Empowering Floodplain Administrators on 2D Hydraulic Modeling using HEC-RAS 5.0

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Phoenix AZ

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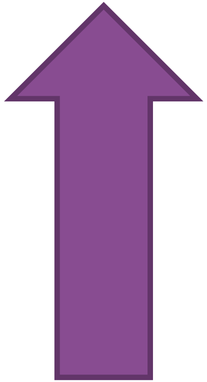
woodplc.com

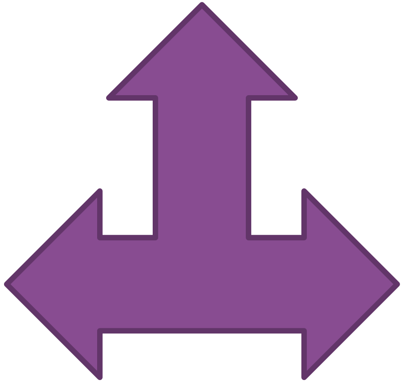
Agenda

- Introduction
- 1D vs 2D
- 2D Basics with HEC-RAS 5.0
- Conclusions

Introduction



1D



2D

1D vs 2D

- Not well defined channel / flow direction
- Flat topography
- Flow directions changes significantly with different stages
- Parallel stream reaches with shared floodplains
- Urbanized areas

- Other Reasons:
  - Need local flow velocities
  - Circulation patterns
  - Variations in lateral velocity

1D vs 2D

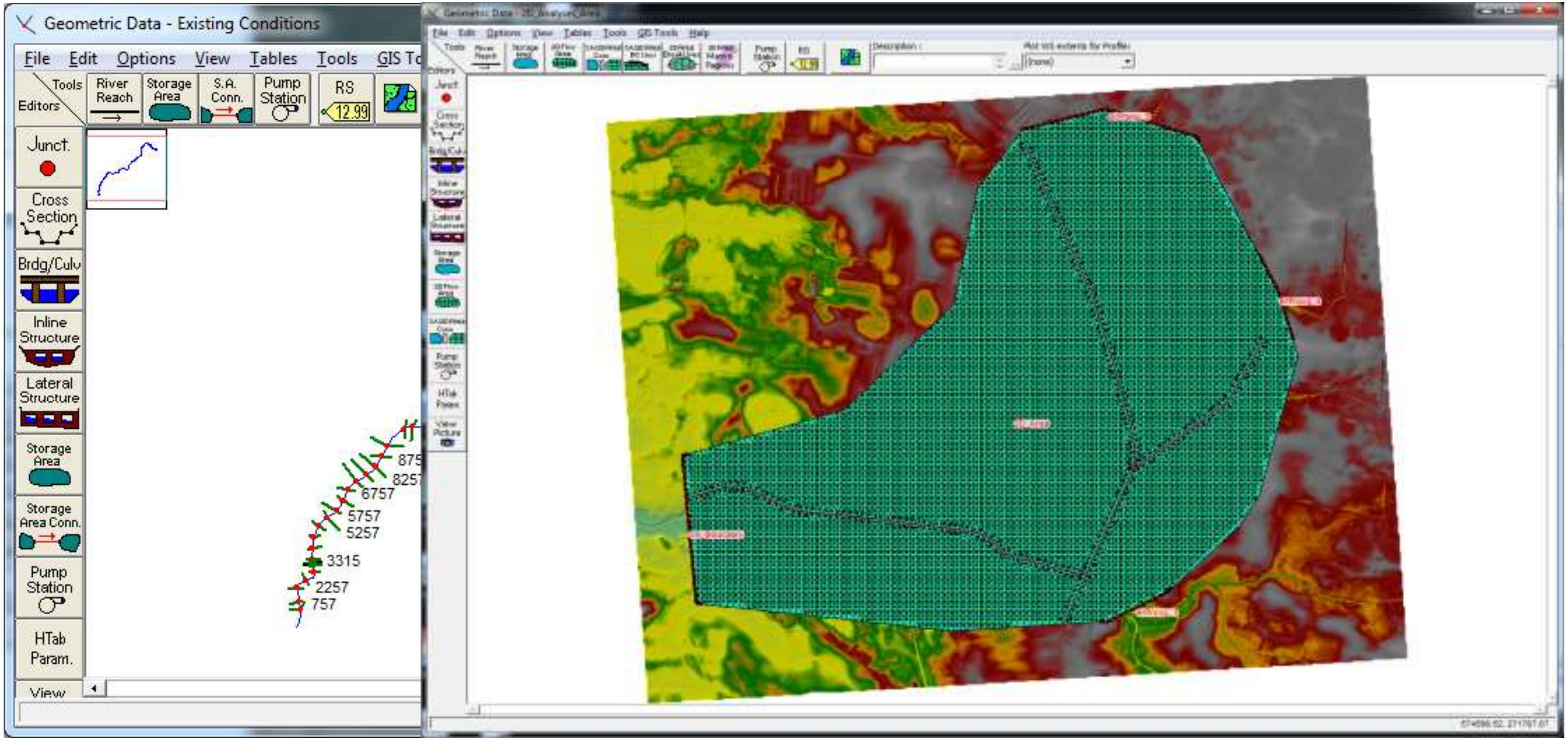
COLORADO
FLOODPLAIN AND STORMWATER CRITERIA MANUAL

The modeler can use angle points or “doglegs” in cross sections if necessary to satisfy this requirement. The cross section data can be obtained from direct survey of the cross sections, or can be derived from topographic mapping or digital terrain.

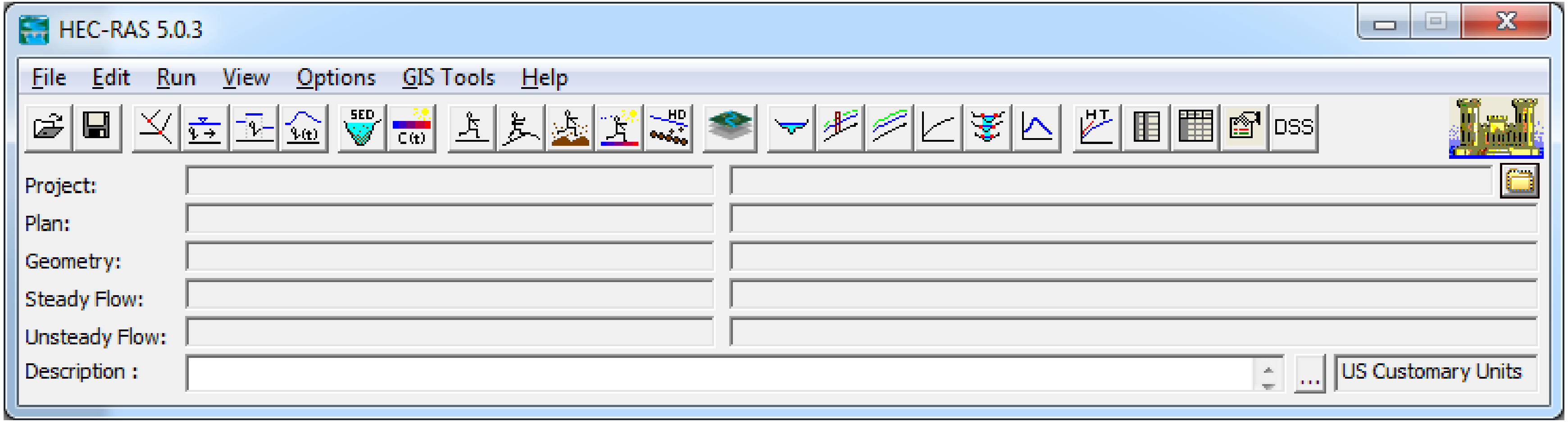
Table CH12-601. Differences between One-Dimensional and Two-Dimensional Modeling

Property or Factor	One-Dimensional Modeling	Two-Dimensional Modeling
flow direction	prescribed (streamwise)	computed
transverse velocity and momentum	neglected	computed
vertical velocity and momentum	neglected	neglected
velocity averaged over...	cross sectional area	depth at a point
transverse velocity distribution	assumed proportional to conveyance	computed
transverse variations in water surface	neglected	computed
vertical variations	neglected	neglected
unsteady flow routing	can be included	can be included

1D vs 2D….


Geometric Data - Existing Conditions
File
Edit
Options
View
Tables
Tools
Tools
Editors
River Reach
Storage Area
S.A. Conn.
Pump Station
RS
12.99
Junct.
Cross Section
Brdg/Culv
Inline Structure
Lateral Structure
Storage Area
Storage Area Conn.
Pump Station
HTab Param.
View
3315
2257
757
5757
5257
6757

HEC-RAS 5.0


HEC-RAS 5.0.3
File Edit Run View Options GIS Tools Help
SED
C(t)
HD
HT
DSS
Project:
Plan:
Geometry:
Steady Flow:
Unsteady Flow:
Description :
US Customary Units

2D Theory

- Full Momentum Equation (Dynamic Wave / Shallow Wave)
  - Change in Momentum (Velocity) = Change in Hydrostatic Pressure Gradient.
- Diffusion Wave Equation
  - Bottom friction = Pressure Gradient

$$\frac{\partial v}{\partial t} + u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} = -g\frac{\partial H}{\partial y} + v_t\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right) - c_f v + fu$$

2D MODEL with HEC-RAS Inputs

- Establish a Horizontal Coordinate Projection from within HEC-RAS Mapper
- Develop a terrain model in HEC-RAS Mapper
  - Used to establish the geometric and hydraulic properties of the 2D cells and cell faces
  - Useful to perform any inundation mapping
- Build a Land classification data set in order to establish Manning's n values within the 2D analysis area

2D - Mesh

2D Mesh

- Mesh automatically generated within 2D area boundary
  - Add breaklines to re-align cell faces
  - Manually adjust points
- Underlying terrain provides geometric and hydraulic property tables representing cells and cell faces
  - "Subgrid" allows cells to be partially wet
  - Improves computation time

Geometric Data Window with 2D Area

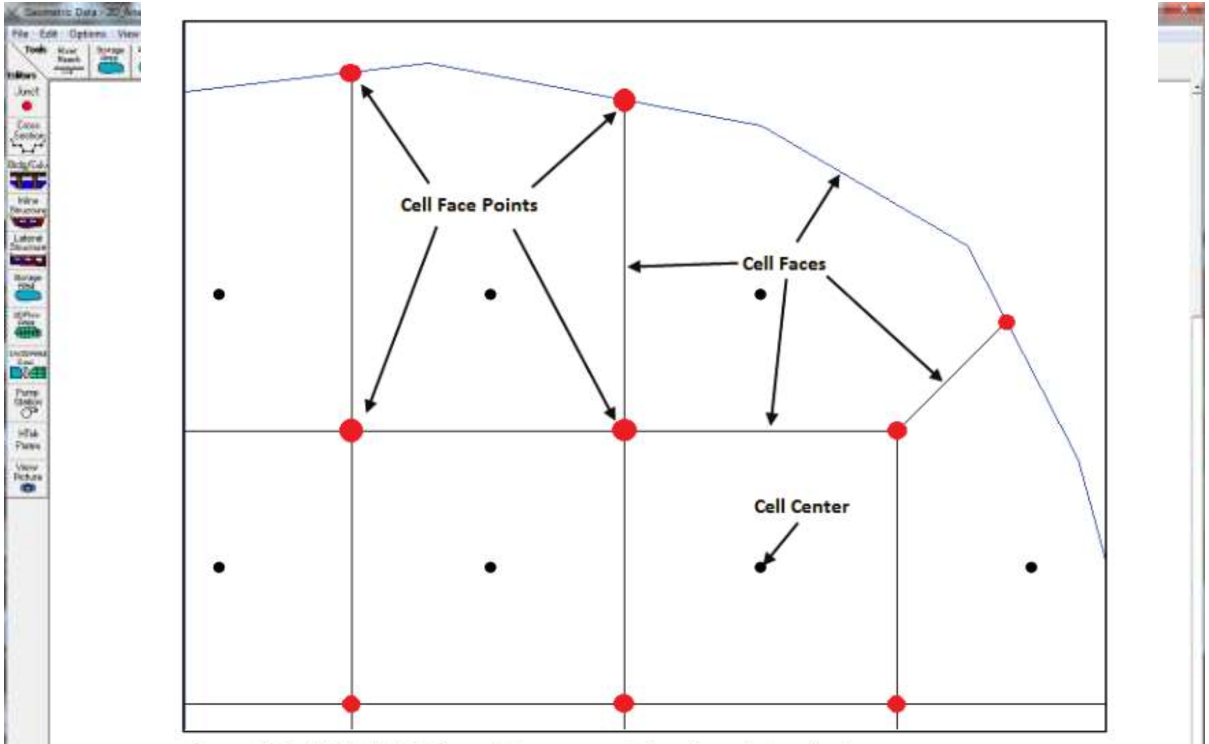
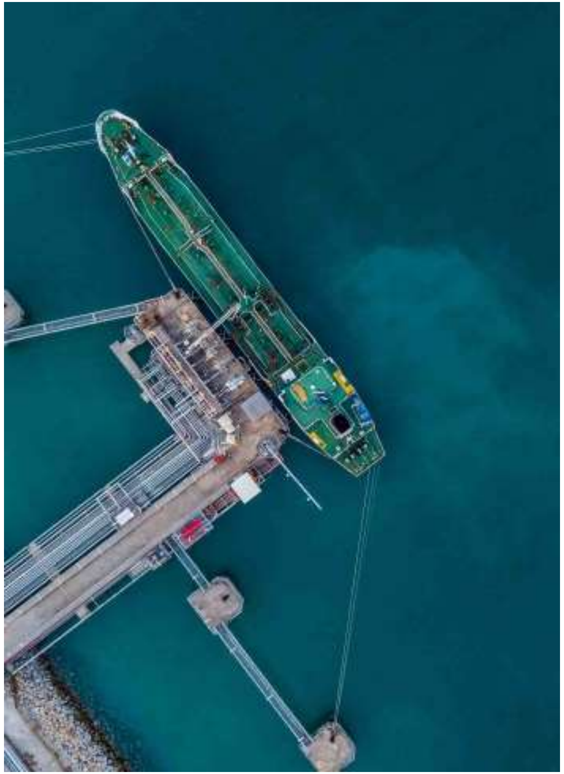
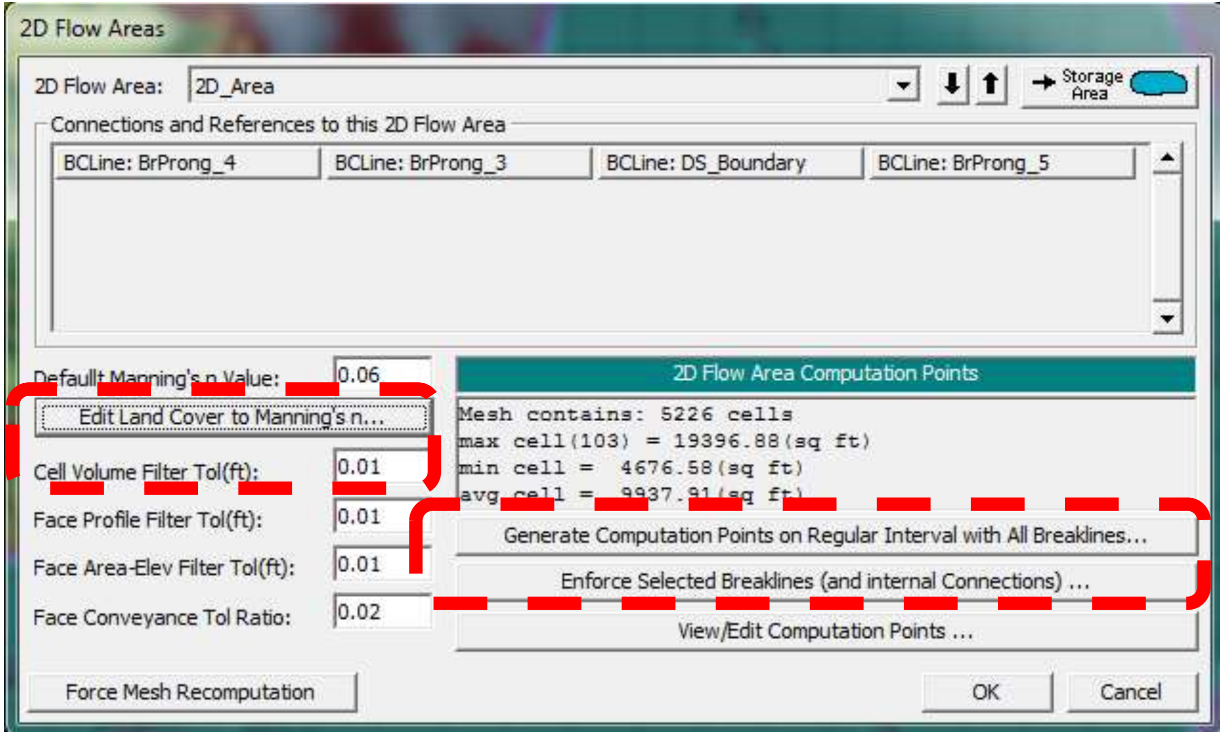


Figure 3-3. HEC-RAS 2D modeling computational mesh terminology.

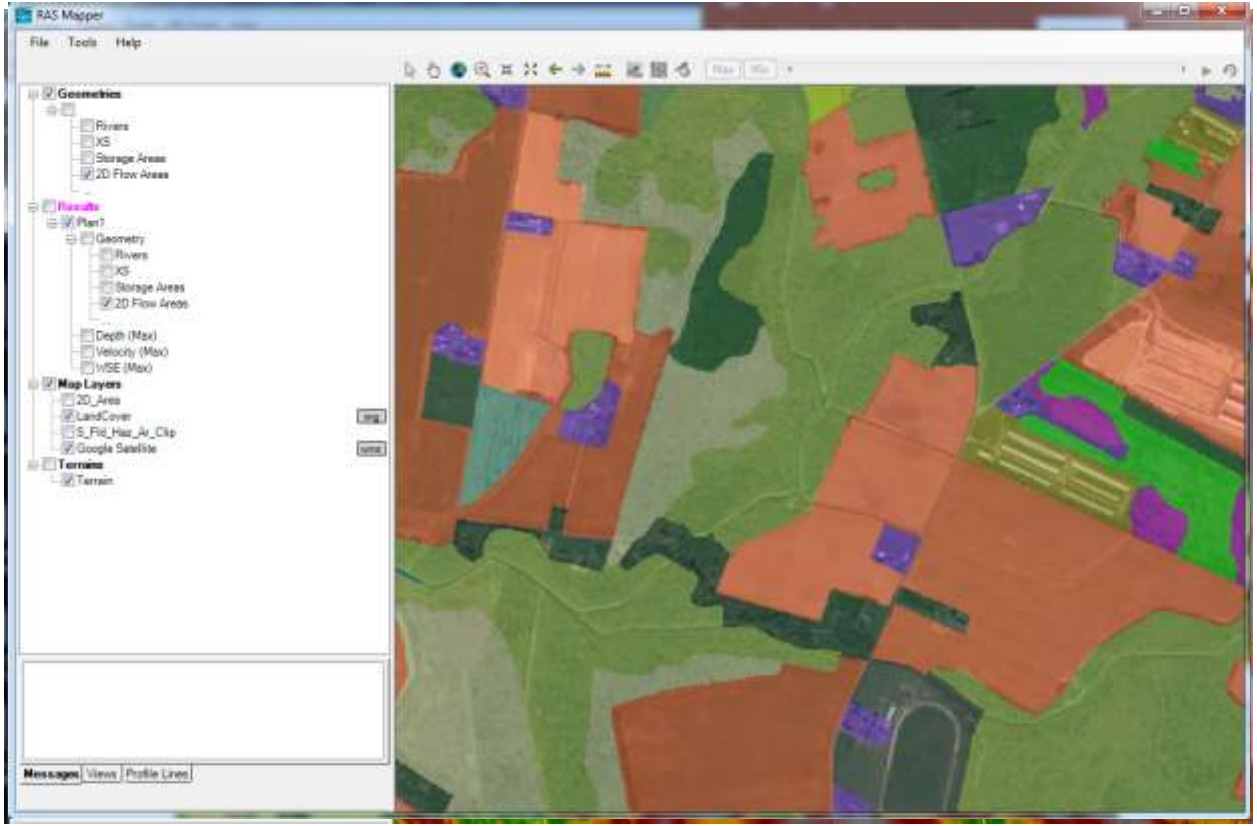
Define Mannings n values with LandCover



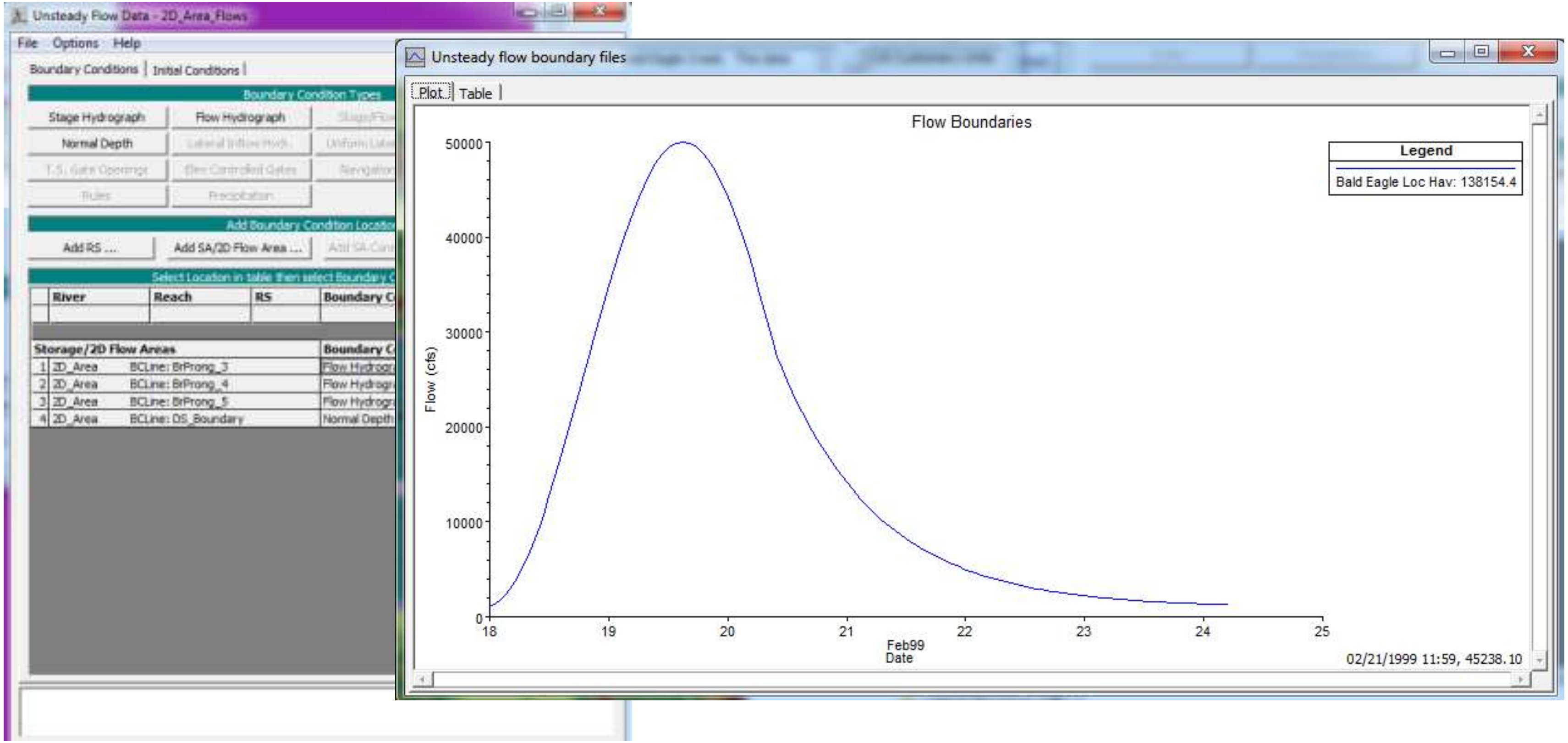
2D Model Inputs…



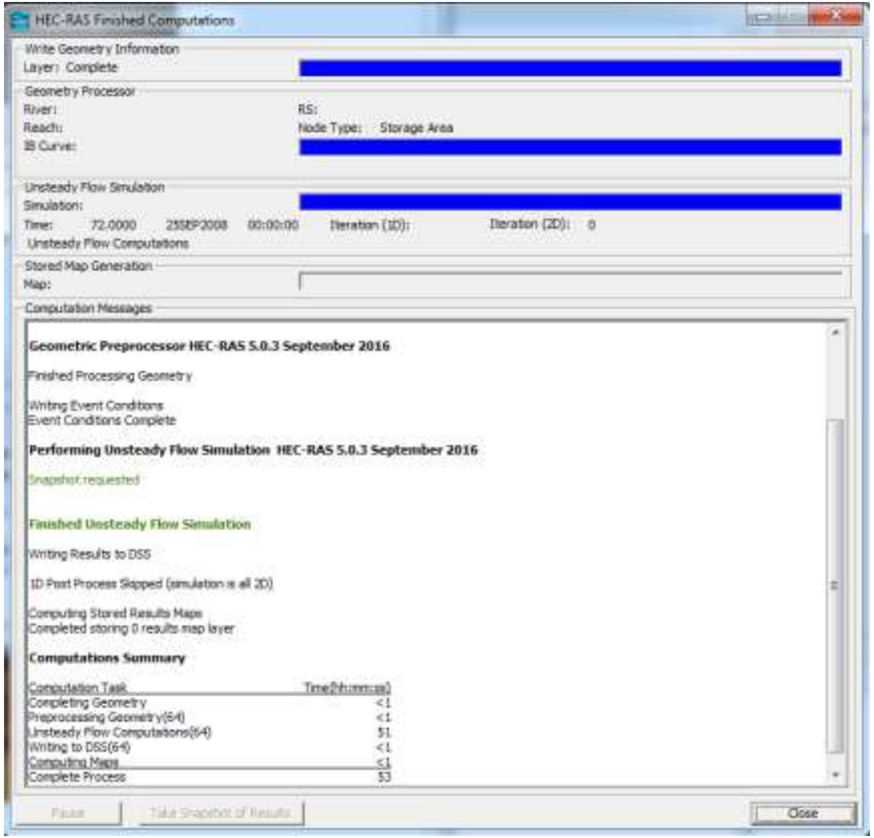
RAS Mapper


RAS Mapper
File Tools Help
Geometries
Rivers
XS
Storage Areas
2D Flow Areas
Results
Plan1
Geometry
Rivers
XS
Storage Areas
2D Flow Areas
Depth (Max)
Velocity (Max)
WSE (Max)
Map Layers
2D_Area
LandCover
Google Satellite
Terrains
Terrain
Messages Views Profile Lines

2D Model Inputs…



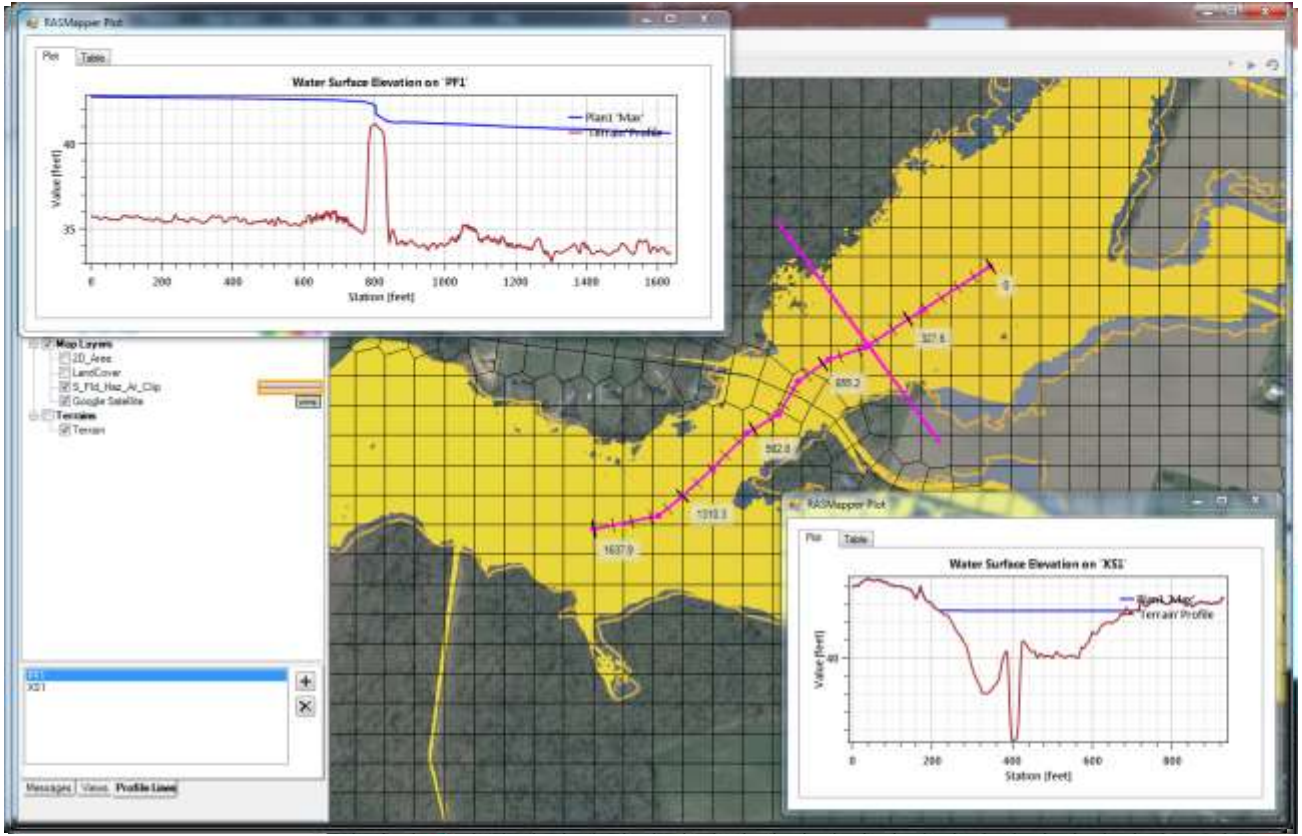
Running 2D analysis



Viewing 2D Output

- RAS Mapper
  - Real-Time Query
  - Dynamic Mapping
  - Managing Map Layers
  - Velocity Mapping
  - Adding profile lines*
  - Results by Cell

Viewing 2D Output cont…



Rasmapper

Conclusions

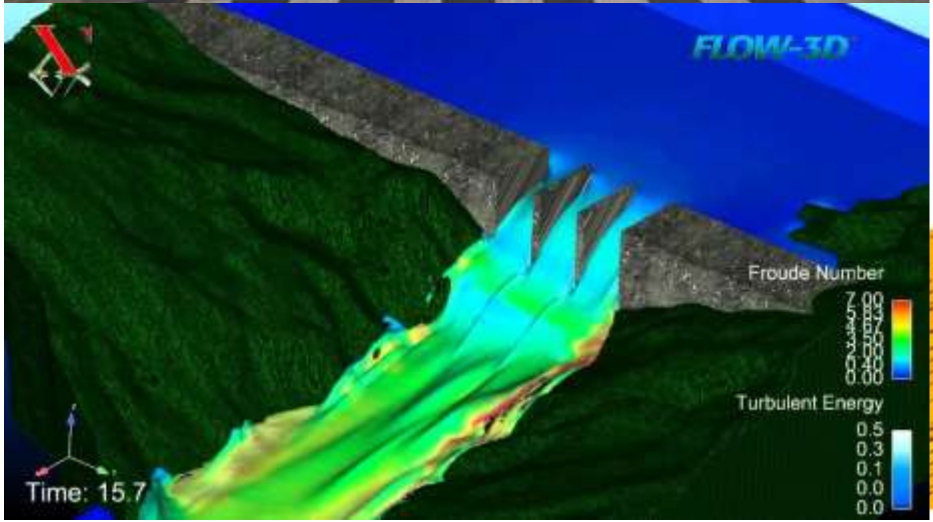
Technical obstacles:

1. Unsteady modeling experience (stability, flows)
2. 2D modeler expertise/experience
3. Linking 1D to 2D areas
4. Hydraulic structures

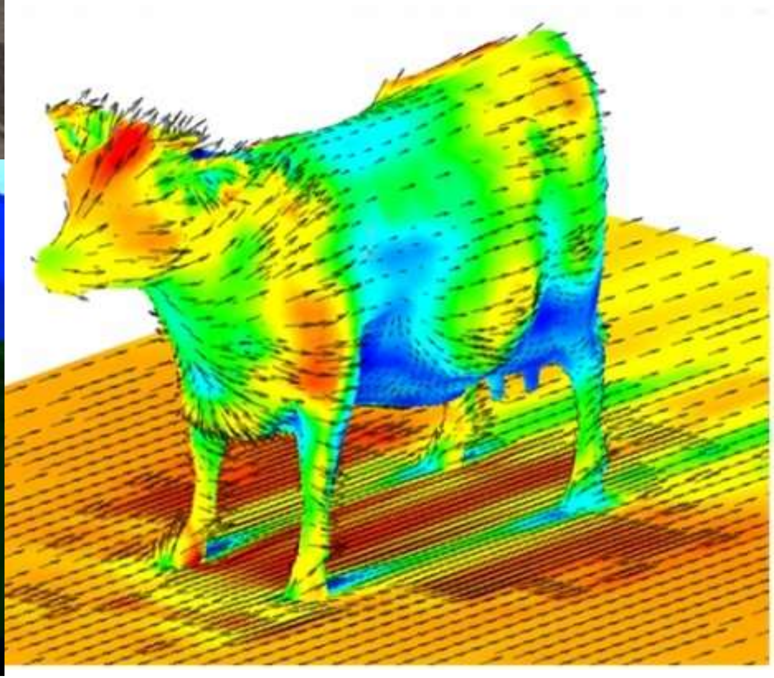
Regulatory obstacles:

1. Unsteady models
2. Awareness and acceptance
3. Expertise (reviewers)

Next time!....



FLOW-3D
Froude Number
7.00
0.00
Turbulent Energy
0.5
0.3
0.1
0.0
0.0
Time: 15.7




THANK YOU