

Upper Mormon Slough Erosion Repair Project

*Hydraulic Impact Analysis
Technical Memorandum*

This Technical Memorandum (TM) presents the methods and assumptions used in the hydraulic impact analysis. The hydraulic impact analysis is performed to evaluate the potential impact of the proposed upper Mormon slough erosion repair project on the design water surface elevations (WSELs) and evaluate design flow velocities through the study reach.

Background:

The PBI version of the HEC-RAS model was used as the base of this hydraulic analysis. Kleinfelder incorporated additional survey cross sections and refined the PBI model to reflect the post-project condition and conducted preliminary analysis for the purpose of developing 60% repair design plans, which involves placing RSP on the channel slopes at 1.5:1 side slopes up to 2/3 of the bank height. DWR received the model from Kleinfelder and made some updates to the model to reflect the recent changes in erosion repair length and carried out the hydraulic impact analysis as part of the permit requirements for the board.

Project Location and Description:

The project site is located in eastern San Joaquin County, approximately 4 miles east of the town of Linden; on Mormon Slough and reach number three (MS reach 3) starting from river station 95+056.00 on the upstream end to river station 91+568.80 on the downstream end as defined in the model. The estimated total length of the RSP repair is 4740 linear feet and it's combination of station 94+814.40 to 91+568.80 on north bank (covering estimated 3250 linear feet RSP) and station 95+056.00 to 93+570.80 on south bank (covering estimated 1490 linear feet) including transitions. Within the study area, a total of 32 representative cross sections are used to simulate and evaluate the proposed repair works (existing versus post-project conditions).

Discussions of Hydraulic Analysis:

The HEC-RAS water surface profiles and cross-sections output attached to this technical memo showed that the design flow was contained within the channel for both existing and post-project conditions. The post-project WSELs was compared to the existing condition WSELs and to the original design WSELs for Mormon Slough that is presented in the 1965 USACE O&M manual. *The post-project WSP remains below the*

original 1965 design WSP throughout the project reach and it shows a slight increase in WSELs compared to the existing WSP in the upstream portion of the project area, that is typical for erosion repair projects when the eroded sections are backfilled and hardened with riprap. Overall, the project reach has a substantial amount of freeboard, primarily due to scour that has occurred over the past 60+ years, and the proposed project won't cause the post-project WSELs to encroach into the design freeboard.

To evaluate the existing and post-project average channel velocities, a design flow of 12,500 cfs was simulated in the HEC-RAS model and the comparison output table is attached to this memo. The difference in average cross-sectional velocities due to the proposed repair project shows a varied increase along the channel within the project reach compared to the existing channel velocities. The average post-project velocity within the project reach is approximately 8 feet per second (fps). The maximum velocity of 10.19 fps (from a 9.74 fps – pre-project) occurs at project station 93+362.23 where there is the narrowest section of channel within the study area. Even though there is an increase of 0.45 fps in post project velocity that is less than significant and is typical for erosion repair projects, that backfill the eroded banks and encroaching in to the temporary enlarged cross-sectional areas.

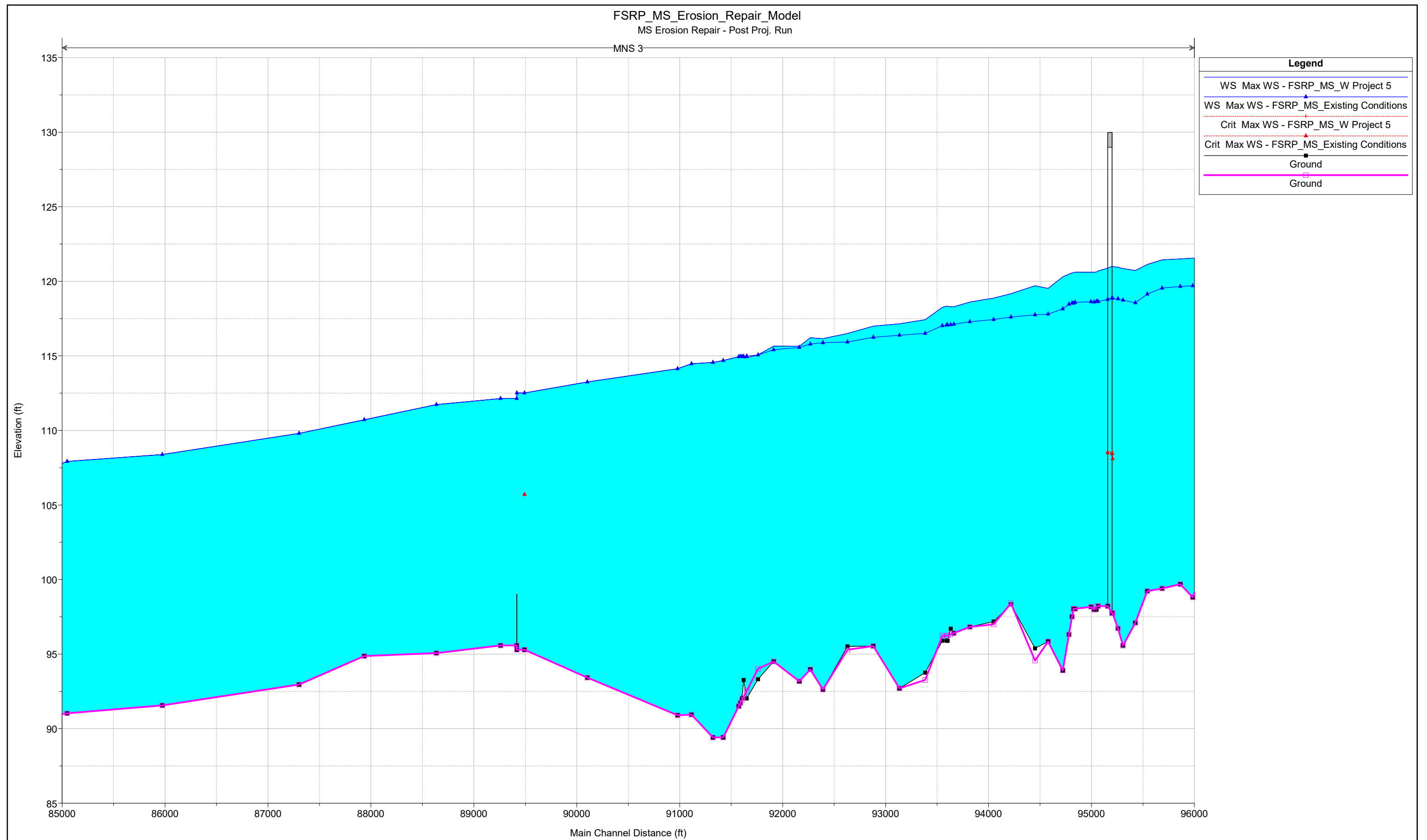
In conclusion, the proposed upper Mormon Slough erosion repair project was modeled in HEC-RAS and used to evaluate the pre-project and post-project conditions. The hydraulic impact analysis identified that the post-project WSELs remains below the 1965 USACE design WSELs throughout the project reach and the insignificant rise in WSELs compared to the existing WSELs due to the project has no impact on the design freeboard.

Civil Engineer Certification

I hereby certify that the hydraulic impact analysis of the proposed project was conducted in accordance with approved hydraulic design guidelines and reference manuals including EM 1110-2-1601 and HEC-RAS user's manual.

Sincerely,

Ran Singh, P.E. 63636 (Expires 09/30/2020)



HEC-RAS Locations: User Defined Profile: Max WS

River	Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Flow Area (sq ft)	Top Width (ft)	Vel Left (ft/s)	Vel Right (ft/s)	Vel Chnl (ft/s)	Vel Total (ft/s)
MNS	3	95382.82	Max WS	FSRP_MS_W Project 5	12438.78	99.23	121.13		121.66	0.000771	2584.25	165.93	2.66	3.11	6.70	4.81
MNS	3	95382.82	Max WS	FSRP_MS_Existing Conditions	12440.01	99.23	119.14		119.82	0.001118	2261.93	158.87	3.03	3.52	7.55	5.50
MNS	3	95266.62	Max WS	FSRP_MS_W Project 5	12438.73	97.09	120.73		121.65	0.000868	1951.64	132.61	2.76	4.54	8.53	6.37
MNS	3	95266.62	Max WS	FSRP_MS_Existing Conditions	12439.92	97.09	118.56		119.80	0.001313	1670.60	126.42	3.07	5.12	9.79	7.45
MNS	3	95156.8	Max WS	FSRP_MS_W Project 5	12438.73	95.58	120.86		121.49	0.000553	2148.40	134.75	3.75	4.18	7.20	5.79
MNS	3	95156.8	Max WS	FSRP_MS_Existing Conditions	12439.98	95.57	118.74		119.58	0.000788	1870.05	126.74	4.12	4.26	8.10	6.65
MNS	3	95109.06	Max WS	FSRP_MS_W Project 5	12438.72	96.72	120.95		121.45	0.000450	2436.31	158.51	3.41	3.10	6.30	5.11
MNS	3	95109.06	Max WS	FSRP_MS_Existing Conditions	12439.94	96.72	118.83		119.52	0.000664	2109.29	149.79	3.57	1.84	6.99	5.90
MNS	3	95109 MNS_4410	Max WS	FSRP_MS_W Project 5	12438.75	97.75	121.00	108.43	121.42	0.000390	2555.35	166.72	3.65	4.00	6.04	4.87
MNS	3	95109 MNS_4410	Max WS	FSRP_MS_Existing Conditions	12439.96	97.75	118.86	108.10	119.47	0.000581	2210.52	155.67	2.41	1.69	6.44	5.63
MNS	3	95081 MNS_4400		Bridge												
MNS	3	95056 MNS_4360	Max WS	FSRP_MS_W Project 5	12438.71	98.22	120.70		121.10	0.000983	2570.88	172.14	3.11	2.78	5.25	4.84
MNS	3	95056 MNS_4360	Max WS	FSRP_MS_Existing Conditions	12439.92	98.22	118.64		119.18	0.001013	2231.54	161.49	2.48	2.42	6.05	5.57
MNS	3	95054 L_69116_MNS		Lat Struct												
MNS	3	95053 R_69115_MNS		Lat Struct												
MNS	3	95039.7	Max WS	FSRP_MS_W Project 5	12438.74	97.97	120.63		121.09	0.000663	2455.42	170.82	1.51	2.32	5.63	5.07
MNS	3	95039.7	Max WS	FSRP_MS_Existing Conditions	12439.92	98.21	118.65		119.16	0.000864	2246.42	159.80	2.35	3.79	5.84	5.54
MNS	3	95012.6	Max WS	FSRP_MS_W Project 5	12438.73	97.98	120.61		121.07	0.000640	2368.94	169.11	2.35	3.16	5.61	5.25
MNS	3	95012.6	Max WS	FSRP_MS_Existing Conditions	12439.92	97.98	118.60		119.14	0.000872	2212.42	158.25	2.34	2.90	6.00	5.62
MNS	3	94980.2	Max WS	FSRP_MS_W Project 5	12438.73	98.17	120.61		121.05	0.000480	2440.43	169.72	1.02	2.02	5.41	5.10
MNS	3	94980.2	Max WS	FSRP_MS_Existing Conditions	12439.92	98.17	118.63		119.11	0.000798	2286.28	155.12	2.42	4.16	5.71	5.44
MNS	3	94814.4	Max WS	FSRP_MS_W Project 5	12438.73	98.03	120.61		120.96	0.000607	2656.41	148.55	1.98	1.98	4.76	4.68
MNS	3	94814.4	Max WS	FSRP_MS_Existing Conditions	12439.92	98.04	118.59		119.00	0.000612	2456.76	146.47	3.54	4.36	5.34	5.06
MNS	3	94796.55	Max WS	FSRP_MS_W Project 5	12438.68	98.03	120.58		120.96	0.000416	2559.17	148.00	1.78	1.48	4.97	4.86
MNS	3	94796.55	Max WS	FSRP_MS_Existing Conditions	12439.92	98.03	118.53		119.00	0.000508	2459.94	145.11	3.30	2.07	5.75	5.06
MNS	3	94783.5	Max WS	FSRP_MS_W Project 5	12438.72	97.51	120.56		120.95	0.000561	2511.12	144.98	1.85	2.14	5.07	4.95
MNS	3	94783.5	Max WS	FSRP_MS_Existing Conditions	12439.89	97.51	118.54		118.99	0.000477	2422.33	142.59	3.58	3.18	5.64	5.14
MNS	3	94753.5	Max WS	FSRP_MS_W Project 5	12438.74	96.32	120.48		120.93	0.000732	2359.90	137.61	2.14	1.82	5.41	5.27
MNS	3	94753.5	Max WS	FSRP_MS_Existing Conditions	12439.92	96.32	118.46		118.98	0.000607	2299.24	135.13	3.20	2.97	6.11	5.41
MNS	3	94693.05	Max WS	FSRP_MS_W Project 5	12438.73	93.91	120.30		120.89	0.000779	2068.74	120.68	2.00	2.45	6.21	6.01
MNS	3	94693.05	Max WS	FSRP_MS_Existing Conditions	12439.88	93.91	118.14		118.99	0.000741	1955.06	116.74	2.26	2.32	7.73	6.36
MNS	3	94550.59	Max WS	FSRP_MS_W Project 5	12438.71	95.84	119.52		120.74	0.002169	1475.25	110.37	3.89	4.86	9.12	8.43
MNS	3	94550.59	Max WS	FSRP_MS_Existing Conditions	12439.90	95.84	117.81		118.90	0.001025	1634.56	105.39	2.12	4.67	8.81	7.61
MNS	3	94423.98	Max WS	FSRP_MS_W Project 5	12438.70	95.38	119.70		120.49	0.001165	1792.23	116.62	3.20	3.25	7.27	6.94
MNS	3	94423.98	Max WS	FSRP_MS_Existing Conditions	12439.89	94.56	117.75		118.77	0.000884	1800.80	112.39	2.27	2.42	8.43	6.91
MNS	3	94207	Max WS	FSRP_MS_W Project 5	12438.68	98.34	119.17		120.17	0.001654	1585.84	107.33	3.69	3.39	8.09	7.84
MNS	3	94207	Max WS	FSRP_MS_Existing Conditions	12439.87	98.41	117.61		118.53	0.000916	1702.50	105.49	3.63	2.88	7.87	7.31

HEC-RAS Locations: User Defined Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Flow Area (sq ft)	Top Width (ft)	Vel Left (ft/s)	Vel Right (ft/s)	Vel Chnl (ft/s)	Vel Total (ft/s)
MNS	3	94205 R_68267_MNS			Lat Struct											
MNS	3	94204 L_68266_MNS			Lat Struct											
MNS	3	94027.03	Max WS	FSRP_MS_W Project 5	12438.65	97.19	118.87		119.89	0.001629	1563.83	100.86	3.35	2.94	8.14	7.95
MNS	3	94027.03	Max WS	FSRP_MS_Existing Conditions	12439.87	97.00	117.43		118.39	0.000854	1679.15	98.87	4.59	3.43	8.12	7.41
MNS	3	93795.63	Max WS	FSRP_MS_W Project 5	12438.68	96.82	118.61		119.53	0.001431	1639.39	104.84	3.37	2.76	7.78	7.59
MNS	3	93795.63	Max WS	FSRP_MS_Existing Conditions	12439.87	96.82	117.29		118.19	0.000817	1716.56	102.98	5.07	3.31	7.92	7.25
MNS	3	93640.8	Max WS	FSRP_MS_W Project 5	12438.64	96.41	118.30		119.30	0.001625	1583.73	102.76	2.97	3.22	8.10	7.85
MNS	3	93640.8	Max WS	FSRP_MS_Existing Conditions	12439.79	96.41	117.12		118.07	0.000866	1712.06	101.39	2.85	4.20	8.06	7.27
MNS	3	93610.8	Max WS	FSRP_MS_W Project 5	12438.64	96.70	118.29		119.25	0.001532	1608.28	102.29	1.29	3.46	7.88	7.73
MNS	3	93610.8	Max WS	FSRP_MS_Existing Conditions	12439.85	96.33	117.09		118.04	0.000850	1711.30	100.83	2.55	4.21	8.07	7.27
MNS	3	93580.74	Max WS	FSRP_MS_W Project 5	12438.64	95.89	118.33		119.21	0.001199	1687.80	101.67	2.57	3.15	7.61	7.37
MNS	3	93580.74	Max WS	FSRP_MS_Existing Conditions	12439.86	96.24	117.07		118.02	0.000827	1711.75	100.18	2.42	4.38	8.04	7.27
MNS	3	93570.8	Max WS	FSRP_MS_W Project 5	12438.64	95.89	118.34		119.20	0.001554	1702.36	101.69	2.89	3.58	7.50	7.31
MNS	3	93570.8	Max WS	FSRP_MS_Existing Conditions	12439.82	96.24	117.06		118.01	0.000832	1710.45	100.17	2.43	4.22	8.07	7.27
MNS	3	93528	Max WS	FSRP_MS_W Project 5	12438.64	95.89	118.26		119.14	0.001298	1694.06	101.60	2.69	3.26	7.58	7.34
MNS	3	93528	Max WS	FSRP_MS_Existing Conditions	12439.78	96.24	117.02		117.97	0.000834	1706.95	100.12	2.43	4.40	8.06	7.29
MNS	3	93362.23	Max WS	FSRP_MS_W Project 5	12438.57	93.76	117.43		118.92	0.002040	1347.12	87.54	5.29	3.88	10.19	9.23
MNS	3	93362.23	Max WS	FSRP_MS_Existing Conditions	12439.80	93.26	116.51		117.87	0.001063	1480.63	85.91	3.82	3.16	9.74	8.40
MNS	3	93112.41	Max WS	FSRP_MS_W Project 5	12438.58	92.70	117.15		118.45	0.001678	1487.93	95.21	4.03	3.90	9.52	8.36
MNS	3	93112.41	Max WS	FSRP_MS_Existing Conditions	12439.78	92.70	116.38		117.62	0.001032	1584.19	94.06	3.08	5.38	9.61	7.85
MNS	3	92858.88	Max WS	FSRP_MS_W Project 5	12438.59	95.54	117.00		118.03	0.001314	1606.43	112.49	3.99	2.65	8.41	7.74
MNS	3	92858.88	Max WS	FSRP_MS_Existing Conditions	12439.79	95.54	116.25		117.31	0.000948	1633.44	109.70	3.34	3.32	8.58	7.62
MNS	3	92606.62	Max WS	FSRP_MS_W Project 5	12438.56	95.52	116.51		117.68	0.001497	1488.83	96.23	4.80	3.39	8.94	8.35
MNS	3	92606.62	Max WS	FSRP_MS_Existing Conditions	12439.74	95.30	115.93		117.07	0.000996	1581.14	95.37	2.34	2.72	8.72	7.87
MNS	3	92385	Max WS	FSRP_MS_W Project 5	12438.55	92.63	116.15		117.34	0.001486	1486.91	95.81	5.77	3.91	9.06	8.37
MNS	3	92385	Max WS	FSRP_MS_Existing Conditions	12439.72	92.63	115.88		116.85	0.000784	1691.19	95.24	4.14	3.36	8.22	7.36
MNS	3	92383 R_66443_MNS			Lat Struct											
MNS	3	92382 L_66444_MNS			Lat Struct											
MNS	3	92244.89	Max WS	FSRP_MS_W Project 5	12438.52	93.97	116.21		117.16	0.001143	1734.23	112.72	2.64	2.68	7.99	7.17
MNS	3	92244.89	Max WS	FSRP_MS_Existing Conditions	12439.73	93.97	115.80		116.76	0.000824	1770.17	111.89	2.46	3.61	8.22	7.03
MNS	3	92138.55	Max WS	FSRP_MS_W Project 5	12438.49	93.18	115.64		117.05	0.001869	1434.65	96.63	3.29	3.40	9.80	8.67
MNS	3	92138.55	Max WS	FSRP_MS_Existing Conditions	12439.71	93.18	115.56		116.68	0.000937	1586.85	96.43	4.79	3.88	8.93	7.84
MNS	3	91888.9	Max WS	FSRP_MS_W Project 5	12438.52	94.51	115.65		116.61	0.001317	1658.78	120.38	4.97	3.12	8.16	7.50
MNS	3	91888.9	Max WS	FSRP_MS_Existing Conditions	12439.72	94.51	115.41		116.42	0.001076	1678.37	119.86	4.45	5.08	8.78	7.41
MNS	3	91737.19	Max WS	FSRP_MS_W Project 5	12438.50	93.31	115.08		116.39	0.001915	1421.98	105.10	5.50	3.96	9.52	8.75
MNS	3	91737.19	Max WS	FSRP_MS_Existing Conditions	12439.74	94.01	115.07		116.26	0.001217	1535.15	105.07	4.39	4.63	9.25	8.10
MNS	3	91628.0	Max WS	FSRP_MS_W Project 5	12438.45	92.02	114.87		116.16	0.002263	1464.03	108.89	4.21	4.27	9.48	8.50

HEC-RAS Locations: User Defined Profile: Max WS (Continued)

River	Reach	River Sta	Profile	Plan	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Flow Area (sq ft)	Top Width (ft)	Vel Left (ft/s)	Vel Right (ft/s)	Vel Chnl (ft/s)	Vel Total (ft/s)
MNS	3	91628.0	Max WS	FSRP_MS_Existing Conditions	12439.71	92.53	114.98		116.14	0.001082	1617.34	109.34	2.93	4.53	9.14	7.69
MNS	3	91598.4	Max WS	FSRP_MS_W Project 5	12438.51	93.26	114.85		116.11	0.001540	1522.49	110.38	3.23	3.47	9.29	8.17
MNS	3	91598.4	Max WS	FSRP_MS_Existing Conditions	12439.66	92.13	114.97		116.11	0.001051	1642.62	110.70	2.69	4.50	9.09	7.57
MNS	3	91591 R_65653_MNS		Lat Struct												
MNS	3	91590 L_65652_MNS		Lat Struct												
MNS	3	91583.6	Max WS	FSRP_MS_W Project 5	12438.46	92.03	114.94		116.08	0.001100	1628.11	111.40	2.65	3.69	8.93	7.64
MNS	3	91583.6	Max WS	FSRP_MS_Existing Conditions	12439.72	91.93	114.96		116.10	0.001037	1655.71	111.47	2.57	4.48	9.07	7.51
MNS	3	91568.8	Max WS	FSRP_MS_W Project 5	12438.51	91.73	114.97		116.05	0.001011	1671.11	112.30	2.46	3.01	8.60	7.44
MNS	3	91568.8	Max WS	FSRP_MS_Existing Conditions	12439.70	91.73	114.95		116.08	0.001024	1669.21	112.25	2.47	4.46	9.04	7.45
MNS	3	91552.36	Max WS	FSRP_MS_W Project 5	12438.50	91.51	114.94		116.06	0.001010	1684.12	113.03	2.37	4.45	9.01	7.39
MNS	3	91552.36	Max WS	FSRP_MS_Existing Conditions	12439.70	91.51	114.95		116.07	0.001009	1684.62	113.05	2.37	4.45	9.01	7.38
MNS	3	91401.5	Max WS	FSRP_MS_W Project 5	12438.48	89.41	114.69		115.92	0.001105	1599.28	103.80	2.35	4.70	9.45	7.78
MNS	3	91401.5	Max WS	FSRP_MS_Existing Conditions	12439.68	89.41	114.69		115.94	0.001116	1599.12	103.80	2.36	5.05	9.63	7.78
MNS	3	91301.5	Max WS	FSRP_MS_W Project 5	12438.44	89.41	114.56		115.81	0.001128	1586.08	103.27	2.36	4.73	9.52	7.84
MNS	3	91301.5	Max WS	FSRP_MS_Existing Conditions	12439.69	89.41	114.56		115.83	0.001140	1585.76	103.26	2.38	5.09	9.70	7.84
MNS	3	91093.08	Max WS	FSRP_MS_W Project 5	12438.48	90.94	114.47		115.55	0.000896	1625.66	105.22	3.44	2.92	8.61	7.65
MNS	3	91093.08	Max WS	FSRP_MS_Existing Conditions	12439.67	90.94	114.47		115.55	0.000896	1625.75	105.22	3.44	2.92	8.61	7.65
MNS	3	90957.9	Max WS	FSRP_MS_W Project 5	12438.42	90.90	114.14		115.45	0.001228	1499.28	102.40	4.60	4.68	9.86	8.30
MNS	3	90957.9	Max WS	FSRP_MS_Existing Conditions	12439.70	90.90	114.14		115.45	0.001228	1499.35	102.40	4.60	4.68	9.86	8.30

