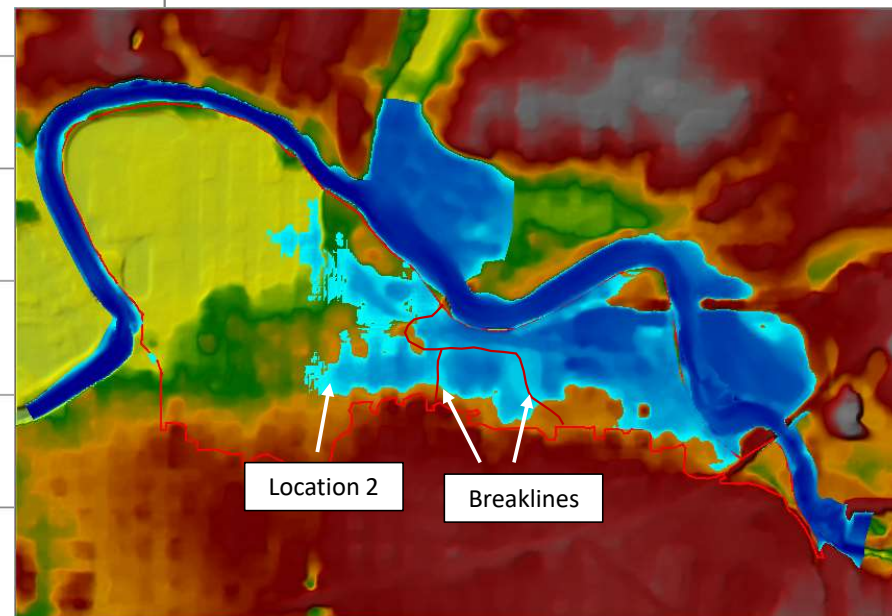




Grid Resolution Sensitivity – With Breaklines



- 25 ft Grid (7.6m)
- 50 ft Grid (15.2 m)
- 100 ft Grid (30.5 m)
- 200 ft Grid (61.0 m)

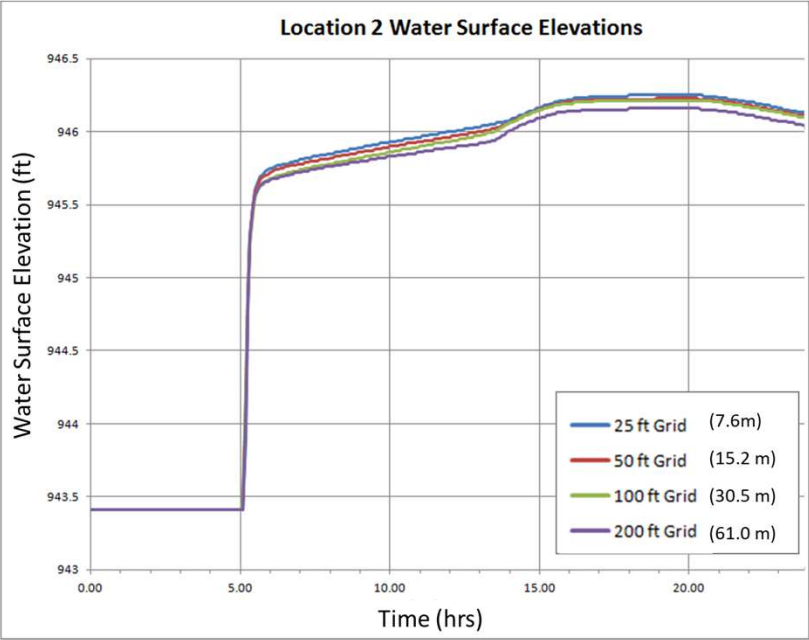
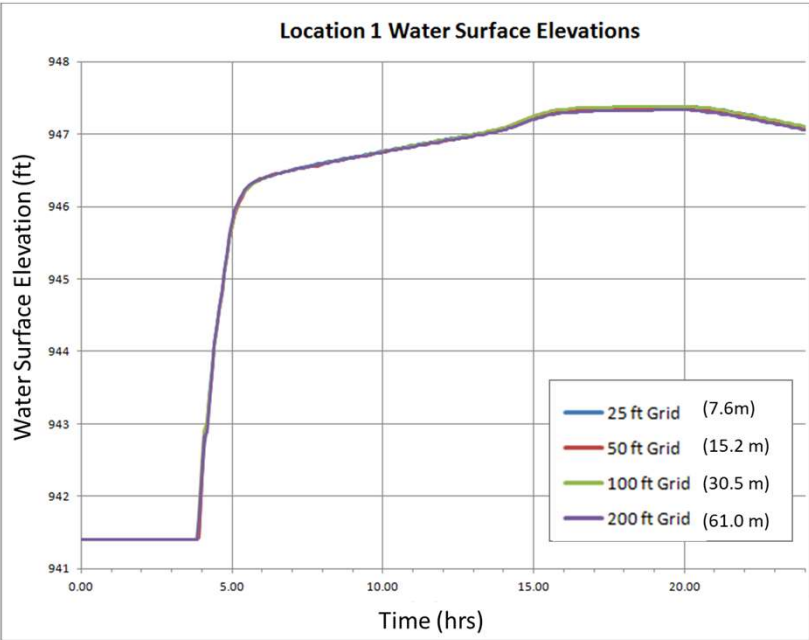




Model Computational Times



Test No	Grid Size	No. Cells	Time Step	RAS Diff Wave	Time Step	RAS Full Eqns.
1	25ft	21719	10 sec	2 min 19s	4 sec	7 min 34s
2	50ft	5379	15 sec	33s	10 sec	1 min 16s
3	100ft	1323	15 sec	7s	15 sec	15s
4	200ft	321	20 sec	4s	15 sec	6s



Questions?

