

McMaster University Winter 2021
CIVENG 4L04: Design of Water Resources Systems

Project 3: Analysis of Hydraulic Characteristics of a Proposed Bridge

Lab Section 01, L01

Group 12
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Question 1

Part A

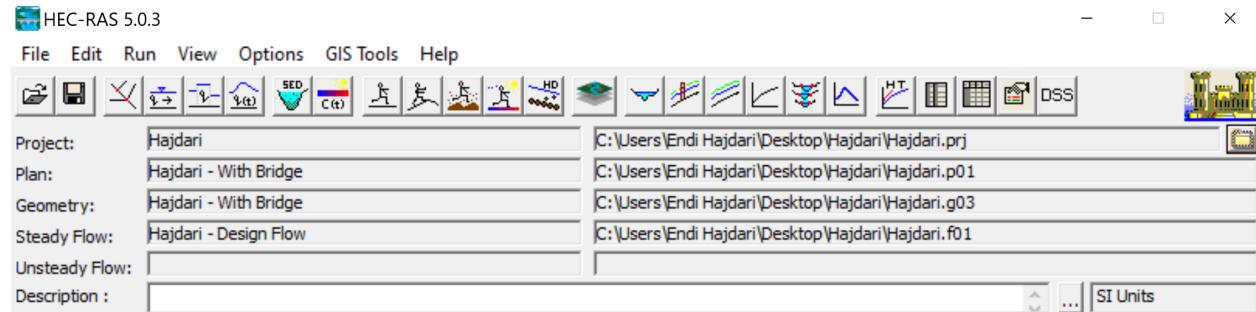


Figure 1: The main HEC-RAS window for the model with the bridge.

Part B

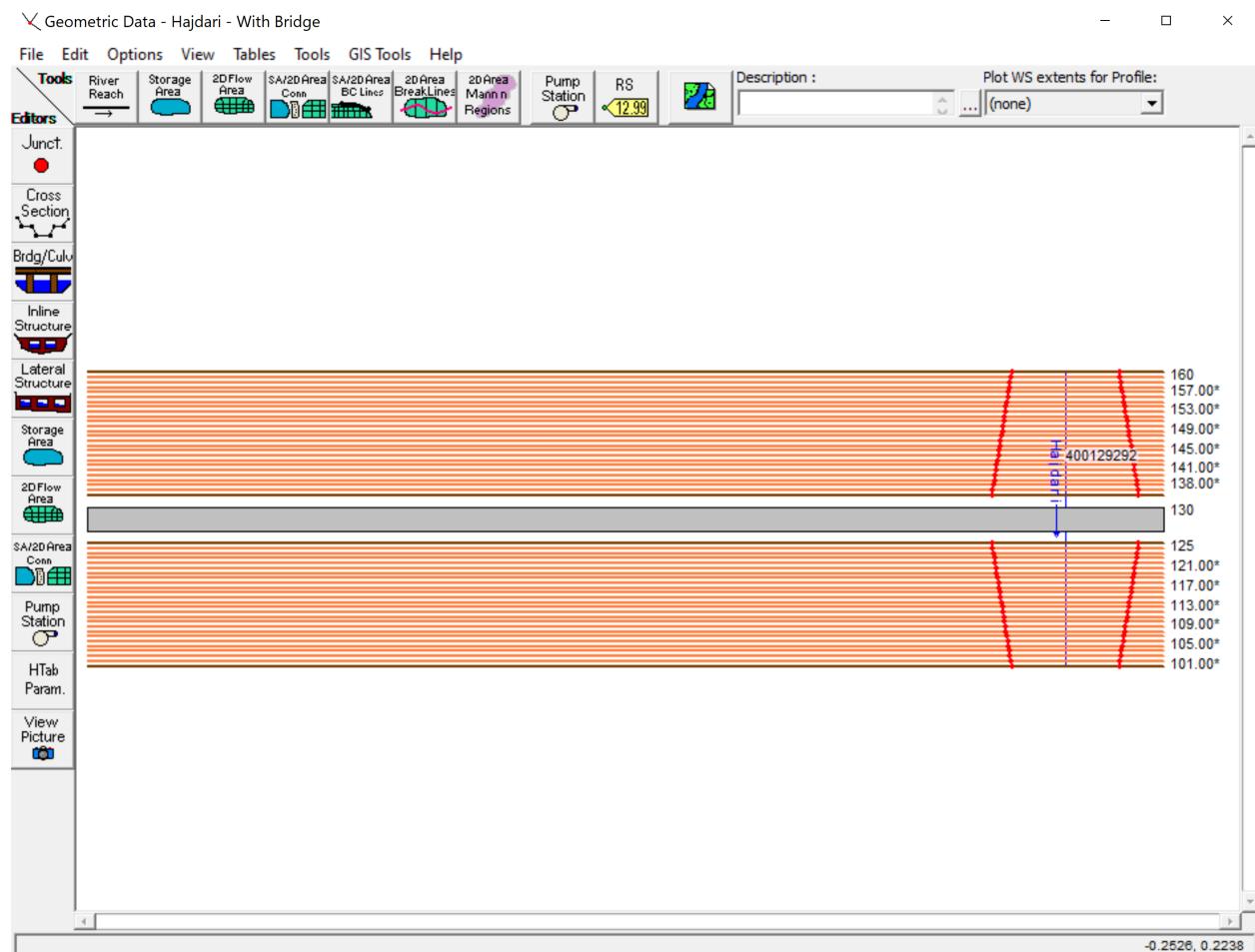


Figure 2: The Geometric Data window for the model with the bridge. Note that additional cross-sections between River Stations 160 and 135, as well as between River Stations 125 and 100 were interpolated. The maximum distance between each of the interpolated cross sections is 1 m.

Part C

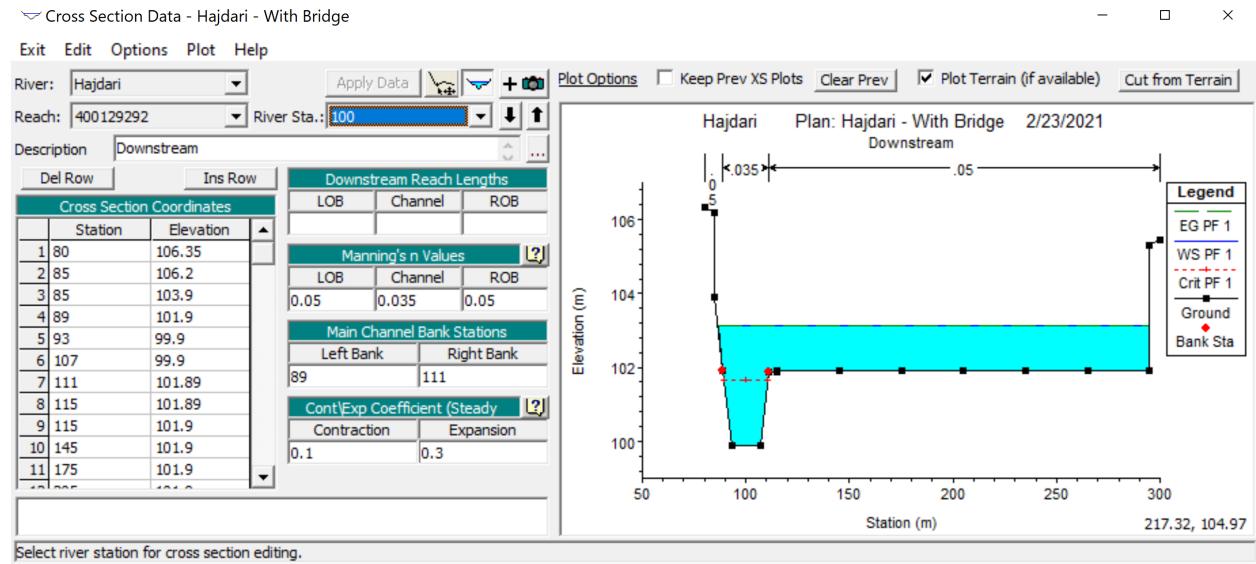


Figure 3: The Cross Section Data window for River Station 100 for the model with the bridge. Note that these screen captures were taken after the steady flow analysis was run.

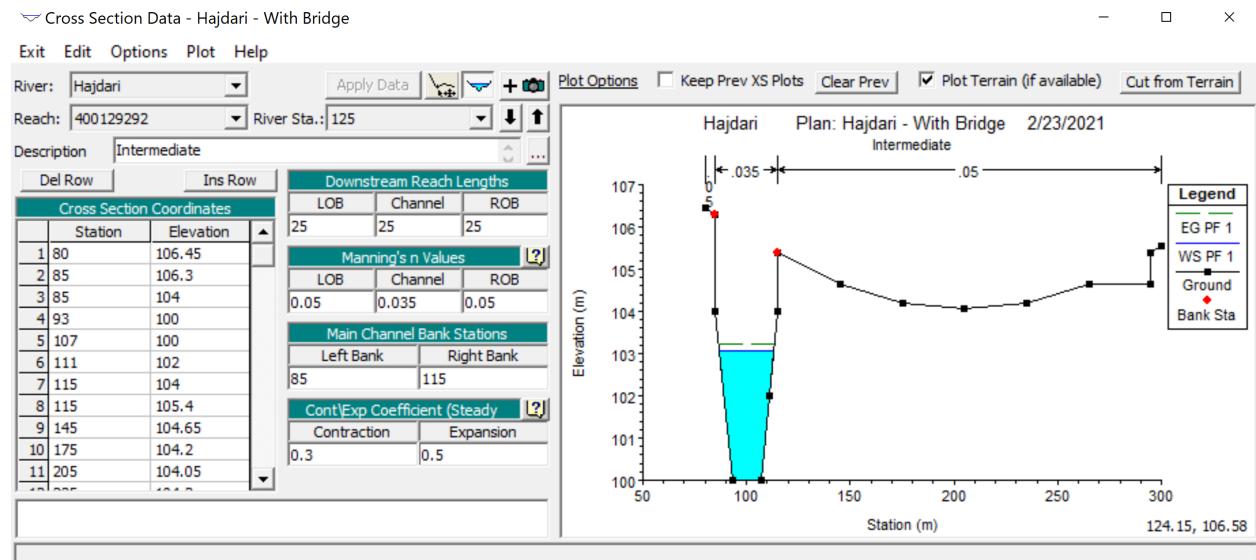


Figure 4: The Cross Section Data window for River Station 125 for the model with the bridge. Note that these screen captures were taken after the steady flow analysis was run.

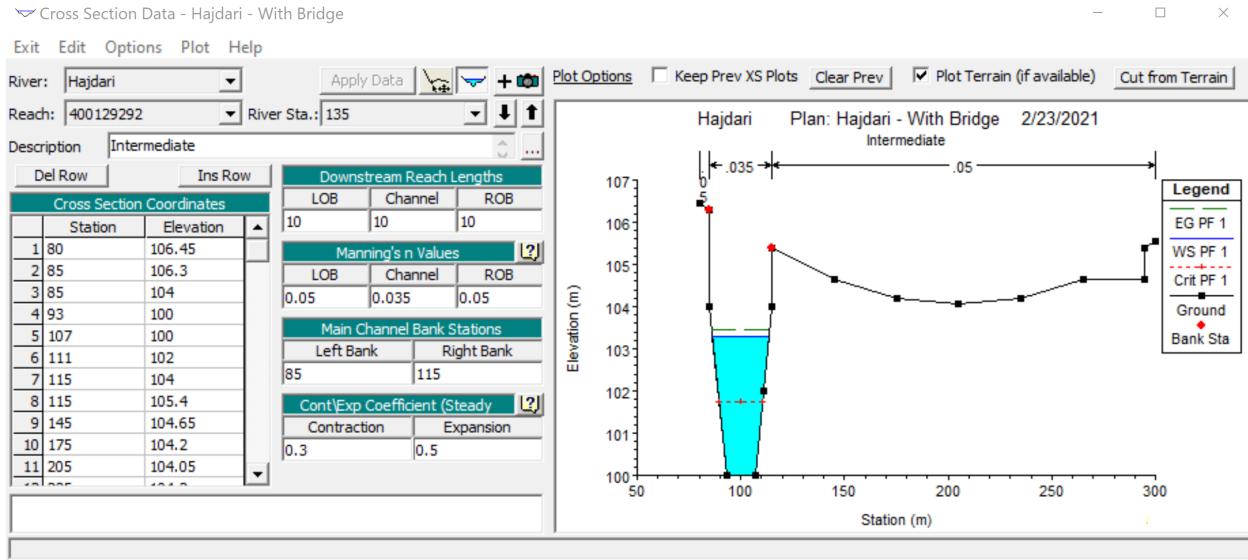


Figure 5: The Cross Section Data window for River Station 135 for the model with the bridge. Note that these screen captures were taken after the steady flow analysis was run.

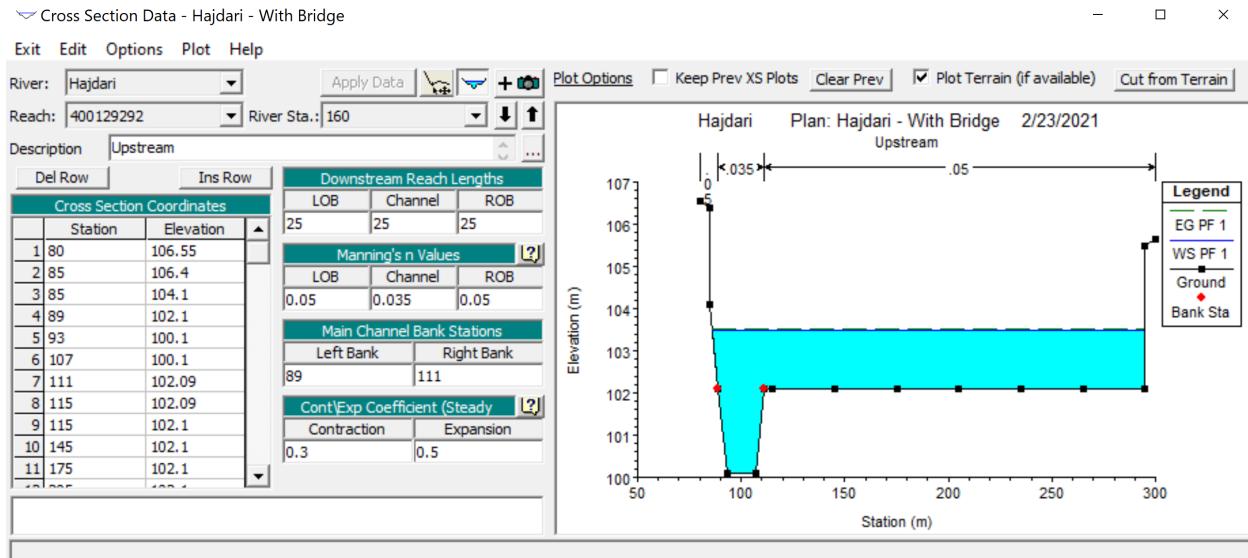


Figure 6: The Cross Section Data window for River Station 160 for the model with the bridge. Note that these screen captures were taken after the steady flow analysis was run.

Part D

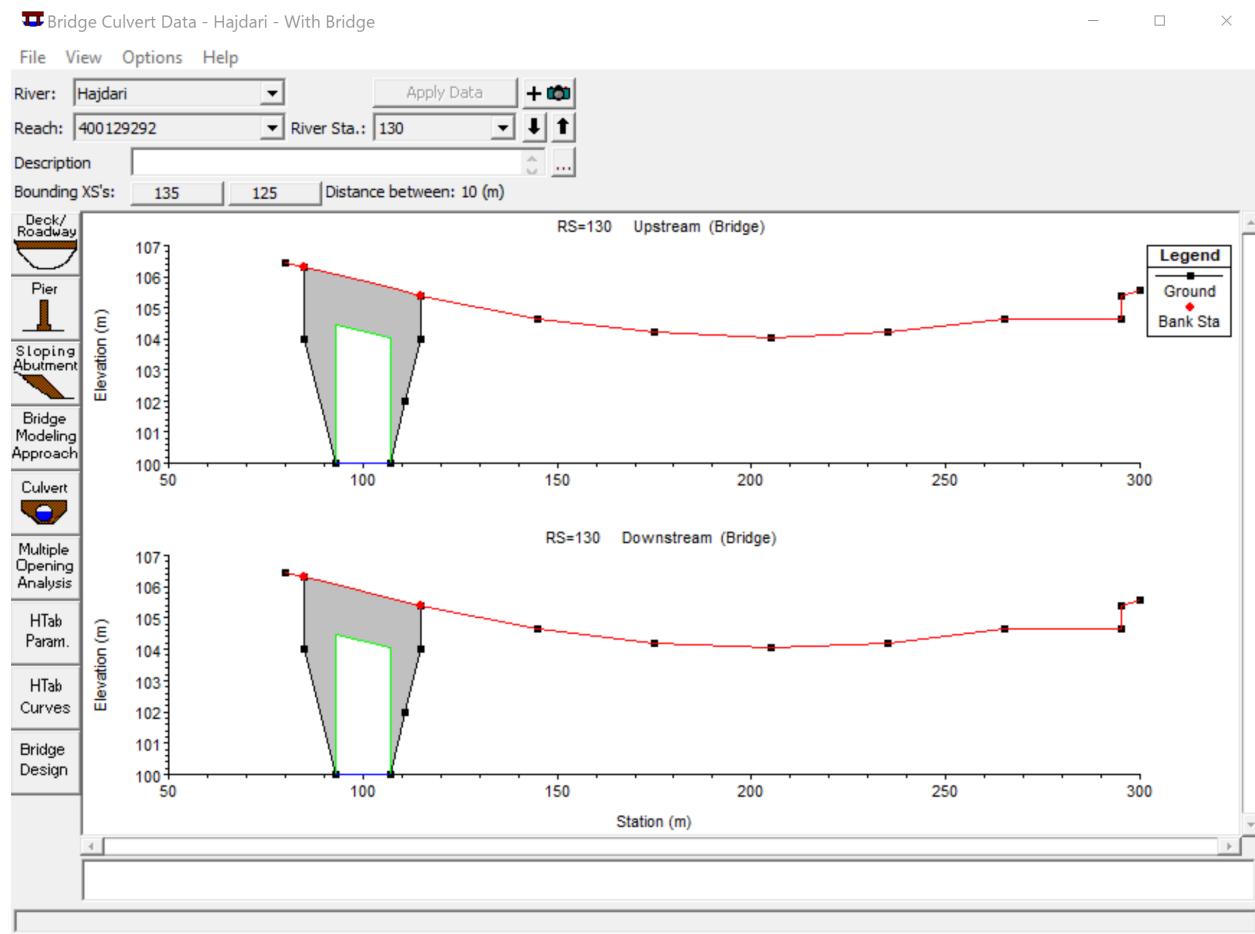


Figure 7: The Bridge Culvert Data window at River Station 130 depicting both the upstream and the downstream bridge cross-sections.

Part E

Deck/Roadway Data Editor

Distance	Width	Weir Coef
2.5	5	

Upstream **Downstream**

	Station	high chord	low chord	Station	high chord	low chord
1	85.	106.3	106.3	85.	106.3	106.3
2	85.	106.3	104.	85.	106.3	104.
3	93.	106.06	100.	93.	106.06	100.
4	93.	106.06	104.47	93.	106.06	104.47
5	107.	105.64	104.05	107.	105.64	104.05
6	107.	105.64	100.	107.	105.64	100.
7	115.	105.4	104.	115.	105.4	104.
8	115.	105.4	105.4	115.	105.4	105.4

U.S Embankment SS D.S Embankment SS

Weir Data

Max Submergence: Min Weir Flow El:

Weir Crest Shape

Broad Crested
 Ogee

OK **Cancel**

Enter station, high chord and low chord for deck/roadway.

Figure 8: The Deck/Roadway Data Editor window. Note that the U.S Embankment SS, D.S Embankment SS, and Weir Coef slots were left blank, as required.

Part F

Bridge Modeling Approach Editor

Add Copy Delete Bridge #

Low Flow Methods

Use [Compute](#)

Energy (Standard Step)
 Momentum Coef Drag Cd
 Yarnell (Class A only) Pier Shape K
 WSPRO Method (Class A only) WSPRO Variables
 Highest Energy Answer

High Flow Methods

Energy Only (Standard Step)
 Pressure and/or Weir
Submerged Inlet Cd (Blank for table)
Submerged Inlet + Outlet Cd
Max Low Chord (Blank for default)

OK **Cancel** **Help**

Enter to add another bridge coefficient set.

Figure 9: The Bridge Modeling Approach Editor window.

Part G

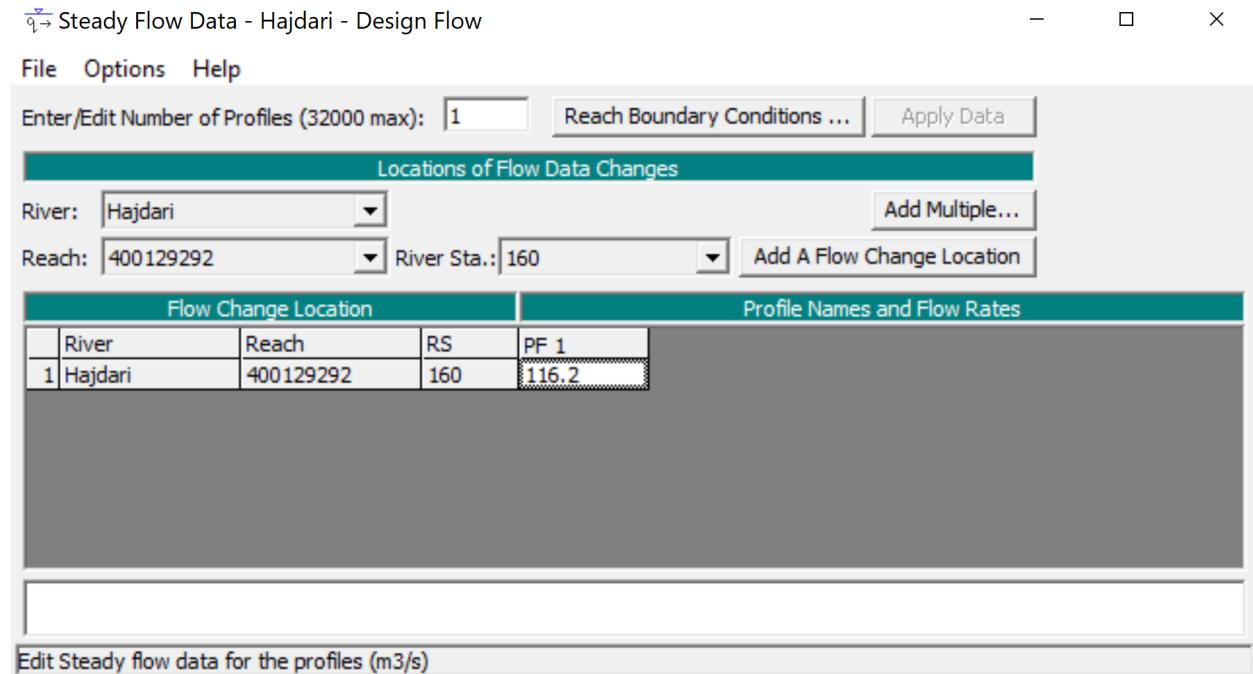


Figure 10: The Steady Flow Data window for the model with the bridge.

Steady Flow Boundary Conditions

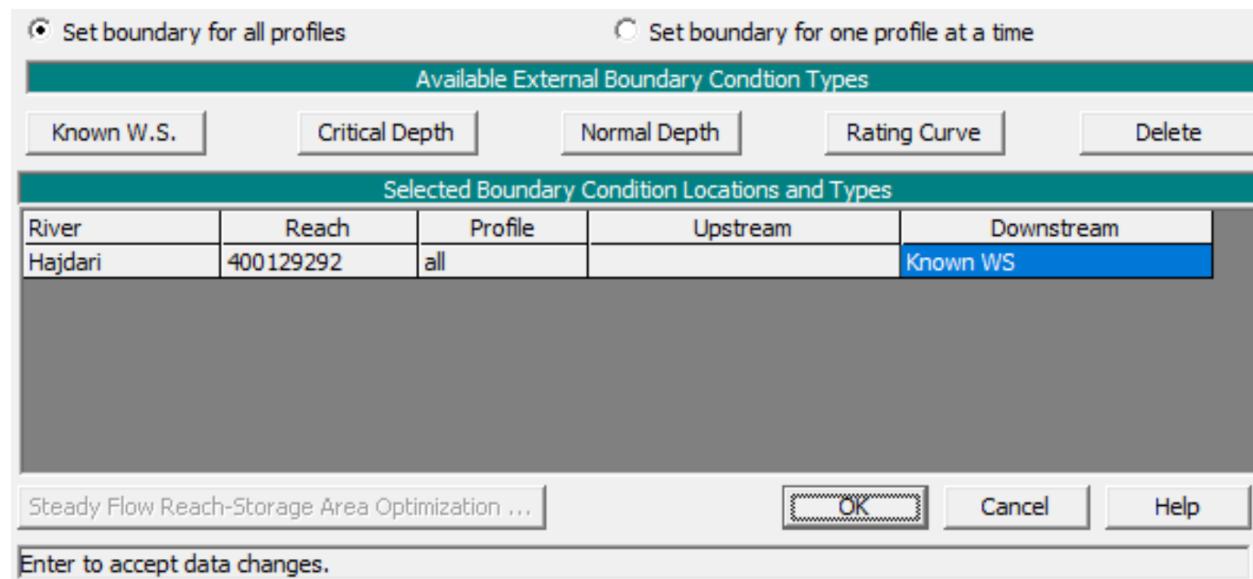


Figure 11: The Steady Flow Boundary Conditions window for the model with the bridge.

HEC-RAS

Set known water surfaces for flows.		
	Flow (m ³ /s)	Known WS El (m)
1	116.2	103.13

OK **Cancel**

Figure 12: The window for setting the Known Water Surface Elevation (WS El).

Part H

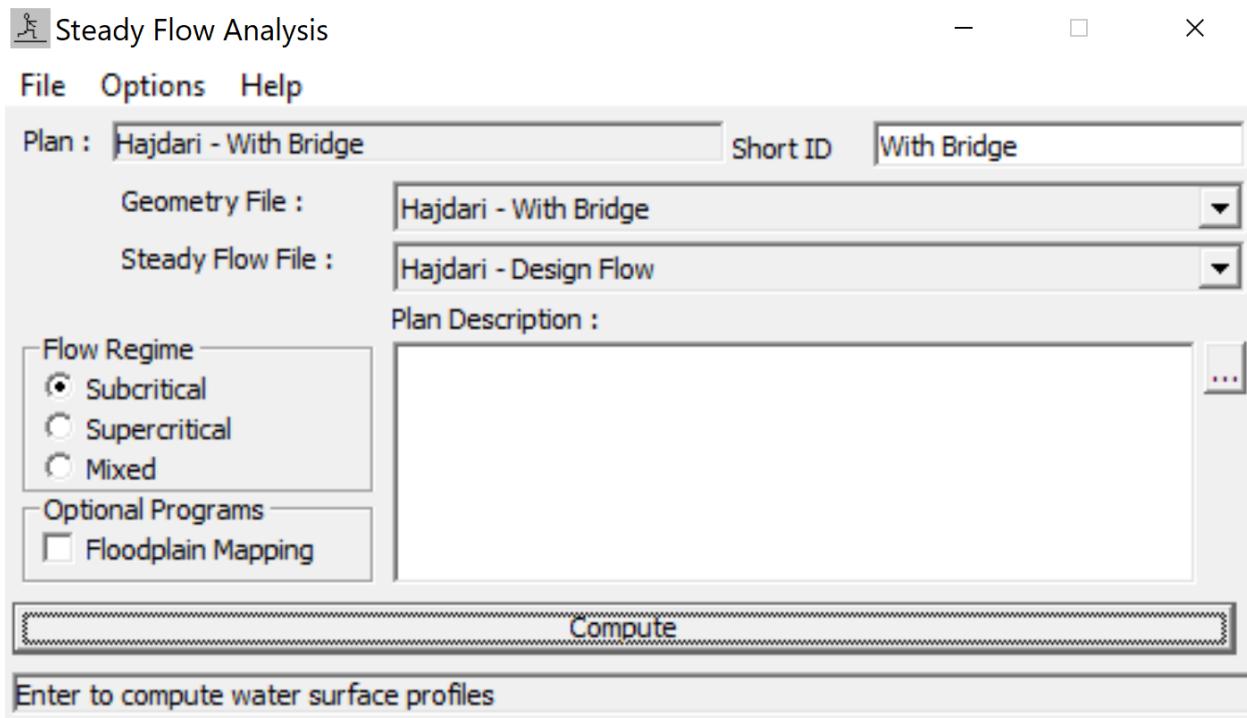


Figure 13: The Steady Flow Analysis window for the model with the bridge.

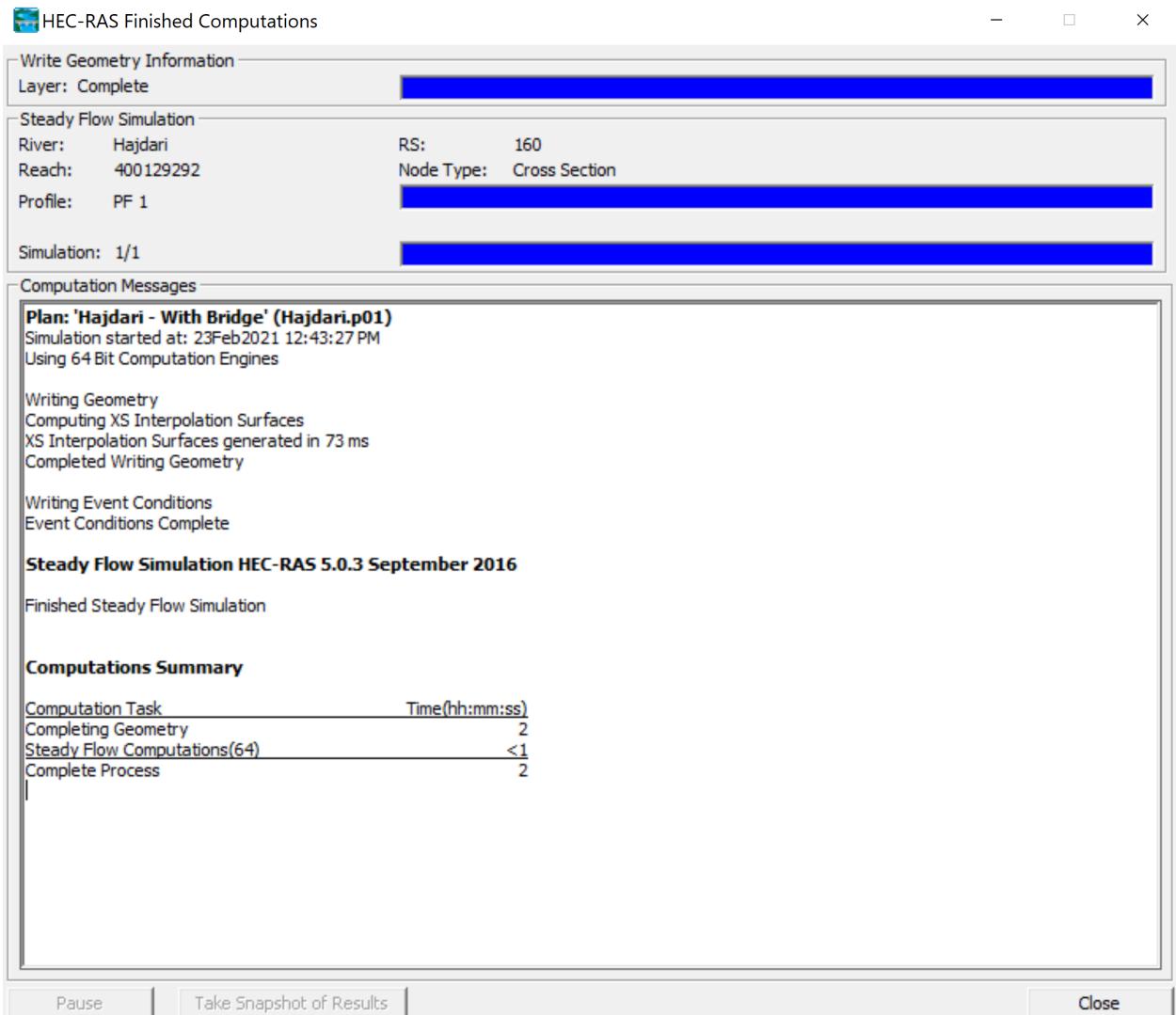


Figure 14: The HEC-RAS Finished Computations window.

Part I

HEC-RAS Plan: Without Bridge River: Hajdari Reach: 400129292 Profile: PF 1

Reach	River Sta	Profile	Q Total (m³/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)	Froude # Chl
400129292	160	PF 1	116.20	100.10	103.34		103.35	0.000175	0.74	292.19	208.47	0.14
400129292	159.00*	PF 1	116.20	100.10	103.33		103.35	0.000206	0.80	274.09	208.34	0.15
400129292	158.00*	PF 1	116.20	100.09	103.33		103.35	0.000245	0.86	255.62	208.19	0.16
400129292	157.00*	PF 1	116.20	100.09	103.32		103.35	0.000293	0.93	236.94	208.03	0.18
400129292	156.00*	PF 1	116.20	100.08	103.31		103.34	0.000354	1.01	217.85	207.84	0.19
400129292	155.00*	PF 1	116.20	100.08	103.30		103.34	0.000433	1.10	198.27	207.64	0.21
400129292	154.00*	PF 1	116.20	100.08	103.28		103.34	0.000536	1.21	177.74	207.40	0.24
400129292	153.00*	PF 1	116.20	100.07	103.26		103.33	0.000676	1.34	155.90	207.15	0.26
400129292	152.00*	PF 1	116.20	100.07	103.23		103.32	0.000867	1.50	131.78	207.31	0.30
400129292	151.00*	PF 1	116.20	100.06	103.18		103.31	0.001101	1.67	106.12	196.20	0.33
400129292	150.00*	PF 1	116.20	100.06	103.14		103.30	0.001330	1.81	83.22	179.21	0.37
400129292	149.00*	PF 1	116.20	100.06	103.12		103.30	0.001425	1.86	71.08	116.24	0.38
400129292	148.00*	PF 1	116.20	100.05	103.11		103.29	0.001480	1.88	64.00	87.67	0.39
400129292	147.00*	PF 1	116.20	100.05	103.11		103.29	0.001496	1.89	61.62	26.16	0.39
400129292	146.00*	PF 1	116.20	100.04	103.11		103.29	0.001495	1.88	61.69	26.26	0.39
400129292	145.00*	PF 1	116.20	100.04	103.11		103.29	0.001491	1.88	61.76	26.27	0.39
400129292	144.00*	PF 1	116.20	100.04	103.11		103.29	0.001486	1.88	61.82	26.28	0.39
400129292	143.00*	PF 1	116.20	100.03	103.10		103.28	0.001481	1.88	61.89	26.29	0.39
400129292	142.00*	PF 1	116.20	100.03	103.10		103.28	0.001477	1.88	61.96	26.30	0.39
400129292	141.00*	PF 1	116.20	100.02	103.10		103.28	0.001472	1.87	62.03	26.31	0.39
400129292	140.00*	PF 1	116.20	100.02	103.10		103.28	0.001468	1.87	62.09	26.32	0.39
400129292	139.00*	PF 1	116.20	100.02	103.10		103.28	0.001463	1.87	62.17	26.33	0.39
400129292	138.00*	PF 1	116.20	100.01	103.10		103.28	0.001458	1.87	62.24	26.34	0.39
400129292	137.00*	PF 1	116.20	100.01	103.10		103.27	0.001454	1.87	62.31	26.35	0.39
400129292	136.00*	PF 1	116.20	100.00	103.09		103.27	0.001449	1.86	62.37	26.36	0.39
400129292	135	PF 1	116.20	100.00	103.09		103.27	0.001444	1.86	62.44	26.37	0.39
400129292	134.00*	PF 1	116.20	100.00	103.09		103.27	0.001447	1.86	62.40	26.37	0.39
400129292	133.00*	PF 1	116.20	100.00	103.09		103.27	0.001450	1.86	62.35	26.36	0.39
400129292	132.00*	PF 1	116.20	100.00	103.09		103.27	0.001453	1.86	62.31	26.35	0.39
400129292	131.00*	PF 1	116.20	100.00	103.09		103.26	0.001456	1.87	62.26	26.35	0.39
400129292	130.00*	PF 1	116.20	100.00	103.08		103.26	0.001459	1.87	62.21	26.34	0.39
400129292	129.00*	PF 1	116.20	100.00	103.08		103.26	0.001463	1.87	62.17	26.33	0.39
400129292	128.00*	PF 1	116.20	100.00	103.08		103.26	0.001466	1.87	62.12	26.32	0.39
400129292	127.00*	PF 1	116.20	100.00	103.08		103.26	0.001469	1.87	62.08	26.32	0.39
400129292	126.00*	PF 1	116.20	100.00	103.08		103.26	0.001472	1.87	62.03	26.31	0.39
400129292	125	PF 1	116.20	100.00	103.08		103.26	0.001475	1.87	61.98	26.30	0.39
400129292	124.00*	PF 1	116.20	100.00	103.07		103.25	0.001470	1.87	62.05	26.31	0.39
400129292	123.00*	PF 1	116.20	99.99	103.07		103.25	0.001466	1.87	62.12	26.33	0.39
400129292	122.00*	PF 1	116.20	99.99	103.07		103.25	0.001461	1.87	62.20	26.34	0.39
400129292	121.00*	PF 1	116.20	99.98	103.07		103.25	0.001456	1.87	62.27	26.35	0.39
400129292	120.00*	PF 1	116.20	99.98	103.07		103.25	0.001451	1.86	62.34	26.36	0.39
400129292	119.00*	PF 1	116.20	99.98	103.07		103.24	0.001447	1.86	62.41	26.37	0.39
400129292	118.00*	PF 1	116.20	99.97	103.07		103.24	0.001442	1.86	62.48	26.38	0.39
400129292	117.00*	PF 1	116.20	99.97	103.07		103.24	0.001437	1.86	62.56	26.39	0.39
400129292	116.00*	PF 1	116.20	99.96	103.06		103.24	0.001433	1.86	62.63	26.41	0.38
400129292	115.00*	PF 1	116.20	99.96	103.06		103.24	0.001428	1.85	62.70	26.42	0.38
400129292	114.00*	PF 1	116.20	99.96	103.06		103.24	0.001423	1.85	62.77	26.43	0.38
400129292	113.00*	PF 1	116.20	99.95	103.06		103.23	0.001407	1.85	63.53	58.98	0.38
400129292	112.00*	PF 1	116.20	99.95	103.06		103.23	0.001369	1.83	68.99	102.44	0.38
400129292	111.00*	PF 1	116.20	99.94	103.06		103.22	0.001301	1.80	77.82	132.86	0.37
400129292	110.00*	PF 1	116.20	99.94	103.07		103.22	0.001197	1.73	92.41	184.43	0.35
400129292	109.00*	PF 1	116.20	99.94	103.08		103.20	0.001037	1.63	111.19	199.18	0.33
400129292	108.00*	PF 1	116.20	99.93	103.09		103.19	0.000863	1.50	132.08	207.31	0.30
400129292	107.00*	PF 1	116.20	99.93	103.10		103.18	0.000701	1.36	152.99	207.15	0.27
400129292	106.00*	PF 1	116.20	99.92	103.11		103.17	0.000567	1.24	173.35	207.35	0.24
400129292	105.00*	PF 1	116.20	99.92	103.12		103.16	0.000459	1.13	193.40	207.58	0.22
400129292	104.00*	PF 1	116.20	99.92	103.12		103.16	0.000375	1.03	213.14	207.79	0.20
400129292	103.00*	PF 1	116.20	99.91	103.12		103.15	0.000307	0.95	232.77	207.99	0.18
400129292	102.00*	PF 1	116.20	99.91	103.13		103.15	0.000254	0.87	252.25	208.16	0.17
400129292	101.00*	PF 1	116.20	99.90	103.13		103.15	0.000211	0.81	271.71	208.32	0.15
400129292	100	PF 1	116.20	99.90	103.13	101.65	103.14	0.000177	0.75	290.93	208.46	0.14

Table 1: The Profile Output Table - Standard Table for the model without the bridge. Note that cross sections were interpolated between River Stations 160 and 135, 135 and 125, as well as 125 and 100. The maximum distance between each of the interpolated cross sections is 1 m.

Reach	River Sta	Profile	Q Total (m³/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)	Froude # Chl
400129292	160	PF 1	116.20	100.10	103.52		103.53	0.000122	0.65	330.43	208.84	0.12
400129292	159.00*	PF 1	116.20	100.10	103.52		103.53	0.000141	0.69	312.60	208.72	0.13
400129292	158.00*	PF 1	116.20	100.09	103.51		103.53	0.000165	0.74	294.49	208.58	0.14
400129292	157.00*	PF 1	116.20	100.09	103.51		103.53	0.000193	0.79	276.32	208.43	0.15
400129292	156.00*	PF 1	116.20	100.08	103.51		103.53	0.000228	0.85	257.96	208.27	0.16
400129292	155.00*	PF 1	116.20	100.08	103.50		103.52	0.000270	0.91	239.40	208.08	0.17
400129292	154.00*	PF 1	116.20	100.08	103.49		103.52	0.000323	0.99	220.48	207.88	0.19
400129292	153.00*	PF 1	116.20	100.07	103.48		103.52	0.000389	1.07	201.14	207.64	0.20
400129292	152.00*	PF 1	116.20	100.07	103.47		103.52	0.000474	1.17	181.05	207.37	0.22
400129292	151.00*	PF 1	116.20	100.06	103.45		103.51	0.000581	1.28	159.89	207.48	0.25
400129292	150.00*	PF 1	116.20	100.06	103.42		103.50	0.000718	1.41	137.29	207.54	0.27
400129292	149.00*	PF 1	116.20	100.06	103.39		103.50	0.000855	1.52	115.43	193.14	0.30
400129292	148.00*	PF 1	116.20	100.05	103.36		103.49	0.000993	1.63	95.39	180.63	0.32
400129292	147.00*	PF 1	116.20	100.05	103.35		103.49	0.001062	1.67	82.53	126.59	0.33
400129292	146.00*	PF 1	116.20	100.04	103.34		103.48	0.001110	1.70	74.30	101.41	0.34
400129292	145.00*	PF 1	116.20	100.04	103.33		103.48	0.001135	1.71	68.99	67.91	0.34
400129292	144.00*	PF 1	116.20	100.04	103.33		103.48	0.001142	1.71	67.83	27.12	0.35
400129292	143.00*	PF 1	116.20	100.03	103.33		103.48	0.001140	1.71	67.91	27.19	0.35
400129292	142.00*	PF 1	116.20	100.03	103.33		103.48	0.001137	1.71	67.98	27.20	0.35
400129292	141.00*	PF 1	116.20	100.02	103.33		103.48	0.001133	1.71	68.06	27.22	0.34
400129292	140.00*	PF 1	116.20	100.02	103.33		103.47	0.001129	1.71	68.14	27.23	0.34
400129292	139.00*	PF 1	116.20	100.02	103.32		103.47	0.001125	1.70	68.23	27.24	0.34
400129292	138.00*	PF 1	116.20	100.01	103.32		103.47	0.001121	1.70	68.31	27.25	0.34
400129292	137.00*	PF 1	116.20	100.01	103.32		103.47	0.001118	1.70	68.39	27.26	0.34
400129292	136.00*	PF 1	116.20	100.00	103.32		103.47	0.001114	1.70	68.47	27.27	0.34
400129292	135	PF 1	116.20	100.00	103.32	101.75	103.47	0.001110	1.70	68.55	27.28	0.34
400129292	130											
400129292	125	PF 1	116.20	100.00	103.08		103.26	0.001475	1.87	61.98	26.30	0.39
400129292	124.00*	PF 1	116.20	100.00	103.07		103.25	0.001470	1.87	62.05	26.31	0.39
400129292	123.00*	PF 1	116.20	99.99	103.07		103.25	0.001466	1.87	62.12	26.33	0.39
400129292	122.00*	PF 1	116.20	99.99	103.07		103.25	0.001461	1.87	62.20	26.34	0.39
400129292	121.00*	PF 1	116.20	99.98	103.07		103.25	0.001456	1.87	62.27	26.35	0.39
400129292	120.00*	PF 1	116.20	99.98	103.07		103.25	0.001451	1.86	62.34	26.36	0.39
400129292	119.00*	PF 1	116.20	99.98	103.07		103.24	0.001447	1.86	62.41	26.37	0.39
400129292	118.00*	PF 1	116.20	99.97	103.07		103.24	0.001442	1.86	62.48	26.38	0.39
400129292	117.00*	PF 1	116.20	99.97	103.07		103.24	0.001437	1.86	62.56	26.39	0.39
400129292	116.00*	PF 1	116.20	99.96	103.06		103.24	0.001433	1.86	62.63	26.41	0.38
400129292	115.00*	PF 1	116.20	99.96	103.06		103.24	0.001428	1.85	62.70	26.42	0.38
400129292	114.00*	PF 1	116.20	99.96	103.06		103.24	0.001423	1.85	62.77	26.43	0.38
400129292	113.00*	PF 1	116.20	99.95	103.06		103.23	0.001407	1.85	63.53	58.98	0.38
400129292	112.00*	PF 1	116.20	99.95	103.06		103.23	0.001369	1.83	68.99	102.44	0.38
400129292	111.00*	PF 1	116.20	99.94	103.06		103.22	0.001301	1.80	77.82	132.86	0.37
400129292	110.00*	PF 1	116.20	99.94	103.07		103.22	0.001197	1.73	92.41	184.43	0.35
400129292	109.00*	PF 1	116.20	99.94	103.08		103.20	0.001037	1.63	111.19	199.18	0.33
400129292	108.00*	PF 1	116.20	99.93	103.09		103.19	0.000863	1.50	132.08	207.31	0.30
400129292	107.00*	PF 1	116.20	99.93	103.10		103.18	0.000701	1.36	152.99	207.15	0.27
400129292	106.00*	PF 1	116.20	99.92	103.11		103.17	0.000567	1.24	173.35	207.35	0.24
400129292	105.00*	PF 1	116.20	99.92	103.12		103.16	0.000459	1.13	193.40	207.58	0.22
400129292	104.00*	PF 1	116.20	99.92	103.12		103.16	0.000375	1.03	213.14	207.79	0.20
400129292	103.00*	PF 1	116.20	99.91	103.12		103.15	0.000307	0.95	232.77	207.99	0.18
400129292	102.00*	PF 1	116.20	99.91	103.13		103.15	0.000254	0.87	252.25	208.16	0.17
400129292	101.00*	PF 1	116.20	99.90	103.13		103.15	0.000211	0.81	271.71	208.32	0.15
400129292	100	PF 1	116.20	99.90	103.13	101.65	103.14	0.000177	0.75	290.93	208.46	0.14

Table 2: The Profile Output Table - Standard Table for the model with the bridge.

Part J

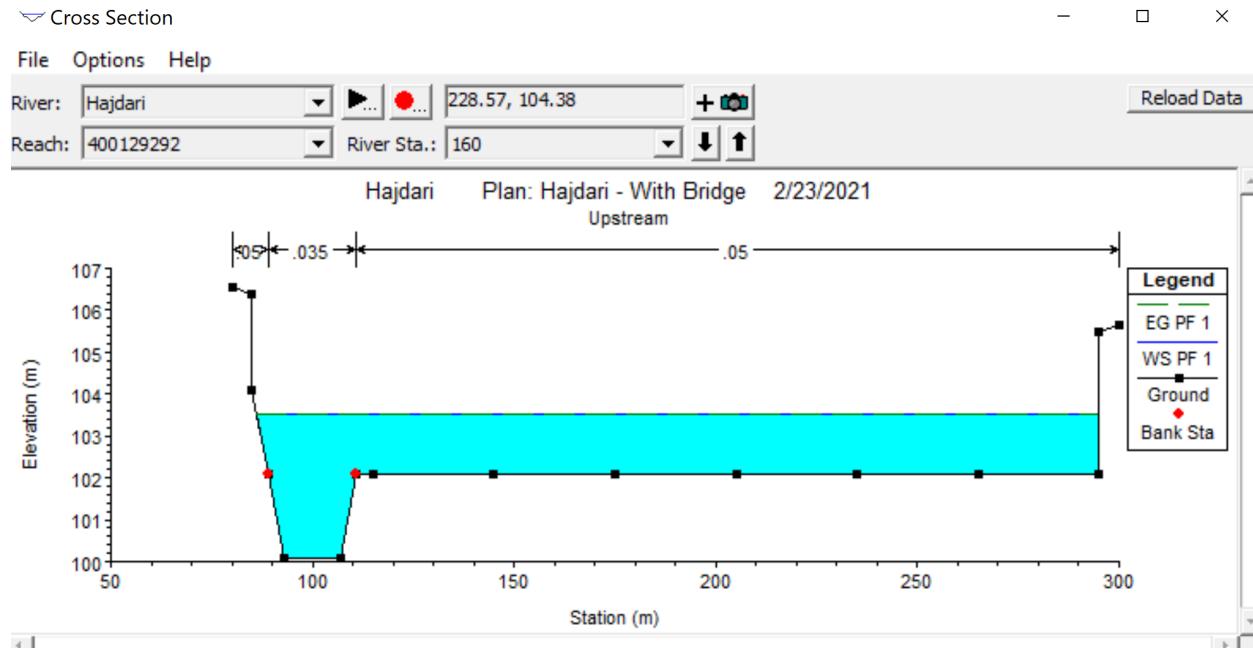


Figure 15: The Cross Section Plot for River Station 160 for the model with the bridge.

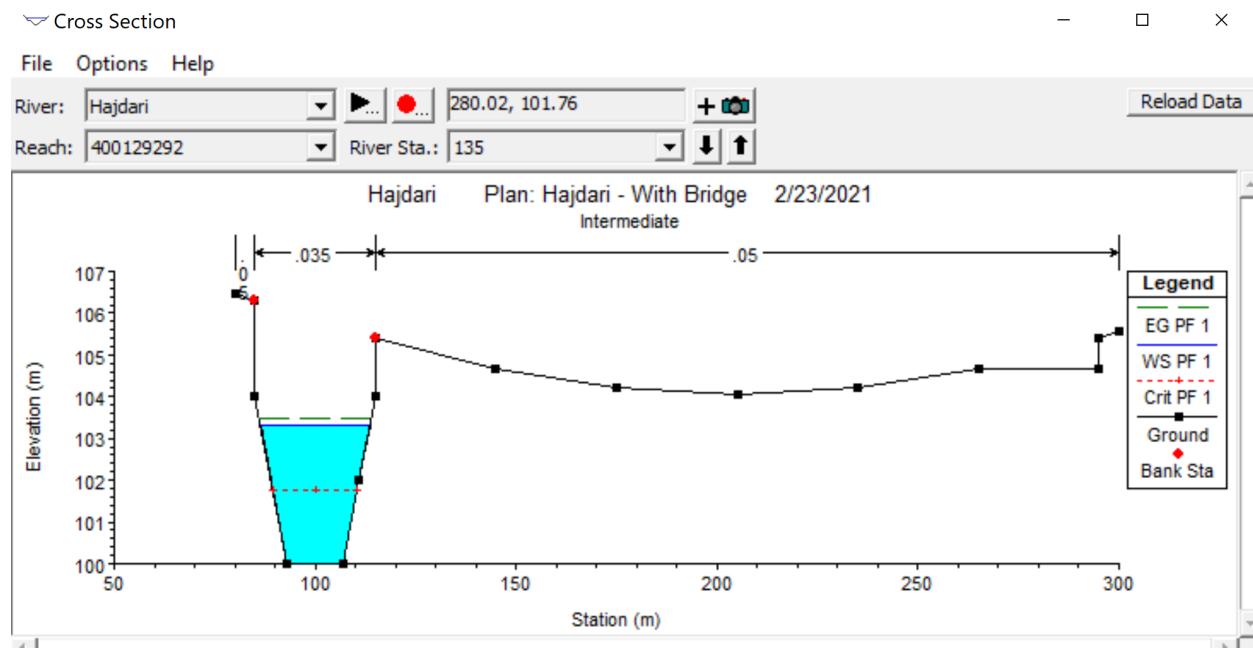


Figure 16: The Cross Section Plot for River Station 135 for the model with the bridge.

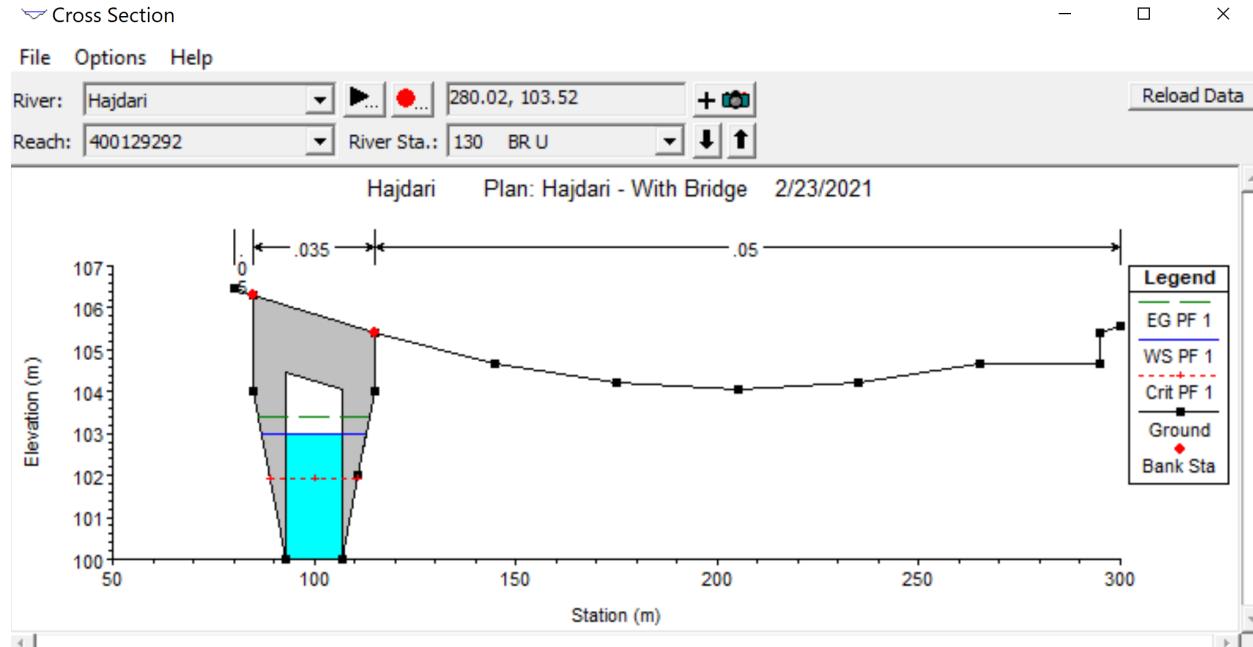


Figure 17: The Cross Section Plot for River Station 130 BR U for the model with the bridge.

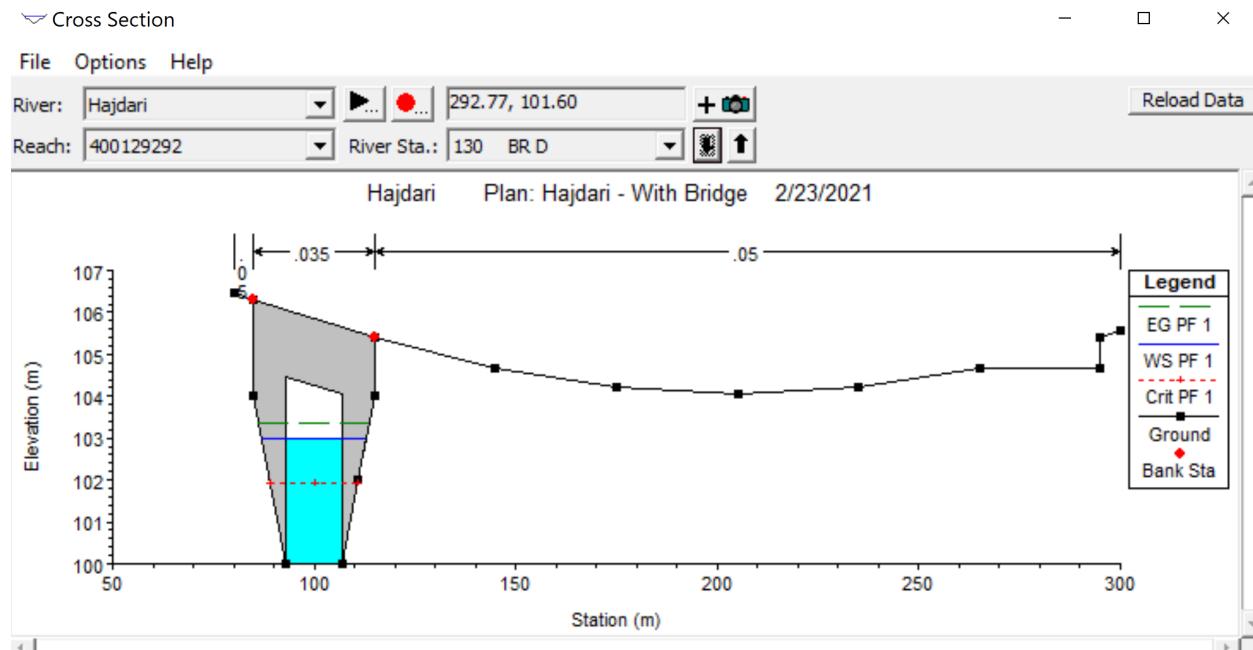


Figure 18: The Cross Section Plot for River Station 130 BR D for the model with the bridge.

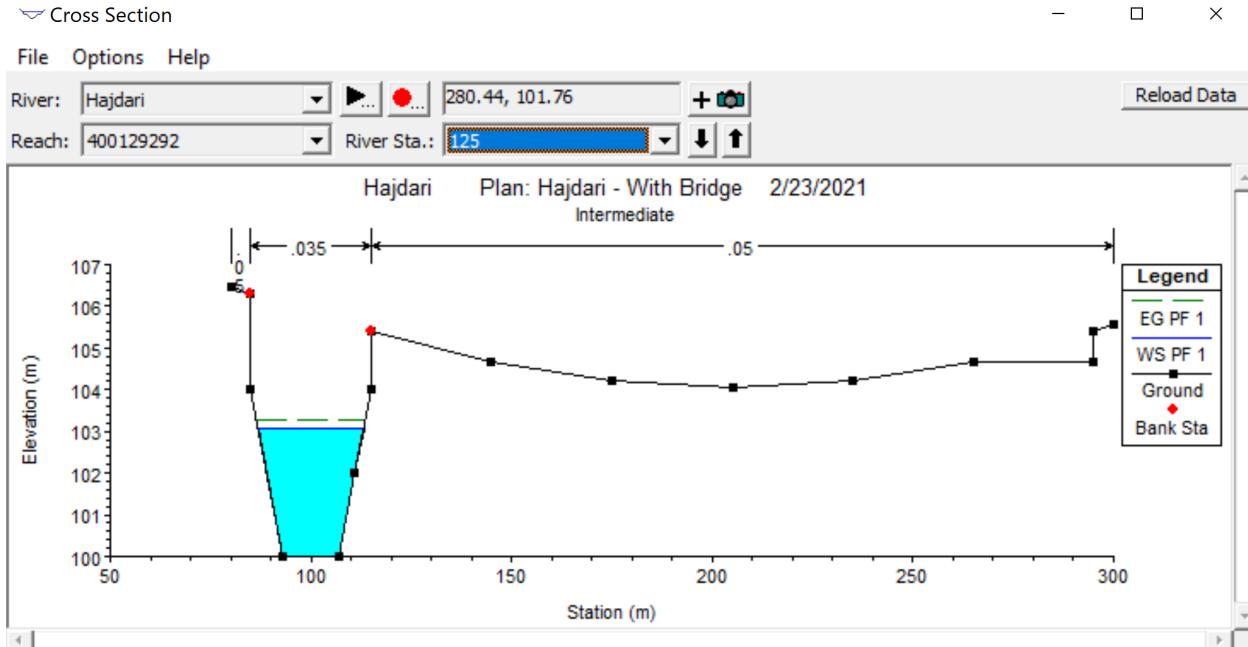


Figure 19: The Cross Section Plot for River Station 125 for the model with the bridge.

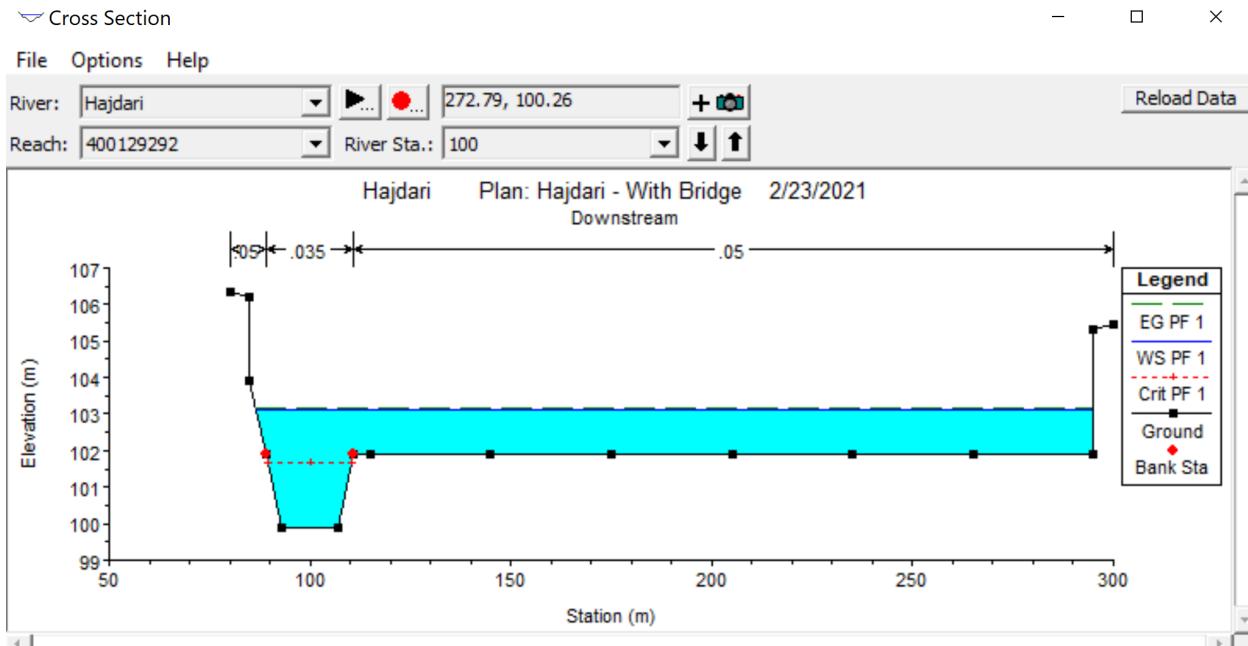


Figure 20: The Cross Section Plot for River Station 100 for the model with the bridge.

Question 2

River Station	Natural Reach			With Bridge		
	WL, m	EGL, m	V, m/s	WL, m	EGL, m	V, m/s
160	103.34	103.35	0.74	103.52	103.53	0.65
135	103.09	103.27	1.86	103.32	103.47	1.7
125	103.08	103.26	1.87	103.08	103.26	1.87
100	103.13	103.14	0.75	103.13	103.14	0.75

Table 3: The water level, energy grade line, and velocity values at River Stations 160, 135, 125, and 100 for both the natural reach (i.e., model without the bridge), as well as for the reach with the bridge (i.e., model with the bridge).

Due to the bridge/backwater effect, the river stations *upstream* of the bridge (i.e., Stations 160 and 135) experienced changes in water level and velocity, whereas the river stations *downstream* of the bridge (i.e., Stations 125 and 100) experienced no change in these values. Moreover, at River Station 160, the water level increased by 0.18 m and the velocity decreased by 0.09 m/s as a result of the bridge. At River Station 135, the changes were more significant as the water level increased by 0.23 m and the velocity decreased by 0.16 m/s as a result of the bridge. At both River Stations 125 and 100, the water level and velocity values in the natural reach were identical to those with the bridge.

Question 3

As depicted in Figure 21 below, the minimum soffit elevation is 104.05 m. Table 4 below summarizes the water surface elevations for River Station 130. As tabulated in Table 4, at River Station 130 BR US, the simulated water surface peak flow elevation is 103.00 m. Thus, the clearance between the minimum soffit and the water level is

$$\text{Clearance} = 104.05 \text{ m} - 103.00 \text{ m} = 1.05 \text{ m},$$

which satisfies the minimum clearance criteria of 1.00 m. As tabulated in Table 4, at River Station 130 BR DS, the simulated water surface peak flow elevation is 102.97 m. Thus, the clearance between the minimum soffit and the water level is

$$\text{Clearance} = 104.05 \text{ m} - 102.97 \text{ m} = 1.08 \text{ m},$$

which satisfies the minimum clearance criteria of 1.00 m.

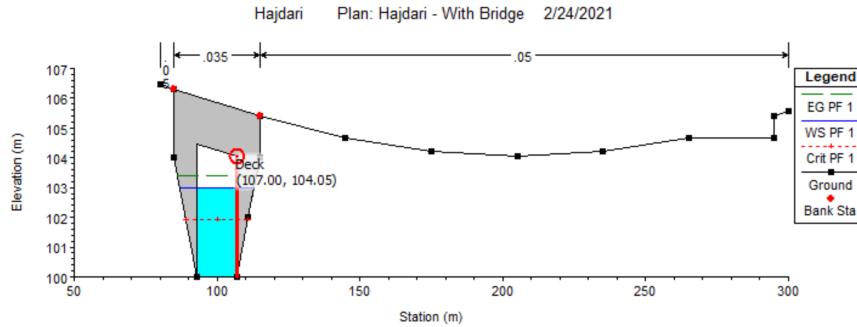


Figure 21: Cross section plot of the bridge that depicts the minimum elevation of the deck.

Plan: With Bridge Hajdari 400129292 RS: 130 Profile: PF 1				
E.G. US. (m)	103.47	Element	Inside BR US	Inside BR DS
W.S. US. (m)	103.32	E.G. Elev (m)	103.39	103.37
Q Total (m³/s)	116.20	W.S. Elev (m)	103.00	102.97
Q Bridge (m³/s)	116.20	Crit W.S. (m)	101.92	101.92
Q Weir (m³/s)		Max Chl Dpth (m)	3.00	2.97
Weir Sta Lft (m)		Vel Total (m/s)	2.77	2.79
Weir Sta Rgt (m)		Flow Area (m²)	41.99	41.61
Weir Submerg		Froude # Chl	0.51	0.52
Weir Max Depth (m)		Specif Force (m³)	95.75	94.93
Min El Weir Flow (m)	104.05	Hydr Depth (m)	3.00	2.97
Min El Prs (m)	104.47	W.P. Total (m)	20.00	19.94
Delta EG (m)	0.21	Conv. Total (m³/s)	1967.0	1941.1
Delta WS (m)	0.24	Top Width (m)	14.00	14.00
BR Open Area (m²)	59.64	Frctn Loss (m)	0.02	0.01
BR Open Vel (m/s)	2.79	C & E Loss (m)	0.00	0.11
BR Sluice Coef		Shear Total (N/m²)	71.86	73.32
BR Sel Method	Energy only	Power Total (N/m s)	198.86	204.74

Table 4: The Bridge Output Table for the model with the bridge.

Question 4 (Optional)

HEC-RAS River: Thames River Reach: Ice Jam Section Profile: PF#1

Reach	River Sta	Profile	Plan	Q Total (m³/s)	Min Ch El (m)	W.S. Elev (m)	Crit W.S. (m)	E.G. Elev (m)	E.G. Slope (m/m)	Vel Chnl (m/s)	Flow Area (m²)	Top Width (m)	Froude # Chl
Ice Jam Section	42000	PF#1	icejam	261.00	171.99	180.12		180.14	0.000167	0.56	463.54	84.57	0.08
Ice Jam Section	42000	PF#1	ice_cover	261.00	171.99	178.77		178.80	0.000123	0.73	357.16	71.67	0.10
Ice Jam Section	42000	PF#1	open_water	261.00	171.99	178.01		178.04	0.000050	0.78	335.60	70.72	0.11
Ice Jam Section	41590	PF#1	icejam	261.00	172.07	180.05		180.07	0.000161	0.57	459.37	80.49	0.08
Ice Jam Section	41590	PF#1	ice_cover	261.00	172.07	178.72		178.75	0.000137	0.74	354.69	76.27	0.11
Ice Jam Section	41590	PF#1	open_water	261.00	172.07	177.99		178.02	0.000055	0.78	334.12	75.45	0.12
Ice Jam Section	41190	PF#1	icejam	261.00	170.00	179.94		179.97	0.000444	0.75	348.20	74.99	0.11
Ice Jam Section	41190	PF#1	ice_cover	261.00	170.00	178.65		178.69	0.000163	0.83	313.82	63.45	0.12
Ice Jam Section	41190	PF#1	open_water	261.00	170.00	177.96		178.00	0.000063	0.87	299.08	62.02	0.13
Ice Jam Section	40690	PF#1	icejam	261.00	171.97	179.82		179.83	0.000172	0.60	434.86	85.51	0.08
Ice Jam Section	40690	PF#1	ice_cover	261.00	171.97	178.58		178.61	0.000147	0.74	354.21	80.70	0.11
Ice Jam Section	40690	PF#1	open_water	261.00	171.97	177.93		177.96	0.000056	0.77	339.26	79.73	0.12
Ice Jam Section	40180	PF#1	icejam	261.00	171.06	179.76		179.77	0.000100	0.48	539.17	101.37	0.07
Ice Jam Section	40180	PF#1	ice_cover	261.00	171.06	178.53		178.55	0.000079	0.59	443.95	89.32	0.08
Ice Jam Section	40180	PF#1	open_water	261.00	171.06	177.92		177.94	0.000028	0.61	430.62	87.07	0.09
Ice Jam Section	39190	PF#1	icejam	261.00	170.67	179.66		179.68	0.000083	0.52	504.39	86.49	0.07
Ice Jam Section	39190	PF#1	ice_cover	261.00	170.67	178.44		178.46	0.000096	0.64	405.32	81.77	0.09
Ice Jam Section	39190	PF#1	open_water	261.00	170.67	177.89		177.91	0.000034	0.66	397.55	81.36	0.09
Ice Jam Section	38560	PF#1	icejam	261.00	168.71	179.63		179.64	0.000046	0.46	563.24	74.38	0.05
Ice Jam Section	38560	PF#1	ice_cover	261.00	168.71	178.40		178.42	0.000047	0.54	480.02	72.09	0.07
Ice Jam Section	38560	PF#1	open_water	261.00	168.71	177.88		177.89	0.000017	0.55	475.11	71.91	0.07
Ice Jam Section	37530	PF#1	icejam	261.00	172.31	179.53		179.55	0.000215	0.65	400.55	79.17	0.09
Ice Jam Section	37530	PF#1	ice_cover	261.00	172.31	178.30		178.33	0.000170	0.79	331.46	76.09	0.12
Ice Jam Section	37530	PF#1	open_water	261.00	172.31	177.83		177.86	0.000057	0.79	330.44	76.05	0.12
Ice Jam Section	36670	PF#1	icejam	261.00	171.32	179.38		179.40	0.000219	0.65	403.69	78.90	0.09
Ice Jam Section	36670	PF#1	ice_cover	261.00	171.32	178.20		178.22	0.000151	0.76	342.87	75.23	0.11
Ice Jam Section	36670	PF#1	open_water	261.00	171.32	177.80		177.83	0.000049	0.75	347.40	75.48	0.11
Ice Jam Section	36320	PF#1	icejam	261.00	171.23	179.31		179.33	0.000181	0.61	428.88	84.70	0.09
Ice Jam Section	36320	PF#1	ice_cover	261.00	171.23	178.15		178.17	0.000138	0.73	358.15	79.03	0.11
Ice Jam Section	36320	PF#1	open_water	261.00	171.23	177.78		177.81	0.000043	0.71	365.66	79.24	0.11
Ice Jam Section	35820	PF#1	icejam	261.00	169.51	179.26		179.27	0.000070	0.45	575.84	94.02	0.06
Ice Jam Section	35820	PF#1	ice_cover	261.00	169.51	178.11		178.13	0.000057	0.53	491.49	90.01	0.07
Ice Jam Section	35820	PF#1	open_water	261.00	169.51	177.78		177.79	0.000018	0.52	502.66	90.54	0.07
Ice Jam Section	35030	PF#1	icejam	261.00	170.82	179.16		179.18	0.000278	0.62	423.05	94.11	0.09
Ice Jam Section	35030	PF#1	ice_cover	261.00	170.82	178.03		178.06	0.000146	0.70	372.64	91.27	0.11
Ice Jam Section	35030	PF#1	open_water	261.00	170.82	177.75		177.77	0.000043	0.67	388.49	92.17	0.10
Ice Jam Section	34320	PF#1	icejam	261.00	171.66	178.90		178.93	0.000445	0.75	349.83	76.36	0.11
Ice Jam Section	34320	PF#1	ice_cover	261.00	171.66	177.92		177.95	0.000165	0.78	334.50	76.00	0.12
Ice Jam Section	34320	PF#1	open_water	261.00	171.66	177.71		177.74	0.000046	0.74	353.78	76.46	0.11
Ice Jam Section	33790	PF#1	icejam	261.00	170.52	178.65		178.68	0.000481	0.79	328.41	70.36	0.12
Ice Jam Section	33790	PF#1	ice_cover	261.00	170.52	177.82		177.86	0.000169	0.81	322.49	70.00	0.12
Ice Jam Section	33790	PF#1	open_water	261.00	170.52	177.68		177.71	0.000047	0.76	344.95	71.37	0.11
Ice Jam Section	33490	PF#1	icejam	261.00	170.41	178.54		178.56	0.000343	0.67	386.84	81.92	0.10
Ice Jam Section	33490	PF#1	ice_cover	261.00	170.41	177.79		177.81	0.000110	0.67	389.74	82.05	0.10
Ice Jam Section	33490	PF#1	open_water	261.00	170.41	177.68		177.70	0.000029	0.62	418.38	83.32	0.09
Ice Jam Section	33090	PF#1	icejam	261.00	170.80	178.36		178.39	0.000551	0.78	335.50	74.38	0.12
Ice Jam Section	33090	PF#1	ice_cover	261.00	170.80	177.74		177.77	0.000128	0.72	364.24	77.56	0.11
Ice Jam Section	33090	PF#1	open_water	261.00	170.80	177.66		177.69	0.000034	0.66	394.54	80.42	0.10
Ice Jam Section	32740	PF#1	icejam	261.00	171.66	178.10		178.13	0.000979	0.87	299.94	76.80	0.14
Ice Jam Section	32740	PF#1	ice_cover	261.00	171.66	177.70		177.72	0.000128	0.71	367.05	79.44	0.11
Ice Jam Section	32740	PF#1	open_water	261.00	171.66	177.65		177.68	0.000033	0.65	400.38	81.14	0.09
Ice Jam Section	32550	PF#1	icejam	261.00	171.31	177.91		177.94	0.001014	0.80	327.68	93.73	0.14
Ice Jam Section	32550	PF#1	ice_cover	261.00	171.31	177.68		177.70	0.000099	0.60	434.12	99.91	0.09
Ice Jam Section	32550	PF#1	open_water	261.00	171.31	177.65		177.67	0.000025	0.55	477.52	101.79	0.08
Ice Jam Section	32310	PF#1	icejam	261.00	169.64	177.76		177.79	0.000443	0.64	405.30	92.75	0.10
Ice Jam Section	32310	PF#1	ice_cover	261.00	169.64	177.67		177.68	0.000054	0.51	515.82	97.05	0.07
Ice Jam Section	32310	PF#1	open_water	261.00	169.64	177.65		177.66	0.000014	0.47	559.10	98.66	0.06
Ice Jam Section	32260	PF#1	icejam	261.00	169.91	177.71		177.75	0.000939	0.90	291.60	71.00	0.14
Ice Jam Section	32260	PF#1	ice_cover	261.00	169.91	177.65		177.67	0.000114	0.69	377.22	77.60	0.10
Ice Jam Section	32260	PF#1	open_water	261.00	169.91	177.64		177.66	0.000029	0.63	412.27	79.12	0.09
Ice Jam Section	32200	PF#1	icejam	261.00	170.36	177.66		177.70	0.000834	0.86	305.01	74.78	0.14
Ice Jam Section	32200	PF#1	ice_cover	261.00	170.36	177.65		177.67	0.000106	0.67	391.67	81.01	0.10
Ice Jam Section	32200	PF#1	open_water	261.00	170.36	177.64		177.66	0.000027	0.61	429.02	84.24	0.09
Ice Jam Section	32100	PF#1	icejam	261.00	170.16	177.64	172.54	177.66	0.000196	0.58	449.01	89.05	0.08
Ice Jam Section	32100	PF#1	ice_cover	261.00	170.16	177.64	172.53	177.66	0.000076	0.58	449.01	89.05	0.08
Ice Jam Section	32100	PF#1	open_water	261.00	170.16	177.64	172.08	177.65	0.000019	0.53	490.30	91.29	0.07

Table 5: The combined Profile Summary Table after running steady flow analysis for each the three plans.

The water levels obtained from each plan may easily be compared using Table 5. From the W.S. Elev column in Table 5, it is evident that the Ice Jam Plan causes the highest water surface elevation values, the Ice Cover Plan causes the next highest water surface elevation values, and the Open Water Plan has the lowest water surface elevation values. It is also evident that the ice jam event affects the water level the most at the upstream stations. For example, at River Station 42000, the greatest difference in water level between the Ice Jam and the Open Water Plans, as well as the Ice Jam and the Ice Cover plans is observed.