Potential Solutions

Several potential solutions exist at this time for remediating some or all of the problems that are apparent. Listed below in order of increasing complexity are potential solutions. The recommended solution will be the result of follow-up discussions with all stake holders and should be based on technical feasibility, overall effectiveness, acceptability, and benefit-cost ratio.

1) It is probable that sometimes the water level at the dam can simply be held higher without impacting the lake if no large inflows occur. See Figure 1 for the impact of higher discharges on Yellow Lake. Benefit: it is simple, helps out home owners along the river and increases the head at the hydro plant, increase in river level expands fish habitat. Drawback: does nothing to help increase discharge capacity of the river. One item for concern is if the grassy weeds will simply adjust to the slightly deeper water and continue to reduce conveyance?

    - Although this seems simple it would require changes in the operating permit as presently the gage house on Yellow Lake is the control to which the plant is operated.

    - One benefit is the increase in discharge capacity of the spillway with an increase in water level. Table 2 below summarizes the impacts of water surface elevation on the discharge capacity of the spillways.

    - Drawbacks include the potential for increased impact to Yellow Lake should a large inflow event occur and that this may solution be unacceptable to residents

1b) Raise set point of Yellow Lake. Benefit: simple and helps out homeowners along river, creates increased spillway capacity and gives operator more ability to control level of Yellow Lake. Drawback: increases normal water level of Yellow and Little Yellow Lakes.

    - Cabins, wells, foundations, septic systems and shoreline erosion problems have occurred with high water in the last 3-yrs. The YLSA has noted that an estimated 15-20 percent of Yellow Lake properties experience problems with only a 6 inch increase in water level while 25-30 percent experience problems with a 1 ft rise.

2) Periodic weed removal was historically preformed and may again be warranted. Benefit: reasonably quick to undertake using known technologies. Drawback: given the 1.5 mile length of the reach that would need to be maintained with a weed free zone nominally 50 ft wide this process may become a logistical problem to

continually perform and to dispose of weeds during the summer. Logistical problems include river access, the numerous stumps, logs and boulders in the river and the long haul. Decay of the disposed weeds may also create undesirable odors that require a remote disposal site and long hauling distances. Cost may be in the $100,000 per year range. Temporarily removes fish habitat.

- When weed cutting was performed years ago, weeds were not collected but were allowed to float downstream, which is no longer an acceptable alternative.

2b) Chemical treatment of weeds in river. Benefit: may be able to quickly treat a large segment of river at relatively low cost. Drawback: treatment normally used in shallow lakes application - effectiveness in river unknown, impacts habitat, short term impact to fish and other wildlife uncertain, length of time that weeds would remain suppressed following application, possible undesirable downstream impacts.

3) Although the river reach appears to be stable, with minimal areas of sediment deposition or erosion, dredging of the critical middle section of river could be used to increase conveyance. Benefit: long term (50-100 year) solution, potentially could be dredged deep enough to minimize impact of weeds long term. Increases overall conveyance of reach. Drawback: is a very drastic solution that cannot be undertaken without further study to address impacts and assess the long-term effectiveness. High capital cost, dredging volume in range of 60,000 to 100,000 cubic yards or more. Neutral item disposal of dredge material could be potential problem but may also be used for the development habitat islands in the reach near Buffalo Lake, reducing sediment re-suspension presently caused by wind. This option has an initial capital cost of between $700,000 and $2,000,000 depending upon the amount of material needing dredging and the method of dredging that can be performed. Given the long narrow reach of river and the shallow river depths hydraulic dredging would probably be more cost effective than mechanical dredging.

4) Reach between Yellow and Little Yellow Lakes.

   a) Reconstruction of bridge and channel between Yellow and Little Yellow Lakes. Benefit: could reduce losses in reach and allow equalization of the water surfaces between Yellow and Little Yellow Lakes. The field surveys indicated that presently the water surface of Little Yellow is typically 0.25 ft lower than Yellow Lake. Could be designed to allow easier passage of boats and automobiles than present bridge. Bridge is nearing end of its useful life and may need replacement anyway. Drawback: limited in effect to that between the lakes, does nothing to help other river problems. High capital cost for isolated reach, cost approximately $500,000.

   b) Construct a second outlet between Yellow and Little Yellow Lakes. Benefit: will allow better relationship between water surface levels at the dam and the lake. Drawback: limited in effect to between the lakes, and does nothing to address

other river problems. Potentially high capital cost-benefit ratio. Cost similar to 4a, depending upon design.

5) Siphon or pumped outlet alternative.

   a) Construct an outlet from Yellow Lake to the Clam River Flowage via Dody Brook. Possible benefit: Dody Brook begins just west of Yellow Lake and pipe could be installed following the topography of the stream. Elevations are such that if the pipe were buried through the initial ridge immediately west of Yellow Lake it may be possible for the system to be designed as a siphon eliminating or minimizing pumping costs. Drawbacks: about 6 miles of pipe needed to reach the Clam River Flowage from Yellow Lake. System only needed during periods of high water, which, while very problematic to Yellow Lake landowners, are typically of duration of two-weeks or so. This in-turn requires that to have a noticeable impact to Yellow Lake the system would need to have the capacity of discharging 100 to 400 cfs. Dody brook is classified as a Class II trout stream by the Wisconsin DNR limiting the likelihood of permitting construction. Cost, for piping alone a 100 cfs system would cost $3,500,000 to $4,000,000 and a 400 cfs system about twice that. Additional costs include but are not limited to; pump station(s), intake and outlet works, valves, land acquisition/ROW, design, legal, and permitting costs, contingency.

   b) Construct an outlet from Yellow Lake to Dody Brook. Possible benefit: Dody Brook begins just west of Yellow Lake requiring only about 1500 ft of piping. Drawbacks: design would require pumping of water. System only needed during periods of high water, which, while very problematic to Yellow Lake landowners, are typically of duration of two-weeks or so. This in-turn requires that to have a noticeable impact to Yellow Lake the system would need to have the capacity of discharging 100 to 400 cfs. Dody brook is classified as a Class II trout stream by the Wisconsin DNR limiting the likelihood of permitting the intermittent discharge of Yellow Lake water to the stream. Cost, for 100 cfs, just the piping and lift station components of such a system would cost $500,000 to $1,000,000 and a 400 cfs system about twice that. Additional costs include but are not limited to; intake and outlet works, valves, land acquisition/ROW, design, legal, and permitting costs, contingency.

   c) Construct an outlet for Little Yellow Lake and pipe the water in a northwesterly direction to the St. Croix River. Issues similar to 5a, benefit is piping length reduced to about 3.1 miles which would cut pipe costs about in half and may reduce ROW costs by a similar amount, other costs would not change significantly. Drawback is that given generally higher topography between the lake and the river, water would have to be pumped.

Site Recommendation for stream gage upstream from Yellow Lake

Given the limitations that the dam has on controlling the water level of Yellow Lake as indicated by the data from May 2003, (Figure 3) and the hydraulic analysis of the river (Figure 1) the effectiveness of a gage as a preparedness tool is minimal. While a stream gage will provide information on the inflow to Yellow Lake the usefulness of the information to aid in hydroplant/dam operation is limited because of the size of the lake and its associated storage volume, and the need for the lake level to rise to pass the water through the channel into Lower Yellow Lake. Should North American Hydro and the Yellow River Sportsman Association choose to install a gage the following site is recommended.

Criteria

The location recommended for installation of the upstream stream gage to monitor river flows coming into Yellow Lake was based on the following criteria.

1. Be as close to the lake as possible allowing capture of as much of the watershed as practical without being impacted by backwater effects related to Yellow Lake.

2. Select a site that is reasonably accessible and has nearby phone and power to allow continuous monitoring of incoming flows.

Discussion

The site recommended is located adjacent to the Austin Lake Road Bridge crossing, approximately 2 miles east of Webster, Wisconsin. Immediately west of the bridge is an access to the river near where the gage can be located and utilities run along Austin Lake Road. The reach is four to five miles above Yellow Lake and is not impacted by backwaters of the lake except at possibly extremely high lake water surface elevations, catches all major tributaries totaling approximately 251 square miles, is relatively steep and has a couple of potential options for installation upstream from a downstream control point. The reach is quite rocky and appears to have minimal vegetation that could seasonally impact gage accuracy. The reach appears stable and has well defined cross sections that may be used for flow measurement to develop a rating curve.

Cost

The cost to install the gaging station with a telemetry system can be expected to cost approximately $20,000, depending upon the instrumentation selected and the amount of work required of outside contractors. Calibration should cost approximately $4000 to $7000 to obtain data over a range of flows necessary to provide a reasonable degree of gaging accuracy. Operation and maintenance costs should be minimal, the power requirements are very low and provided that the unit is installed securely it should be reasonably safe from vandalism. The calibration should be verified every few years at a cost of approximately $1500.

Acknowledgements

Polaris Group, Inc. gratefully acknowledges the assistance of several individuals whose assistance with obtaining data throughout the study lead to a much greater understanding of how the Yellow River changes seasonally. Polaris Group would like to specifically thank the following individuals; Rick Doering, Bob Sorenson, Art and Karen Benson, Kirk Robbins, Loyal Gake and Scott Kalbunde as well the plant operators at North American Hydro.

Appendix

Table 1. Summary of Total Discharge (Q) at Time of Field Observations

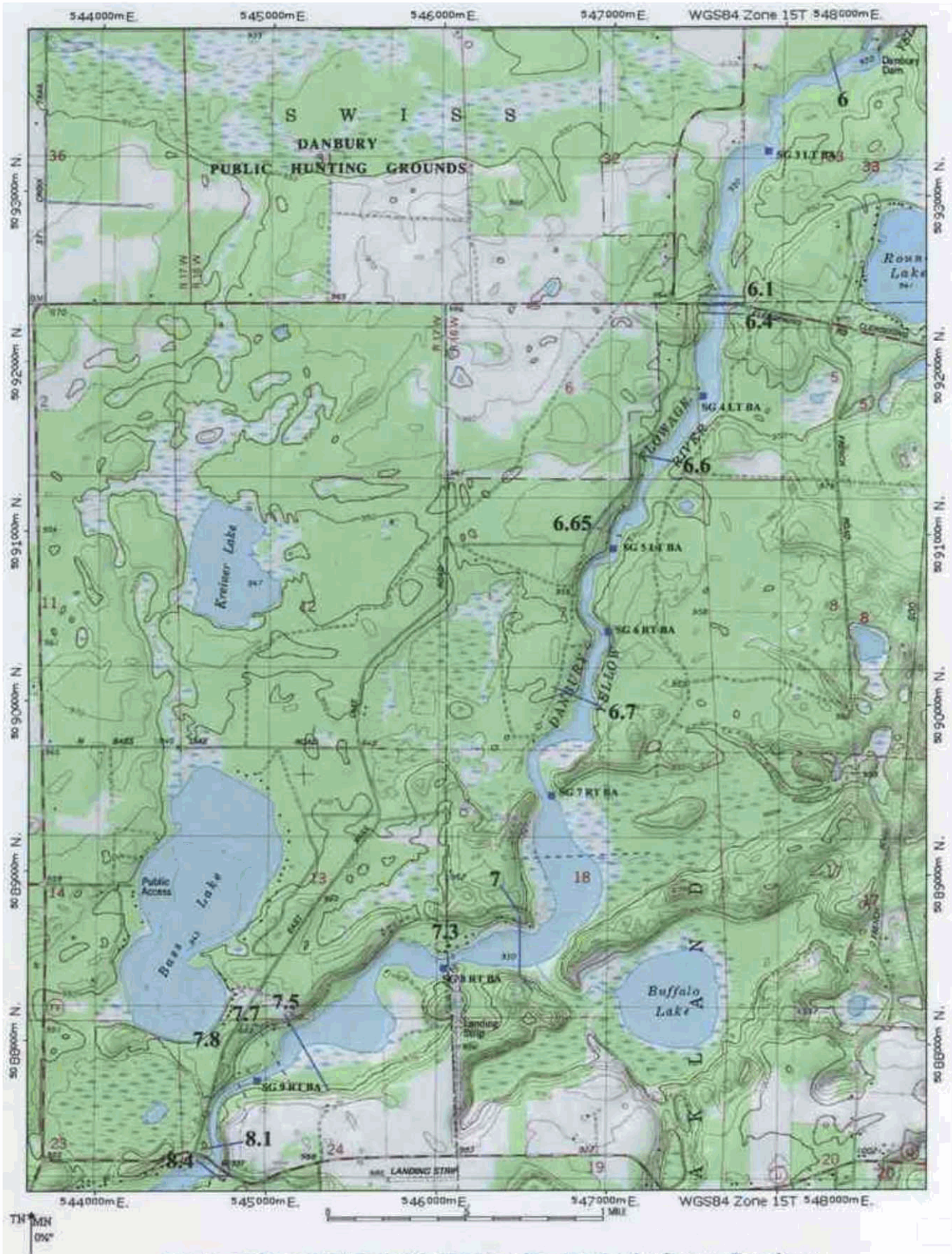
Reach	Total Q (cfs	Lower rang	Upper range
Yellow River upstream of Yellow	493	453	532
Bridge between Yellow and Little	642	591	693

Data taken on May 16, 2003

Difference	149	cfs	
rate of fall assuming 2500 acres	0.12	ft/day	versus field observations of 0.10 ft /day

River Stage Readings

5/15/2003	5/23/2003	5/30/2003	6/6/2003	6/13/2003	6/20/2003	6/27/2003	7/3/2003	7/4/2003	7/12/2003	7/19/2003	7/24/2003	27-Jul	31-Jul ????		8/7/2003	8/14/2003	8/28/2003	9/7/2003	9/17/2003	9/25/2003	10/2/2003
1.15	0.09	1.1	1.3	1.1	0.8	0.6	0.36	0.6	0.22	0.24	0.2	0.7	unable to read	1.25	0.3	0.52	0.4	0.6	0.8	1.1	
1.1	0.88	0.91	1.2	0.8	0.67	0.65	0.56	0.92	0.2	0.4	0.2	1.06	river too low	1.15	0.4	0.44	0.8	0.8	0.9	1.2	
0.8	0.52	0.6	0.82	0.9	0.8	0.75	0.96	0.98	0.6	0.48	0.3	1.16		0.78	0.4	0.22	0.65	0.82	0.8	1.2	
1.2	0.7	1.21	1.2	1.23	1.23	0.9		1	1	0.65	0.7			1.16	0.6	0.89	1.1	1.3	1.4	1.4	1.5
1.3	1.13	1.3	1.26	1.3	1.31	1.13		1	1.2	1.1	1.1			1.4	1.1	1.14	1.4	1.5	1.6	1.6	1.6
1.3	0.82	1	1	1	0.8	0.8		0.9	0.88	0.72	0.72			1	0.73	0.78	1	1.1	1.2	1.2	1.2
0.8	0.1	0.9	0.9	0.9	0.9	0.8		0.9	0.9	0.83	0.83			0.98	0.9	0.9	1.15	1	1.13	1.1	1.12



Yellow River HEC-RAS Hydraulic Analysis Cross-Sections

Yellow River
HEC-RAS Output : Dam Water Elevation = 927.0 cfs (Winter)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Middle Reach	9.7	200 cfs	200	900	928.66		928.66	0	0	233056.2	11653.37	0
Middle Reach	9.7	300 cfs	300	900	929.41		929.41	0	0	241857.5	11841.73	0
Middle Reach	9.7	400 cfs	400	900	930.04		930.04	0	0	249318.5	11990.59	0
Middle Reach	9.7	500 cfs	500	900	930.59		930.59	0	0	255976.8	12000.71	0
Middle Reach	9.7	600 cfs	600	900	931.09		931.09	0	0	261984.5	12009.83	0
Middle Reach	9.6	200 cfs	200	905	928.66		928.66	0	0	151848.8	7562.43	0
Middle Reach	9.6	300 cfs	300	905	929.41		929.41	0	0	157558.9	7680.6	0
Middle Reach	9.6	400 cfs	400	905	930.04		930.04	0	0	162397.1	7773.94	0
Middle Reach	9.6	500 cfs	500	905	930.59		930.59	0	0	166714	7780.82	0
Middle Reach	9.6	600 cfs	600	905	931.09		931.09	0	0	170609.2	7787.02	0
Middle Reach	9.4	200 cfs	200	925.02	928.66		928.66	0.000003	0.14	3014.81	1364.8	0.02
Middle Reach	9.4	300 cfs	300	925.02	929.41		929.41	0.000003	0.16	4112.76	1566.41	0.02
Middle Reach	9.4	400 cfs	400	925.02	930.04		930.04	0.000002	0.17	5146.02	1736.52	0.02
Middle Reach	9.4	500 cfs	500	925.02	930.59		930.59	0.000002	0.19	6153.49	1893.65	0.02
Middle Reach	9.4	600 cfs	600	925.02	931.09		931.09	0.000002	0.2	7136.44	2035.3	0.02
Middle Reach	9.3	200 cfs	200	924.11	928.62	925.58	928.65	0.000149	1.35	148.52	47.6	0.12
Middle Reach	9.3	300 cfs	300	924.11	929.35	925.95	929.4	0.000185	1.69	177.49	50.78	0.14
Middle Reach	9.3	400 cfs	400	924.11	929.96	926.26	930.02	0.000215	1.98	201.52	52.91	0.16
Middle Reach	9.3	500 cfs	500	924.11	930.49	926.54	930.57	0.000241	2.24	222.73	52.94	0.17
Middle Reach	9.3	600 cfs	600	924.11	930.97	926.77	931.06	0.000264	2.48	241.74	52.97	0.18
Middle Reach	9.25		Bridge									
Middle Reach	9.2	200 cfs	200	924.69	928.6	926.31	928.64	0.00029	1.63	122.78	43.52	0.17
Middle Reach	9.2	300 cfs	300	924.69	929.33	926.68	929.39	0.000319	1.97	152.2	45.81	0.18
Middle Reach	9.2	400 cfs	400	924.69	929.93	926.97	930.01	0.000345	2.27	176.6	47.31	0.19
Middle Reach	9.2	500 cfs	500	924.69	930.46	927.23	930.56	0.000368	2.44	237.09	145.38	0.2
Middle Reach	9.2	600 cfs	600	924.69	930.95	927.47	931.05	0.000359	2.58	317.52	192.16	0.2
Middle Reach	9.1	200 cfs	200	924.91	928.6		928.6	0.000062	0.63	317.87	139.9	0.07
Middle Reach	9.1	300 cfs	300	924.91	929.33		929.34	0.000057	0.71	422.72	145.66	0.07
Middle Reach	9.1	400 cfs	400	924.91	929.94		929.95	0.000054	0.78	511.94	147.16	0.07
Middle Reach	9.1	500 cfs	500	924.91	930.49		930.5	0.000044	0.78	1111.66	1243.13	0.07
Middle Reach	9.1	600 cfs	600	924.91	930.98		930.99	0.000033	0.73	1745.29	1300.99	0.06
Middle Reach	8.6	200 cfs	200	920	928.6		928.6	0	0.01	25837.82	3386.73	0
Middle Reach	8.6	300 cfs	300	920	929.34		929.34	0	0.01	28347.49	3449.25	0
Middle Reach	8.6	400 cfs	400	920	929.95		929.95	0	0.01	30469.25	3501.23	0
Middle Reach	8.6	500 cfs	500	920	930.49		930.49	0	0.02	32381.94	3513.14	0
Middle Reach	8.6	600 cfs	600	920	930.99		930.99	0	0.02	34129.22	3520.63	0
Middle Reach	8.4	200 cfs	200	921.29	928.6		928.6	0.000001	0.13	1552.2	322.18	0.01
Middle Reach	8.4	300 cfs	300	921.29	929.34		929.34	0.000001	0.17	1796.56	343.65	0.01
Middle Reach	8.4	400 cfs	400	921.29	929.95		929.95	0.000002	0.2	2009.45	352.35	0.01
Middle Reach	8.4	500 cfs	500	921.29	930.49		930.49	0.000002	0.23	2202.31	355.59	0.02
Middle Reach	8.4	600 cfs	600	921.29	930.99		930.99	0.000002	0.25	2379.65	358.54	0.02
Middle Reach	8.3	200 cfs	200	923.92	928.59	925.1	928.6	0.000061	0.77	260.7	83.93	0.08
Middle Reach	8.3	300 cfs	300	923.92	929.32	925.4	929.33	0.000075	0.92	324.8	92	0.09
Middle Reach	8.3	400 cfs	400	923.92	929.92	925.65	929.94	0.000079	1.05	381.92	96.46	0.09
Middle Reach	8.3	500 cfs	500	923.92	930.46	925.87	930.49	0.000081	1.16	434.96	100.24	0.09
Middle Reach	8.3	600 cfs	600	923.92	930.96	926.07	930.98	0.000083	1.26	484.02	103.35	0.1
Middle Reach	8.25		Bridge									
Middle Reach	8.2	200 cfs	200	923.5	928.47	924.95	928.48	0.000063	0.79	254.23	80.28	0.08
Middle Reach	8.2	300 cfs	300	923.5	929.21	925.25	929.22	0.000077	0.95	316.86	88.68	0.09
Middle Reach	8.2	400 cfs	400	923.5	929.83	925.5	929.84	0.000084	1.07	373.6	94.03	0.09
Middle Reach	8.2	500 cfs	500	923.5	930.38	925.72	930.4	0.000086	1.18	425.01	96.67	0.1
Middle Reach	8.2	600 cfs	600	923.5	930.88	925.93	930.9	0.000088	1.27	471.76	99.07	0.1
Middle Reach	8.1	200 cfs	200	923.25	928.44		928.44	0.000157	0.51	394.88	149.93	0.05
Middle Reach	8.1	300 cfs	300	923.25	929.18		929.18	0.000167	0.59	510.29	162.42	0.06
Middle Reach	8.1	400 cfs	400	923.25	929.79		929.8	0.000168	0.65	612.74	168.27	0.06
Middle Reach	8.1	500 cfs	500	923.25	930.34		930.35	0.000165	0.71	705.82	169.92	0.06
Middle Reach	8.1	600 cfs	600	923.25	930.84		930.85	0.000163	0.76	791.24	171.42	0.06
Middle Reach	7.8	200 cfs	200	924.24	928.09		928.1	0.000362	0.71	280.37	119.15	0.08
Middle Reach	7.8	300 cfs	300	924.24	928.81		928.82	0.000363	0.81	370.2	130.1	0.08
Middle Reach	7.8	400 cfs	400	924.24	929.44		929.45	0.000347	0.88	453.61	135	0.08
Middle Reach	7.8	500 cfs	500	924.24	930		930.01	0.000327	0.94	529.54	135	0.08
Middle Reach	7.8	600 cfs	600	924.24	930.51		930.52	0.000317	1	597.86	135	0.08

Yellow River
HEC-RAS Output : Dam Water Elevation = 927.0 cfs (Winter)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Middle Reach	7.7	200 cfs	200	925.54	928.01		928.02	0.000188	0.92	216.55	123.9	0.12
Middle Reach	7.7	300 cfs	300	925.54	928.74		928.76	0.000143	0.96	312.34	137.14	0.11
Middle Reach	7.7	400 cfs	400	925.54	929.38		929.39	0.000118	0.99	402.16	144	0.1
Middle Reach	7.7	500 cfs	500	925.54	929.95		929.96	0.0001	1.03	484.19	144	0.1
Middle Reach	7.7	600 cfs	600	925.54	930.46		930.47	0.000091	1.08	557.63	144	0.1
Middle Reach	7.5	200 cfs	200	922.36	928.01		928.01	0.000001	0.14	1423.13	344.61	0.01
Middle Reach	7.5	300 cfs	300	922.36	928.75		928.75	0.000002	0.18	1685.08	371.29	0.01
Middle Reach	7.5	400 cfs	400	922.36	929.38		929.38	0.000002	0.21	1924.22	384.31	0.02
Middle Reach	7.5	500 cfs	500	922.36	929.95		929.95	0.000003	0.23	2146.18	395.08	0.02
Middle Reach	7.5	600 cfs	600	922.36	930.46		930.46	0.000003	0.25	2616.86	999.18	0.02
Middle Reach	7.3	200 cfs	200	924.34	927.99		927.99	0.01155	0.74	271.48	107.89	0.08
Middle Reach	7.3	300 cfs	300	924.34	928.71		928.72	0.012698	0.84	355.06	123.28	0.09
Middle Reach	7.3	400 cfs	400	924.34	929.33		929.35	0.012271	0.92	434.71	129	0.09
Middle Reach	7.3	500 cfs	500	924.34	929.9		929.91	0.011582	0.99	507.44	129	0.09
Middle Reach	7.3	600 cfs	600	924.34	930.4		930.42	0.011256	1.05	572.72	129	0.09
Middle Reach	7	200 cfs	200	921.04	927.82		927.82	0.000028	0.06	3578.96	738.95	0
Middle Reach	7	300 cfs	300	921.04	928.46		928.46	0.000042	0.07	4055.19	758.5	0.01
Middle Reach	7	400 cfs	400	921.04	929.01		929.01	0.000056	0.09	4478.32	775.42	0.01
Middle Reach	7	500 cfs	500	921.04	929.51		929.51	0.000067	0.1	4872.54	789.44	0.01
Middle Reach	7	600 cfs	600	921.04	929.97		929.97	0.000077	0.11	5235.35	795.75	0.01
Middle Reach	6.7	200 cfs	200	921.26	927.73		927.73	0.00001	0.16	1216.07	264.11	0.01
Middle Reach	6.7	300 cfs	300	921.26	928.32		928.32	0.000016	0.22	1372.77	270.57	0.02
Middle Reach	6.7	400 cfs	400	921.26	928.82		928.82	0.000021	0.26	1510.97	275.66	0.02
Middle Reach	6.7	500 cfs	500	921.26	929.29		929.29	0.000026	0.3	1639.89	280.33	0.02
Middle Reach	6.7	600 cfs	600	921.26	929.71		929.71	0.00003	0.34	1759.14	284.58	0.02
Middle Reach	6.65	200 cfs	200	922.14	927.64		927.65	0.000481	0.53	375.11	177.89	0.06
Middle Reach	6.65	300 cfs	300	922.14	928.18		928.19	0.00067	0.62	487.16	238.9	0.08
Middle Reach	6.65	400 cfs	400	922.14	928.66		928.67	0.000602	0.67	601.07	241.92	0.07
Middle Reach	6.65	500 cfs	500	922.14	929.1		929.1	0.000554	0.71	707.62	244.72	0.07
Middle Reach	6.65	600 cfs	600	922.14	929.5		929.51	0.000521	0.74	805.68	245	0.07
Middle Reach	6.6	200 cfs	200	921.5	927.28	922.33	927.28	0.000054	0.2	1012.23	251.77	0.02
Middle Reach	6.6	300 cfs	300	921.5	927.57	922.48	927.57	0.0001	0.28	1084.59	256.96	0.02
Middle Reach	6.6	400 cfs	400	921.5	927.89	922.6	927.89	0.000143	0.34	1168.35	262.83	0.03
Middle Reach	6.6	500 cfs	500	921.5	928.22	922.72	928.22	0.00018	0.4	1256.62	268.88	0.03
Middle Reach	6.6	600 cfs	600	921.5	928.55	922.82	928.55	0.000212	0.45	1346.51	274.9	0.04
Middle Reach	6.4	200 cfs	200	921.63	927.09		927.09	0.000076	0.23	887.63	234.27	0.02
Middle Reach	6.4	300 cfs	300	921.63	927.19		927.19	0.000159	0.33	911.37	236.03	0.03
Middle Reach	6.4	400 cfs	400	921.63	927.32		927.32	0.000256	0.42	942.22	238.29	0.04
Middle Reach	6.4	500 cfs	500	921.63	927.47		927.47	0.000359	0.51	978.5	240.91	0.04
Middle Reach	6.4	600 cfs	600	921.63	927.64		927.64	0.000459	0.59	1018.79	243.8	0.05
Middle Reach	6.3	200 cfs	200	921.66	927.04	922.58	927.04	0.000284	0.47	424.21	97.58	0.04
Middle Reach	6.3	300 cfs	300	921.66	927.09	922.79	927.1	0.000618	0.7	428.96	97.81	0.06
Middle Reach	6.3	400 cfs	400	921.66	927.15	922.99	927.17	0.001051	0.92	435.41	98.11	0.08
Middle Reach	6.3	500 cfs	500	921.66	927.24	923.14	927.26	0.001554	1.13	443.36	98.49	0.09
Middle Reach	6.3	600 cfs	600	921.66	927.33	923.3	927.36	0.002103	1.33	452.58	98.93	0.11
Middle Reach	6.25		Bridge									
Middle Reach	6.2	200 cfs	200	922.38	927.02	923.18	927.03	0.000414	0.53	378.7	97.74	0.05
Middle Reach	6.2	300 cfs	300	922.38	927.05	923.39	927.06	0.000912	0.79	381.38	97.87	0.07
Middle Reach	6.2	400 cfs	400	922.38	927.09	923.57	927.1	0.001575	1.04	385.05	98.06	0.09
Middle Reach	6.2	500 cfs	500	922.38	927.13	923.73	927.16	0.002374	1.28	389.66	98.29	0.11
Middle Reach	6.2	600 cfs	600	922.38	927.19	923.89	927.23	0.003276	1.52	395.12	98.56	0.13
Middle Reach	6.1	200 cfs	200	921.27	927.02		927.02	0.000006	0.27	749.57	205.04	0.02
Middle Reach	6.1	300 cfs	300	921.27	927.04		927.04	0.000013	0.4	754.32	205.28	0.04
Middle Reach	6.1	400 cfs	400	921.27	927.07		927.08	0.000022	0.53	760.91	205.6	0.05
Middle Reach	6.1	500 cfs	500	921.27	927.11		927.12	0.000034	0.65	769.21	206.02	0.06
Middle Reach	6.1	600 cfs	600	921.27	927.16		927.17	0.000047	0.77	779.13	206.51	0.07
Middle Reach	6	200 cfs	200	921.27	927	921.88	927	0.000002	0.15	1343.72	369.12	0.01
Middle Reach	6	300 cfs	300	921.27	927	922.04	927	0.000004	0.22	1343.72	369.12	0.02
Middle Reach	6	400 cfs	400	921.27	927	922.18	927	0.000007	0.3	1343.72	369.12	0.03
Middle Reach	6	500 cfs	500	921.27	927	922.3	927	0.000011	0.37	1343.72	369.12	0.03
Middle Reach	6	600 cfs	600	921.27	927	922.41	927	0.000017	0.45	1343.72	369.12	0.04

Yellow River
HEC-RAS Output : Dam Water Elevation = 927.0 cfs (Winter)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Middle Reach	9.7	700 cfs	700	900	931.56		931.56	0	0	267608	12018.36	0
Middle Reach	9.7	800 cfs	800	900	932.01		932.01	0	0	273056.5	12027.55	0
Middle Reach	9.7	844 cfs	844	900	932.2		932.2	0	0	275277.1	12043.37	0
Middle Reach	9.7	900 cfs	900	900	932.44		932.44	0	0	278180.9	12064.03	0
Middle Reach	9.7	981 cfs	981	900	932.79		932.79	0	0	282381	12093.85	0
Middle Reach	9.6	700 cfs	700	905	931.56		931.56	0	0	174255.5	7792.82	0
Middle Reach	9.6	800 cfs	800	905	932.01		932.01	0	0	177788.4	7798.53	0
Middle Reach	9.6	844 cfs	844	905	932.2		932.2	0	0	179227.6	7802.11	0
Middle Reach	9.6	900 cfs	900	905	932.44		932.44	0	0	181107.8	7806.78	0
Middle Reach	9.6	981 cfs	981	905	932.79		932.79	0	0.01	183823.5	7813.53	0
Middle Reach	9.4	700 cfs	700	925.02	931.56		931.56	0.000002	0.21	8121.15	2180.45	0.02
Middle Reach	9.4	800 cfs	800	925.02	932.01		932.01	0.000002	0.22	9146.94	2376.93	0.02
Middle Reach	9.4	844 cfs	844	925.02	932.2		932.2	0.000002	0.22	9585.8	2380.07	0.02
Middle Reach	9.4	900 cfs	900	925.02	932.44		932.44	0.000002	0.22	10159.53	2383.02	0.02
Middle Reach	9.4	981 cfs	981	925.02	932.79		932.79	0.000002	0.22	10988.89	2387.28	0.02
Middle Reach	9.3	700 cfs	700	924.11	931.41	927.01	931.53	0.000283	2.7	259.47	52.99	0.19
Middle Reach	9.3	800 cfs	800	924.11	931.84	927.21	931.97	0.000299	2.89	276.63	53.02	0.19
Middle Reach	9.3	844 cfs	844	924.11	932.05	927.3	932.16	0.000275	2.67	341.2	519.57	0.18
Middle Reach	9.3	900 cfs	900	924.11	932.3	927.41	932.41	0.000266	2.69	476.74	596.72	0.18
Middle Reach	9.3	981 cfs	981	924.11	932.66	927.55	932.76	0.000238	2.63	695.77	628.71	0.17
Middle Reach	9.25		Bridge									
Middle Reach	9.2	700 cfs	700	924.69	931.41	927.67	931.51	0.00034	2.66	413.66	235.98	0.2
Middle Reach	9.2	800 cfs	800	924.69	931.85	927.88	931.95	0.000316	2.69	524.92	278.07	0.19
Middle Reach	9.2	844 cfs	844	924.69	932.04	927.96	932.14	0.000314	2.73	577.54	335.43	0.19
Middle Reach	9.2	900 cfs	900	924.69	932.27	928.07	932.37	0.000292	2.7	656.77	341.08	0.19
Middle Reach	9.2	981 cfs	981	924.69	932.6	928.21	932.68	0.000267	2.67	766.52	348.75	0.18
Middle Reach	9.1	700 cfs	700	924.91	931.45		931.45	0.000026	0.69	2361.86	1357.72	0.05
Middle Reach	9.1	800 cfs	800	924.91	931.89		931.9	0.000021	0.66	2974.46	1411.84	0.05
Middle Reach	9.1	844 cfs	844	924.91	932.07		932.08	0.000022	0.69	3302.43	2387.26	0.05
Middle Reach	9.1	900 cfs	900	924.91	932.31		932.31	0.000019	0.66	3869.1	2405.81	0.05
Middle Reach	9.1	981 cfs	981	924.91	932.63		932.63	0.000016	0.62	4644.94	2428.34	0.04
Middle Reach	8.6	700 cfs	700	920	931.45		931.45	0	0.02	35760.29	3527.61	0
Middle Reach	8.6	800 cfs	800	920	931.89		931.89	0	0.02	37319.95	3534.27	0
Middle Reach	8.6	844 cfs	844	920	932.08		932.08	0	0.02	37964.34	3537.58	0
Middle Reach	8.6	900 cfs	900	920	932.31		932.31	0	0.02	38799.27	3542.9	0
Middle Reach	8.6	981 cfs	981	920	932.63		932.63	0	0.02	39935.7	3550.12	0
Middle Reach	8.4	700 cfs	700	921.29	931.45		931.45	0.000003	0.28	2546.14	361.29	0.02
Middle Reach	8.4	800 cfs	800	921.29	931.89		931.89	0.000003	0.3	2706.22	363.92	0.02
Middle Reach	8.4	844 cfs	844	921.29	932.07		932.08	0.000003	0.31	2772.66	365.99	0.02
Middle Reach	8.4	900 cfs	900	921.29	932.31		932.31	0.000003	0.32	2859.46	370.51	0.02
Middle Reach	8.4	981 cfs	981	921.29	932.63		932.63	0.000003	0.33	2979.1	376.66	0.02
Middle Reach	8.3	700 cfs	700	923.92	931.41	926.25	931.44	0.000085	1.35	530.07	105.37	0.1
Middle Reach	8.3	800 cfs	800	923.92	931.85	926.44	931.88	0.000087	1.42	574.35	107.3	0.1
Middle Reach	8.3	844 cfs	844	923.92	932.03	926.51	932.07	0.000087	1.46	592.67	108.1	0.1
Middle Reach	8.3	900 cfs	900	923.92	932.27	926.6	932.3	0.000088	1.5	616.39	109.13	0.1
Middle Reach	8.3	981 cfs	981	923.92	932.58	926.73	932.62	0.000089	1.55	648.59	110.53	0.11
Middle Reach	8.25		Bridge									
Middle Reach	8.2	700 cfs	700	923.5	931.34	926.12	931.37	0.000089	1.36	514.96	101.29	0.1
Middle Reach	8.2	800 cfs	800	923.5	931.78	926.29	931.81	0.00009	1.44	556.11	103.4	0.1
Middle Reach	8.2	844 cfs	844	923.5	931.96	926.36	932	0.000091	1.48	573.43	104.29	0.1
Middle Reach	8.2	900 cfs	900	923.5	932.19	926.45	932.23	0.000091	1.52	594.89	105.39	0.11
Middle Reach	8.2	981 cfs	981	923.5	932.51	926.58	932.55	0.000092	1.58	624.77	106.92	0.11
Middle Reach	8.1	700 cfs	700	923.25	931.31		931.32	0.000162	0.81	870.84	172.81	0.06
Middle Reach	8.1	800 cfs	800	923.25	931.75		931.76	0.000161	0.85	947.28	174.13	0.06
Middle Reach	8.1	844 cfs	844	923.25	931.93		931.95	0.000161	0.87	979.62	174.69	0.06
Middle Reach	8.1	900 cfs	900	923.25	932.16		932.18	0.000161	0.89	1019.87	175.38	0.06
Middle Reach	8.1	981 cfs	981	923.25	932.48		932.5	0.00016	0.92	1076.12	176.34	0.06
Middle Reach	7.8	700 cfs	700	924.24	930.97		930.99	0.000312	1.06	660.6	135	0.08
Middle Reach	7.8	800 cfs	800	924.24	931.41		931.43	0.000308	1.11	720.43	135	0.08
Middle Reach	7.8	844 cfs	844	924.24	931.6		931.62	0.000307	1.13	745.54	135	0.08
Middle Reach	7.8	900 cfs	900	924.24	931.83		931.85	0.000306	1.16	776.64	135	0.09
Middle Reach	7.8	981 cfs	981	924.24	932.15		932.17	0.000305	1.2	819.81	135	0.09

Yellow River
HEC-RAS Output : Dam Water Elevation = 927.0 cfs (Winter)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Middle Reach	7.7	700 cfs	700	925.54	930.92		930.94	0.000085	1.12	624.9	144	0.09
Middle Reach	7.7	800 cfs	800	925.54	931.37		931.39	0.000081	1.16	689	144	0.09
Middle Reach	7.7	844 cfs	844	925.54	931.56		931.58	0.00008	1.18	715.86	144	0.09
Middle Reach	7.7	900 cfs	900	925.54	931.79		931.81	0.000078	1.2	749.14	144	0.09
Middle Reach	7.7	981 cfs	981	925.54	932.11		932.13	0.000076	1.23	795.31	144	0.09
Middle Reach	7.5	700 cfs	700	922.36	930.93		930.93	0.000003	0.27	3092.51	1033.96	0.02
Middle Reach	7.5	800 cfs	800	922.36	931.37		931.37	0.000003	0.28	3560.45	1063.64	0.02
Middle Reach	7.5	844 cfs	844	922.36	931.56		931.56	0.000003	0.29	3760.51	1075.96	0.02
Middle Reach	7.5	900 cfs	900	922.36	931.79		931.79	0.000003	0.3	4011.5	1091.22	0.02
Middle Reach	7.5	981 cfs	981	922.36	932.11		932.11	0.000003	0.31	4369.85	1148.79	0.02
Middle Reach	7.3	700 cfs	700	924.34	930.87		930.89	0.0111	1.11	632.62	129	0.09
Middle Reach	7.3	800 cfs	800	924.34	931.31		931.33	0.010959	1.16	689.86	129	0.09
Middle Reach	7.3	844 cfs	844	924.34	931.5		931.52	0.010924	1.18	713.85	129	0.09
Middle Reach	7.3	900 cfs	900	924.34	931.73		931.75	0.010892	1.21	743.58	129	0.09
Middle Reach	7.3	981 cfs	981	924.34	932.05		932.07	0.010879	1.25	784.81	129	0.09
Middle Reach	7	700 cfs	700	921.04	930.39		930.39	0.000085	0.13	5572.36	801.81	0.01
Middle Reach	7	800 cfs	800	921.04	930.8		930.8	0.000092	0.14	5901.85	808.92	0.01
Middle Reach	7	844 cfs	844	921.04	930.97		930.97	0.000095	0.14	6040.99	811.9	0.01
Middle Reach	7	900 cfs	900	921.04	931.19		931.19	0.000098	0.15	6214.43	815.6	0.01
Middle Reach	7	981 cfs	981	921.04	931.48		931.48	0.000103	0.15	6456.31	820.46	0.01
Middle Reach	6.7	700 cfs	700	921.26	930.1		930.1	0.000033	0.37	1871.24	288.08	0.03
Middle Reach	6.7	800 cfs	800	921.26	930.48		930.49	0.000036	0.4	1983.19	292.54	0.03
Middle Reach	6.7	844 cfs	844	921.26	930.65		930.65	0.000037	0.42	2030.71	294.41	0.03
Middle Reach	6.7	900 cfs	900	921.26	930.85		930.85	0.000039	0.43	2090.21	296.73	0.03
Middle Reach	6.7	981 cfs	981	921.26	931.13		931.13	0.00004	0.45	2173.52	299.96	0.03
Middle Reach	6.65	700 cfs	700	922.14	929.87		929.88	0.000497	0.78	897.2	245	0.07
Middle Reach	6.65	800 cfs	800	922.14	930.24		930.25	0.000471	0.81	988.91	245	0.07
Middle Reach	6.65	844 cfs	844	922.14	930.4		930.41	0.000463	0.82	1027.46	245	0.07
Middle Reach	6.65	900 cfs	900	922.14	930.6		930.61	0.000453	0.84	1075.42	245	0.07
Middle Reach	6.65	981 cfs	981	922.14	930.87		930.88	0.000442	0.86	1141.96	245	0.07
Middle Reach	6.6	700 cfs	700	921.5	928.87	922.93	928.88	0.00024	0.49	1436.05	280.77	0.04
Middle Reach	6.6	800 cfs	800	921.5	929.2	923	929.21	0.000269	0.52	1530.36	293.42	0.04
Middle Reach	6.6	844 cfs	844	921.5	929.34	923.04	929.34	0.000282	0.54	1571.45	299.42	0.04
Middle Reach	6.6	900 cfs	900	921.5	929.52	923.09	929.52	0.000296	0.55	1624.7	307.01	0.04
Middle Reach	6.6	981 cfs	981	921.5	929.76	923.16	929.77	0.000316	0.58	1701.39	317.64	0.04
Middle Reach	6.4	700 cfs	700	921.63	927.81		927.82	0.000553	0.66	1062.01	246.86	0.06
Middle Reach	6.4	800 cfs	800	921.63	927.99		928	0.000639	0.72	1107.26	250.02	0.06
Middle Reach	6.4	844 cfs	844	921.63	928.08		928.08	0.000674	0.75	1127.62	251.43	0.06
Middle Reach	6.4	900 cfs	900	921.63	928.18		928.19	0.000717	0.78	1153.87	253.24	0.06
Middle Reach	6.4	981 cfs	981	921.63	928.33		928.34	0.000775	0.82	1191.74	255.82	0.07
Middle Reach	6.3	700 cfs	700	921.66	927.43	923.45	927.47	0.002673	1.51	462.93	99.42	0.12
Middle Reach	6.3	800 cfs	800	921.66	927.55	923.59	927.59	0.003247	1.69	474.18	99.95	0.14
Middle Reach	6.3	844 cfs	844	921.66	927.6	923.64	927.65	0.003497	1.76	479.36	100.19	0.14
Middle Reach	6.3	900 cfs	900	921.66	927.67	923.71	927.72	0.003812	1.85	486.16	100.51	0.15
Middle Reach	6.3	981 cfs	981	921.66	927.77	923.81	927.83	0.004256	1.98	496.28	100.98	0.16
Middle Reach	6.25		Bridge									
Middle Reach	6.2	700 cfs	700	922.38	927.25	924.01	927.3	0.004252	1.74	401.35	98.88	0.15
Middle Reach	6.2	800 cfs	800	922.38	927.32	924.15	927.38	0.005272	1.96	408.26	99.22	0.17
Middle Reach	6.2	844 cfs	844	922.38	927.35	924.2	927.42	0.005729	2.05	411.49	99.38	0.18
Middle Reach	6.2	900 cfs	900	922.38	927.4	924.27	927.47	0.006313	2.16	415.76	99.59	0.19
Middle Reach	6.2	981 cfs	981	922.38	927.46	924.36	927.55	0.007157	2.32	422.22	99.91	0.2
Middle Reach	6.1	700 cfs	700	921.27	927.22		927.23	0.000061	0.89	790.53	207.07	0.08
Middle Reach	6.1	800 cfs	800	921.27	927.28		927.29	0.000076	1	803.3	207.7	0.09
Middle Reach	6.1	844 cfs	844	921.27	927.31		927.33	0.000083	1.04	809.31	208	0.09
Middle Reach	6.1	900 cfs	900	921.27	927.35		927.37	0.000091	1.1	817.31	208.39	0.1
Middle Reach	6.1	981 cfs	981	921.27	927.4		927.43	0.000104	1.18	829.46	208.99	0.1
Middle Reach	6	700 cfs	700	921.27	927	922.51	927	0.000023	0.52	1343.72	369.12	0.05
Middle Reach	6	800 cfs	800	921.27	927	922.61	927.01	0.000029	0.6	1343.72	369.12	0.05
Middle Reach	6	844 cfs	844	921.27	927	922.65	927.01	0.000033	0.63	1343.72	369.12	0.06
Middle Reach	6	900 cfs	900	921.27	927	922.7	927.01	0.000037	0.67	1343.72	369.12	0.06
Middle Reach	6	981 cfs	981	921.27	927	922.78	927.01	0.000044	0.73	1343.72	369.12	0.07

Yellow River
HEC-RAS Output : Dam Water Elevation = 928.0 cfs (Winter)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Middle Reach	9.7	200 cfs	200	900	929.02		929.02	0	0	237281.8	11744.18	0
Middle Reach	9.7	300 cfs	300	900	929.63		929.63	0	0	244464.8	11896.96	0
Middle Reach	9.7	400 cfs	400	900	930.2		930.2	0	0	251228.9	11993.5	0
Middle Reach	9.7	500 cfs	500	900	930.71		930.71	0	0	257416.9	12002.9	0
Middle Reach	9.7	600 cfs	600	900	931.2		931.2	0	0	263245.4	12011.74	0
Middle Reach	9.6	200 cfs	200	905	929.02		929.02	0	0	154590.7	7619.4	0
Middle Reach	9.6	300 cfs	300	905	929.63		929.63	0	0	159249.8	7715.24	0
Middle Reach	9.6	400 cfs	400	905	930.2		930.2	0	0	163635.6	7775.91	0
Middle Reach	9.6	500 cfs	500	905	930.71		930.71	0	0	167647.7	7782.3	0
Middle Reach	9.6	600 cfs	600	905	931.2		931.2	0	0	171426.8	7788.32	0
Middle Reach	9.4	200 cfs	200	925.02	929.02		929.02	0.000002	0.12	3525.34	1462.01	0.01
Middle Reach	9.4	300 cfs	300	925.02	929.63		929.63	0.000002	0.15	4463.34	1625.53	0.01
Middle Reach	9.4	400 cfs	400	925.02	930.2		930.2	0.000002	0.17	5426.35	1781.63	0.01
Middle Reach	9.4	500 cfs	500	925.02	930.71		930.71	0.000002	0.18	6382.75	1927.62	0.02
Middle Reach	9.4	600 cfs	600	925.02	931.2		931.2	0.000002	0.19	7351.79	2065.03	0.02
Middle Reach	9.3	200 cfs	200	924.11	928.99	925.58	929.02	0.000109	1.23	163.15	49.2	0.11
Middle Reach	9.3	300 cfs	300	924.11	929.58	925.95	929.62	0.000157	1.61	186.45	51.76	0.13
Middle Reach	9.3	400 cfs	400	924.11	930.12	926.26	930.18	0.000193	1.92	208.06	52.92	0.15
Middle Reach	9.3	500 cfs	500	924.11	930.61	926.54	930.69	0.000224	2.2	227.68	52.95	0.16
Middle Reach	9.3	600 cfs	600	924.11	931.08	926.77	931.17	0.000248	2.44	246.1	52.97	0.17
Middle Reach	9.25		Bridge									
Middle Reach	9.2	200 cfs	200	924.69	928.98	926.31	929.01	0.000197	1.45	137.97	44.71	0.14
Middle Reach	9.2	300 cfs	300	924.69	929.56	926.68	929.61	0.000262	1.86	161.52	46.54	0.16
Middle Reach	9.2	400 cfs	400	924.69	930.1	926.97	930.17	0.000316	2.15	191.77	110.27	0.18
Middle Reach	9.2	500 cfs	500	924.69	930.59	927.23	930.68	0.000332	2.36	256.05	157.7	0.19
Middle Reach	9.2	600 cfs	600	924.69	931.07	927.47	931.16	0.000328	2.5	339.62	203.09	0.19
Middle Reach	9.1	200 cfs	200	924.91	928.98		928.98	0.000038	0.54	371.49	143.23	0.06
Middle Reach	9.1	300 cfs	300	924.91	929.56		929.57	0.000044	0.66	456.46	146.24	0.07
Middle Reach	9.1	400 cfs	400	924.91	930.11		930.12	0.000045	0.74	650.75	1199.54	0.07
Middle Reach	9.1	500 cfs	500	924.91	930.62		930.62	0.000037	0.73	1273.1	1258.05	0.06
Middle Reach	9.1	600 cfs	600	924.91	931.1		931.1	0.000029	0.69	1893.7	1314.87	0.06
Middle Reach	8.6	200 cfs	200	920	928.98		928.98	0	0.01	27122.6	3418.88	0
Middle Reach	8.6	300 cfs	300	920	929.57		929.57	0	0.01	29144.06	3468.85	0
Middle Reach	8.6	400 cfs	400	920	930.11		930.11	0	0.01	31056.8	3507.45	0
Middle Reach	8.6	500 cfs	500	920	930.62		930.62	0	0.02	32832.57	3515.08	0
Middle Reach	8.6	600 cfs	600	920	931.1		931.1	0	0.02	34526.64	3522.33	0
Middle Reach	8.4	200 cfs	200	921.29	928.98		928.98	0.000001	0.12	1675.95	333.23	0.01
Middle Reach	8.4	300 cfs	300	921.29	929.57		929.57	0.000001	0.16	1876.21	347.8	0.01
Middle Reach	8.4	400 cfs	400	921.29	930.11		930.11	0.000002	0.19	2068.61	353.35	0.01
Middle Reach	8.4	500 cfs	500	921.29	930.62		930.62	0.000002	0.22	2247.98	356.35	0.02
Middle Reach	8.4	600 cfs	600	921.29	931.1		931.1	0.000002	0.25	2420.15	359.21	0.02
Middle Reach	8.3	200 cfs	200	923.92	928.97	925.1	928.98	0.000044	0.68	293.41	88.14	0.07
Middle Reach	8.3	300 cfs	300	923.92	929.55	925.4	929.56	0.000061	0.87	346.43	93.86	0.08
Middle Reach	8.3	400 cfs	400	923.92	930.09	925.65	930.11	0.000069	1.01	398.36	97.65	0.09
Middle Reach	8.3	500 cfs	500	923.92	930.59	925.87	930.61	0.000074	1.13	447.86	101.14	0.09
Middle Reach	8.3	600 cfs	600	923.92	931.07	926.07	931.09	0.000078	1.23	495.47	103.85	0.09
Middle Reach	8.25		Bridge									
Middle Reach	8.2	200 cfs	200	923.5	928.86	924.95	928.86	0.000045	0.7	286.28	84.68	0.07
Middle Reach	8.2	300 cfs	300	923.5	929.45	925.25	929.46	0.000064	0.89	338.6	91.41	0.08
Middle Reach	8.2	400 cfs	400	923.5	930	925.5	930.02	0.000073	1.03	389.81	94.86	0.09
Middle Reach	8.2	500 cfs	500	923.5	930.51	925.72	930.53	0.000078	1.14	437.58	97.31	0.09
Middle Reach	8.2	600 cfs	600	923.5	930.99	925.93	931.01	0.000081	1.25	482.41	99.61	0.1
Middle Reach	8.1	200 cfs	200	923.25	928.84		928.84	0.000104	0.44	455.9	157.02	0.05
Middle Reach	8.1	300 cfs	300	923.25	929.42		929.43	0.000132	0.54	550.88	165.3	0.05
Middle Reach	8.1	400 cfs	400	923.25	929.97		929.98	0.000144	0.62	642.78	168.8	0.06
Middle Reach	8.1	500 cfs	500	923.25	930.48		930.49	0.000148	0.69	729.26	170.33	0.06
Middle Reach	8.1	600 cfs	600	923.25	930.96		930.97	0.00015	0.74	811.22	171.77	0.06
Middle Reach	7.8	200 cfs	200	924.24	928.62		928.63	0.000197	0.58	345.86	127.26	0.06
Middle Reach	7.8	300 cfs	300	924.24	929.15		929.16	0.000261	0.72	414.69	135	0.07
Middle Reach	7.8	400 cfs	400	924.24	929.68		929.69	0.000277	0.82	485.84	135	0.08
Middle Reach	7.8	500 cfs	500	924.24	930.18		930.19	0.000283	0.9	553.51	135	0.08
Middle Reach	7.8	600 cfs	600	924.24	930.65		930.67	0.000285	0.97	617.57	135	0.08

Yellow River
HEC-RAS Output : Dam Water Elevation = 928.0 cfs (Winter)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Middle Reach	7.7	200 cfs	200	925.54	928.59		928.59	0.000078	0.69	290.94	134.4	0.08
Middle Reach	7.7	300 cfs	300	925.54	929.1		929.11	0.000092	0.83	362.61	143.35	0.09
Middle Reach	7.7	400 cfs	400	925.54	929.63		929.64	0.000088	0.91	438.54	144	0.09
Middle Reach	7.7	500 cfs	500	925.54	930.13		930.15	0.000084	0.98	510.92	144	0.09
Middle Reach	7.7	600 cfs	600	925.54	930.61		930.63	0.00008	1.04	579.44	144	0.09
Middle Reach	7.5	200 cfs	200	922.36	928.59		928.59	0.000001	0.12	1626.82	365.52	0.01
Middle Reach	7.5	300 cfs	300	922.36	929.1		929.1	0.000002	0.16	1819.29	379	0.01
Middle Reach	7.5	400 cfs	400	922.36	929.63		929.63	0.000002	0.2	2021.84	389.08	0.02
Middle Reach	7.5	500 cfs	500	922.36	930.13		930.13	0.000002	0.23	2296.22	975.04	0.02
Middle Reach	7.5	600 cfs	600	922.36	930.61		930.61	0.000003	0.25	2769.14	1010.45	0.02
Middle Reach	7.3	200 cfs	200	924.34	928.57		928.57	0.00644	0.59	338.15	120.48	0.06
Middle Reach	7.3	300 cfs	300	924.34	929.07		929.08	0.008917	0.75	401.23	128.32	0.07
Middle Reach	7.3	400 cfs	400	924.34	929.59		929.6	0.009641	0.85	468.09	129	0.08
Middle Reach	7.3	500 cfs	500	924.34	930.09		930.1	0.009929	0.94	532.04	129	0.08
Middle Reach	7.3	600 cfs	600	924.34	930.56		930.57	0.010064	1.01	592.84	129	0.08
Middle Reach	7	200 cfs	200	921.04	928.46		928.46	0.000019	0.05	4055.01	758.49	0
Middle Reach	7	300 cfs	300	921.04	928.88		928.88	0.000034	0.07	4375.42	771.34	0.01
Middle Reach	7	400 cfs	400	921.04	929.32		929.32	0.000048	0.08	4718.63	784.55	0.01
Middle Reach	7	500 cfs	500	921.04	929.75		929.75	0.00006	0.1	5058.98	793.65	0.01
Middle Reach	7	600 cfs	600	921.04	930.17		930.17	0.00007	0.11	5392.12	797.9	0.01
Middle Reach	6.7	200 cfs	200	921.26	928.4		928.4	0.000007	0.14	1394.57	271.38	0.01
Middle Reach	6.7	300 cfs	300	921.26	928.77		928.77	0.000012	0.2	1495.56	275.1	0.02
Middle Reach	6.7	400 cfs	400	921.26	929.16		929.16	0.000018	0.25	1604.74	279.06	0.02
Middle Reach	6.7	500 cfs	500	921.26	929.55		929.55	0.000022	0.29	1713.95	282.97	0.02
Middle Reach	6.7	600 cfs	600	921.26	929.93		929.93	0.000027	0.33	1822.77	286.53	0.02
Middle Reach	6.65	200 cfs	200	922.14	928.34		928.34	0.000234	0.38	524.85	239.9	0.05
Middle Reach	6.65	300 cfs	300	922.14	928.67		928.68	0.000333	0.5	604.29	242.01	0.06
Middle Reach	6.65	400 cfs	400	922.14	929.03		929.04	0.000382	0.58	691.48	244.3	0.06
Middle Reach	6.65	500 cfs	500	922.14	929.39		929.4	0.000404	0.64	779.28	245	0.06
Middle Reach	6.65	600 cfs	600	922.14	929.75		929.75	0.000409	0.69	866.84	245	0.06
Middle Reach	6.6	200 cfs	200	921.5	928.15	922.33	928.15	0.00003	0.16	1237.25	267.56	0.01
Middle Reach	6.6	300 cfs	300	921.5	928.31	922.48	928.32	0.000061	0.23	1282.09	270.6	0.02
Middle Reach	6.6	400 cfs	400	921.5	928.52	922.6	928.52	0.000096	0.3	1338.67	274.38	0.02
Middle Reach	6.6	500 cfs	500	921.5	928.76	922.72	928.76	0.000131	0.36	1403.49	278.65	0.03
Middle Reach	6.6	600 cfs	600	921.5	929.01	922.82	929.01	0.000165	0.41	1474.41	285.84	0.03
Middle Reach	6.4	200 cfs	200	921.63	928.04		928.04	0.000039	0.18	1119.93	250.9	0.01
Middle Reach	6.4	300 cfs	300	921.63	928.1		928.1	0.000084	0.26	1133.38	251.83	0.02
Middle Reach	6.4	400 cfs	400	921.63	928.17		928.17	0.000142	0.35	1151.57	253.08	0.03
Middle Reach	6.4	500 cfs	500	921.63	928.26		928.26	0.00021	0.43	1174.02	254.62	0.03
Middle Reach	6.4	600 cfs	600	921.63	928.36		928.36	0.000284	0.5	1200.09	256.39	0.04
Middle Reach	6.3	200 cfs	200	921.66	928.02	922.58	928.02	0.000152	0.38	522.06	102.17	0.03
Middle Reach	6.3	300 cfs	300	921.66	928.04	922.79	928.05	0.000337	0.57	524.53	102.28	0.04
Middle Reach	6.3	400 cfs	400	921.66	928.08	922.99	928.09	0.000588	0.76	527.95	102.44	0.06
Middle Reach	6.3	500 cfs	500	921.66	928.12	923.14	928.13	0.000896	0.94	532.29	102.64	0.07
Middle Reach	6.3	600 cfs	600	921.66	928.17	923.3	928.19	0.001253	1.12	537.48	102.87	0.09
Middle Reach	6.25		Bridge									
Middle Reach	6.2	200 cfs	200	922.38	928.01	923.18	928.01	0.000205	0.42	477.67	102.62	0.03
Middle Reach	6.2	300 cfs	300	922.38	928.02	923.39	928.03	0.000457	0.63	478.95	102.69	0.05
Middle Reach	6.2	400 cfs	400	922.38	928.04	923.57	928.05	0.000803	0.83	480.75	102.77	0.07
Middle Reach	6.2	500 cfs	500	922.38	928.06	923.73	928.08	0.001238	1.04	483.03	102.88	0.08
Middle Reach	6.2	600 cfs	600	922.38	928.09	923.89	928.11	0.001752	1.24	485.79	103.01	0.1
Middle Reach	6.1	200 cfs	200	921.27	928.01		928.01	0.000003	0.21	957.55	215.17	0.02
Middle Reach	6.1	300 cfs	300	921.27	928.02		928.02	0.000006	0.31	959.89	215.28	0.03
Middle Reach	6.1	400 cfs	400	921.27	928.03		928.04	0.000011	0.42	963.15	215.43	0.03
Middle Reach	6.1	500 cfs	500	921.27	928.05		928.06	0.000017	0.52	967.31	215.63	0.04
Middle Reach	6.1	600 cfs	600	921.27	928.08		928.08	0.000024	0.62	972.35	215.87	0.05
Middle Reach	6	200 cfs	200	921.27	928	921.88	928	0.000001	0.12	1722.07	387.56	0.01
Middle Reach	6	300 cfs	300	921.27	928	922.04	928	0.000002	0.17	1722.07	387.56	0.01
Middle Reach	6	400 cfs	400	921.27	928	922.18	928	0.000003	0.23	1722.07	387.56	0.02
Middle Reach	6	500 cfs	500	921.27	928	922.3	928	0.000005	0.29	1722.07	387.56	0.02
Middle Reach	6	600 cfs	600	921.27	928	922.41	928	0.000008	0.35	1722.07	387.56	0.03

Yellow River
HEC-RAS Output : Dam Water Elevation = 928.0 cfs (Winter)

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl
Middle Reach	9.7	700 cfs	700	900	931.56		931.56	0	0	267608	12018.36	0
Middle Reach	9.7	800 cfs	800	900	932.01		932.01	0	0	273056.5	12027.55	0
Middle Reach	9.7	900 cfs	900	900	932.44		932.44	0	0	278180.9	12064.03	0
Middle Reach	9.7	1000 cfs	1000	900	932.85		932.85	0	0	283156.2	12099.35	0
Middle Reach	9.7	1331 cfs	1331	900	933.93		933.93	0	0	296217.2	12191.57	0
Middle Reach	9.6	700 cfs	700	905	931.56		931.56	0	0	174255.5	7792.82	0
Middle Reach	9.6	800 cfs	800	905	932.01		932.01	0	0	177788.4	7798.53	0
Middle Reach	9.6	900 cfs	900	905	932.44		932.44	0	0	181107.8	7806.78	0
Middle Reach	9.6	1000 cfs	1000	905	932.85		932.85	0	0.01	184324.3	7814.77	0
Middle Reach	9.6	1331 cfs	1331	905	933.93		933.93	0	0.01	192739.3	7835.64	0
Middle Reach	9.4	700 cfs	700	925.02	931.56		931.56	0.000002	0.21	8121.15	2180.45	0.02
Middle Reach	9.4	800 cfs	800	925.02	932.01		932.01	0.000002	0.22	9146.94	2376.93	0.02
Middle Reach	9.4	900 cfs	900	925.02	932.44		932.44	0.000002	0.22	10159.53	2383.02	0.02
Middle Reach	9.4	1000 cfs	1000	925.02	932.85		932.85	0.000002	0.22	11141.91	2388.07	0.02
Middle Reach	9.4	1331 cfs	1331	925.02	933.93		933.93	0.000002	0.24	13716.91	2401.23	0.02
Middle Reach	9.3	700 cfs	700	924.11	931.41	927.01	931.53	0.000283	2.7	259.47	52.99	0.19
Middle Reach	9.3	800 cfs	800	924.11	931.84	927.21	931.97	0.000299	2.89	276.63	53.02	0.19
Middle Reach	9.3	900 cfs	900	924.11	932.3	927.41	932.41	0.000266	2.69	476.74	596.72	0.18
Middle Reach	9.3	1000 cfs	1000	924.11	932.72	927.58	932.82	0.000234	2.62	737.06	634.57	0.17
Middle Reach	9.3	1331 cfs	1331	924.11	933.84	928.16	933.91	0.000163	2.41	1486.5	733.42	0.15
Middle Reach	9.25		Bridge									
Middle Reach	9.2	700 cfs	700	924.69	931.41	927.67	931.51	0.00034	2.66	413.66	235.98	0.2
Middle Reach	9.2	800 cfs	800	924.69	931.85	927.88	931.95	0.000316	2.69	524.92	278.07	0.19
Middle Reach	9.2	900 cfs	900	924.69	932.27	928.07	932.37	0.000292	2.7	656.77	341.08	0.19
Middle Reach	9.2	1000 cfs	1000	924.69	932.66	928.24	932.75	0.000264	2.67	788.48	350.27	0.18
Middle Reach	9.2	1331 cfs	1331	924.69	933.81	928.81	933.88	0.000202	2.59	1202.25	398.35	0.16
Middle Reach	9.1	700 cfs	700	924.91	931.45		931.45	0.000026	0.69	2361.86	1357.72	0.05
Middle Reach	9.1	800 cfs	800	924.91	931.89		931.9	0.000021	0.66	2974.46	1411.84	0.05
Middle Reach	9.1	900 cfs	900	924.91	932.31		932.31	0.000019	0.66	3869.1	2405.81	0.05
Middle Reach	9.1	1000 cfs	1000	924.91	932.69		932.7	0.000015	0.61	4799.37	2432.8	0.04
Middle Reach	9.1	1331 cfs	1331	924.91	933.84		933.84	0.000009	0.53	7630.52	2513.15	0.03
Middle Reach	8.6	700 cfs	700	920	931.45		931.45	0	0.02	35760.29	3527.61	0
Middle Reach	8.6	800 cfs	800	920	931.89		931.89	0	0.02	37319.95	3534.27	0
Middle Reach	8.6	900 cfs	900	920	932.31		932.31	0	0.02	38799.27	3542.9	0
Middle Reach	8.6	1000 cfs	1000	920	932.7		932.7	0	0.02	40161.09	3551.55	0
Middle Reach	8.6	1331 cfs	1331	920	933.84		933.84	0	0.03	44238.09	3577.32	0
Middle Reach	8.4	700 cfs	700	921.29	931.45		931.45	0.000003	0.28	2546.14	361.29	0.02
Middle Reach	8.4	800 cfs	800	921.29	931.89		931.89	0.000003	0.3	2706.22	363.92	0.02
Middle Reach	8.4	900 cfs	900	921.29	932.31		932.31	0.000003	0.32	2859.46	370.51	0.02
Middle Reach	8.4	1000 cfs	1000	921.29	932.69		932.7	0.000003	0.34	3003.03	377.87	0.02
Middle Reach	8.4	1331 cfs	1331	921.29	933.84		933.84	0.000004	0.39	3441.61	389.78	0.02
Middle Reach	8.3	700 cfs	700	923.92	931.41	926.25	931.44	0.000085	1.35	530.07	105.37	0.1
Middle Reach	8.3	800 cfs	800	923.92	931.85	926.44	931.88	0.000087	1.42	574.35	107.3	0.1
Middle Reach	8.3	900 cfs	900	923.92	932.27	926.6	932.3	0.000088	1.5	616.39	109.13	0.1
Middle Reach	8.3	1000 cfs	1000	923.92	932.65	926.75	932.68	0.000089	1.57	654.94	110.8	0.11
Middle Reach	8.3	1331 cfs	1331	923.92	933.77	927.22	933.82	0.000094	1.79	769.67	116.5	0.11
Middle Reach	8.25		Bridge									
Middle Reach	8.2	700 cfs	700	923.5	931.34	926.12	931.37	0.000089	1.36	514.96	101.29	0.1
Middle Reach	8.2	800 cfs	800	923.5	931.78	926.29	931.81	0.00009	1.44	556.11	103.4	0.1
Middle Reach	8.2	900 cfs	900	923.5	932.19	926.45	932.23	0.000091	1.52	594.89	105.39	0.11
Middle Reach	8.2	1000 cfs	1000	923.5	932.58	926.6	932.62	0.000092	1.59	631.59	107.27	0.11
Middle Reach	8.2	1331 cfs	1331	923.5	933.71	927.07	933.76	0.000098	1.81	737.26	112.56	0.11
Middle Reach	8.1	700 cfs	700	923.25	931.31		931.32	0.000162	0.81	870.84	172.81	0.06
Middle Reach	8.1	800 cfs	800	923.25	931.75		931.76	0.000161	0.85	947.28	174.13	0.06
Middle Reach	8.1	900 cfs	900	923.25	932.16		932.18	0.000161	0.89	1019.87	175.38	0.06
Middle Reach	8.1	1000 cfs	1000	923.25	932.56		932.57	0.00016	0.93	1089.01	176.56	0.06
Middle Reach	8.1	1331 cfs	1331	923.25	933.69		933.7	0.000165	1.05	1290.67	179.95	0.07
Middle Reach	7.8	700 cfs	700	924.24	930.97		930.99	0.000312	1.06	660.6	135	0.08
Middle Reach	7.8	800 cfs	800	924.24	931.41		931.43	0.000308	1.11	720.43	135	0.08
Middle Reach	7.8	900 cfs	900	924.24	931.83		931.85	0.000306	1.16	776.64	135	0.09
Middle Reach	7.8	1000 cfs	1000	924.24	932.22		932.25	0.000305	1.21	829.66	135	0.09
Middle Reach	7.8	1331 cfs	1331	924.24	933.34		933.37	0.000316	1.36	980.71	135	0.09