Unsteady Flow Modeling for Dam Safety Studies Workshop

Introduction

In this workshop you will be introduced to using the Inline Structure capabilities in HEC-RAS, and perform unsteady flow computations with both reservoir modeling approaches covered in the previous lecture.

NOTE: While this data is from an actual river system, the model and results of this workshop do not represent current or future conditions of the river. The United States Army Corps of Engineers has granted access to the information in this model for instructional purposes only. Do not copy, forward, or release the information without United States Army Corps of Engineers approval.

Problem Description

A project file (**UnsteadyFlowDamSafety.prj**) titled "**Bald Eagle Creek Example Dam Break Study**" is in your workshop directory. This data file includes the bathymetry of the river but not the dam. You will add the dam and experiment with two methods to define the reservoir.

Part A. Cross-Section Reservoir Method

1. Open the project file.
Look over the geometry and flow data.

2. Add inline structure to the geometry file with the following specifications:

Station – 81454
Top of Dam – 683'
Embankment Side Slopes – 3.5
Emergency Spillway in the Left Overbank:
- Spillway Location – XS Station 1700 to 2300
- Crest Elevation – 657'
- Length – 600'
- Distance to Upstream: 450'
- Width – 25'
- Weir Coef – 3.82

Gates (2 gates):
- Centerline stationing – 5070 & 5090
- Height – 15'
- Width – 7'
- Invert Elevation – 590'
- Type – Sluice, Sluice Coefficient - 0.65
- Weir Flow over Gate Sill Method: Broad Crested
- Weir Flow over Gate Sill Coefficient: 3

Set the initial pool elevation at the appropriate level for a PMF analysis of the dam (elevation 657.0 ft – spillway crest elevation).

3. Set Gate Openings.
Open the unsteady flow editor. Add a boundary condition location at Station 81454 IS. Click on the blank field. Select **T. S. Gate Openings** as the boundary condition. Set each entry in the time series to a gate opening of 1 ft.

4. Compute.
Save your geometry and flow data. Open the **Unsteady Flow Analysis** window. Press **Compute**. Once the calculations are complete, review the output and answer the following questions.

Which levees (lateral weirs) are overtopped? _____

What is the maximum water surface elevation at station 19487? _____

What is the maximum reservoir pool elevation? _____

Does the emergency spillway pass the PMF as designed? _____

What other calculations should be done to ensure the emergency spillway size is adequate?

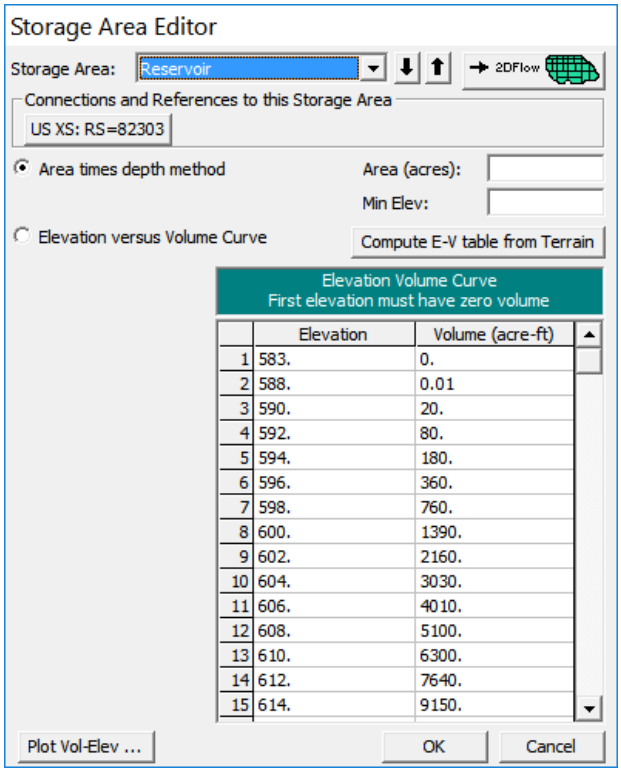
Part B. Storage Area Reservoir Method

1. Create a New Geometry
Create a new geometry by saving the existing geometry with a new name reflecting the use a storage area for the reservoir.

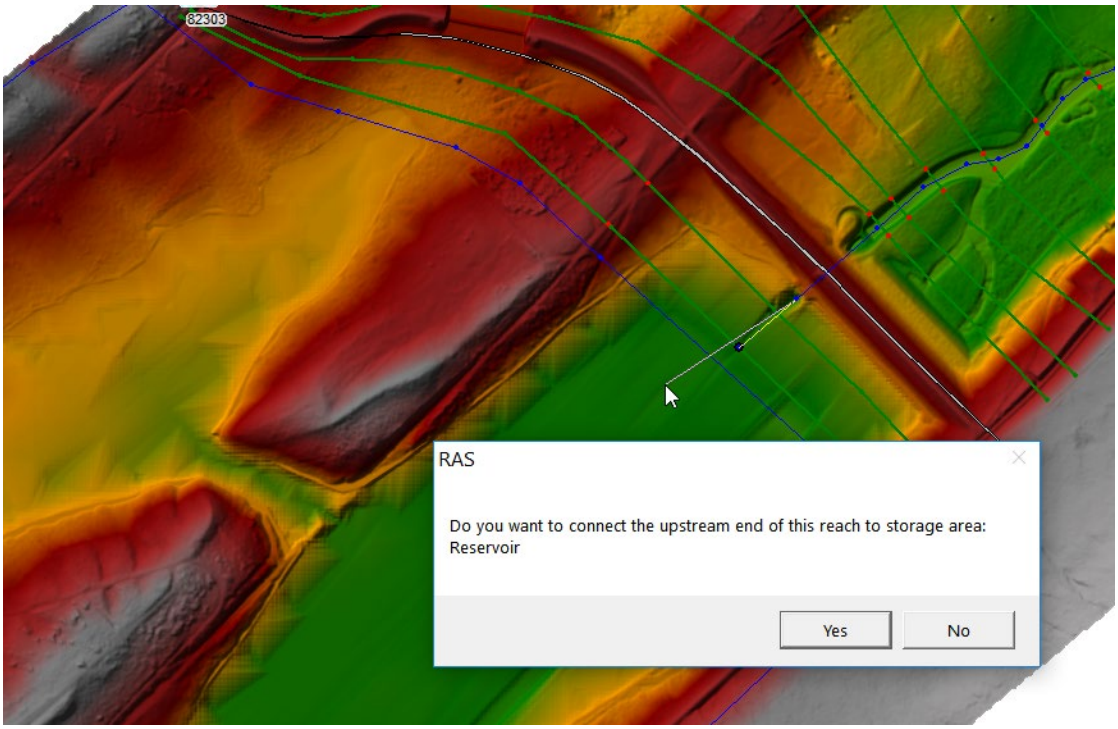
2. Delete the Reservoir Cross-Sections
Delete the reservoir cross sections but remember to save two cross sections immediately upstream of the inline structure. Delete all of the other nodes upstream of the dam. You can delete multiple cross sections by selecting **Delete Nodes** under the **Edit** menu on the geometric data editor. Also delete any storage areas and lateral weirs that are associated with the cross sections deleted.

3. Create a Storage Area.
Create a storage area by pressing the **Storage Area** button on the top of the geometric editor. The Storage area can have any shape you choose, but in order for the mapping output to plot appropriately it should be drawn to resemble the outline of the extent of the cross sections upstream of the dam.

4. Add Area-Capacity Reservoir Information
Next open the storage area and define the elevation-volume curve. (This can be copied from Dam Area-Capacity Table.xls file provided in your workshop directory). Press the **Plot Vol-Elev** button to view the curve.



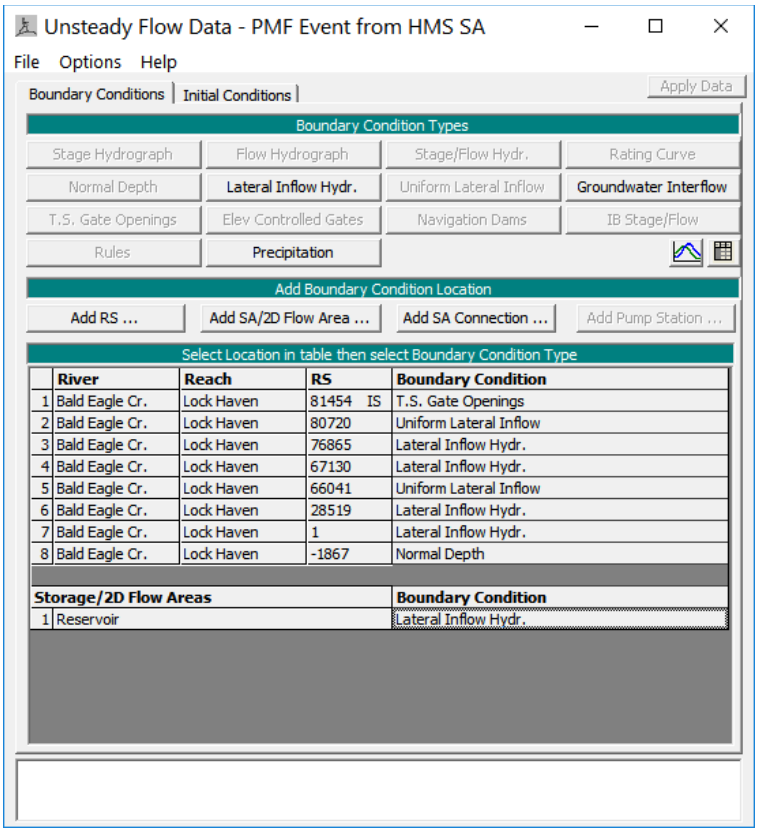
5. Connect Reach to Storage Area.
To set the storage area as your upstream boundary condition, go to the **Edit** menu on the Geometric Data editor and select the **Move Object** option. Then drag the end of your stream centerline into the bounds of the storage area. If it is already in the storage area polygon just move it slightly. A message will appear asking if you want to connect the upstream end of this reach to the storage area. Select Yes.

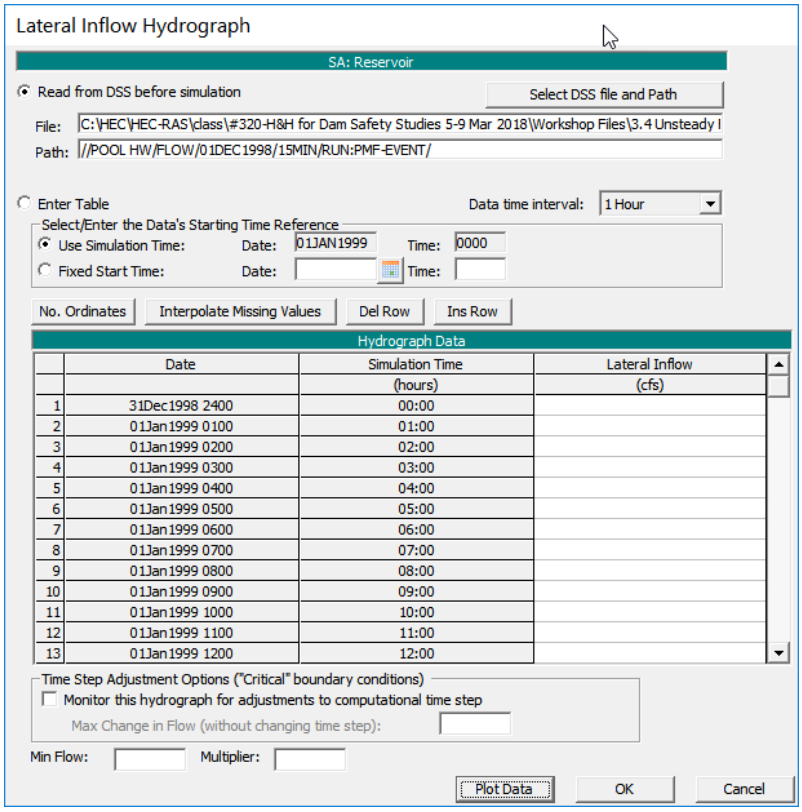


6. Create New Unsteady Flow Data file with SA
Open the unsteady flow editor. Create a new Unsteady Flow Data file by saving the existing flow data with a new name reflecting the use of the Storage Area.

7. Set Initial and Boundary Conditions
Delete all boundary conditions that originally flowed into the deleted cross sections. All of that flow must still be accounted for however. So we must add a lateral hydrograph to the reservoir (storage area). Since you can only add one lateral hydrograph to each storage area, a DSS record was created that combines these flows. Select the new storage area that you created and press the **Add a Boundary Condition Location** button. Then select the boundary condition type field and select **Lateral Inflow Hydr**. Select the DSS file **Bald_Eagle_Creek.dss** and the record:

//POOL HW/FLOW/01DEC1998/15MIN/RUN:PMF-EVENT/


Unsteady Flow Data - PMF Event from HMS SA
File Options Help
Boundary Conditions Initial Conditions
Apply Data
Boundary Condition Types
Stage Hydrograph
Flow Hydrograph
Stage/Flow Hydr.
Rating Curve
Normal Depth
Lateral Inflow Hydr.
Uniform Lateral Inflow
Groundwater Interflow
T.S. Gate Openings
Elev Controlled Gates
Navigation Dams
IB Stage/Flow
Rules
Precipitation
Add Boundary Condition Location
Add RS ...
Add SA/2D Flow Area ...
Add SA Connection ...
Add Pump Station ...
Select Location in table then select Boundary Condition Type
River Reach RS Boundary Condition
1 Bald Eagle Cr. Lock Haven 81454 IS T.S. Gate Openings
2 Bald Eagle Cr. Lock Haven 80720 Uniform Lateral Inflow
3 Bald Eagle Cr. Lock Haven 76865 Lateral Inflow Hydr.
4 Bald Eagle Cr. Lock Haven 67130 Lateral Inflow Hydr.
5 Bald Eagle Cr. Lock Haven 66041 Uniform Lateral Inflow
6 Bald Eagle Cr. Lock Haven 28519 Lateral Inflow Hydr.
7 Bald Eagle Cr. Lock Haven 1 Lateral Inflow Hydr.
8 Bald Eagle Cr. Lock Haven -1867 Normal Depth
Storage/2D Flow Areas Boundary Condition
1 Reservoir Lateral Inflow Hydr.


Lateral Inflow Hydrograph
SA: Reservoir
Read from DSS before simulation
Select DSS file and Path
File: C:\HEC\HEC-RAS\class\#320-H&H for Dam Safety Studies 5-9 Mar 2018\Workshop Files\3.4 Unsteady I
Path: //POOL HW/FLOW/01DEC1998/15MIN/RUN:PMF-EVENT/
Enter Table
Data time interval: 1 Hour
Select/Enter the Data's Starting Time Reference
Use Simulation Time: Date: 01JAN1999 Time: 0000
Fixed Start Time: Date: Time:
No. Ordinates
Interpolate Missing Values
Del Row
Ins Row
Hydrograph Data
Date Simulation Time (hours) Lateral Inflow (cfs)
1 31Dec1998 2400 00:00
2 01Jan1999 0100 01:00
3 01Jan1999 0200 02:00
4 01Jan1999 0300 03:00
5 01Jan1999 0400 04:00
6 01Jan1999 0500 05:00
7 01Jan1999 0600 06:00
8 01Jan1999 0700 07:00
9 01Jan1999 0800 08:00
10 01Jan1999 0900 09:00
11 01Jan1999 1000 10:00
12 01Jan1999 1100 11:00
13 01Jan1999 1200 12:00
Time Step Adjustment Options ("Critical" boundary conditions)
Monitor this hydrograph for adjustments to computational time step
Max Change in Flow (without changing time step):
Min Flow:
Multiplier:
Plot Data
OK
Cancel

8. Compute and Compare
Create a new plan that uses the new geometry and flow files. Run the new plan. Compare the results

9. Questions
What is the maximum water surface elevation at station 19487? _____

What is the maximum reservoir pool elevation? _____

Are you satisfied with how similar the answers are between the two methods of modeling the reservoir pool? _____

How can the discrepancy between the profiles be explained?

Explain why you might consider using one method over the other?