Unsteady Flow Modeling for Reservoir Analysis with HEC-RAS

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BUILDING STRONG®

Outline

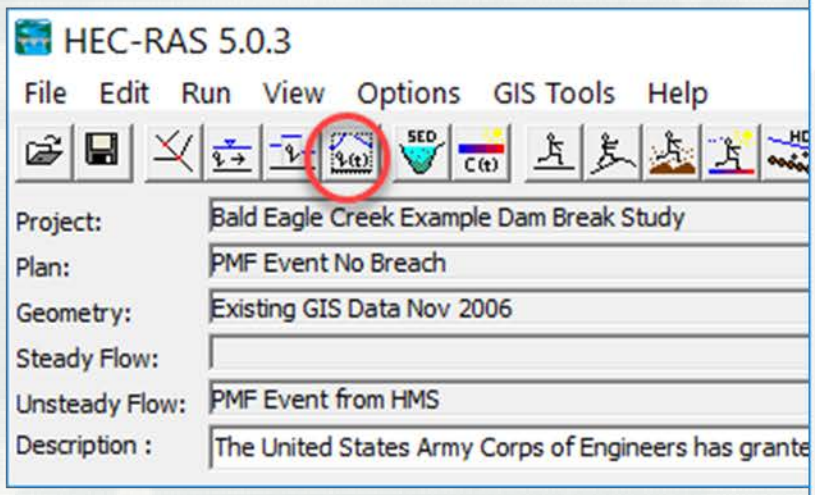
- Boundary Conditions and Computation
- Inline Structures and Gates
- Reservoir Modeling Layout Options

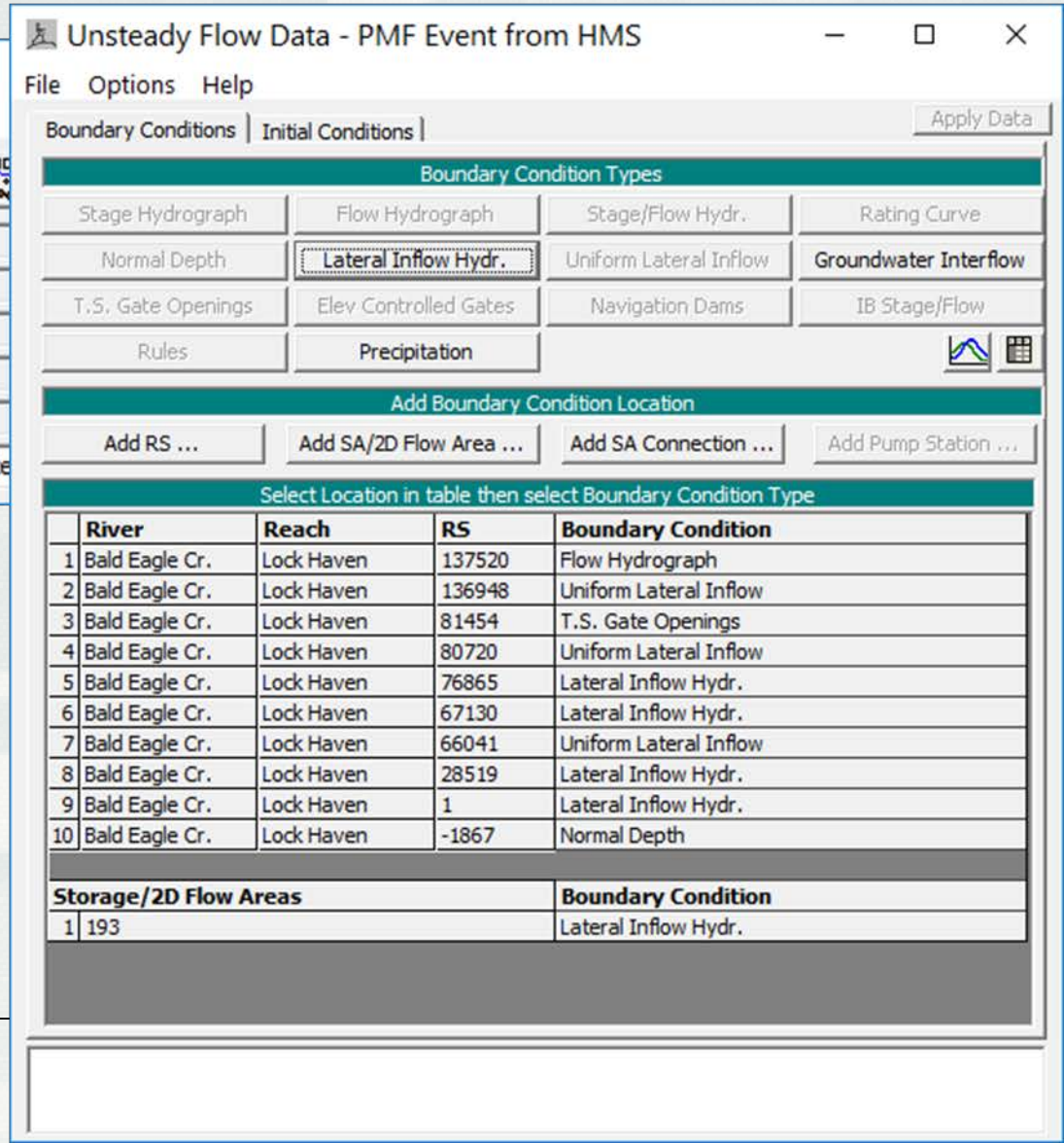
Boundary and Initial Conditions, and Computation Options and Tolerances

Unsteady Flow Data

- External Boundaries required
  - Upstream and Downstream ends of the river
  - Typically flow or stage hydrograph upstream
  - Typically rating or “normal depth” downstream
- Internal Boundaries can be added
  - Add flow within the river system
  - Define gate operation
- Initial Conditions - at the start of simulation

Unsteady Flow Data Editor



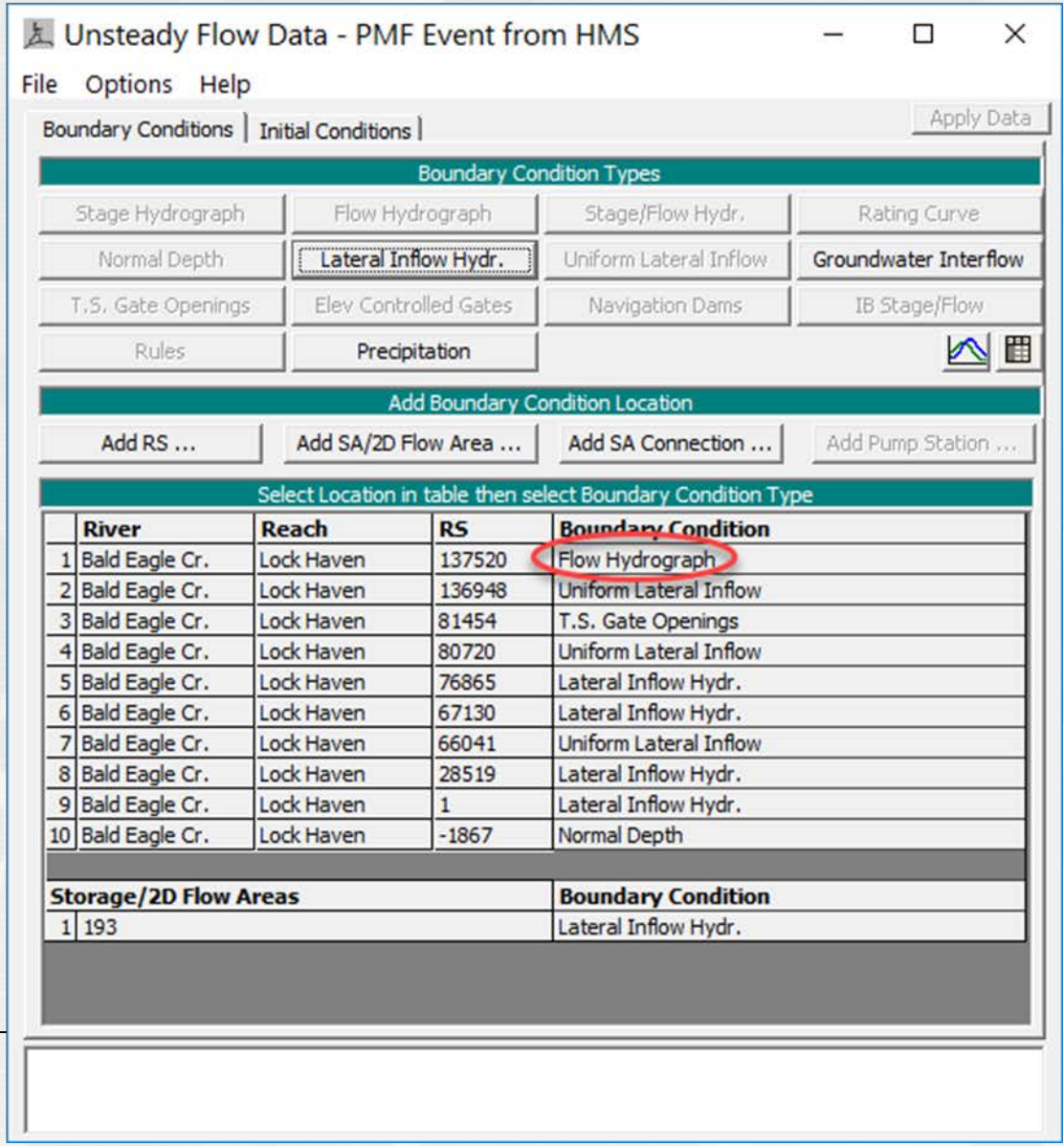


	River	Reach	RS	Boundary Condition
1	Bald Eagle Cr.	Lock Haven	137520	Flow Hydrograph
2	Bald Eagle Cr.	Lock Haven	136948	Uniform Lateral Inflow
3	Bald Eagle Cr.	Lock Haven	81454	T.S. Gate Openings
4	Bald Eagle Cr.	Lock Haven	80720	Uniform Lateral Inflow
5	Bald Eagle Cr.	Lock Haven	76865	Lateral Inflow Hydr.
6	Bald Eagle Cr.	Lock Haven	67130	Lateral Inflow Hydr.
7	Bald Eagle Cr.	Lock Haven	66041	Uniform Lateral Inflow
8	Bald Eagle Cr.	Lock Haven	28519	Lateral Inflow Hydr.
9	Bald Eagle Cr.	Lock Haven	1	Lateral Inflow Hydr.
10	Bald Eagle Cr.	Lock Haven	-1867	Normal Depth

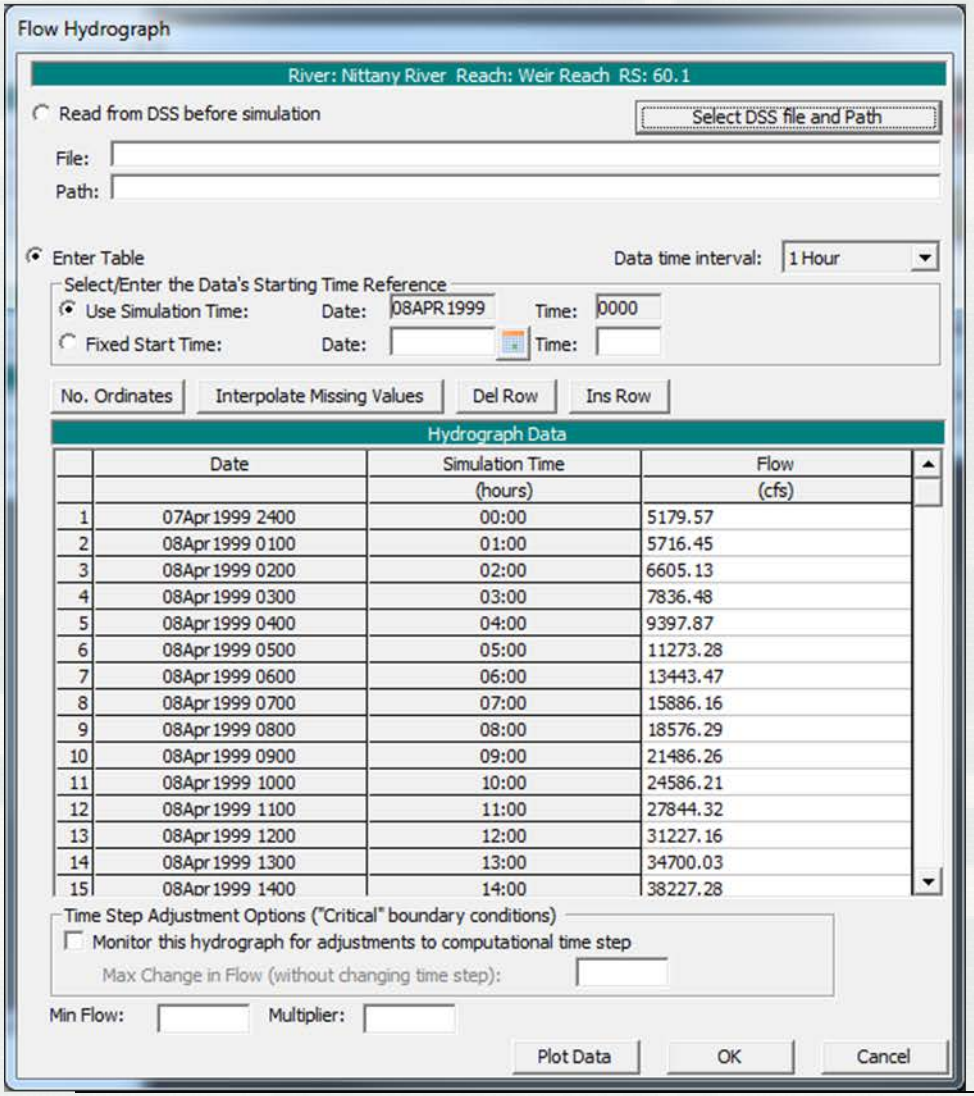
	Storage/2D Flow Areas	Boundary Condition
1	193	Lateral Inflow Hydr.

Upstream Boundary Conditions

- Flow Hydrograph
- Stage Hydrograph
- Stage/Flow Hydrograph

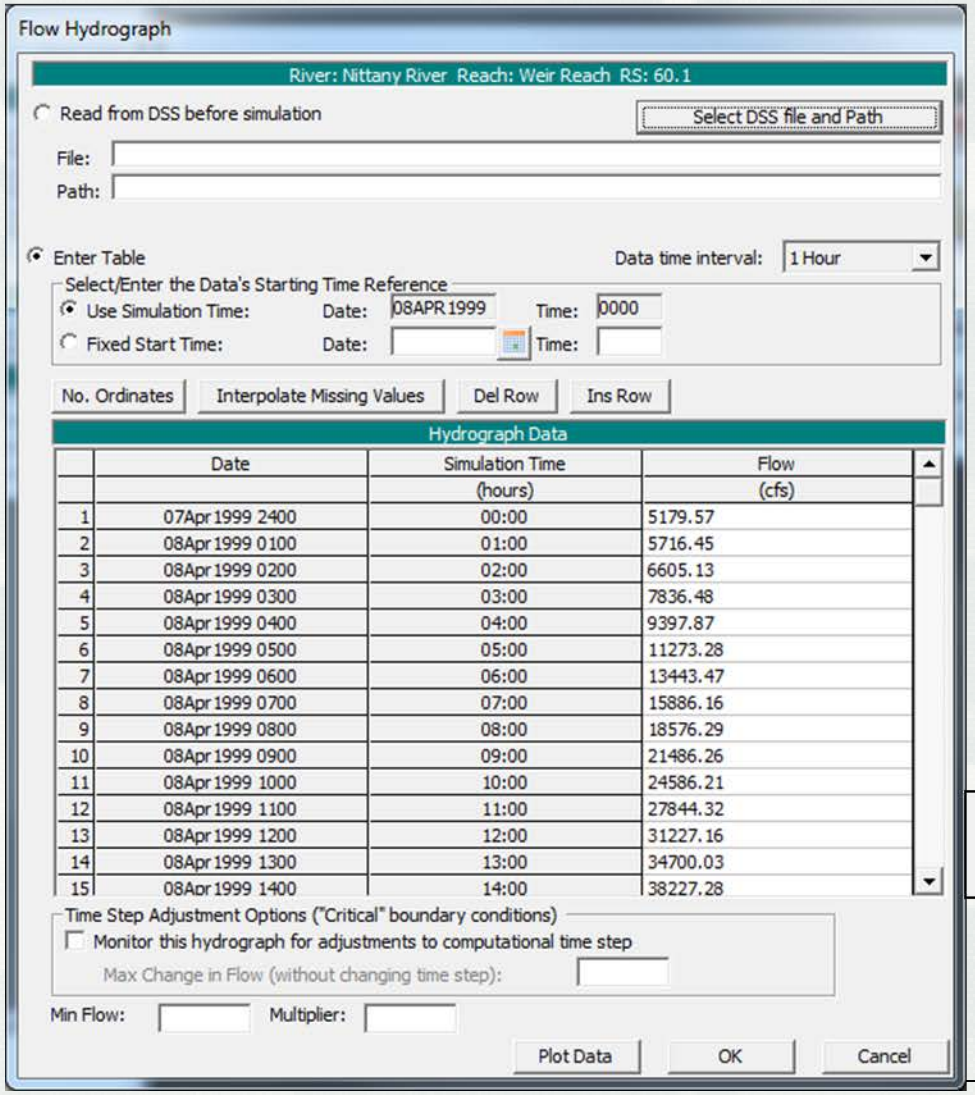


Flow Hydrograph



- Read from DSS
  - Select DSS file
  - Select Pathname
- Enter in Table
  - Select time interval
  - Select start date/time
  - Enter flow data - or cut & paste

Flow Hydrograph



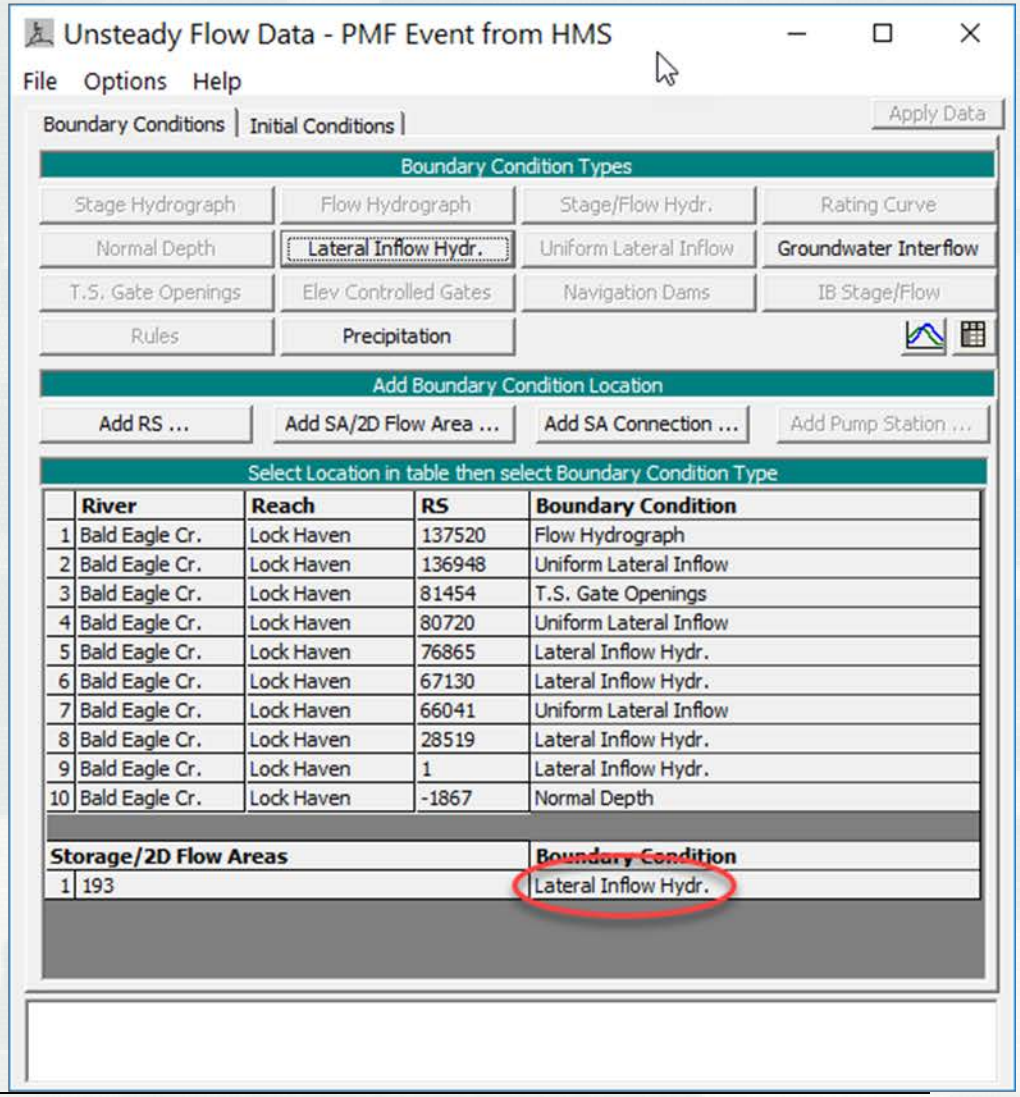
	Date	Simulation Time (hours)	Flow (cfs)
1	07Apr1999 2400	00:00	5179.57
2	08Apr1999 0100	01:00	5716.45
3	08Apr1999 0200	02:00	6605.13
4	08Apr1999 0300	03:00	7836.48
5	08Apr1999 0400	04:00	9397.87
6	08Apr1999 0500	05:00	11273.28
7	08Apr1999 0600	06:00	13443.47
8	08Apr1999 0700	07:00	15886.16
9	08Apr1999 0800	08:00	18576.29
10	08Apr1999 0900	09:00	21486.26
11	08Apr1999 1000	10:00	24586.21
12	08Apr1999 1100	11:00	27844.32
13	08Apr1999 1200	12:00	31227.16
14	08Apr1999 1300	13:00	34700.03
15	08Apr1999 1400	14:00	38227.28

- Min Flow
- Multiplier

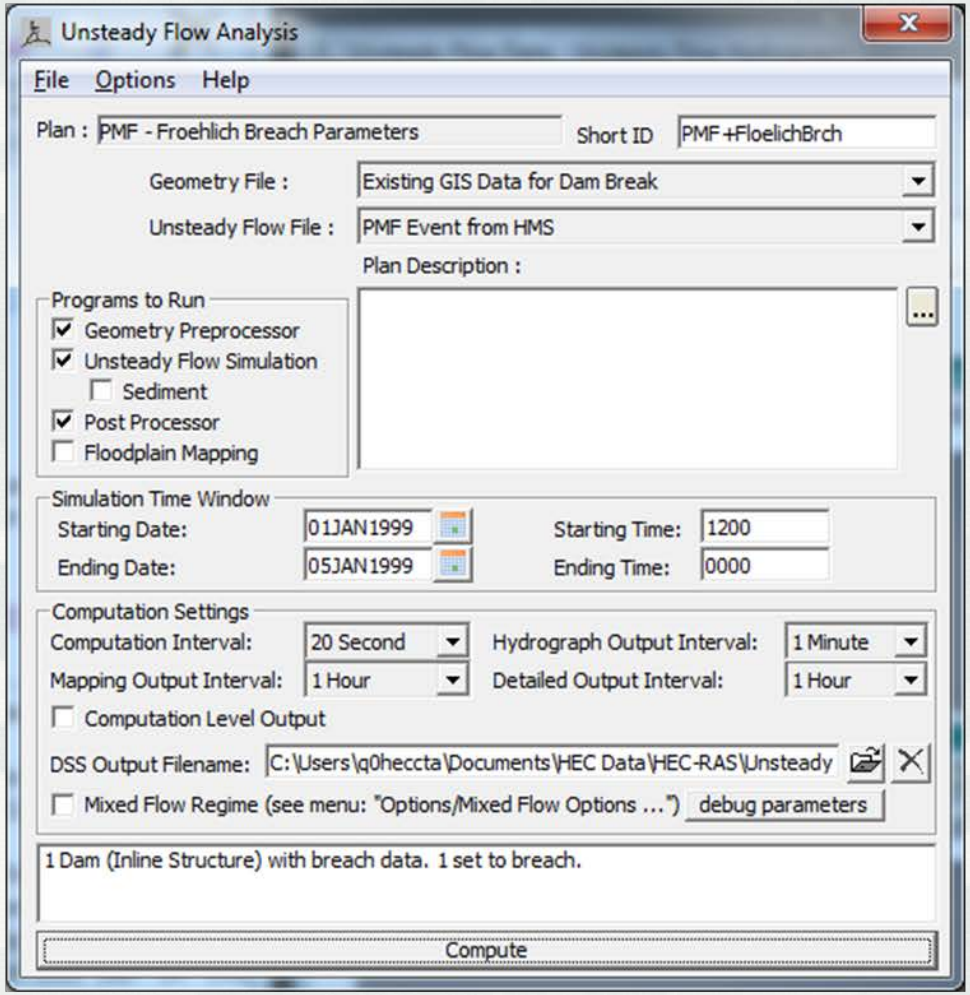
- Hydrograph Monitor for Time Slicing

Downstream Boundary Conditions

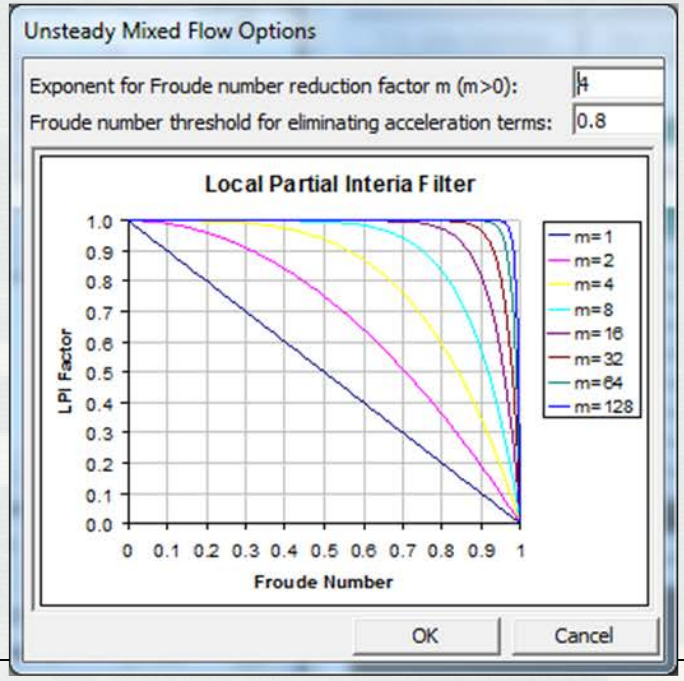
- Downstream Options:
  - Normal Depth
  - Rating Curve
  - Stage Hydrograph
  - Flow Hydrograph
  - Stage & Flow Hydrograph



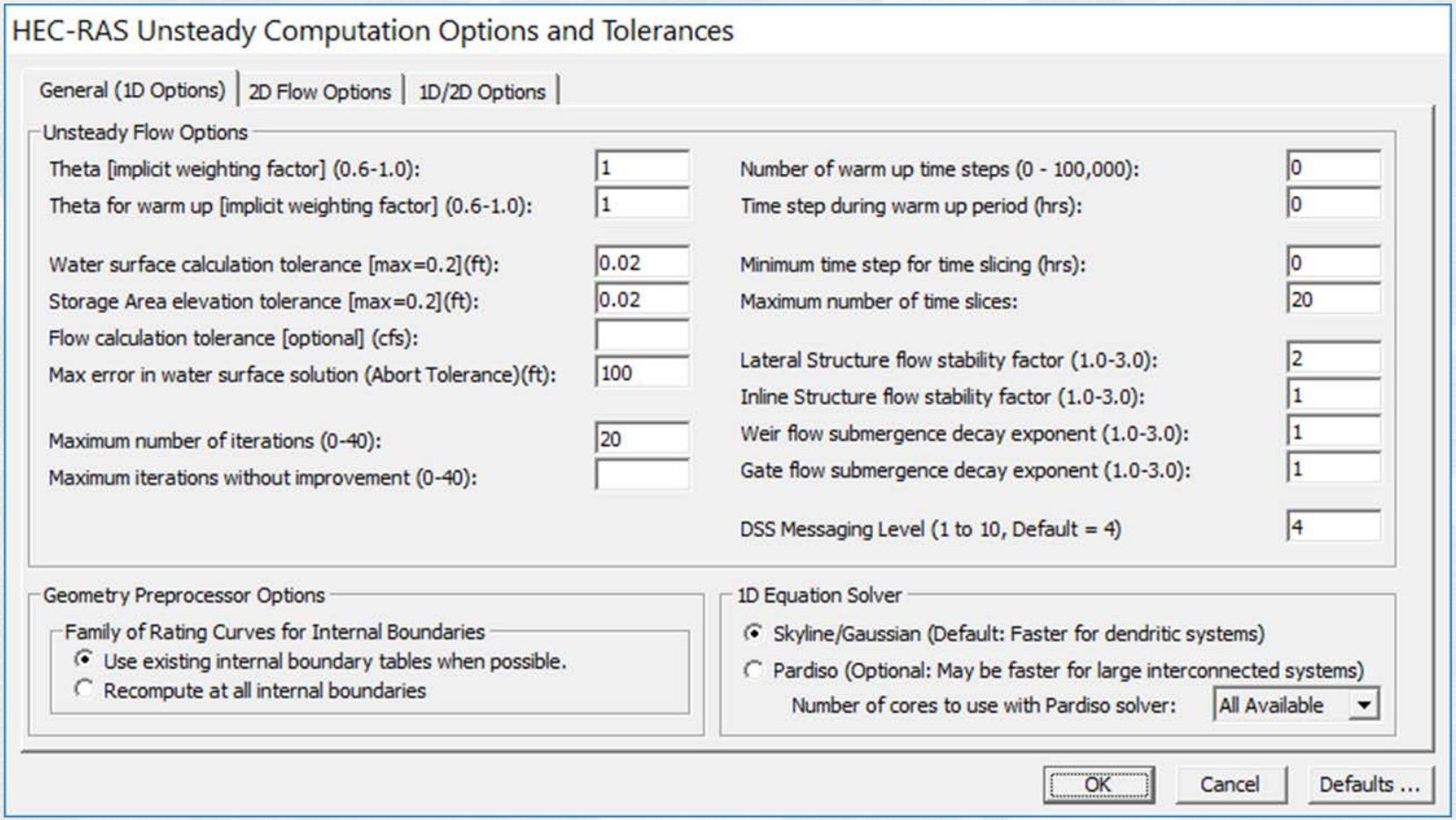
Computation



- Computation Time Step
- Hydrograph Output
- Detailed Output
- Mixed Flow Regime



Computation Options



- **Theta**
  1 = Most Stable
- **Water Surface Tolerance**
- **Stability Factors**
  1 = Most Accurate
  3 = Most Stable

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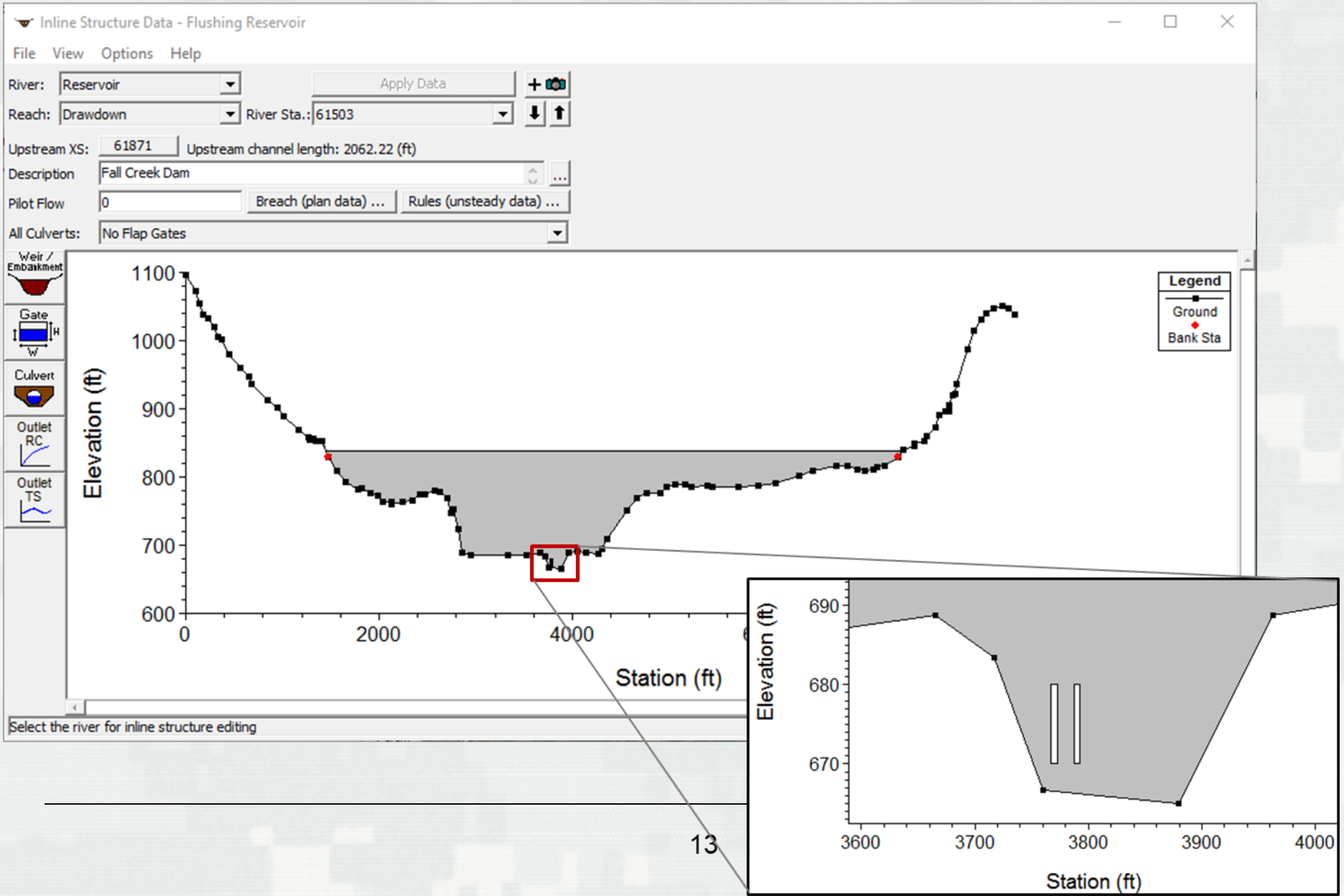
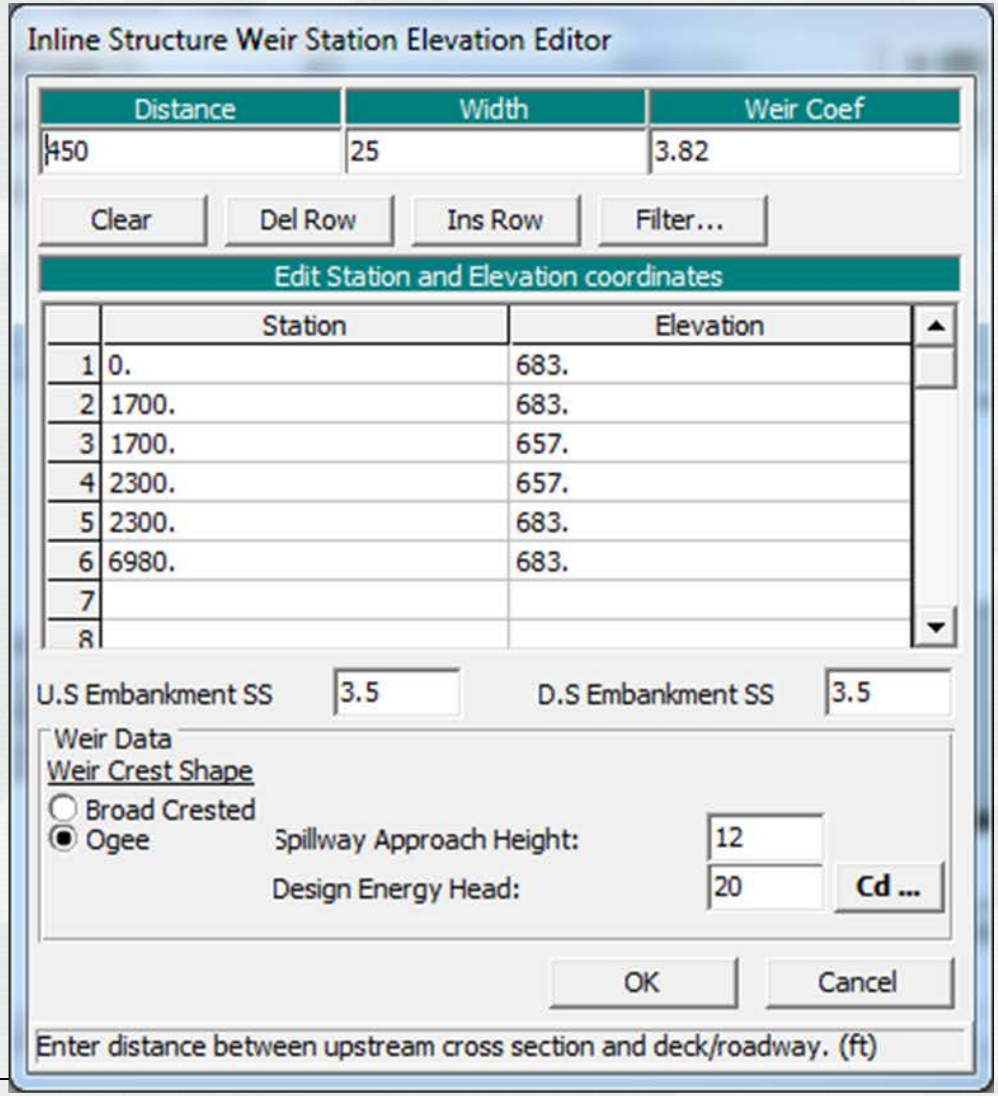
Entering Inline Structure Data



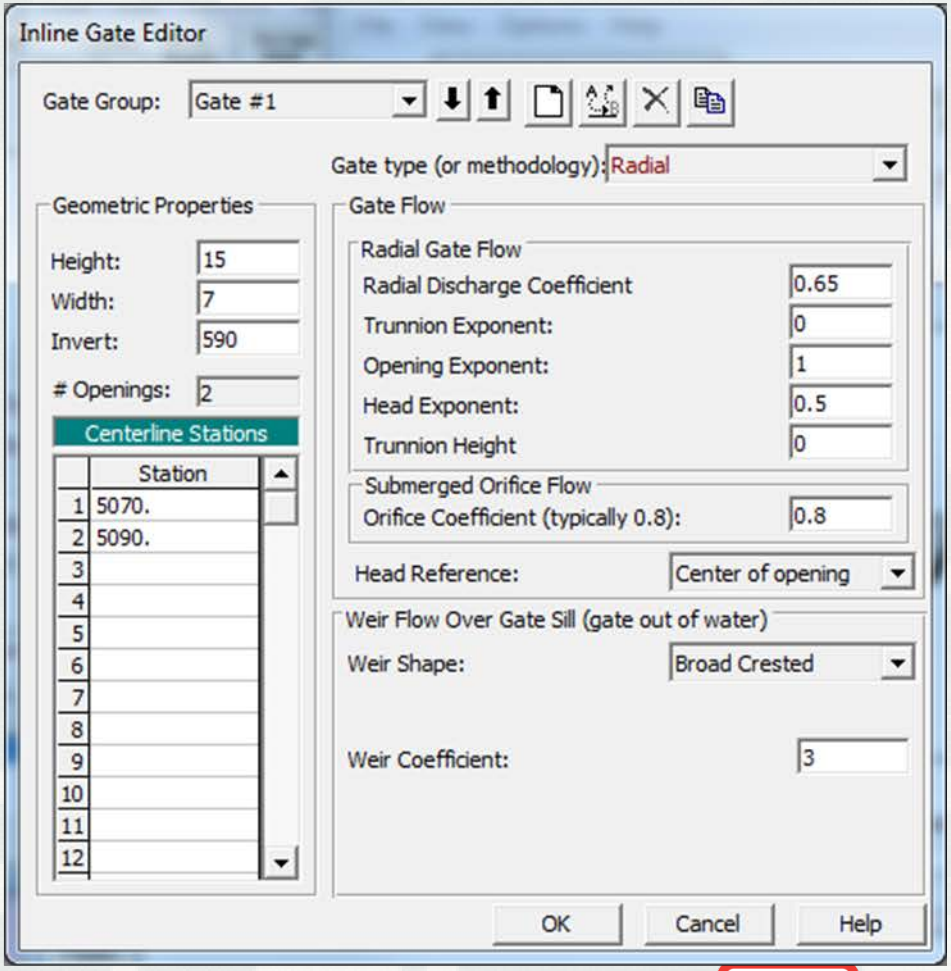
Weir and Embankment Profile

- Distance + Width < U/S XS Reach Length
- Weir include top of dam and spillway
- Weir Coef. used for both dam and spillway

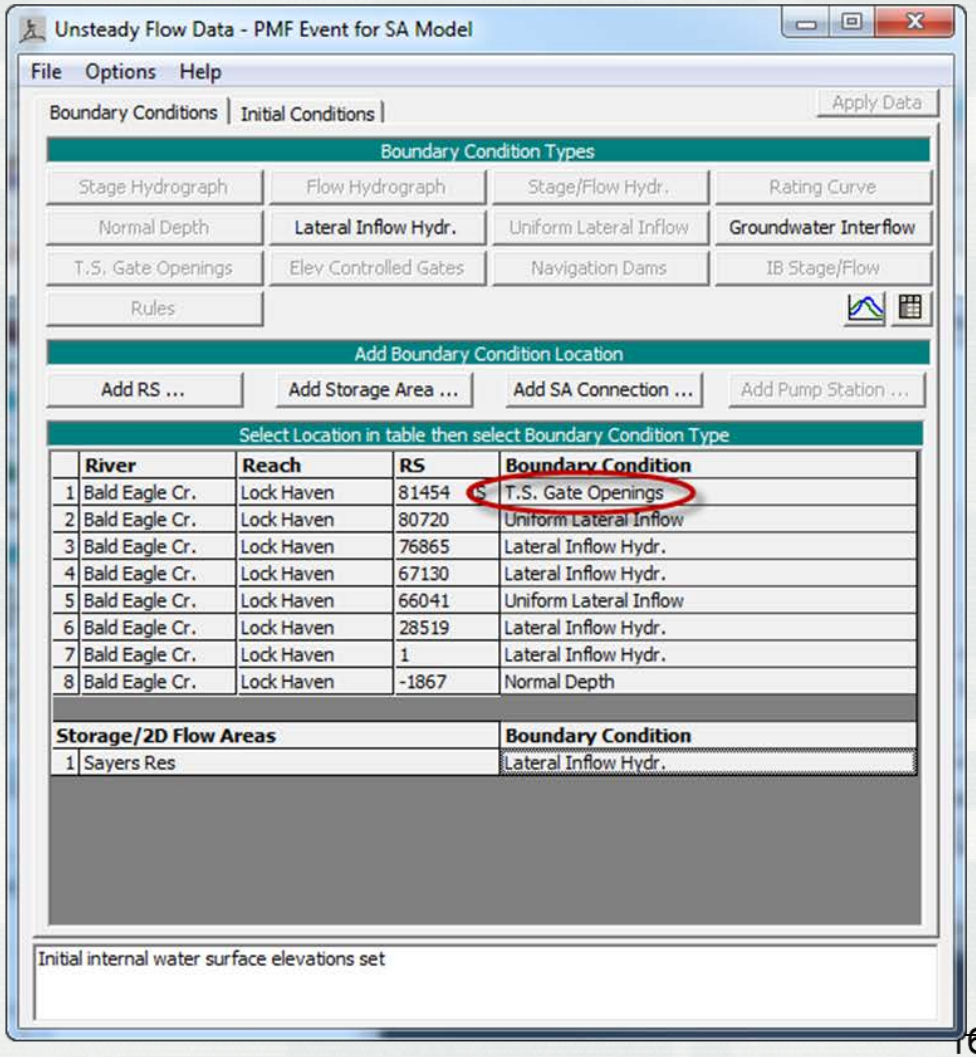


Gates

- Sluice
- Radial
- Overflow
- User Defined Curves

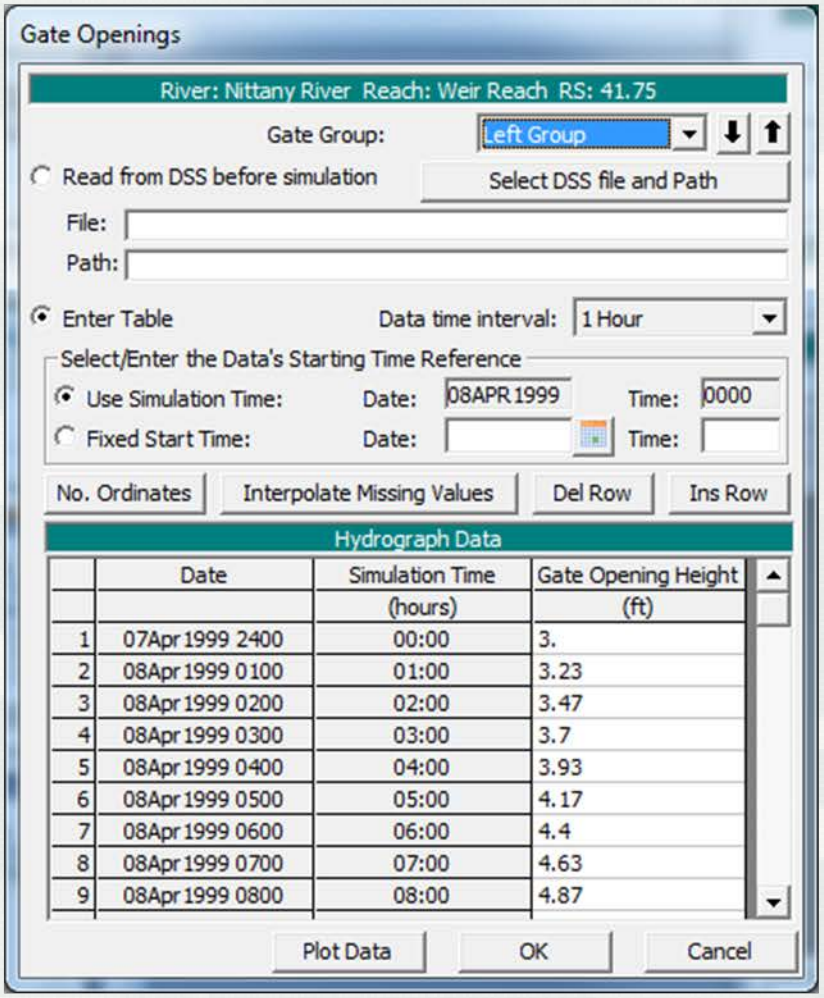


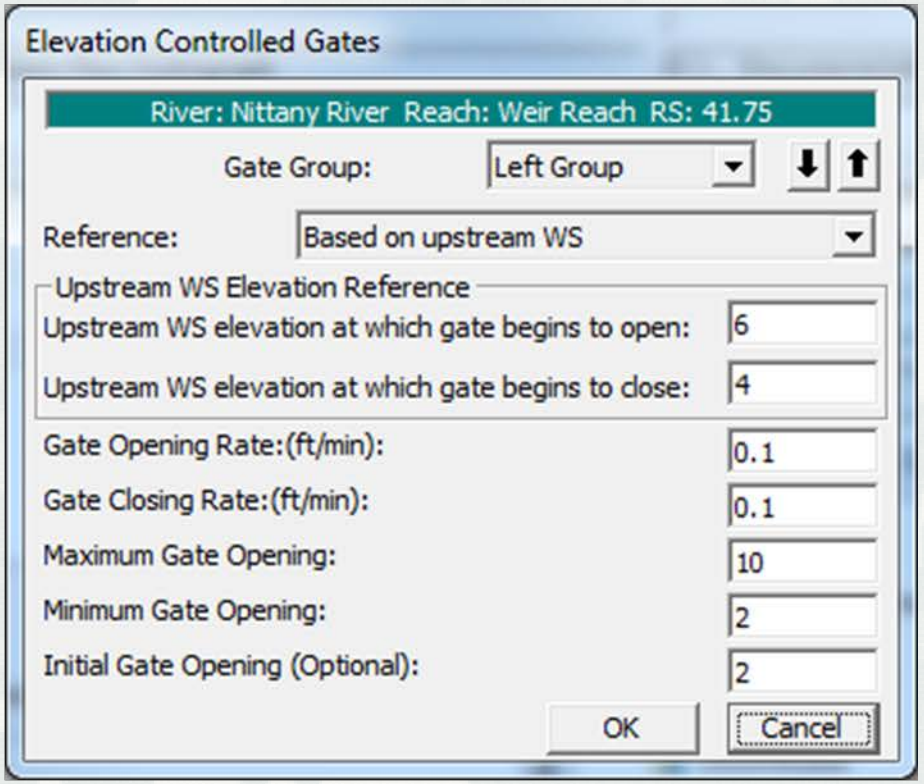
Gate Settings



- Add the Inline Structure station as a BC location to Specify Gate Settings

Gate Boundary Conditions





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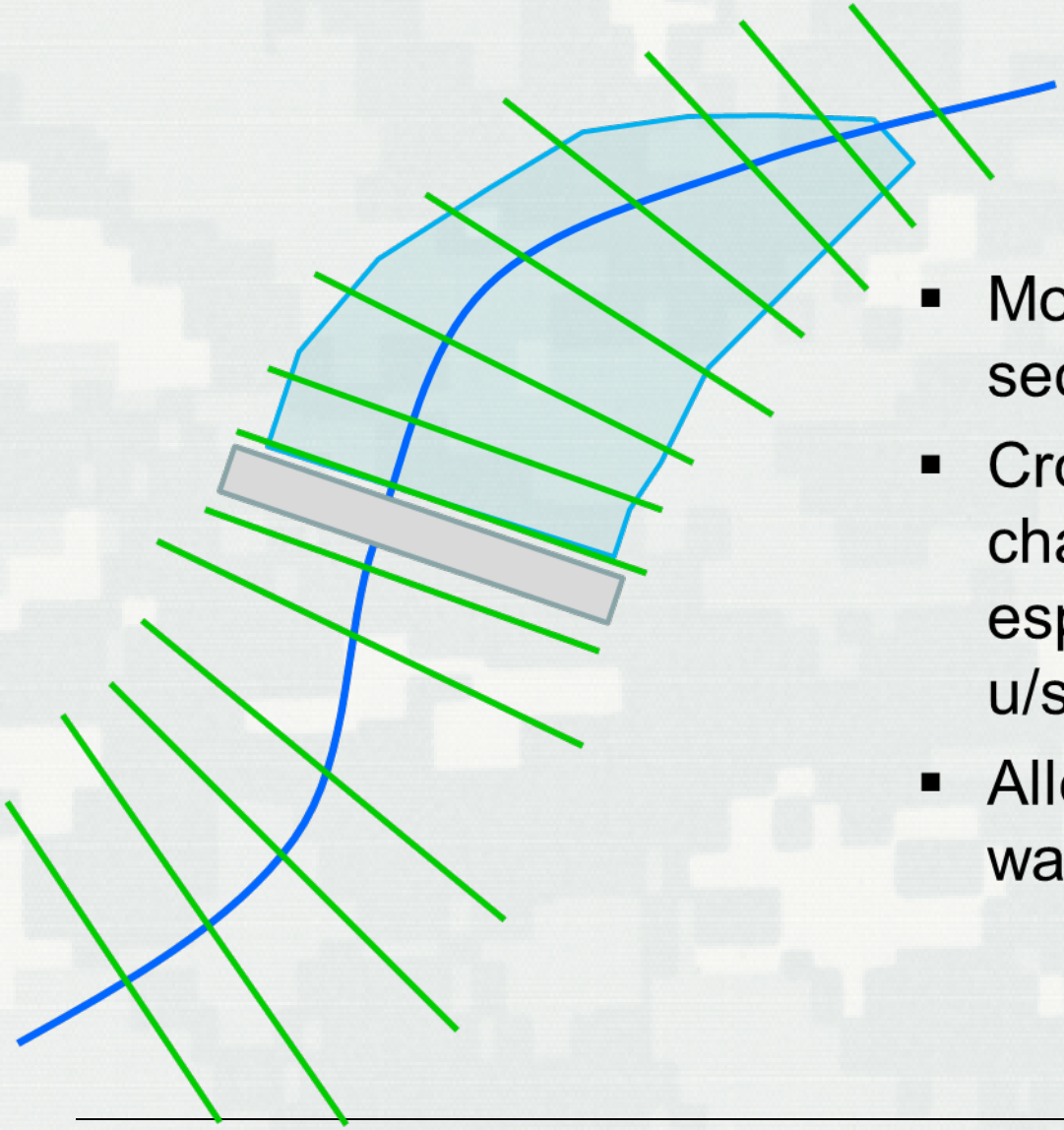
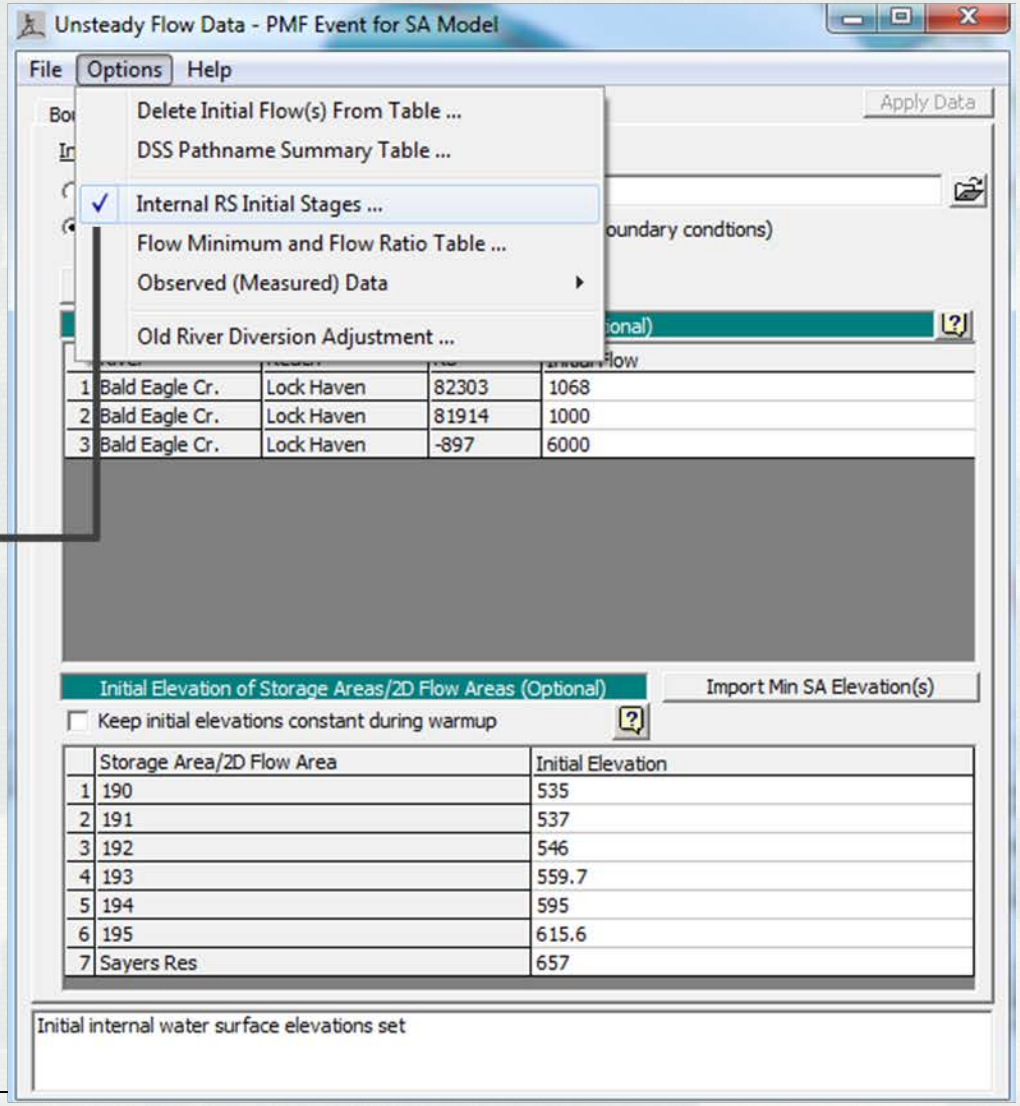
Reservoir Modeling Option

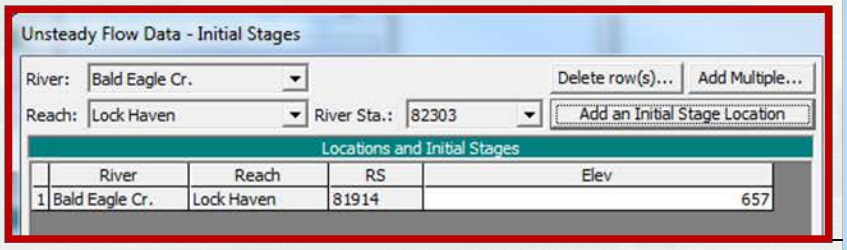


- Model Reservoir with cross sections
- Cross sections must include channel information, especially around dam both u/s and d/s
- Allows for dynamic routing of water (sloped water surface)

Initial Internal Stages

- Internal RS Initial Stages used to set initial water surface at a XS
- Stage U/S from inline structure is based on a balance of outlet size/gate opening and water surface.





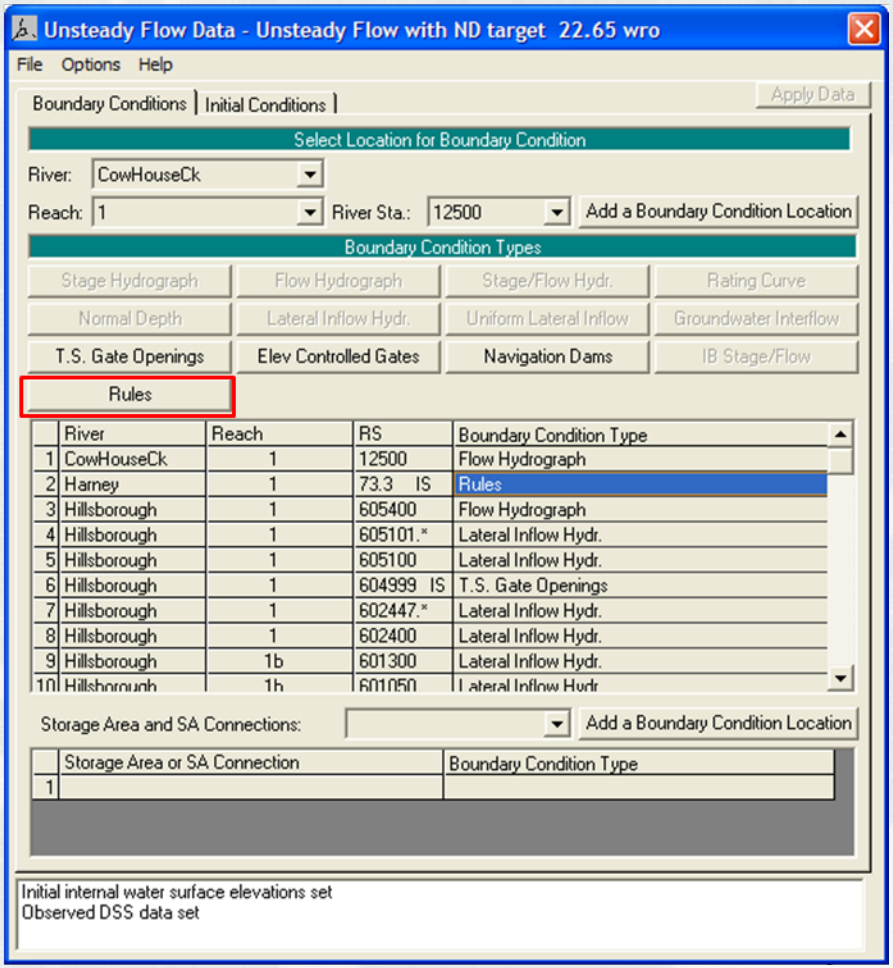
Operation Rules for Gated Structures

- Unsteady Flow Editor "Rules" boundary condition
- Inline/Lateral Structures
- Storage Area Connections

Controls

  - Gates
  - Weir Coefficients
  - Min/Max Flow

- Rules are evaluated at every time step



User Defined Rules Editor for Operating Gated Structures

```
Operation
'PoolElev' = Cross Sections:WS Elevation(Missouri River,Missouri,811.076,Value at current time step)
'Flushing Time' = Time:Hour of Simulation(Beginning of time step)
!
! Set initial 30000 cfs flows for 2 Days
!
Gate.Flow (Desired)(Gates) = 30000
Gate.Flow(Tunnels) = 0
!
! Start draining in2 Days in
If ('Flushing Time' > 48) Then
    ! Steve said this was over specified
    Gate.Flow (Desired)(Tunnels) = 62000
    Gate.Flow (Desired)(Gates) = 0
End If
!
! Close gates 7 days (+warm up and draining) later
If ('Flushing Time' > 312) Then
    Structure.Total Flow (Desired) = 5000
    If ('PoolElev' >= 1206) Then
        Structure.Total Flow (Desired) = 30000
    End If
End If
```