Basic Unsteady Flow Modeling
Workshop

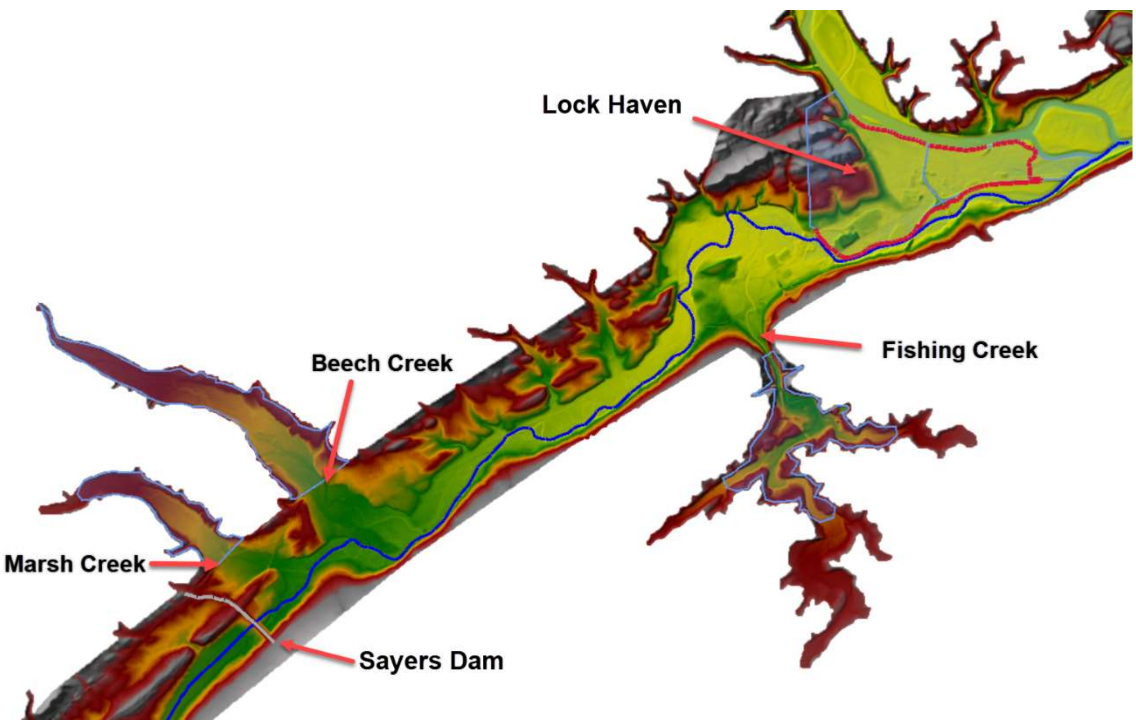
1 Objective

In this workshop, you will exercise your knowledge on the basics on unsteady flow modeling to setup and compute a simulation for Bald Eagle Creek, PA. The workshop consists of the following major tasks:

- Creating an Unsteady Flow file and adding boundary conditions
- Linking boundary conditions to DSS data
- Setting initial conditions
- Performing a sensitivity analysis on boundary conditions
- Revieing results using various methods

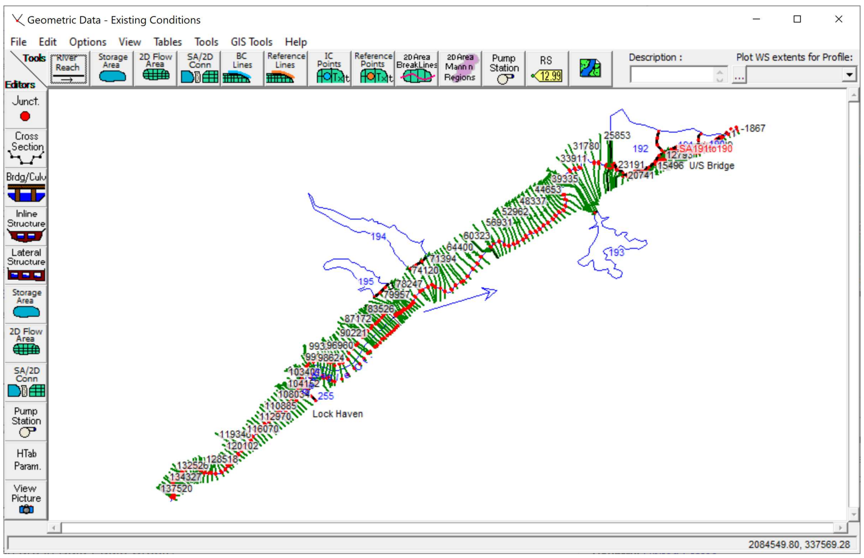
2 Background

You will be working with a dataset for Sayers Dam on Bald Eagle Creek in central Pennsylvania. Sayers Dam is approximately 15 miles upstream of the town of Lock Haven, which is protected by a levee system. See the figure below to become acquainted with the dataset.



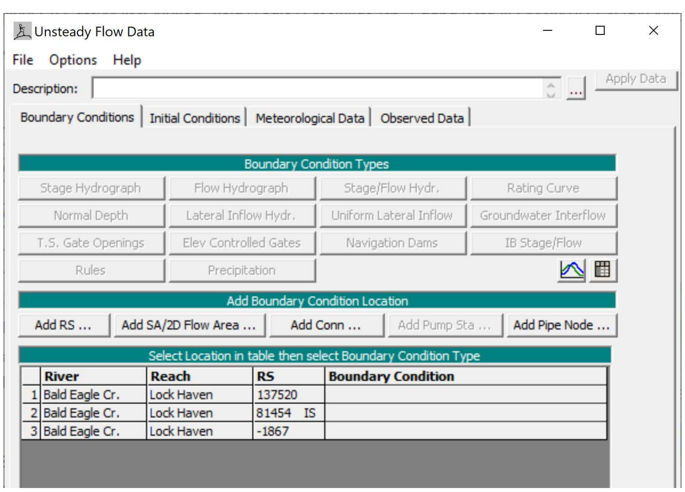
3 Setup Unsteady Flow Boundary Conditions

1. Start HEC-RAS and **Open** the "**Bald Eagle – Unsteady**" project
2. **Open** the **Geometric Data** editor to become familiar with the data. Identify areas of interest such as Lock Haven, Sayers Dam and the tributaries using the figure above.



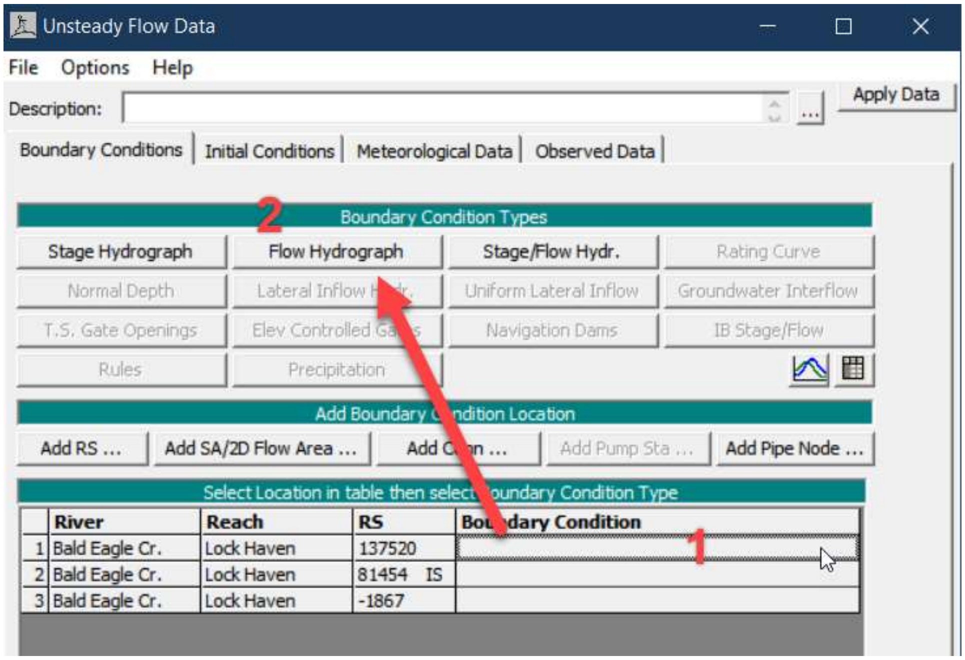
3. **Open** the **Unsteady Flow Data** editor

   a. Notice that at a minimum, the this geometry requires an upstream, downstream, and inline structure boundary condition.



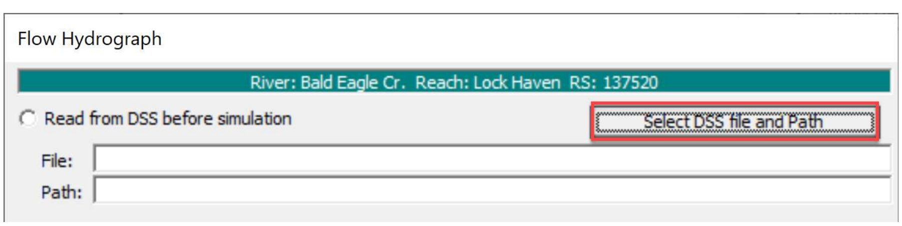
4. Select **File, Save Unsteady Flow Data**. Name flow file "**PMF-HMS**".

5. Set the upstream boundary condition at **River Station** "**137520**" to a **Flow Hydrograph**. This boundary condition will represent the reservoir inflows.

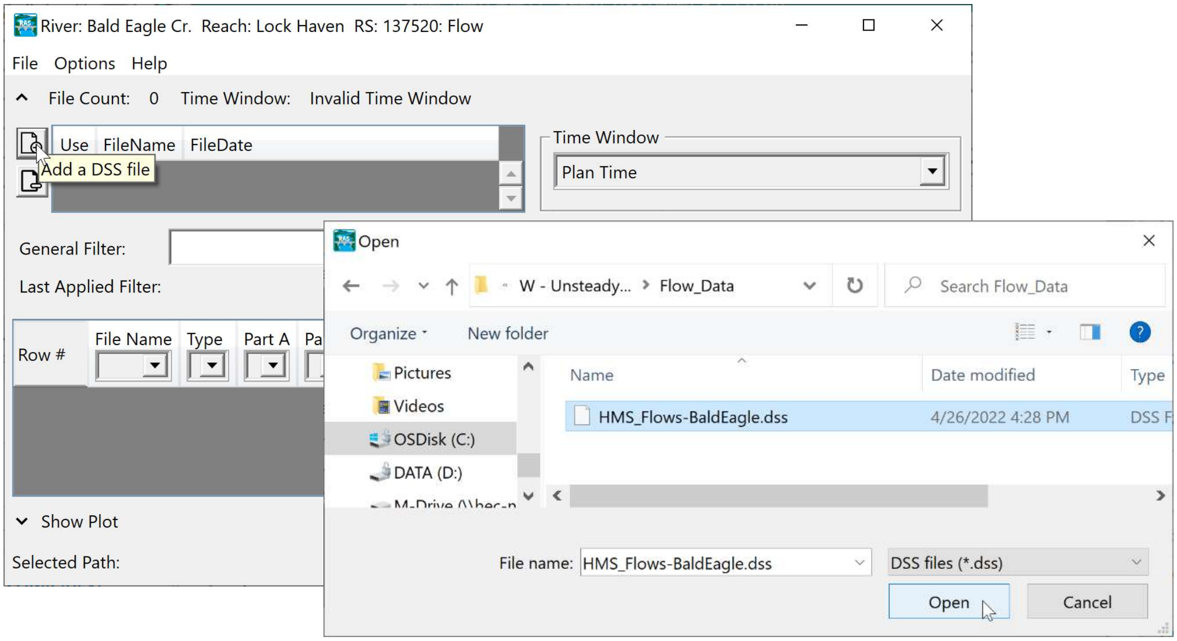


6. When the **Flow Hydrograph** editor opens**,** select **Read from DSS before Simulation Option**.

7. Click **Select DSS File and Path** button.

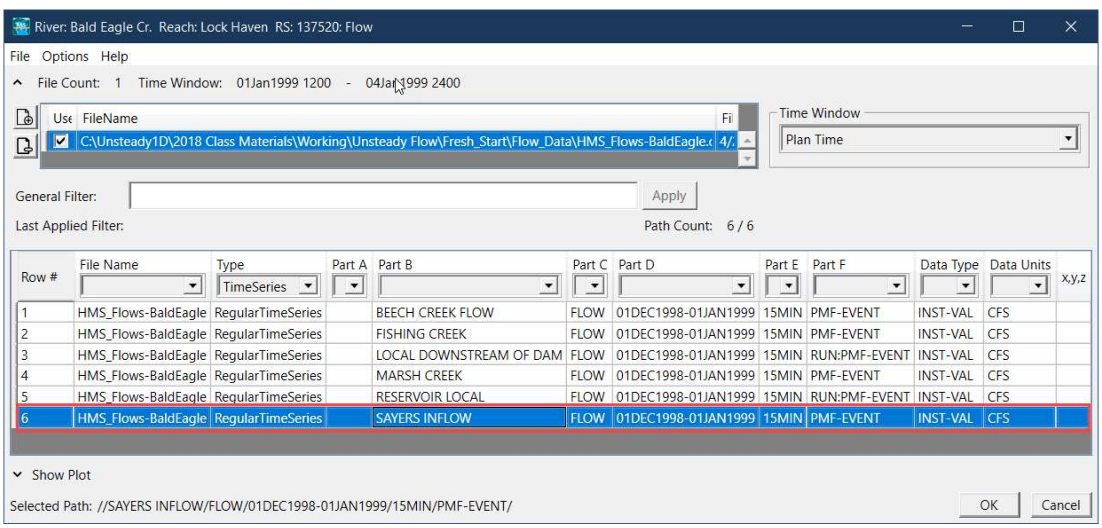


8. Click the **Add File** button and select the DSS file in the "**Flow_Data"** directory as shown below.



a. This DSS file contains results from an HEC-HMS hydrologic model. You will add those results as boundary conditions to this model.

9. Select the pathname with the "**SAYERS INFLOW**" B-Part and **select OK.**

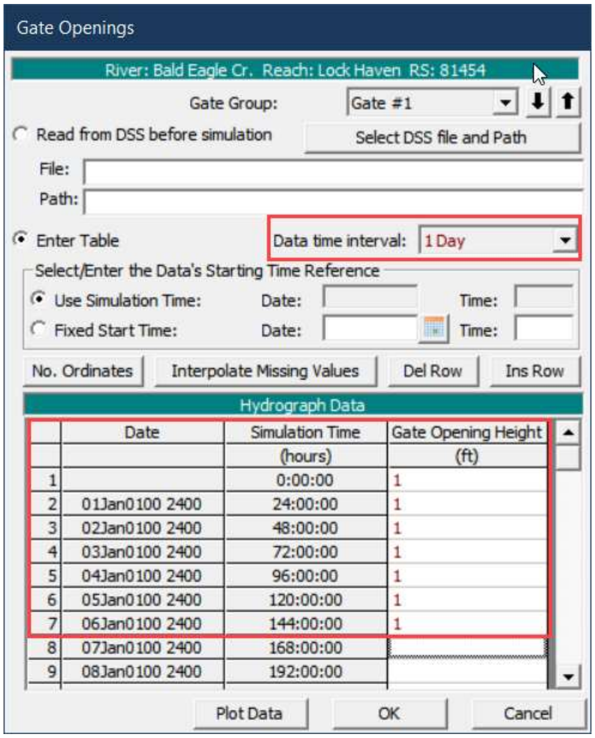


10. **Select OK** in the **Flow Hydrograph** editor to accept the changes.

11. Set the downstream boundary condition at **River Station** "**-1867**" to **Normal Depth**. Use a **Friction Slope** of **0.0005.**

12. Set the **Inline Structure** boundary condition at **River Station "81454 IS"** to **T.S. Gate Opennings**.

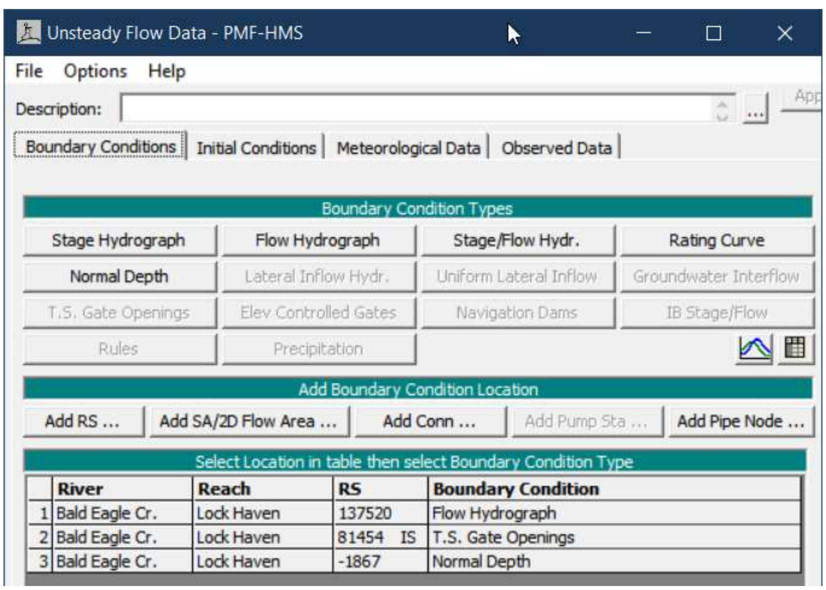
    a. Change the **Data time interval** to **1 day**. Enter **1 ft** in the table through 06 Jan as shown below. **Click OK**.



	Date	Simulation Time (hours)	Gate Opening Height (ft)
1		0:00:00	1
2	01Jan0100 2400	24:00:00	1
3	02Jan0100 2400	48:00:00	1
4	03Jan0100 2400	72:00:00	1
5	04Jan0100 2400	96:00:00	1
6	05Jan0100 2400	120:00:00	1
7	06Jan0100 2400	144:00:00	1
8	07Jan0100 2400	168:00:00	
9	08Jan0100 2400	192:00:00	

13. In the Unsteady Flow Data Editor select **File | Save Unsteady Flow Data**

    a. At this point, the **Unsteady Flow Data** editor should look like the figure below.

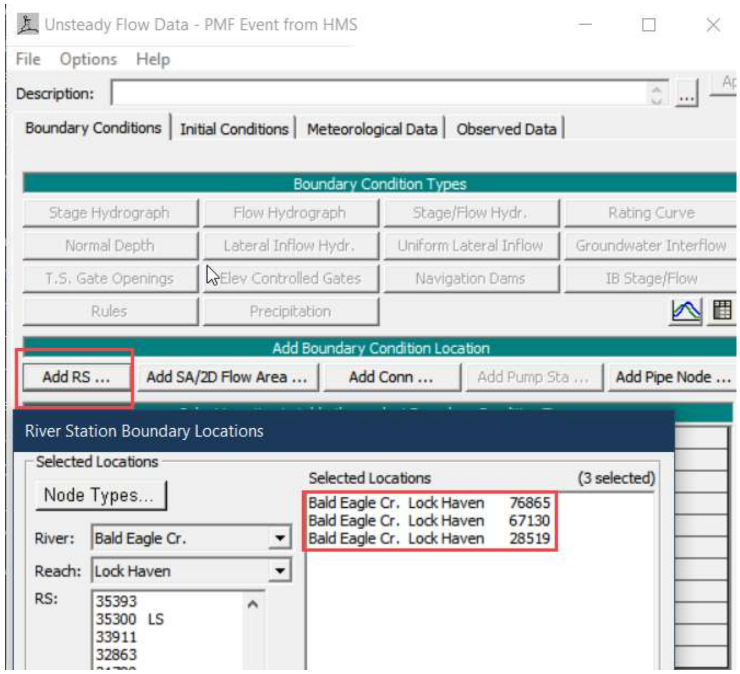


	River	Reach	RS	Boundary Condition
1	Bald Eagle Cr.	Lock Haven	137520	Flow Hydrograph
2	Bald Eagle Cr.	Lock Haven	81454 IS	T.S. Gate Openings
3	Bald Eagle Cr.	Lock Haven	-1867	Normal Depth

14. Next you'll create additional boundary conditions for the tributary inflows.

    a. In the **Unsteady Flow Data** editor **Select** the **Add RS…** button.

    b. Select the 3 rivers stations where tributary flow will enter the model. **River Stations: 76865, 67130, and 28519**

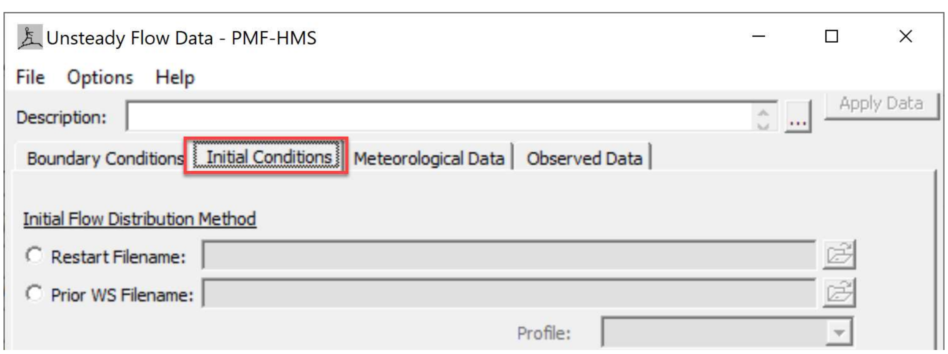


c. Set each of the new locations to a **Lateral Inflow Hydrograp** boundary condition and **select the appropriate DSS File and path** for each location as indicated below:

River Station	DSS B-Part
76865	**MARSH CREEK**
67130	**BEECH CREEK**
28591	**FISHING CREK**

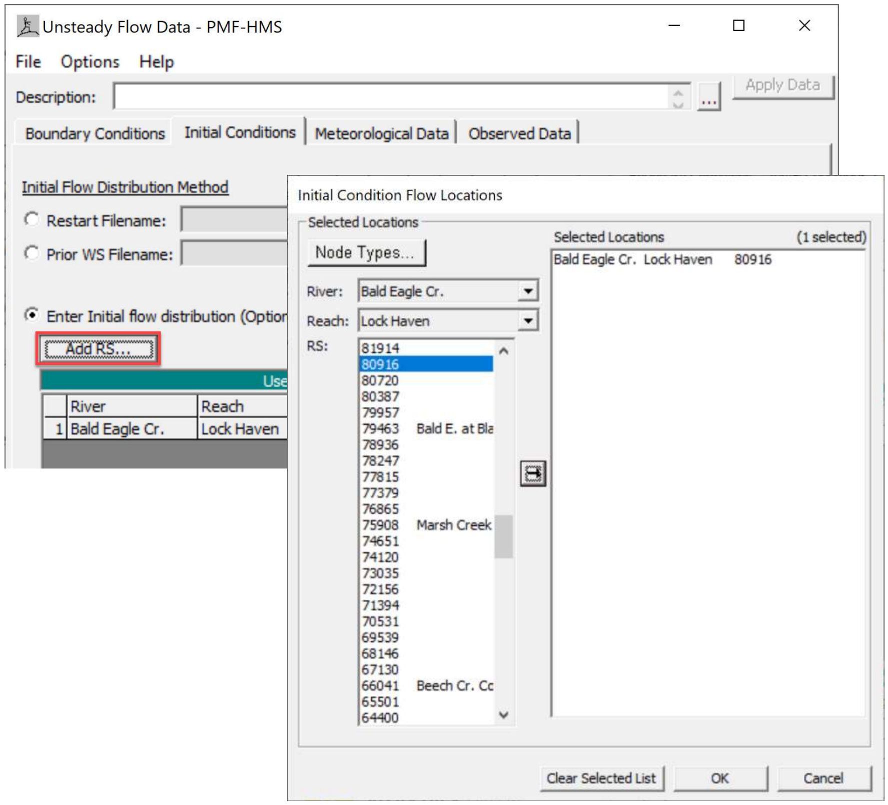
4 Set Initial Conditions

15. In the **Unsteady Flow Data** editor, switch to the **Initial Conditions** tab.

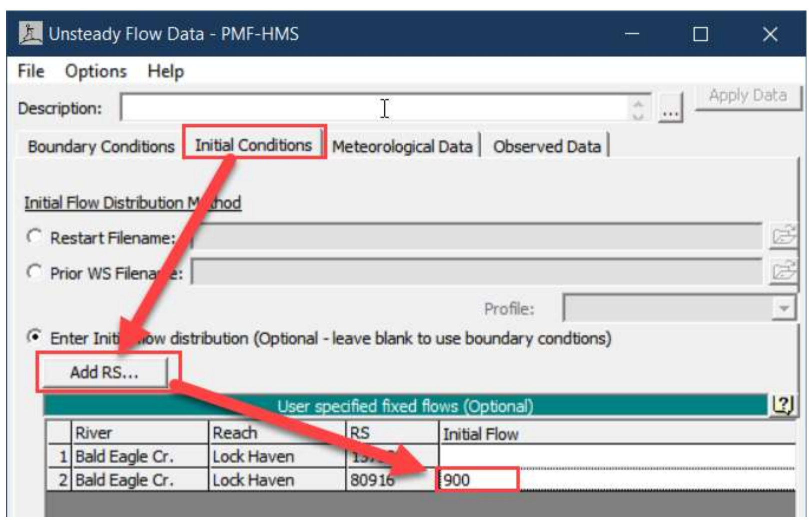


16. Set the initial flow at the cross-section just downstream of the dam

    a. Select **Add RS…** and ad, **River Station 80916**.

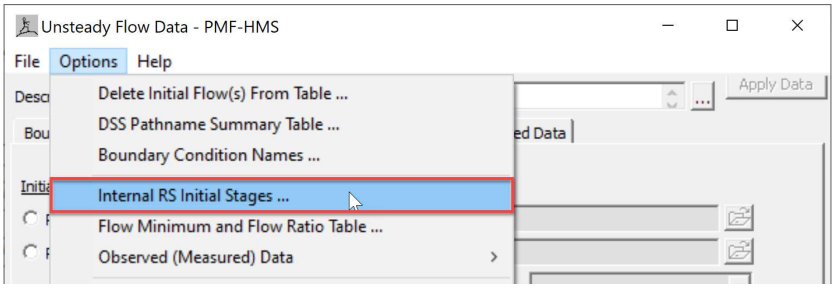


    b. Then set the **Initial Flow** to **900 CFS**. This will represent the initial outflow from the dam.

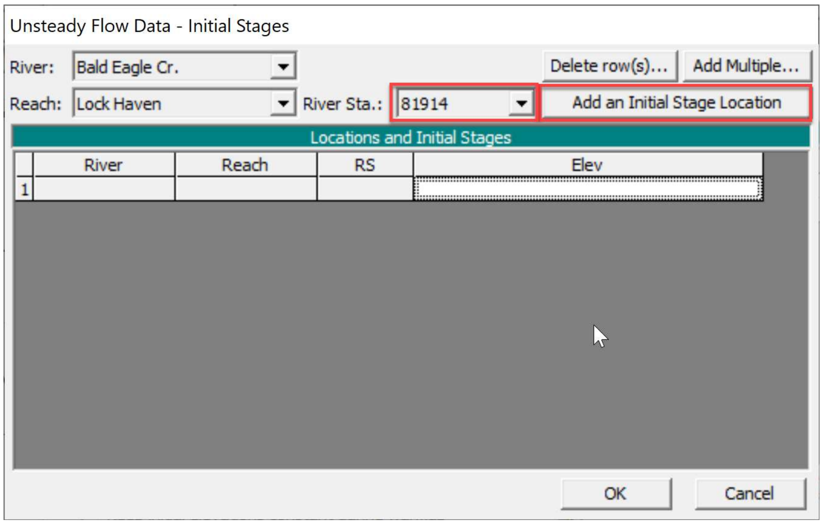


17. Next, add an **Initial Stage** to represent the starting pool elevation.

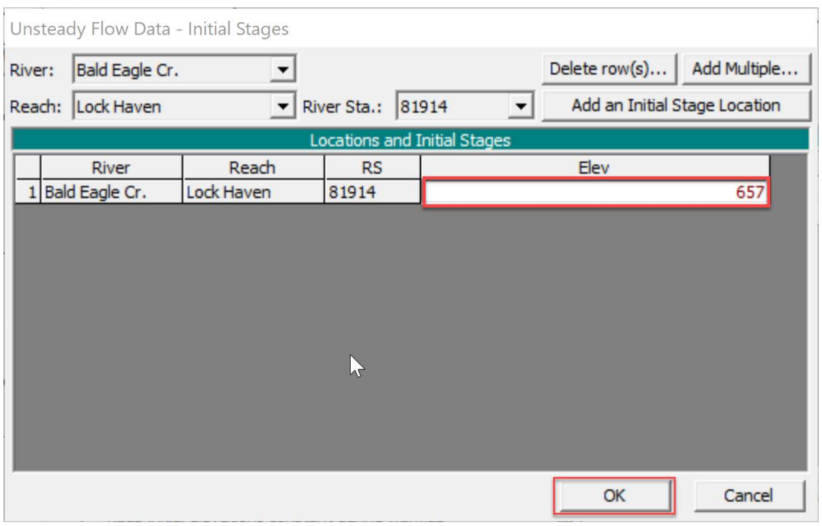
    a. In the **Options** menu select **Internal RS Initial Stages…**



    b. Find **RS 81914** in the "**River Sta.:**" dropdown and select **Add an Initial Stage Location.**



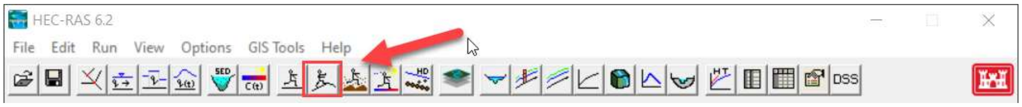
    c. Set the starting elevation to **657 ft**, the spillway crest elevation, and press OK.



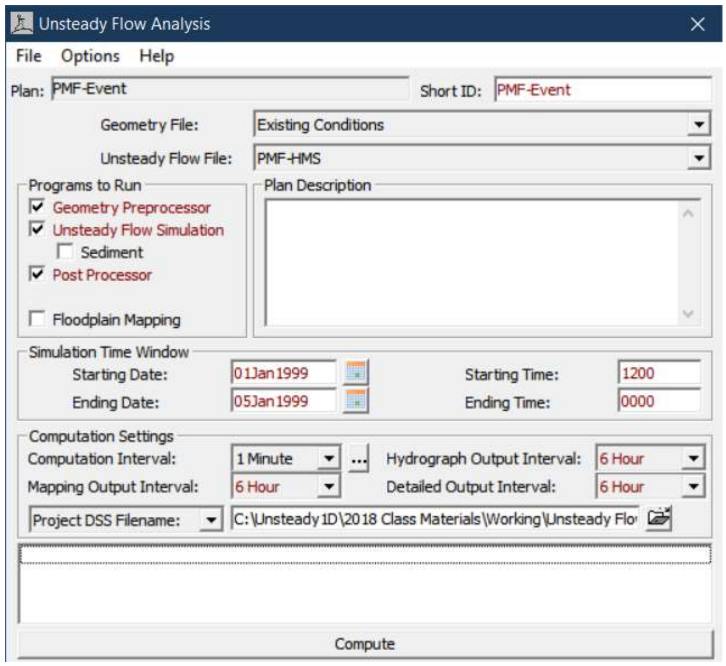
18. **Save** and **close** the **Unsteady Flow Data** editor.

5 Create a Plan and Compute

19. Open the **Unsteady Flow Analysis** editor.



20. Enter the **Programs to Run, Simulation Time Window, and Computation Settings** as shown below:



Note: The 6 hour output intervals will be changed again later in the workshop.

21. **Save** the **Plan** and call it "**PMF-Event".**

22. **Compute**

6 Reviewing Results

23. **Open** the **Cross-Section Plot** and the **Profile Plot.** Arrange them side-by-side on your screen.

24. In the **Cross Section Viewer**, display River Station "**81454 IS Joseph Sayers Dam"**

25. Launch the **Animation Control** and advance through the profiles and answer the questions

Question: Which profile (date and time) had the highest water surface elevation at the dam and what was it?

Question: What is the water surface elevation at the dam for the "Max WS" profile? What is the difference in from the answer above?

26. Open the **Stage & Flow Hydrograph Viewer**

27. From the **Type** menu select **Inline Structures** to view the hydrographs for the dam.

Question: What is the maximum water surface elevation and maximum total flow for the dam? Comment on the shape of the hydrographs.

28. In the **Unsteady Flow Analysis** editor, go to **File | Save Plan As …** and call the plan **PMF-Event-New**. Change the output intervals to **30 min**.

29. **Recompute**

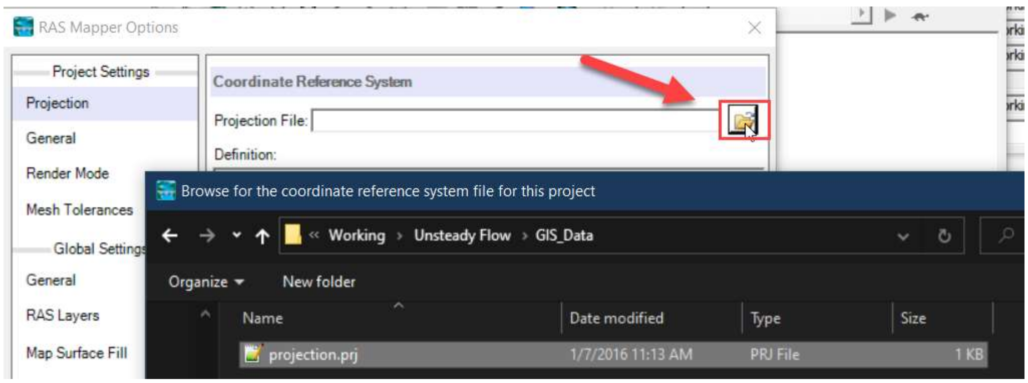
Question: Now that we've decreased the output interval, how do the stage and flow hydrographs compare to the previous run?

Question: Similarly, how does Profile Plot compare to the previous run?

7 Revieing Results in RAS Mapper

30. Open **RAS Mapper**

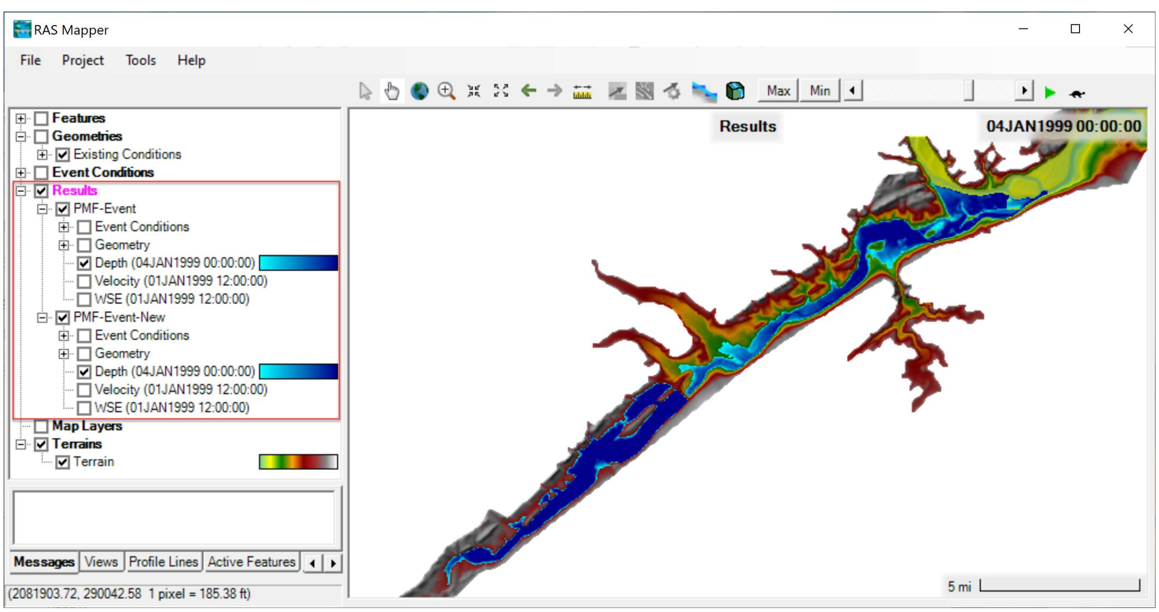
31. From the **Project Menu** select **Set Projection** and navigate to the projection in the **GIS_Data** directory.



32. Right-click on "**Terrains**" in the tree and select **Add Existing RAS Terrain**.

    a. Navigate to the "**Terrain.hdf**" file in the "**Terrain**" directory.

33. Expand the "**Results"** node in the tree and turn on the "**Depth**" layer. Use the **Animation Toolbar** to visualize the flood wave move downstream.



34. In Mapper, **animate** the **Depth** layer again to see the impact of the output interval change.

35. **Turn on** the **Velocity** Layer and **Select** the **Max** button in the animation toolbar.

Question: Locate 3 areas where velocities are the highest. What are the velocities in these areas? What do you think is causing the high velocities?

8 Downstream Boundary Sensitivity

36. Open the **Unsteady Flow Data Editor**, and select **File | Save Unsteady Flow Data As….** Name the **Unsteady Flow Data** as "**PMF-HMS_0001"**.

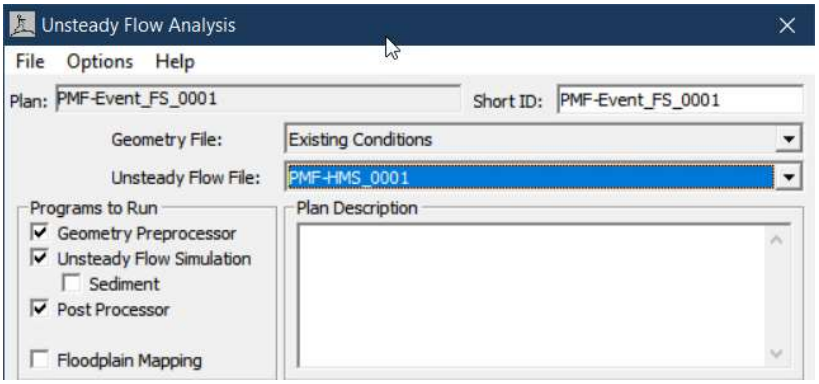
37. Reduce to **Friction Slope** on the downstream boundary condition to **0.0001.**

38. **Save** the new **Unsteady Flow File**.

39. **Create** a new **Plan** using the **File | Save Plan As….** in the **Unsteady Flow Analysis** editor.

    a. Name the new plan "**PMF-Event_FS_0001"**

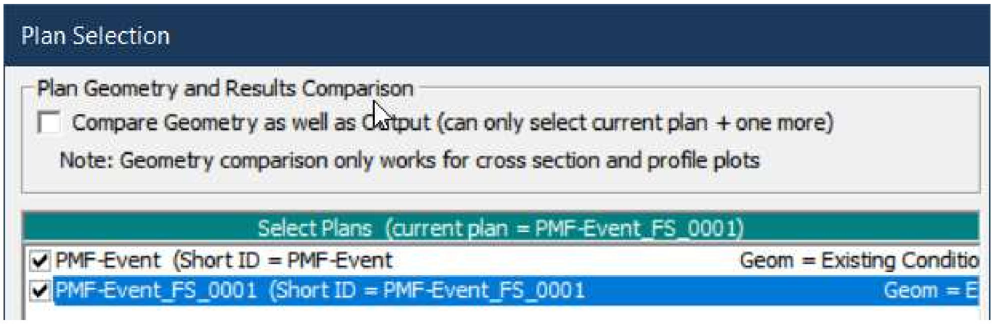
    b. Ensure the plan is using the new Unsteady Flow Analysis file



40. **Save** and **Compute**

41. Open the **Profile Plot** and select **Plans…** from the **Options Menu.**

42. **Check** on both plans to display them simultaneously.



Question: What is the largest difference in maximum water surface elevations between the two plans? Where does this occur?

Question: Do you think this is a good location for a downstream boundary condition? Why or why not?