

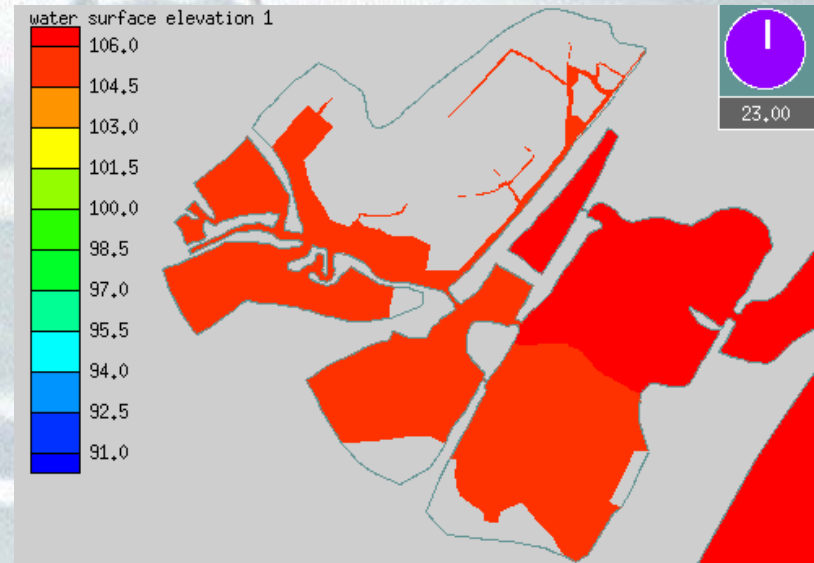
The Surface-water Modeling System (SMS)

2D Numerical Hydraulics
Alan K. Zundel Ph.D.



SMS – 2D Numerical Applications

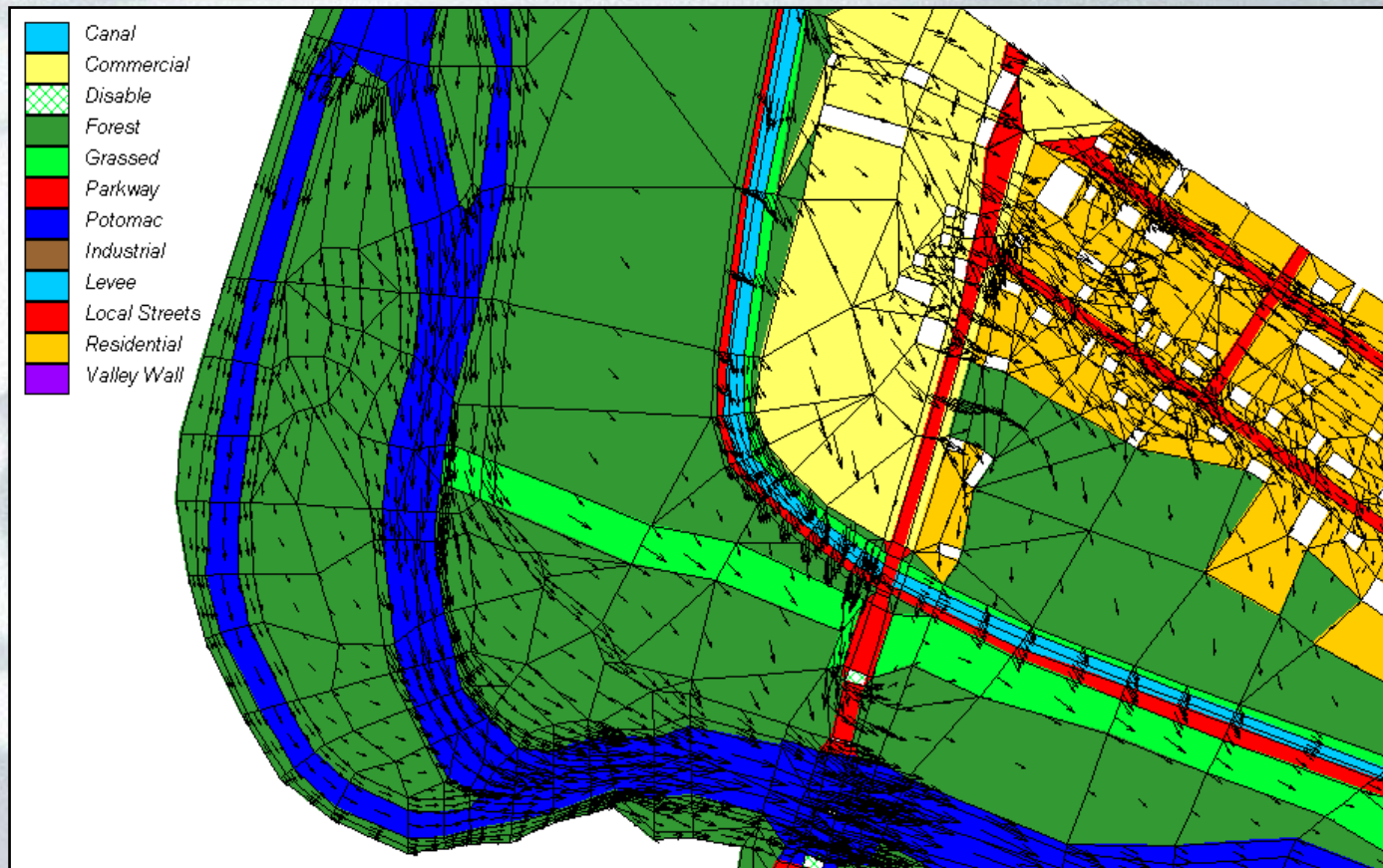
- Rivers
- Estuaries/Bays
- Coastal Zones
- Theoretical Studies



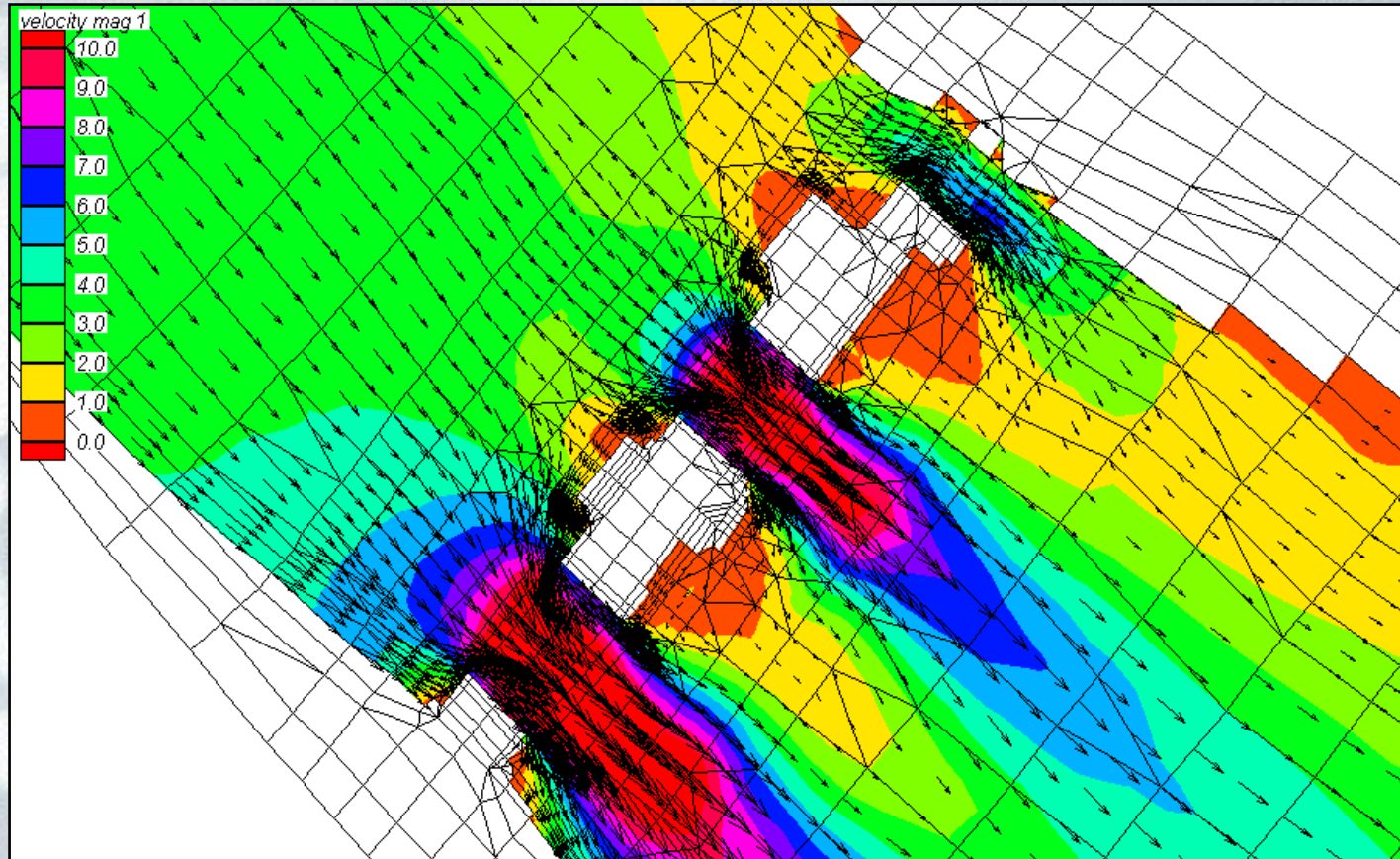
Rivers

- Flooding – Inundation studies
- Bridge Crossings
- Velocity/Scour/Sedimentation
- Flow Separations
- Navigation Studies

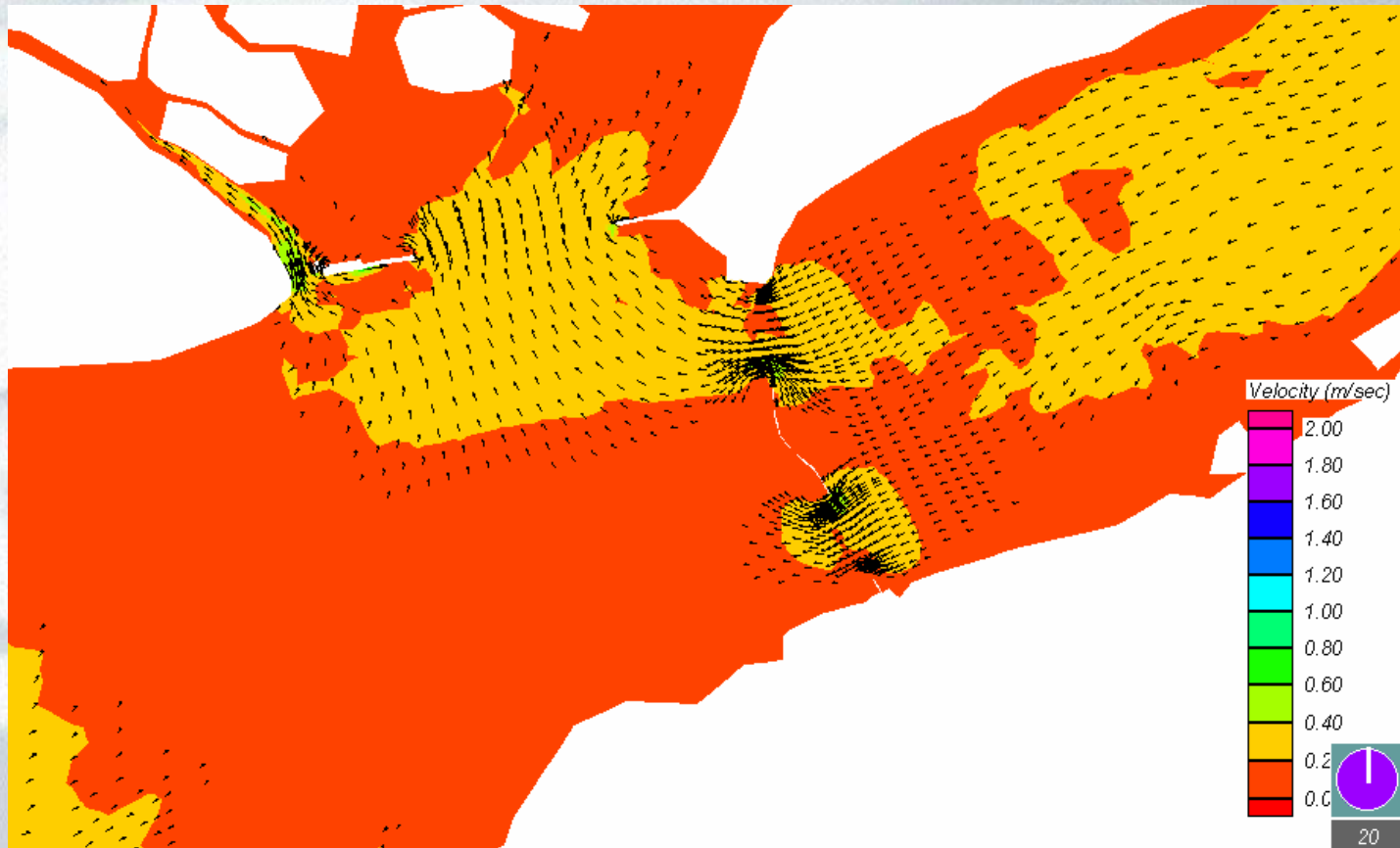
Floodplain Analysis



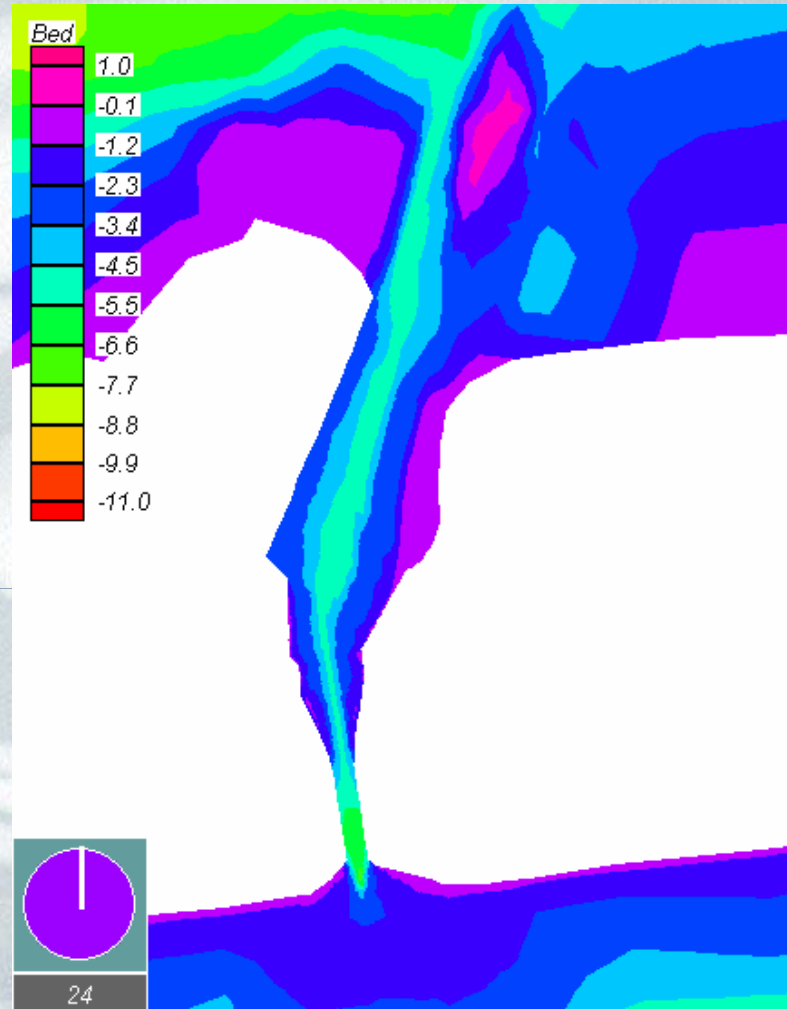
Bridge Design



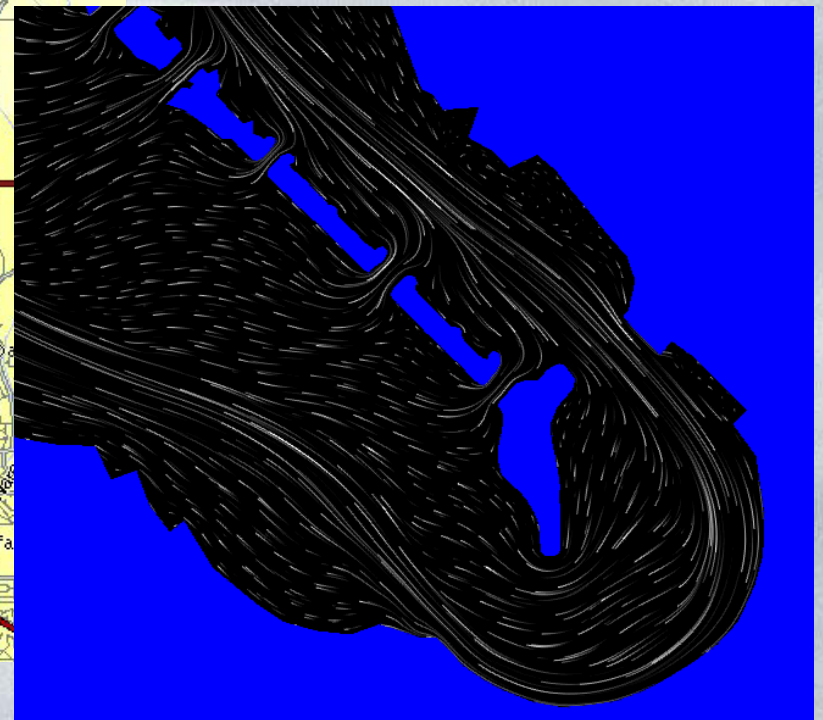
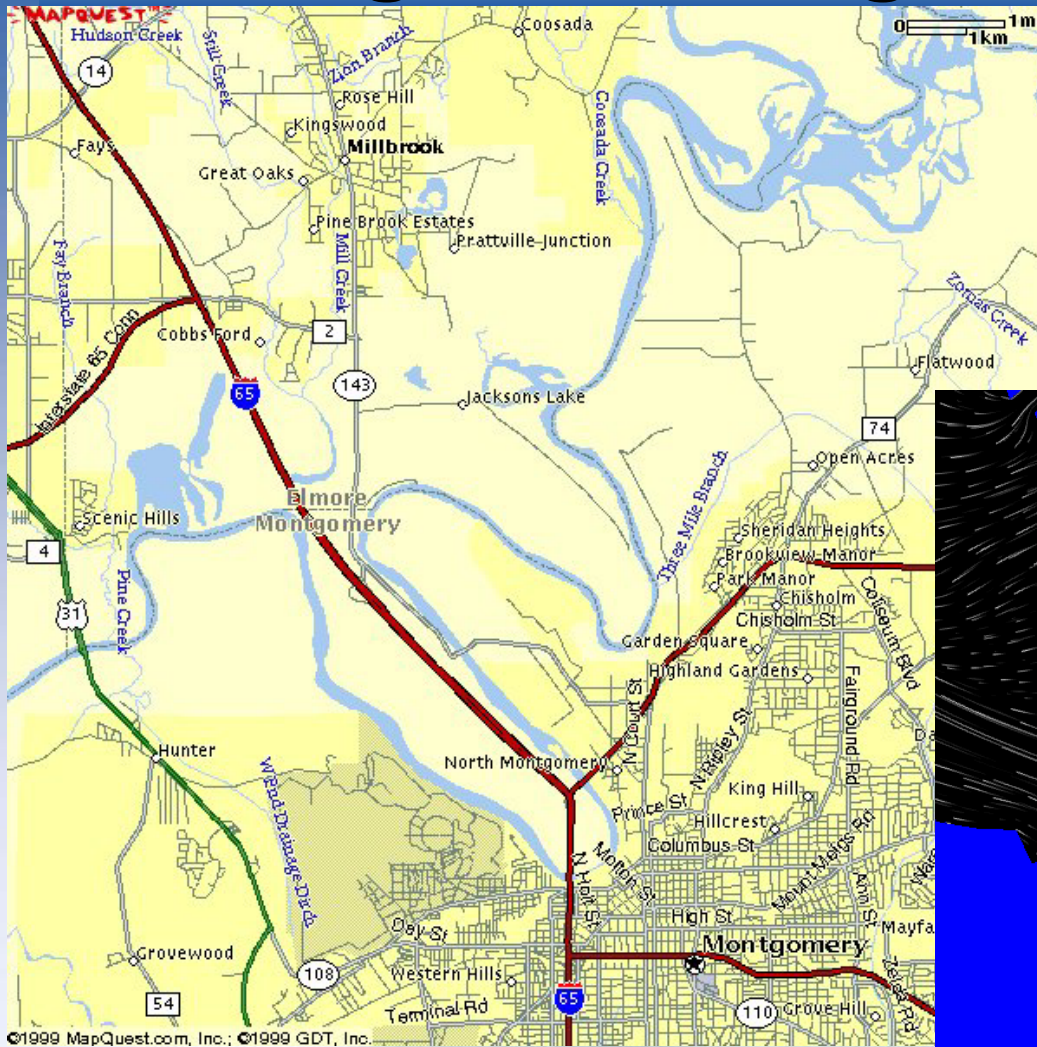
Dynamic Flow Analysis



Sediment Transport



Bridge Crossings – Interstate 65



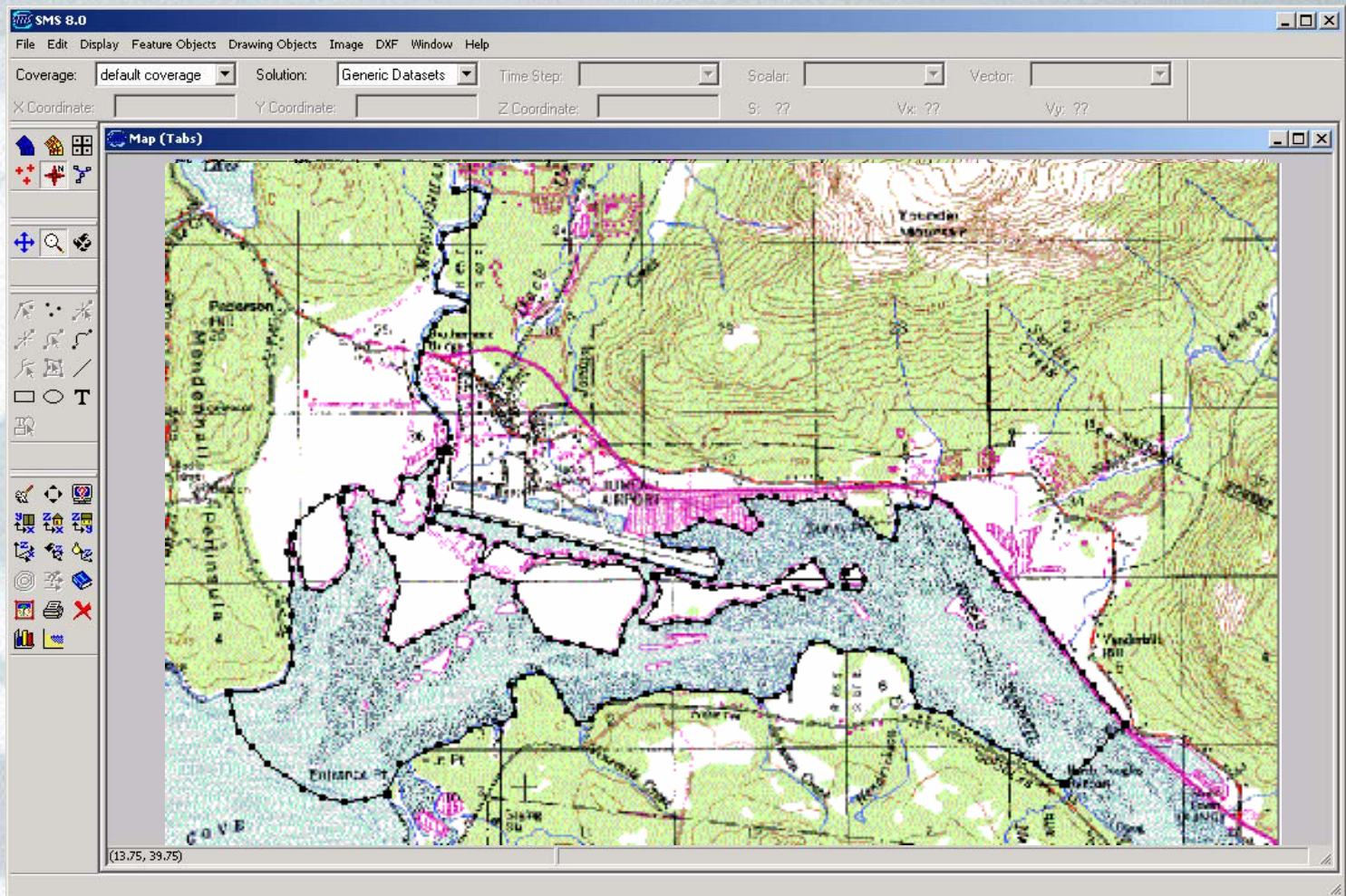
Flow Separations – Mississippi River



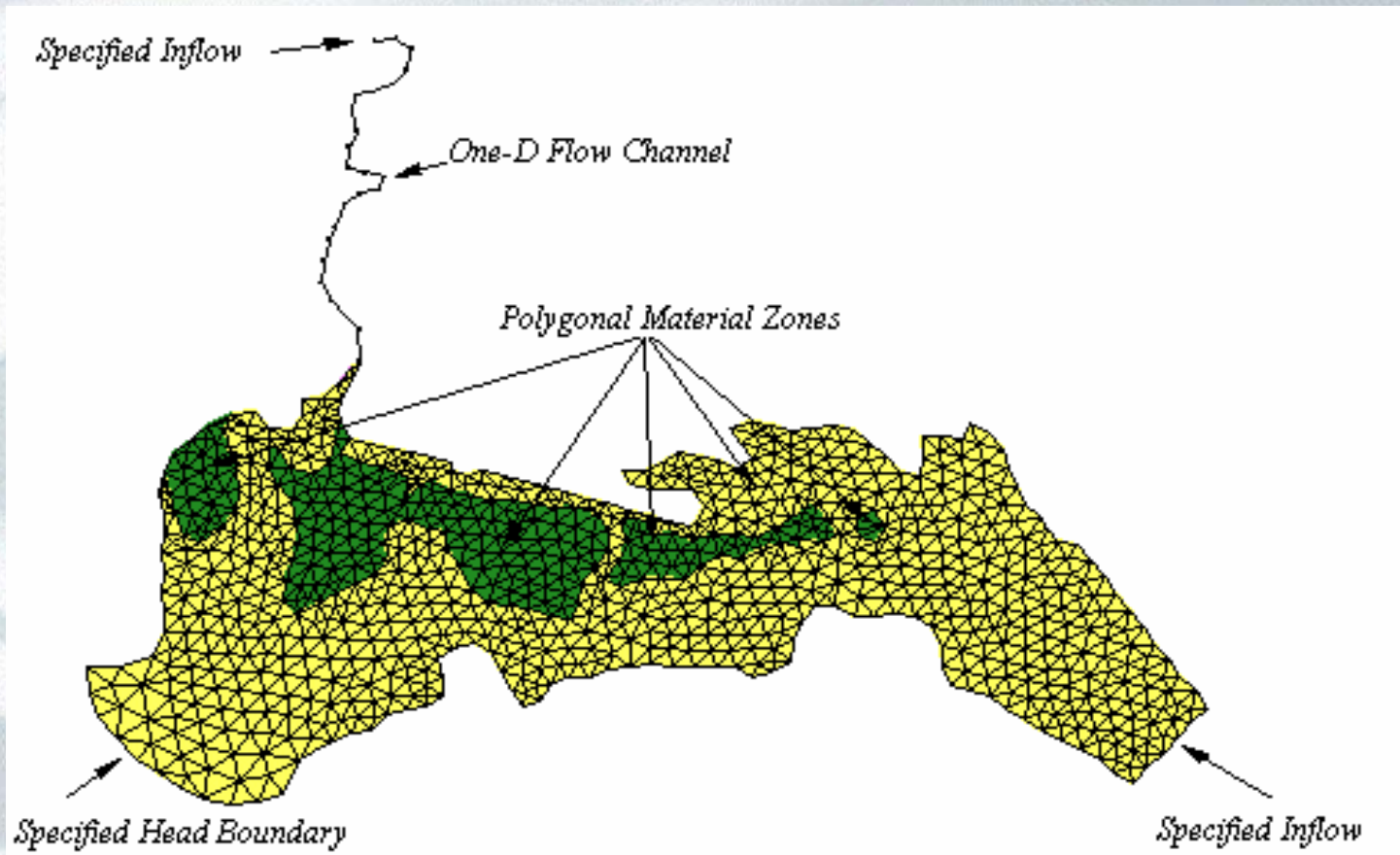
SMS Functional Modules

- Map Module
 - ▶ Background Images
 - ▶ Conceptual Model
- Scatter Point Module
 - ▶ Survey Data – Visualization and Filtering
- Mesh Module
 - ▶ Numerical Model – FESWMS/Flo2DH Data
- River Module
 - ▶ HEC-RAS Data

Map Module Data



Automatically Generated Mesh



Flo2DH Interface – Model Control

Network Stamp: Flume For Hydraulic Jump
BC descriptor: 5 ft. downstream head

FESWMS Version:
Read/Write as version: FESWMS 1.* FESWMS 2.* FESWMS 3.*

FLO2DH Input
Created by SMS

NET file External files
 BND file Restart
 Time file INI file jump_steer.flo
 Wind file Initial Sediment
 Wave file

FLO2DH Output

LUD matrix file
 Scalar Data Set file Options
 Vector Data Set file Options
 Restart
 Sediment Transport Solutions

Run Type

Hydrodynamic
 Sediment
 Semi-coupled

Bottom Stresses:

Manning's Equation
 Chezy Equation

Solution Type:

Steady state
 Dynamic

Slip Conditions:

Slip
 No slip
 Semi-slip

Higher Order Integration:

None
 Curved
 All

Write data every:
0 th time step

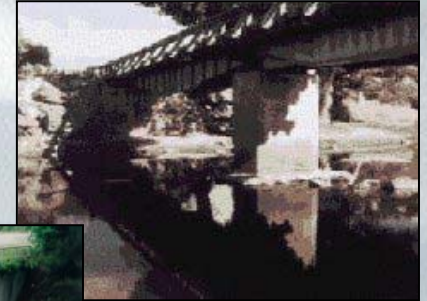
Wind/Storm... Iterations... Sediment...
Parameters... Print...
Help OK Cancel

- Simulation Comments
- Version
- Hydrodynamics/Sediment
- Steady State/Dynamic
- Output Options

Hydraulic Structures

Hydraulic structures that can be modeled with 2D modeling include the following:

- Bridges
- Culverts
- Weirs
- Roadway embankments
- Drop-inlet spillways



1 Dimensional Flow Control

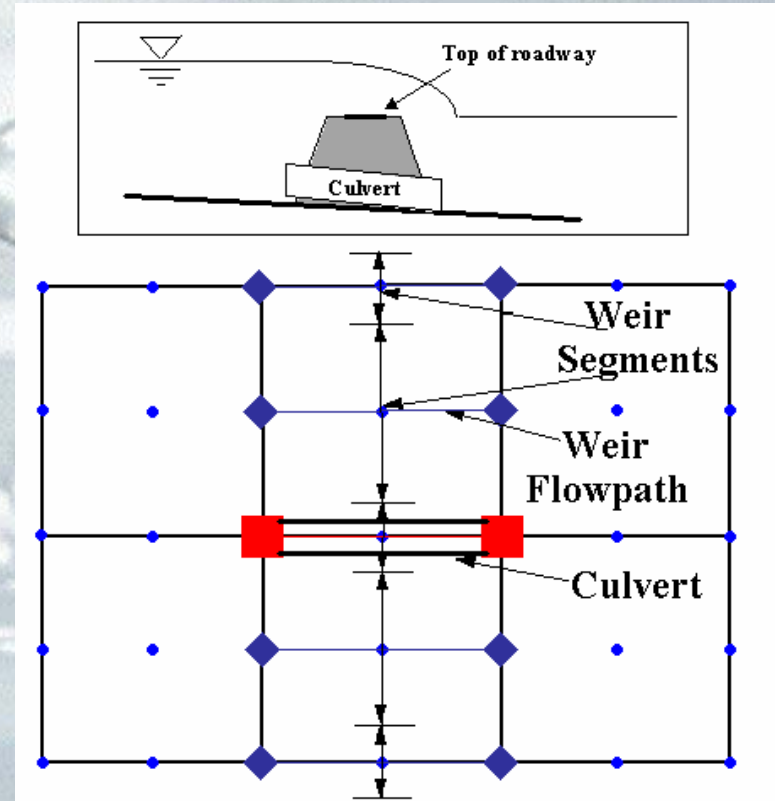
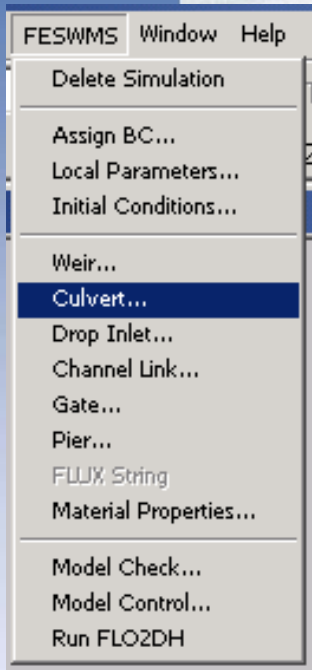
Several types of hydraulic structures can be modeled as one-dimensional links between node points:

- Weirs
- Culverts
- Gates
- Channel Links
- Drop-inlet spillways



1 Dimensional Flow Control

- Select the position in the network.
- Select the structure type from the menu



1 Dimensional Flow Control

- Specify the structure characteristics

FESWMS Weir

Upstream node id: 40
Downstream node id: 54

Switch

Flap-gate:

ID string:

Weir Coefficients

Weir type: Gravel roadway

Default discharge and submergence coefficients

Override

Cw - discharge: 0.544 0.5

a-sub - submergence: 15.40 0.0

b-sub - submergence: 0.608 0.0

Weir Geometry

Lw - Crest length: 25

Zc - Crest elevation: 54

Minimum Head Difference: 0.0

Free Flow

Tailwater Elevation

Weir Description

Help OK Delete Cancel

FESWMS Culvert

ID string: culvert

Comment:

Nodes

Upstream ID: 40

Downstream ID: 54

Switch

Flap-gate:

Type code: 1011

Material: Concrete

Shape: Circular

Inlet: Headwall, square edge

Number of barrels: 2

Entrance loss coefficient (ke): 0.2 Help

Manning roughness coefficient (nc): 0.015 Help

Rise (height): 50.0

Span (width): 48.0

Barrel length (Lc): 200.0

Invert elevation at upstream node: 226.0

Invert elevation at downstream node: 221.0

Tailwater elevation for outlet control: 0.0

Minimum head difference: 0.0

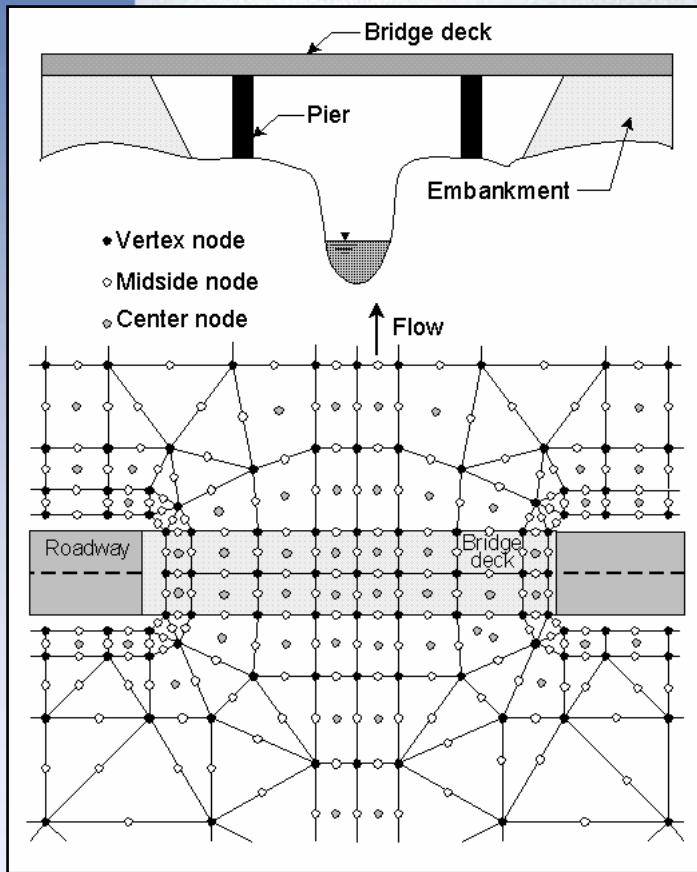
Riprap basin depth: 0.0

Inlet Control Flow Coefficients

	Default values	Override defaults
K:	0.0098	<input checked="" type="checkbox"/> 0.0098
M:	2.000	<input type="checkbox"/> 0.0
c:	0.0398	<input checked="" type="checkbox"/> 0.0398
Y:	0.670	<input type="checkbox"/> 0.0
alpha:	1.040	<input type="checkbox"/> 0.0

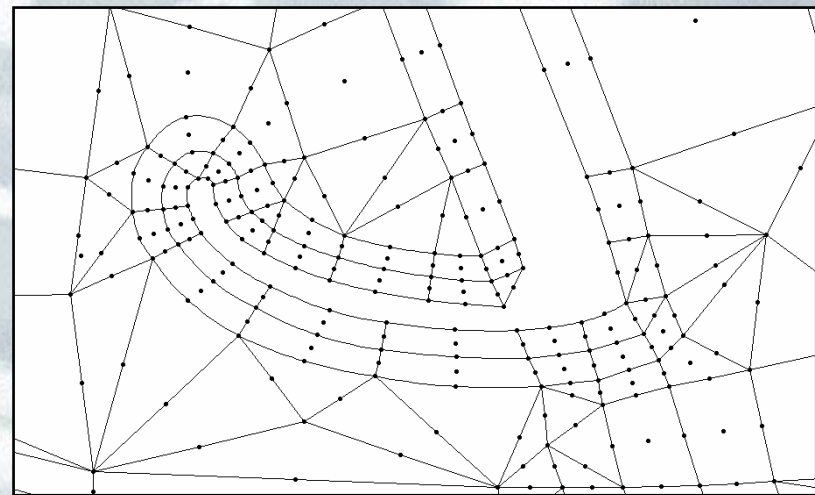
Help OK Delete Cancel

2-Dimensional Flow Control

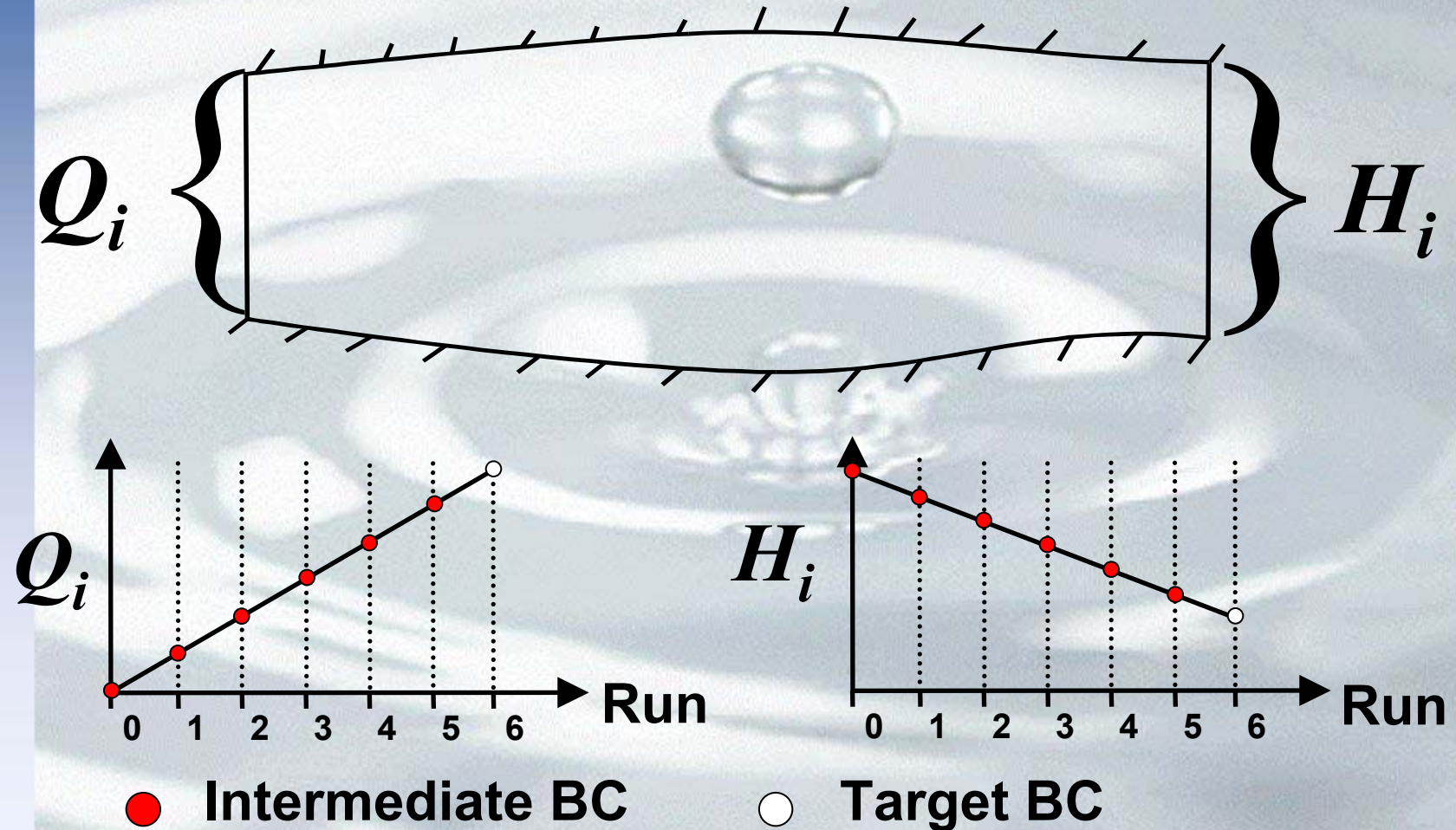


Form elements around the structure:

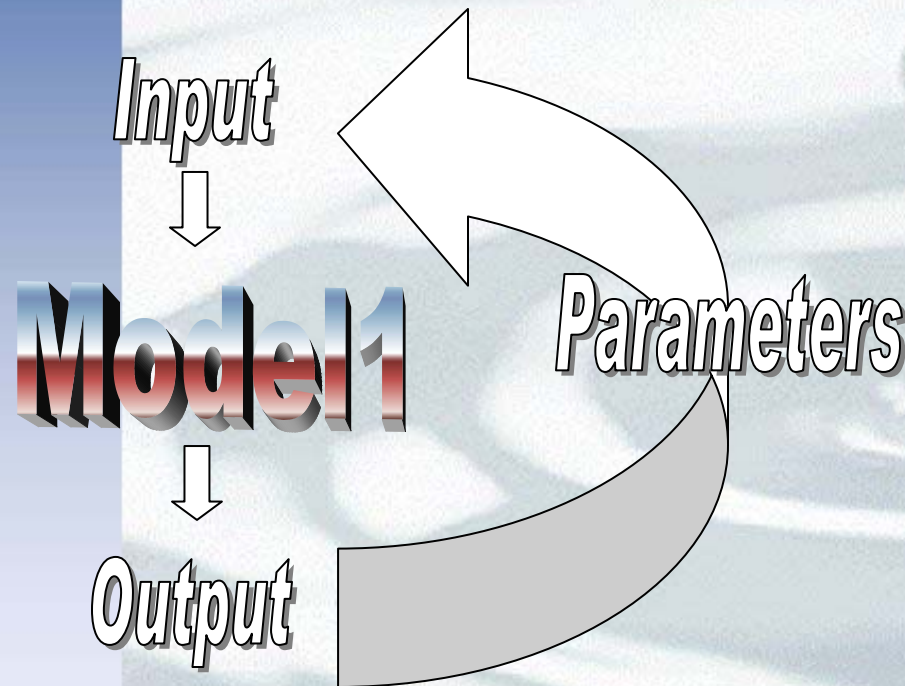
- Embankments
- Guidebanks



Incremental Loading Strategy



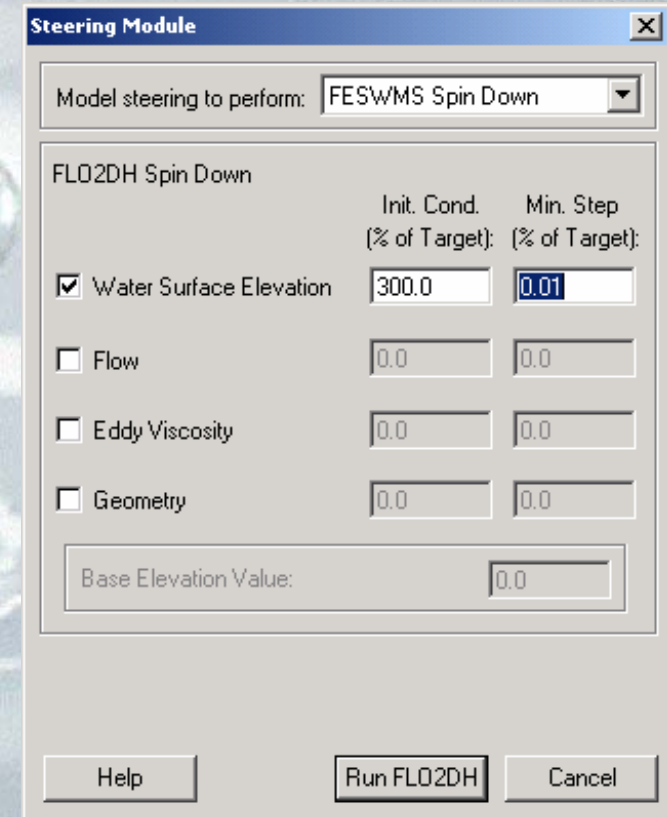
Single Model Steering



- Model Warm Up
 - ▶ Ramp Parameters
 - Flow rates
 - Water elevations
 - Eddy Viscosity
 - Geometry
- Multiple Cases
 - ▶ Range Parameters
 - Roughness
 - Viscosity
 - Particle Size

Automatic Incremental Loading

- Spin Down Channel
- Select Spin Down Option
- Initial Percentage
- Minimum Step



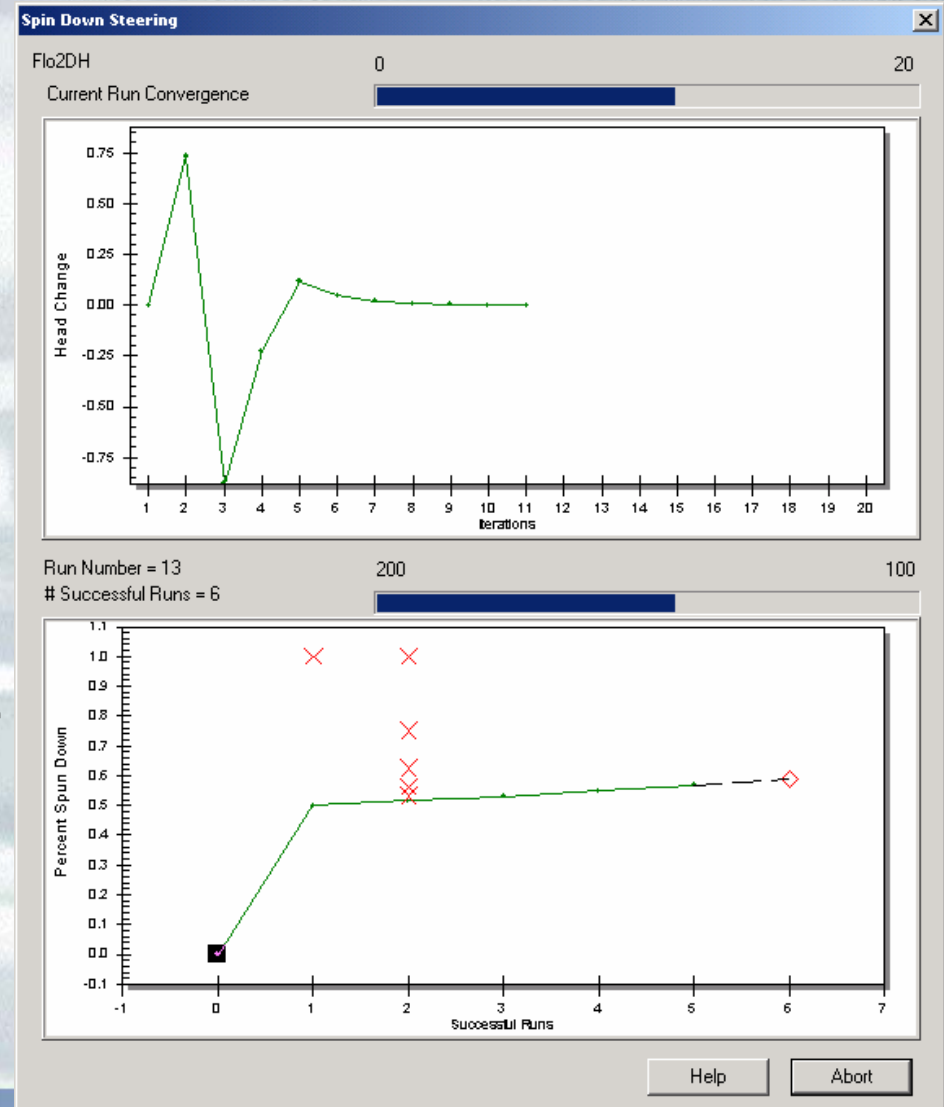
The image shows a software dialog box titled "Steering Module" with a close button (X) in the top right corner. The dialog is set to "Model steering to perform: FESWMS Spin Down". It contains a section for "FLO2DH Spin Down" with the following parameters:

	Init. Cond. (% of Target):	Min. Step (% of Target):
<input checked="" type="checkbox"/> Water Surface Elevation	300.0	0.01
<input type="checkbox"/> Flow	0.0	0.0
<input type="checkbox"/> Eddy Viscosity	0.0	0.0
<input type="checkbox"/> Geometry	0.0	0.0

Below this table is a "Base Elevation Value:" field with a value of 0.0. At the bottom of the dialog are three buttons: "Help", "Run FLO2DH", and "Cancel".

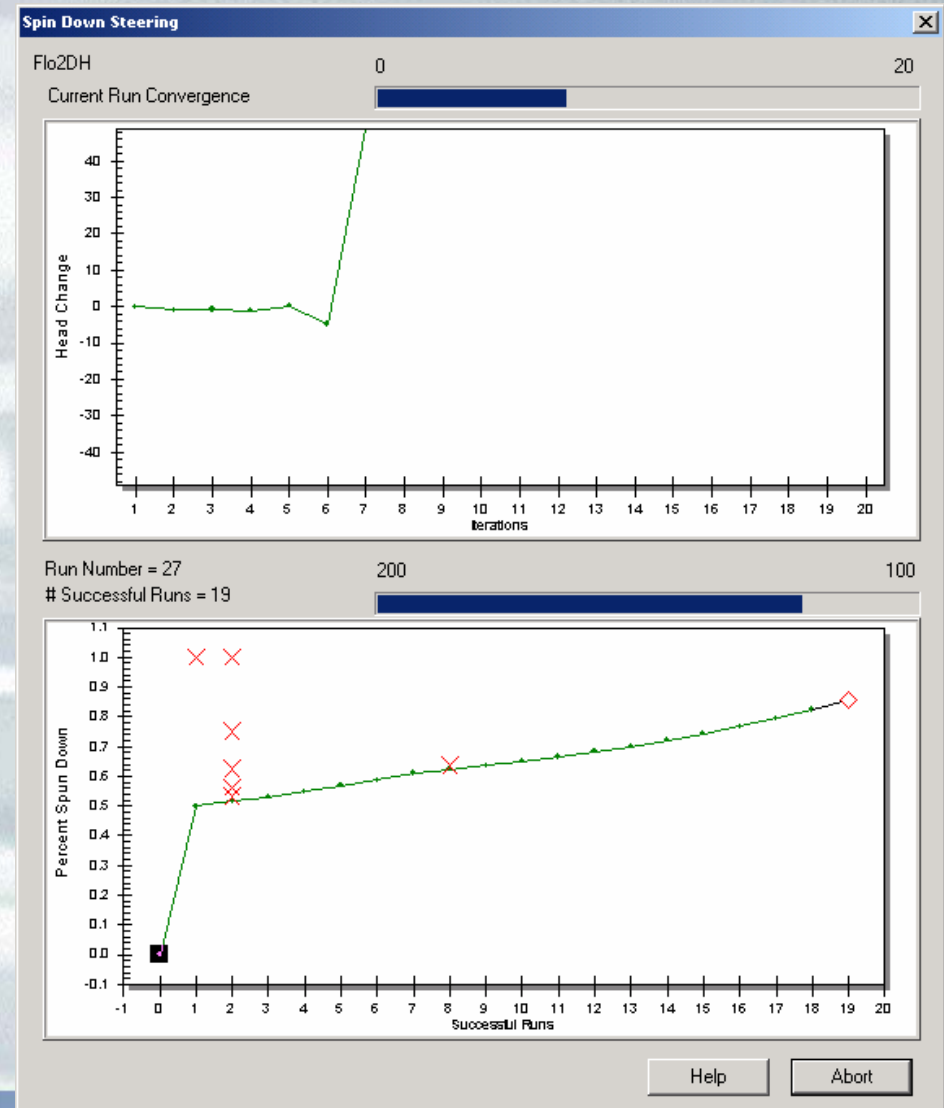
Successful Step

- Top Bar
 - ▶ Iteration Number
- Top Graph
 - ▶ Depth Convergence
- Run Numbers
- Bottom Bar
 - ▶ Percentage Complete
- Bottom Graph
 - ▶ Completion



Unsuccessful Step

- Divergent Top Graph
- X added to Bottom Graph
- Smaller increment selected



SMS – 2D Numerical Models

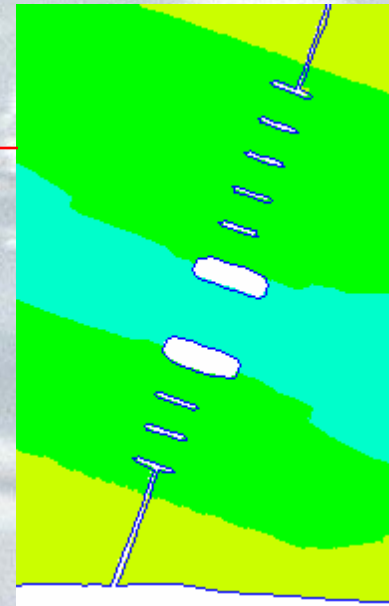
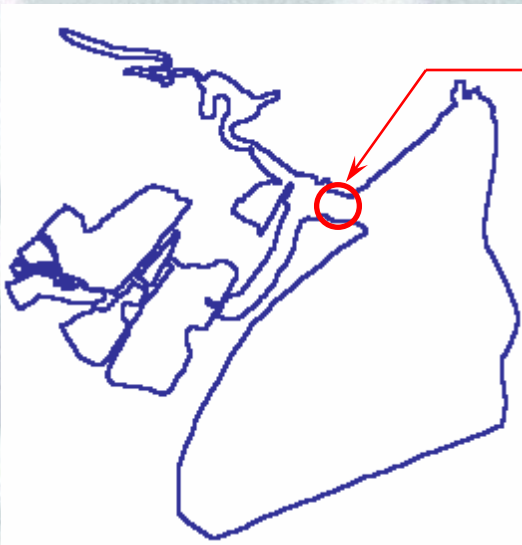
- River Hydraulics/Water Quality
 - ▶ Flo2DH
 - ▶ RMA2/RMA4/SED2D-WES
- Coastal Circulation
 - ▶ ADCIRC
 - ▶ M2D
- Wave Analysis
 - ▶ STWAVE
 - ▶ CGWAVE

Applications in Estuaries/Bays

- Tidal Flooding
- Freshwater/Saltwater Interfaces
- Marsh Circulation
- Navigation Channels
- Water Quality – Detention
- Storm Modeling

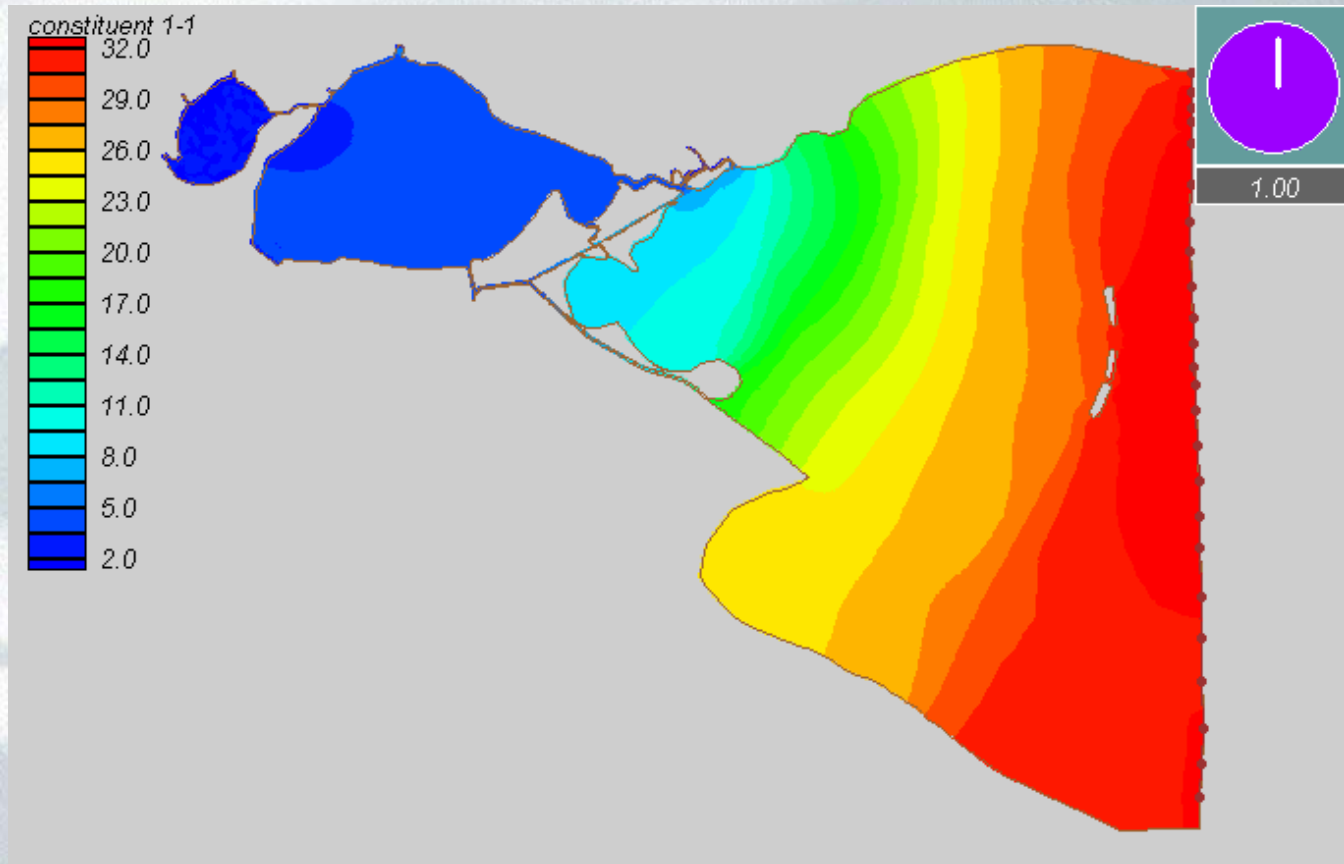
Tidal Flooding – Saugus Bay

- Wetting and drying
- Flood control gate
- Guard against severe wave conditions (storm surge)



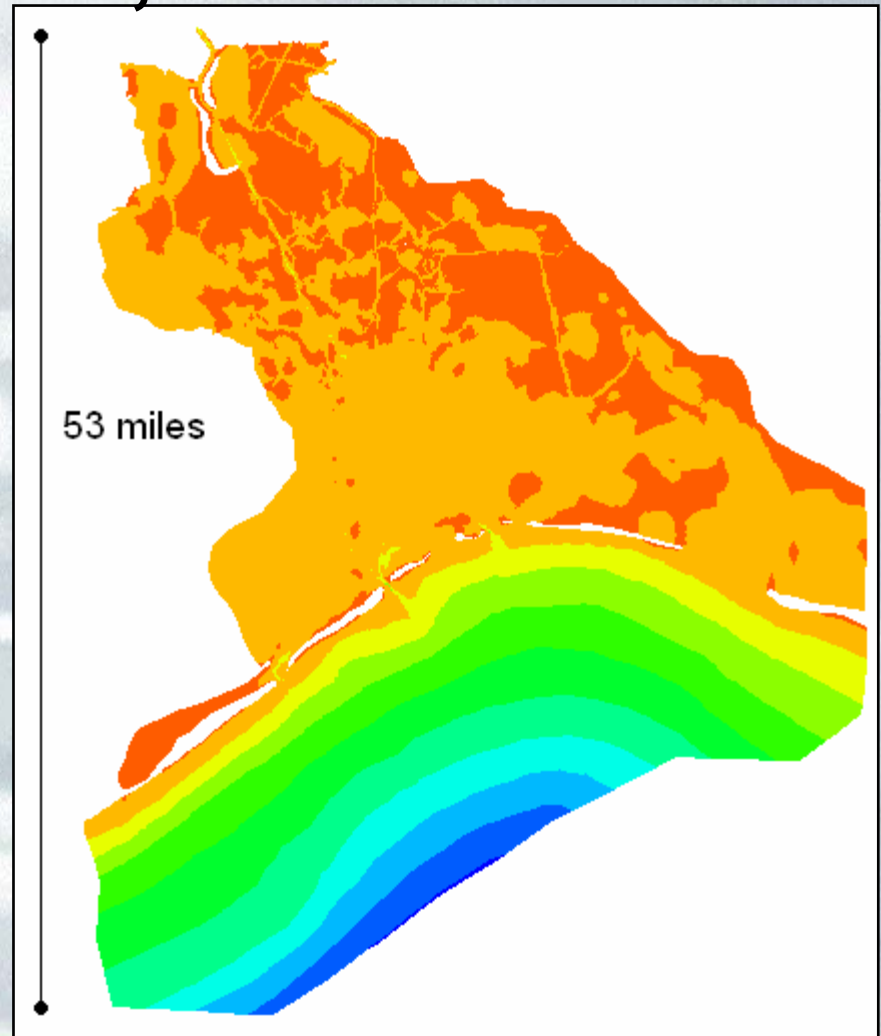
Salinity Intrusion –

Lake Ponchartraine - Louisiana

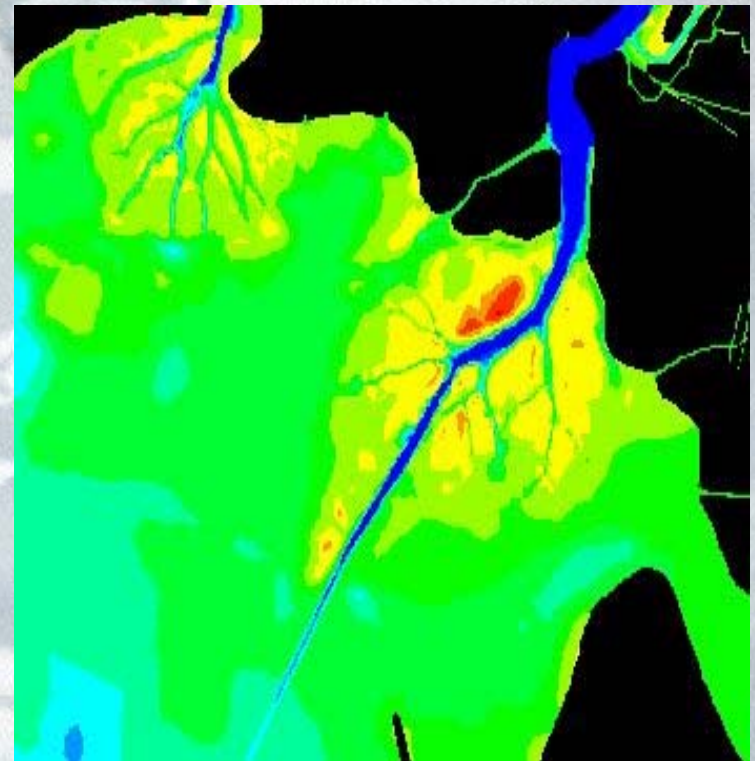


Freshwater Discharge – Barataria Basin, Louisiana

Water Quality
Issues



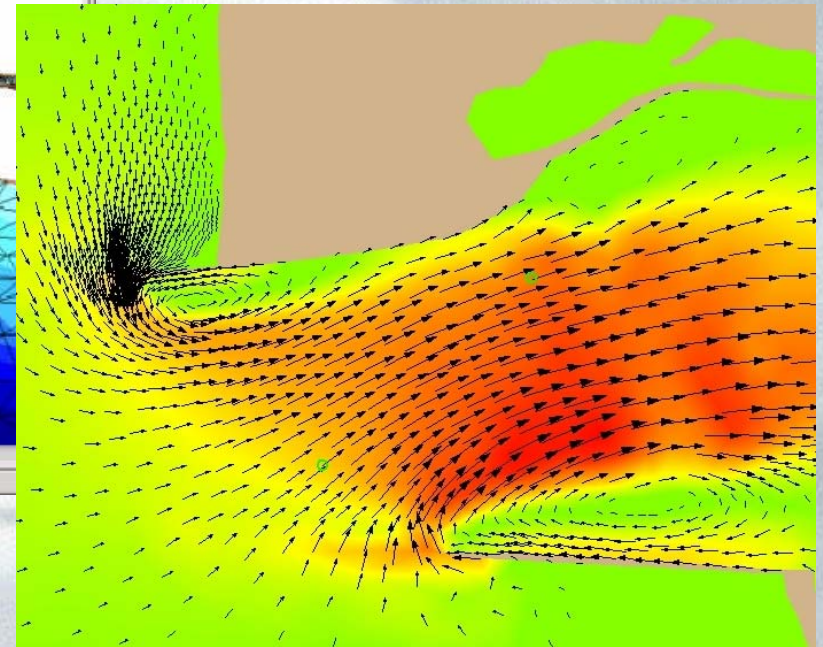
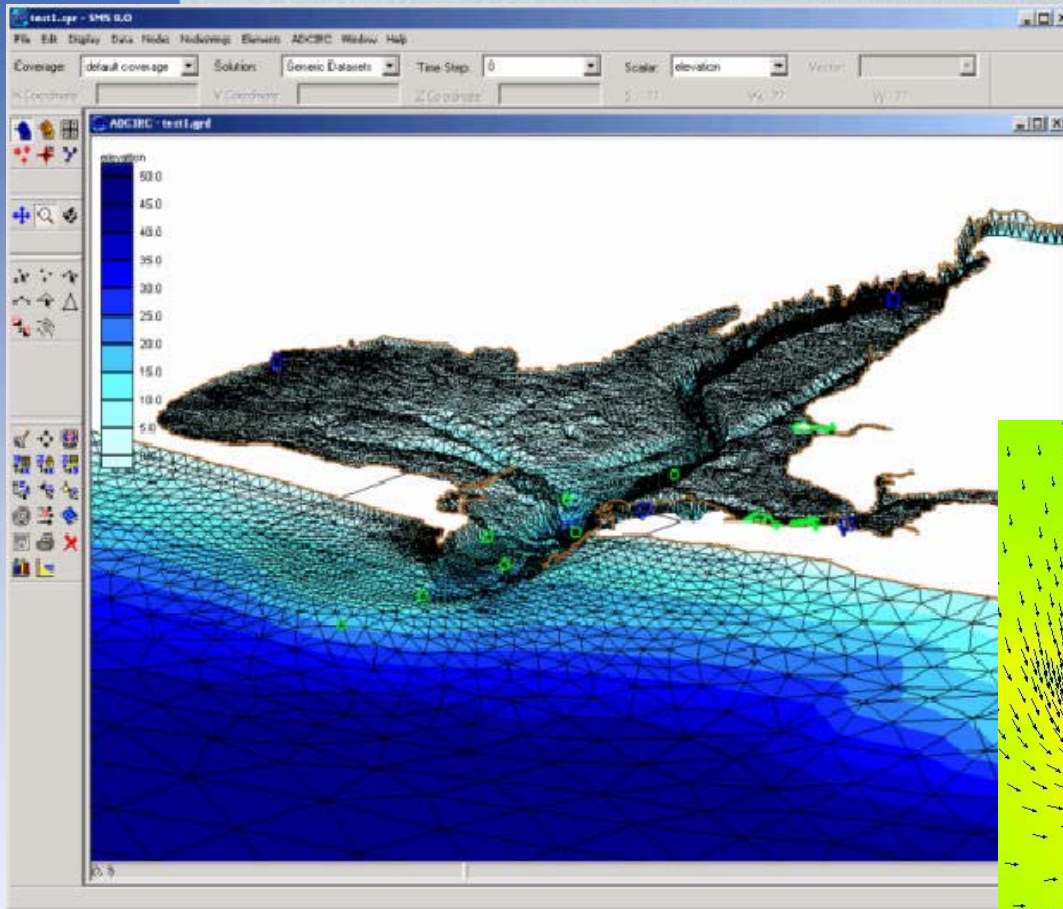
Marsh Circulation– Atchafalaya Bay Delta



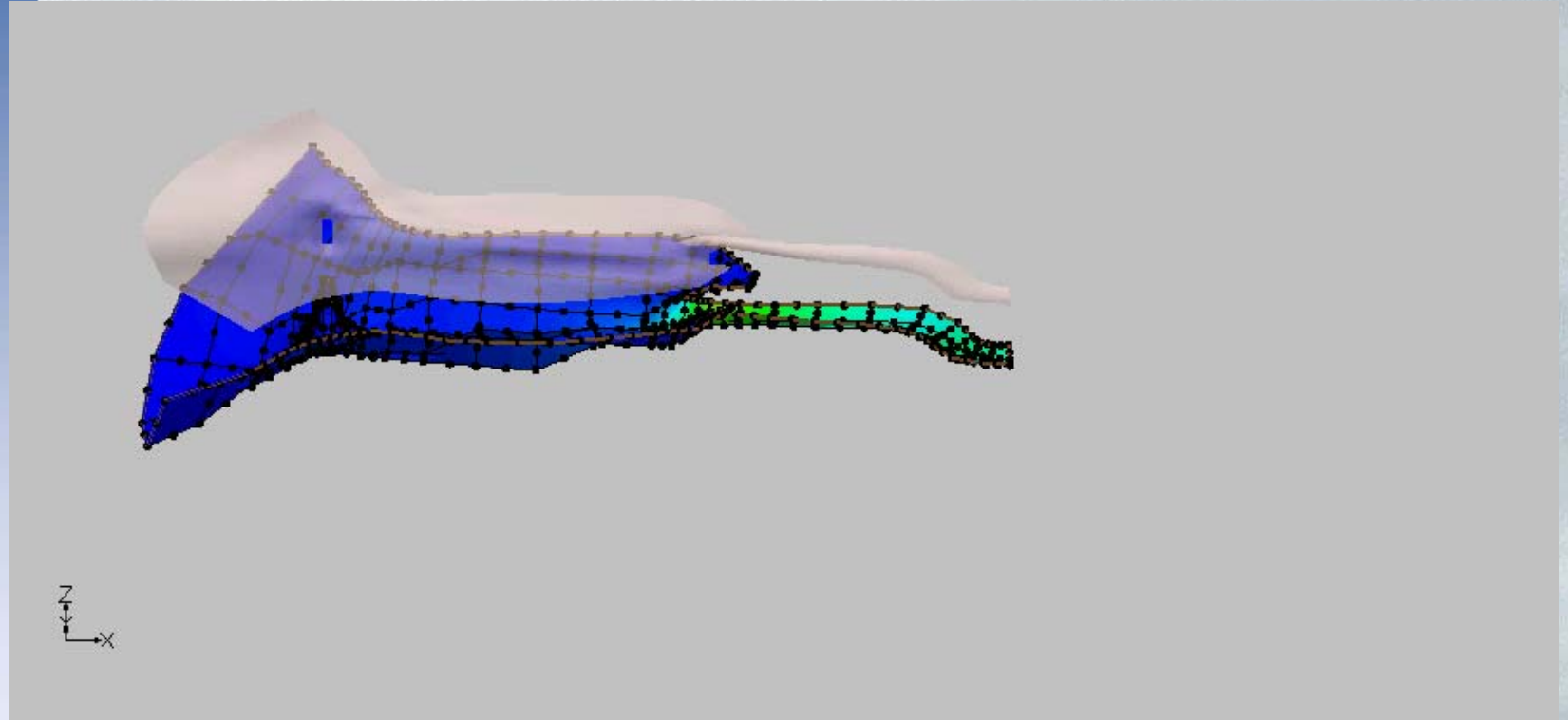
New Visualization

- Three Dimensional Views
- Functional Surfaces/Animations
- Drogue Plots

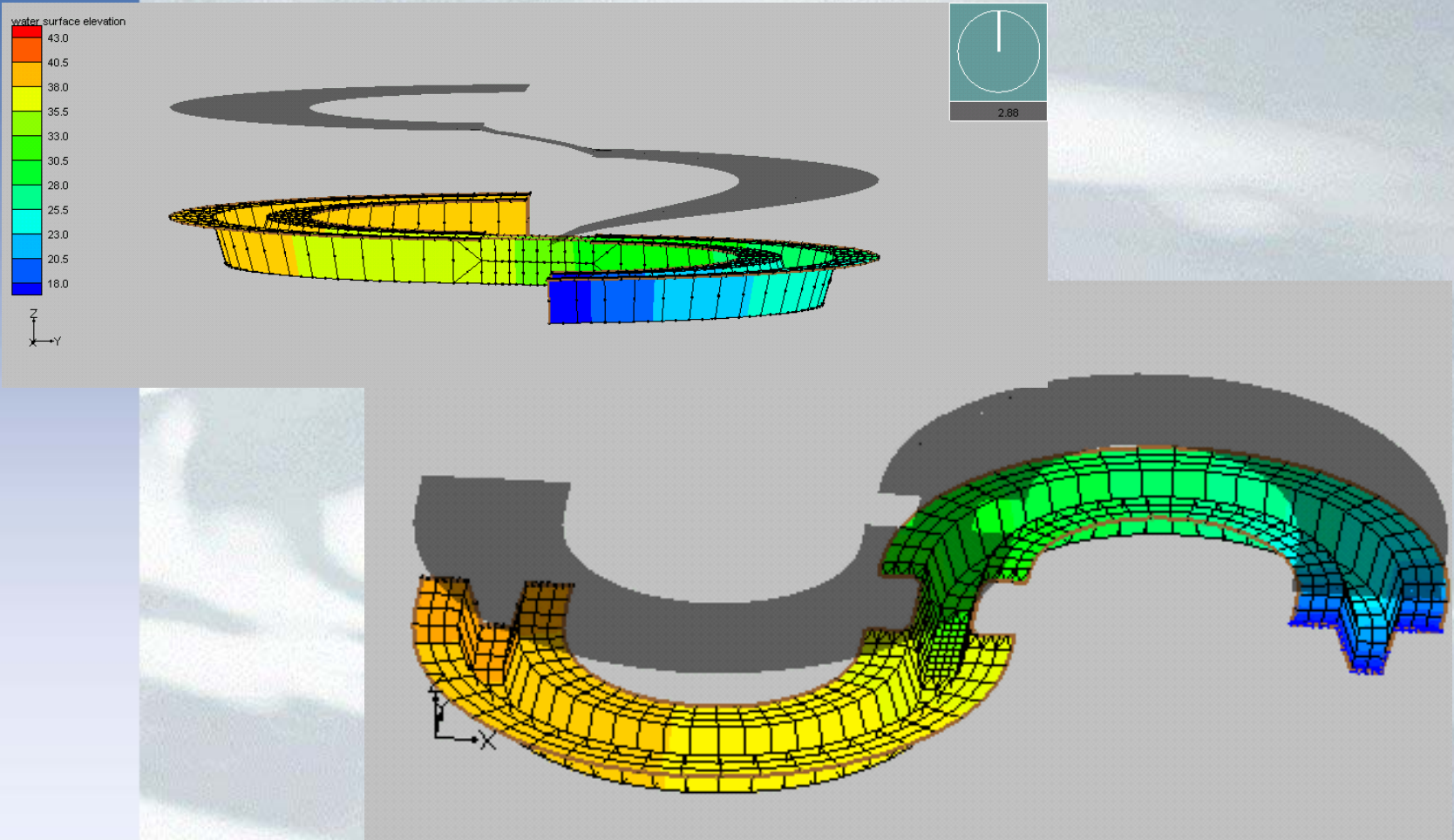
3-Dimensional View



Animation of View Location



Animated Water Surface

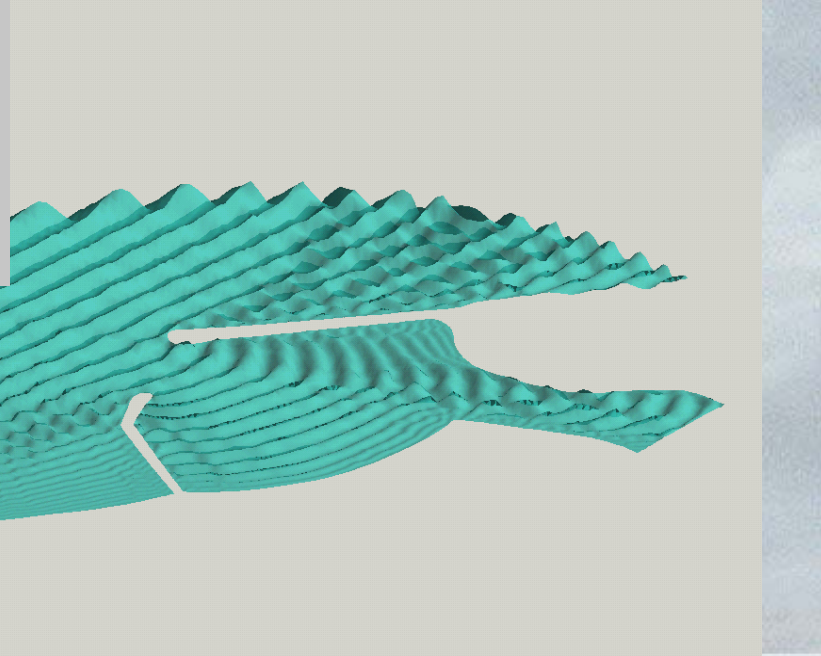
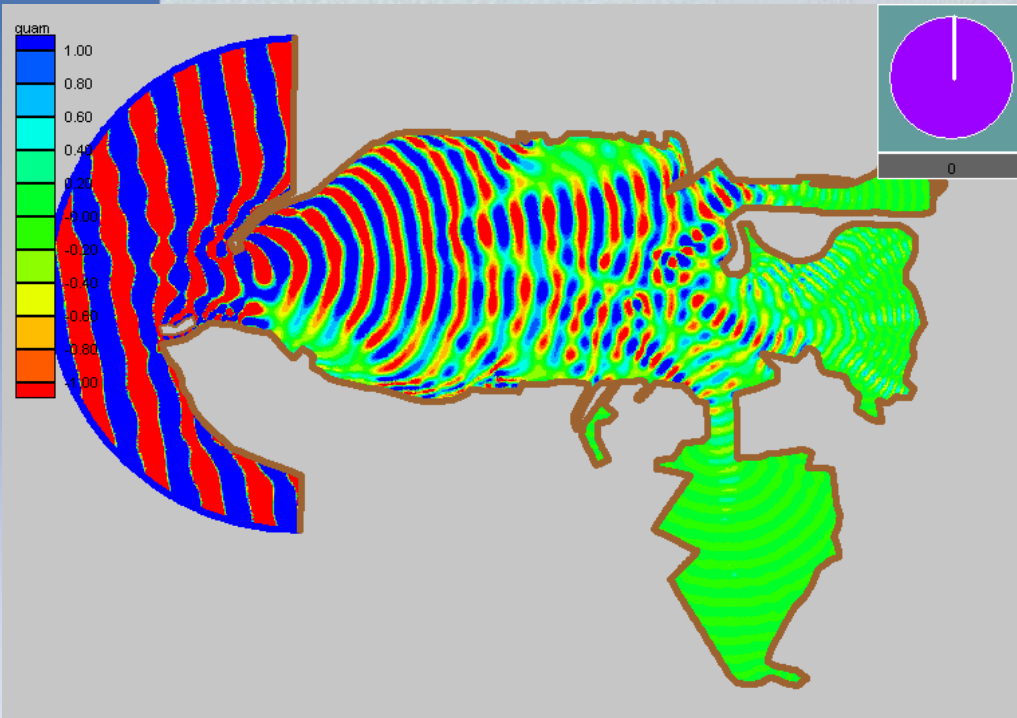


Drogue Plots



Environmental Modeling Research Laboratory, BYU

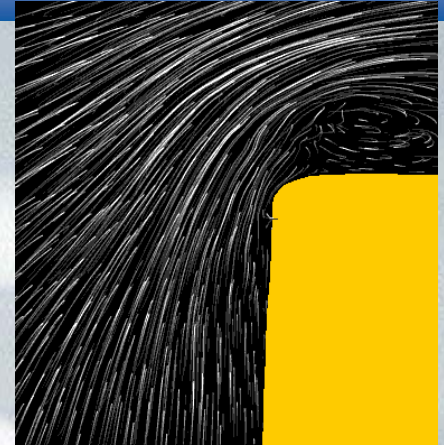
Other Applications



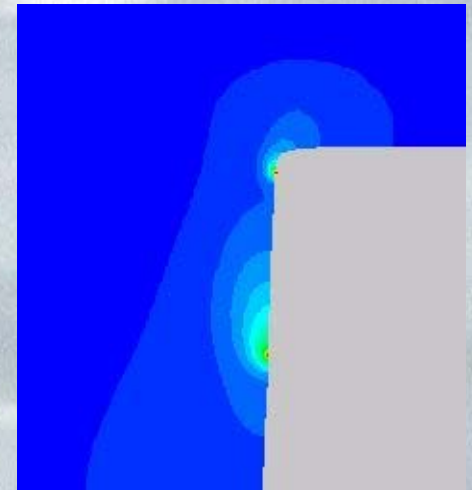
Theoretical Applications

- Design Alternatives
- Flumes
- Artificial Conditions
- Sensitivity

Using models to Examine Effects of Outlet Weirs from a Confined Disposal Facility (CDF)



Flow Trace at Ebb Tide



Turbidity Plume at Ebb Tide

The End

- Questions?

