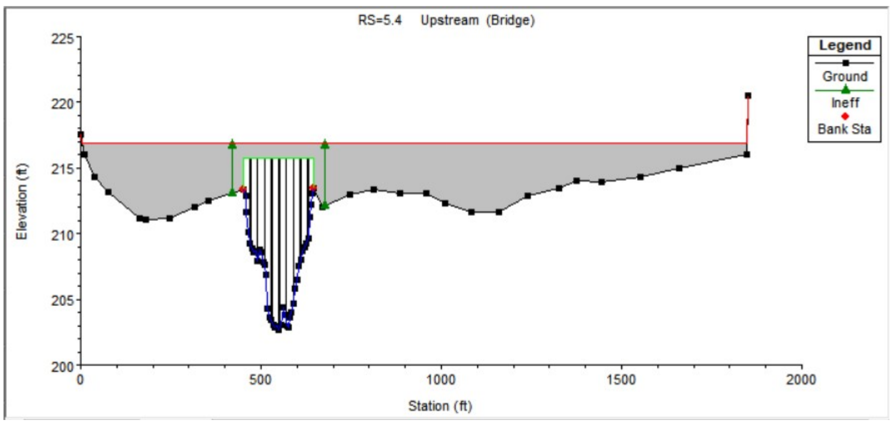
Bridge Development & Analysis
Workshop Solution

1 Bridge Data Development

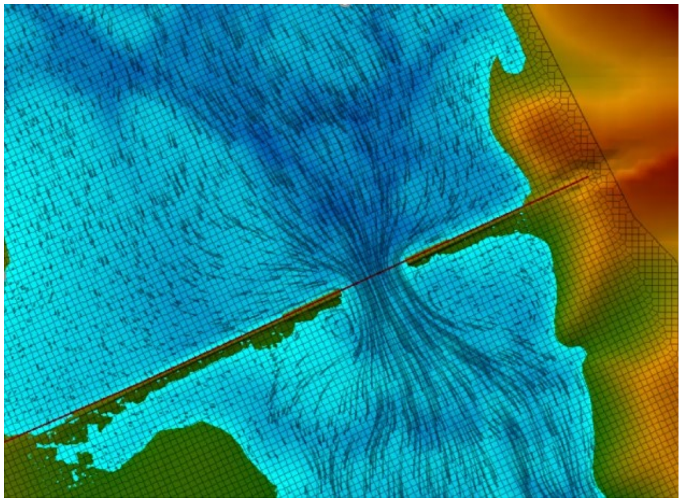
Question: If the expansion and contraction ratios were not provided, how would you estimate them?

The expansion and contraction ratios (ER and CR) in the figure below were provided in the workshop as 2:1 and 1:1 respectively. This means that for every foot upstream of the bridge the flow area on each side of the channel will widen by a foot. The upstream cross-section is 30 feet from the bridge, so the ineffective flow areas on each side should be 30 ft wider than the bridge opening.



If the ratios were not provided, the HEC-RAS Hydraulic Reference Manual contains a tables of ranges for both expansion and contraction ratios based channel slope and n values.

Another way to do this is to create and run a small 2D model through the bridge and use tracers to see how flow contracts and expands due to the constriction of the bridge as shown in the image below.



Question: What expansion and contraction coefficients did you use?

For a typical bridge section, the HEC-RAS Hydraulic Reference Manual suggests:

Contraction – 0.3

Expansion – 0.5

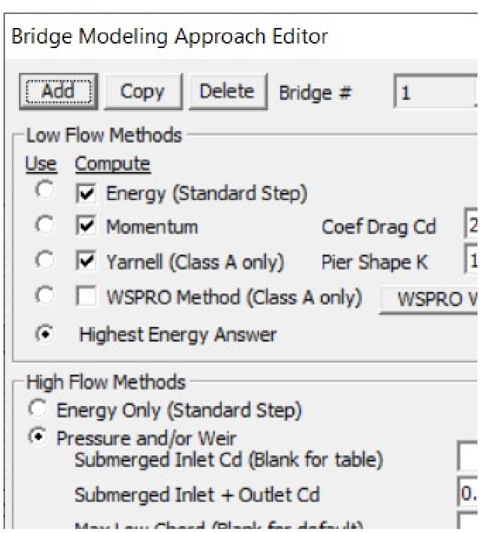
However, the embankment for this bridge blocks a good portion of the cross-sections rather abruptly, so a sensitivity analysis would help in determining which coefficients to are more appropriate.

Question: What Momentum and Yarnell parameters did you use and why?

The help buttons in the Bridge Modeling Approach Editor took me right to a helpful page int the Hydraulic Reference Manual that suggest Yarnell and Momentum parameters based on pier shape nose shape.

Momentum – 2.0

Yarnell – 1.2



Question: In looking at the geometry of the bridge, which high flow method would you anticipate being more appropriate and why?

The embankments block a significant amount of the cross-sections around the bridge, and the opening is relatively small compared to the embankments. That said, I would expect water to back up behind the bridge, pressure flow though the opening, and weir flow for the long embankments on either side of the bridge.

2 Bridge Analysis

Question: What plan resulted in the Highest WSELs upstream of the bridge for the May 1974 Profile (14,000 cfs). For both bridge plans, how much higher were WSELs than the without bridge plan?

The pressure and weir method resulted in the highest elevations upstream of the bridge. The Six XS Bridge Table was used to compare WSELs between plans. The pressure weir method was approximately 2 ft higher at the bridge.

Profile Output Table - Six XS Bridge

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HEC-RAS River: Beaver Creek Reach:

Reach	River Sta	Profile	Plan	E.G. Elev	W.S. Elev	Crit W.S.
				(ft)	(ft)	(ft)
Kentwood	5.44	May 74 Flood	Press/Weir	217.88	217.80	214.23
Kentwood	5.44	May 74 Flood	Bvr Crk	217.13	217.00	214.23
Kentwood	5.41	May 74 Flood	Press/Weir	217.68	217.44	212.24
Kentwood	5.41	May 74 Flood	Bvr Crk	216.54	215.47	212.23
Kentwood	5.4 BR U	May 74 Flood	Press/Weir	217.68	217.44	212.52
Kentwood	5.4 BR D	May 74 Flood	Press/Weir	217.68	217.44	212.52
Kentwood	5.39	May 74 Flood	Press/Weir	216.01	215.58	212.26
Kentwood	5.39	May 74 Flood	Bvr Crk	216.01	215.58	212.26
Kentwood	5.29	May 74 Flood	Press/Weir	215.16	215.03	211.45
Kentwood	5.29	May 74 Flood	Bvr Crk	215.16	215.03	211.45

Question: How far upstream does the bridge impact WSELs?

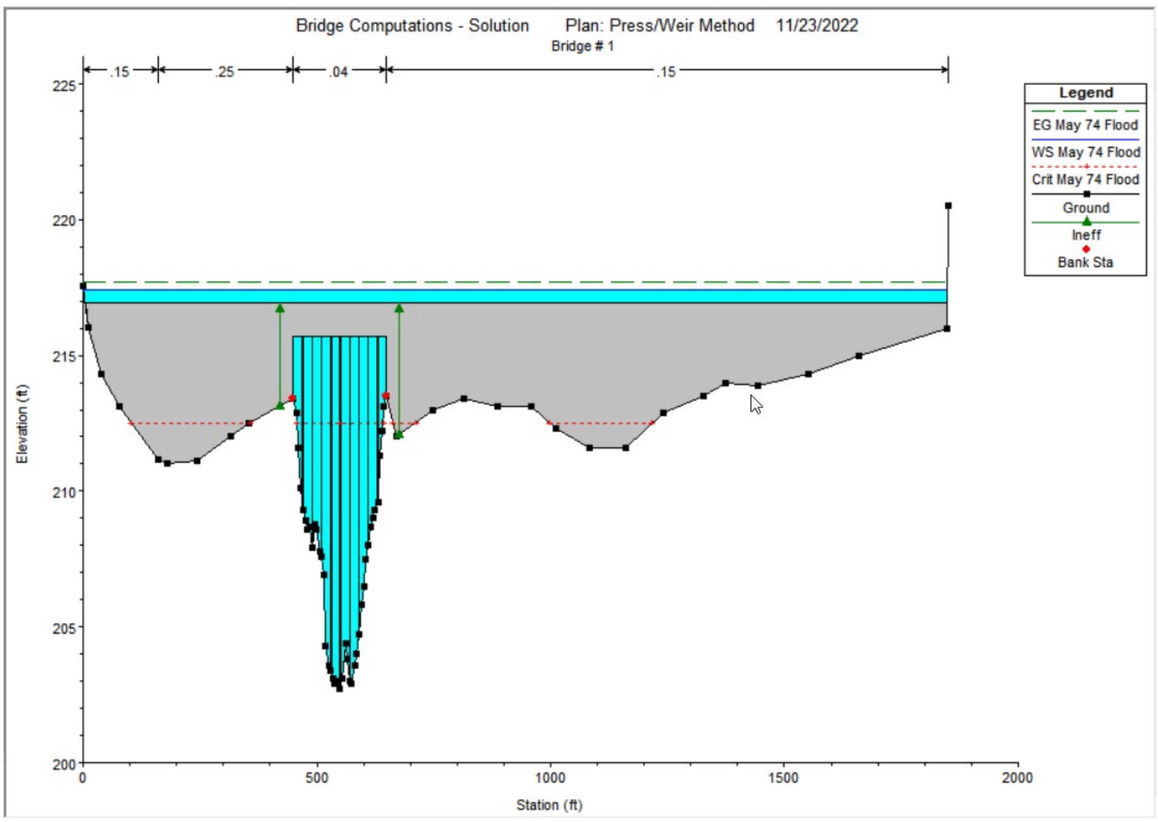
In comparing the profiles for the pressure/weir and without bridge plans, the pressure weir method, backwater from the bridge impacted WSELs all the way to the upstream cross-section of the reach (approximately 2900 ft upstream).

Question: Which bridge high flow modeling approach looks more appropriate for this bridge and why? Does this line up with your initial guess from the previous workshop?

In comparing results to the observed data, the pressure / weir method looks more appropriate than the energy method. This was my initial guess because. The embankments block a significant amount of the cross-sections around the bridge, and the opening is relatively small compared to the embankments.

Question: Was any adjustment to the trigger elevation needed? Why or why not?

No adjustment was needed for the trigger elevations. That is because for the only profile in which the energy grade exceeded the bridge deck (and weir flow occurs), the WSEL was also above the bridge deck. So, setting the ineffective flow areas at the top of the bridge deck for this profile was fine.



Now, if we had a profile where the energy grade exceeded the deck but the WSEL did not, an adjustment would be required to ensure the ineffective flow areas turn off as weir flow over the bridge began.

Question: How did the overbank Manning's n adjustment impact the results?

For this dataset the water surface profiles were minimally impacted by adjusting the Manning's n to distribute flow appropriately around the bridge.