Watershed Modeling using HEC-RAS

Outlet Structure Modeling

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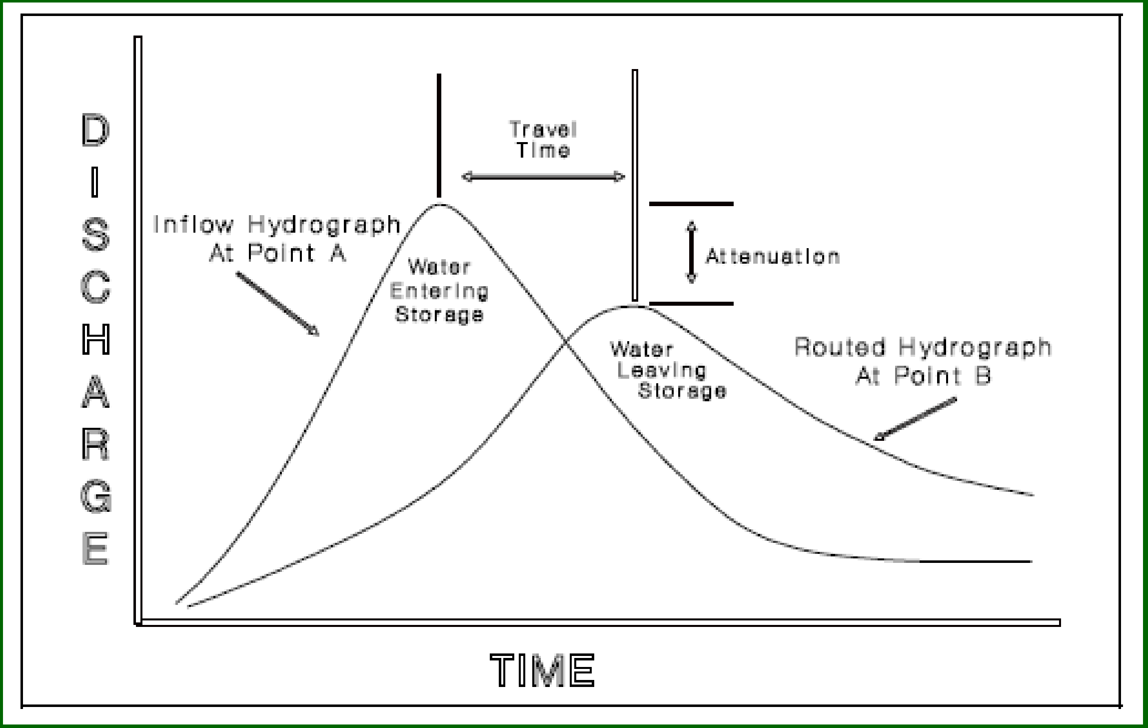
Outline of Presentation

- Why unsteady and steady state modeling approaches are different
- Modeling outlet structures for online lakes and detention basins
- Case studies

Hydrograph Routing

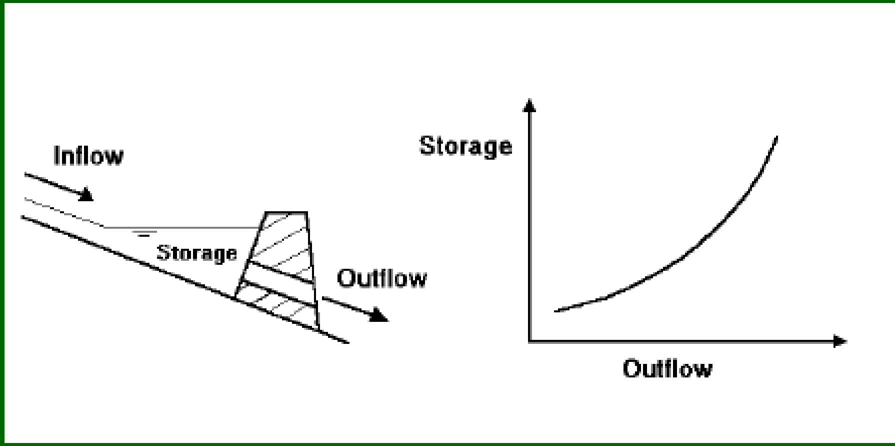
Procedure used to predict the temporal and spatial variation of a flood hydrograph as it moves through a river reach or reservoir.

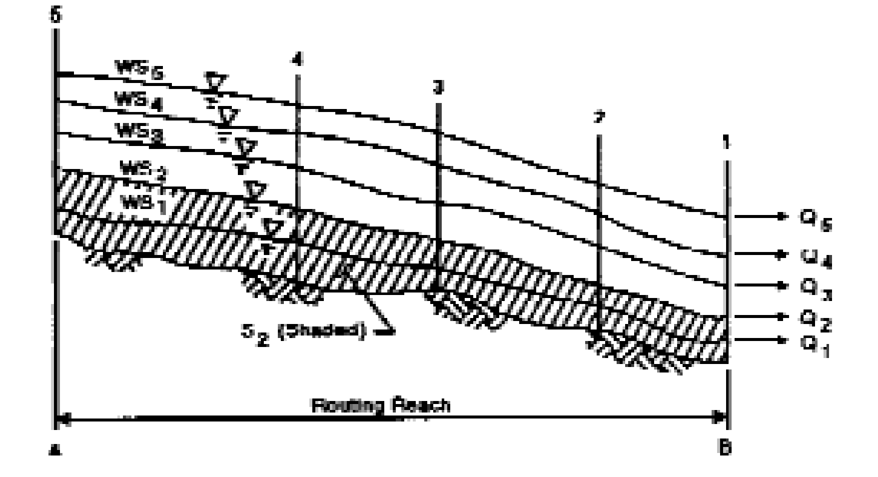


Hydrologic/Hydraulic Routing

- Hydrologic
  - Function of time, no spatial variability
  - Governed by continuity equation and flow/storage relationship
- Hydraulic
  - Function of space and time
  - Governed by continuity and momentum (dynamic) equations

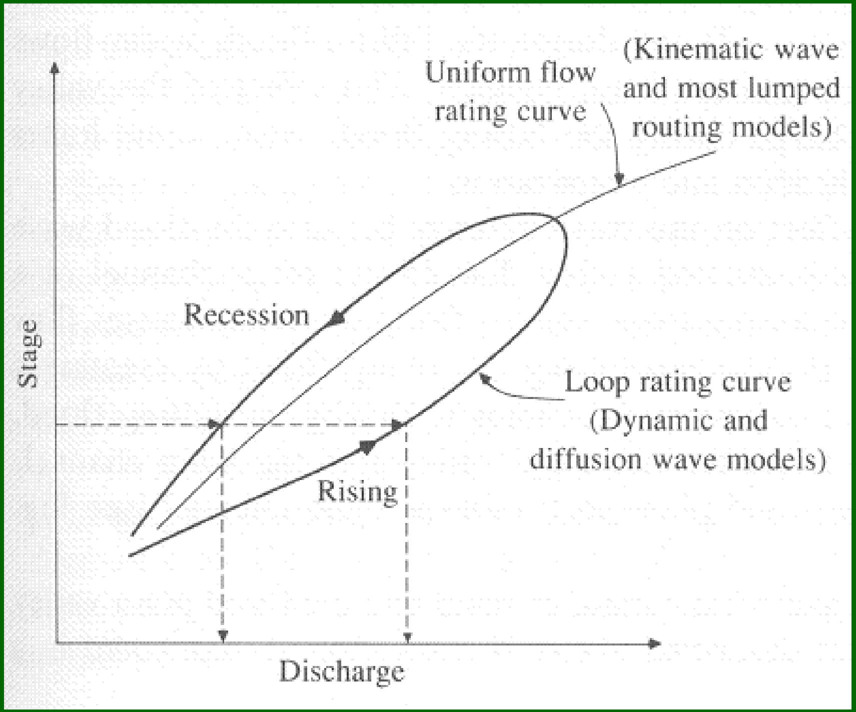
Stage-Discharge Relationships





Water Surface Profiles

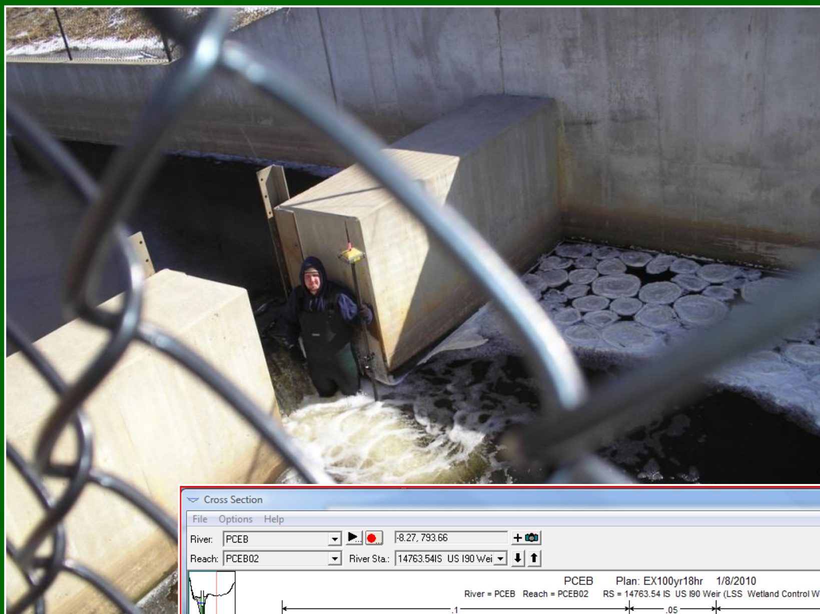
(a)

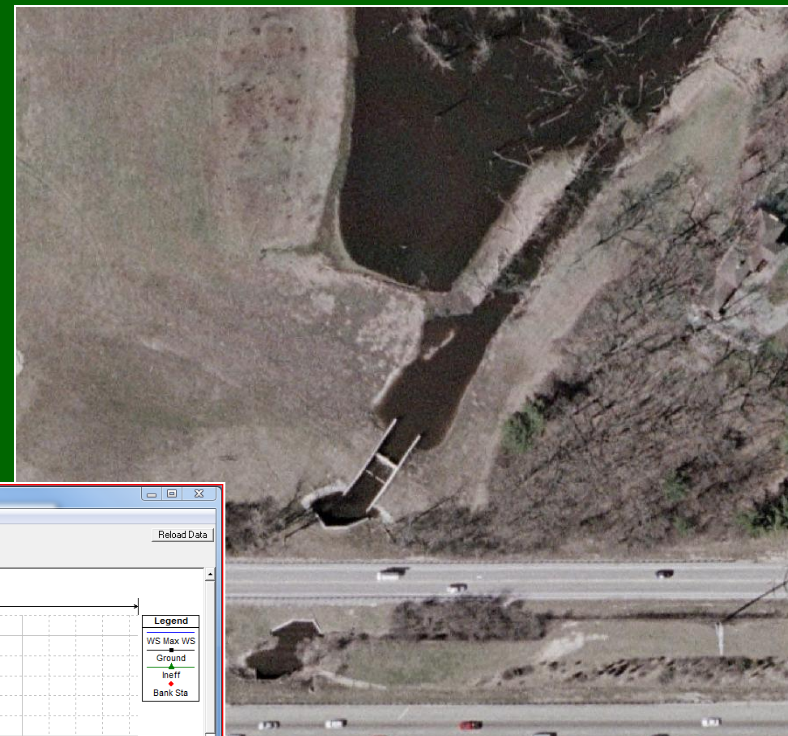


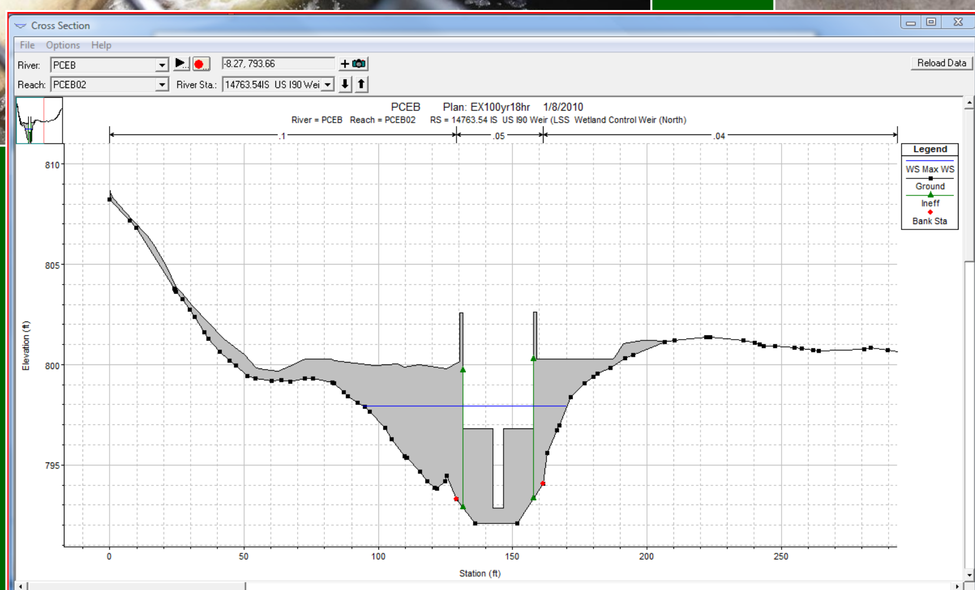
Steady vs. Unsteady State

- Unsteady HEC-RAS allows for consideration of complex interactions that could affect stage-storage-discharge
- Possible to extend HEC-RAS model to reservoirs where tailwater is important
- Off-line reservoirs not influenced by main channel tailwater should be kept as hydrologic model elements

Modeling in HEC-RAS







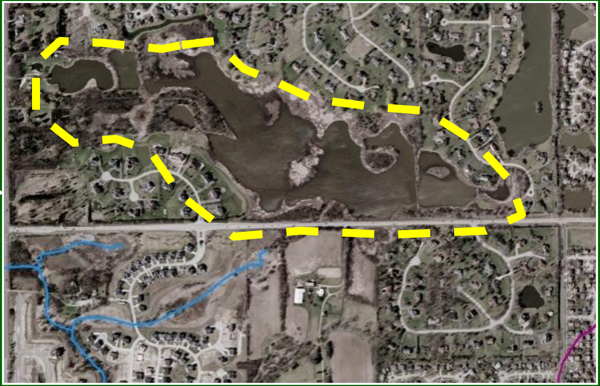
Basics of Online Storage

Structures

- Culvert / Bridge
- Inline Structure
  - – Gates
  - – Weirs
  - – Spillways

How to model storage

- Storage Area



- Cross Sections

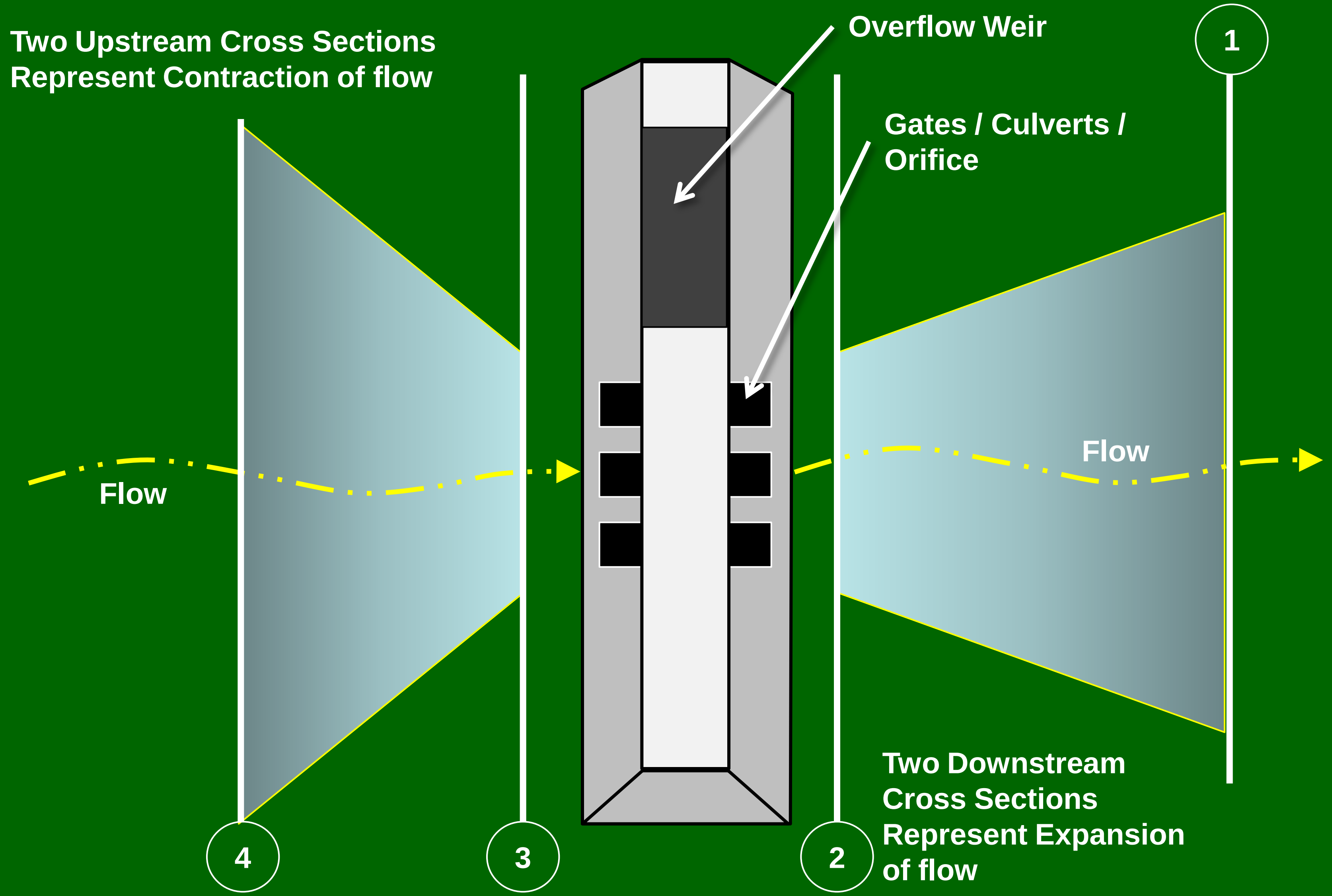
Advanced Features

- HEC-RAS offers many advanced options for modeling storage area hydraulics including
  - User defined hydraulic curves (Flow vs. Headwater vs. Tailwater)
  - Moving gates (i.e. changes in the gate opening height)
  - Elevation controlled gates
  - Pump stations
  - Navigation Dams

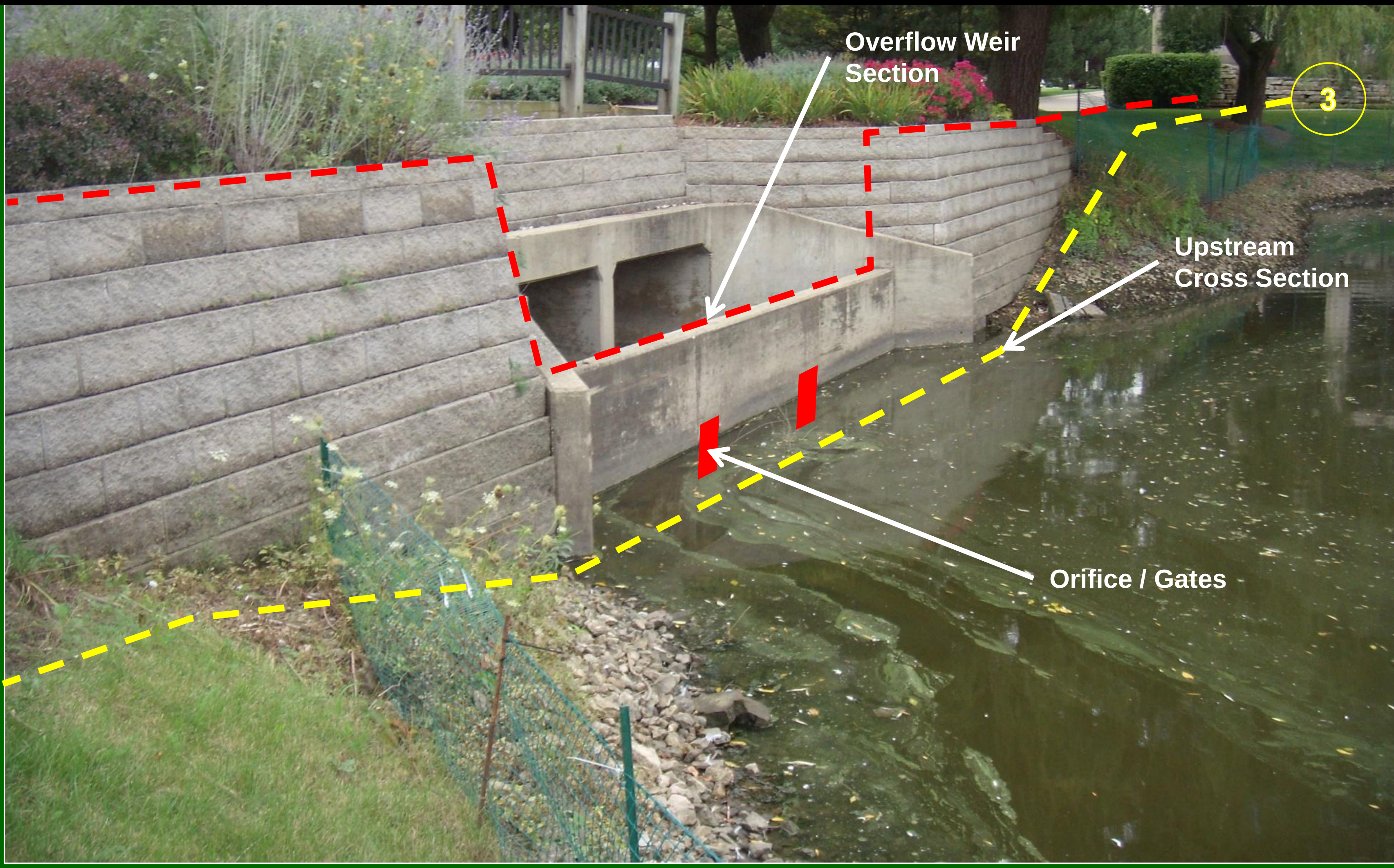
Model Startup

- Need to set initial water surface elevations
- Check the Computational Log file to compare initial backwater computations to initial storage area elevations
- Some inline structures will need a Pilot Flow
- Add gate openings time series

Model Parameters



Model Parameters



Model Parameters

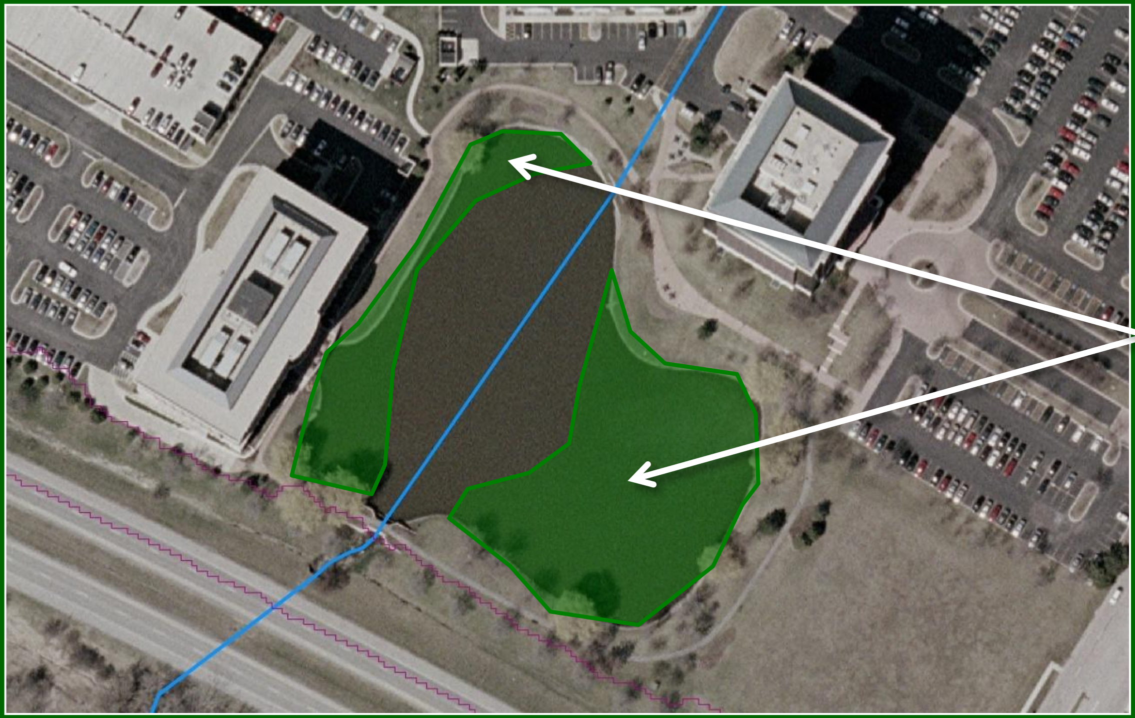
- For modeling gates:
  - Orifices can be represented as gates
  - Size and Elevation
  - Various coefficients for appropriate equations
  - Model can handle weir flow for low flow over gates
  - Model can switch from weir flow to gate flow as specified
  - Model can handle submerged / unsubmerged conditions at the inlet and outlet

Model Parameters

- Weirs need station/elevation, width, type and coefficients
- Bridges / Culverts are setup normally
- Cross Section spacing
- Ineffective flow parameters
  - Place them on the cross sections to appropriately model expansion/contraction
  - Make sure that your elevations are set to confine and release flow appropriately

Model Parameters

- When modeling lakes with cross sections, make sure that you adequately represent what can be effective flow in the lake



Ineffective flow area based on expansion and contraction

Case Studies:
Weir into bridge/culvert

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Weir into bridge/culvert

- Many online ponds/lakes are controlled by a weir discharging into a culvert/bridge
- Need to decide on hydraulic controls
  - Weir / Culvert / Roadway overtopping

Case Studies: Weir into bridge/culvert

- Keep cross sections close to face of weir
- Weir section should represent the overall effective flow length over the weir
- "Cut" the weir section into the road overtopping section to have the major overflow match
- May need to interpolate cross-sections to maintain stability

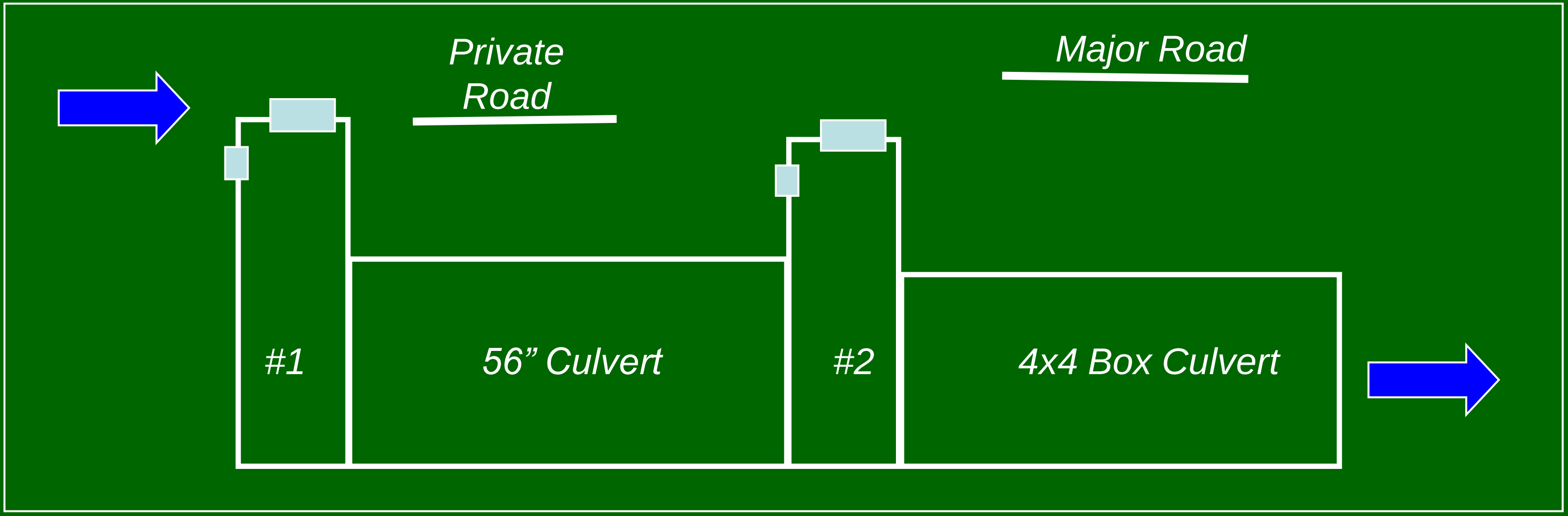
Case Studies: Weir, drop structure, culvert and bridge

- Control Starts with detention weirs, inlet is never controlling
- Modeling approach: inline weir upstream of culvert/road



Case Studies: Inlet structures into culverts

- Inlet #1 initially controls
- Control shifts to private road
- Once weir flow begins, Inlet #2 and Major road become limiting
- Culverts not limiting (not included in model)



Questions?