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Vancouver Lake
Briefing Objectives

- Background
- Section 536 Program overview
- Feasibility Study scope & strategy
- Biologic Synthesis
- HEC RAS (1-D model)
- 2-D Hydrodynamics

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Background

- **USACE & Partnership objectives**
  - Environmental restoration
  - Watershed issues & concerns
  - GI study
- **Section 536**
  - Authorization: WRDA 2000
  - Funding: Cost Shared
  - Scope: Tidally influenced estuary & side channel salmonid habitat restoration

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Feasibility Study Scope & Strategy

- **Preliminary investigation**
  - Site survey for habitat potential
  - Preliminary Restoration Plan
- **Biological Synthesis**
  - Historical & literature search
- **Hydraulic dynamics**
  - Bathymetry
  - 1-D model
  - 2-D model

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Biologic Synthesis

- Background and lake history
- Critical assumptions & constraints
- Salmonid use & history prior to lake modifications
- Regional recommendations prior to flushing channel construction (1977)
- Post construction studies Envirosphere (1984)
- Fisherman Environmental Services (2002)

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Biologic Synthesis Findings

- **Juveniles enter lake via the flushing-channel**
- **Comprise yearling and subyearling Chinook**
- **Egress via Lake River or flushing channel in early July**
- **Only small numbers of adults were observed**
- **Speculation from researchers:**
  - Water quality not a factor for salmonids
  - Predatory fish found in small numbers; not a problem
  - Dredging would reduce the wind-induced turbidity

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Hydraulic Study

HEC RAS 1-D Model

- **Objectives of one-dimensional model study:**
  - Establish without project conditions
  - Determine if hydraulics support project objectives
- **Key question: Can flow and circulation be increased to improve habitat?**

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Hydraulic Study

Criterion used in 1-D Model

Hydraulic Residence Time

- Hydraulic Residence Time (HRT): average time required to renew water volume
- High HRT equals degraded water quality
- Simplified HRT calculated as:

  Mean Daily Volume / Mean Daily Net Flux

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Hydraulic Study

1-D Model Parameters

- Model includes: Lower Columbia River, its tributaries and storage areas (including Vancouver Lake) from Bonneville Dam to Astoria
- Model input: hourly hydrographs for river inflows to the Lower Columbia system and hourly stage data at Vancouver and Astoria.
- Simulation windows (May-Jul 2006 & May-Jul 2007) were selected to allow calibration against observed Vancouver Lake stage and flushing channel flow data

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Hydraulic Study

1-D Model

Scenarios Modeled

- Existing condition: Two 7 ft diameter culverts with tide-gates, 500 ft in length, linking the Flushing Channel to Vancouver Lake.
- Increased culvert: Flushing Channel culverts' size increased from 7 to 11 feet, tide gates remain.
- Max culvert: Flushing Channel culverts' size increased from 7 to 11 feet, tide gates removed.
- Max capacity: Two 11 ft diameter culverts, 500 ft in length. No tide gates, modified Lake River channel with bottom width increased to 150 ft.

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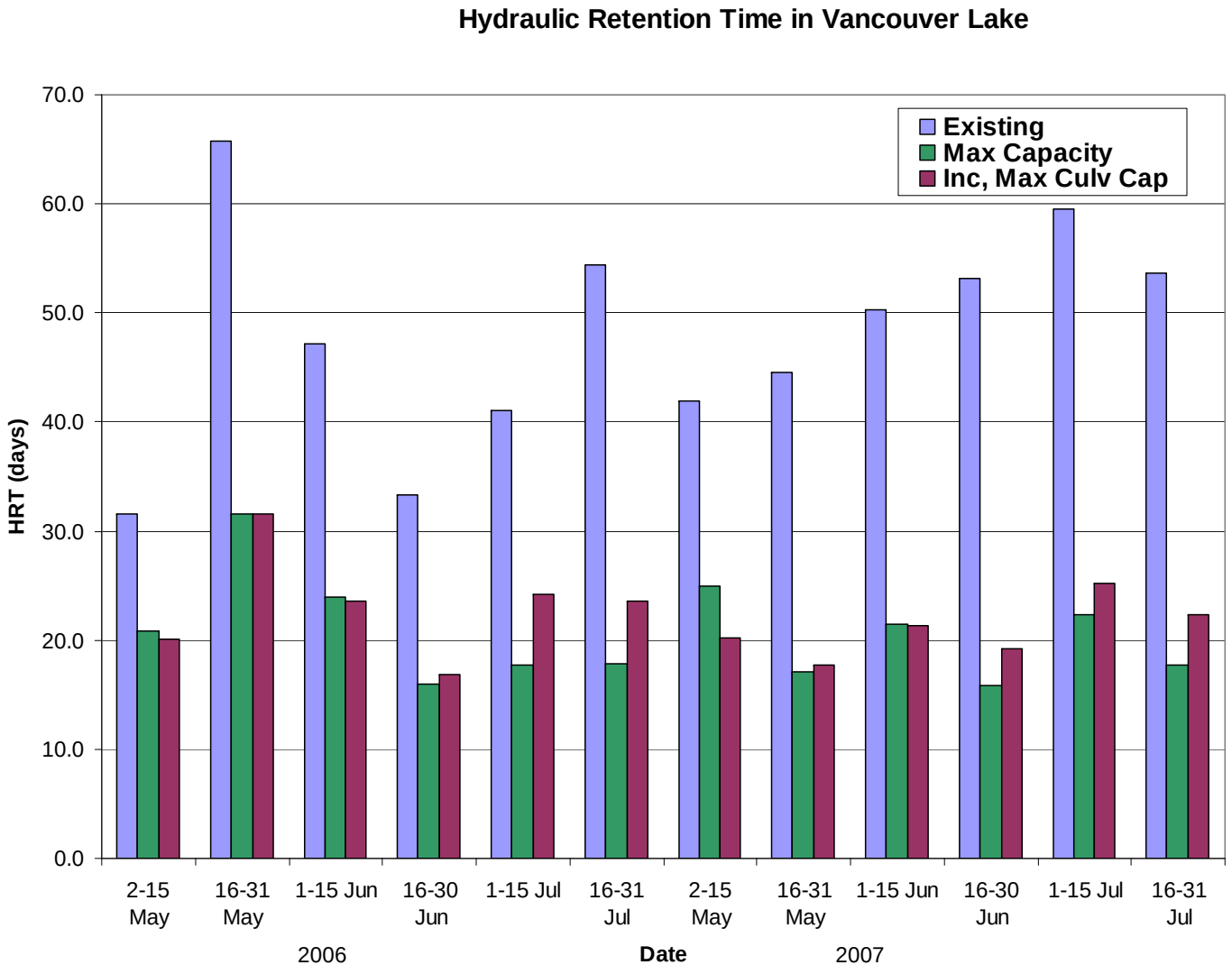
1-D Model Results
Hydraulic Retention Time



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1-D Model Results, What's next

- Increasing size of the culverts made greatest change in lowering the HRT in Vancouver Lake
- Further investigation of circulation patterns and connection to the Columbia River is necessary
- Two-dimensional modeling:
  - **circulation patterns in the lake**
  - **analysis of water exchange between the Columbia River and Vancouver Lake**

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Hydraulic Study

2-D Model

- **Objectives of two-dimensional model study:**
  - Establish flow patterns in Vancouver Lake for the existing condition and the enlarged flushing-channel culvert condition.
  - Determine general hydrodynamic effects of dredging Vancouver Lake.
  - Determine general hydrodynamic effects of an enlarged culvert with no tide gates.

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Hydraulic Study

2-D Model

- **Approach:**
  - Develop a model mesh of the existing Lake condition (a mesh is how the model interprets the survey data).
  - Use 1-D model outputs as boundary conditions for the 2-D model.
  - Calibrate and run model for existing condition, enlarged culvert condition and enlarged culvert with no gates condition.
  - Modify the existing condition model mesh to reflect dredged condition.
  - Run model for dredged condition.
  - Analyze model outputs.

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2-D Model

- **Limitations/Assumptions of the Vancouver Lake 2-D model:**
  - No water quality aspects were considered.
  - No wind effects were considered.
  - Boundary conditions limited to Lake River and the Flushing Channel.
  - Boundary conditions taken from 1-D modeling effort. Limited to conditions modeled in 1-D.
  - Short representative time frames were modeled in 2-D due to long computation times.

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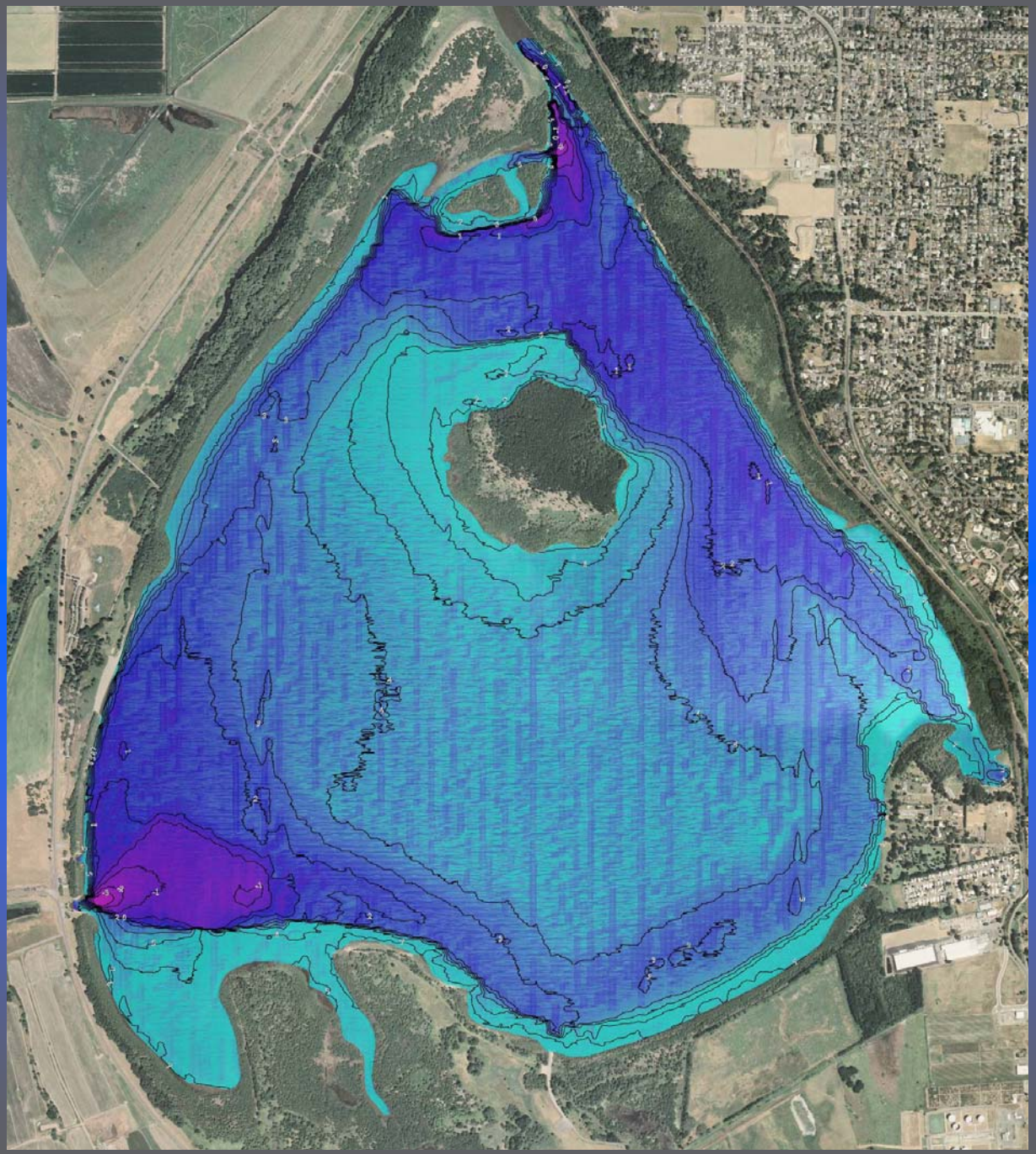
Hydro Survey

- Survey performed by USACE Jan-Mar 2008.
- Data used to inform both the 1-D and 2-D hydrodynamic models.



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2-D Model Mesh and Boundary Condition Locations

RMA2, depth averaged, 2-dimensional, unsteady state hydrodynamic model.

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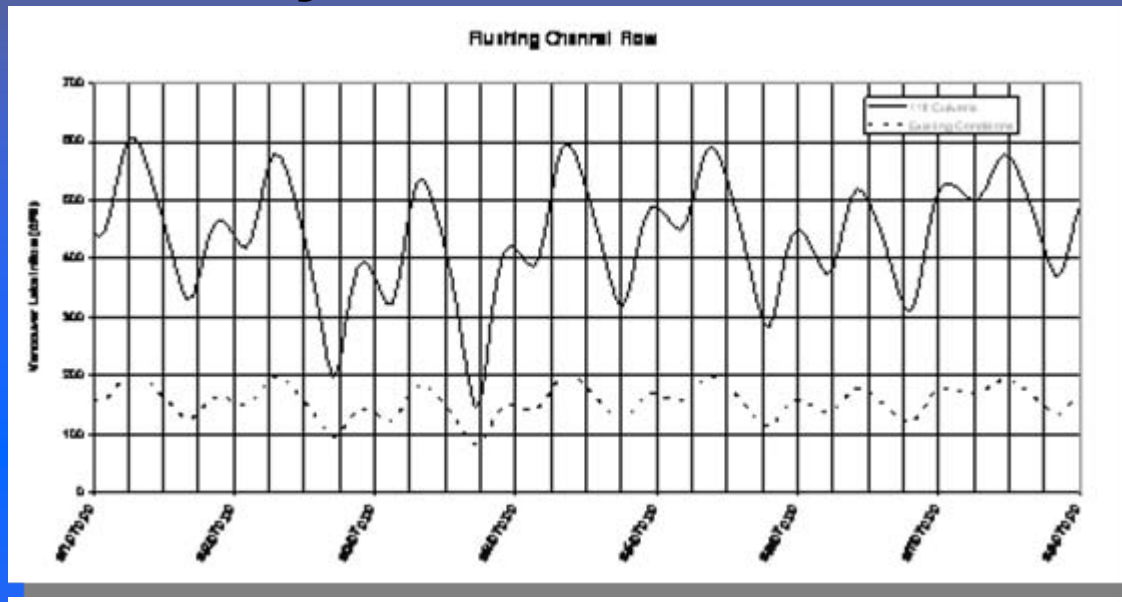
2-D Model Boundary Conditions

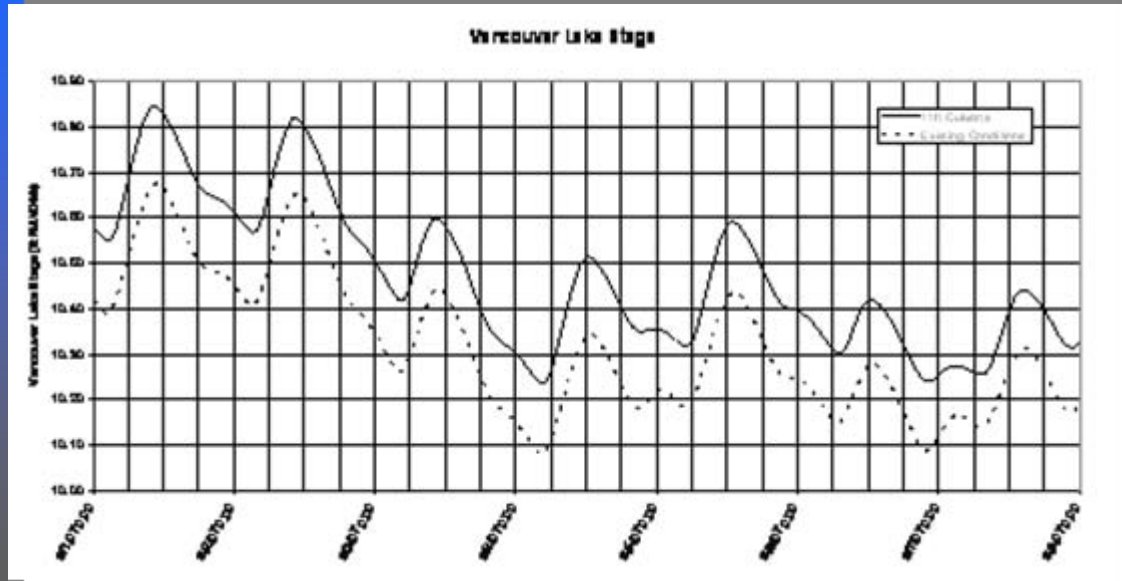
Three short representative time frames were modeled for general analysis. Selection based on stage in Vancouver Lake.

- May 15-16, 2007 – High
- June 4, 2007 – Medium
- June 28, 2007 – Low

One longer time frame was modeled for demonstration purposes.

- June 1-7, 2007 – Medium





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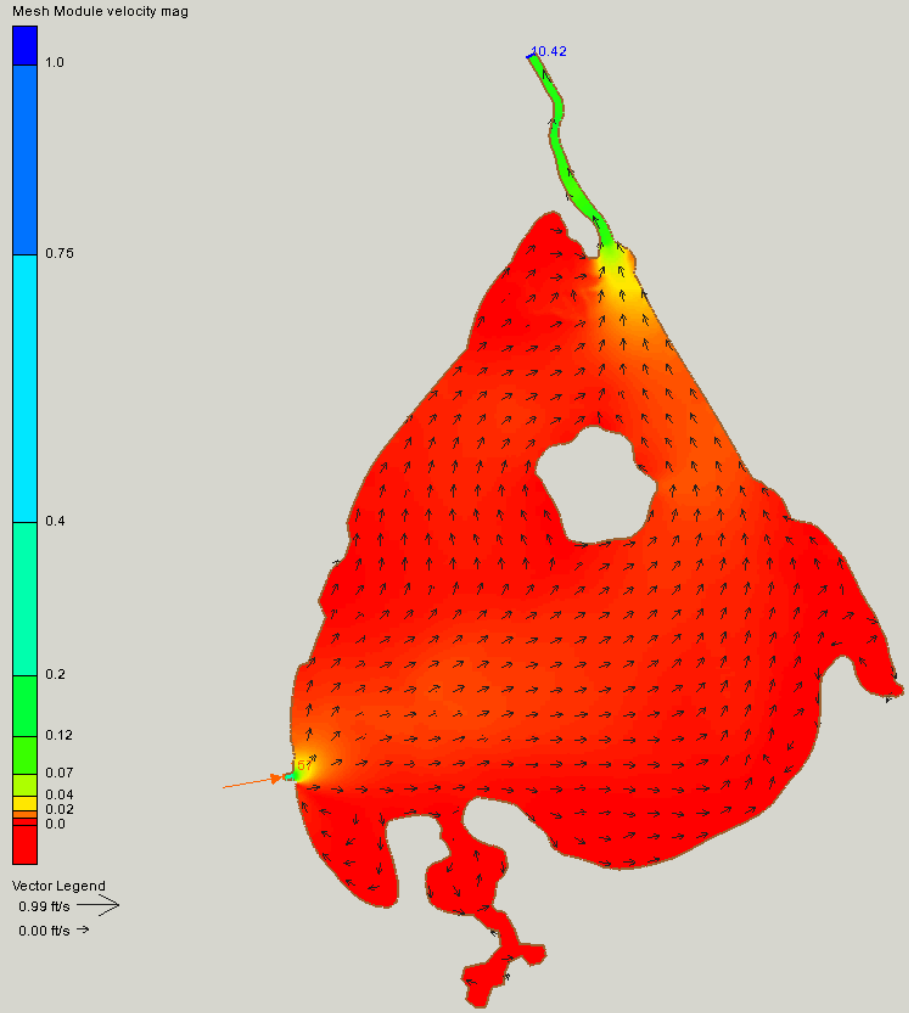
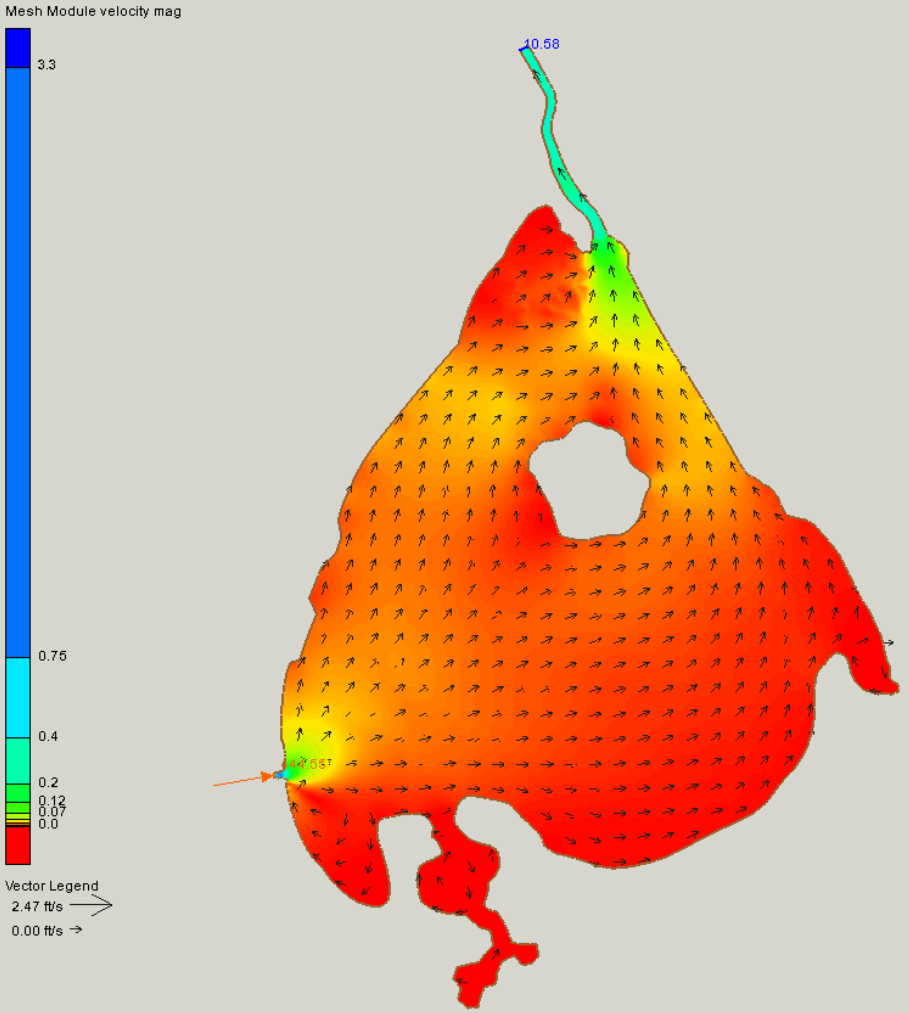
Hydraulic Study

2-D Velocity Vector and Contour Plots

Existing Condition



Enlarged Culverts



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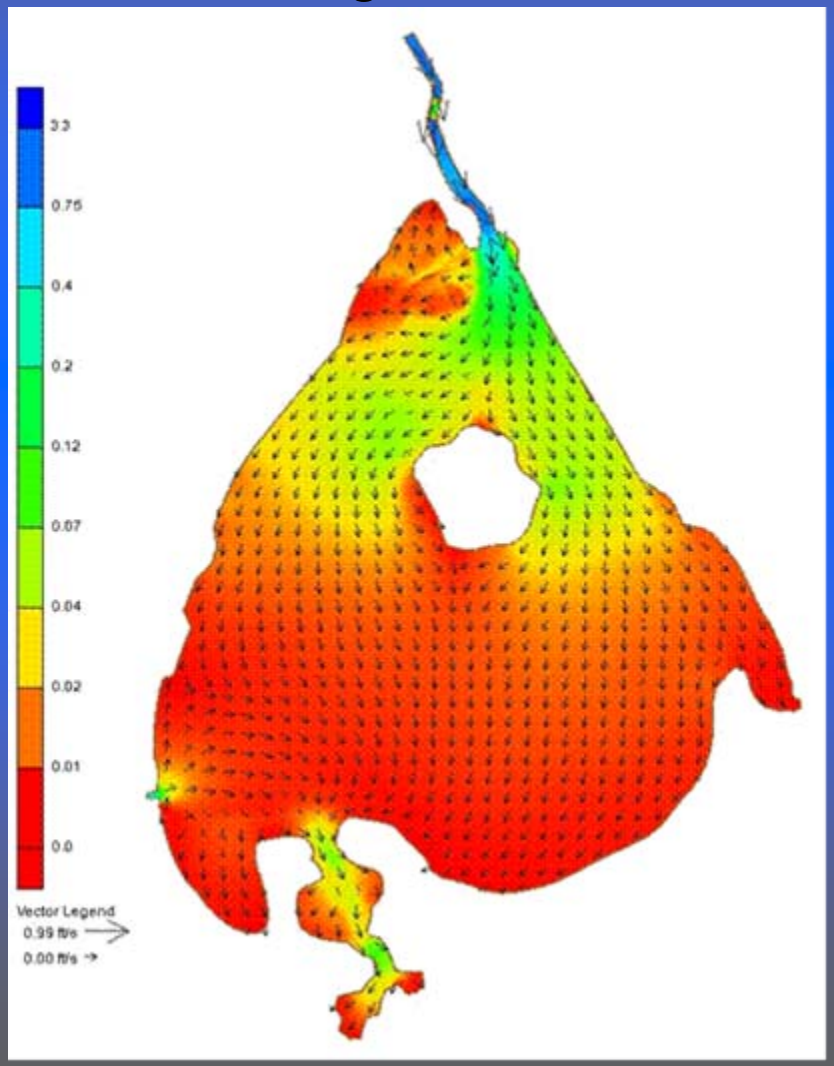
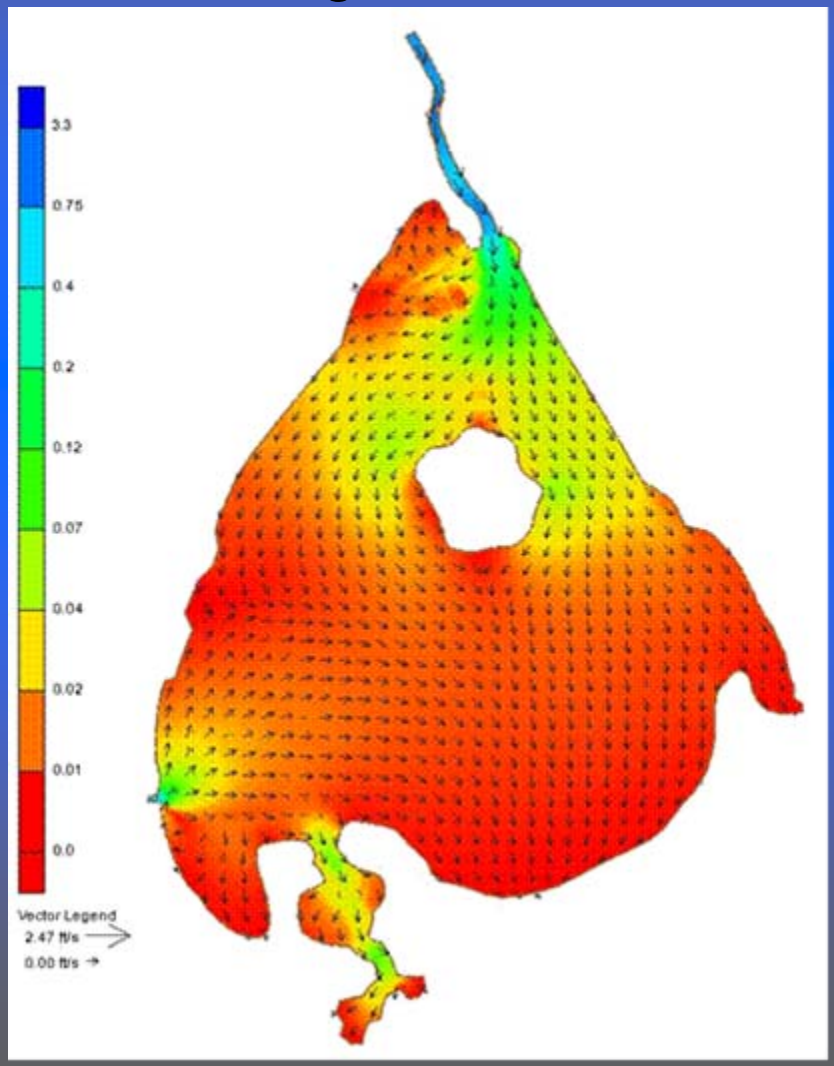
Hydraulic Study

Typical Tidal Flooding

Existing Condition



Enlarged Culverts



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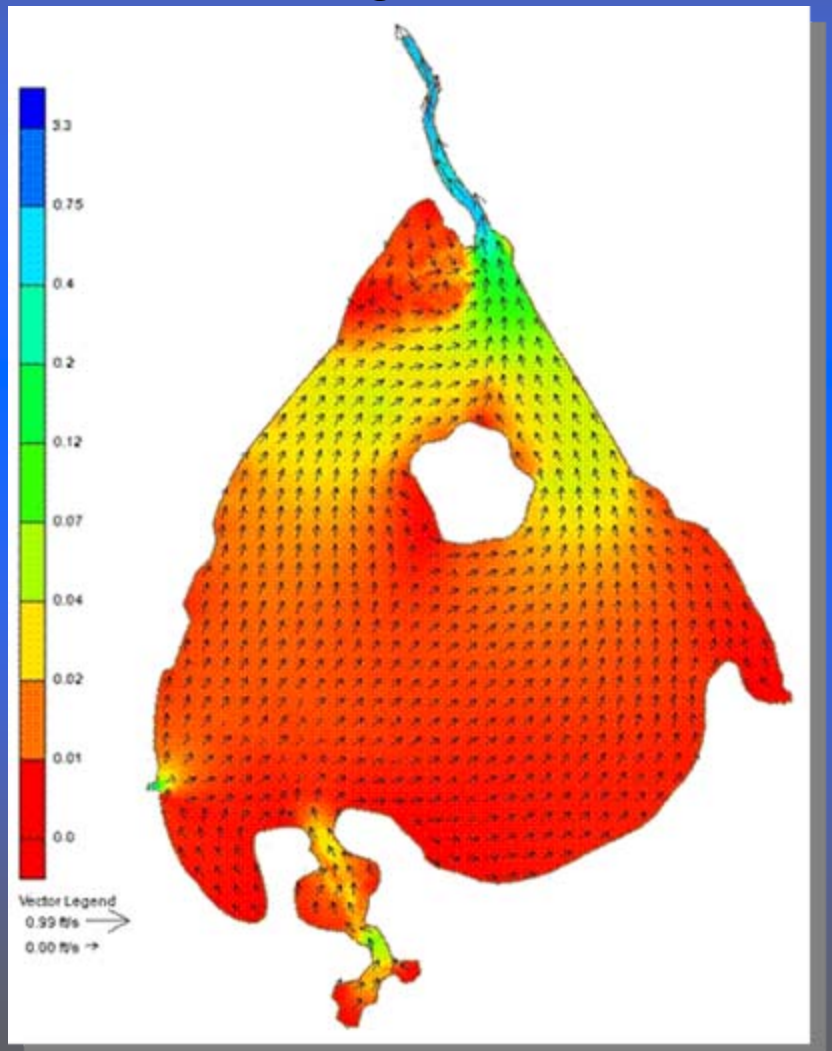
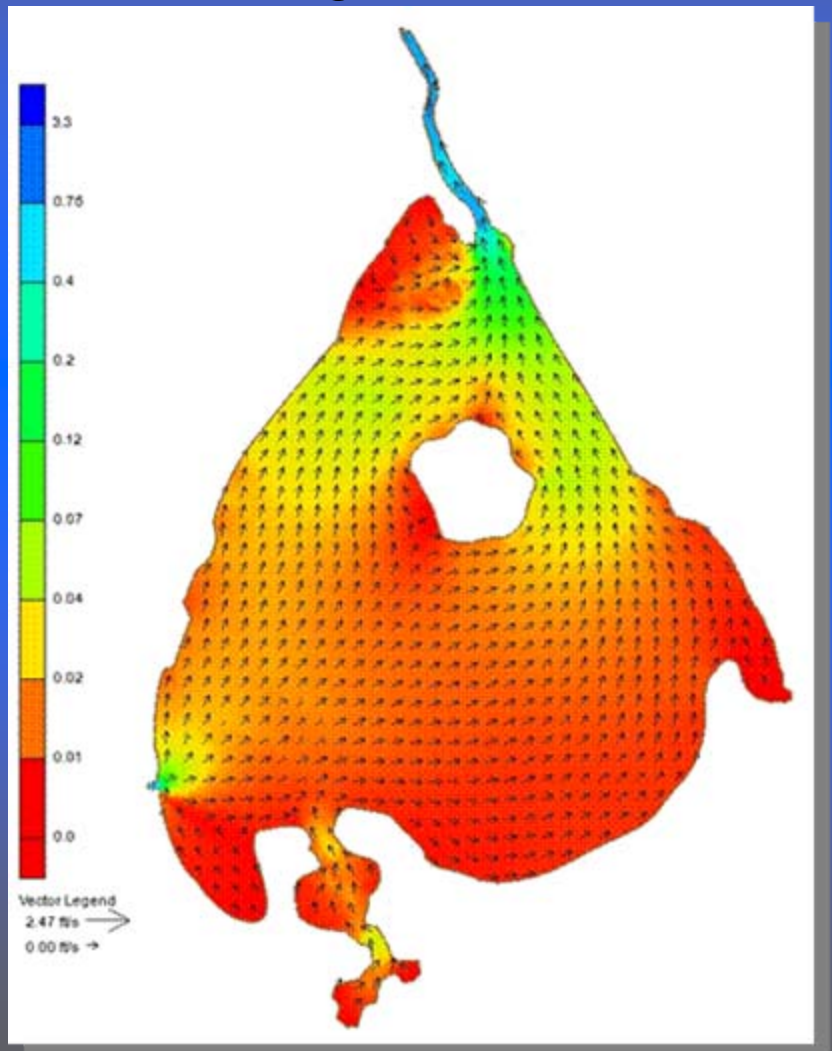
Hydraulic Study

Typical Tidal Ebbing

Existing Condition



Enlarged Culverts



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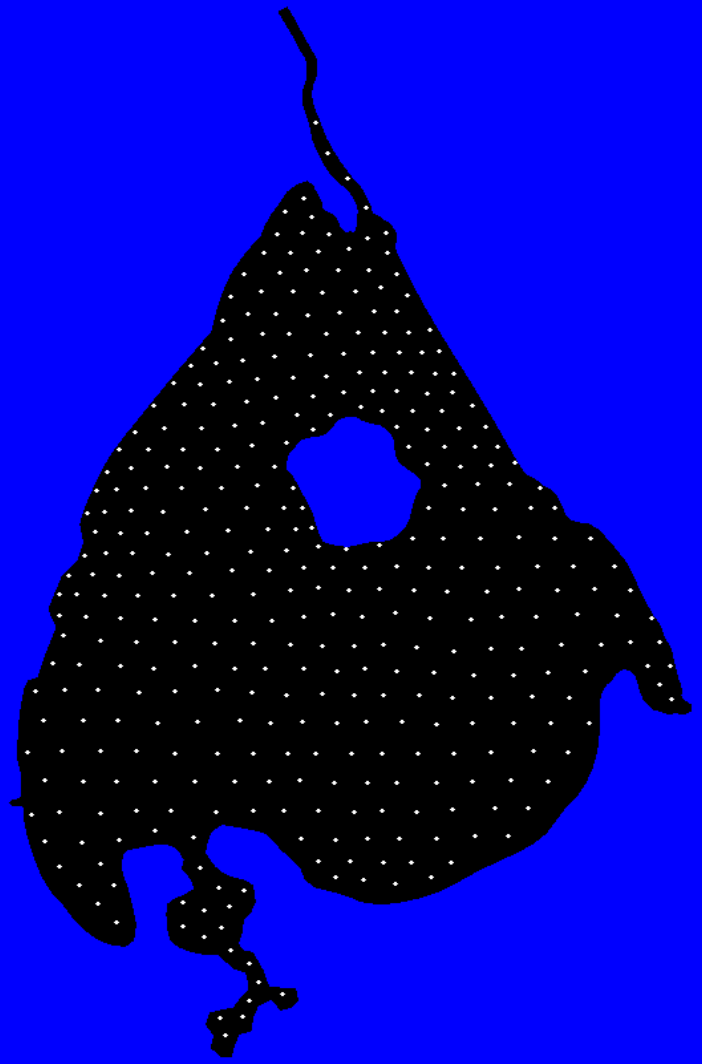
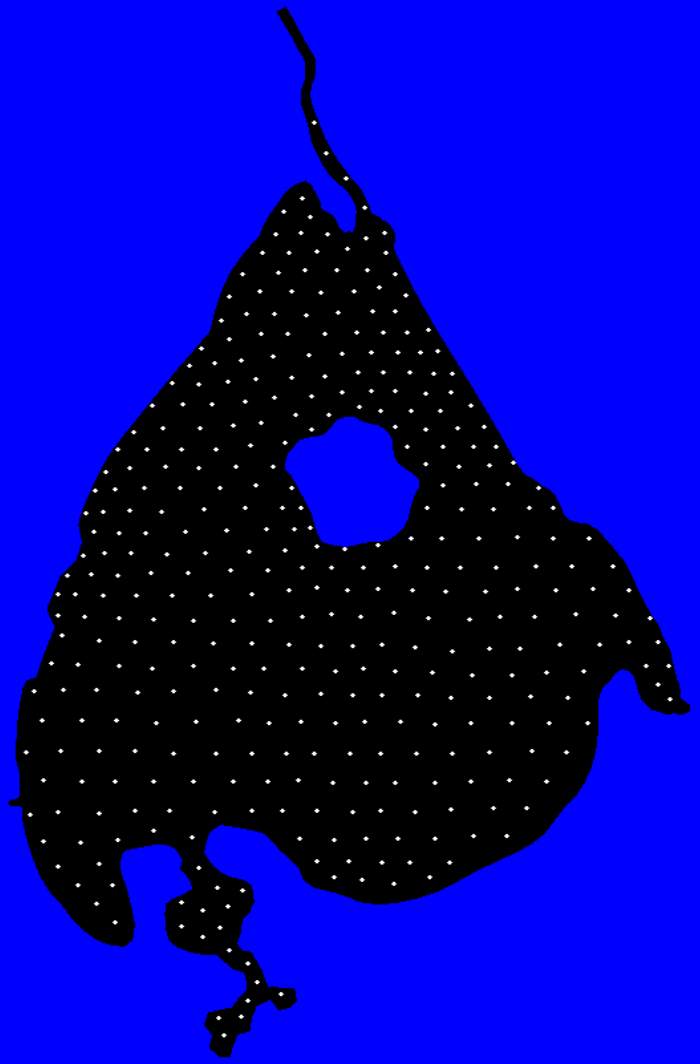
Hydraulic Study

2-D Drogue Plots (Neutrally Buoyant Particles)

Existing Condition



Enlarged Culverts



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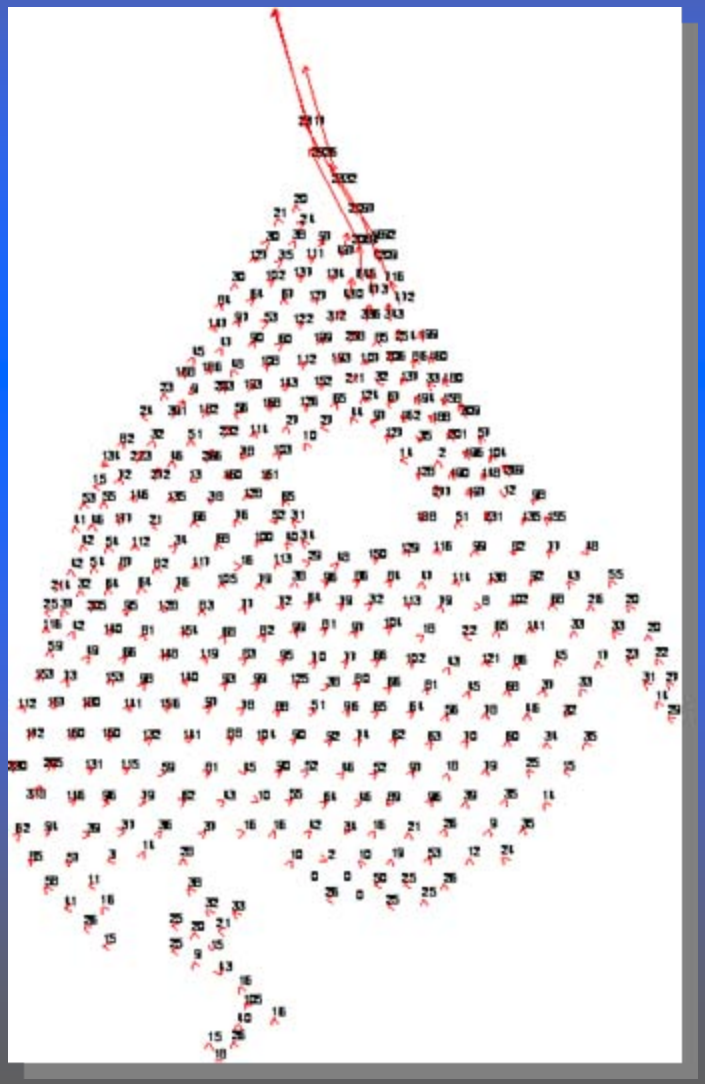
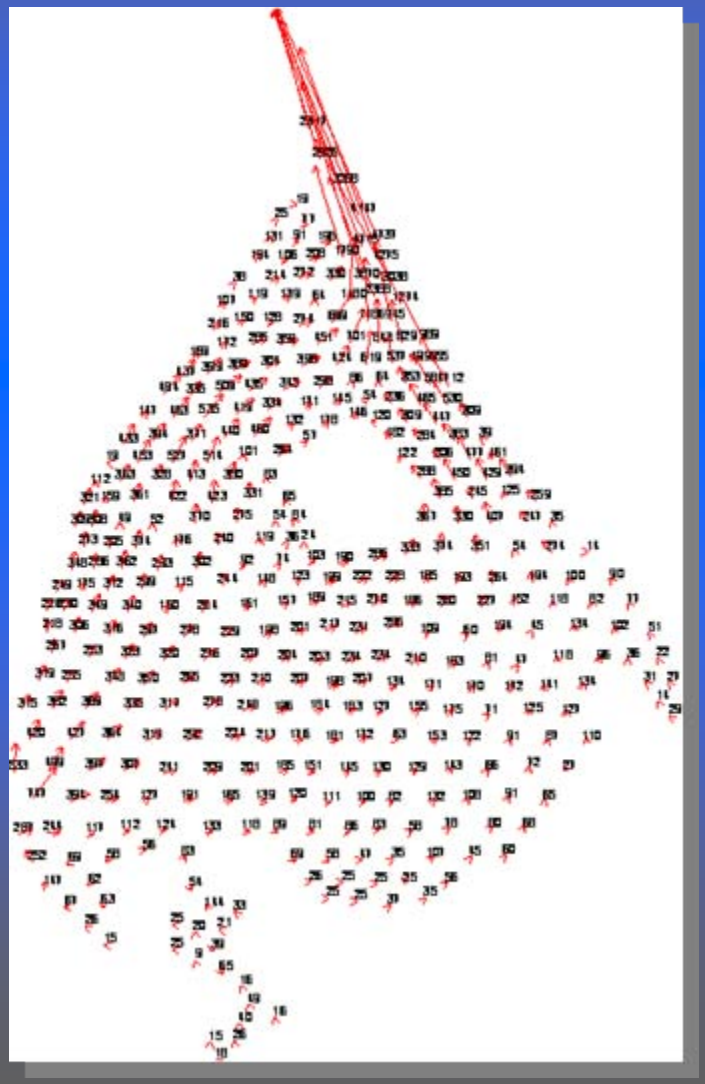
Drogue Distances Traveled

Existing Condition



Enlarged Culverts



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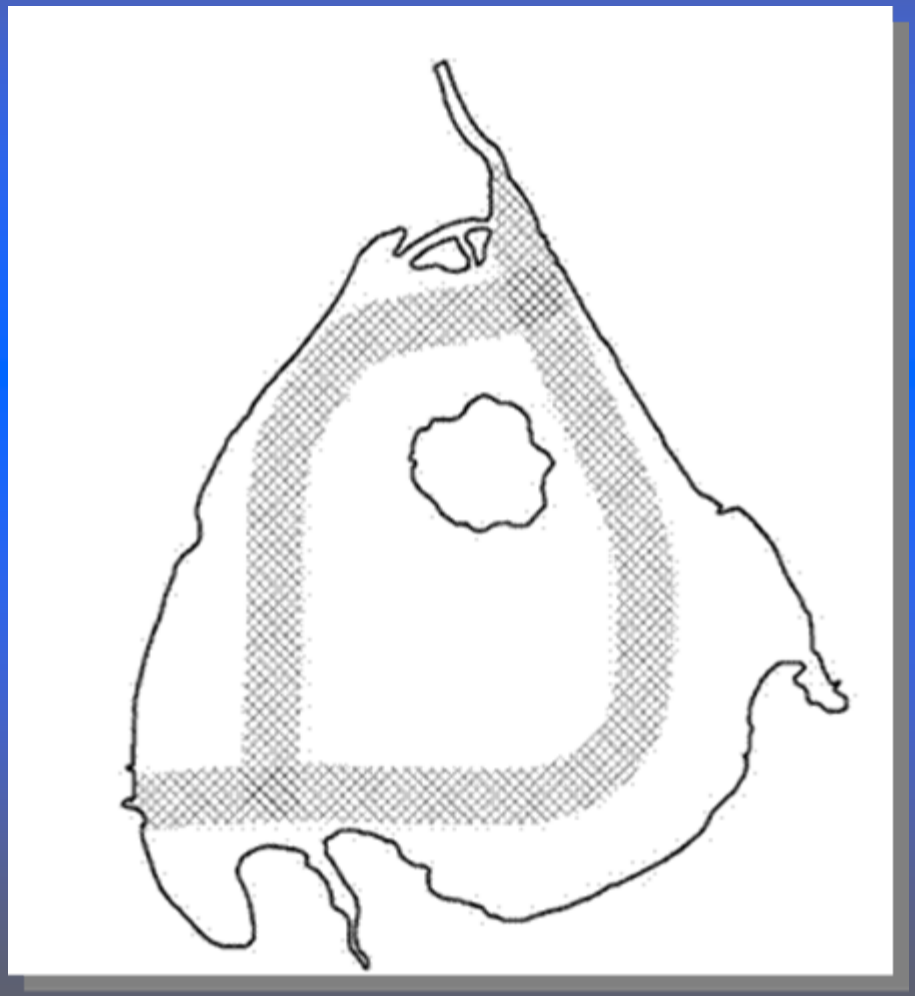
2-D Model Dredge Area

- Modeled dredge profile is 1000 ft wide.
- Bottom of dredge profile is 1.00 ft NAVD88.



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Hydraulic Study

2-D Model

- **Conclusions:**
  - Velocities in the Lake are low in all conditions modeled with relatively higher velocities near connection Lake River and Flushing Channel.
  - Lake dynamics remain tidally dominated in all conditions modeled.
  - Enlarging the Flushing Channel culverts increases velocities in the lake, specifically along the western and northern shores and adjacent to Dredge disposal island.
  - Removing the tide gates has a negligible effect on hydrodynamics in most hydrologic conditions.
  - Dredging generally decreases Lake dynamics due to flushing channel flow.

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Questions ?