HEC-RAS Subgrid Bathymetry

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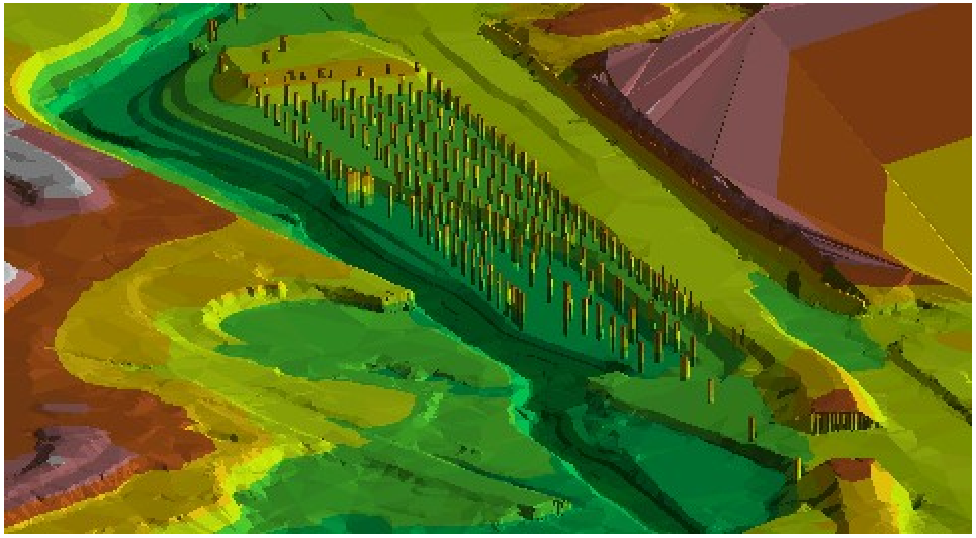
HEC

Objective

- Understand the Subgrid Technology in HEC-RAS.

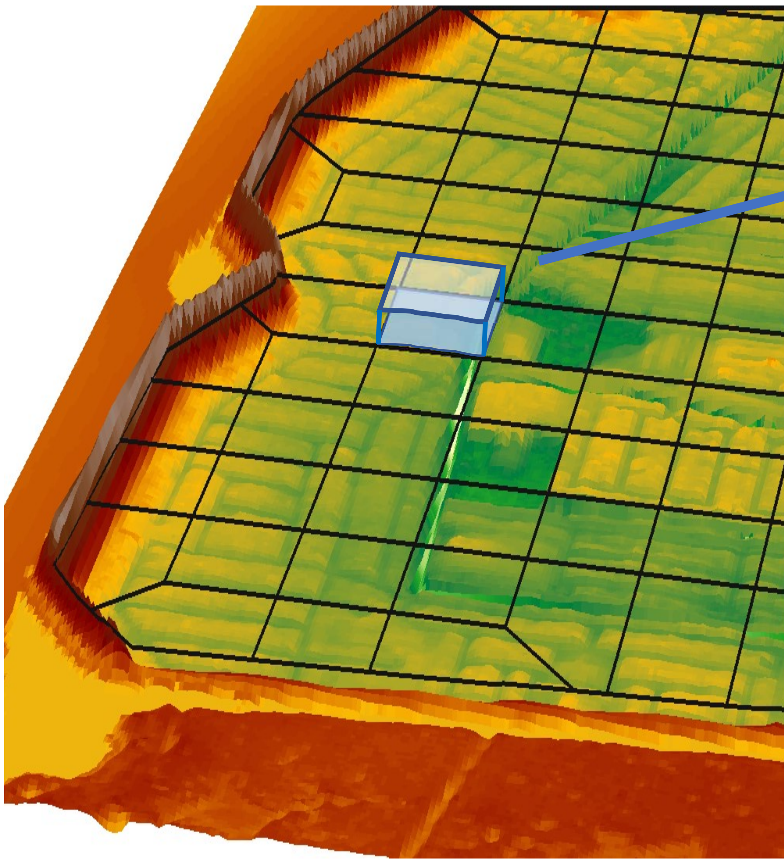
- Problem
  - Water levels usually vary much more smoothly than the terrain
  - Unfeasible to resolve every detail of the terrain with the computational mesh
- Approach
  - Utilize a grid resolution sufficient to resolve the hydraulics
  - Capture the details of the subgrid terrain through hydraulic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

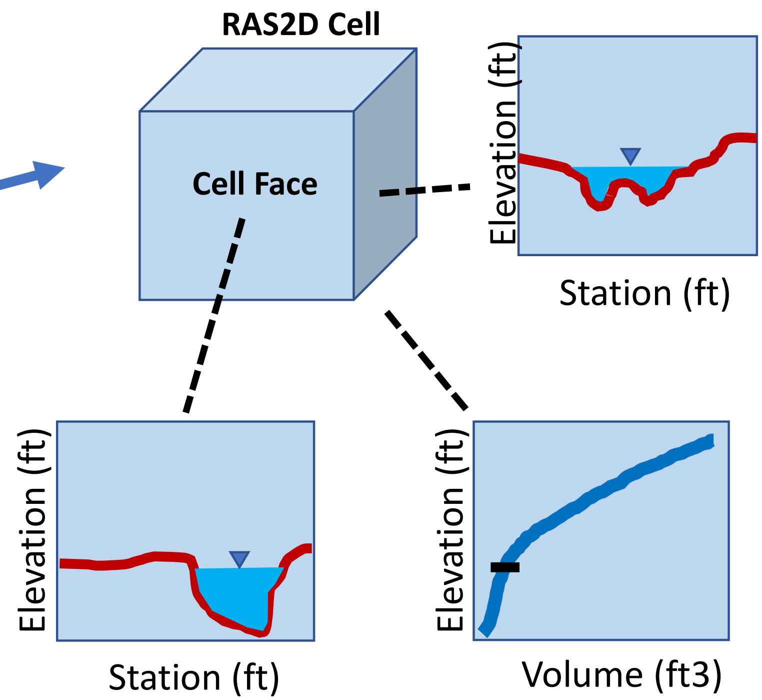


2D Modeling Subgrid Technology

- 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.

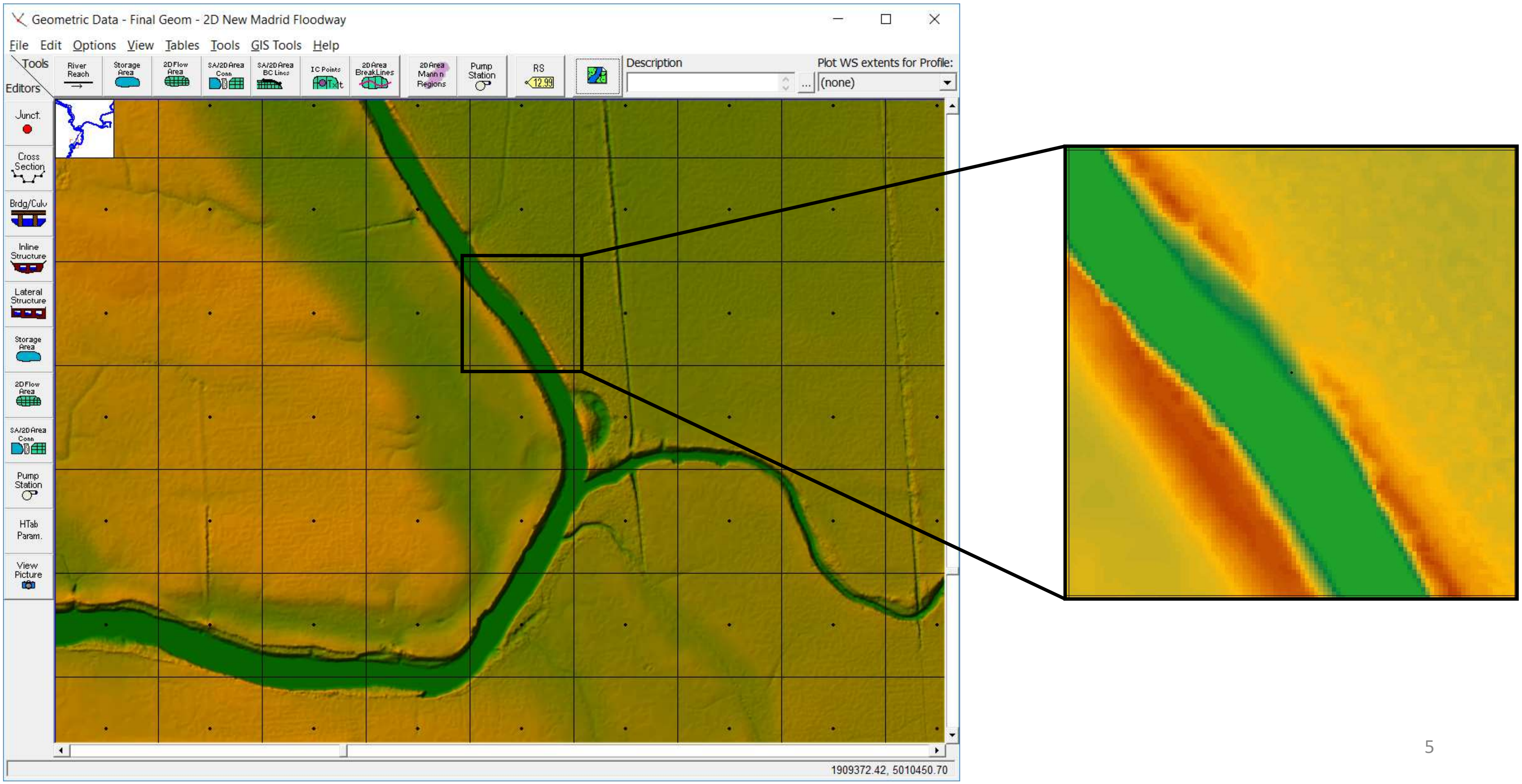
2D Computational Mesh Subgrid Terrain



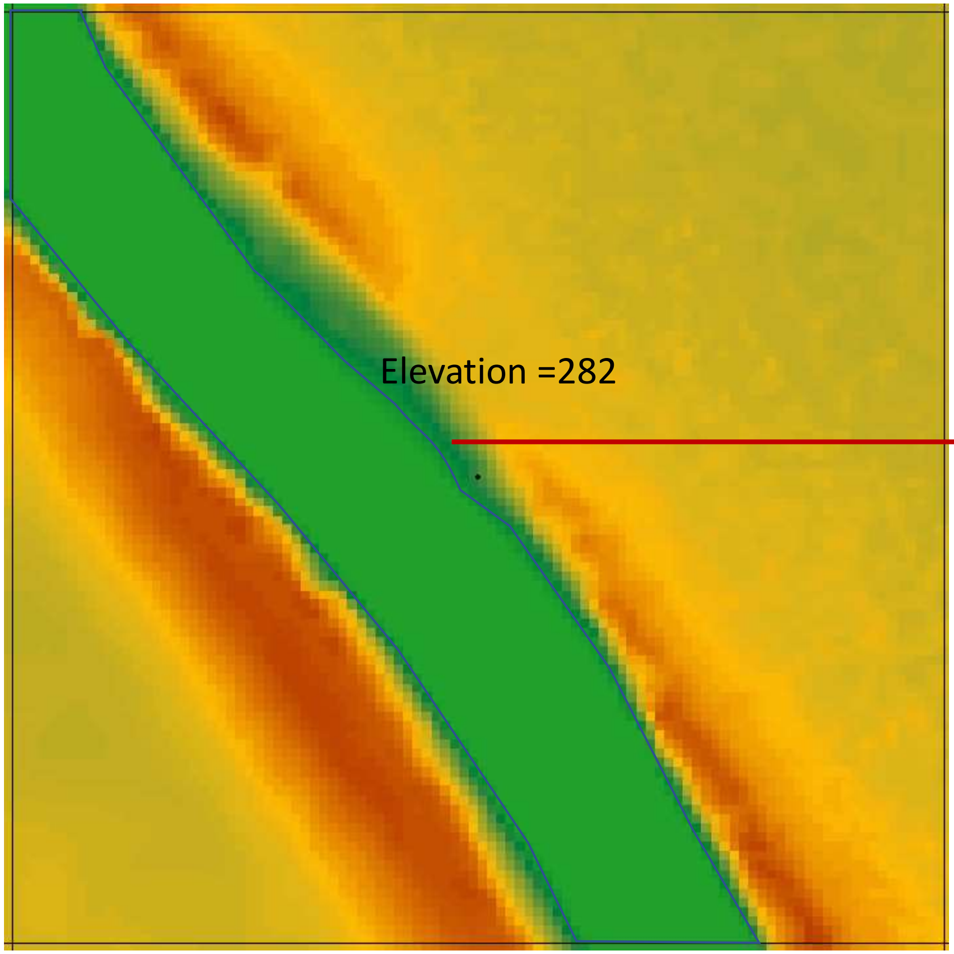


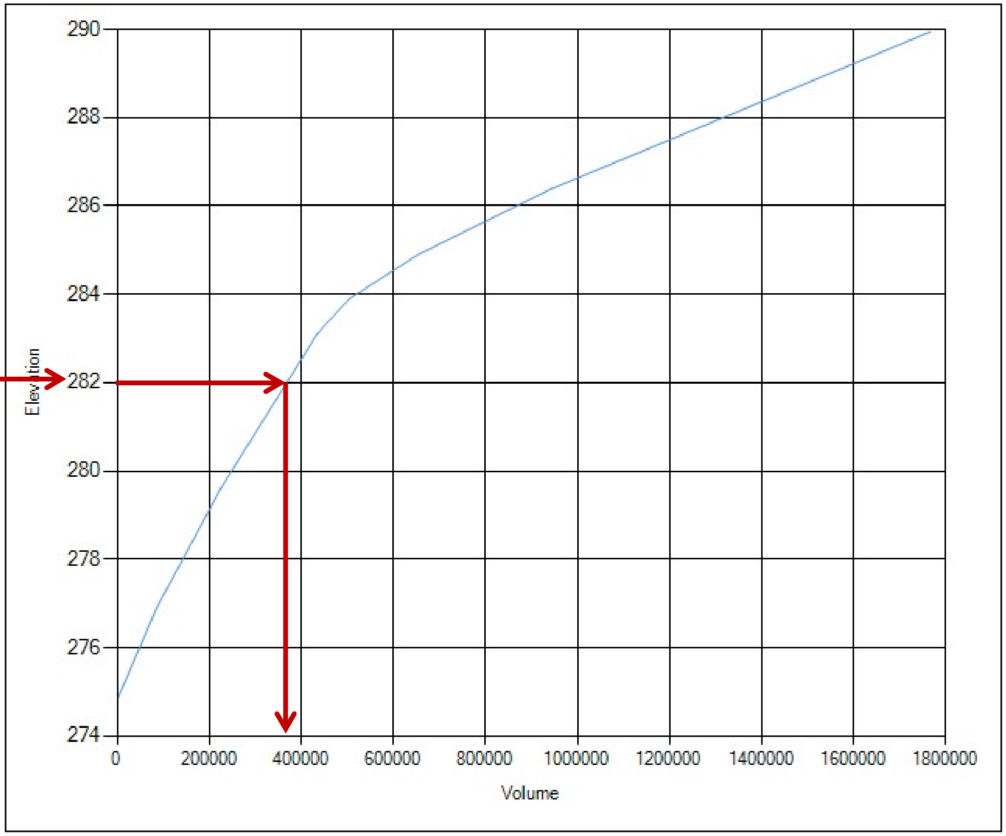
Each cell face profile and stage-volume curve is based on hundreds to thousands topo-bathymetric data-points, depending of resolution of underlying terrain raster.
Cell approach very efficiently discretizes space including complex terrain & surface roughness.

Computational Mesh Sub-grid Terrain

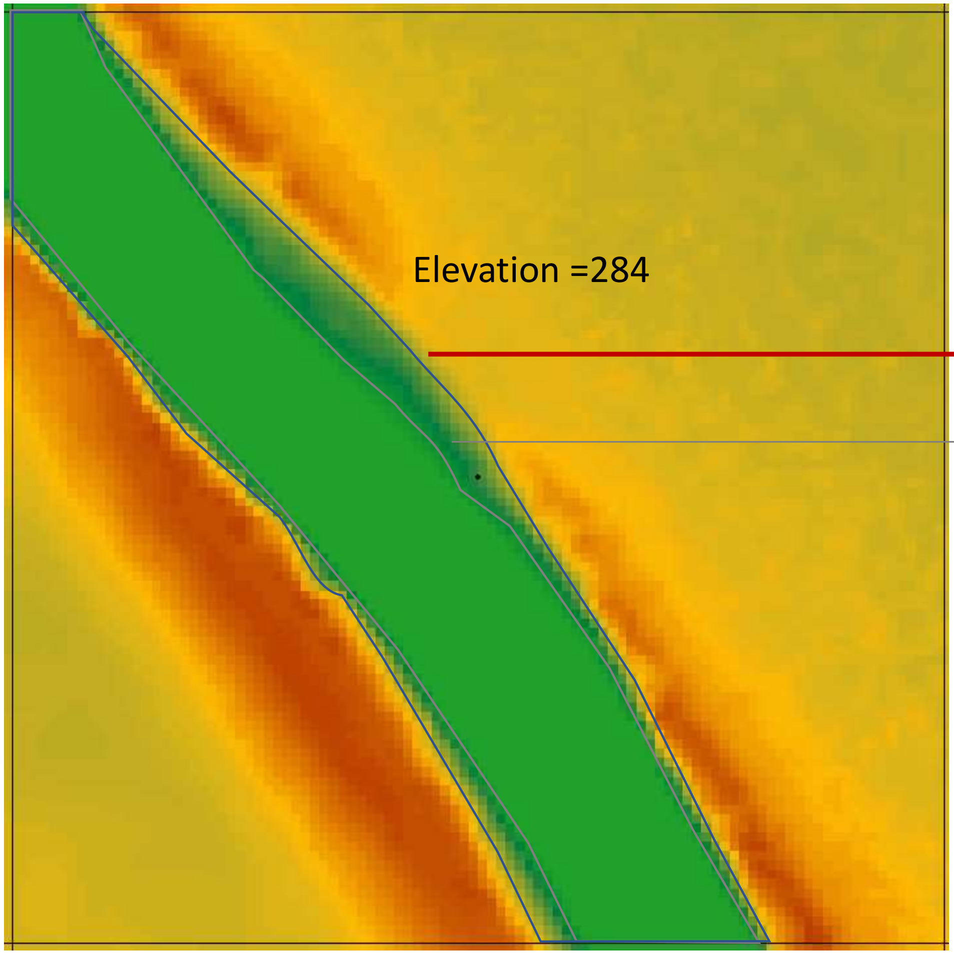


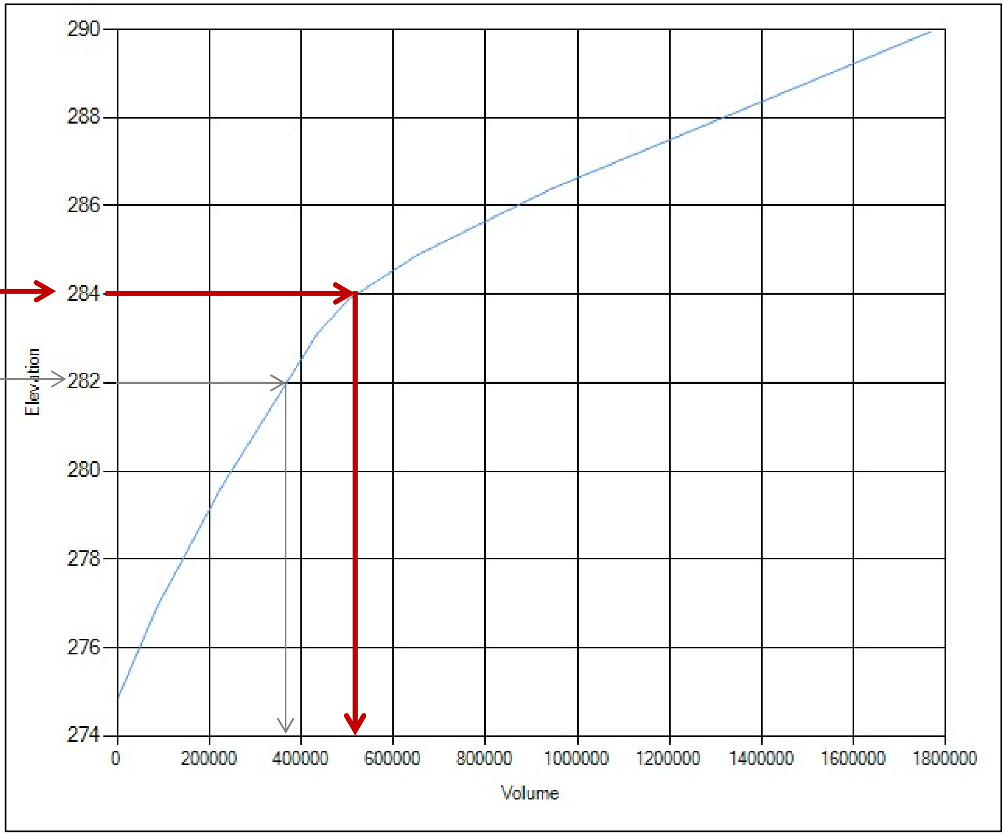
Computational Cells - Elevation vs. Volume





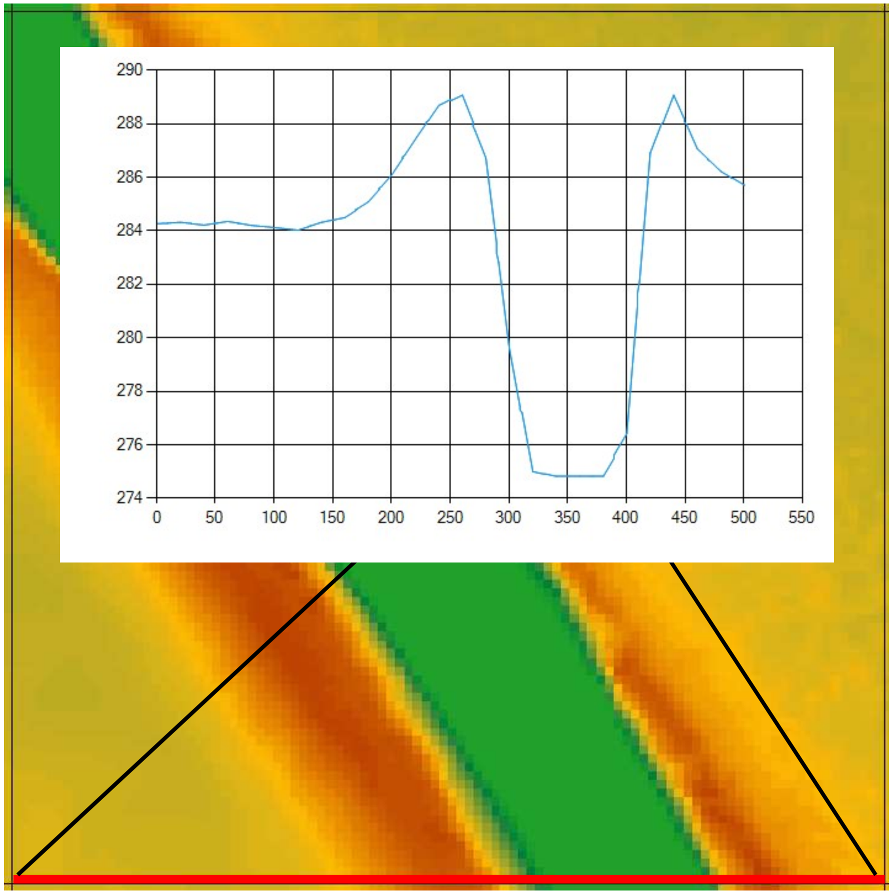
Computational Cells - Elevation vs. Volume

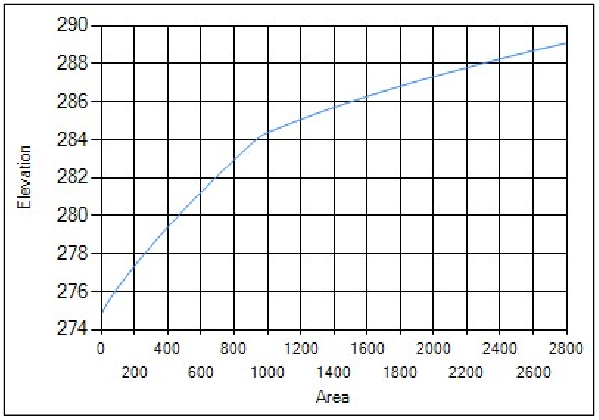


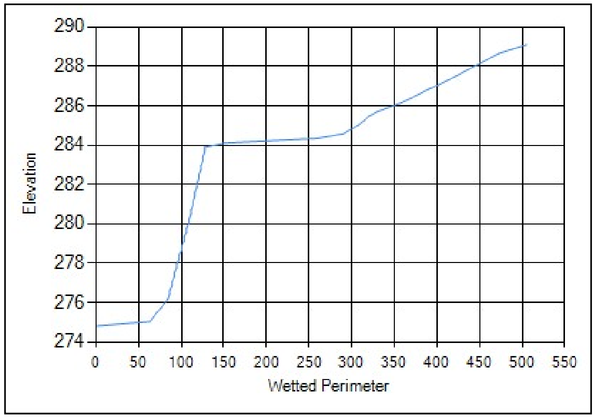


Subgrid = Higher fidelity cell volume tracking

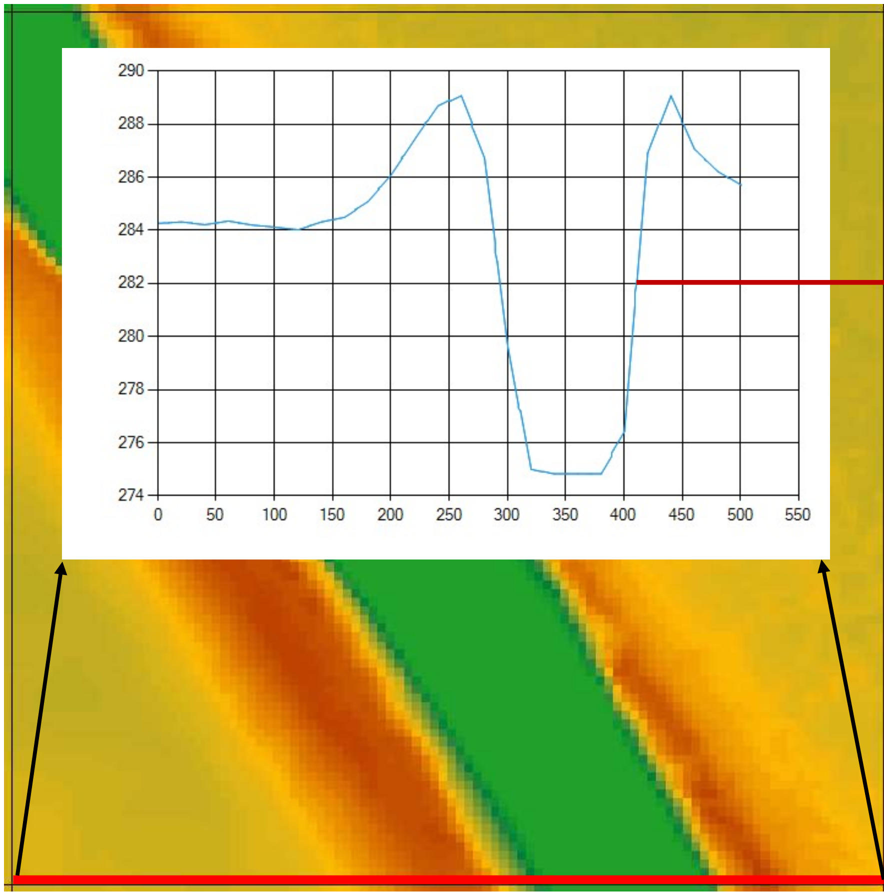
Computational Faces - Elevation vs. Area, Wetted Perimeter, and n

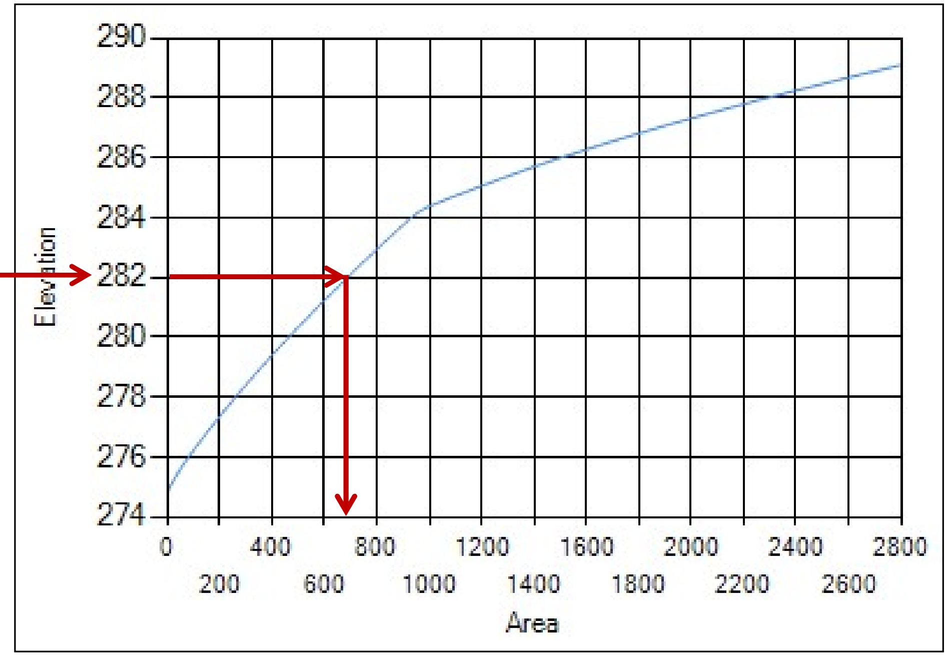






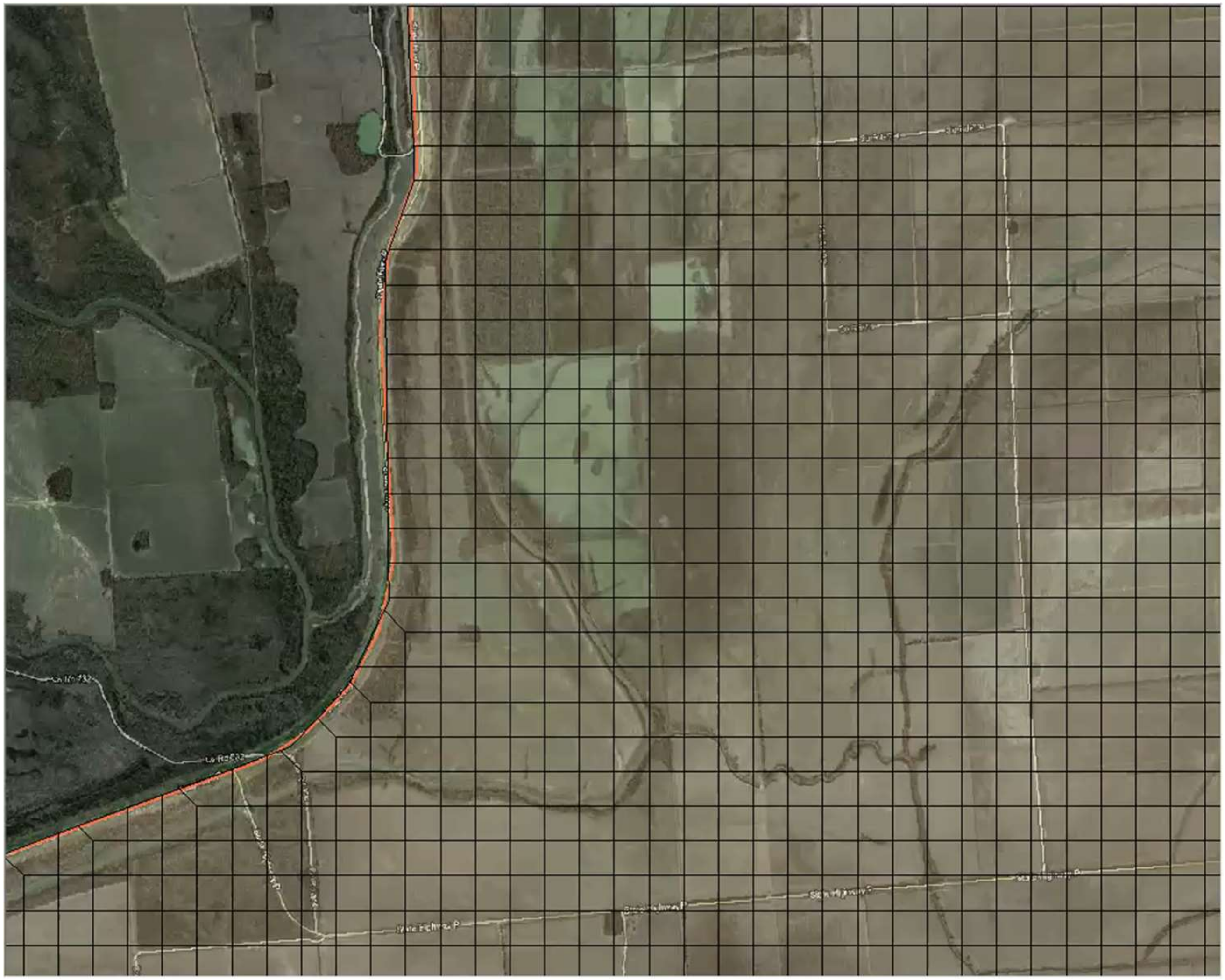
Computational Faces - Elevation vs. Area





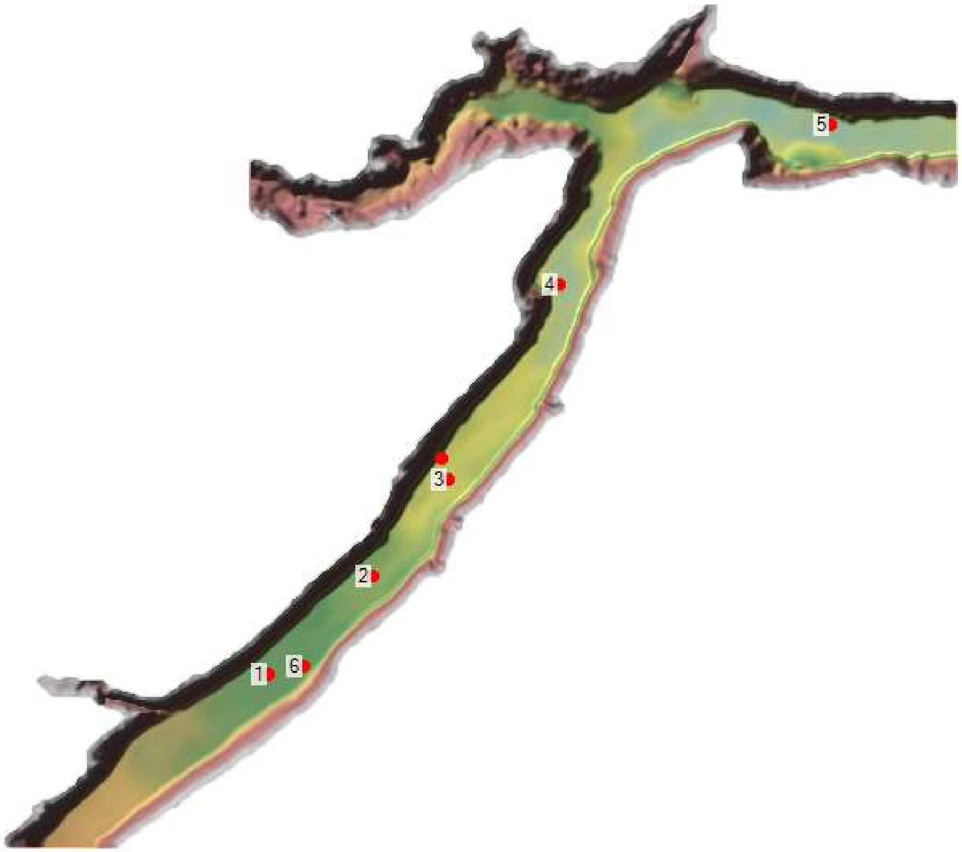
Subgrid = Controls flow into and out of cell

Benefits of using the detailed sub-terrain

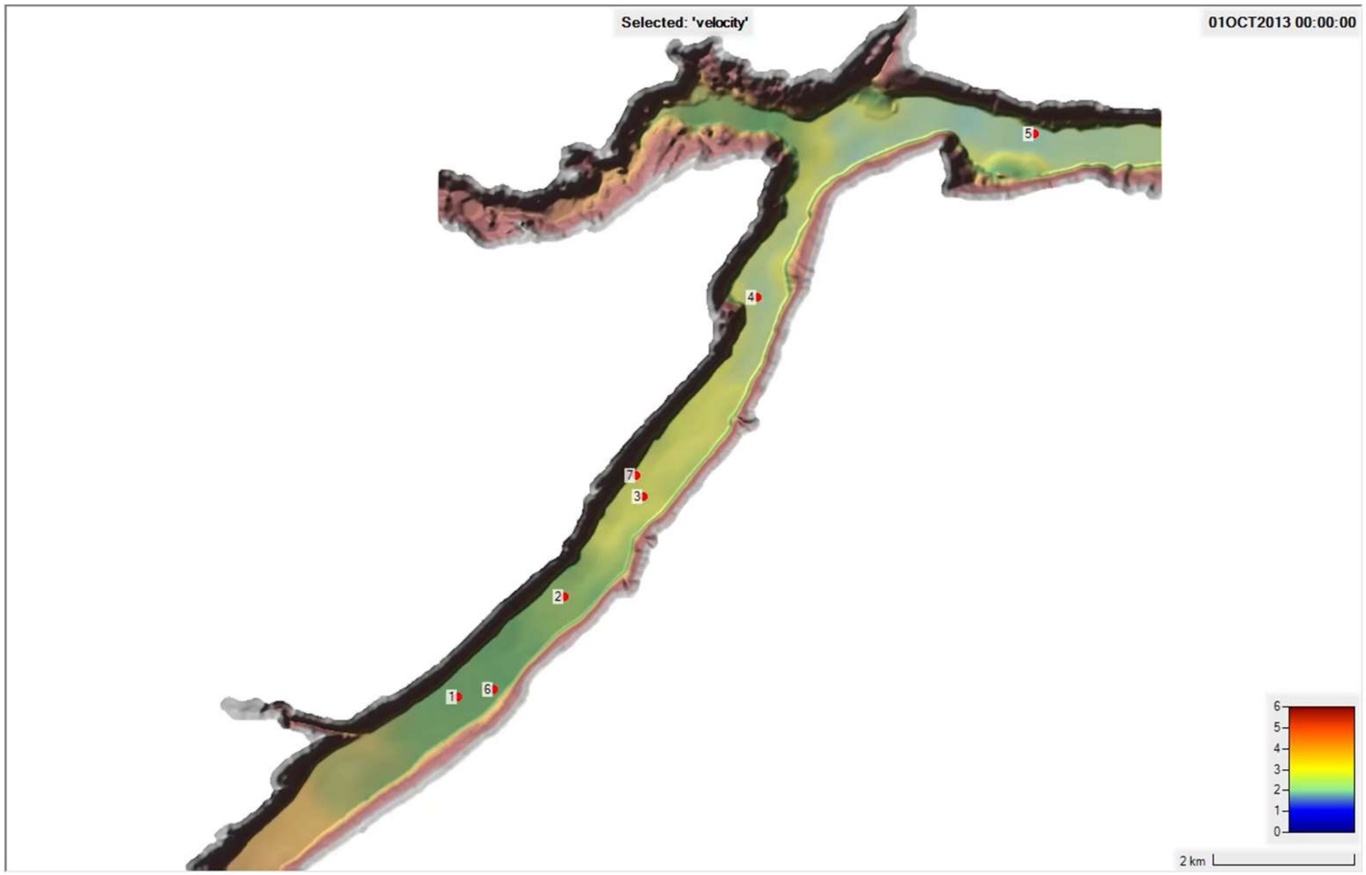


Example Application – EU Test 5

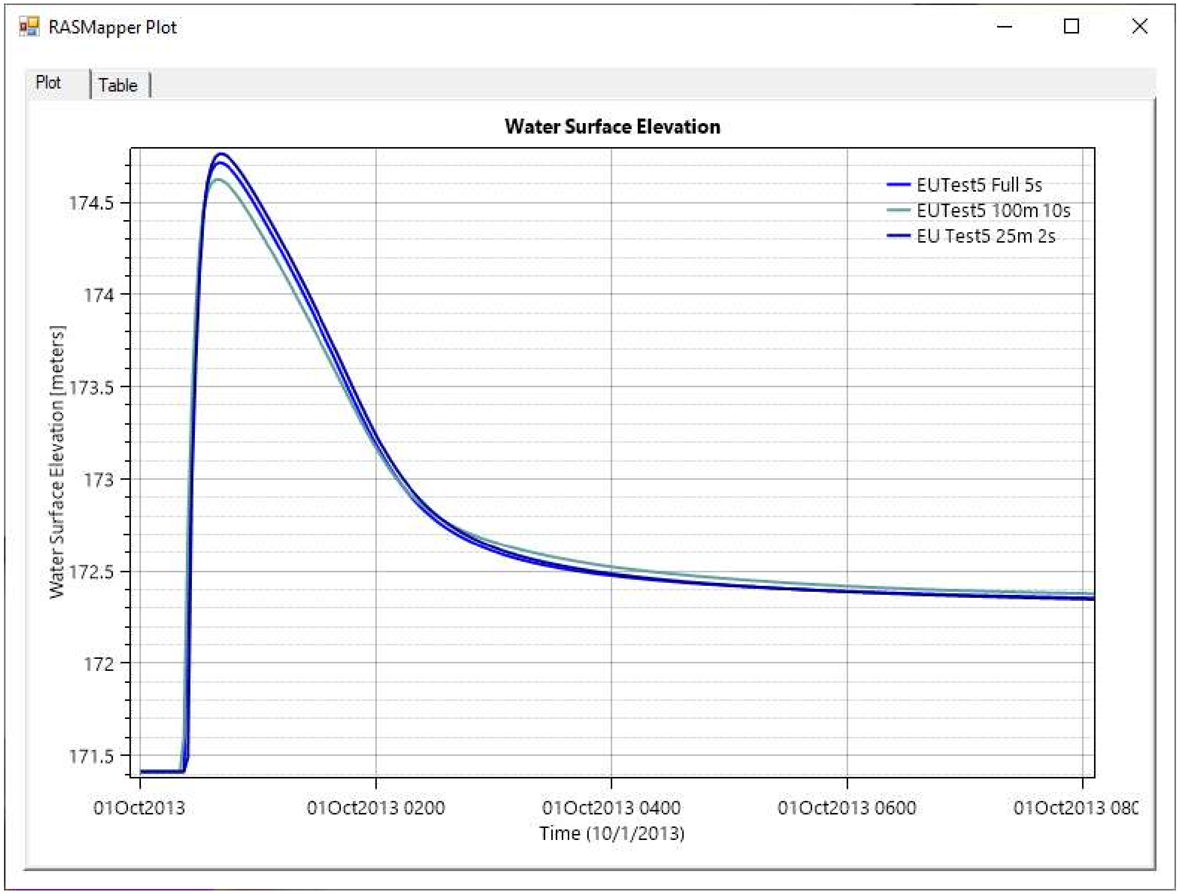
- Extremely Rapidly rising hydrograph of a dry bed. From 0.0 to 3000 cms in 5 minutes.
- Compare results at multiple locations for three grid resolutions (25, 50, and 100m)
- Compare Computational times



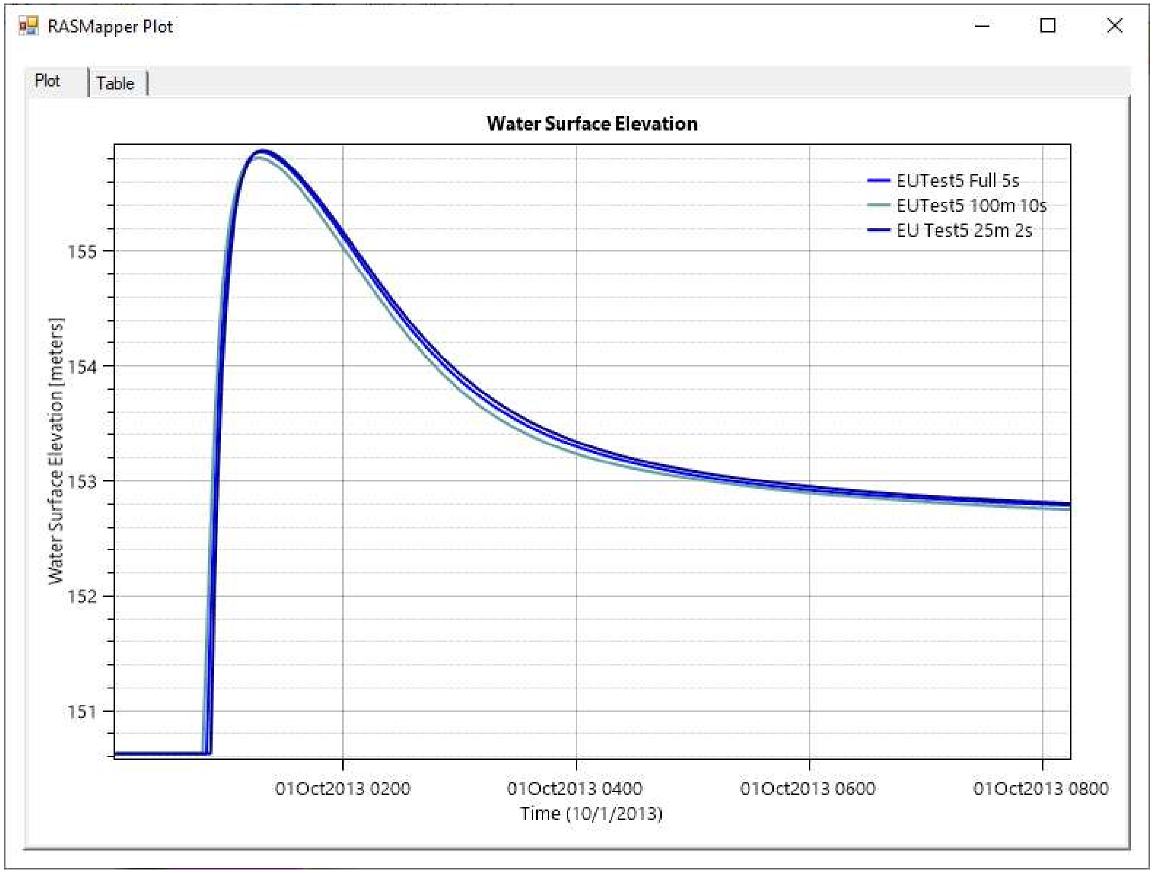
EU Test 5 – Animation



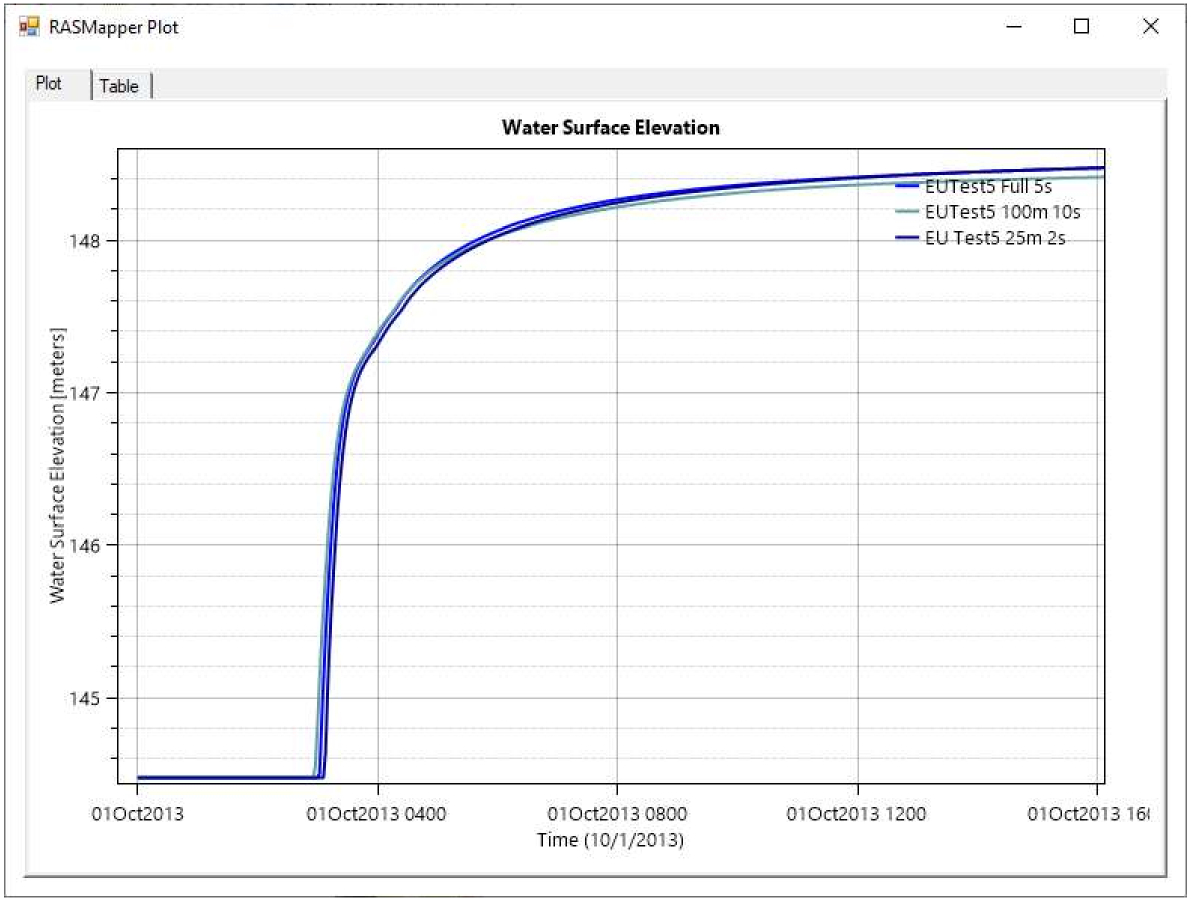
EU Test 5 – Location 1



EU Test 5 – Location 3



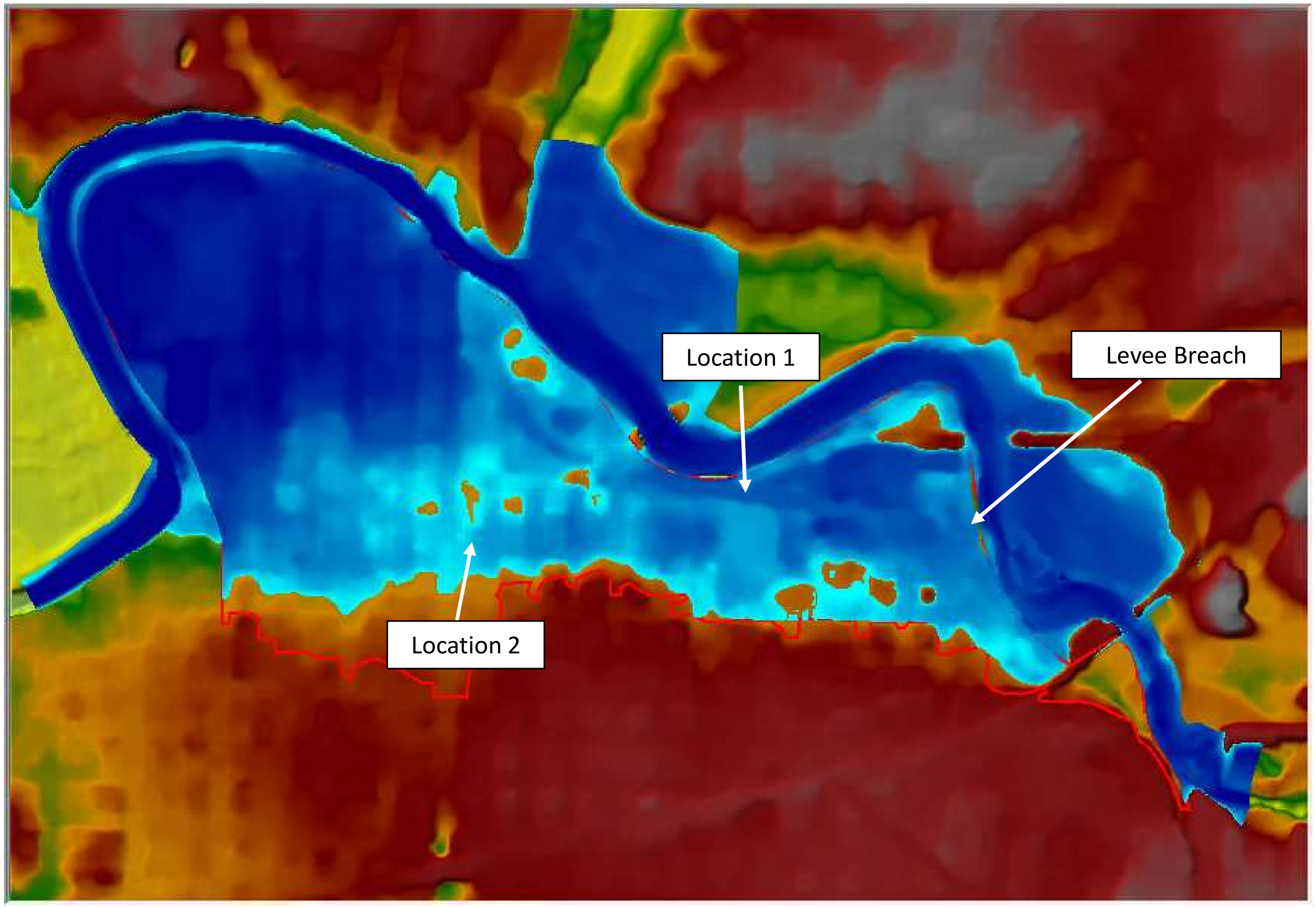
EU Test 5 – Location 5



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

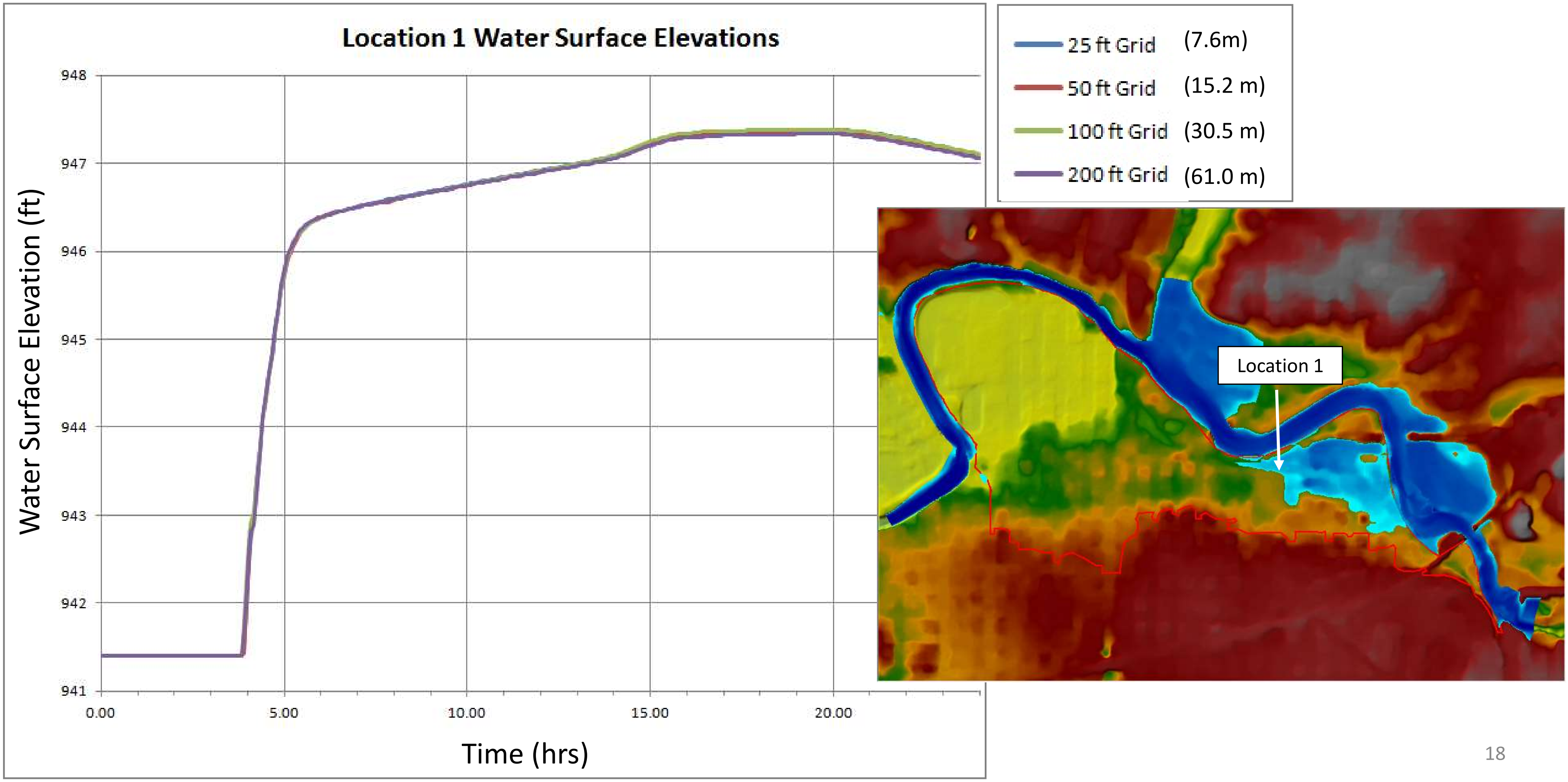
Grid Resolution Evaluation



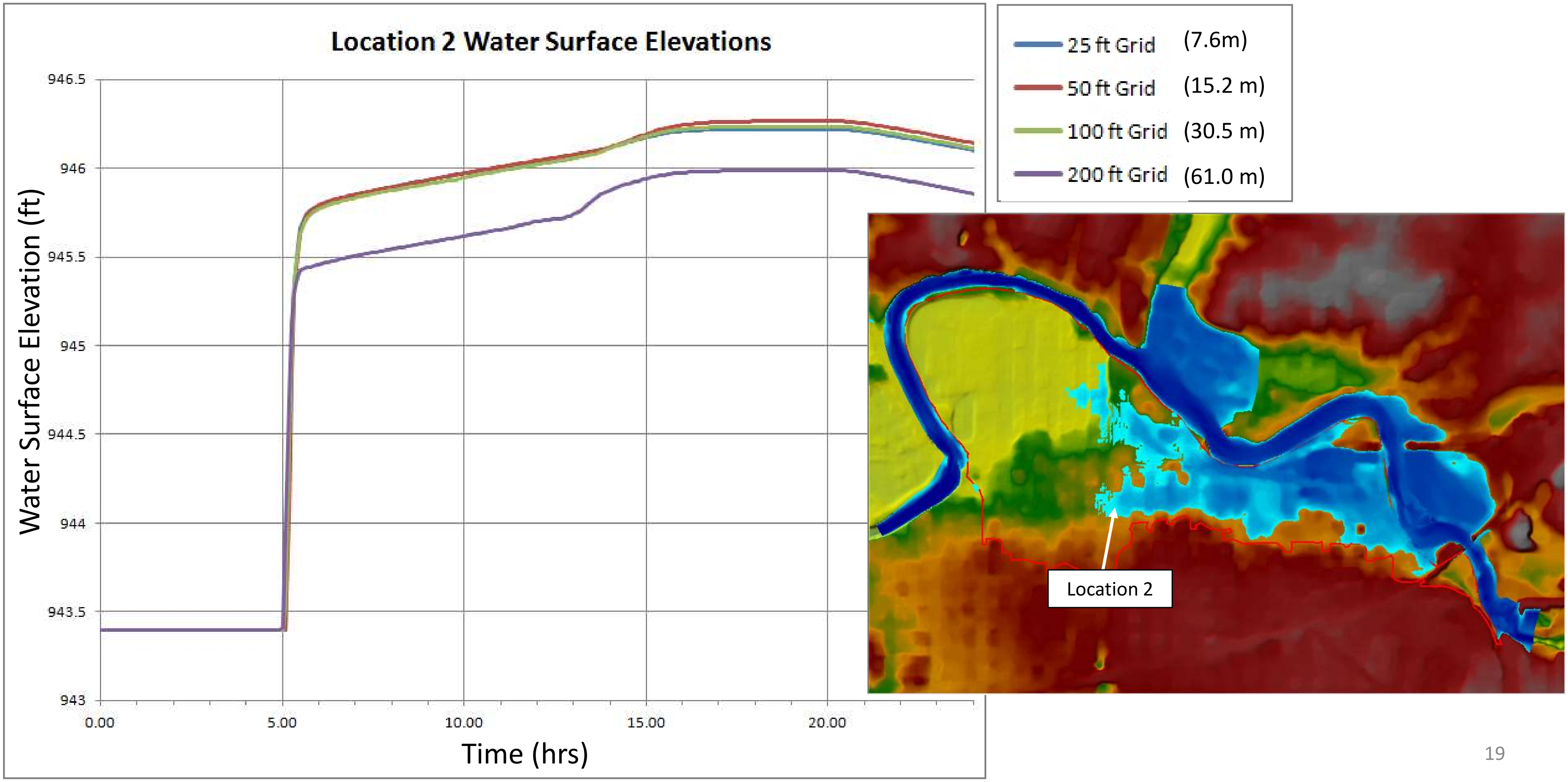
Modeled With Four Grid Resolutions:

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

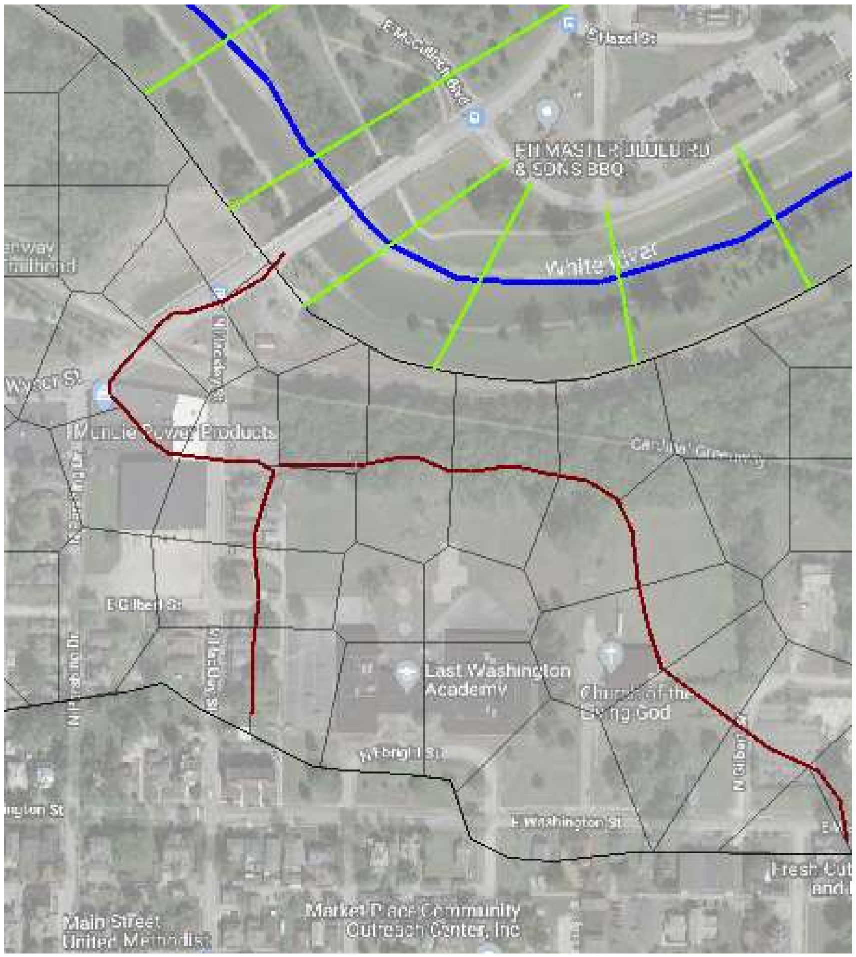
Grid Resolution Sensitivity

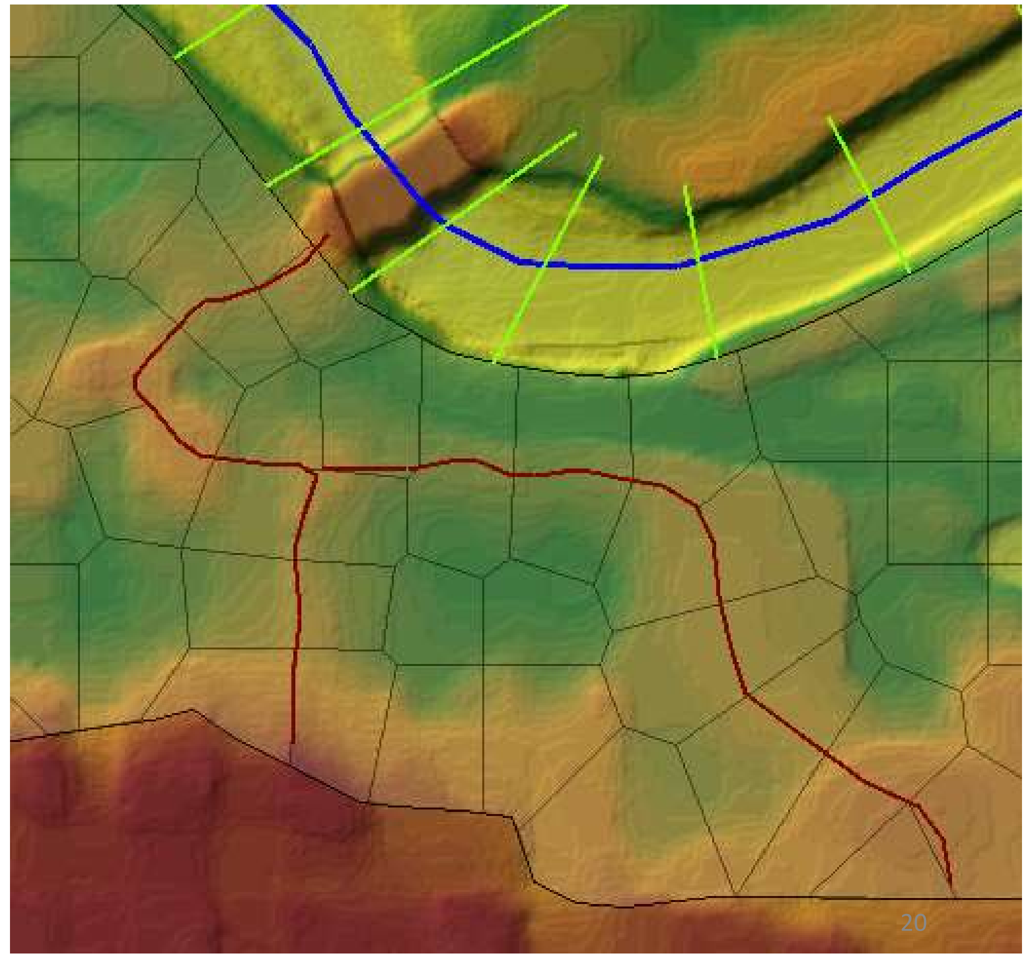


Grid Resolution Sensitivity

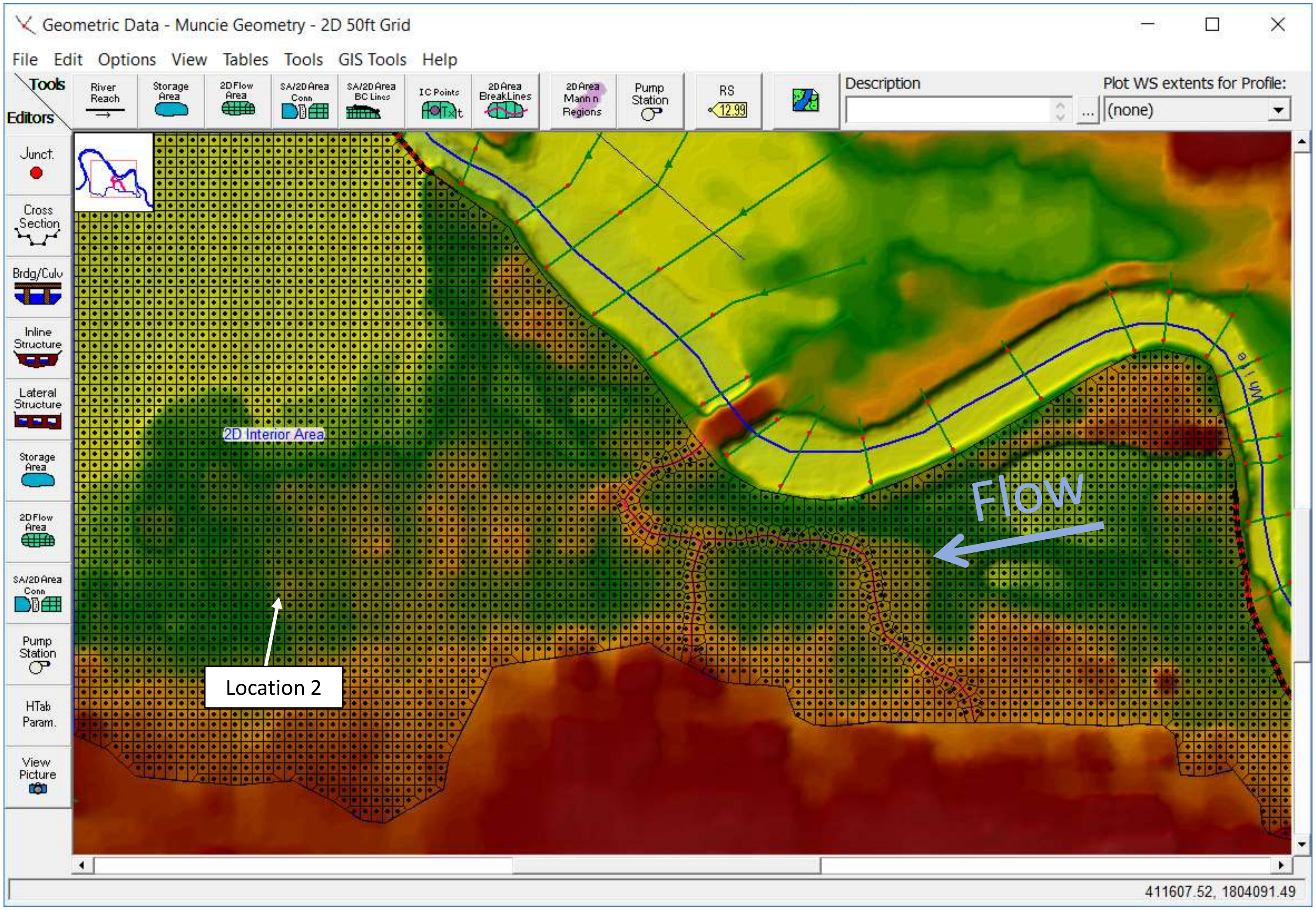


Breaklines - Define Hydraulic Control

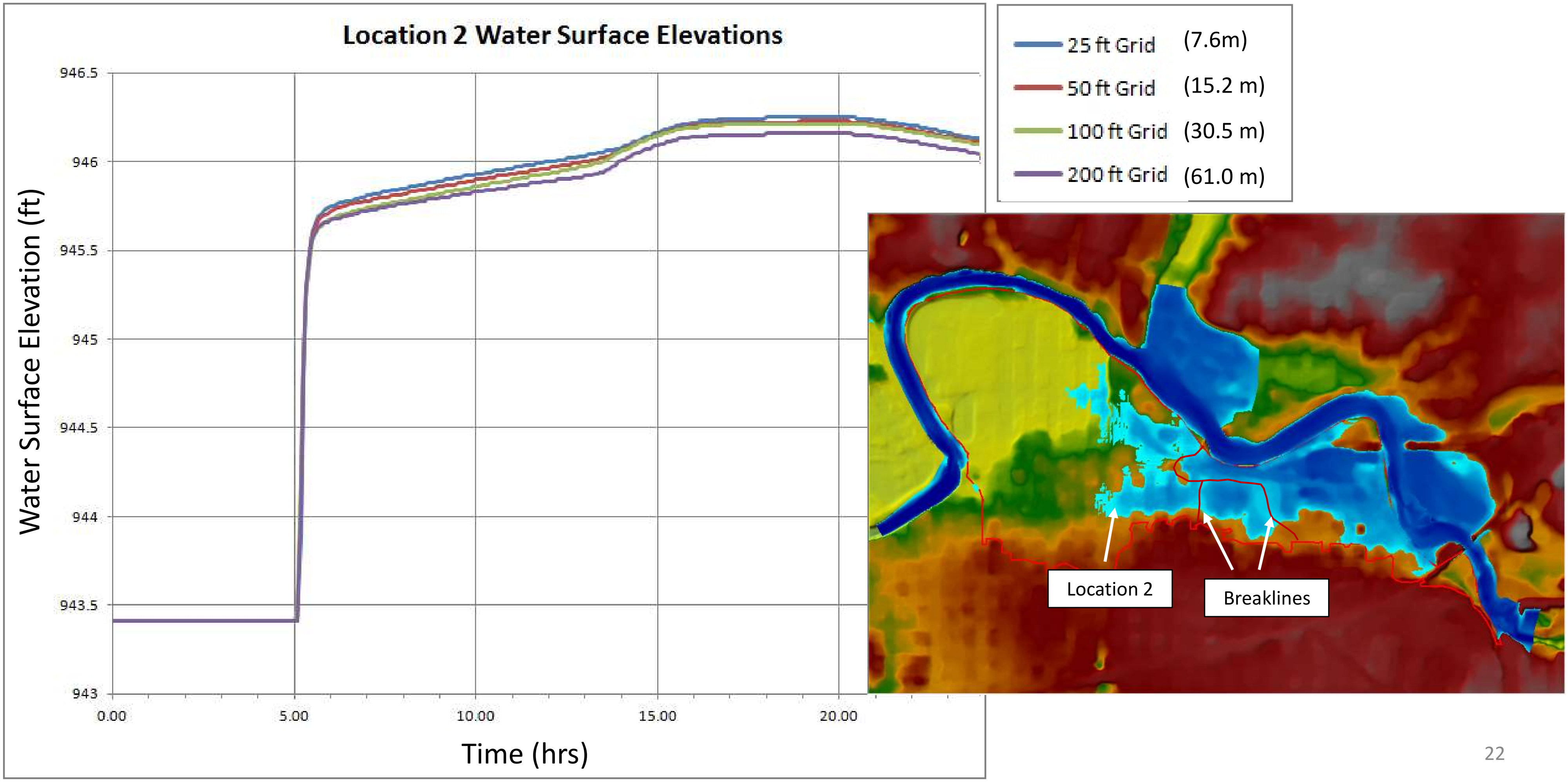




Add Breaklines to Control Hydraulics

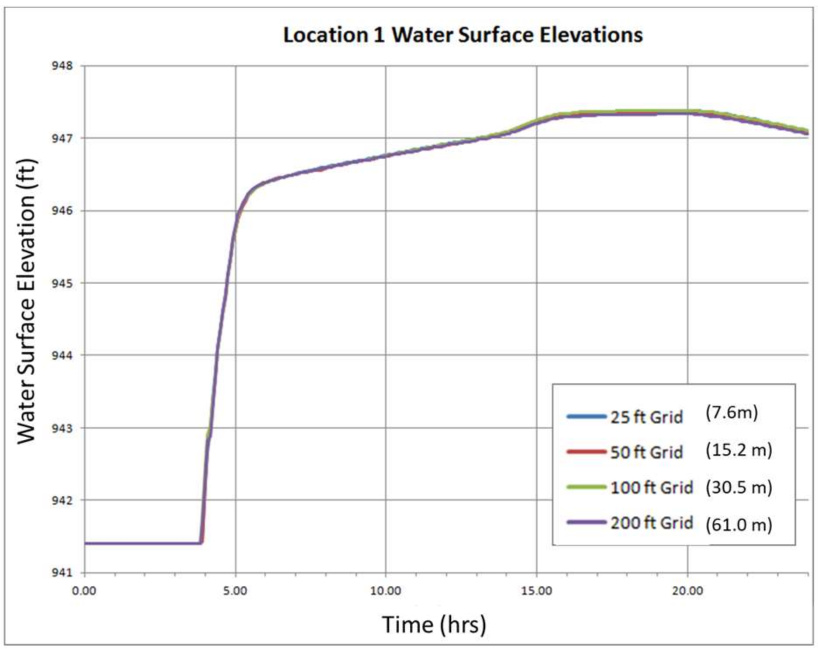


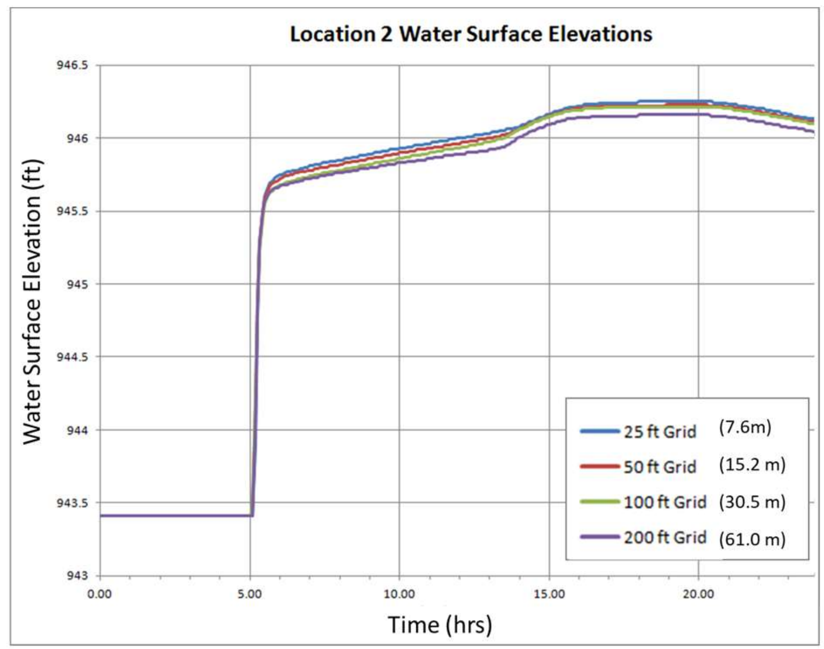
Grid Resolution Sensitivity – With Breaklines



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?